

Chapter 2: The Silvicultural Options Study

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Introduction

The Washington Department of Natural Resources (DNR) administers some 2.1 million acres of state forest land, much of it in the highly productive west-side Douglas-fir region. The primary objective—defined by law—is to generate income in perpetuity for trust beneficiaries consisting of educational and other state and county institutions. The DNR also must retain broad citizen support. Public concerns stemming from the visual effects of harvesting activities have become major considerations in DNR management decisions, especially along major travel routes. There is a need for sound quantitative information about the consequences of alternative practices in terms of public response to visual appearance, economic costs and returns, and the associated biological and ecological effects.

The Pacific Northwest Research Station (PNW), DNR, University of Washington, and University of Idaho scientists are cooperating in an operation-scale study that compares harvest and regeneration options. This study is located on the Capitol State Forest, a 90,000-acre forest near Olympia, Washington, managed by DNR. Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) is the predominant species although some western hemlock (*Tsuga heterophylla* (Raf.) Sarg.), western redcedar (*Thuja plicata* Donn ex D. Don), and red alder (*Alnus rubra* Bong.) are present. Many stands are 50 to 70 years old and would normally be considered ready for regeneration harvest, but DNR plans to defer harvest of some in order to develop a more balanced age distribution. The forest contains and abuts many scenic areas and is adjoined by many residences, and portions are visible from major travel routes. Much of the forest is surrounded by industrial lands where extensive recent cutting indirectly limits DNR options.

Literature Review

There is a large body of literature dealing with techniques of natural and artificial regeneration of Douglas-fir under the clearcutting system and with intermediate management of the resulting even-aged stands, and good yield estimates for such management are available. Until recently, most of this work was in the context of a primary objective of timber production.

There have been a few experiments with shelterwood cutting, mostly in mature or old-growth stands (e.g., Williamson 1973, Williamson and Ruth 1975).

The early and unsuccessful work with selective cutting (Curtis 1998, Isaac 1956, Kirkland and Brandstrom 1936) was done in old-growth stands under unfavorable economic conditions and has little relevance to management of young-growth stands.

There has been considerable work on alternative systems in other regions and types (Dale et al. 1995, Leak 1999, Leak and Filip 1977, Marquis 1981, Miller and Schuler 1995, Miller et al. 1995, Smith et al. 1989). These authors have reported on various forms of group selection, small patch cuts, and two-age management as means of mitigating visual impacts of forestry operations and improving wildlife habitat while maintaining timber production.

Evaluation of visual impacts and economic and wildlife aspects requires fairly large experimental units. Several large experiments comparing alternative silvicultural systems on operation-size units that were established in the Northeast during the 1950s (e.g., Sendak et al. 2003) have considerable similarities to the study described in this report. Baker (1994) described a very large-scale recently established interdisciplinary study addressing similar questions in the Ouachita Mountains of Arkansas.

Early work on reproductive requirements of Douglas-fir (Isaac 1943) showed that successful establishment and early growth of Douglas-fir on mesic sites generally require openings of 1 acre or more or overstory densities of less than 50 percent of full stocking. Current work on Oregon State University's McDonald Forest found satisfactory initial establishment under residual overstories of 8 to 12 trees per acre and on small patch cuts of 0.5 acre (Ketchum and Tappeiner, in press). Brandeis (1999) found markedly reduced survival and early growth of Douglas-fir planted under residual overstories of 75, 85, 112, and 128 ft²/acre basal area.

It has become apparent that many questions relating to integrated management for multiple resource objectives cannot be answered by the type of small-plot silvicultural studies common in the past. These questions require long-term experimentation on areas large enough to allow evaluation of operational feasibility, public response to visual effects, wildlife effects, comparative costs, and timber yields (McComb et al. 1994).

Several large-scale experiments involving different forms of nonstandard silviculture recently have been established in the Pacific Northwest (Monserud 2002). Perhaps the most elaborate of these is the Demonstration of Ecosystems Options (DEMO) study (Franklin et al. 1999). In that study, however, most installations are in mature stands, stand treatments are confined to a single entry and do not include the subsequent operations that most managers consider essential in a management regime having timber production as one of its major objectives, and comparative cost data are lacking.

Curtis et al. (1998), DeBell and Curtis (1993), DeBell et al. (1998), Curtis and Carey (1996), and Kohm and Franklin (1997) have discussed possible practices for integrated production of both timber and other forest values in the Douglas-fir region. The study reported here is a further development of these ideas.

Objectives

This experiment is intended to provide a comparison of silvicultural regimes that will have long-term value both for research and demonstration. The selected silvicultural regimes are planned programs of silvicultural treatment extending over the entire life of the stand, from regeneration through intermediate operations to final harvest and regeneration. The objectives are:

- To create on-the-ground examples of a number of contrasting silvicultural regimes that can be evaluated for effectiveness in reducing visual and other environmental impacts of forestry operations while providing high timber outputs over time.
- To monitor development of stands under these contrasting regimes over an extended period by using procedures that will provide quantitative estimates of biological and physical change, timber outputs, costs, and statistically sound tests of differences between regimes.

Design Considerations

Joint Design by Managers and Scientists

Early in the project, PNW scientists and DNR managers agreed on several principles that would guide its development.

Local managers and field foresters identified the driving issue: develop harvesting options that reconcile aesthetic values with economic return and sustained wood production in visually sensitive areas. Research scientists provided guidance in experimental design. Together, we developed (a) rational regimes (silvicultural systems), (b) ways to implement and test them, and (3) methods to obtain the quantitative data needed for useful comparisons.

Operational and Adaptive Nature

Operational scale and operational feasibility were essential if the project was to provide useful information to managers and be effective as a demonstration area. We agreed that in each option we would carry out whatever intermediate operations were necessary to provide the desired regeneration and stand structure. Thus, a given cultural practice (e.g., herbicide application, animal damage control) might be necessary for some regimes or sites but not for others, and the associated costs and complications become part of the evaluation.

Financial and Staffing Resources

No special funding was initially available to either organization. Stand treatments were to be done as components of ongoing operations in conjunction with DNR's timber sale program. Evaluation procedures were planned so that much basic data on stand growth and development could be collected within the framework of existing PNW funding, although we hope to attract additional partners and funds for assessment of other biological and social values.

Continuity—Any project comparing silvicultural regimes must continue beyond the careers of the initial participants. We attempted to incorporate a number of features to favor long-term survival and continuity:

1. Wide range of options: Social needs and desires change as do forest conditions. Even in multipurpose forests, the relative importance of different features will no doubt differ 20 or more years hence.
2. Large treatment areas and adequate replication: Size and number of treatment areas must be sufficient to accommodate the damage and mortality that are to be expected on any operational unit and still provide useful information. Also, assessments of nontimber values such as wildlife habitat generally require larger areas than assessments of timber values alone.
3. Applicability to major portions of the forest land base: The areas selected must be representative of major portions of the land base available for multipurpose forestry.
4. Minimum essential expenses: Essential expenses should be minimized so that the project can survive the lows of financial cycles and political interest. Flexibility should be provided to accommodate additional work when resources permit.

5. Multiple disciplines and organizations: Inclusion of multiple disciplines and cooperating organizations can increase cost efficiency and permit more comprehensive evaluations. Diversity in partners can help to buffer the project from the cycles of support that occur within and among disciplines and organization.

Statistical Design

The study is a randomized block design, having six treatments and a minimum of three replicates on Capitol Forest, with possibilities of additional replication at other locations. Stand growth and yield information is based primarily on repeated measurements on a grid of permanent plots, maintained for the life of the experiment. Supplementary short-term studies of aspects such as harvesting costs, visual impacts, and wildlife also are planned and in progress in cooperation with other organizations.

Choice of Regimes

As we use the terms in this report, a silvicultural regime (system) is a planned series of treatments for tending, harvesting, and regenerating a stand. A silvicultural treatment is a single silvicultural operation that is part of a silvicultural regime. A unit is the physical land area to which a specific silvicultural regime is applied.

Limitations imposed by cost, area required for each selected regime, and size of available homogeneous areas meant that only a limited number of possible regimes could be included. We selected six regimes that we expect to (1) produce sharply contrasting stand structures and visual effects and (2) be biologically and operationally feasible on the basis of existing knowledge.

The regimes selected are (1) clearcut, (2) two-age, (3) patch cut, (4) group selection, (5) extended rotation with repeated thinning (hereafter referred to as thinning), and (6) extended rotation without thinning (control). Each regime consists of a sequence of operations applied over an extended period and intended to produce stands with widely different characteristics. Regimes are applied to units of about 30 to 70 acres. We expect differences in economic productivity and public response, but each regime would be reasonable under some circumstances. Four regimes are regeneration harvests; the other two extend the rotation age of the present stand (one with thinning, the other without thinning). These options will lead to even-aged, two-aged, and uneven-aged stands (fig. 2-1), thus creating a wide range of stand conditions, habitat values, and visual appearances. Below, we outline the general characteristics of each regime and intended goal, without attempting to specify in advance the exact nature and timing of all activities needed to achieve this.

Clearcut

This regime is well understood and is included primarily to provide a direct quantitative comparison of clearcut costs and outputs with those of the other regimes discussed.

Initial cut—Cut all merchantable and unmerchantable trees on the area, except for streamside strips and scattered groups of leave trees as needed to meet Forest Practices Act and Habitat Conservation Plan requirements.

Regeneration—Plant according to current DNR practice, predominantly Douglas-fir with western redcedar or possibly some alder in root rot areas.

Subsequent operations—

- Brush control, if and when needed, according to current DNR practice.
- Precommercial thinning, if needed, depending on stocking achieved and feasibility of early commercial thinning as an alternative. Retain some naturally established stems of species other than Douglas-fir, when present.

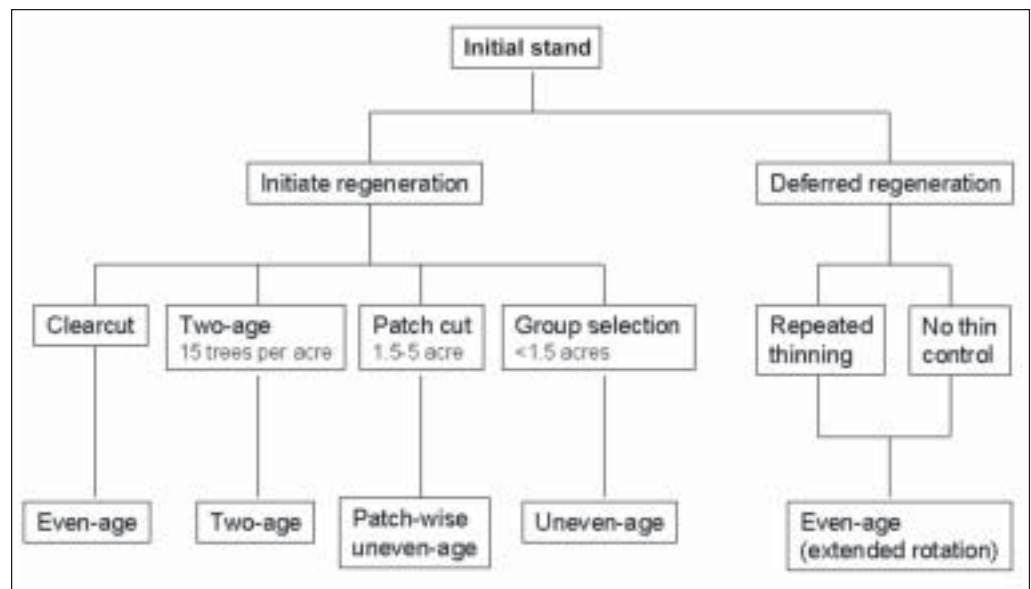


Figure 2-1—Relationships among treatment regimes.

- Commercial thinning as needed, to reduce relative density (RD) (Curtis 1982) to about RD35 in the first thinning and thereafter to maintain density in the range of RD40 to RD60.
- Harvest at a rotation age to be determined, probably in the range of 60 to 80 years.

Characteristics and current expectations—A well-understood and simple regime that will probably maximize timber yield and minimize harvest and administrative costs. Appearance may be objectionable to much of the public.

This initially resembles a conventional shelterwood but with the overwood, or a portion of it, carried through the second rotation to provide large trees and high-quality material.

Initial cut—This will remove a high percentage of the initial basal area, with a target residual stand of 15 trees per acre, or about 20 percent of initial basal area. Leave trees will be selected for vigor and stem quality.

Regeneration—Supplement existing and prospective natural regeneration by underplanting with Douglas-fir. The aim is a mixed-species stand including 50 percent or more Douglas-fir.

Subsequent operations—

- Brush control, if and when needed.
- Precommercial thinning some years after initial cut if needed to control spacing and remove damaged advance regeneration.
- Commercial thinning as needed to maintain reasonable growth rates in the younger cohort.
- Remove some overstory trees if and when needed to maintain satisfactory development of understory.
- Harvest at a rotation age to be determined, perhaps 60 years after initial cut.

Two-Age Stand Management (Reserve Shelterwood)

Patch Cut (Patch-Wise Uneven-Age) Management

Characteristics and current expectations—Maintains at least partial forest cover over at least two conventional rotations and sharply reduces the area in the highly visible, freshly harvested condition. Potential for high-value production in the retained overstory. Layered structure favorable to some wildlife. Probable increase in hemlock component. Possibility of major windfall losses. Possible difficulty in marketing very large trees.

Small patch cuts on the order of 1.5 to 5 acres can be treated by conventional even-age management techniques emphasizing Douglas-fir. Over time, a unit can be converted to an uneven-aged mosaic of even-aged patches that would be predominantly Douglas-fir while lacking large and visually obtrusive harvest areas.

The 1.5-acre minimum patch size is determined by the need for (1) direct light for satisfactory development of Douglas-fir and (2) avoidance of future need to fell large trees into established regeneration.

First entry—Cut all stems on 1.5- to 5-acre patches, somewhat irregular in shape, dispersed over the unit, and amounting to 20 percent of the available area. Concurrently do a light thinning in the intervening areas, aimed to reduce RD in the thinned area to about RD45. Plant patches to Douglas-fir or a mix of Douglas-fir and other species. Do any brush control needed to obtain reasonable survival and early growth.

Subsequent entries (15-year cycle)—Make additional patch cuts and regenerate another 20 percent of the area. Precommercially thin regenerated patches as needed. Commercially thin intervening areas as appropriate. This will, in time, produce a unit consisting of five age classes with a 75-year rotation, a condition that could be maintained indefinitely.

Characteristics and current expectations—Avoids large and highly visible harvest areas, provides near-constant landscapes, will probably maintain Douglas-fir and provide long-term yields near those under clearcutting. Uses well-understood even-age management techniques. Mix of habitat conditions should be favorable for many wildlife species. Harvest and administrative costs may be higher than under the clearcut and two-age regimes. Increased amount of edge may result in windfall losses higher than in the clearcut regime.

Because of the extended conversion period involved in this and in the group selection regime (below), the initial cut in these regimes should ideally be made at younger ages than the 70-year-old stands used in the first replicate of this study. Future replicates should include younger stands.

Group Selection

This resembles the patch cut regime (above), except that removals will cover a range from individual trees to groups not exceeding 1.5 acres, on the same 15-year cycle. Residual basal area over the unit will be comparable to that of the patch cut regime of the same replication. Early entries will not differ much from conventional thinning except for conscious creation of scattered openings intended to secure or release regeneration.

Openings of 0.1 acre and larger will be planted to Douglas-fir. Brush control and precommercial thinning will be done in openings as needed to ensure survival and development of regeneration.

Characteristics and current expectations—Compared to the patch cut regime, smaller group sizes mean (a) reduced visual impacts, (b) increased difficulty in managing intermediate treatments, and (c) increased harvest cost and damage. The small size of openings will probably result in reduced representation of Douglas-fir in regeneration and possibly in reduced growth of all species.

Extended Rotation With Repeated Thinning

Available information suggests that systematic thinning of vigorous Douglas-fir stands can maintain high growth rates in volume and value for extended periods, well beyond commonly used rotations. Continued commercial thinning can prolong the period of high production and produce current income while also producing aesthetically desirable and high-value large trees and reducing the land area in highly visible regeneration stages at any point in time. It is, therefore, one of the options to be considered for reducing visual impacts.

The stand would ultimately be reproduced by clearcut, shelterwood, or patch cut methods, at some rotation age now unspecified.

Extended Rotation Without Thinning (Control)

This provides a comparison with gains obtainable by the repeated thinning regime (above) when some stands are held on an extended rotation as a means of adjusting currently unbalanced age distributions and reducing visual impacts on the landscape.

Selection of Study Areas

One replicate (block) in this study requires an area of 200 to 250 acres, as nearly uniform in stand characteristics, site, and topography as reasonably attainable. Individual regimes require units of 25 to 50 or more acres, with the less uniform regimes (patch and group cuts) requiring larger areas than the more uniform regimes. To allow randomization of regime assignments, however, areas of 40 to 50 acres should be available for each regime, even though all may not be used. It is desirable, but not essential, that regime areas be contiguous, but they should be in the same general area.

Three replicates are being established on Capitol Forest. The first, Blue Ridge, was cut in 1998, and preharvest and postharvest measurements have been completed. The second, Copper Ridge, was harvested in summer 2002. The third, Rusty Ridge, had plot establishment and initial measurements completed in 2002 and is scheduled to be cut in 2004. The Blue Ridge stand is about 70 years old and originated from natural seeding after cutting and fire, as did Copper Ridge. The Rusty Ridge stand is a plantation and is substantially younger (about 40 years). Blue Ridge and Rusty Ridge are on fairly gentle terrain, and harvesting is by ground-based equipment. Copper Ridge is on much steeper terrain and requires cable logging.

The British Columbia Ministry of Forests has installed an additional replicate on Vancouver Island. Two more are planned.

Measurement Procedures

One major objective is quantitative comparisons of growth and yield among regimes and of the stand structures produced by the different regimes. This requires detailed specification of sampling and measurement procedures that can be applied consistently over long periods and by different people.

The basic stand measurements and procedures are detailed in the study plan.¹

Stand measurements are based on a systematic grid of permanent 1/5-acre plots. Plots are monumented and trees are identified by tags. Diameters and a sample of heights are measured before cut, after cut, and are repeated on a 5-year cycle thereafter as consistent with planned harvest operations. Regeneration (natural and planted) is inventoried at the same time, with additional regeneration inventories done 1 and 2 years after planting. Planted seedlings are identified. Postharvest regeneration inventories are based on a

¹ Curtis, R.O.; Clendenen, G.W.; DeBell, D.S.; DeBell, J.; Poch, T.; Shumway, J. Silvicultural options for harvesting young-growth production forests. Study plan on file at Olympia Forestry Sciences Laboratory. 1997, revised 2001. 34 p.

Supplementary Studies

sample of four 4-milacre plots superimposed on each 1/5-acre permanent plot. Visual estimates of average height and percentage cover of the principal shrub and herbaceous species are recorded.

Time and cost records are kept for all management operations (as opposed to purely research costs) as well as receipts from timber sale and harvest activities, by regime and treatment.

The primary objective is to secure all data necessary for evaluation of comparative production and costs of the different regimes. The supplementary studies discussed below, however, will require collection of additional data specific to the individual study.

A number of supplementary studies are in progress or anticipated. These include evaluations of:

- Harvesting costs
- Public response to visual effects
- Soil effects
- Wildlife effects
- Economics

The extent of these efforts is dependent on funding and cooperative arrangements with other organizations.

The remainder of this report documents the work done to date specifically at the Blue Ridge installation, organized as a number of chapters authored by the individual scientist(s) primarily concerned with each topic. We expect it to be a useful reference for those working on the study in the future, and for visitors seeing the study for the first time.

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