Restoration Thinning Adaptive Management Trial – 2005 and 2007 Installations

Original draft prepared on 7/26/2005 by Rolf Gersonde
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Purpose

This document describes the installation and sampling of an adaptive management trial in restoration thinning project areas to inform the restoration thinning program that is being conducted under the Cedar River Municipal Watershed (CRMW) Habitat Conservation Plan. This trial is designed as replicated treatment blocks that have been installed in 2005 and 2007. The key uncertainties connected with restoration thinning are: (1) if the treatments increase tree growth and crown development of the residual trees; (2) if the treatments increase cover and diversity of shrub, herb, and cryptogam species; and (3) if decomposition of thinning slash can be accelerated with certain treatments. This project focuses on questions (1) and (2), including the height and diameter growth of trees, vertical and lateral crown development, and cover and diversity of understory species and tree regeneration. Question (3) has been addressed in a Slash Treatment Trial that was installed in 2008.

The restoration thinning adaptive management trial is designed to address the following hypotheses: that the spatial distribution of trees after thinning has an effect on (a) individual tree growth and (b) crown development, (c) that understory cover (shrubs and herbs) is higher in stands with wider or irregular tree spacing, (d) that individual species differ in their response to regular and irregular spacing, and (e) that site quality has an effect on tree growth after thinning treatments.

Background

Restoration thinning in young stands of mixed conifers has been conducted at CRMW watershed since 1995. Goals of the treatments included increasing growth of residual trees and increasing development of understory vegetation. Treatment prescriptions have varied in the past and are currently being changed to incorporate greater variability in stand density and spatial patterns.

Assumptions regarding future tree growth and understory development are derived from a Fir-Hemlock Spacing Trial by the USFS (Curtis et al. 2000). That study included a range of tree spacings in a uniform distribution. Data analysis included tree growth by spacing distance for Western hemlock, Pacific silver fir, and noble fir. Understory development was observed as number of species present in the sample plots. Information on tree growth and vegetative development under clumped tree distribution is not available for this forest type. Studies in young Douglas-fir however show increased understory cover and growth of residual trees in thinned stands that contain gaps (Harrington et al. 2004). While we might assume that similar developments do occur in the hemlock-silver fir forests at CRMW, we thought it was worthwhile to install silvicultural trials to test the assumptions of tree growth and understory development. The effect of recent thinning practices might be observed in the Effectiveness Monitoring

Plots in Restoration Thinning units at CRMW, which have been installed in a few restoration thinning units since 2002. These monitoring plots, however, are designed to follow vegetative development over time within certain treatment units and are less suited to test different prescriptions on a given site.

Site description

The trials have been installed in restoration thinning project areas in the *Abies amabilis* forest series and the upper limit of the *Tsuga heterophylla* series (Henderson and Peter 1981). Sites were selected for homogeneity of tree distribution and species composition. To capture the variability in site conditions and regeneration conditions within the series, blocks are distributed across project areas by sub-basin (211 Road system, 300 Road system, and others to be selected in coming years). The majority of sites selected for restoration thinning have been regenerated through clearcuts and slash has been burned on some sites. Timber productivity in this zone ranges from moderate to low.

Experimental design

Treatments are assigned in a blocked 2 X 2 factorial design with replication within the blocks. Density and spatial patterns are the treatment factors, plus untreated controls. Treatments are replicated and randomly distributed within the blocks. Blocks are replicated across different sites and project areas. A maximum of five blocks will be installed over three years, starting in 2005. The size of the blocks depends on the number of treatments, number of replications, and minimum treatment area. Minimum treatment area depends on the size of the trees (edge effect) and spatial heterogeneity of the treatment. Given the current and expected tree size development as well as spacing and clumped distribution, treatment plots should have a minimum size of 0.4 hectare (1.0 acre), allowing for a 0.2 hectare sample plot (0.5 acre) and 10 meter buffer to the treatment edge. Each treatment will be replicated at least three times in each block.

The proposed treatment range includes implemented spacing prescriptions (high and low density and untreated control) and spatial patterns of residual trees as uniform and clumped. This design addresses the assumption that clumped patterns with larger gaps between trees improves understory development, while uniform tree distribution maximizes tree growth on the residual trees. Both are goals of restoration thinning and might be balanced by any of the proposed treatments.

Treatment Matrix

High density/uniform	Low density/uniform	Untreated control
High density/clumped	Low density/clumped	

Random block layout (example)

H/U	L/C	H/C	L/C	L/U
Control	L/C	H/U	L/U	Control
H/C	Control	L/U	H/U	H/C

Treatment implementation

Plot boundaries are flagged in the field and treatments are randomly assigned to the square 1-acre plots. Thinning is performed by the contract crew. Uniform thinning is achieved by following a spacing prescription. Clumped distribution of residual trees is achieved by thinning the trees to achieve the same plot density as under uniform spacing in 75% of the area and installing a number of small canopy gaps at irregular distances, covering 25% of the clumped treatment areas (15 gaps per 1 acre, average gap size of 30ft diameter, 707 ft^2). Stocking of high density plots is 740 trees per hectare (300 TPA), stocking of low density plots is 420 trees per hectare (170 TPA). Thinning slash in all treatment areas is lopped and scattered to less than 18 inches above ground.

Prescription in 2005 Restoration Thinning Contract

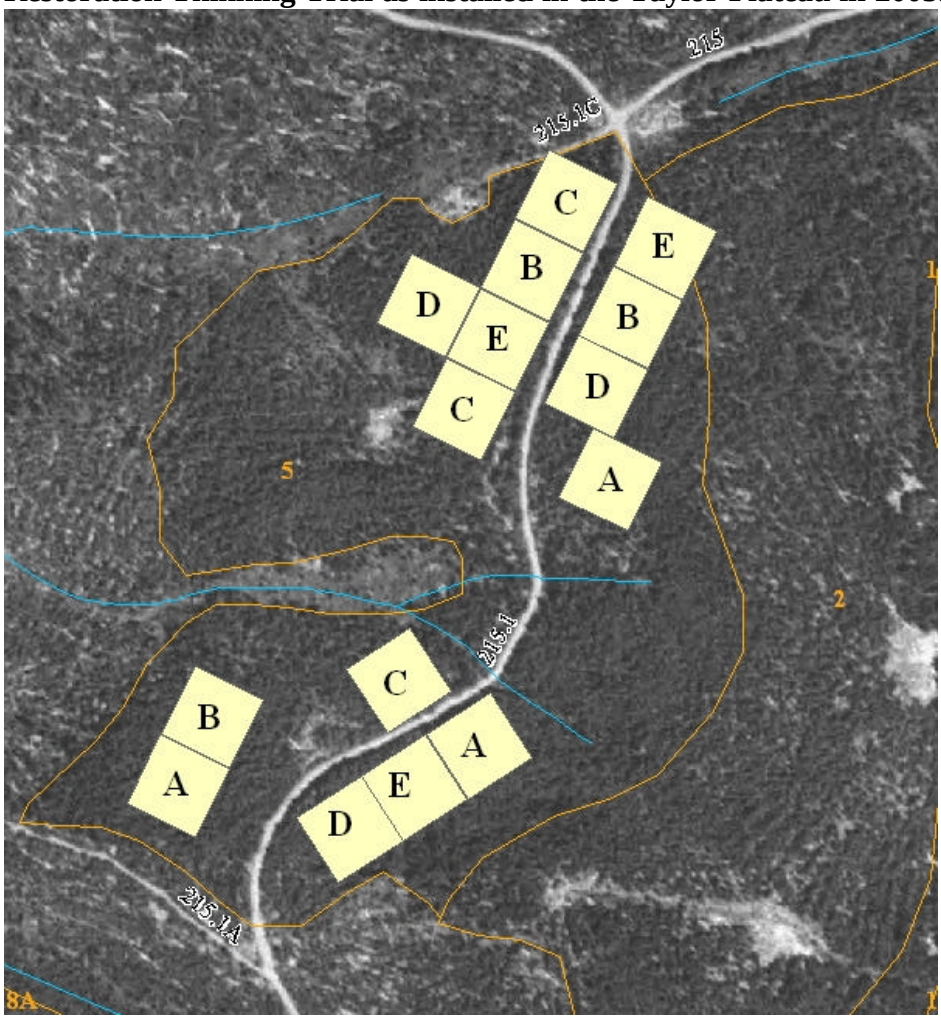
• Experimental one-acre sub-units (blocks); blocks will be marked with flagging • Thin 3 blocks to 12x12 foot spacing (A) • Thin 3 blocks to 16x16 foot spacing (B) • Thin 3 blocks to 13x13-foot spacing. After these 3 blocks are thinned SPU staff will flag the locations of twelve 20' radius (40' diameter) gaps in each block. The contractor will then thin all trees in those flagged locations to a 20' radius gap (C) • Thin 3 blocks to 10x10 spacing. After these 3 blocks are thinned SPU staff will flag the locations of twelve 20' radius (40' diameter) gaps in each block. The contractor will then thin all trees in those flagged locations to a 20' radius gap (D) • Leave 3 blocks untreated (E)
Lop experimental one-acre sub units (blocks), leaving thinning slash approximately 18" within the forest floor.

Methods for establishing clumped tree distributions:

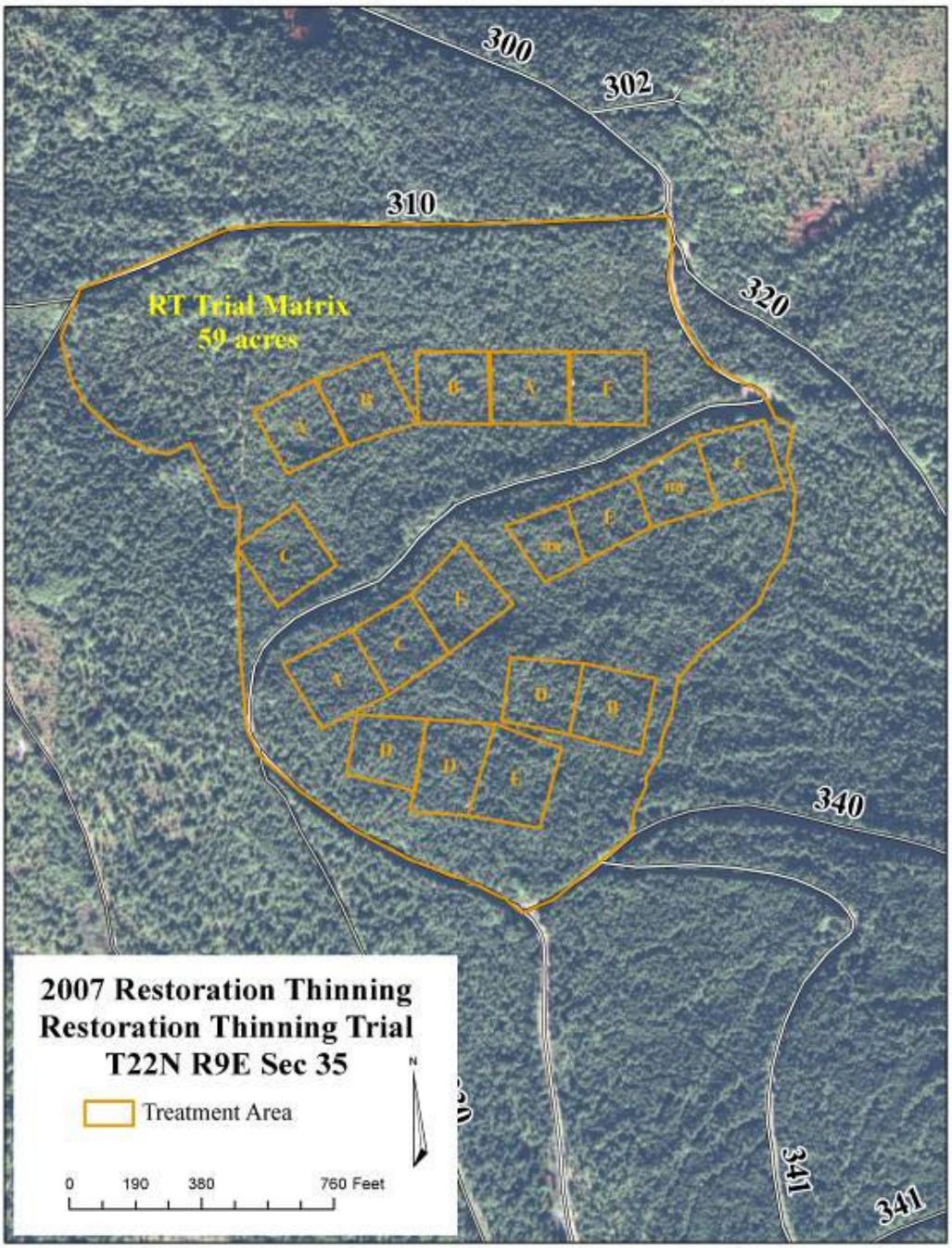
All units "C" are thinned to 260 TPA (13x13 feet spacing). All units "D" are thinned to 435 TPA (10x10 feet spacing). Establish 6-10 count plots in the unit and determine post-thinning TPA. Use Laser Rangefinder to determine tree distance from plot center. To reduce the post-thinning TPA to the desired density (170 TPA unit C, 300 TPA unit D) calculate the "excess" number of trees, divide by 12 gaps and calculate the approx. gap radius to remove $1/12^{th}$ of the excess trees at the current post-thinning spacing. Locate 12 well distributed gaps in the unit and mark/paint excess trees. The thinning crew can then cut the marked trees in units C and D.

One block was installed in 2005, and a second block was installed in 2007. The maps of these blocks are shown below.

Restoration Thinning Trial as installed in the Taylor Plateau in 2005.



Restoration Thinning Trial as installed on the 300 Road system in 2007.

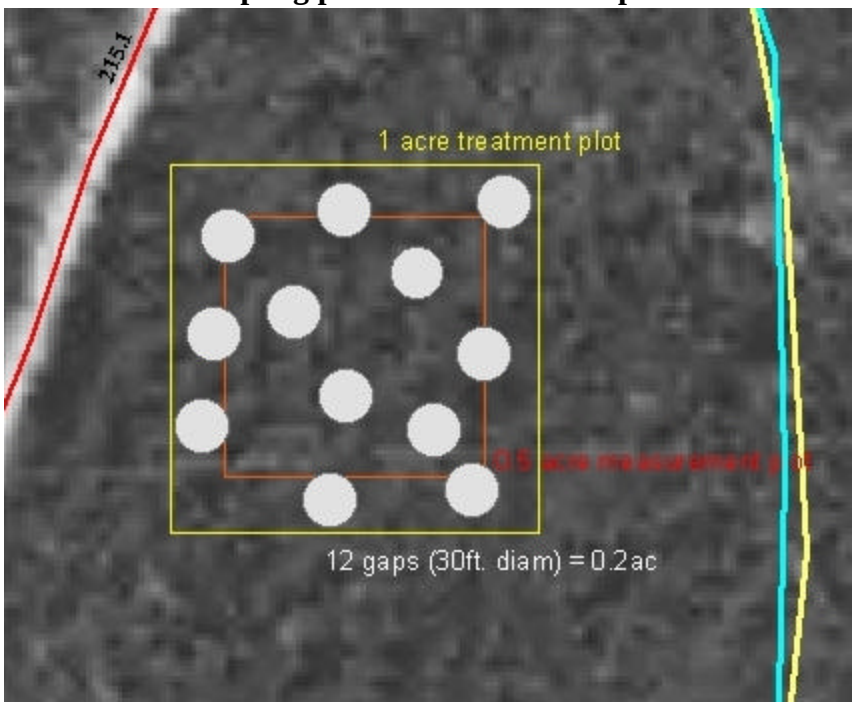


Sampling design
The treatment plots and control areas are sampled after thinning implementation and in subsequent years 3, 5, and 10. A nested sampling plot is established in each of the treatments, large enough in size to capture the variability of the treatment unit. Tree sampling plot is sized to include a minimum of 50 trees depending on residual density. Maximum sample plot size in the treatment areas is 0.2 hectare to allow for a 10m buffer to the treatment boundary. Sampling in the control area should include a minimum of 50 trees of similar size and species distribution as selected as leave trees in the treatment areas. Plot center and four corners are permanently marked in the field. See Attachment A for more detail on sampling design, including schematics of plot installation and measurements.

Understory vegetation is sampled along shrub transects and cover plots following the current PSP sampling protocol.

Plot description includes: Installation number, plot number, location, date, treatment, site index, plot area and shape, sampling design, species composition, elevation aspect, slope, measurement units, stand origin, measurement date, thinning date, thinning type, soil description, soil type, plant association, and damage.

Schematic of sampling plot within treatment plot.



Tree description includes: Installation number, plot number, tree number, species, age, coordinates (optional), diameter, height, crown base, crown width, crown class, tree class, damage class, diameter growth, and height growth.

Information on understory vegetation includes: Installation number, plot number, cover percentage by plant group, species, cover, and average height.

First year post-treatment sampling was conducted on the Taylor Plateau block in 2006, and on the 300 Road block in 2008.

Budget and coordination

Installation and initial measurements were covered by the 2005 and 2007 Restoration Thinning budgets. Installation of the blocks was included in bid packages for thinning contractors. A separate contract was prepared for sampling plot installation and initial sampling. Resampling of the plots will be included in future Restoration Thinning and/or Upland Forest Restoration Project Monitoring budgets.

References:

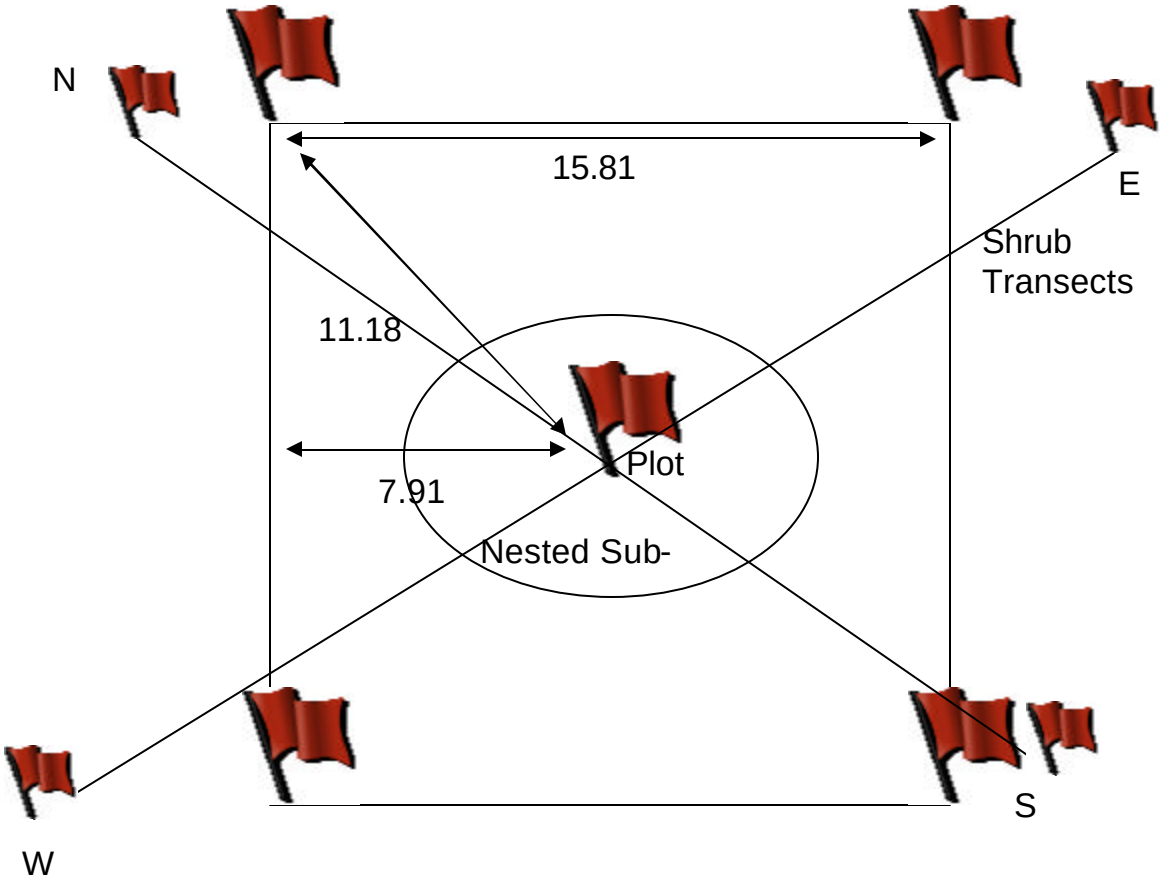
Curtis, R.O., Clendenen, G.W., and Henderson, J.A. 2000. True fir-hemlock spacing trails, Design and first results. USDS-FS Pacific Northwest Research Station, PNW-GTR-492.

Harrington, C.A., DeBell, D.S., and Brodie, L.C. 2004. Alternative silvicultural treatments for young plantations in the Pacific Northwest. (http://www.fs.fed.us/pnw/olympia/silv/selected-studies/clearwater/index.shtml)

Henderson, J.A. and Peter, D. 1981. Preliminary plant associations and habitat types of the Green and Cedar River drainages. USDA-FS, North Bend District, Mt. Baker-Snoqualmie National Forest.

ATTACHMENT A: RESTORATION THINNING TRIAL SAMPLING METHODS

Restoration Thinning Trial Plot Layout for Control Units
R. Gersonde, 10/21/2008



- Use long PVC post at plot center and short posts at plot corner and end of shrub transect.
- All distances should be slope corrected.
- Locate a 0.025 hectare square plot in the center of the control unit with homogeneous and representative tree distribution. Establish plot center and four plot corners (tape and compass, rebar and PVC pipe). The side of the square is 15.81m long, distance from plot center to side is 7.91m, and distance from plot center to corner post is 11.18m. All plot distances are slope corrected.
- Tag all trees in the plot using cable ties; mark the trees with blue paint at breast height (1.37m above ground); measure and record DBH (0.1 inch, diameter tape or caliper), species, height and base of the live crown (0.1 ft., Haglof Hypsometer), and two crown radii (south and north, 0.5 ft., tape).
- If the number of trees in a plot exceeds 50 trees, sample all live trees >4.5" DBH (marked blue) and sample all live trees <4.5" (marked yellow) in a radius of 4 meter around the plot center. Sub-sample tree heights and crown radii of trees <4.5 inch DBH by diameter classes (0.5, 1.0, 1.5, 2.0, 3.0, 4.0, 5.0 inch …) and species. The dominant trees should still be completely sampled; smaller

overtopped and intermediate trees can be sub-sampled for heights and crown radii with 3-5 trees per diameter class. All trees in the plot should be marked, tagged, and species and DBH should be recorded.

- Vegetation transect sampling follows the protocol of the thinned experimental units: Line intercept sampling (start, end, or distance to 0.01m) along 16.1 m transect, corrected for slope.

Sampling as conducted in 2006
By Christopher Riely, November 6, 2006

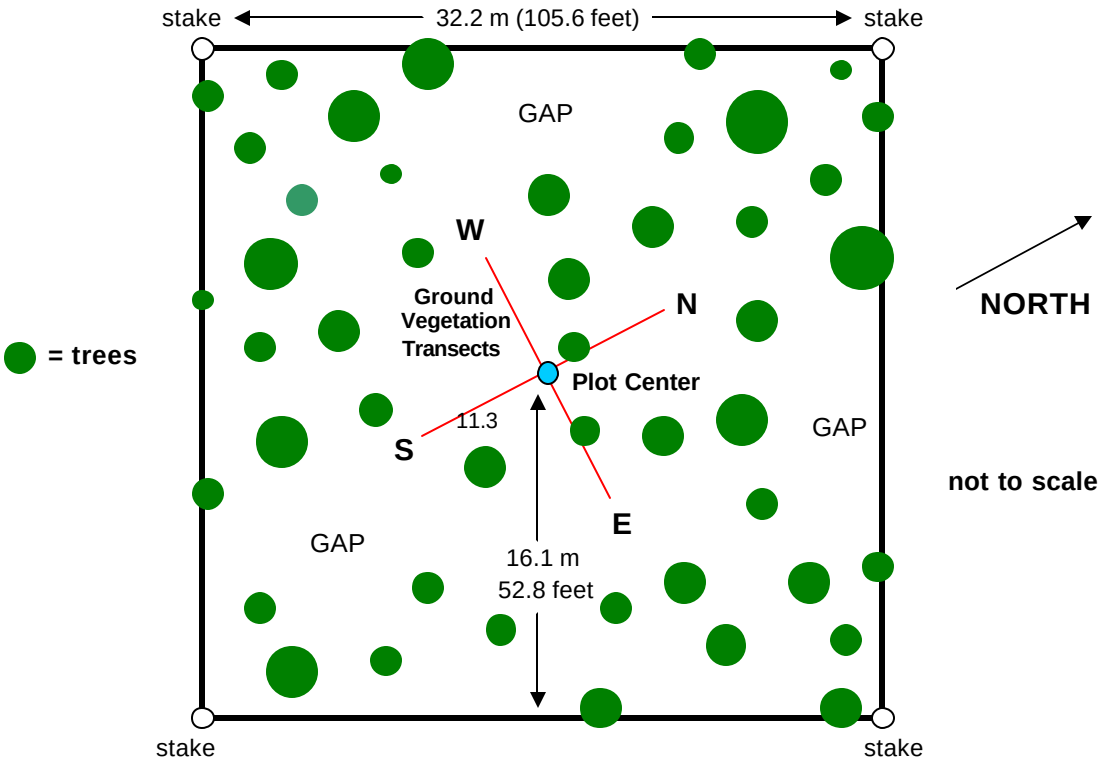
PLOT LAYOUT

Square 0.1 hectare plots were located near the center of each treatment unit. The plots were oriented so that the upper and lower plot boundary lines were roughly parallel to the contours of the slope in each unit. Distance from plot center to the center point of each boundary line (52.8 feet or 16.1 meters) was measured horizontally with a tape. The corners of the plots were located at the intersection point of the compass bearings corresponding to the two adjoining plot boundary lines.

The three square 0.025 hectare control plots were oriented so that the corners are at the cardinal points of the compass from plot center. Distance from plot center to each corner was again measured horizontally with a tape.

Plot center and the four corners were each marked with rebar capped with an easily visible 3-foot blue-tipped length of white PVC pipe. Where a plot corner was located beneath a deep pile of slash, the corner marker was moved to the nearest location where it could be set in the ground and would be easily visible. In these cases, the location of the actual plot corner was recorded and still used as the point of reference for establishing which trees were "in" or "out" of the plot.

Example of restoration thinning trial sampling plot.



TREE MARKING AND MEASUREMENTS

Almost all the trees in the were tagged with a number and marked as close to breast height (4.5 feet, measured from the uphill side) as possible with blue tree marking paint. Only trees with damaged crowns or small stems growing out of the upturned rootballs of fallen old-growth trees – those which will likely exhibit atypical growth patterns -- were not marked or tagged and thus excluded from the experiment. A number was affixed to each tree by looping a plastic cable tie through a metal number tag and stapling the end of the cable tie to the bole of the tree at or as close to DBH as possible. The number tags face plot center unless it is impractical to approach a particular tree from that direction to read its number and measure its DBH. Because of the user's control over the precise placement of the staple, a staple *gun* worked better than a staple *hammer* for fastening the cable ties to the trees. The long cable ties were used instead of nailing the number tags to the trees because it was thought that the number tags would be less likely to "grow into the trees" over the course of the experiment's duration, which is expected to coincide with a period of rapid diameter growth for the trees.

In each plot, the numbering sequence (i.e. the lowest number) began with the tree closest to true north from plot center and continued in a clockwise direction around the plot back to true north, so that the lowest- and highest-numbered trees are usually quite close to each other. The intention was to keep trees tagged in numerical sequence as close together as possible, so that researchers measuring the trees can proceed around the plot as quickly as possible.

The species and five measurements were recorded for each marked tree at the time the plots were established:

- DBH to the nearest 0.1 inch
- total and live crown height (using a Haglof Vertex Laser instrument and transponder). The base of the live crown was defined as the lowest live branch along the bole not separated by a large gap from the rest of the crown. Measurements were recorded to the nearest foot in the first few plots and, after discussion, to the nearest 1/10 foot in the remaining ones.
- crown width on the north and south side of the tree, estimated to the nearest 0.5 foot (note: these measurements were the most subjective of the empirical data collected)

Although only one quarter the size of the thinned plots, the control plots still contained many more trees. Thus, control plots measurements included all trees in the plot greater than 4.5 inches DBH but only a subsample of smaller trees. This subsample took the form of a nested plot within the larger one, comprising all live trees within 4 meters of plot center. All trees greater than 4.5" DBH were marked with blue paint, as in the thinned plots, and trees less than 4.5" DBH in the nested plot were marked with yellow paint. Trees in the control plots were numbered in the same manner as those in the thinned plots, except that all the larger blue trees were tagged with numbers preceding those on the smaller yellow trees.

GROUND VEGETATION TRANSECTS

In each treatment unit, transects for sampling woody ground vegetation were established along the four cardinal points of the compass (north, south, east, west) from plot center to 11.3 meters. The ends of these four transects were marked with rebar capped with a 1.5-foot length of blue-tipped white PVC pipe. Since the plot corner markers serve as the ends of the vegetation transects in the control plots, no additional transect markers were needed in these three plots.

Vegetation was sampled by extending a metric measuring tape along the transect. The species, precise location, and extent of woody vegetation and ferns falling *directly under* the transect line were recorded. Measurements were rounded to the nearest 0.1 meter in the first few plots and, after discussion, recorded to the nearest 0.01 meter in the remaining ones. Plants were identified by known recognizance, verified by *Plants of the Pacfic Northwest Coast* (Pojar and Mackinnon, 1994) when necessary. Data was recorded beginning at plot center and extending to the end of each transect, so all measurements are from plot center.