

PLANT COMPETITION AND THE GROWTH OF WESTERN HEMLOCK
IN THE EVE RIVER WATERSHED

by

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ABSTRACT

In the Eve River watershed on northeastern Vancouver Island, chlorotic and stunted stands of naturally regenerated western hemlock (Tsuga heterophylla (Raf.) Sarg.) occur on several hundred hectares of clearcuts that have been burned. Similar stands have been observed in adjacent watersheds. Unburned parts of the same clearcuts have nonchlorotic and vigorously growing western hemlock. In this study, microsite, soil, tree, and vegetation data were collected from two sites with adjacent burned and unburned areas. All stands in the area were characterized by low concentrations of foliar N, P, K, S, and Cu. Stem volume was not significantly correlated with any site variable on the burned or unburned area of either site. Although not significant, the largest correlations with stem volume on the burned areas involved slope, seedling density, and cover of decaying wood. For the unburned areas, the largest correlations with stem volume involved seedling density and depth of forest floor. Because only two sites were sampled, this approach was inconclusive for assessing the factors which control growth of western hemlock in this watershed; sampling of additional sites is needed.

Growth responses of western hemlock on two burned sites were monitored for two years following herbicide application to herbs and shrubs, conifer removal, and these two treatments combined. For these treatments, plots of 2 m radius were centered on individual western hemlock target trees. On average, the trees on these sites were 2 m tall and 8 years old. One site had greater tree density, and the other had greater cover of herb and shrub species. A trenching treatment was included for a limited number of plots on the first site. The response to treatments was

affected by initial site characteristics, leader breakage, herbicide damage, and substrate characteristics. Significantly greater growth in diameter and stem volume of target trees occurred during both growing seasons after conifer removal. Responses to herbicide application were similar. These responses were more pronounced after the second growing season. Results for trenching were not significantly different from the combined treatment.

Foliage of western hemlock had significantly greater concentrations of N, P, and K after conifer removal and of N, K, and Cu after herbicide application. Significant positive correlations were found between stem volume growth after both growing seasons and increases in foliar concentrations after the first growing season; this was true for N, K, and S on site E55 and for N, S, and Cu on site E44. Moisture deficits may have limited growth during both growing seasons.

This study indicates that after slashburning the growth of western hemlock is reduced by competition from herb and shrub species as well as from conifers.

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INTRODUCTION

Chlorotic and stunted stands of naturally regenerated western hemlock (*Tsuga heterophylla* (Raf.) Sarg.) occur on several hundred hectares of clearcuts in the Eve River watershed on northeastern Vancouver Island. Similar stands have been observed in adjacent watersheds. Many of these stands occur on clearcuts that were slashburned during the early 1970's. Unburned parts of the same clearcuts have nonchlorotic and vigorously growing western hemlock. A preliminary study found that height and basal diameter growth rates were significantly greater on several unburned areas relative to adjacent burned areas (Kuzmuk 1987). Some of the difference was attributed to an establishment delay of up to five years on burned areas. Growth of western hemlock of comparable age was similar on a few burned and unburned sites, indicating that burning is not the only factor contributing to the stunted growth of western hemlock. For three years prior to the present study, operational forestry staff in the Eve River drainage had noted that foliage of western hemlock in April was yellow (chlorotic) on many burned areas. Chlorotic trees were occasionally observed on unburned sites and nonchlorotic trees were observed on some burned areas. These sites had been burned 1-2 years after harvesting (J. Loftus, personal communication).

In the first part of this study, correlational techniques and literature comparisons were used to determine what factors were most likely causing the poor growth of western hemlock. On the basis of observations and results from the first part of the study, treatments were selected to assess the growth response of western hemlock. Chapter 1 is an hypothesis generating exercise (Romesburg 1981). Microsite, soil, and vegetation data were collected from two sites with adjacent burned and unburned areas. Correlation techniques were used to relate these properties to growth of

western hemlock. For a subset of the plots, potential limiting nutrients were identified by comparing nutrient concentrations of foliage and soil with values reported in the literature. Graphical analysis for 12 sites was used to determine if there were nutrient differences between burned and unburned areas and between chlorotic and green western hemlock. Competition appeared to be important in reducing growth of western hemlock. Thus, competition from trees and from herbs plus shrubs was experimentally reduced on 2 m radius plots within two burned areas. The resulting changes in diameter, height, stem volume, and needle weight of western hemlock are reported in Chapter 2 for each of two growing seasons. In Chapter 3, the changes in foliar concentrations of six nutrients are reported. These data were used to monitor nutrient responses after reduced plant competition. Correlations between change in foliar nutrients and change in stem volume after each growing season were used to determine if growth response was significantly related to foliar nutrients and to identify nutrients which may have limited the growth of western hemlock. This study assesses the effect of plant competition on the growth and nutrition of juvenile western hemlock.

Chapter 1.

RELATIONSHIPS BETWEEN GROWTH OF WESTERN HEMLOCK AND MICROSITE CHARACTERISTICS ON BURNED AND UNBURNED AREAS.

Introduction

Slashburning after clearcutting can affect soil chemical and physical properties as well as alter the composition of the vegetation (Kozlowski and Ahlgren 1974, Pritchett 1979). Slashburning is usually detrimental to western hemlock because trees established before logging are killed and post-burn germinants suffer greater mortality from summer drought (Feller 1982). In contrast, slashburning in the Coastal Western Hemlock zone on Vancouver Island improved the growth and foliar nutrient status of Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco) (Vihnanek and Ballard 1988). Improved growth of Douglas-fir was associated with reduced height and cover of salal (Gaultheria shallon Pursh), a major competitor on these sites. The Douglas-fir on burned areas also had significantly greater concentrations of P, K, Ca, Fe, and B in the foliage. A seven year study in Oregon on sites that had been logged and slashburned found that some species, including western hemlock, were largely restricted to microsites with undisturbed soil (Dyrness 1973). Degree of disturbance determined whether predisturbance species or invader species formed the main component of the developing stands. Burning on these sites increased the postburn cover of invading species such as Epilobium angustifolium L., Anaphalis margaritacea (L.) B.&H., and Senecio sylvaticus L.

The frequency of natural fires in the Eve River drainage is unknown. The probability of fire is low, as the north coastal regions of Vancouver Island have high precipitation, moderate to cool temperatures, and little if any summer drought (Schaefer 1978). Thus the fire regime

may be closer to that of old-growth forests in southeast Alaska (Alaback 1982) than to that of forests in northern Washington, which have a greater frequency of burning (Hemstrom and Franklin 1982). Windthrow caused by infrequent high-velocity winds is the main source of disturbance in the Alaska coastal forests, whereas fire plays a minor role (Alaback 1982).

Considerable effort has been directed toward the examination of foliar and soil nutrients in western hemlock stands in order to document the range of values occurring, to determine if relationships exist between these properties and tree growth, and to monitor the effects of various management practices. Foliar concentrations of macro and micro nutrients are summarized in Beaton *et al.* (1965), van den Driessche (1976), and Radwan and DeBell (1980). Ballard and Carter (1986) list foliar concentrations that correspond to deficiency levels in western hemlock. The values were considered tentative because of limited research on this species. Radwan and DeBell (1980) found that site index for western hemlock was positively correlated with foliar levels of total N and negatively correlated with Mn and SO_4^{2-} -S. Another study found that site index is strongly correlated with available P in the mineral soil and growth response to N fertilizers is highly correlated with extractable P in the forest floor (Radwan and Shumway 1983). Studies on the soils from stands of western hemlock have found that tree roots are predominantly near the soil surface and thus the forest floor is an important source of nutrients (Heilman 1976, Meurisse 1976).

The overall objective of this study was to identify the possible factors controlling growth of young western hemlock on burned and unburned clearcuts in the Eve River drainage. Specifically, I examined (1) factors related to growth of western hemlock within burned and unburned areas and (2) patterns of variation among 12 sites representing all

combinations of poor versus good hemlock growth and burned versus unburned clearcuts. Correlational techniques were used to search for factors related to growth of western hemlock. Thus the first part of the study was an hypothesis generating exercise (Romesburg 1981); the results of this part of the study were used to select treatments for the experiments reported in Chapters 2 and 3.

Materials and methods

Study area

The Eve River watershed (Figure 1), on the northeast coast of Vancouver Island, is at the eastern edge of the Vancouver Island Ranges. These mountain ranges are a heterogeneous group of preCretaceous sedimentary and volcanic rocks with numerous granitic batholiths. The region has been uplifted, dissected, and glaciated to yield a rugged area of high relief (Jungen 1985). The most extensive soils are derived from morainal deposits on the lower to mid slopes and from colluvial deposits on the upper slopes. Soils derived from fluvial or fluvio-glacial deposits occur occasionally in the valley bottoms. In the Eve River drainage, most soils are well drained, gravelly sandy loam in texture, and derived from extrusive bedrocks. These soils commonly have strongly cemented horizons at 50-100 cm depth (Jungen 1985).

The closest climatic station is at Sayward, B.C., approximately 40 km east of the study area and in the same general physiographic area. Precipitation means (1951-1980) for Sayward are 2006 mm annually, 266 mm in January, and 50 mm in July. Mean annual temperature is 7.8°C, mean January temperature is 0.0°C, and mean July temperature is 14.8°C (Environment Canada 1982).

The Eve River drainage is primarily in the wetter subzone of the Coastal Western Hemlock Zone (Klinka *et al.* 1984). The study area is in the windward, submontane, and

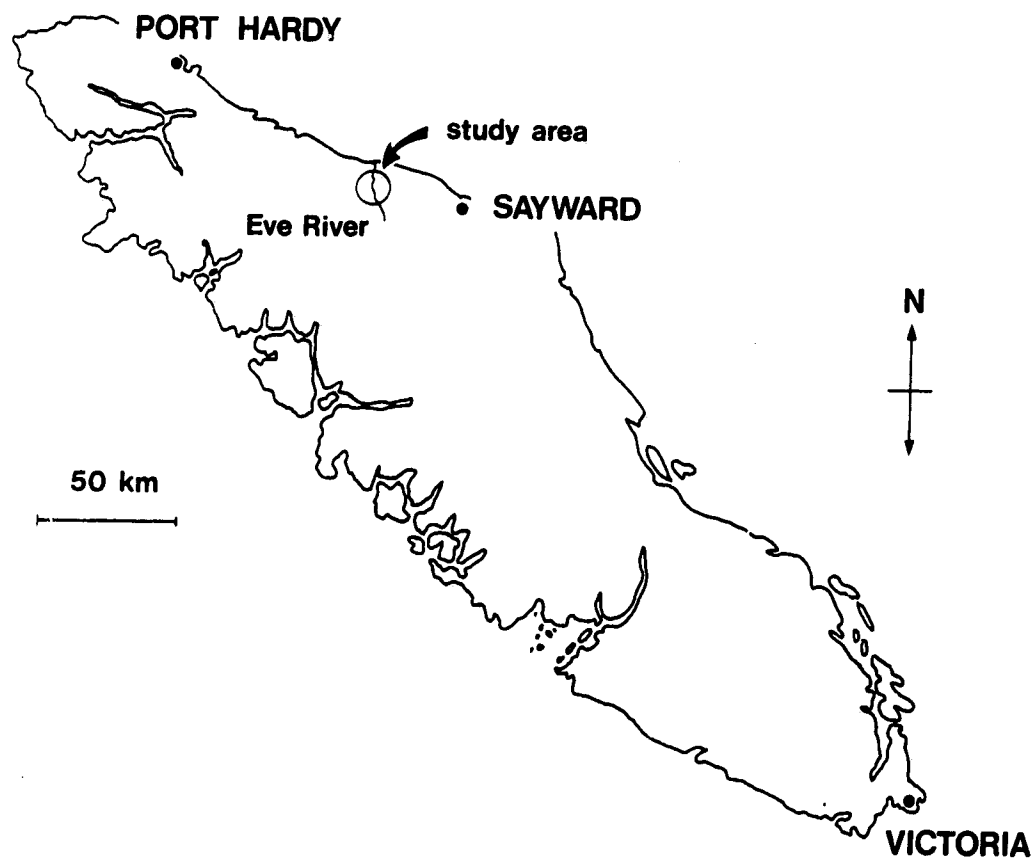


Figure 1. Location of study area.

maritime variant of this subzone. This vegetation unit is characterized by western hemlock and amabilis fir (Abies amabilis (Dougl.) Forbes) in the overstory and by Vaccinium parvifolium Smith, V. alaskaense Howell, Blechnum spicant L., Hylocomium splendens (Hedw.) B.S.G., and Rhytidiadelphus loreus (Hedw.) Warnst. in the understory.

Site selection and field methods

Detailed study of two sites

Two sites in the Eve River drainage, with burned and unburned areas adjacent or intermixed, were selected. Transects across the sites prior to sampling indicated that soil depth, soil texture, and slope were reasonably uniform within each site. Both sites had large numbers of >1 m radius stumps, indicating that they had previously supported large trees. Site E55 was harvested by high-lead cable yarding in 1973, partially broadcast burned in 1974, and sampled in May 1987. Site TN48 was harvested by high-lead cable yarding in 1974, partially broadcast burned in 1976, and sampled in May 1988. I collected foliar and soil samples in September of the same year that plot data were collected. At each site, the burned and unburned areas were mapped to scale and a grid was used to locate 40 sample points within each area. The grid spacing was 14 m at E55 and 20 m at TN48. For each area on a site, random coordinates were selected to establish the first point. The tree closest to each measured grid point was selected as the target tree and plot center. Circular plots of 2 m radius for the burned and 4 m radius for the unburned areas were marked with flagging. A preliminary study (Kuznik 1987) found that mean tree height was 2 m on burned and 7 m on unburned areas. The plot dimensions reflect the average root extension found by Eis (1974) for trees of these sizes.

Plots were centered on individual trees in order to relate growth of trees to their immediate microhabitat. For

each plot, microsite information at the point of germination of the target tree was collected on slope position, aspect, and hand texture of soil. The following data were collected for the target tree: height, basal diameter, diameter at breast height (dbh), leader increment, and tree age. Basal diameter and age were determined at 10 cm above the germination point. A dissecting microscope was used to count annual rings. Leader increment was calculated by averaging the distance between bud scars on the main stem for the previous three years. Stem volume was calculated using the formula for a cone. Tree height and basal diameter were used for the cone dimensions. Annual volume, height, and basal diameter growth were calculated using the age at 10 cm above the germination point.

On burned areas, an index of competition from trees was formed by measuring the basal diameter (at a height of 10 cm) for all trees ≥ 1 m tall, calculating the basal area of each tree, and summing these to obtain a total basal area per plot. Seedling density (no./plot) was determined by counting all trees, including germinants, < 1 m tall within the plot. For unburned areas, tree competition was examined by measuring dbh for all trees ≥ 3 m tall, calculating the stem cross sectional area at breast height, converting this to basal area at 10 cm height using a regression equation, and summing the basal areas to obtain a total basal area per plot. A regression relationship was developed for each unburned area using the 40 target trees in that area ($r^2 = 0.969$, $F_{\text{prob}} = 0.0001$, $df = 39$ for E55; $r^2 = 0.892$, $F_{\text{prob}} = 0.0001$, $df = 39$ for TN48). For unburned areas, seedling density (no./plot) was determined by counting all trees, including germinants, < 3 m tall within the plot.

Cover (%) of each vascular plant species was visually estimated within the following strata: A1 - trees > 10 m tall, B1 - trees 2-10 m tall, B2 - shrubs plus trees < 2 m tall, and C - herbaceous species. Species were identified

using Hitchcock and Cronquist (1973). Within each stratum, the cover values for the individual species were summed to obtain a total for the stratum (%). The total values were used in the subsequent data analysis.

The proportions of each plot with exposed mineral soil or intact woody debris were visually estimated. At the germination point, a soil pit was excavated to 50 cm depth. For each pit, the depth of the forest floor was measured. Mineral soil samples, at 0-20 cm and 20-50 cm depths, were removed from the pit and separated into two fractions with a 2 mm sieve. A visual estimate was made of the volume of coarse fragments (>2 mm fraction).

Ten of the 40 sample plots of each burn condition per site were randomly selected for foliar and soil nutrient sampling. The coarse fragment contents for the 0-20 cm and 20-50 cm soil depths were measured at these points using a uniform stainless steel cylinder, 10 cm in diameter by 30 cm tall. The coarse fragment content was calculated from the ratio of the depth of the >2 mm fraction to the total depth of both >2 mm and <2 mm fractions, to verify the visual estimates for coarse fragments. Samples of current year foliage of the target tree, the forest floor, and the mineral soil from the 0-20 cm depth were collected for laboratory analysis.

General study of twelve sites

Eight sites were selected in April 1988 in the Eve River drainage such that when combined with the burned and unburned areas from E55 and TN48 there were four groups (chlorotic burned, chlorotic unburned, nonchlorotic burned, and nonchlorotic unburned) with three sites each. Chlorotic trees were defined as those with one year old foliage that was obviously yellow (7.8 Y 3.8/5.3 or yellower, using The Munsell Limit Color Cascade; Munsell Color, MacBeth Color & Photometry Division, 2441 N. Calvert St., Baltimore, MD

21213), while trees with normal-appearing green foliage (0.5 GY 4.2/6.2 or greener) were considered nonchlorotic. In September 1988, a stand of trees at least 1 ha in size was selected at each of the eight sites. A random starting coordinate plus a random bearing were used to obtain a sampling transect. At 10 m intervals along this transect, the closest western hemlock was selected for sampling. Ten trees were selected per site. A composite sample of current year's foliage was obtained by combining equal weights of foliage from each of the 10 trees. Equal volumes of both the forest floor and the mineral soil (0-20 cm) layers were collected at the base of each sample tree and combined to form a composite sample for each layer. At two of the 10 transect points, heights and diameters of trees within 2-4 m radius were measured. Mean values for data taken for the other part of the study (described above) were used for the burned and unburned areas at E55 and TN48.

Laboratory methods

The foliar samples were oven-dried at 70°C for 12 hours, ground to pass through a 20-mesh sieve, and stored in air-tight plastic containers. Mean needle weight was determined by weighing 100 oven-dried needles. For total elemental analysis, a 0.250 gm sample of oven-dried foliage was digested using the method of Parkinson and Allen (1975). Total N and total P were determined colorimetrically by use of the Technicon Autoanalyzer II (Anonymous, 1974). Total N determination was based on the indophenol blue method (Keeney and Nelson 1982). Total P was based on the reduction of the ammonium molybdophosphate complex by ascorbic acid (Watanabe and Olsen 1965). Total Ca, Mg, K, Fe, Mn, Zn, and Cu were determined using atomic absorption spectrophotometry (Price 1978). Boron was determined using the colorimetric technique of Gaines and Mitchell (1979). Total S was determined with a Fisher Sulfur Analyzer as

described by Guthrie and Lowe (1984). Sulfate-S was determined by the method of Johnson and Nishita (1952). Active Fe was determined by atomic absorption spectroscopy (Price 1978) following extraction with 1 M HCl (Oserkowsky 1933).

The forest floor samples were air dried, ground in a Wiley Mill to pass through a 40-mesh sieve, and stored in air-tight plastic containers. The mineral soil samples were treated similarly except that instead of being ground they were sieved to obtain the <2 mm fraction. Water content was determined at the time of each analysis to correct all values to an oven-dry weight. The following methods were used on both organic and mineral soil samples. Total C was determined using the dichromate oxidation of the Walkley-Black procedure (Nelson and Sommers 1982). Total N was measured using a semi-micro Kjeldahl procedure to convert N into ammonium (Bremner and Mulvaney 1982). Mineralizable N was measured after two weeks at 30°C with an anaerobic incubation (Keeney 1982). The ammonium was displaced with 3 N KCl. The ammonium in solution for both procedures was determined colorimetrically using the Technicon Autoanalyzer II (Anonymous 1974). Extractable P was measured using the Bray No. 2 solution (Bray and Kurtz 1945) followed by colorimetric determination in the Technicon Autoanalyzer II (Anonymous 1974). Exchangeable Ca, Mg, K, and Al were determined by displacing the cations with 1 N NaCl. The 1 N NaCl was used in place of the 1 N NH₄OAc outlined in Thomas (1982). The displaced cations were analyzed by atomic absorption spectrophotometry following procedures outlined in Price (1978). The CEC characteristic of field pH was determined by leaching the sodium-saturated soil with 1 N KCl. The displaced Na was determined by atomic absorption spectrophotometry (Price 1978). These values for CEC reflect plant growing conditions in the acid podzol soils of British Columbia better than values obtained from buffered

systems (Lewis 1976).

For the general study using 12 sites, analyses for total S and extractable B, Cu, and Zn were also performed. Total S was determined with a Fisher Sulfur Analyzer as described by Guthrie and Lowe (1984). Extractable B was measured on a hot-water extract using the azomethine-H method (McKeague 1981). Extractable Cu and Zn were displaced with DTPA (Baker and Amacher 1982). The displaced Cu and Zn were measured by atomic absorption spectroscopy (Price 1978).

Data analysis

Detailed study of two sites

Analyses were performed on two data sets: one containing the data collected from all 40 plots at each area on a site and one containing the laboratory data collected from a subset of 10 plots per site.

Descriptive statistics were generated on each area for tree growth and site variables. For the full data set, scatter plots and correlation matrices were generated for all tree growth and site variables by area to determine if transformations were necessary for any variables and to aid in removing highly correlated variables. Percent cover of exposed mineral soil and cover of plant species in the A1 stratum were removed because these variables had values >0 on less than 10 plots in the entire study area. Cover of trees in the B1 stratum was removed because these trees were also represented by the basal area variable. The coarse fragment content of the 20-50 cm soil depth was removed because it was highly correlated ($r > 0.819$, $P < 0.001$) with the coarse fragment content of the 0-20 cm soil depth for all areas except TN48 burned, which had bedrock < 50 cm from the surface in two plots. Incremental volume, height, and diameter growth were also removed from the analysis, because these variables were highly correlated ($r > 0.826$, $P < 0.001$)

with stem volume, height, and diameter, respectively, for all areas except TN48-unburned. In this area, diameter increment and diameter had a smaller but significant correlation coefficient ($r=0.539$, $P<0.001$) while height increment and height were not significantly correlated ($r=0.166$, $P=0.308$). Approximately one third of the trees sampled in this area had variable degrees of suppressed growth prior to harvesting, which caused considerable variation in size-age relationships. Because all trees >2.5 m tall would have been removed at harvesting, the simple dimension variables better reflect growth since harvesting. Prior to further analysis, the values for stem volume and basal diameter were log-transformed to increase homogeneity of variance and linearity of relationships with the independent variables (Myers 1986). After the log-transformation of stem volume and basal diameter, the remaining tree variables were all highly and positively correlated on all areas ($r>0.466$, $P<0.003$). If a significant correlation exists between any of the tree variables and a site variable, the same relationship would likely exist for the other tree variables. Stem volume should integrate diameter and height growth since disturbance. The large positive correlations between stem volume and leader increment indicate that the largest trees have the greatest current growth. Therefore, stem volume was selected as the variable that best represents tree growth after disturbance and current growth.

Thus the analysis was reduced to the dependent variable of stem volume, and to the independent variables of slope at germination point, depth of forest floor, content of coarse fragments (0-20 cm), seedling density, basal area of competing trees, cumulative cover of B2 species, cumulative cover of herbaceous species, and surface cover of decaying wood. For each of the four areas, the correlations between the log-transformed values of stem volume and the eight site

variables were evaluated to determine if significant relationships existed between growth of western hemlock and site factors. To correct for multiple comparisons within each group of eight comparisons per site, an adjusted significance level ($\alpha=0.0064$) was used (Harris 1985, pp 504-506). All data analyses were performed using the following SAS procedures: MEANS, PLOT, and CORR (SAS Institute 1985a, 1985b).

For the subset of plots with soil and foliar nutrient data, the mean value and standard error for all variables were calculated for each area.

Nutrient status of several sites

Because of the limited number of sites (3) per combination of burn condition and foliar color, statistical analysis is limited or misleading. The values for each foliar, forest floor, and mineral soil nutrient were plotted against the two levels of foliage color under the two burn conditions. The graphs were visually examined for obvious trends or relationships relative to the burn and foliar color factors.

Results and discussion

Site and burned-unburned differences

Irrespective of site or burn condition, the germination point of most trees occurred on middle to upper microsite positions, with aspects that reflected the general aspect of the site, and with sandy loam to loam textured mineral soils. Thus these microsite characteristics did not appear to be related to differences in growth of western hemlock within any area.

Species composition varied between the two sites and between the burned and unburned areas (Table 1; data for individual plots is included in Appendix I). The overall species composition of the sites, though, is typical of that

TABLE 1. Mean percent cover (with standard error in parentheses) within strata for plants on two sites in the Eve River drainage.

Species	Site			
	E55		TN48	
	Unburned	Burned	Unburned	Burned
A1 layer - trees (>10 m tall)				
<u>Tsuga heterophylla</u> ^a	8.6 (1.8) ^b	0.0 (0.0)	0.3 (0.3)	0.0 (0.0)
B1 layer - trees (2-10 m tall)				
<u>Abies amabilis</u>	1.8 (1.1)	0.0 (0.0)	9.4 (1.9)	0.0 (0.0)
<u>Picea sitchensis</u>	0.9 (0.4)	1.5 (0.9)	0.1 (0.1)	0.0 (0.0)
<u>Tsuga heterophylla</u>	76.5 (2.1)	18.7 (1.9)	41.4 (3.5)	10.3 (2.3)
B2 layer - trees (<2 m tall)				
<u>Abies amabilis</u>	0.4 (0.1)	0.0 (0.0)	1.2 (0.4)	0.0 (0.0)
<u>Thuja plicata</u>	0.3 (<0.1)	0.9 (0.1)	2.6 (0.5)	10.6 (1.6)
<u>Tsuga heterophylla</u>	11.4 (0.9)	10.3 (0.9)	4.0 (0.6)	6.2 (0.7)
B2 layer - shrubs				
<u>Rubus parviflorus</u>	0.5 (0.2)	1.2 (0.5)	<0.1 (<0.1)	0.2 (<0.1)
<u>Rubus spectabilis</u>	3.0 (0.6)	5.6 (1.1)	6.9 (0.7)	8.0 (1.4)
<u>Vaccinium alaskaense</u>	<0.1 (<0.1)	0.1 (<0.1)	2.4 (0.6)	1.0 (0.3)
<u>Vaccinium parvifolium</u>	1.6 (0.3)	4.0 (1.6)	7.6 (0.9)	3.3 (0.8)
C layer - herbs				
<u>Anaphalis margaritacea</u>	<0.1 (<0.1)	2.0 (0.5)	0.5 (0.2)	1.5 (0.3)
<u>Achlys triphylla</u>	1.4 (1.0)	1.3 (0.8)	0.0 (0.0)	0.0 (0.0)
<u>Cornus canadensis</u>	0.3 (0.3)	3.8 (1.8)	17.5 (3.0)	18.4 (3.4)

TABLE 1. (continued)

Species	Site			
	E55		TN48	
	Unburned	Burned	Unburned	Burned
<u>Epilobium</u>				
<u>angustifolium</u>	0.9 (0.2)	19.1 (1.1)	5.3 (0.7)	18.8 (1.4)
<u>Elymus glaucus</u>	0.2 (<0.1)	2.1 (0.8)	0.0 (0.0)	0.0 (0.0)
<u>Lactuca muralis</u>	0.2 (<0.1)	1.4 (0.2)	0.4 (<0.1)	4.4 (0.6)
<u>Linnaea borealis</u>	<0.1 (<0.1)	0.0 (0.0)	0.2 (0.1)	1.5 (1.0)
C layer - ferns				
<u>Athyrium filix-femina</u>	0.1 (<0.1)	0.8 (0.4)	1.4 (0.3)	2.0 (0.4)
<u>Blechnum spicant</u>	2.4 (0.5)	4.0 (0.9)	11.0 (1.1)	5.8 (0.8)
<u>Dryopteris austriaca</u>	0.3 (<0.1)	1.0 (0.4)	0.7 (0.2)	1.2 (0.3)
<u>Polystichum munitum</u>	3.7 (0.6)	7.0 (0.3)	1.4 (0.4)	3.8 (0.5)

NOTE: List includes those species with mean cover >1% for at least one area.
^aPlants identified using Hitchcock and Cronquist (1973).
^bn=40 for all values.

expected for the region except for the absence of Gaultheria shallon (Klinka et al. 1984), which has been observed elsewhere in the Eve River drainage. The two burned areas lacked amabilis fir and had abundant coverage of Epilobium angustifolium and Anaphalis margaritacea. Greater coverage of these two herbaceous species has persisted for almost two decades after burning on plots in the western Cascades of Oregon (Dyrness 1973, Halpern 1989). The unburned areas had relatively greater coverage of western hemlock in both the B1 and A1 strata. This suggests that burning increased the coverage of herbs such as Epilobium angustifolium at the expense of western hemlock.

Trees on burned plots had smaller heights, diameters, volumes, and leader increments than on unburned plots (Table 2). Trees on the burned plots were also younger than those on adjacent unburned plots. The mean tree age for the burned and unburned areas of E55 were 7.8 yr and 14.8 yr, respectively. The corresponding values for TN48 were 7.3 yr and 16.8 yr, respectively. The age differences are slightly misleading as one third of the trees on the unburned areas had very suppressed growth for up to 33 years prior to release following logging. If suppressed trees are deleted, the average tree age was 10.7 yr and 10.2 yr for the unburned areas of sites E55 and TN48, respectively, indicating an establishment delay of about three years on the burned sites. These values are consistent with the results of Kuzmuk (1987) for this watershed. However, these results are for only two sites. More sites need to be sampled to determine if differences in size, growth rate, and age between burned and unburned areas are a general impact of burning or are simply unique characteristics of these two sites.

Tree growth and site variables

The raw data and the complete set of correlations among

TABLE 2. Mean and standard error (in brackets) for variables used in correlation analysis.

Variables	Site			
	E55		TN48	
	Unburned	Burned	Unburned	Burned
Tree				
Basal diameter (cm) (0.65)	7.95 (0.22)	2.94 (0.70)	3.98 (0.21)	2.47
Height (m)	6.35 (0.33)	2.12 (0.13)	5.12 (0.23)	1.79 (0.11)
Stem volume (m ³ x 10 ⁻³) (3.54)	16.79 (0.17)	0.77 (2.98)	16.15 (0.13)	0.50
Leader increment (cm/yr)	52.7 (2.2)	32.4 (2.3)	38.8 (2.6)	29.5 (2.1)
Site				
Slope (%)	41.9 (5.0)	31.0 (4.2)	77.7 (5.9)	40.6 (4.1)
Depth of forest floor (cm)	24.2 (3.1)	21.0 (2.2)	42.8 (3.2)	30.1 (3.8)
Coarse fragments: 0-20 cm depth (%)	29.0 (1.8)	30.0 (2.3)	54.4 (1.3)	56.3 (1.7)
Seedling density ^a (no./m ²) (0.1)	1.3 (0.1)	1.4 (0.1)	1.1 (0.3)	2.4
Basal area of competing trees ^a (m ² /m ² x 10 ⁻³)	3.38 (0.29)	0.43 (0.06)	1.93 (0.30)	0.07 (0.01)
Cumulative cover of B2 species ^b (%)	17.6 (1.6)	23.3 (2.1)	25.4 (2.0)	29.7 (2.3)
Cumulative cover of herbs (%)	9.7 (1.9)	44.7 (3.7)	40.0 (3.3)	61.0 (3.8)
Surface cover of decaying wood (%)	19.4 (1.6)	22.4 (2.2)	18.6 (1.4)	20.9 (2.0)

NOTE: n=40 for each value.

^aValues are per unit area. Values per root zone (< 2 m and 4 m radius plots for burned and unburned areas, respectively) were used in the regression analysis.

^bB2 layer includes shrubs plus trees < 2 m tall.

all variables are included in Appendices II and III. Using an adjusted significance level ($\alpha=0.0064$), the logarithm of stem volume was not significantly correlated with any site variable on any of the four areas (Table 3). A few correlations would have been significant if unadjusted significance levels had been used.

On the burned area of site E55, the largest correlation involved cover of decaying wood. Other studies have found that this substrate plays an important role in the establishment of western hemlock (Christy and Mack 1984, Harmon 1987, 1989). This result suggests that silvicultural practices, such as slashburning, that reduce the volume of decaying wood on a site, can be detrimental where western hemlock is the next crop. Even if the volume of decaying wood is not significantly reduced, surface charring can change the suitability of this substrate for germination of western hemlock seedlings. I observed very few western hemlocks germinated on logs or stumps with a high degree of charring. In contrast, germinants on logs or stumps in the unburned areas are abundant. The charred wood appears to be harder, less porous, and slower to decay than uncharred material. These characteristics would make this substrate less suitable for germination. However, the simple correlation indicates that the cover of decaying wood explains at most 10% of the variation in stem volume (Table 3). In contrast, the correlation for cover of decaying wood was relatively small on the burned area of site TN48.

A positive correlation with slope and a negative correlation with seedling density were the largest correlations with stem volume on the burned area of TN48 (Table 3). A possible relationship with slope suggests a microclimate factor. For example, a steeper microsite on the south aspect of TN48 could be important for tree growth in early spring. Microsites with steeper slopes would have earlier snow melt. However, slope and tree volume had a

TABLE 3. Pearson product moment correlations (probability levels in brackets) between site variables and stem volume for western hemlock on burned and unburned areas of two sites.

Site variables	----- Stem volume ^a -----			
	Site			
	E55		TN48	
	Unburned	Burned	Unburned	Burned
Slope	0.1671 (0.3028)	-0.0736 (0.6520)	0.2650 (0.0984)	0.3203 (0.0439)
Depth of forest floor	0.2314 (0.1507)	0.1380 (0.3957)	-0.3909 (0.0126)	0.2554 (0.1118)
Coarse fragments: 0-20 cm depth	0.1657 (0.3068)	0.0934 (0.5665)	-0.0694 (0.6703)	0.0933 (0.5667)
Seedling density	-0.3114 (0.0505)	0.0526 (0.7471)	-0.3450 (0.0293)	-0.3289 (0.0382)
Basal area of competing trees	0.2278 (0.1574)	-0.0855 (0.6000)	-0.0789 (0.6284)	-0.0031 (0.9848)
Cumulative cover of B2 species	-0.2459 (0.1262)	0.0552 (0.7353)	0.0785 (0.6301)	0.0326 (0.8418)
Cumulative cover of herbs	-0.1215 (0.4554)	0.0923 (0.5711)	-0.1763 (0.2766)	-0.1034 (0.5255)
Surface cover of decaying wood	-0.0142 (0.9309)	0.3240 (0.0414)	-0.2100 (0.1936)	0.2346 (0.1452)

NOTE: $\alpha=0.0064$ was used for the significance level for each correlation coefficient (n=40).

^aThe values for stem volume were log-transformed prior to calculating the correlation coefficient.

very small correlation on the corresponding area of site E55. A negative correlation with seedling density indicates that tree competition may exist on the burned area of TN48. Competition from seedlings is possible on this area as seedlings are comparable in size to the target trees. Greater numbers could have a negative impact on the growth of the target tree. For the unburned area of site TN48, The largest negative correlations were between stem volume and depth of forest floor and seedling density. The negative correlation with depth of forest floor suggests that tree growth has been smaller on microsites with thick organic layers. In this study, thick organic layers often represented accumulations of slightly decomposed woody substrates. These may provide relatively few nutrients for tree growth. Degree of substrate decomposition is important in determining growth. Tree competition is again suggested as greater seedling densities had a negative impact on tree growth in the unburned area of site TN48.

The correlation analysis suggests that growth of western hemlock may be limited by tree competition or by substrate deficiencies. These results are very tenuous. I found high cover of herb and shrub species on many microplots (Table 1) which suggests that competition from these species should exist on these areas. The correlations for cumulative cover of B2 species and of herb species do not give any indication of a possible relationship with the growth of western hemlock (Table 3). Visual cover estimates can have observational errors exceeding 10% of the mean for some species (Kennedy and Addison 1987), which would decrease the amount of variation that can be explained. The reliability of cover estimates has also been found to vary for different structural categories of vegetation (Floyd and Anderson 1987). More importantly, cover of a plant in a plot is probably not directly or linearly related to its competitive effect on the target tree, which may partly

explain why a relatively small percent of the variation in tree variables was accounted for on the burned areas. A number of other factors could account for the small amount of variation explained in total tree growth. On the burned areas of E55, a few sample points included microsites that had soil compaction apparently caused by several passes of a Caterpillar tractor. At these spots relatively small, slow-growing trees occurred although there was little competition from conifers or other plant species. Also, on both burned areas, accumulations of wood on several plots appeared to have two different effects on tree growth. For trees germinated on a favourable microsite, the reduced availability of other microsites yielded a site with reduced competition and a larger tree. In contrast, a poor microsite would yield a smaller tree with relatively little competition from other plants. Either of these situations would make it difficult to detect the effects of vegetation competition on tree growth.

The scatter plots between stem volume and the site variables approximated those for randomly generated variables. For the variables with the largest correlations, the scatter plots suggested very general or weak relationships. A few plots of this type could result from random chance alone. It appears that this study has largely involved measurement error within a site rather than assessing true relationships between site variables and the growth of western hemlock. Assuming that the site variables measured have some influence on tree growth, significant relationships may be more readily detected by sampling many sites and by collecting multiple observations within each site. Even with such a strategy, the observational properties may be inadequate to indicate which factors are controlling growth of western hemlock on these sites. An experimental approach may be the preferred method for assessing the factors that are controlling the growth of

this species on these sites. For example, treatments could include removal or reduction of various components of competing vegetation from a plot. However, for trees with life-spans of hundreds of years, the response variables would need to be monitored for many years or decades. This is a major limitation when studying tree growth.

Tree growth and nutrients

The raw data for the foliar and soil nutrient analysis are included in Appendix IV. The mean values for foliar, forest floor, and mineral soil nutrient concentrations along with growth and size characteristics of the corresponding western hemlock target trees are presented in Table 4 for the burned and unburned areas at each site. Stem volume, basal diameter, and height for the subset of plots used in the nutrient analysis are similar to values for the entire set of plots (Tables 2 and 4). Needle weights for the present study are slightly lower than those reported for the upper crown of 35 year old western hemlock near Haney, British Columbia (Smith 1972).

Although Kuzmuk (1987) found that western hemlock are much larger and are currently growing more rapidly on the unburned areas, there were no obvious differences in foliar, forest floor, or mineral nutrient concentrations between burned and unburned areas (Table 4). As noted earlier, these results are for only two sites. A larger number of sites should be sampled to determine if burning has caused significant changes in the concentration of foliar nutrients.

The foliar concentrations for N, P, K, Ca, and Mg (Table 4) were within the range found for 60 to 150 year old stands of western hemlock on three sites in coastal British Columbia (Beaton *et al.* 1965). Total S was generally lower in the present study. The N, P, and K levels represent moderately to severely deficient stands (Ballard and Carter

TABLE 4. Mean and standard error (in brackets) for size and growth characteristics, foliar nutrient concentrations, and forest floor and mineral soil nutrient concentrations for western hemlock on burned and unburned areas of two sites.

Variables	Site			
	E55		TN48	
	Unburned	Burned	Unburned	Burned
Tree variables				
Basal diameter (cm)	7.04 (1.34)	2.85 (0.45)	8.57 (1.17)	2.55 (0.37)
Height (m)	5.77 (0.50)	1.97 (0.29)	4.82 (0.37)	1.91 (0.24)
Stem volume (m ³ x 10 ⁻³)	12.53 (6.86)	0.69 (0.27)	12.20 (4.22)	0.49 (0.16)
Leader increment (cm/yr)	55.2 (4.1)	30.9 (5.3)	41.8 (5.2)	30.5 (5.2)
Needle weight (mg)	2.26 (0.12)	2.07 (0.15)	2.62 (0.17)	2.53 (0.12)
Foliar nutrients				
N (%)	1.179 0.936 (0.044)	1.016 0.1016 (0.048)	0.990 0.990 (0.064)	(0.100)
P (%)	0.188 0.148 (0.009)	0.123 0.123 (0.009)	0.164 0.164 (0.011)	(0.009)
K (%)	0.508 0.632 (0.028)	0.615 0.615 (0.034)	0.682 0.682 (0.031)	(0.040)
S (%)	0.088 0.086 (0.004)	0.090 0.090 (0.005)	0.085 0.085 (0.005)	(0.007)
SO ₄ ²⁻ -S (mg/kg)	105.8 (14.9)	205.5 (30.9)	156.4 (28.4)	124.3 (16.7)
Ca (%)	0.247 (0.009)	0.271 (0.032)	0.260 (0.017)	0.246 (0.024)
Mg (%)	0.120 (0.005)	0.095 (0.005)	0.092 (0.008)	0.088 (0.007)

TABLE 4. (continued)

Variables	Site			
	E55		TN48	
	Unburned	Burned	Unburned	Burned
Mn (mg/kg)	1165. (121.)	1665. (372.)	1434. (172.)	1410. (170.)
Fe (mg/kg)	44.5 (3.0)	55.8 (4.6)	110.5 (26.8)	149.1 (30.5)
Active Fe (mg/kg)	29.1 (2.3)	47.7 (4.0)	70.3 (12.0)	86.2 (12.6)
Cu (mg/kg)	1.9 (0.2)	0.7 (0.3)	5.8 (0.6)	3.9 (0.4)
Zn (mg/kg)	8.2 (0.4)	8.3 (0.7)	13.1 (1.8)	11.3 (1.8)
B (mg/kg)	13.2 (0.9)	15.5 (1.2)	20.3 (0.7)	20.1 (2.0)
Forest floor				
C (%) 57.3	60.5 (1.9)	49.1 (1.1)	49.1 (0.9)	(0.7)
N (%) 1.01	0.88 (0.07)	0.85 (0.06)	0.99 (0.08)	(0.06)
Mineralizable N (mg/kg)	359.0 (34.1)	169.3 (16.5)	184.7 (46.4)	292.0 (48.2)
Extractable P (mg/kg)	65.6 (10.3)	22.8 (4.6)	30.7 (5.2)	40.5 (9.2)
CEC (meq/100 g)	78.33 (5.21)	94.11 (8.05)	64.75 (4.22)	103.38 (7.39)
Ca (meq/100 g)	14.54 (1.52)	18.98 (1.42)	20.95 (1.57)	40.48 (4.65)
Mg (meq/100 g)	3.67 (0.60)	3.69 (0.43)	4.40 (0.50)	6.95 (0.94)
K (meq/100 g)	1.78 (0.24)	0.52 (0.05)	1.26 (0.25)	1.40 (0.19)
Al (meq/100 g)	2.38 (0.40)	1.99 (0.46)	0.86 (0.21)	0.63 (0.20)

TABLE 4. (continued)

Variables	Site			
	E55		TN48	
	Unburned	Burned	Unburned	Burned
Mineral soil (0-20 cm)				
C (%) 7.7	8.3 (0.7)	9.2 (1.0)	7.6 (1.6)	(0.8)
N (%) 0.27	0.24 (0.02)	0.23 (0.03)	0.20 (0.04)	(0.02)
Mineralizable N (mg/kg)	21.2 (4.7)	18.8 (5.8)	39.0 (11.4)	35.9 (7.0)
Extractable P (mg/kg)	2.7 (0.6)	1.1 (0.3)	0.2 (0.2)	3.3 (1.9)
CEC (meq/100 g)	16.44 (0.96)	20.70 (2.10)	27.18 (3.40)	26.22 (2.41)
Ca (meq/100 g)	1.23 (0.31)	1.26 (0.58)	4.19 (1.11)	3.72 (0.69)
Mg (meq/100 g)	0.24 (0.04)	0.21 (0.06)	0.88 (0.22)	1.02 (0.14)
K (meq/100 g)	0.09 (0.02)	0.06 (0.01)	0.10 (0.03)	0.13 (0.02)
Al (meq/100 g)	0.78 (0.17)	0.90 (0.24)	0.70 (0.22)	0.44 (0.12)

NOTE: n=10 for each value.

1986). The S values for some areas suggest that deficiency could be induced by the addition of nitrogen fertilizer (Ballard and Carter 1986). The N levels were lower and the P levels were greater than those reported for unfertilized seedlings of western hemlock grown in a pot study (Heilman and Ekuan 1980). Except for the unburned area of E55, the N and P concentrations were lower than those reported for unfertilized trees from 20 to 30 year old stands of western hemlock in Oregon and Washington (Radwan and DeBell 1980, 1989). The K concentrations on all areas were lower than the values reported in the same study. The N, P, and K levels corresponded to the low and very low levels found for one year old seedlings in a sand culture study; seedlings with these levels of foliar nutrients would be expected to respond to nutrient additions (van den Driessche 1976). The concentrations of the micronutrients B, Fe, and Mn were comparable to those for stands in Washington, while the values for Cu on E55 and Zn on both sites were lower (Radwan and DeBell 1980). The values for Cu and Zn on E55 correspond to moderately deficient levels (Ballard and Carter 1986). However, the foliar concentrations for B and Zn were greater than the deficiency levels reported for western hemlock on Vancouver Island (Carter *et al.* 1986). Overall, the foliar concentrations of the macronutrients N, P, and K in the present study are comparable to or slightly lower than for other unfertilized stands of western hemlock. The levels correspond to those for which nutrient additions have yielded growth response in seedlings and 20 to 30 year old stands (Radwan *et al.* 1984, van den Driessche 1976). Thus growth on the sites in the Eve River drainage is probably nutrient limited. Competition for nutrients among plants is likely and one would predict that reduced competition should yield increased nutrient levels in trees. In particular, the foliar nutrients that should respond include P, N, K, S, and possibly Cu.

The total N values in the forest floor and mineral soils (Table 4) were comparable to values reported for soils from stands of western hemlock in coastal Washington (Heilman 1976, Heilman and Ekuan 1980, Anderson et al. 1982). The mineralizable N values reported here are greater than those found for similar soils in Washington (Anderson et al. 1982), although values are not strictly comparable because an aerobic incubation technique was used in the latter study. Except for site E55, the extractable P values for the forest floor and mineral samples were lower than values reported for soils with western hemlock in Washington and Alaska (Anderson et al. 1982, Heilman 1976, Heilman and Ekuan 1980). The above comparisons are tentative because they involve concentration data. Bulk densities and rooting depths are needed for all sites to properly compare nutrients on a mass per area basis. Radwan and Shumway (1983) found a high correlation between extractable P, or the ratio of extractable P to total N, and growth response of western hemlock to N fertilizer. However, it is difficult to compare their values with those of the present study as their results were reported in kg/ha.

The overall result of the soil analysis is that, with the exception of the unburned area of site E55, the sites in the Eve River drainage have lower P values than for soils in Washington and Alaska and lower total N values than for some sites in Washington. This assumes that bulk densities and rooting depths are similar on all sites. Therefore soil nutrient supply may be limiting growth of western hemlock at the sites, but from the data obtained it is unclear why growth of trees is so much poorer on the burned areas. Because trees on the unburned areas are growing faster, they must be taking up greater total amounts of nutrients than trees on burned areas. Possibly the greater growth is diluting nutrients such that concentrations are maintained at similar levels in trees on both types of areas. It is

possible that differences in foliar nutrient concentrations only occur during part of the year and were not detected at the single sampling period. Thus sampling should be undertaken at different times during the year.

The lack of obvious differences in soil nutrients between burned and unburned areas is puzzling. At least five explanations are possible: (1) The concentration data do not adequately reflect actual nutrient availability. (2) Critical nutrient deficiencies occur at times other than when sampling was conducted. (3) Herbs and shrubs rapidly remove nutrients as they become available and thus limit uptake by western hemlock. (4) The smaller size of western hemlock is largely due to historical factors such as later establishment of trees on the burn, past competition, or transient nutrient deficiencies that occurred following burning. (5) Finally, the nutrients measured may not be responsible for the observed growth differences. If so, it is unclear what would cause the growth differences. The climate is very wet and it seems unlikely that the larger trees would have less water stress than nearby smaller ones. However, the possibility of greater soil water removal due to the higher cover of herbs and shrubs on the burned areas cannot be ruled out. Also, growing season water deficits have been found for similar stands on other parts of Vancouver Island (Giles et al. 1985). Experimental manipulations involving removal of competitors and fertilization are required to unravel these factors. N and P appear to be the nutrients most likely to be involved in limiting tree growth. For each of these possibilities a greater number of sites should be sampled to properly test for differences between burned and unburned areas.

General study of twelve sites

The height and diameter of trees in nonchlorotic stands appeared to be greater than in chlorotic stands

irrespective of the presence of burning (Table 5). This indicates that burning is not the sole factor contributing to poor growth of western hemlock. The raw data for foliar, forest floor, and mineral soil nutrients used in assessing the nutrient status of the twelve sites are included in Appendix V. The concentrations for foliar N, S, $\text{SO}_4^{2-}\text{-S}$, and forest floor B are plotted by color and burn condition in Figures 2 and 3. All other plots of foliar and soil nutrients did not possess any obvious trends with respect to burning or foliar color. The small sample size for each burn and foliar color combination limits one's ability to detect relationships. Concentrations of foliar N and S were consistently greater for the nonchlorotic stands irrespective of burn condition (Figure 2). A significant correlation between foliar N and the chlorophylls in western hemlock has been reported in 20 to 30 year old stands in Washington (Radwan and DeBell 1980). Sulfur metabolism is strongly interrelated with N for processes such as synthesis of protein and chlorophyll molecules; thus, chlorosis observed in plants could be the result of sulfur deficiency (Marschner 1986). The plot for $\text{SO}_4^{2-}\text{-S}$ suggests a possible interaction between burning and chlorosis (Figure 3). For chlorotic stands the $\text{SO}_4^{2-}\text{-S}$ concentrations were generally greater for unburned than for burned sites, whereas the reverse occurred in the nonchlorotic stands. In Douglas-fir and Radiata pine (Pinus radiata D. Don), foliar concentration of $\text{SO}_4^{2-}\text{-S}$ generally increases from sulfur deficient to nitrogen deficient stands (Turner et al. 1977). If this type of relationship was present in western hemlock, one would expect to see greater $\text{SO}_4^{2-}\text{-S}$ concentrations in the chlorotic stands with decreases in the nonchlorotic stands associated with better nitrogen status. Irrespective of burning, chlorotic stands had lower levels of B in the forest floor (Figure 3). This indicates that soil supply capabilities for this nutrient may be directly or indirectly

TABLE 5. Characteristics of study sites.

Site	Latitude/ longitude	Eleva- tion (m)	Aspect	Mean slope (%)	Date of logging	Date of burning	Western hemlock	
							Height (m)	Diameter at 10cm (cm)
Nonchlorotic and unburned ^a								
E55 ^b	50°22'30"N/ 126°12'30"W	170	SW	5	1973	-	6.35 ^d (0.33,40)	7.95 ^d (0.65,40)
PC12 ^c	50°24'40"N/ 126°17'18"W	450	E	50	1972	-	9.17 (0.93,10)	10.18 (0.94,52)
TN48 ^c	50°21'40"N/ 126°17'45"W	500	S	30	1974	-	5.12 (0.23,40)	8.98 (0.70,40)
Nonchlorotic and burned								
E25 ^b	50°25'42"N/ 126°13'50"W	190	NE	5	1969	1970	7.16 (0.76,10)	4.38 (0.23,168)
PC12 ^c	50°24'40"N/ 126°17'18"W	450	E	50	1972	1972	5.33 (0.36,10)	4.84 (0.21,160)
TN5 ^c	50°23'55"N/ 126°14'29"W	300	NE	30	1971	1971	6.61 (0.64,10)	7.48 (1.0,29)
Chlorotic and unburned								
E25 ^b	50°25'22"N/ 126°13'25"W	200	NW	10	1977	-	2.79 (0.14,39)	3.21 (0.27,39)

TABLE 5. (continued)

Site	Latitude/ longitude	Eleva- tion (m)	Aspect	Mean slope (%)	Date of logging	Date of burning	Western hemlock	
							Height (m)	Diameter at 10cm (cm)
TS45 ^c	50°21'40"N/ 126°17'48"W	550	E	35	1976	-	1.84 (0.08,46)	2.04 (0.14,46)
TN51 ^b	50°22'00"N/ 126°17'23"W	500	S	5	1975	-	2.66 (0.29,82)	2.98 (0.26,82)
Chlorotic and burned								
E44 ^c	50°23'00"N/ 126°12'13"W	270	W	35	1973	1974	2.40 (0.06,40)	3.13 (0.12,40)
E55 ^b	50°22'30"N/ 126°12'30"W	170	SW	5	1973	1974	2.12 (0.13,40)	2.94 (0.22,40)
TN48 ^c	50°21'40"N/ 126°17'45"W	500	S	30	1974	1976	1.79 (0.11,40)	2.47 (0.21,40)

NOTE: Soils were predominantly Duric Ferro-Humic Podzols with minor inclusions of Orthic Humo-Ferric Podzols (Jungen 1985).

^aTrees on chlorotic sites had one year old foliage that was predominantly yellow (7.8Y 3.8/5.3 or yellower). Nonchlorotic sites had trees with predominant foliar color of green-yellow (0.5GY 4.2/6.2 or greener). Sites were selected in April 1988 using The Munsell Limit Color Cascade (Munsell Color, Macbeth Color Photometry Division, 2441 N. Calvert St., Baltimore, Md. 21218).

^bLandform is fluvial or fluvialglacial (Jungen 1985).

^cLandform is moraine (Jungen 1985).

^dMean with standard error and sample size in brackets. For burned and unburned areas only trees >1m and >3m tall, respectively, are included.

Figure 2. Concentration versus color status under two burn conditions for foliar nitrogen and sulfur. The levels for burn are unburned (0) and broadcast burned (+). Each value is obtained from a composite sample for ten trees on each site.

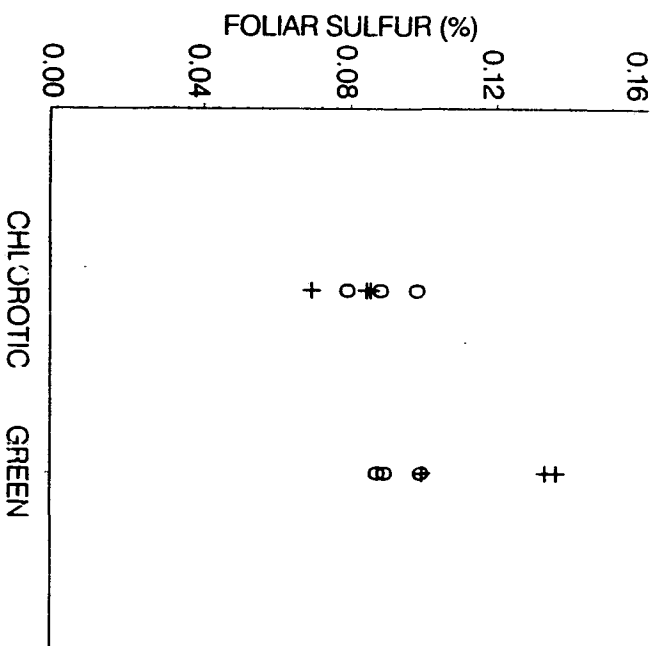
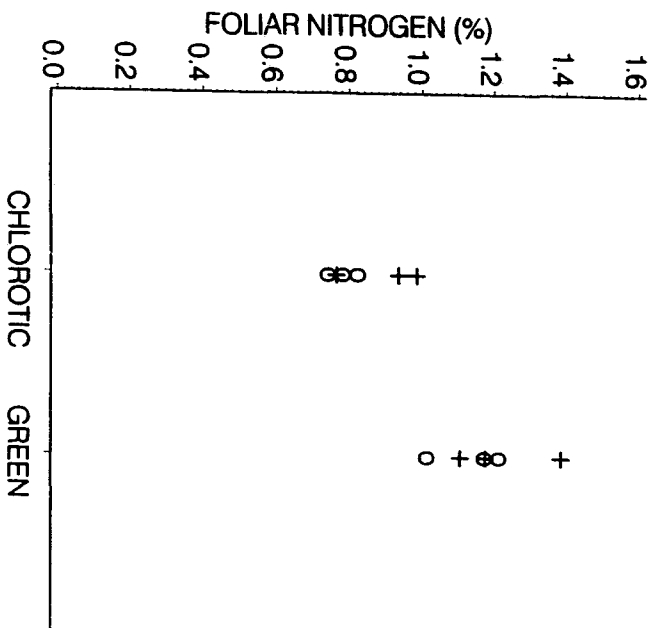
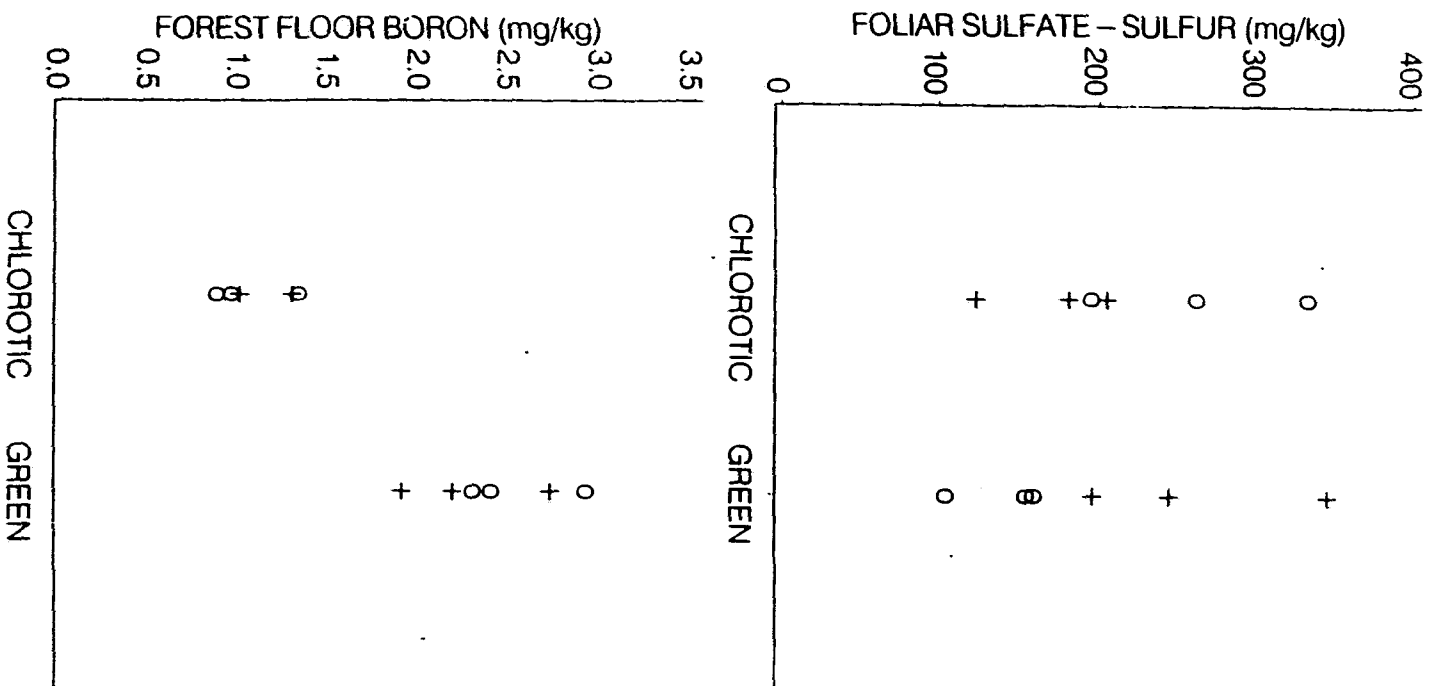


Figure 3. Concentration versus color status under two burn conditions for foliar sulfate-sulfur and forest floor boron. The levels for burn are unburned (0) and broadcast burned (+). Each value is obtained from a composite sample for ten trees on each site.



affecting foliar color. Chlorosis is one of the visible symptoms of B deficiency in conifers and other plants (Ballard and Carter 1986, Marschner 1986). Boron deficiency has been reported in western hemlock on Vancouver Island (Carter *et al.* 1986). The levels obtained for foliage in the Eve River drainage, however, are similar to those reported by Carter *et al.* (1986) for vigorous rather than deficient Douglas-fir. Thus the role of B in the poor growth of western hemlock is equivocal.

Overall, the chlorotic condition and poor growth of some stands in the Eve River drainage appears to be related to levels of foliar N and S. The low levels of foliar N and S could account for poor growth of chlorotic trees. Other nutrient deficiencies or imbalances may also exist but cannot be detected graphically or statistically because of the limited sample size. The chlorotic condition of stands results from a plant nutrition or soil supply problem that varies from site to site and is not strictly a result of burning, although burning appears to greatly exacerbate the problem. Burning could act by decreasing the availability of nutrients, especially N or S, on sites where they are borderline deficient by either changing soil processes directly or changing species composition and therefore altering patterns of competition for nutrients.

Summary and conclusions

The burned areas in the present study were characterized by lower cover and smaller trees of western hemlock, absence of amabilis fir, and greater cover of herbaceous species. An establishment delay of three years has occurred on the burned areas. Size and growth variables in western hemlock were highly correlated. Stem volume was selected as the best measure of tree growth on these sites. The logarithm of stem volume was not significantly correlated with the site variables on any area, using

adjusted significance levels. For one burned area, a weak relationship was found between decaying wood and tree growth but it explains little of the variation in growth of western hemlock. The other burned site had weak relationships between stem volume and slope or seedling density. On one unburned area, the role of woody substrates and seedling density were suggested as possible factors affecting growth of western hemlock. Although high cover of herb and shrub species was observed on many plots, significant correlations with stem volume were not found. Problems in measuring some of the variables may have prevented the development of significant relationships. Significant relationships may not have been found because within-site variability was assessed, rather than relationships between tree growth and site characteristics. An alternative sampling strategy may be necessary or an experimental study is needed to properly assess the factors controlling the growth of western hemlock on these sites.

Growth of western hemlock may be nutrient limited on these sites, as foliar analysis indicated low levels of P, N, K, S, and possibly Cu, relative to values reported in other studies on western hemlock. Differences in either foliar or soil nutrients between burned and unburned areas could not be detected, though, indicating that growth may not be directly related to nutrient concentrations. Various factors could modify relationships between tree growth and nutrient concentrations. Graphical analysis of data from 12 sites showed that chlorosis was associated with possible nutrient deficiencies or imbalances involving foliar N and S. Although soil B levels were low on chlorotic sites, foliar concentrations were comparable to those found in vigorously growing western hemlock from other parts of Vancouver Island. Other nutrient problems may be present but could not be detected due to sample size limitations.

These results combined with field observations suggest

that competition from herbs, shrubs, or other trees could be limiting the growth of western hemlock on both burned and unburned areas in the Eve River drainage. One hypothesis to test on these sites is that reduced competition from herb, shrub, or tree species should yield increased growth of western hemlock. Another hypothesis, if competition for nutrients is occurring on these sites, is that reduced vegetation competition should yield increased nutrient concentrations in western hemlock. In particular, the foliar nutrients which should be affected by reduced vegetation competition include P, N, K, S, SO_4^{2-} -S, and Cu.

Chapter 2

GROWTH RESPONSES OF WESTERN HEMLOCK TO REDUCED PLANT COMPETITION

Introduction

Numerous studies have examined interspecific plant competition. Harper (1977) reviewed studies on plant competition, which up to that time were primarily greenhouse or garden trials involving herbaceous species. Recent research has involved a combination of greenhouse and field studies to estimate the effect of competing vegetation on a target species (Bookman and Mack 1982, 1983, Gurevitch 1986, Mack and Harper 1977, Sydes and Grime 1981).

Root competition from trees can limit the growth of understory herb or shrub species. For instance, repeated trenchings in a 40 to 60 year old stand of eastern white pine (*Pinus strobus* L.) in New Hampshire resulted in increased size and abundance of shrubs and herbs, and also increased growth of understory eastern hemlock (*Tsuga canadensis* (L.) Carr.) (Toumey and Kienholz 1931). In a grand fir (*Abies grandis* (Dougl.) Lindl.) forest in western Montana, McCune (1986) used trenching to demonstrate that the growth of herbs is limited by root competition from overstory trees, but as in other trenching studies, competition for moisture and competition for nutrients were not separated.

Other studies have examined the effects of herb and shrub competition on the establishment and subsequent growth of trees. Seedlings of flowering dogwood (*Cornus florida* L.) had increased survival if planted in a windthrow plot where trenching was combined with removal of all aboveground vegetation (Horn 1985). The increased survival was attributed to greater moisture in the soil due to reduced uptake by competing plants. In northern California,

greenleaf manzanita (Arctostaphylos patula Greene) greatly reduced the aboveground biomass production of ponderosa pine (Pinus ponderosa Dougl. ex Laws) seedlings, after the first growing season, by reducing the soil moisture available to the trees (Radosevich 1984). The establishment of trees such as eastern hemlock and red maple (Acer rubrum) was limited by the ferns Dryopteris spinulosa (Mueller) Watt and Dennstaedtia punctilobula (Michaux) Moore in an old-growth forest in West Virginia (Maguire and Forman 1983). The growth of Douglas-fir seedlings can also be reduced by competition from grass species or from red alder (Alnus rubra Bong.) (Cole and Newton 1987). In a review paper, summarizing several studies on Pinus spp. where growth was water-limited, Gjerstad et al. (1984) noted that control of herbaceous competition can yield short-term increases in the survival and growth of tree species as well as a residual long-term effect that can last for at least 20 years. After trees have overtopped herbs and shrubs, competition from these plants can still limit tree growth. For example, photosynthesis and transpiration of 14 m tall Douglas-fir was reduced by competition for moisture by salal on a dry site on the east coast of Vancouver Island (Price et al. 1986). Tree to tree competition must be accounted for when studying the effects of plant competition on the growth of individual trees. For example, the annual increment of pitch pine (Pinus rigida Mill.) in a monospecific stand was significantly correlated with the size, number, and distance to neighboring trees (Weiner 1984). The importance of tree to tree competition in affecting the growth of individual trees was also demonstrated for Douglas-fir by Cole and Newton (1987). Thus studies involving plant competition need to incorporate treatments that involve all species that affect the species of interest.

A few studies have examined the types of competition affecting western hemlock and the response of this species

to reduced competition. Christy (1986) studied the response of suppressed western hemlock, 40 to 200 cm tall, to reduced above- and below-ground competition. Above-ground competition was reduced by pruning and below-ground competition was reduced by trenching and root cutting. Both treatments resulted in an increase in growth within two years, with the largest response for the trenching treatments. In a plantation of 20 year old western hemlock near Haney, B.C., width of the annual growth ring was positively correlated with spacing at the time of planting (Smith 1980), suggesting the existence of intraspecific competition. Response to reduced competition has also been demonstrated in naturally regenerated stands of this species. A study involving thinning, shelterwood, and seed tree cuttings of a 60 year old stand of western hemlock measured the growth response of the naturally regenerated stand eight years after removal of the final overstory trees (Jaeck *et al.* 1984). The greatest height, diameter, and age of regenerated trees was found in the seed tree treatment. Thus, the greatest response in growth for western hemlock occurred with the largest reduction in overstory competition. Western hemlock can respond to reduced competition over a wide range of ages and sizes. For example, in Washington an increase in growth rate was found for suppressed trees ranging in age from 9 to 110 years and in dbh from 1 to 33 cm (Oliver 1976). After a short time lag, the growth curve for suppressed trees was the same as that for nonsuppressed trees of a similar size. A study involving thinned stands of western hemlock in western Washington and Oregon found an average increase in radial increment 7 years after thinning of 24% in stands 21 to 40 years in age compared with 9% for stands aged 10 to 20 years (Olson *et al.* 1979). The smaller response in the younger stands was attributed to smaller tree size and greater room remaining on the site for growth. By contrast, the older

and larger trees would have more completely occupied the space available. This study not only demonstrated that intraspecific competition exists, but also that one response to reduced competition is greater radial growth. Thus the response of western hemlock to reduced competition is increased growth in diameter and height, which can occur over a wide range of ages and sizes.

In the first part of this study, I was unable to find significant relationships between growth of western hemlock and site factors on burned and unburned areas in the Eve River watershed (Chapter 1). During the field sampling, I measured plots on the burned areas with high seedling density, high basal area of competing trees, and high cumulative cover of herb plus shrub species. These measurements suggested that plant competition may be a critical factor related to the poor growth and chlorotic condition of western hemlock on burned clearcuts. Treatments involving the removal or reduction of competing vegetation were suggested as an alternative approach to assessing factors that affect the growth of western hemlock. This second phase of the study was therefore designed to experimentally evaluate the response of poorly growing individual western hemlocks on two burned areas to the reduction of competition. Plant competition was separated into two types that are of both theoretical and practical interest: (1) competition from all other trees irrespective of size (thinning treatment) and (2) competition from herb and shrub species (brush reduction treatment). For a limited subset of plots on one site, a trenching treatment was included in order to reduce root competition from plants outside the plot. The trenching treatment included thinning, brush removal, and root severing at the periphery of the plot. The study was limited to burned areas where both of the above types of competition appeared to be present and where vegetation competition appeared to be an

important cause of reduced growth after slashburning. The response of western hemlock to treatments reducing competition was measured after one and two growing seasons.

The main hypothesis was that the diameter, height, volume, and needle weight of western hemlock trees should significantly increase as the result of reduction in either tree or herb plus shrub competition. Because all plants have similar requirements for water and nutrients for growth, reduction in both types of competition should yield a greater response than either alone. Therefore the order of increased growth with time should be control, thinning or brush reduction, and a combined thinning plus brush reduction. The relative magnitude of the response to thinning or brush reduction should depend on the magnitude of each type of competition on a particular site. If the response to different types of competition reduction is additive, there should not be a significant interaction between thinning and brush reduction. An additive response would occur if reduction in one type of competition is not followed by a corresponding increase in the other type. If there is root competition from plants outside the individual plots, the trenching treatment should yield another reduction in competition, and the response would be greater than any of the other treatments.

Materials and methods

Study sites

The general characteristics of the study area are described in Chapter 1. Two sites were selected for treatments involving reduced competition. The first site, E55, is a fluvial or fluvial-glacial terrace with an average slope of 5% and a southwest aspect. The second site, E44, is a morainal deposit with an average slope of 35% and a west aspect. The first site was used in the correlation and descriptive study reported in Chapter 1. Both sites were

logged in 1973 and broadcast burned in 1974. All woody fragments were severely charred and forest floor was reduced in thickness for all areas on these sites. Preliminary observations indicated that each site was relatively uniform in its site, soil, and vegetation characteristics. Detailed information for both sites is included in Table 5 of Chapter 1. Both sites had western hemlock that were observed to have chlorotic foliage in April 1987.

Field methods

At each site, the burned area was mapped to scale. A grid for locating sample points was used to obtain an even distribution of 40 points at a spacing of 14 m for E55 and 60 points at a spacing of 25 m for E44. For each site, 10 sample points were randomly selected for locating a block of treatments. Each block included four randomly selected trees within a radius of 7 m for E55 or 12 m for E44 from the sample point. Each target tree was randomly assigned to one treatment. For seven blocks on E55, an additional tree was selected for a trenching treatment. Target trees were 1.5 to 2.4 m high and at least 4 m apart. The tree sizes were comparable to the average size for these sites found in an earlier study (Kuzmuk 1987). For each treatment, the selected tree formed the center of a circular plot of 2 m radius. The plot dimension selected reflects the estimated root extension for trees of this size (Eis 1974).

During July 1987, prior to application of the treatments, height and basal diameter (at 10 cm above the germination point) were measured on the target trees. Stem volume of each tree was calculated using the formula for a cone. Tree height and basal diameter were used for the cone dimensions. A foliar sample of the current year's growth was collected from the target tree and returned to the laboratory to obtain the mean dry weight per needle. Samples were oven dried to constant weight at 70°C. Within

the plot, the basal diameters, at 10 cm, for all other trees ≥ 1 m tall were measured and the basal area was calculated for each tree; the basal areas were summed to obtain a total basal area within the root zone of each target tree. Seedling density (no./root zone) was determined by counting all trees, including germinants, < 1 m tall within the plot. Percent cover of all vascular plant species was visually estimated within the following strata: B1 - trees 2-10 m tall, B2 - shrubs plus trees < 2 m tall, and C - herbaceous species. Species were identified according to Hitchcock and Cronquist (1973). For each stratum, the cover for all species was summed to obtain a total for the stratum.

The following four treatments were applied to plots at all sample points on both sites during July and August 1987. The first was a thinning treatment that included cutting and removal of all trees, including seedlings and germinants, within two meters of the target tree. The second was a brush reduction (herbicide) treatment that consisted of an application of a 2% (volume/volume) solution of the isopropylamine salt of glyphosate (Vision^{®1}) in water, at a rate equivalent to 2 L/ha of active ingredient. A hand-held, backpack sprayer was used to spray all herb and shrub species within two meters of the target tree. Application to conifers was avoided, as previous experience indicated that foliage of western hemlock was sensitive to this solution prior to late September (J. Loftus, personal communication). The other two treatments were a combined herbicide plus tree removal treatment and an untreated control. The trenching treatment, applied within seven blocks on E55, was the same as the combined treatment above except that it also included digging (to a root restricting layer, 50 to 100 cm deep), and refilling of a trench along

¹®A registered trademark of Monsanto Chemical Company, St. Louis, MO.

the perimeter of the 2 m radius plot.

The target trees were remeasured at the end of one and two growing seasons (September of 1988 and 1989). At these times, tree height and diameter were measured, stem volume was calculated, and a foliar sample was collected for the current year's growth to obtain the mean dry weight per needle.

Data analysis

Changes in tree dimensions (diameter, height, stem volume, and needle weight) were calculated by subtracting the initial values from the values at the end of the first and second growing seasons. These temporal differences were used as the response variables in the analysis of variance (ANOVA) described below. Preliminary analysis of needle weight indicated that the response pattern for this variable was complex, inconsistent, and ambiguous. Thus descriptive statistics were calculated for this variable but it was not included in the subsequent data analysis.

Three ANOVAs were performed on the dimension differences to determine if significant responses to the treatments had occurred. All analyses were performed separately for dimension differences at the end of each growing season. The first analysis involved a two site design with a site factor, a brush reduction factor, and a thinning factor. The first factor was random and the last two were fixed. The brush removal and thinning factors formed a 2x2 factorial in a randomized complete block design within each site. The following experimental design model was used in the analysis:

$$Y_{ijkl} = \mu + S_i + B_{j(i)} + T_k + (T \times S)_{ki} + (T \times B)_{kj(i)} + H_l \\ + (H \times S)_{li} + (H \times B)_{lj(i)} + (T \times H)_{kl} \\ + (T \times H \times S)_{kli} + (T \times H \times B)_{klj(i)} + e_{ijkl}$$

where: Y = the observation on the *i*th site within the *j*th block with the *k*th thinning and *l*th brush

reduction,

μ = the grand mean,

S = sites with $i=2$,

B = blocks with $j=10$,

T = thinning with $k=2$,

H = brush reduction by herbicide with $l=2$, and

e = residual or error.

The experimental design, degrees of freedom, and expected mean squares for this model are described on pages 535-543 of Kirk (1982). Because more than one dependent variable was involved in the analysis, the α level for each dependent variable was adjusted to protect the experiment-wise error rate (Harris 1985, pp. 504-506). The means for each dimension difference were plotted by growing season for each site to aid interpretation of the results where individual factors were significant or where significant interactions existed. The sources of variation, degrees of freedom, and expected mean squares for this model are given in Table 6.

The second set of analyses examined each site separately, because the first analyses indicated a significant site factor with few significant relationships for the other factors or their interactions. This indicated that each site was causing a different treatment response and thus the sites should be examined individually. It is recognized that this is a post hoc analysis. For each site, brush removal and thinning were fixed factors in a 2x2 factorial design. A nonadditive model was used relative to treatments and blocks, because a plot of the response variable versus treatments, by block, showed several nonparallel lines, indicating that a significant interaction between treatment and block factors may exist (Kirk 1982). The following experimental design model was used in the analysis:

$$Y_{ijkl} = \mu + B_j + T_k + (T \times B)_{kj} + H_l + (H \times B)_{lj} + (T \times H)_{kl} + (T \times H \times B)_{klj} + e_{ijkl}$$

TABLE 6. ANOVA table for comparison of treatments on two sites.

Source	df	Expected MS	Test MS
Site _i	1	$\sigma_e^2 + 4\sigma_B^2 + 40\sigma_S^2$	Block
Block _{j(i)}	18	$\sigma_e^2 + 4\sigma_B^2$	
Thin _k	1	$\sigma_e^2 + 2\sigma_{TB}^2 + 20\sigma_{TS}^2 + 40\sigma_T^2$	Thin x Site
Thin x Site _{ki}	1	$\sigma_e^2 + 2\sigma_{TB}^2 + 20\sigma_{TS}^2$	Thin x Block
Thin x Block _{kj(i)}	18	$\sigma_e^2 + 2\sigma_{TB}^2$	
Brush _l	1	$\sigma_e^2 + 2\sigma_{HB}^2 + 20\sigma_{HS}^2 + 40\sigma_H^2$	Brush x Site
Brush x Site _{li}	1	$\sigma_e^2 + 2\sigma_{HB}^2 + 20\sigma_{HS}^2$	Brush x Block
Brush x Block _{lj(i)}	18	$\sigma_e^2 + 2\sigma_{HB}^2$	
Thin x Brush _{kl}	1	$\sigma_e^2 + \sigma_{BTH}^2 + 10\sigma_{THS}^2 + 20\sigma_{TH}^2$	Thin x Brush x Site
Thin x Brush x Site _{kl(i)}	1	$\sigma_e^2 + \sigma_{BTH}^2 + 10\sigma_{THS}^2$	Thin x Brush x Block
Thin x Brush x Block _{klj(i)}	18	$\sigma_e^2 + \sigma_{BTH}^2$	
e_{ijkl}	0	σ_e^2 (not retrievable)	
Total	79		

NOTE: The following symbols are used for sources of variation and levels within each source:
 S, sites with $i=2$;
 B, blocks within each site with $j=10$;
 T, thinning or tree removal with $k=2$;
 H, brush reduction by herbicide with $l=2$; and
 e, error or residual variation.
 The experimental design is described in the text.

where: Y = the observation in the j th block with the k th thinning and l th brush reduction,
 μ = the grand mean,
 B = blocks with $j=10$,
 T = thinning with $k=2$,
 H = brush reduction by herbicide with $l=2$, and
 e = residual or error.

The experimental design, degrees of freedom, and expected mean squares for this model are described on pages 441-453 of Kirk (1982). Adjusted α levels were used in the same manner as described for the first set of analyses. The sources of variation, degrees of freedom, and expected mean squares for this model are given in Table 7.

The third set of analyses involved the subset of blocks on site E55 with the trenched plots. For this analysis, it was assumed that a single treatment factor exists with the five levels of control, brush reduction, thinning, brush reduction plus thinning, and trenching. The treatments were laid out in randomized blocks at seven locations. A nonadditive model was used for the same reason as in the second set of analyses. The following experimental design model was used in the analysis:

$$Y_{jk} = \mu + B_j + T_k + (B \times T)_{jk} + e_{jk},$$

where: Y = the observation in the j th block with the k th treatment,
 μ = the grand mean,
 B = blocks with $j=7$,
 T = treatments with $k=5$, and
 e = residual or error.

The experimental design, degrees of freedom, and expected mean squares for this model are described on pages 237-307 of Kirk (1982). Adjusted α levels were used in the same manner as described for the two-site analyses. The sources of variation, degrees of freedom, and expected mean squares for this model are given in Table 8.

TABLE 7. ANOVA table for comparison of treatments on individual sites.

Source	df	Expected MS	Test MS
Block _j	9	$\sigma_e^2 + 4\sigma_B^2$	
Thin _k	1	$\sigma_e^2 + 2\sigma_{TB}^2 + 20\sigma_T^2$	Thin x Block
Thin x Block _{kj}	9	$\sigma_e^2 + 2\sigma_{TB}^2$	
Brush _l	1	$\sigma_e^2 + 2\sigma_{HB}^2 + 20\sigma_H^2$	Brush x Block
Brush x Blocks _{lj}	9	$\sigma_e^2 + 2\sigma_{HB}^2$	
Thin x Brush _{kl}	1	$\sigma_e^2 + \sigma_{THB}^2 + 10\sigma_{TH}^2$	Thin x Brush x Block
Thin x Brush x Block _{klj}	9	$\sigma_e^2 + \sigma_{THB}^2$	
e _{ijkl}	0	σ_e^2 (not retrievable)	
Total	39		

NOTE: The following symbols are used for sources of variation and levels within each source:
 B, blocks with j=10;
 T, thinning or tree removal with k=2;
 H, brush reduction by herbicide with l=2; and
 e, error or residual variation.
 The experimental design is described in the text.

TABLE 8. ANOVA table for comparison of treatments involving trenching on site E55.

Source	df	Expected MS	Test MS
Block _j	6	$\sigma_e^2 + 5\sigma_B^2$	
Treatment _k	4	$\sigma_e^2 + \sigma_{TB}^2 + 10\sigma_T^2$	Block x Treatment
Block x Treatment _{jk}	24	$\sigma_e^2 + \sigma_{TB}^2$	
e_{jkl}	0	σ_e^2 (not retrievable)	
Total	35		

NOTE: The following symbols are used for sources of variation and levels within each source:

B, blocks with trenching on site E55 with $j=7$;

T, treatment factor with $k=5$; and

e, error or residual variation.

The experimental design is described in the text. The means are compared using the orthogonal contrasts of Table 9.

For the third set of analyses, the treatment means were compared using four orthogonal contrasts (Kirk 1982). The coefficients for the contrasts, the mathematical hypotheses, and the verbal hypotheses are summarized in Table 9. Because the comparison of means involves more than one dependent variable, adjusted α levels were used for each contrast. The means for each of the five treatment levels were plotted by year to aid the interpretation.

All analysis was performed using the Statistical Analysis System (SAS Institute 1985a and 1985b). The procedures used included MEANS, PLOT, ANOVA, and GLM.

Results and discussion

The raw data and descriptive statistics for competing trees, competing seedlings, cover of vascular plants, target tree dimensions at 0, 1, and 2 growing seasons, and target tree dimensions for the subset of blocks with trenching are in Appendices VI to X. The descriptive statistics for the dimension differences of the target trees for each treatment on sites E55 and E44 are in Table 10.

Two site analysis

The interaction terms of thin x brush x site, thin x brush, and brush x site were not significant for any of the individual dimension differences after either growing season (Table 11). Also, significant dimension differences were not found for either growing season for the main effects of brush or thin (Table 11). There was a significant interaction between thinning and site, after each growing season, for change in basal diameter (Table 11). After the first growing season, the average diameter growth on site E55 was 1.80 cm (se=0.11 cm, n=20) for plots with thinning (thinning, combined) and 1.00 cm (se=0.11 cm, n=20) for plots without thinning (control, brush reduction). For site E44, average diameter growth was 1.00 cm (se=0.09 cm, n=20)

TABLE 9. Hypotheses and associated orthogonal contrasts for comparing the means for treatments involving trenching on site E55.

Contrast	Coefficients	Hypotheses
C ₁	0 0 0 -1 1	H ₀ : $\mu_4 - \mu_5 = 0$ H ₁ : $\mu_4 - \mu_5 \neq 0$
C ₂	-2 -2 -2 3 3	H ₀ : $(\mu_1 + \mu_2 + \mu_3)/3 - (\mu_4 + \mu_5)/2 = 0$ H ₁ : $(\mu_1 + \mu_2 + \mu_3)/3 - (\mu_4 + \mu_5)/2 \neq 0$
C ₃	-2 1 1 0 0	H ₀ : $2\mu_1 - (\mu_2 + \mu_3) = 0$ H ₁ : $2\mu_1 - (\mu_2 + \mu_3) \neq 0$
C ₄	0 -1 1 0 0	H ₀ : $\mu_2 - \mu_3 = 0$ H ₁ : $\mu_2 - \mu_3 \neq 0$

NOTE: The five treatment means were: control (μ_1), brush reduction (μ_2), thinning (μ_3), brush reduction + thinning (μ_4), and trenching (μ_5). The verbal comparisons were:

C₁: trenching versus brush reduction + thinning;

C₂: brush reduction + thinning versus not both at the same time;

C₃: brush reduction or thinning versus control; and

C₄: thinning only versus brush reduction only.

These were tested against the mean square for block x treatment interaction described in Table 8.

TABLE 10. Mean and standard error for change in tree dimensions after one and two years, by treatments, on sites E55 and E44.

Variables	Year	Treatment			
		Control	Brush	Thin	Combined
E55					
Basal diameter (cm)	1	0.92 (0.13)	1.07 (0.17)	1.73 (0.17)	1.86 (0.14)
	2	1.39 (0.19)	1.78 (0.24)	2.61 (0.27)	3.36 (0.28)
Height (m)	1	0.68 (0.08)	0.72 (0.11)	0.80 (0.08)	0.92 (0.07)
	2	1.24 (0.11)	1.36 (0.20)	1.44 (0.09)	1.79 (0.08)
Stem volume ($m^3 \times 10^{-3}$)	1	0.73 (0.14)	0.92 (0.25)	1.53 (0.33)	1.64 (0.24)
	2	1.34 (0.22)	2.00 (0.50)	3.08 (0.68)	4.25 (0.65)
Needle weight (mg)	1	0.15 (0.15)	0.19 (0.13)	0.15 (0.13)	0.53 (0.20)
	2	0.62 (0.12)	0.15 (0.15)	0.46 (0.13)	0.21 (0.27)
E44					
Basal diameter (cm)	1	0.56 (0.11)	1.03 (0.10)	0.87 (0.10)	1.13 (0.15)
	2	1.28 (0.13)	2.11 (0.22)	2.02 (0.14)	2.64 (0.23)
Height (m)	1	0.38 (0.09)	0.57 (0.08)	0.55 (0.04)	0.65 (0.09)
	2	0.82 (0.16)	1.24 (0.12)	1.22 (0.10)	1.35 (0.15)
Stem volume ($m^3 \times 10^{-3}$)	1	0.37 (0.09)	0.76 (0.11)	0.62 (0.09)	1.08 (0.21)
	2	1.01 (0.17)	2.13 (0.34)	1.91 (0.25)	3.25 (0.57)
Needle weight (mg)	1	0.05 (0.14)	0.42 (0.11)	0.44 (0.16)	0.60 (0.18)
	2	0.32 (0.15)	0.05 (0.13)	0.67 (0.17)	0.23 (0.14)

TABLE 10. (continued)

NOTE: Changes in dimension values were calculated by subtracting the initial values from the values at the end of each growing season. $n=10$ for all values.

TABLE 11. ANOVAs for western hemlock stem volume, diameter, and height differences on the two sites after one and two growing seasons following application of treatments.

Source of variation	Error term	Error df ^a	Growing season					
			Mean square error	1		Mean square error	2	
				F value	P		F value	P
<u>Stem volume (m³)</u>								
Site	Block	18	0.00000076	6.54	0.0198	0.00000349	2.02	0.1721
Thin	Thin x Site	1	0.00000115	4.78	0.2731	0.00000482	9.37	0.2011
Thin x Site	Thin x Block	18	0.00000032	3.55	0.0757	0.00000188	2.57	0.1266
Brush	Brush x Site	1	0.00000037	4.38	0.2837	0.00000051	45.41	0.0938
Brush x Site	Brush x Block	18	0.00000034	1.08	0.3116	0.00000186	0.27	0.6067
Thin x Brush	Thin x Brush x Site	1	0.00000003	0.00	0.9684	0.00000011	6.04	0.2461
Thin x Brush x Site	Thin x Brush x Block	18	0.00000019	0.15	0.7016	0.00000140	0.08	0.7836

TABLE 11. (continued)

Source of variation	Error term	Error df ^a	Mean square error	Growing season				
				1		2		
				F value	P	Mean square error	F value	P
<u>Diameter (cm)</u>								
Site	Block	18	0.26951	18.37	0.0004	0.65401	2.27	0.1492
Thin	Thin x Site	1	1.7701	2.85	0.3403	2.9261	7.08	0.2289
Thin x Site	Thin x Block	18	0.12068	14.67	0.0012	0.25807	11.34	0.0034
Brush	Brush x Site	1	0.25313	5.04	0.2668	0.12013	69.80	0.0758
Brush x Site	Brush x Block	18	0.24635	1.03	0.3242	0.51013	0.24	0.6333
Thin x Brush	Thin x Brush x Site	1	0.045125	1.47	0.4396	0.40613	0.07	0.8362
Thin x Brush x Site	Thin x Brush x Block	18	0.11285	0.40	0.5351	0.46463	0.87	0.3622

TABLE 11. (continued)

Source of variation	Error term	Error df ^a	Mean square error	Growing season				
				1		2		
				F value	P	Mean square error	F value	P
<u>Height (m)</u>								
Site	Block	18	0.060385	19.96	0.0003	0.12007	14.62	0.0012
Thin	Thin x Site	1	0.0076050	53.03	0.0869	0.017111	93.44	0.0656
Thin x Site	Thin x Block	18	0.078970	0.10	0.7599	0.19956	0.09	0.7730
Brush	Brush x Site	1	0.022445	10.39	0.1915	0.0082013	160.13	0.0502
Brush x Site	Brush x Block	18	0.075135	0.30	0.5914	0.19819	0.04	0.8411
Thin x Brush	Thin x Brush x Site	1	0.036125	0.00	1.0000	0.31626	0.01	0.9357
Thin x Brush x Site	Thin x Brush x Block	18	0.056685	0.64	0.4351	0.16203	1.95	0.1794

NOTE: The experimental design is described in the text. For all sources of variation, $\alpha = 0.0169$ was used.

^aThe degrees of freedom for hypothesis is 1 for all tests.

for plots with thinning and 0.80 cm (se=0.09 cm, n=20) for plots without thinning. The same relationship held for the second growing season. Thus the increase in diameter growth in response to thinning was greater on E55 than on E44 (Figure 4, Table 10). This may reflect greater pretreatment competition from trees on E55 than on E44. At the start of the experiment, the average total basal area of competing trees within the root zone on E44 was $1.59 \times 10^{-3} \text{ m}^2$ (se=0.26 $\times 10^{-3} \text{ m}^2$, n=40) versus $5.83 \times 10^{-3} \text{ m}^2$ (se=0.75 $\times 10^{-3} \text{ m}^2$, n=40) on E55. Thus thinning yielded a greater reduction in competition on E55.

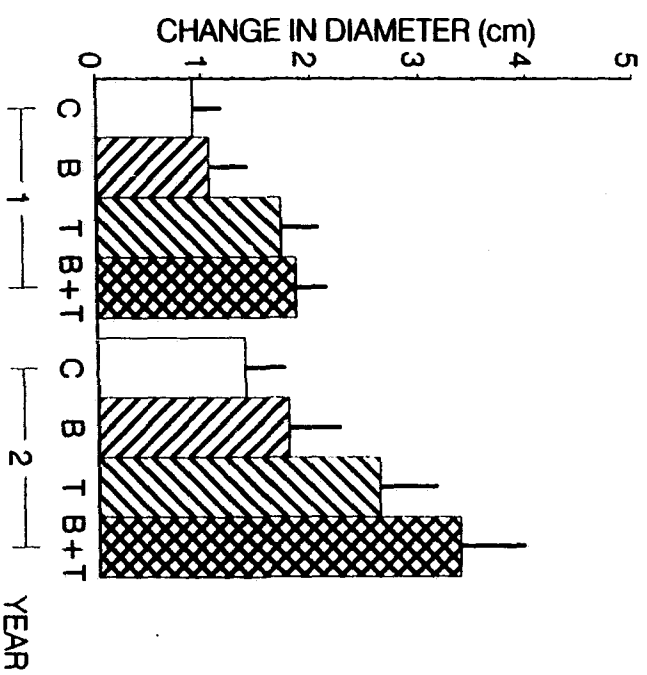
The site factor was significant for differences in height and diameter after one growing season, and for height difference after two growing seasons (Figures 4 and 5, Table 11). Difference in stem volume after one growing season would have been significant if adjusted α levels had not been used (Figure 6, Table 11). As there was a significant thin x site interaction for diameter, this variable was discussed above. The overall gain in height over all sample plots on E55 and E44 after one growing season was 0.78 m (se=0.04 m, n=40) and 0.53 m (se=0.04 m, n=40), respectively. The corresponding height gains after two growing seasons for E55 and E44 were 1.45 m (se=0.07 m, n=40) and 1.16 m (se=0.07 m, n=40), respectively. Thus there was a greater overall growth in diameter and height on E55 than on E44. The same initial tree sizes were selected on both sites. Site E44 is steeper than E55 and has a westerly aspect (Table 5), thus it could be drier with a greater chance of moisture stress. This could limit plant growth (Fitter and Hay 1987). By contrast, E55, on the lower slopes of the Eve River drainage, is almost level and should have more favourable moisture status.

Analysis of individual sites

Analysis of each site separately shows that the thin x

Figure 4. Average change in basal diameter after one and two growing seasons, by treatment, for sites E55 and E44. These values were calculated by subtracting the initial value from the value at the end of each growing season. The treatments are C = control, B = brush reduction, T = thinning, and B+T = combined. The vertical bars represent 2 se (n=10).

E55



E44

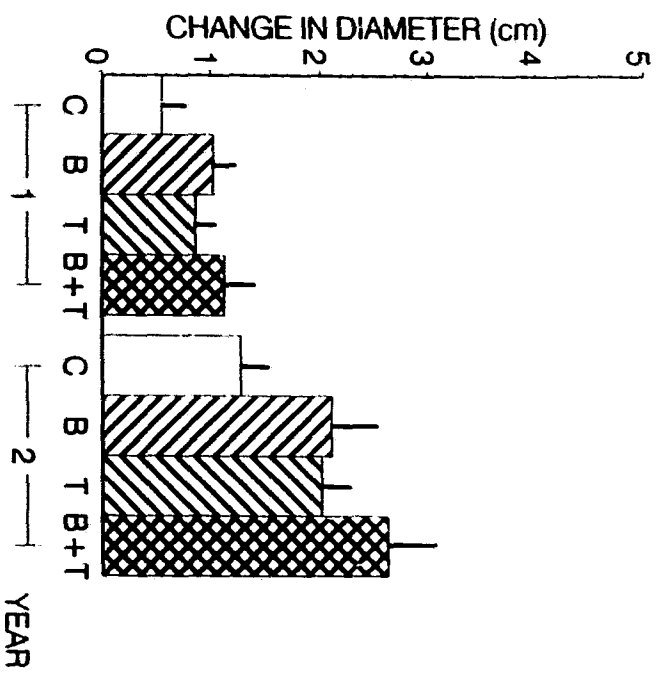


Figure 5. Average change in height after one and two growing seasons, by treatment, for sites E55 and E44. These values were calculated by subtracting the initial value from the value at the end of each growing season. The treatments are C = control, B = brush reduction, T = thinning, and B+T = combined. The vertical bars represent 2 se (n=10).

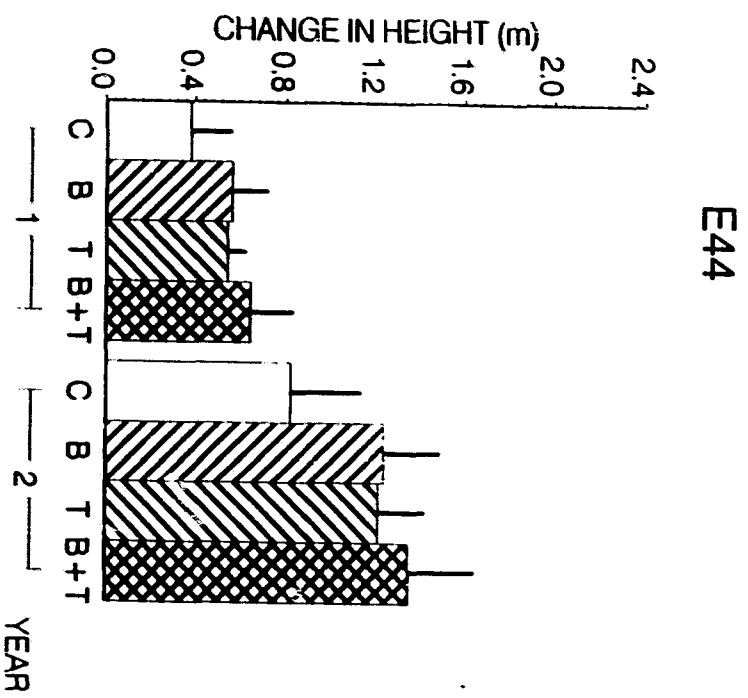
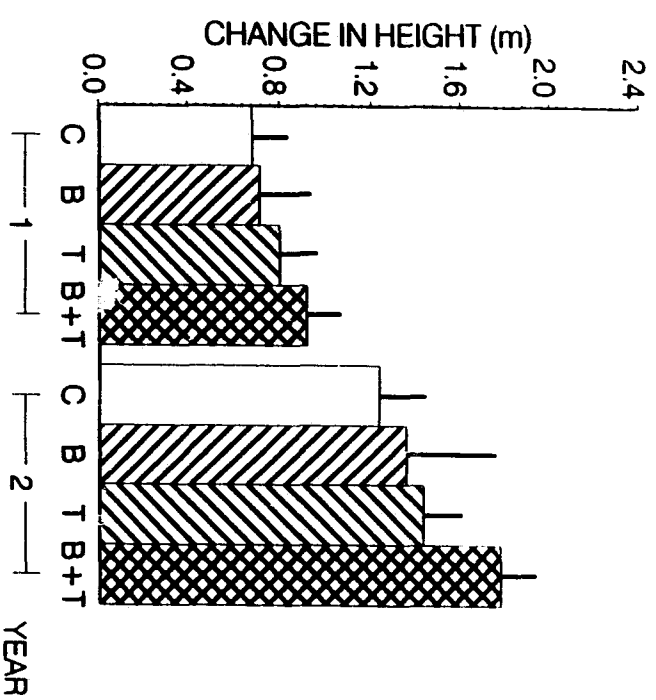
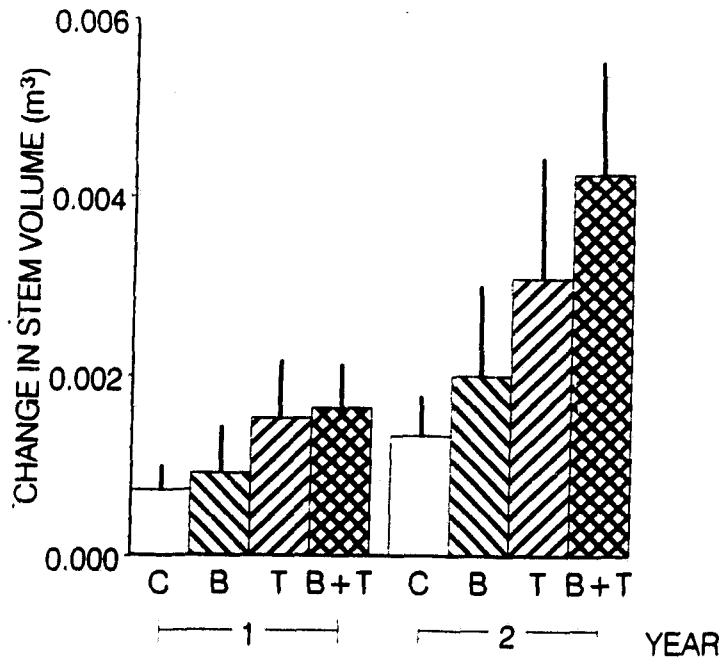
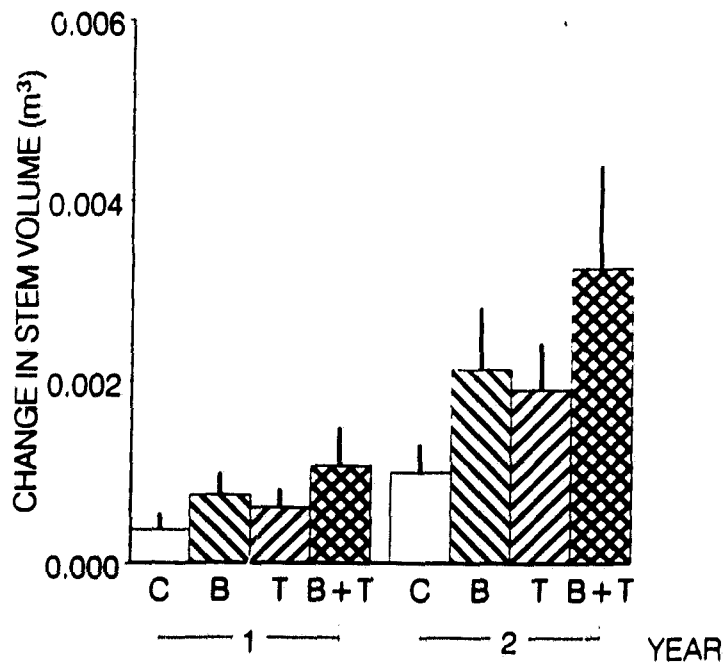


Figure 6. Average change in stem volume after one and two growing seasons, by treatment, for sites E55 and E44. These values were calculated by subtracting the initial value from the value at the end of each growing season. The treatments are C = control, B = brush reduction, T = thinning, and B+T = combined. The vertical bars represent 2 se (n=10).

E55



E44



brush interaction was not significant on either site for either growing season (Table 12), indicating that these factors are independent and can be discussed separately.

The thinning factor was significant for stem volume and diameter after both growing seasons for site E55 (Table 12). Diameter was significant for this factor after the second growing season on site E44 (Table 12). For E55, the mean values for volume differences on plots with thinning (thinning, combined) and without thinning (control, brush reduction) were $1.59 \times 10^{-3} \text{ m}^3$ ($se=0.20 \times 10^{-3} \text{ m}^3$, $n=20$) and $0.82 \times 10^{-3} \text{ m}^3$ ($se=0.14 \times 10^{-3} \text{ m}^3$, $n=20$), respectively, after one growing season, and $3.67 \times 10^{-3} \text{ m}^3$ ($se=0.48 \times 10^{-3} \text{ m}^3$, $n=20$) and $1.67 \times 10^{-3} \text{ m}^3$ ($se=0.28 \times 10^{-3} \text{ m}^3$, $n=20$), respectively, after two growing seasons. Diameter differences on site E55 follow the same patterns as volume differences for both growing seasons (Figures 4 and 6, Table 12). For site E44, the mean values for diameter differences on plots with thinning (thinning, combined) and without thinning (control, brush reduction) were 2.33 cm ($se=0.15$ cm, $n=20$) and 1.70 cm ($se=0.16$ cm, $n=20$), respectively, after the second growing season. Although not significant, the first year volume and diameter differences and the second year volume differences followed the same trend on site E44 (Figures 4 and 6, Table 12). Thus the gain in diameter and stem volume was greater for plots with thinning than for plots without thinning. The gain was greater the second year on E44 (Figures 4 and 6), suggesting that reduced tree competition the first year allows the target tree to accumulate resources for an even greater growth response the second year. Studies on other conifers have found that the shoot growth for the current year is a function of growing conditions during bud formation the previous year (Ford 1980, Junttilla 1986, Junttilla and Heide 1981).

For site E55, the brush reduction factor was not

TABLE 12. ANOVAs for western hemlock stem volume, diameter, and height differences for each site separately, and for one and two growing seasons following application of treatments.

Source of variation	Error term	Error df ^a	Mean square error	Growing season				
				1		2		
				F value	P	Mean square error	F value	P
E55								
<u>Stem volume (m³)</u>								
Thin	Thin x Block	9	0.00000049	11.83	0.0074	0.00000247	16.11	0.0030
Brush	Brush x Block	9	0.00000050	0.44	0.5235	0.00000272	3.09	0.1129
Thin x Brush	Thin x Brush x Block	9	0.00000022	0.07	0.7946	0.00000136	0.48	0.5072
<u>Diameter (cm)</u>								
Thin	Thin x Block	9	0.17722	36.11	0.0002	0.39056	50.18	0.0001
Brush	Brush x Block	9	0.29322	0.67	0.4347	0.69622	4.67	0.0590
Thin x Brush	Thin x Brush x Block	9	0.12933	0.01	0.9319	0.49678	0.65	0.4401

TABLE 12. (continued)

Source of variation	Error term	Error df ^a	Mean square error	Growing season				
				1		2		
				F value	P	Mean square error	F value	P
<u>Height (m)</u>								
Thin	Thin x Block	9	0.073684	3.54	0.0926	0.24265	4.01	0.0762
Brush	Brush x Block	9	0.069430	0.80	0.3946	0.13758	4.05	0.0751
Thin x Brush	Thin x Brush x Block	9	0.060546	0.30	0.5983	0.11217	1.14	0.3138
E44								
<u>Stem volume (m³)</u>								
Thin	Thin x Block	9	0.00000015	5.27	0.0473	0.00000129	7.92	0.0202
Brush	Brush x Block	9	0.00000018	9.79	0.0121	0.00000099	15.35	0.0035
Thin x Brush	Thin x Brush x Block	9	0.00000016	0.08	0.7816	0.00000144	0.08	0.7832

TABLE 12. (continued)

Source of variation	Error term	Error df ^a	Mean square error	Growing season				
				1		2		
				F value	P	Mean square error	F value	P
<u>Diameter (cm)</u>								
Thin	Thin x Block	9	0.064139	6.55	0.0307	0.12558	32.11	0.0003
Brush	Brush x Block	9	0.19947	6.68	0.0295	0.32403	16.22	0.0030
Thin x Brush	Thin x Brush x Block	9	0.096361	1.14	0.3126	0.43247	0.25	0.6258
<u>Height (m)</u>								
Thin	Thin x Block	9	0.084257	1.78	0.2148	0.15648	4.11	0.0733
Brush	Brush x Block	9	0.08084	2.48	0.1500	0.25880	2.95	0.1198
Thin x Brush	Thin x Brush x Block	9	0.052824	0.34	0.5731	0.21190	0.91	0.3662

NOTE: The experimental design is described in the text. For all sources of variation, $\alpha = 0.0169$ was used.

^aThe degrees of freedom for hypothesis is 1 for all tests.

significant for any dimension difference after either growing season (Table 12). However, significant differences were found on site E44. This may reflect greater pretreatment competition from herbs and shrubs on E44 than on E55. At the start of the experiment, the average total cover of herb species on E44 was 53.4% (se=2.9%, n=40) versus 46.7% (se=2.5%, n=40) on E55. The average total cover of shrub species on E44 was 14.0% (se=1.4%, n=40) versus 10.4% (se=1.1%, n=40) on E55. Thus brush reduction should yield a greater reduction in competition on site E44. For site E44, the brush reduction factor was significant for stem volume after the first growing season and for stem volume and diameter after the second growing season (Table 12). On this site, the mean values for volume differences on plots with and without brush reduction were $0.92 \times 10^{-3} \text{ m}^3$ (se= $0.12 \times 10^{-3} \text{ m}^3$, n=20) and $0.50 \times 10^{-3} \text{ m}^3$ (se= $0.07 \times 10^{-3} \text{ m}^3$, n=20), respectively, after one growing season, and $2.69 \times 10^{-3} \text{ m}^3$ (se= $0.35 \times 10^{-3} \text{ m}^3$, n=20) and $1.46 \times 10^{-3} \text{ m}^3$ (se= $0.18 \times 10^{-3} \text{ m}^3$, n=20), respectively, after two growing seasons. The diameter response followed the same pattern as volume response for both years (Figures 4 and 6, Table 10) although it was not significant the first year (Table 12). The first year response would have been significant if adjusted α levels had not been used. Thus the gain in diameter and stem volume was greater for plots with brush reduction than for plots without this treatment. The gain on E44 was greater the second year for this treatment (Figures 4 and 6), as was found for thinning. This suggests that reduced competition from herbs and shrubs the first year allows the target tree to accumulate resources for an even greater growth response the second year.

Although significant responses to brush reduction were detected, two other factors may have limited the response. First, the herbicide did not always target the desired group of plants; some herbicide damage was observed on a few of

the target trees on both sites, while on five plots at E44 the herbicide failed to completely kill competing herbs and shrubs or damaged competing trees within the plot. On site E44 herbicide damage was observed on three target trees. Although these trees appeared to be relatively healthy at the end of the study, there was some foliar discoloration the first year after treatment and these trees showed the smallest growth response in this treatment. These undesired effects of the herbicide could increase the variation in response to this treatment, which could reduce the likelihood of finding a significant difference. Second, the target tree may respond poorly to brush reduction. Some of the trees on E44 were growing on areas of predominantly mineral soil with little if any decaying wood present, a substrate considered important to the growth of western hemlock (Christy and Mack 1984, Kropp 1982). Thus these trees may not have been able to respond to brush reduction because plant growth was already limited by some factor related to decaying wood.

No significant responses in height growth were detected, possibly because of leader breakage. Of the 80 trees studied, the leader broke under its own weight on two trees during the first growing season and seven trees during the second growing season. This breakage occurred in trees that produced a long, thin leader during shoot elongation. Following breakage of the leader a lateral shoot became dominant. Although the lateral shoot could be as healthy as the original leader, it was usually shorter. Leader breakage may be a partial explanation for the inconsistent response of western hemlock to treatments reported in other studies (Olson *et al.* 1979, Radwan and DeBeil 1980).

Analysis of subset of blocks with trenching

The contrast comparing the means for brush reduction plus thinning to trenching was not significant for any

variable after either growing season. The pattern of growth responses for the nontrenching treatments was the same as for the complete set of plots on site E55. Thus, the results of this part of the study are not presented here to avoid repetition. The means and standard errors for this analysis are included in Appendix XI. However, the mean response in diameter, height, and volume was slightly greater for trenching than for brush reduction plus thinning. For example, the mean gains in stem volume for trenching versus brush reduction plus thinning were $5.07 \times 10^{-3} \text{ m}^3$ ($se=0.88 \times 10^{-3} \text{ m}^3$, $n=7$) and $4.22 \times 10^{-3} \text{ m}^3$ ($se=0.80 \times 10^{-3} \text{ m}^3$, $n=7$), respectively, after two growing seasons. Although Christy (1986) found that subsurface competition was important in the growth of western hemlock, the result for trenching in this study is not surprising, as both brush reduction and thinning would already have reduced subsurface competition. Mortality of the plants targeted by either treatment would reduce subsurface demand for nutrients and water. Reduced subsurface competition for nutrients or water by trenching results from severing of the roots of plants with tops located outside the plot. For the size of trees used in this study, competition from plants within 2 m of the target tree is much greater than competition from plants with tops located at greater distances.

Summary and conclusions

Western hemlock responded to decreased tree competition with greater diameter and stem volume growth. Greater response to thinning occurred on the site with greater initial basal area of competing trees. Greater diameter and stem volume growth occurred after herbiciding on the site with greater initial cover of herb and shrub species. Growth responses to treatments thus reflected the initial species composition of each site. In general, improved growing conditions the first year after treatments yielded

greater response the second year. Analysis of a subset of blocks that included a trenching treatment suggested that plants further than 2 m from the target tree had little or no effect on growth of the target tree.

Other factors had an impact on the responses observed for various treatments. Herbicide damage may have reduced the growth response of a few target trees, nontarget trees were occasionally damaged, and complete mortality of competitors was not always achieved. Also, response to competition reduction may not occur if substrate limitations are present. Leader breakage may have prevented the detection of a response in height growth and also reduced the calculated volume growth. Thus, diameter response may be the preferred variable for growth studies on western hemlock.

The hypothesis of greater growth in western hemlock after reduction in either type of vegetation competition was supported by the results of this part of the study. This response was found for diameter and stem volume. As predicted, the order of increasing growth response was control, thinning or brush reduction, and combined thinning plus brush reduction. The response on each site to brush reduction or thinning depended on the magnitude of each type of competition. Because the interaction between thinning and brush reduction was not significant on either site, a synergistic effect between these factors is apparently not occurring in the study area.

Chapter 3

EFFECTS OF REDUCED PLANT COMPETITION ON FOLIAR NUTRIENT CONCENTRATIONS IN WESTERN HEMLOCK

Introduction

Analysis of plant tissues, including foliage, is one of several approaches used for diagnosing and evaluating the nutrient status of trees (Mead 1984). Foliar analysis has been used in forestry to characterize the nutrient status of species over a range of sites; to determine the concentrations associated with deficiencies or toxicities; to predict the response to nutrient additions; to monitor the response of trees to treatments in terms of nutrient uptake; and to detect nutrient limitations by correlating the growth response with a specific nutrient (Ballard and Carter 1986, Beaton *et al.* 1965, Everard 1973, van den Driessche 1974). The advantages cited for foliar analysis are rapid evaluation of nutritional problems and prediction of the growth response to nutrient additions for several years in the future. In contrast, mensuration data must be collected for many years to determine if a growth response has occurred after nutrient additions (Everard 1973, Weetman and Fournier 1982). However, additional methods, including soil analyses, are recommended to supplement foliar analysis (Marschner 1986, Mead 1984). Foliar analysis has its limitations because nutrient interactions complicate the response when multiple nutrient deficiencies are present; it assumes that needle growth response reflects overall tree growth; it is difficult to determine which form of a nutrient is most strongly correlated with growth potential; and foliar concentrations are highly variable with respect to spatial location, position in the crown, season, species, and stand density (Ballard 1985, Mead 1984, Timmer and Stone 1978, van den Driessche 1974). Methods used to evaluate

foliar data in studies of tree nutrition include: (1) comparisons of the foliar concentrations of healthy trees to those of unhealthy trees; (2) correlations of the concentration of specific nutrients with growth parameters of trees; (3) derivation of curves for growth response that relate concentration of a nutrient to deficiency, sufficiency, or toxicity; (4) measurement of nutrient gradients within the canopy of individual trees; (5) graphing of concentration versus content of a nutrient before and after a treatment to assess nutrient responses such as uptake, dilution, or antagonism; (6) development of critical ratios between nutrients to predict growth response relative to changes in the status of pairs of nutrients; (7) derivation of multinutrient ratios for individual species using N content as the reference value; and (8) use of a spectrum of reference ratios, involving pairs of nutrients, to calculate deviations from the norm and to rank nutrients for deficiencies or potential response (Ballard and Carter 1986, Everard 1973, Mead 1984, Timmer and Stone 1978).

Nutrient concentrations in the foliage of western hemlock have been used to examine patterns of variation over a range of growing conditions, for diagnosing deficiency problems on a regional scale, and for monitoring the response to fertilizer applications (Ballard and Carter 1986, Beaton *et al.* 1965, Heilman and Ekuan 1980, Radwan and DeBell 1980 and 1989, Radwan *et al.* 1984). In Chapter 1, potential nutrient problems for western hemlock on the Eve River sites were identified by comparing foliar concentrations with values cited in the literature and by graphical analysis of foliar nutrients relative to foliar color. Potential problem nutrients included P, N, K, S, SO_4^{2-} -S, and Cu. In Chapter 2, significant increases in basal diameter and stem volume growth of western hemlock were found on treatments reducing plant competition.

The first objective of this part of the study was to

determine if significant changes in the concentrations of foliar nutrients occurred after one or two growing seasons when plant competition was reduced. The hypothesis was that if growth of western hemlock was limited by competition for nutrients on sites in the Eve River drainage, reduced competition from trees or shrubs should yield an increase in available nutrients and a corresponding increase in the uptake and concentration of limiting nutrients in the foliage. This assumes that nutrient concentrations are not reduced by greater biomass production or increased uptake of water. Available nutrients could increase because of reduced competition for nutrients, release of nutrients from the tissues of plants killed by treatments, or improved transport of nutrients by water. Increased foliar concentrations of nutrients should yield improved plant growth irrespective of the mechanism that yields greater nutrient availability. A simple additive increase in foliar nutrient concentrations should occur (provided that different competitors are not interacting among themselves) when treatments that reduce different components of plant competition are combined. Because site differences in growth response were detected earlier, site differences may be found in the response of foliar nutrients, assuming that nutrients are limiting growth. The greatest response should be found the first year. Second year response would probably not be as great because of biomass dilution associated with subsequent growth of the trees, renewed competition from vegetation at the periphery of the plots, and the development of sufficiency levels of nutrients (Everard 1973, Marschner 1986, Timmer and Stone 1978).

The second objective was to identify which nutrients may have limited growth. For this objective, change in foliar concentrations after one year was selected as it is desirable to relate foliar response, after the shortest time interval, to subsequent growth. Growth response in tree

dimensions should be correlated with change in foliar concentration of limiting nutrients, irrespective of treatment, as nutrient increase caused by any of the treatments should yield increased growth. However, differences between sites in initial characteristics and growth response suggest the need for stratification by sites. Thus the data analysis for the second objective involves a pooling of all treatments on a site, and a stratification of the data by site to account for location differences. The specific hypothesis was that if growth of western hemlock was nutrient limited, a significant correlation should exist between change in foliar concentrations of limited nutrients and tree growth. The growth response should be detectable after both growing seasons but should be easier to detect the second year. Improved first year growing conditions should yield a greater height growth the second year because of increases in the number of needle primordia per bud and greater elongation per stem unit. Again, this assumes that nutrient concentrations are not diluted by biomass production or greater water uptake. Because improved water status could increase growth, experimental additions of nutrients would be required to unequivocally demonstrate nutrient-limited growth. Significant correlations simply identify the nutrients to be used for fertilizers in further research.

On the basis of the results of Chapter 1, reduced plant competition should yield increases in the foliar concentrations of P, N, K, S, and Cu. These nutrients occurred in low concentrations relative to other stands of western hemlock. Increases in the concentrations of SO_4^{2-} -S may be found but would depend on the magnitude of the response, the adequacy of sampling, and the relative changes in total N and S. Thus these five nutrients were monitored to determine the nutrient response to reduced plant competition and to identify nutrients which could be

limiting growth.

Materials and methods

Study sites, field methods, and laboratory analysis

Foliar samples were collected from the western hemlock used in the study of tree growth on sites E55 and E44. The site descriptions, plot layout, treatments applied, and time of sample collection are described in Chapter 2. The laboratory methods used on the foliar samples are described in Chapter 1. The nutrients measured were N (total), P (total), K (total), S (total and $\text{SO}_4^{2-}\text{-S}$), and Cu (total).

Data analysis

Changes in foliar concentrations of each of the five nutrients were calculated by subtracting the initial value for each nutrient from the value obtained at the end of the first and second growing seasons. These temporal differences were used as the response variables in the ANOVAs described below. The analysis was performed separately for each growing season.

To address the first objective, the same three sets of ANOVA designs were used for the nutrient differences, after each growing season, as were used for the analysis of the growth differences described in Chapter 2. The three sets of analyses included a two site design, an individual site design, and a design for the subset of blocks with trenching. For each set of analyses, the factors involved, the experimental design model, the components of variance, the use of adjusted α levels, the orthogonal contrasts, and the plotting of means are described in Chapter 2. The experiment-wise error rate was protected by using $\alpha=0.0085$ for an analysis involving six variables (Harris 1985, pp 504-506).

To address the second objective, the data from the 40 trees used in the control, brush reduction, tree thinning,

and combined treatments were pooled by site. The change in stem volume, after each growing season, was used as the dimension growth variable and the change in each foliar nutrient, after the first growing season, was used as the nutrient response variable. The change in stem volume after each growing season was plotted against change in each foliar nutrient after the first growing season, to check for the existence of a continuous distribution and to determine if transformations were needed to obtain a linear relationship. The change in stem volume after each growing season was transformed with natural logarithms. Pearson product moment correlations were calculated between the resulting transformed variables and the change in concentration of each foliar nutrient, after the first growing season. Thus for each site, six comparisons were obtained for each growing season. As for the ANOVAs described above, an adjusted α level ($\alpha=0.0085$) was used (Harris 1985, pp 504-506).

All data analyses were performed using the Statistical Analysis System, version 5 (SAS Institute 1985a and 1985b). The procedures used included MEANS, PLOT, ANOVA, GLM, and CORR.

Results and discussion

The raw data and descriptive statistics for concentrations of foliar nutrients at 0, 1, and 2 growing seasons are included in Appendices VIII to X. The means and standard errors for nutrient differences by site and treatment after each growing season are given in Table 13.

Analysis of both sites together

The three-way interaction involving thin x brush reduction x site was nonsignificant after both growing seasons for all nutrient differences using an adjusted α level of 0.0085 (Table 14). Except for N, significant

TABLE 13. Mean and standard error for change in concentrations of foliar nutrients after one and two years, by treatments, for sites E55 and E44.

Variables	Year	Treatment			
		Control	Brush	Thin	Combined
E55					
N (%)	1	0.143 (0.026)	0.157 (0.070)	0.299 (0.068)	0.350 (0.062)
	2	0.164 (0.033)	0.110 (0.051)	0.075 (0.042)	0.161 (0.054)
P (%)	1	-0.016 (0.005)	-0.006 (0.008)	0.017 (0.007)	0.033 (0.011)
	2	-0.024 (0.007)	-0.011 (0.008)	-0.002 (0.008)	0.031 (0.009)
K (%)	1	0.045 (0.029)	0.242 (0.041)	0.172 (0.046)	0.375 (0.036)
	2	-0.004 (0.022)	0.086 (0.011)	0.066 (0.040)	0.127 (0.030)
S (%)	1	0.017 (0.003)	0.018 (0.005)	0.025 (0.006)	0.031 (0.004)
	2	0.010 (0.004)	0.013 (0.005)	0.008 (0.005)	0.016 (0.005)
SO ₄ ²⁻ -S (mg/kg)	1	7.8 (21.4)	10.1 (14.4)	2.2 (21.9)	15.4 (22.5)
	2	-44.1 (22.4)	-7.4 (15.7)	-13.9 (19.1)	21.6 (19.8)
Cu (mg/kg)	1	-0.2 (0.8)	0.2 (0.4)	0.3 (0.6)	-1.2 (0.5)
	2	-1.7 (0.7)	3.5 (0.5)	1.5 (0.7)	-1.3 (0.5)
E44					
N (%)	1	0.184 (0.031)	0.320 (0.039)	0.202 (0.047)	0.425 (0.061)
	2	0.162 (0.029)	0.208 (0.033)	0.038 (0.059)	0.225 (0.046)
P (%)	1	-0.011 (0.006)	0.008 (0.003)	0.001 (0.007)	0.016 (0.009)
	2	-0.014 (0.007)	-0.005 (0.006)	-0.009 (0.008)	0.004 (0.010)

TABLE 13. (continued)

Variables	Year	Treatment			
		Control	Brush	Thin	Combined
K (%)	1	0.108 (0.018)	0.211 (0.026)	0.140 (0.031)	0.270 (0.029)
	2	0.075 (0.033)	0.145 (0.030)	0.017 (0.039)	0.116 (0.073)
S (%)	1	0.018 (0.002)	0.023 (0.003)	0.024 (0.004)	0.032 (0.005)
	2	0.018 (0.004)	0.017 (0.004)	0.010 (0.006)	0.015 (0.003)
SO ₄ ²⁻ -S (mg/kg)	1	44.1 (15.9)	-11.5 (12.0)	3.7 (17.0)	21.1 (30.6)
	2	35.8 (26.0)	-1.7 (18.7)	-12.2 (21.6)	17.2 (26.4)
Cu (mg/kg)	1	-0.8 (0.4)	2.2 (0.5)	1.3 (0.2)	2.6 (0.3)
	2	-0.5 (0.8)	2.6 (0.5)	7.9 (0.5)	1.6 (0.5)

NOTE: Changes in nutrient concentrations were calculated by subtracting the initial values from the values at the end of each growing season. n=10 for all values.

TABLE 14. ANOVAs for comparing brush reduction and thinning treatments on two sites after one and two growing seasons using differences in concentrations of foliar nutrients of western hemlock as the dependent variables.

Source of variation	Error term	Error df ^a	Growing season					
			1			2		
			Mean square error	F value	P	Mean square error	F value	P
<u>N (%)</u>								
Site	Block	18	0.026394	1.57	0.2264	0.020878	0.91	0.3538
Thin	Thin x Site	1	0.063845	4.36	0.2843	0.0059513	4.42	0.2828
Thin x Site	Thin x Block	18	0.020349	3.14	0.0934	0.019952	0.30	0.5917
Brush	Brush x Site	1	0.10804	2.08	0.3860	0.050501	1.74	0.4131
Brush x Site	Brush x Block	18	0.038869	2.78	0.1128	0.020905	2.42	0.1375
Thin x Brush	Thin x Brush x Site	1	0.0031250	6.15	0.2440	0.00000125	78961.00	0.0023
Thin x Brush x Site	Thin x Brush x Block	18	0.026442	0.12	0.7350	0.017260	0.00	0.9933

TABLE 14. (continued)

Source of variation	Error term	Error df ^a	Mean square error	Growing season				
				1		2		
				F value	P	Mean square error	F value	P
	<u>P (%)</u>							
Site	Block	18	0.00057778	0.42	0.5232	0.00067611	0.60	0.4490
Thin	Thin x Site	1	0.0033800	3.13	0.3275	0.0031250	2.43	0.3629
Thin x Site	Thin x Block	18	0.00019944	16.95	0.0006	0.00049833	6.27	0.0221
Brush	Brush x Site	1	0.00008000	56.25	0.0844	0.00072000	8.03	0.2160
Brush x Site	Brush x Block	18	0.00063722	0.13	0.7272	0.00083333	0.86	0.3649
Thin x Brush	Thin x Brush x Site	1	0.00012500	0.04	0.8743	0.00032000	2.25	0.3743
Thin x Brush x Site	Thin x Brush x Block	18	0.00072333	0.17	0.6825	0.00049222	0.65	0.4306

TABLE 14. (continued)

Source of variation	Error term	Error df ^a	Mean square error	Growing season				
				1		2		
				F value	P	Mean square error	F value	P
<u>K (%)</u>								
Site	Block	18	0.013343	1.03	0.3230	0.013781	0.55	0.4672
Thin	Thin x Site	1	0.035701	4.31	0.2857	0.049005	0.01	0.9232
Thin x Site	Thin x Block	18	0.0063495	5.62	0.0291	0.0089236	5.49	0.0308
Brush	Brush x Site	1	0.034861	14.37	0.1642	0.00040500	316.05	0.0358
Brush x Site	Brush x Block	18	0.0078363	4.45	0.0492	0.022169	0.02	0.8940
Thin x Brush	Thin x Brush x Site	1	0.00055125	2.47	0.3608	0.0042050	0.00	1.0000
Thin x Brush x Site	Thin x Brush x Block	18	0.015853	0.03	0.8542	0.014441	0.29	0.5961

TABLE 14. (continued)

Source of variation	Error term	Error df ^a	Mean square error	Growing season				
				1		2		
				F value	P	Mean square error	F value	P
<u>S (%)</u>								
Site	Block	18	0.00018993	0.21	0.6493	0.00024073	1.08	0.3132
Thin	Thin x Site	1	0.00003251	49.55	0.0898	0.00014580	0.73	0.5508
Thin x Site	Thin x Block	18	0.00014201	0.23	0.6381	0.00019699	0.74	0.4009
Brush	Brush x Site	1	0.00007801	6.22	0.2428	0.00008000	3.06	0.3305
Brush x Site	Brush x Block	18	0.00013559	0.58	0.4580	0.00012581	0.64	0.4356
Thin x Brush	Thin x Brush x Site	1	0.00000781	9.49	0.1999	0.00000020	784.00	0.0227
Thin x Brush x Site	Thin x Brush x Block	18	0.00024660	0.03	0.8607	0.00021247	0.00	0.9759

TABLE 14. (continued)

Source of variation	Error term	Error df ^a	Mean square error	Growing season				
				1		2		
				F value	P	Mean square error	F value	P
<u>SO₄²⁻-S (mg/kg)</u>								
Site	Block	18	4039.9	0.15	0.7046	6693.0	1.28	0.2721
Thin	Thin x Site	1	70.313	1.17	0.4755	9746.1	0.12	0.7909
Thin x Site	Thin x Block	18	3694.5	0.02	0.8918	2704.7	3.60	0.0738
Brush	Brush x Site	1	3604.6	0.18	0.7454	8060.1	0.64	0.5711
Brush x Site	Brush x Block	18	4162.8	0.87	0.3644	3502.2	2.30	0.1466
Thin x Brush	Thin x Brush x Site	1	4820.5	1.83	0.4056	5797.0	0.93	0.5114
Thin x Brush x Site	Thin x Brush x Block	18	4466.2	1.08	0.3126	5530.0	1.05	0.3195

TABLE 14. (continued)

Source of variation	Error term	Error df ^a	Growing season					
			1			2		
			Mean square error	F value	P	Mean square error	F value	P
<u>Cu (mg/kg)</u>								
Site	Block	18	1.5417	31.17	0.0001	4.0056	28.76	0.0001
Thin	Thin x Site	1	14.450	0.22	0.7200	101.25	0.42	0.6356
Thin x Site	Thin x Block	18	3.4083	4.24	0.0543	6.2333	16.24	0.0008
Brush	Brush x Site	1	36.450	0.35	0.6594	39.200	0.02	0.9097
Brush x Site	Brush x Block	18	1.2639	28.84	0.0001	1.6389	23.92	0.0001
Thin x Brush	Thin x Brush x Site	1	0.050000	324.00	0.0353	2.4500	154.47	0.0511
Thin x Brush x Site	Thin x Brush x Blocks	18	2.5972	0.02	0.8912	1.8667	1.31	0.2669

NOTE: The experimental design is described in the text. For all sources of variation, $\alpha = 0.0085$ was used.

^aThe degrees of freedom for hypothesis is 1 for all tests.

variables in the two site analysis involved treatment x site interactions. The brush x site interaction was significant for the nutrient differences for Cu after both growing seasons (Table 14). Also, the thin x site interaction was significant for nutrient differences for P after the first growing season and for Cu after the second growing season (Table 14). For these nutrients, it is appropriate to examine the response on each site using the individual site analyses. For N, the thin x brush interaction was significant after the second growing season (Table 14). Because of the significant treatment x site interactions and because the growth response to the treatment was different on both sites (Chapter 2), detailed analysis of the nutrient responses will be limited to the ANOVAs for individual sites. Discussion of N on an individual site basis is also desirable because each site may have a different type of interaction between treatments.

Analysis of each site separately

The thinning and brush reduction factors are discussed separately for each site. A similar response by more than one nutrient often occurred for each factor, thus all nutrients with a significant response are discussed simultaneously for each factor to avoid repetition. Total S and SO_4^{2-} -S were not significant after either growing season for any factor on either site (Table 15). Because a significant brush reduction x thinning interaction occurred after the second growing season for Cu on both sites (Table 15), these interactions are discussed separately.

Thinning significantly altered the nutrient differences of N, P, and K after the first growing season and P after the second growing season, on site E55 (Table 15). On this site, the overall mean for N differences after the first growing season was 0.325% (se=0.045%, n=20) on plots with thinning versus 0.150% (se=0.036%, n=20) on unthinned plots.

TABLE 15. ANOVAs for comparing brush reduction and thinning treatments on each site separately, after one and two growing seasons, using differences in concentrations of foliar nutrients of western hemlock as the dependent variables.

Source of variation	Error term	Error df ^a	Growing season					
			1			2		
			Mean square error	F value	P	Mean square error	F value	P
E55								
<u>N (%)</u>								
Thin	Thin x Block	9	0.018780	16.21	0.0030	0.012337	0.29	0.6017
Brush	Brush x Block	9	0.050463	0.21	0.6581	0.030410	0.08	0.7783
Thin x Brush	Thin x Brush x Block	9	0.038223	0.09	0.7716	0.019372	2.53	0.1462
<u>P (%)</u>								
Thin	Thin x Block	9	0.00027667	46.84	0.0001	0.00055111	18.58	0.0020
Brush	Brush x Block	9	0.00099556	1.70	0.2250	0.0010900	4.85	0.0551
Thin x Brush	Thin x Brush x Block	9	0.00074000	0.12	0.7353	0.00075556	1.32	0.2796

TABLE 15. (continued)

Source of variation	Error term	Error df ^a	Mean square error	Growing season				
				1		2		
				F value	P	Mean square error	F value	P
<u>K (%)</u>								
Thin	Thin x Block	9	0.0066944	25.24	0.0007	0.0036581	8.42	0.0175
Brush	Brush x Block	9	0.012317	32.48	0.0003	0.013214	4.31	0.0676
Thin x Brush	Thin x Brush x Block	9	0.024096	0.00	0.9526	0.011969	0.18	0.6850
<u>S (%)</u>								
Thin	Thin x Block	9	0.00019674	5.34	0.0462	0.00019260	0.01	0.9294
Brush	Brush x Block	9	0.00014680	0.59	0.4611	0.00013572	2.23	0.1697
Thin x Brush	Thin x Brush x Block	9	0.00036047	0.18	0.6810	0.00022890	0.32	0.5863

TABLE 15. (continued)

Source of variation	Error term	Error df ^a	Mean square error	Growing season				
				1		2		
				F value	P	Mean square error	F value	P
<u>SO₄²⁻-S (mg/kg)</u>								
Thin	Thin x Block	9	4222.9	0.00	0.9943	2833.3	3.09	0.1125
Brush	Brush x Block	9	5114.7	0.12	0.7397	4301.3	3.03	0.1157
Thin x Brush	Thin x Brush x Block	9	3753.3	0.08	0.7848	4200.3	0.00	0.9773
<u>Cu (mg/kg)</u>								
Thin	Thin x Block	9	4.8028	0.42	0.5323	4.0667	1.57	0.2413
Brush	Brush x Block	9	1.8028	1.68	0.2274	2.5111	5.73	0.0402
Thin x Brush	Thin x Brush x Block	9	4.2472	2.12	0.1789	1.5556	102.86	0.0001

TABLE 15. (continued)

Source of variation	Error term	Error df ^a	Mean square error	Growing season				
				1		2		
				F value	P	Mean square error	F value	P
E44								
<u>N (%)</u>								
Thin	Thin x Block	9	0.021917	1.73	0.2215	0.027567	1.04	0.3348
Brush	Brush x Block	9	0.027275	11.81	0.0074	0.011400	11.91	0.0073
Thin x Brush	Thin x Brush x Block	9	0.014661	1.29	0.2853	0.015147	3.28	0.1035
<u>P (%)</u>								
Thin	Thin x Block	9	0.00012222	8.18	0.0188	0.00044556	1.10	0.3217
Brush	Brush x Block	9	0.00027889	10.36	0.0105	0.00057667	2.10	0.1814
Thin x Brush	Thin x Brush x Block	9	0.00070667	0.06	0.8173	0.00022889	0.17	0.6857

TABLE 15. (continued)

Source of variation	Error term	Error df ^a	Mean square error	Growing season				
				1		2		
				F value	P	Mean square error	F value	P
<u>K (%)</u>								
Thin	Thin x Block	9	0.0060025	3.45	0.0963	0.014189	1.33	0.2779
Brush	Brush x Block	9	0.0033558	40.44	0.0001	0.031125	2.29	0.1642
Thin x Brush	Thin x Brush x Block	9	0.0076114	0.24	0.6363	0.016914	0.12	0.7325
<u>S (%)</u>								
Thin	Thin x Block	9	0.00008729	6.79	0.0284	0.00020139	1.24	0.2941
Brush	Brush x Block	9	0.00012438	3.83	0.0821	0.00011589	0.19	0.6699
Thin x Brush	Thin x Brush x Block	9	0.00013273	0.13	0.7294	0.00019604	0.43	0.5289

TABLE 15. (continued)

Source of variation	Error term	Error df ^a	Growing season					
			Mean square error	1		Mean square error	2	
				F value	P		F value	P
<u>SO₄²⁻-S (mg/kg)</u>								
Thin	Thin x Block	9	3166.0	0.05	0.8314	2576.2	0.82	0.3883
Brush	Brush x Block	9	3210.9	1.14	0.3142	2703.1	0.06	0.8109
Thin x Brush	Thin x Brush x Block	9	5179.1	2.57	0.1432	6859.7	1.63	0.2335
<u>Cu (mg/kg)</u>								
Thin	Thin x Block	9	2.0139	7.76	0.0212	8.4000	16.30	0.0029
Brush	Brush x Block	9	0.72500	63.76	0.0001	0.76667	33.39	0.0003
Thin x Brush	Thin x Brush x Block	9	0.94722	7.63	0.0220	2.1778	101.43	0.0001

NOTE: The experimental design is described in the text. For all sources of variation, $\alpha = 0.0038$ was used.

^aThe degrees of freedom for hypothesis is 1 for all tests.

The first year response of P and K to thinning followed the same pattern as N on this site (Figures 7-9, Table 13). Thus the result of thinning on site E55 was a significant increase in concentrations of foliar N, P, and K after the first growing season. This implies that trees were competing for these nutrients on this site. In contrast, thinning had no significant effect on N, P, and K on site E44 (Table 15). Site E55 had greater initial values for basal area of competing trees than E44, suggesting that greater competition between trees existed for these nutrients on site E55 than on E44. For the second growing season, the average change in foliar concentration of P on site E55, for plots with and without thinning, was 0.015% (se=0.007%, n=20) and -0.018% (se=0.005%, n=20), respectively. Although the second year response in foliar P was smaller than the first year response, the benefit of reduced tree competition was retained for at least two growing seasons for this nutrient on site E55. The pattern for N after the first and for P after both growing seasons is similar to the patterns for response in stem volume and diameter for both growing seasons on this site (Figures 4, 6, 7, and 8). This suggests that N and P are involved in the growth response observed after thinning on this site.

On site E44, thinning had a significant effect on Cu after the second growing season (Table 15). This variable is discussed below, as a significant brush reduction x thinning interaction occurred. All other variables for this factor were nonsignificant for both growing seasons.

Brush reduction showed a significant effect after the first growing season, but not the second growing season, on differences in K on site E55 (Table 15). The average increase in foliar concentration of K on this site, for plots with and without brush reduction, was 0.309% (se=0.030%, n=20) and 0.109% (se=0.030%, n=20) after the first growing season. The greater foliar concentration of K

Figure 7. Average change in concentration of foliar nitrogen after one and two growing seasons, by treatment, for sites E55 and E44. These values are calculated by subtracting the initial value from the value at the end of each growing season. The treatments are C = control, B = brush reduction, T = thinning, and B+T = combined. The vertical bars represent 2 se (n=10).

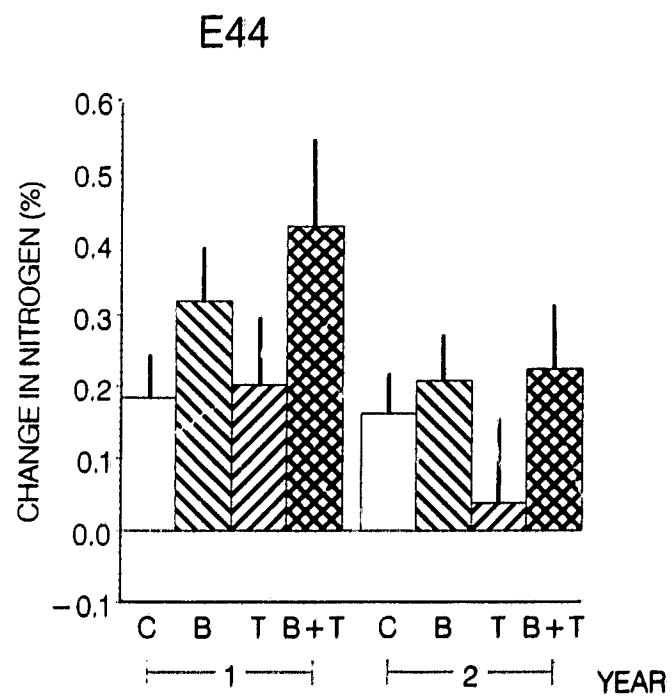
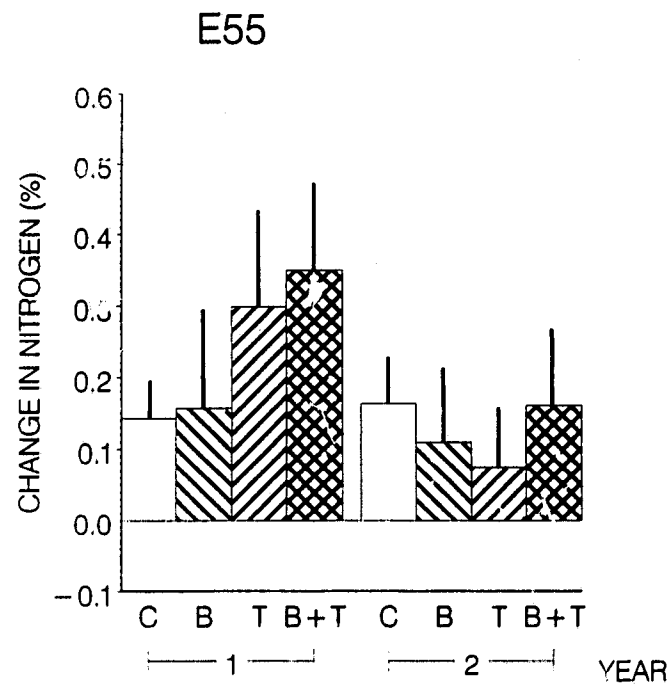


Figure 8. Average change in concentration of foliar phosphorus after one and two growing seasons, by treatment, for sites E55 and E44. These values are calculated by subtracting the initial value from the value at the end of each growing season. The treatments are C = control, B = brush reduction, T = thinning, and B+T = combined. The vertical bars represent 2 se (n=10).

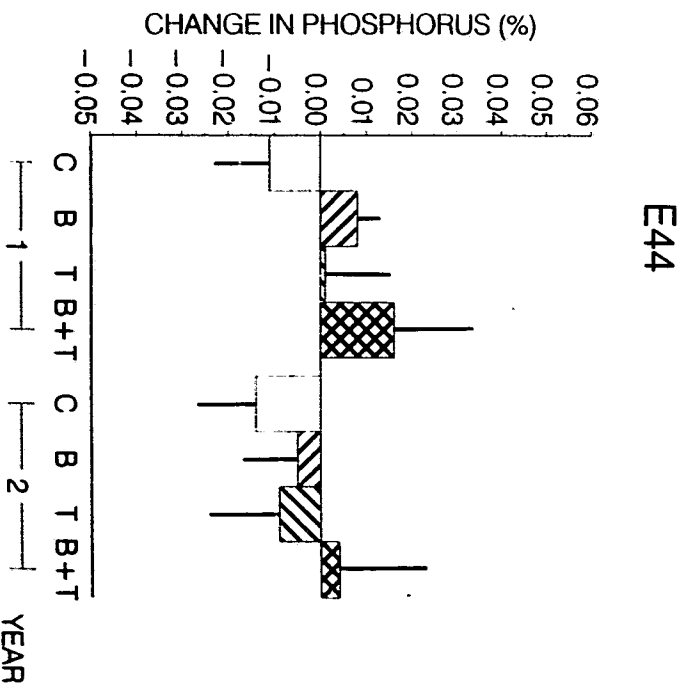
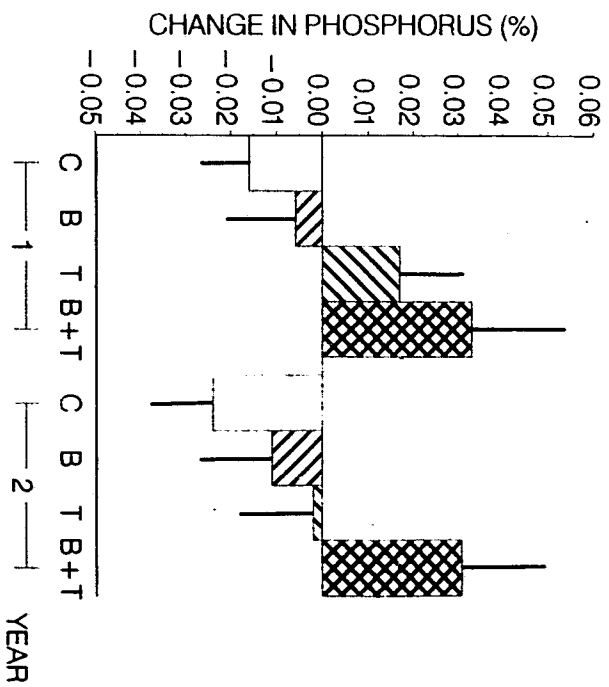
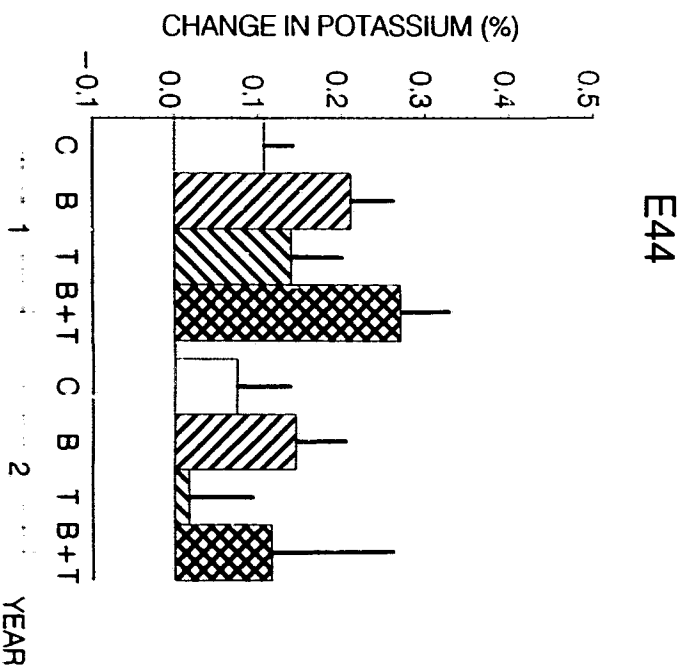
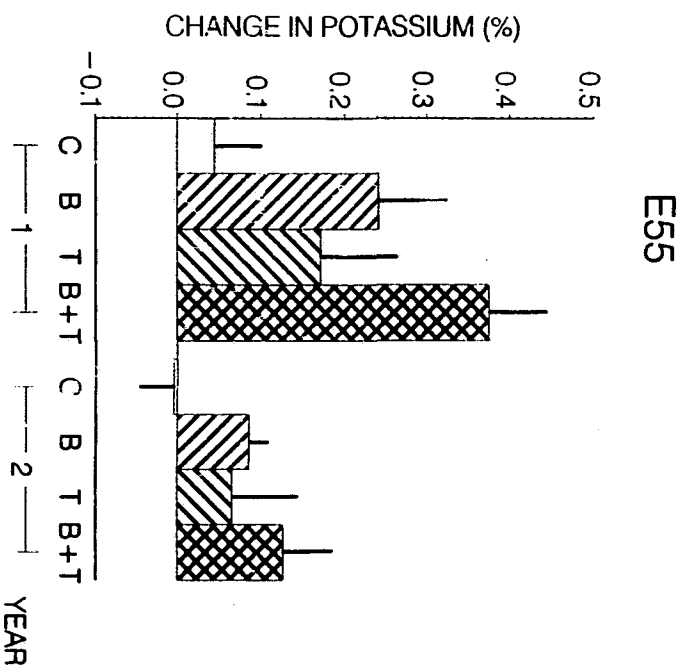


Figure 9. Average change in concentration of foliar potassium after one and two growing seasons, by treatment, for sites E55 and E44. These values are calculated by subtracting the initial value from the value at the end of each growing season. The treatments are C = control, B = brush reduction, T = thinning, and B+T = combined. The vertical bars represent 2 se (n=10).



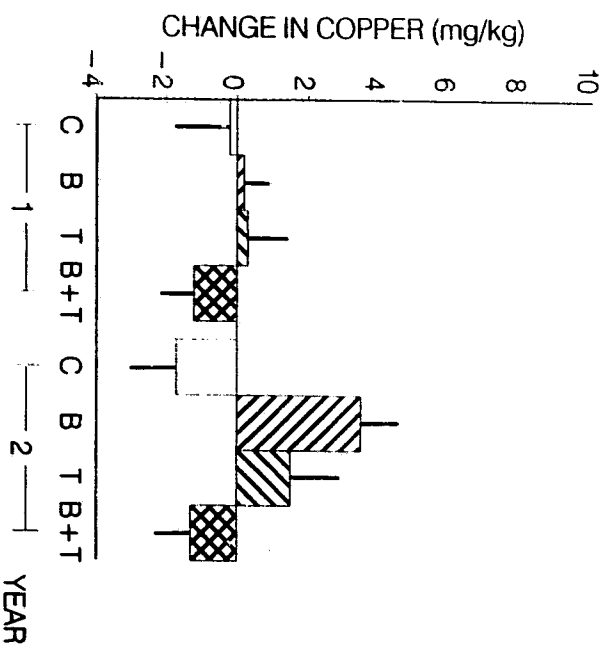
after reduced brush competition implies that herb and shrub species were competing for this nutrient on site E55. However, the benefit of reduced competition, in terms of greater K concentrations, was not retained for the second growing season (Figure 9). Initial foliar levels for this nutrient were lower than values reported for western hemlock in Washington state (Radwan and DeBell 1980, 1989).

For site E44, brush reduction had a significant effect on foliar N, K, and Cu after the first growing season and on N and Cu after the second growing season (Table 15). For the first growing season, the average increase in foliar concentration of N on site E44 was 0.373% (se=0.037%, n=20) for plots with brush reduction and 0.193% (se=0.027%, n=20) for plots without brush reduction. The first year response of K and Cu to brush reduction followed the same pattern as N on this site (Figures 7, 9, and 10; Table 13). The greater foliar concentrations after the first year imply that brush species were competing for N, K, and Cu on site E44. Growth of western hemlock might be limited by N, K, and Cu, because the response pattern for these nutrients after the first year was similar to that for the diameter and stem volume responses (Figures 4, 6, 7, 9, and 10). For the second growing season, the average increase in foliar concentration of N on site E44, for plots with and without brush reduction, was 0.217% (se=0.028%, n=20) and 0.100% (se=0.035%, n=20). Although the second year response in foliar N was smaller than the first year response, the benefit of reduced brush competition was retained for at least two growing seasons for this nutrient.

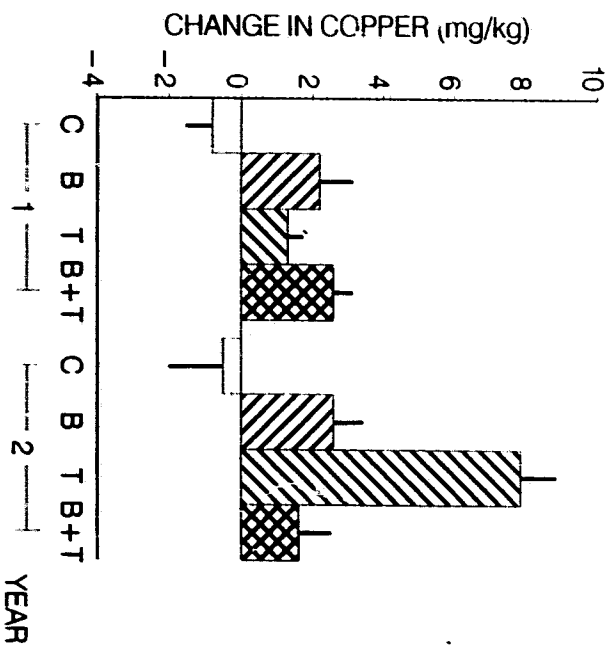
A significant brush reduction x thinning interaction, after the second growing season, occurred for the change in Cu on site E55 (Table 15). There was a one year lag before a significant interaction for Cu was detected. After two growing season, the concentration of foliar Cu increased with either type of competition reduction alone but the

Figure 10. Average change in concentration of foliar copper after one and two growing seasons, by treatment, for sites E55 and E44. These values are calculated by subtracting the initial value from the value at the end of each growing season. The treatments are C = control, B = brush reduction, T = thinning, and B+T = combined. The vertical bars represent 2 se (n=10).

E55



E44



combined treatment yielded a concentration approximately the same as the control (Table 13). The pattern for Cu on E55 is for increased concentrations after the first growing season, followed by the retention of greater concentrations in the foliage for the brush reduction or thinning treatment alone in the second year (Figure 10). The combined treatment had the largest increase in stem volume of the four treatments, especially after the second growing season (Figure 6). Assuming growth in stem volume reflects overall tree growth, the greatly improved growth of the trees in the combined treatment could have resulted in the dilution of Cu by dispersing this nutrient through a much larger biomass. For brush reduction or thinning alone, reduced competition may have been adequate to improve the availability of Cu, as reflected in the greater foliar concentrations, but not enough to cause such a large growth in biomass that the concentration increase was reduced by dilution. It is also possible that another factor, such as water availability, was affected by plant competition and that this factor could affect growth and possible nutrient dilution. For example, water stress is a major limitation in shoot elongation (Kramer and Kozlowski 1979). One of the possible effects of the combined treatment was greatly improved water status, which could have increased tree growth. This could have diluted the concentrations of some nutrients, even though overall uptake was improved. Thus competition for Cu may exist on site E55 but detection of this could be confounded by other factors. A complete year by year budgeting of these nutrients in the tree, along with year-by-year monitoring of growth, would be required to show that this is the case.

For site E44, a significant brush reduction x thinning interaction was found for foliar Cu after the second growing season (Table 15). This site also had a one year lag before a significant interaction for Cu was detected. The

interaction for Cu after two years probably occurred for the same reason as on site E55. The greatest increase in concentration of Cu was for thinning on E44 versus brush reduction on E55 (Figure 10); this was the reverse of the pattern for stem volume growth (Figure 6), which supports the hypothesis of dilution through greater biomass production. Also, on E44 there was a net increase in concentration of Cu for the combined treatment after both growing seasons, compared to the slight decrease found on E55 (Figure 10). This may reflect the smaller stem volume growth and nutrient dilution on site E44.

Analysis of the blocks on site E55 with trenching

The contrast comparing the means for brush reduction plus thinning to trenching did not yield a significant difference for any nutrient after either growing season. The means and standard errors for this analysis are included in Appendix XI. After trenching, increases in foliar nutrient concentrations were not significantly greater than increases caused by the combined brush reduction and thinning treatment. Data on net change in foliar biomass for each treatment are needed to determine if overall nutrient status was altered.

Relationships between nutrient and volume responses

Plotting of the transformed volume responses versus first year nutrient responses showed continuous distributions. For site E55, significant positive correlations were found between change in foliar K and first year volume response, and change in foliar N, K, and S and second year volume response (Figures 11-13; Table 16). The earlier analysis of nutrient differences using ANOVA had indicated that N and K are affected by both brush and tree competition on site E55.

For site E44, volume response of western hemlock was

significantly and positively correlated after both years with the nutrient differences for N, S, and Cu (Figures 11-13; Table 16). The earlier analysis had indicated that N and Cu were involved in plant competition on site E44.

For both sites, greater numbers of significant correlations were found, or the correlation coefficients were larger, in the second year. This occurs for two reasons. First, there is a lag, partly resulting from the determinate shoot growth of western hemlock, between increase of foliar nutrient concentrations as a result of reduced competition, and increase in growth. Greater response in stem volume occurred on both sites after the second growing season (Figure 6). Second, stem volume is cumulative. The increase in stem volume after two growing seasons includes the first year increase. For both sites, nutrient differences with significant correlations to first year volume response often also had significant correlations with second year volume response of western hemlock. This relationship holds for K on site E55 and for N, S, and Cu on site E44.

Growth of western hemlock is limited by competition on both sites. The correlation analysis suggests nutrients that may be limiting growth. For site E55, growth may be limited by the nutrients N, K, and S. For site E44, growth may be limited by the nutrients N, S, and Cu. Enhanced water uptake after reduced competition may also improve nutrient uptake. Thus, experiments with nutrient additions and irrigation are necessary to determine if nutrient competition is limiting growth on these sites.

Nutrient and water competition on the Eve River sites

The results of ANOVA and correlation analyses indicate that growth of western hemlock may be nutrient limited on the Eve River sites. A fertilizer trial was started on sites E55 and E44 (Appendix XII). The results were

Figure 11. Change in stem volume of western hemlock, after two growing seasons, versus change in foliar nitrogen, after one growing season for sites E55 and E44. The treatments are C = control, B = brush reduction, T = thinning, and K = combined brush reduction and thinning.

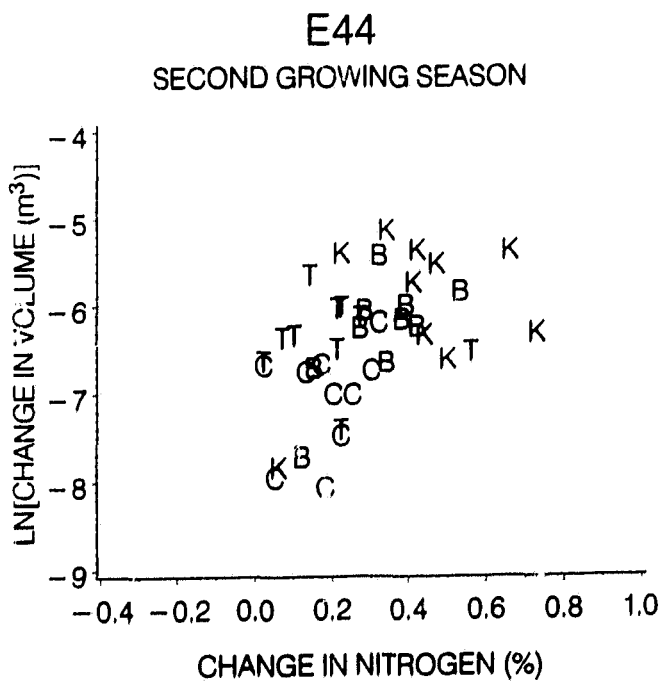
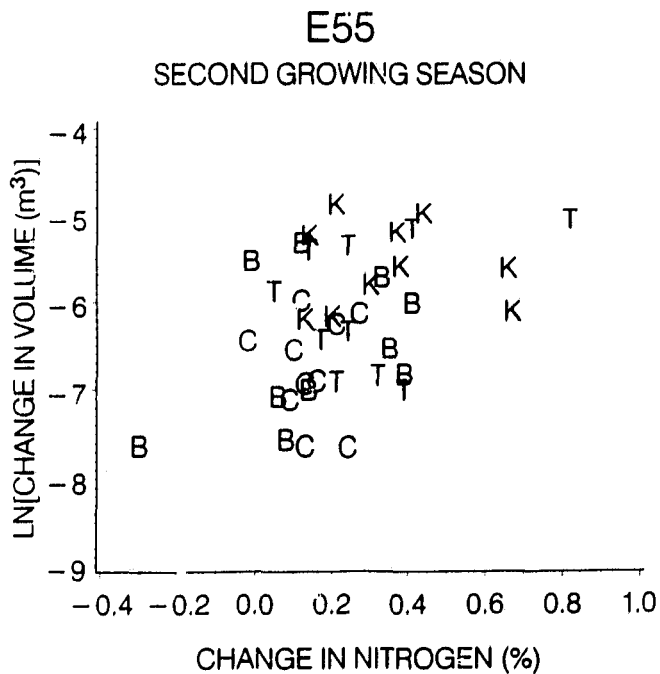
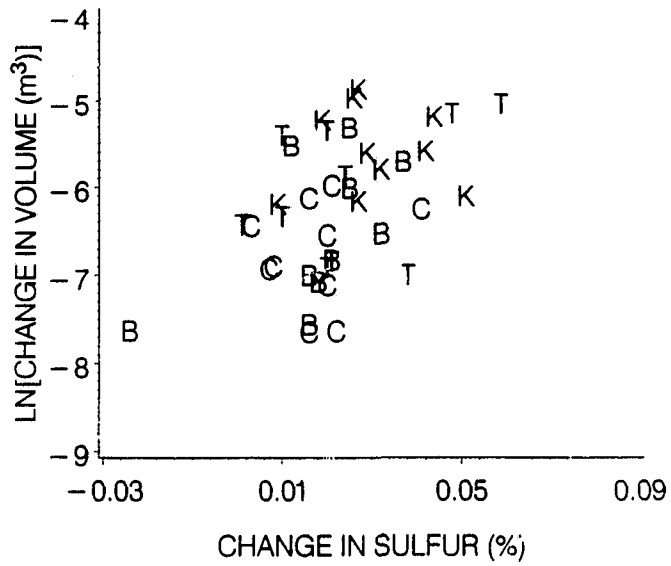


Figure 12. Change in stem volume of western hemlock, after two growing seasons, versus change in foliar sulfur, after one growing season for sites E55 and E44. The treatments are C = control, B = brush reduction, T = thinning, and K = combined brush reduction and thinning.

E55
SECOND GROWING SEASON



E44
SECOND GROWING SEASON

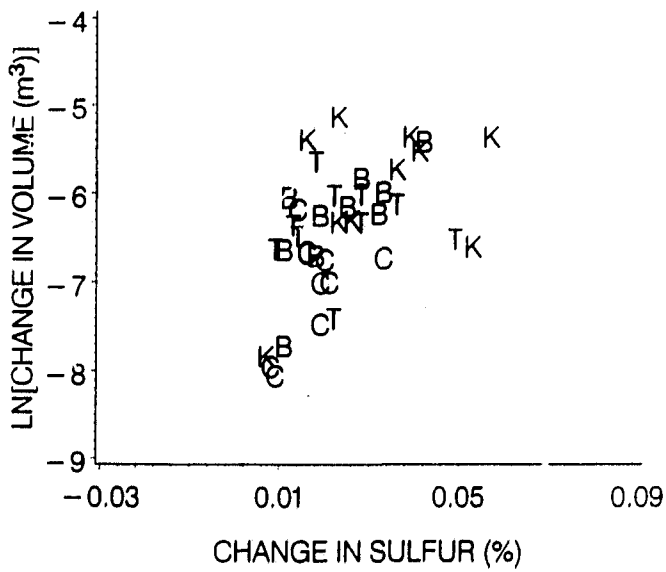


Figure 13. Change in stem volume of western hemlock, after two growing seasons, versus change after one growing season in foliar potassium on site E55 and foliar copper on site E44. The treatments are C = control, B = brush reduction, T = thinning, and K = combined brush reduction and thinning.

TABLE 16. Pearson product moment correlations (probability levels in brackets) for change in concentrations of foliar nutrients after one growing season versus change in tree volume after one and two growing seasons for two sites.

Change in foliar nutrient concentrations after 1 growing season	Change in stem volume ^a	
	Growing season	
	1	2
E55		
N	0.2814 (0.0786)	0.4163 (0.0075)
P	0.2515 (0.1175)	0.3447 (0.0294)
K	0.4354 (0.0050)	0.5158 (0.0007)
S	0.3592 (0.0228)	0.4784 (0.0018)
SO ₄ ²⁻ -S	0.2038 (0.2073)	0.1423 (0.3811)
Cu	-0.2138 (0.1853)	-0.2045 (0.2057)
E44		
N	0.4523 (0.0034)	0.4821 (0.0016)
P	0.3171 (0.0462)	0.2813 (0.0787)
K	0.1713 (0.2907)	0.2441 (0.1291)
S	0.4523 (0.0034)	0.5203 (0.0006)
SO ₄ ²⁻ -S	-0.3187 (0.0450)	-0.3237 (0.0416)
Cu	0.4130 (0.0081)	0.4660 (0.0024)

NOTE: $\alpha=0.0085$ was used as the significance level with $n=40$ for each correlation coefficient.
^aThe values for volume difference were transformed with natural logarithms prior to calculating the correlation coefficients.

confounded by a flaw in the field layout. However, the fertilizer trial did indicate a few trends. On E44, net growth in stem volume after two years was greater on plots with fertilizer than on the control plots (Appendix XII). On E55, the net growth in stem volume for fertilizer plots approached that for control plots, even though the control plots had larger trees than the fertilizer plots at the beginning of the trial. These results suggest that nutrients were limiting growth on these sites. The foliar N and P levels increased dramatically in trees on the plots where these nutrients were added (Appendix XIII). However, for both sites, net volume growth was greater for plots with brush reduction plus thinning than for plots with either fertilizer or control (Appendix XII). Greater response after reduced vegetation competition supports the idea that both water and nutrients are limiting growth. Water could be limited by plant competition or storage capacity of the soil.

To determine whether water was likely to be limiting, climatic moisture deficits were calculated for the Eve River watershed using a model based on monthly precipitation, total sunlight hours, and mean air temperatures (Spittlehouse 1989). Results of these calculations are given in Appendix XIV. A climatic moisture deficit existed by the end of July during the first growing season and by the end of May during the second growing season. The effect of climatic moisture deficits can be reduced if a plant has access to adequate soil water supplies (Spittlehouse 1989). This depends on the soil type and the rooting depth of the plant. Western hemlock roots almost exclusively in the organic layer, and for 13 of the 40 sample sites examined in Chapter 1, the organic layer was ≤ 10 cm in depth. A 10 cm layer of organic soil can supply approximately 25 mm of available water on an areal basis (British Columbia Irrigation Committee 1980). The soil moisture supply for

the shallow organic layers would probably have been exhausted by the end of July for both growing seasons (Appendix XIV).

Rapid shoot elongation in western hemlock is completed by early July (Owens and Molder 1973). Slower shoot elongation occurs during July and early August. A pattern similar to this for radial growth was found for Tsuga canadensis Carr. in Massachusetts (Skene 1972). In the latter study, radial growth continued at the slower rate till September and significant rainfall was noted during late July and August. If western hemlock has a similar growth pattern, water stress could have had an impact on shoot elongation and radial growth during both growing seasons on the Eve River sites, from July onwards.

Climatic moisture deficits combined with limited soil supply would result in competition for water. Decreased plant competition after brush reduction or thinning could have increased the water supply for trees in these treatments, which could increase growth by decreasing the period of moisture stress. However, the relatively small supply of soil moisture for many of the trees in this study may provide a very short term gain on the treated plots. The gain in water supply for a treated plot would primarily occur during the period of slow radial and shoot growth (Owens and Molder 1973; Skene 1972).

Thus, competition for moisture may exist on the sites with shallow-rooted western hemlock, and moisture stress probably affects tree growth. However, the net effect on tree growth may be small, and may occur mainly when relatively small increments are forming near the end of the growing season. If this is the case, a significant part of the growth response may have occurred before climatic moisture deficits existed. Increased nutrient supply after reduced vegetation competition may be a more plausible explanation for the observed growth response. A proper

fertilizer trial combined with an irrigation treatment is needed to test this hypothesis.

Summary and conclusions

With the exception of N, significant variables in the two site analysis involved site x treatment interactions. Separate analysis of each site was appropriate because the interactions indicated different nutrient responses. Following thinning, N, P, and K increased on site E55. A smaller but significant increase in P was retained for two growing seasons. Following reduction of brush competition, foliar concentrations of K increased on site E55 and N, K, and Cu increased on site E44. Part of the increase in foliar N was retained on site E44 for two years. The patterns for first year response in N and P after thinning on site E55 and for N, K, and Cu after brush reduction on E44 were the same as the patterns found for stem volume response after both growing seasons. This indicates that these nutrients may be involved in the growth response and are possibly limiting growth on these sites. Analysis of the subset of blocks with trenched plots indicated that trenching did not significantly increase the concentration of foliar nutrients compared to the combined brush reduction and thinning treatment. The synergistic benefit of simultaneously reducing both types of competition apparently yielded such improved growth that concentrations of foliar Cu on both sites were less than for each treatment separately, as a result of nutrient dilution after enhanced production of biomass. The greatly enhanced growth, when both types of competition were reduced, indicated that both groups of competitors are depleting the same limiting resources.

Correlations between volume growth and foliar nutrient concentrations of western hemlock indicated that relationships are stronger after two years of growth than

after only one year, and that the growth of western hemlock on these sites may be limited by competition for nutrients. This assumes that restrictions on plant uptake of nutrients do not exist. However, improved water status could explain both improved growth and increased nutrient uptake. Thus, correlation analysis indicates potentially limiting nutrients. Potentially limiting nutrients are N, K, and S on site E55 and N, S, and Cu on site E44.

Increased concentrations of P, N, K, and Cu in the foliage of western hemlock, after reduction of plant competition, supports the hypothesis that nutrient availability on these sites is limited by this competition. Although S was not significantly increased by treatments on either site, it was positively correlated with stem volume response. As initially hypothesized, response of second year nutrient concentrations was less than the first year response. N and P had this response pattern. Copper was the exception to this pattern. Different types of competition are important on each site, reflecting differences in initial site conditions. A greater number of nutrients increased in concentration after thinning on site E55 than on site E44. A greater number of nutrients increased in concentration after brush reduction on site E44 than on site E55. The only significant interaction between the two types of competition yielded an unexpected decrease in foliar Cu, probably because enhanced growth caused biomass dilution. Significant correlations between response in stem volume and N, S, K, and Cu support (although they do not prove) the hypothesis that growth of western hemlock on the sites is nutrient limited and that these may be the limiting nutrients. Water deficits may also limit growth of western hemlock on these sites. Further work involving nutrient and water additions is required to confirm that nutrient deficiencies are limiting growth on these sites.

OVERALL CONCLUSIONS

Significant relationships between the growth of western hemlock and eight site variables, on burned and unburned areas in the Eve River drainage, were not found using correlational analysis. Observations during sampling suggested that tree growth on these sites may be limited by competition from herbs, shrubs, or other trees. Because an earlier study found that growth on burned areas was significantly less than on unburned areas, plant competition during and after establishment of western hemlock was a possible mechanism causing reduced growth on the burned areas. Growth of western hemlock appeared to be nutrient-limited on both burned and unburned areas, where potentially limiting levels of P, N, K, S, and Cu occurred.

On burned areas, the response of western hemlock to decreased competition from herbs and shrubs or from trees was greater diameter and stem volume growth, relative to untreated plots. The magnitude of the response to different treatments reflected the particular competing species on a site at the beginning of the treatment. Where significant growth responses occurred, significant increases were found in the foliar concentrations of N, P, K, and Cu. The similarity of first year response patterns for these nutrients to the first and second year response patterns for diameter and stem volume provided support for nutrient-limited growth. Nutrient-limited growth was also suggested by significant correlations between stem volume response for two growing seasons and first year change in foliar concentrations of N, S, K, and Cu. On the burned areas, significant growth responses after brush reduction or thinning indicate that plant competition was limiting the growth of western hemlock. Competition for nutrients may be an important part of this process. After burning, competition is increased from plants that delay the

establishment and subsequent growth of western hemlock. Increased competition from herb and shrub species may also increase the competition for nutrients between western hemlock and other species. For western hemlock approximately 2 m tall, most of the competition occurs within 2 m of an individual tree.

Climatic moisture deficits occurred on these sites during both growing seasons. Hypotheses involving water stress could explain some of the growth responses. It is difficult to completely separate the effects of moisture and nutrients on plant growth. Nutrient limitations may explain a large part of the growth rates for western hemlock on these sites because a growth response was significantly correlated with increased concentrations of foliar nutrients. A few refinements and additions to the experimental layout could address the question of the relative importance of moisture versus nutrients. Moisture stress could be evaluated by measuring xylem pressure potential before and after the treatments are applied. This would indicate if moisture stress ever occurs. The measurements could be made over a growing season or during critical periods of low rainfall and high temperatures. Measurements should be made on both control and treatment plots. Atmospheric moisture demand and soil moisture status should also be measured. A further improvement would be to include an irrigation treatment. This would be feasible if plots were located near a water source and if a timed irrigation system could be installed. In conjunction with improved water supply, a set of plots with a balanced fertilizer application would help to indicate the importance of nutrient limitations. Because of the site differences in nutrient responses, consideration should be given to a proper fertilizer study involving several nutrients. A multifactorial design with thinning and/or brush reduction, complete fertilizer, and irrigation as the factors should be

established. The layout should include four or five randomized blocks per site, five sites per watershed, and at least three watersheds within the wetter subzone of the Coastal Western Hemlock zone. This design would take into account spatial variability within sites, watersheds, and the subzone of interest. Stratification by coarse or shallower soils may also be desirable, as water stress is more likely on these sites.

The present research demonstrates that herbs and shrub species can affect the growth of coniferous trees. It also demonstrates that measuring critical nutrient properties has limited value for predicting tree growth response. For example, significant growth was found in trees with foliar nutrient concentrations that would be rated as deficient, based on comparisons with reference stands.

Finally, for sites with coarse soils in the wetter areas of the Coastal Western Hemlock zone, I would recommend that slashburning be limited to landings and other areas with wood accumulations, if western hemlock is to be the next crop. On areas that have been burned, or on unburned areas with exposed mineral soil, vegetation control may be necessary to avoid the reduced initial growth rates on these potentially brushy sites. Rapid restocking with large stock is necessary to minimize domination of the site by weed species.

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Appendix I

Vegetation cover of plots used in the correlation analysis of Chapter 1.

The data are sorted by sites. The abbreviations used, including plant species, are explained below. The species are listed alphabetically by abbreviation within each strata. The criteria for plant strata are explained in Chapter 1.

PLOTNUM The sample point number within a site

A1 stratum

A1ALRU87 Alnus rubra
A1HW87 Tsuga heterophylla

B1 stratum

B1BA87 Abies amabilis
B1CR87 Thuja plicata
B1DF87 Pseudotsuga menziesii
B1HW87 Tsuga heterophylla
B1SS87 Picea sitchensis

B2 stratum

B2BA87 Abies amabilis
B2CR87 Thuja plicata
B2CY87 Chamaecyparis nootkatensis
B2DF87 Pseudotsuga menziesii
B2HW87 Tsuga heterophylla
B2SS87 Picea sitchensis
GAUSHA87 Gaultheria shallon
MENFER87 Rhododendron albiflorum
RIBES87 Ribes laxiflorum
RUBLEU87 Rubus leucodermis
RUBPAR87 Rubus parviflorus
RUBSPE87 Rubus spectabilis
SALSIT87 Salix sitchensis
SAMRAC87 Sambucus racemosa
TAXBRE87 Taxus brevifolia
VACJVA87 Vaccinium ovalifolium
VACPAR87 Vaccinium parvifolium
VALASK87 Vaccinium alaskaense
VMEMB87 Vaccinium membranaceum

C stratum

ACHTRI87 Achlys triphylla
ADIANTUM Adiantum pedatum

AGRTEN87	<u>Agrostis scabra</u>
ANAMAR87	<u>Anaphalis margaritacea</u>
ATHFEL87	<u>Athyrium filix-femina</u>
BLESPI87	<u>Blechnum spicant</u>
BOTMUL87	<u>Botrychium multifidum</u>
CARMER87	<u>Carex mertensii</u>
CIRSARVE	<u>Cirsium arvense</u>
CIRVUL87	<u>Cirsium vulgare</u>
COPASP87	<u>Coptis asplenifolia</u>
CORCAN87	<u>Cornus canadensis</u>
DESELO87	<u>Deschampsia elongata</u>
DRYAUS87	<u>Dryopteris austriaca</u>
ELYGLA87	<u>Elymus glaucus</u>
EPIANG87	<u>Epilobium angustifolium</u>
EQUISET	<u>Equisetum arvense</u>
FRAGAR87	<u>Fragaria sp.</u>
GALTRI87	<u>Galium triflorum</u>
GYMDRY87	<u>Gymnocarpium dryopteris</u>
HIEALB87	<u>Hieracium albiflorum</u>
HYPORADI	<u>Hypochaeris radicata</u>
LACCER87	<u>Lactuca muralis</u>
LINNEA87	<u>Linnaea borealis</u>
LONINV87	<u>Lonicera involucrata</u>
LUZCAM87	<u>Luzula campestris</u>
LUZPAR87	<u>Luzula parviflora</u>
LYCCLA87	<u>Lycopodium clavatum</u>
MIADL87	<u>Maianthemum dilatatum</u>
PLANTAGO	<u>Plantago major</u>
POLMUN87	<u>Polystichum munitum</u>
PTEAQU87	<u>Pteridium aquilinum</u>
SENTRI87	<u>Senecio triangularis</u>
STELLA87	<u>Stellaria claycantha</u>
STREPT87	<u>Streptopus roseus</u>
TIAREL87	<u>Tiarella trifoliata</u>
TRISSET87	<u>Trisetum canescens</u>

Strata totals

SUMA	Sum of the cover for all species in stratum A1
SUMB1	Sum of the cover for all species in stratum B1
SUMB2	Sum of the cover for all species in stratum B2
SUMB	Sum of the cover for all species in stratum B
SUMC	Sum of the cover for all species in stratum C
SUMVEG	Sum of the cover for all species within strata A1, B1, B2, and C

----- SITE=E55-BURNED -----

PLOTNUM	A1ALR87	A1HW87	B1BA87	B1CR87	B1DF87	B1HW87	B1SS87	B2BA87	B2CR87	B2DF87
1	0	0	0	0	0	15	0	0.0	0.2	0.0
2	0	0	0	0	0	25	0	0.0	0.1	0.0
3	0	0	0	0	0	20	0	1.0	0.1	0.1
4	0	0	0	0	0	40	0	0.0	0.1	0.1
5	0	0	0	0	0	10	0	0.0	0.1	0.0
6	0	0	0	0	0	1	0	0.0	0.1	0.0
7	0	0	0	0	0	15	0	0.0	0.5	0.0
8	0	0	0	0	0	10	0	0.0	0.1	0.0
9	0	0	0	0	5	10	0	0.0	2.0	0.0
10	0	0	0	0	5	25	0	0.0	0.0	0.0
11	0	0	0	0	5	40	0	0.0	0.1	0.0
12	0	0	0	0	0	25	0	0.0	0.1	0.0
13	0	0	0	0	0	10	0	0.0	0.1	0.5
14	0	0	0	0	0	30	0	0.0	0.1	0.0
15	0	0	0	0	0	15	0	0.0	1.0	0.0
16	0	0	0	0	0	8	0	0.0	2.0	0.1
17	0	0	0	0	0	25	8	0.0	0.1	0.1
18	0	0	0	0	0	10	8	0.0	2.0	0.0
19	0	0	0	0	0	35	0	0.0	1.0	0.0
20	0	0	0	0	0	40	0	0.0	1.0	0.0
21	0	0	0	0	0	4	0	0.0	2.0	0.0
22	0	0	0	0	0	10	0	0.0	0.5	0.1
23	0	0	0	0	0	0	0	0.0	0.5	0.1
24	0	0	0	0	0	8	0	0.0	1.0	0.0
25	0	0	0	0	0	35	0	0.0	2.0	1.0
26	0	0	0	0	0	2	0	0.0	1.0	0.0
27	0	0	0	0	0	8	0	0.1	1.0	1.0
28	0	0	0	0	0	15	30	0.0	2.0	0.0
29	0	0	0	0	0	10	0	0.0	1.0	0.0
30	0	0	0	0	0	5	0	0.0	1.0	0.0
31	0	0	0	0	0	30	0	0.0	1.0	0.0
32	0	0	0	0	0	35	15	0.0	2.0	2.0
33	0	0	0	0	0	10	0	0.0	1.0	0.0
34	0	0	0	0	0	30	0	0.0	1.0	1.0
35	0	0	0	0	0	30	0	0.0	2.0	0.0
36	0	0	0	0	0	20	0	0.0	1.0	0.0
37	0	0	0	0	0	10	0	0.0	1.0	0.0
38	0	0	0	0	0	25	0	0.0	2.0	0.0
39	0	0	0	0	0	15	0	0.0	1.0	0.0
40	0	0	0	0	0	35	0	0.0	1.0	0.0

----- SITE=ESS-BURNED -----

PLOTNUM	B2HW87	B2SS87	GAUSHA87	MENFER87	RIBES87	RUBLEU87	RUBPAR87	RUBSPE87	SALST87
1	10	0.1	0.0	0	0	0.1	0	2.0	0.0
2	10	0.0	0.0	0	0	0.0	0	10.0	0.0
3	15	0.0	0.0	0	0	0.0	0	0.0	0.0
4	10	0.0	0.0	0	0	0.0	0	2.0	0.0
5	5	0.0	0.0	0	0	0.0	0	35.0	0.1
6	3	0.0	0.0	0	0	0.0	1	15.0	0.0
7	5	0.1	0.0	0	0	0.0	0	0.0	0.0
8	15	0.1	0.0	0	0	0.0	0	0.1	0.0
9	5	0.0	0.0	0	0	0.0	0	5.0	0.0
10	10	0.0	0.0	0	0	0.0	0	0.0	0.0
11	10	0.0	0.0	0	0	0.0	0	0.0	0.0
12	10	0.0	0.0	0	0	0.0	3	15.0	0.0
13	15	0.0	0.0	0	0	0.0	0	1.0	0.0
14	5	0.0	0.0	0	0	0.0	0	1.0	0.0
15	10	0.0	0.5	0	0	0.0	0	0.0	0.1
16	5	0.0	0.0	0	0	0.0	0	3.0	0.0
17	10	1.0	0.0	0	0	0.0	0	2.0	0.0
18	10	0.0	0.0	0	0	0.0	0	5.0	0.0
19	5	0.0	0.0	0	0	0.0	0	5.0	0.0
20	5	2.0	0.0	0	0	0.0	0	5.0	0.0
21	10	1.0	0.0	0	0	0.0	0	1.0	0.0
22	5	0.0	0.0	0	0	0.0	0	0.5	0.0
23	25	2.0	0.0	0	0	0.0	0	0.5	0.0
24	15	0.0	0.0	0	0	1.0	0	3.0	0.0
25	15	0.0	0.0	0	0	0.0	0	5.0	0.0
26	5	0.0	0.0	0	0	0.1	0	3.0	0.0
27	25	0.0	1.0	0	0	0.0	2	10.0	0.0
28	5	0.0	0.0	0	0	0.0	5	1.0	0.0
29	15	1.0	0.0	0	0	0.0	0	1.0	0.0
30	15	5.0	0.0	0	0	0.0	0	0.5	0.0
31	10	0.0	0.0	0	0	0.0	0	2.0	0.0
32	10	1.0	0.0	0	0	0.0	5	7.0	0.0
33	25	1.0	0.0	0	0	0.0	0	10.0	0.0
34	10	1.0	0.0	0	0	0.0	2	10.0	0.0
35	5	0.0	0.0	0	0	0.0	0	10.0	0.0
36	15	1.0	0.0	0	0	1.0	20	5.0	0.0
37	10	10.0	0.0	0	0	1.0	1	20.0	0.0
38	10	0.0	0.0	0	0	1.0	5	20.0	0.0
39	5	0.0	0.0	0	0	0.1	0	1.0	0.0
40	5	5.0	0.0	0	0	0.1	0	5.0	0.0

----- SITE=E55-BURNED -----

PLOTNUM	SAMRAC87	TAXBRE87	VACPAR87	VALASK87	VMEMB87	ACHTRI87	ADIANIUM	AGRTEN87	ANAMAR87
1	0.0	0	5.0	0	0	0.0	0.0	0	0.1
2	0.0	0	0.5	0	0	0.0	0.0	0	0.0
3	0.1	0	8.0	0	0	0.0	0.0	0	0.1
4	0.0	0	0.0	0	0	0.0	0.0	0	0.1
5	0.1	0	0.0	0	0	0.0	0.0	0	5.0
6	0.1	0	0.5	0	0	0.0	0.0	0	0.5
7	0.1	0	3.0	0	0	0.0	0.0	0	0.1
8	0.1	0	2.0	0	0	0.0	0.0	0	0.0
9	0.0	0	0.0	0	0	0.0	0.0	0	0.5
10	0.0	0	0.1	0	0	0.0	0.0	0	0.0
11	0.0	0	0.5	0	0	0.0	0.0	0	2.0
12	0.1	0	0.0	0	0	0.0	0.0	0	0.1
13	0.1	0	0.5	0	0	0.0	0.0	0	0.0
14	0.1	0	5.0	0	0	0.0	0.0	0	0.0
15	0.0	0	0.0	0	0	0.0	0.0	0	0.5
16	0.0	0	1.0	2	0	0.0	0.0	0	0.5
17	0.0	0	1.0	0	0	0.0	0.0	0	0.5
18	0.0	0	1.0	0	0	0.0	0.0	0	1.0
19	0.0	0	1.0	0	0	0.0	0.0	0	1.0
20	0.0	0	20.0	0	0	0.0	0.0	0	0.1
21	0.1	0	0.0	0	0	0.0	0.0	0	5.0
22	0.0	0	0.0	0	0	0.0	0.0	0	5.0
23	0.0	0	0.5	0	0	15.0	0.0	0	0.5
24	1.0	0	1.0	0	0	0.0	0.0	0	1.0
25	0.0	0	10.0	0	0	0.0	0.0	0	2.0
26	0.0	0	5.0	0	0	0.1	0.0	0	5.0
27	0.0	0	3.0	0	0	0.0	0.0	0	5.0
28	0.0	0	2.0	0	0	0.0	0.0	0	0.1
29	0.0	0	1.0	0	0	5.2	0.0	0	5.0
30	1.0	0	1.0	0	0	0.1	0.0	0	5.0
31	2.0	0	5.0	0	0	0.0	0.0	0	1.0
32	0.0	0	1.0	0	0	0.0	0.0	0	15.0
33	0.0	0	5.0	0	0	10.0	0.0	0	5.0
34	0.0	0	3.0	0	0	25.0	0.0	0	0.1
35	0.0	0	5.0	0	0	15.0	0.0	0	5.0
36	0.0	0	1.0	0	0	0.0	1.0	0	2.0
37	0.0	0	1.0	0	0	0.0	0.0	0	2.0
38	0.0	0	5.0	0	0	0.0	0.0	0	0.0
39	0.0	0	60.0	0	0	0.0	0.0	0	5.0
40	0.0	0	0.1	0	0	0.0	0.1	0	0.0

----- SITE=E55-BURNED -----

PLOTNUM	ATHFEL87	BLESPI87	CARMER87	CIRSARVE	CORCAN87	DESELO87	DRYAUS87	ELYGLA87	EPIANG87
1	0.1	1.0	0.1	0.0	1	0	0.1	0.0	5
2	0.1	2.0	0.0	0.0	0	0	0.0	1.0	10
3	0.0	0.5	0.0	0.0	0	0	0.1	0.0	5
4	0.1	0.5	0.0	0.0	0	0	0.1	0.0	15
5	0.0	0.0	0.1	0.0	0	0	0.0	0.0	25
6	0.0	0.1	0.0	0.0	0	0	1.0	0.0	25
7	0.0	1.0	0.0	0.0	0	0	0.5	0.0	15
8	3.0	0.0	0.0	0.0	0	0	0.0	0.0	15
9	0.0	0.0	0.0	0.0	0	0	0.0	0.0	15
10	1.0	5.0	0.0	0.0	0	0	0.0	0.0	25
11	0.1	5.0	1.0	0.0	0	0	0.0	0.0	15
12	0.0	1.0	0.0	0.0	0	0	0.0	0.0	25
13	2.0	5.0	0.0	0.0	0	0	1.0	0.0	30
14	0.5	2.0	0.0	0.0	0	0	0.0	0.0	30
15	0.0	3.0	0.0	0.0	0	0	0.0	0.0	20
16	0.0	5.0	0.1	0.0	0	0	1.0	0.0	15
17	0.0	2.0	0.0	0.0	0	0	1.0	0.0	20
18	0.5	0.0	0.0	0.0	0	0	3.0	0.0	15
19	0.0	0.5	0.0	0.0	0	0	1.0	0.0	20
20	0.0	5.0	0.0	0.0	0	0	1.0	0.0	15
21	1.0	5.0	0.0	0.0	0	0	0.5	0.0	0
22	1.0	2.0	1.0	0.0	0	0	0.0	0.0	25
23	0.0	0.0	0.0	0.0	0	0	0.0	5.0	20
24	0.0	5.0	0.0	0.0	0	0	2.0	0.1	15
25	1.0	0.5	0.0	0.0	0	0	1.0	10.0	15
26	1.0	5.0	0.0	0.1	30	0	0.0	20.0	15
27	0.1	0.1	0.0	0.0	0	0	1.0	5.0	15
28	2.0	3.0	0.0	0.1	0	0	2.0	0.0	20
29	0.0	0.0	0.0	0.1	0	0	0.0	0.0	20
30	0.0	2.0	0.0	0.1	0	0	0.5	0.0	25
31	0.0	3.0	0.0	0.0	0	0	2.0	0.0	25
32	0.1	10.0	0.0	2.0	0	0	0.0	0.0	15
33	0.0	5.0	0.0	0.0	60	0	0.0	0.0	25
34	0.0	15.0	0.0	0.0	0	0	15.0	1.0	30
35	2.0	7.0	0.0	0.0	2	0	0.1	1.0	25
36	0.5	5.0	0.0	0.0	15	0	5.0	0.0	20
37	0.0	30.0	0.0	0.0	5	0	0.0	2.0	20
38	0.1	5.0	0.0	0.0	20	1	0.0	5.0	30
39	15.0	15.0	0.1	0.1	0	2	0.0	5.0	15
40	0.5	5.0	1.0	0.0	20	0	1.0	0.0	30

 SITE=E55-BURNED

PLOTNUM	GALTRI87	HIEALB87	HYPORADI	LACCR87	LINNEA87	LONINV87	LUZCAM87	LUZPAR87	LYCCLA87
1	0	0	0.0	0.1	0	0	0	0	0.0
2	0	0	0.0	0.1	0	0	0	0	2.0
3	0	0	0.0	0.0	0	0	0	0	2.0
4	0	0	0.0	0.1	0	0	0	0	0.0
5	0	0	0.0	2.0	0	0	0	0	1.0
6	0	0	0.0	0.1	0	0	0	0	0.0
7	0	0	0.0	0.5	0	0	0	0	0.0
8	0	0	0.0	0.0	0	0	0	0	0.0
9	0	0	0.0	2.0	0	0	0	0	0.0
10	0	0	0.0	2.0	0	0	0	0	0.0
11	0	0	0.0	5.0	0	0	0	0	0.0
12	0	0	0.0	5.0	0	0	0	0	0.0
13	0	0	0.0	2.0	0	0	0	0	0.0
14	0	0	0.0	0.0	0	0	0	0	0.0
15	0	0	0.0	1.0	0	0	0	1	0.0
16	0	0	0.0	0.1	0	0	0	0	10.0
17	0	0	0.0	1.0	0	0	0	0	0.0
18	0	0	0.0	0.1	0	0	0	0	0.0
19	0	0	0.0	2.0	0	0	0	0	0.0
20	0	0	0.0	1.0	0	0	0	0	0.0
21	0	0	0.0	5.0	0	0	0	0	0.0
22	0	0	0.0	5.0	0	0	0	0	0.0
23	0	0	0.0	0.1	0	0	0	0	0.0
24	0	0	0.0	0.1	0	0	0	0	0.1
25	0	0	0.0	1.0	0	0	0	0	0.0
26	0	0	0.1	1.0	0	0	0	0	0.0
27	0	0	0.0	1.0	0	0	0	0	0.0
28	0	0	0.0	1.0	0	0	0	0	0.0
29	0	0	0.0	5.0	0	0	0	0	0.0
30	0	0	0.0	1.0	0	0	0	0	0.0
31	0	0	0.0	5.0	0	0	0	0	0.1
32	0	0	0.0	0.0	0	0	0	0	0.0
33	0	0	0.0	2.0	0	0	0	0	0.0
34	0	0	0.0	0.0	0	0	0	0	0.0
35	0	0	0.0	1.0	0	0	0	0	0.0
36	0	0	0.0	0.1	0	0	0	0	0.0
37	1	0	0.0	1.0	0	0	0	0	0.0
38	1	0	0.0	1.0	0	0	0	0	0.0
39	0	0	0.0	0.1	0	0	0	0	0.0
40	0	0	0.0	0.5	0	0	0	1	0.0

SITE=E55-BURNED

PLOT#	MIADL87	POLMUN87	PTEAQU87	STELLA87	TIAREL87	TRISSET87	SUMA	SUMB1	SUMB2
1	0	3.0	0	0.0	0.0	0.0	0	15	17.4
2	0	0.0	0	0.0	0.0	0.1	0	25	20.6
3	0	0.5	0	0.0	0.0	0.1	0	20	24.3
4	0	1.0	0	0.0	0.0	0.0	0	40	12.2
5	0	3.0	0	0.0	0.0	0.0	0	10	40.3
6	0	15.0	0	0.0	0.0	0.0	0	1	19.7
7	0	3.0	0	0.0	0.0	0.1	0	15	8.7
8	0	5.0	0	0.0	0.0	0.1	0	10	17.4
9	0	5.0	0	0.0	0.0	5.0	0	15	12.0
10	0	5.0	0	0.0	0.0	1.0	0	25	10.1
11	0	5.0	0	0.0	0.0	0.0	0	45	28.6
12	0	1.0	0	0.0	0.0	5.0	0	25	11.5
13	0	5.0	0	0.0	0.0	1.0	0	10	20.2
14	0	5.0	0	0.0	0.0	0.5	0	30	11.3
15	0	5.0	0	0.0	0.0	0.0	0	15	14.5
16	0	2.0	0	0.0	0.0	0.5	0	8	12.6
17	0	5.0	0	0.0	0.0	0.0	0	33	17.2
18	0	10.0	0	0.0	0.0	0.1	0	18	13.0
19	0	5.0	0	0.0	0.0	0.5	0	35	12.0
20	0	15.0	0	0.0	0.0	0.0	0	40	33.0
21	0	15.0	0	0.0	0.0	0.1	0	4	18.1
22	0	10.0	0	0.0	0.0	0.0	0	10	6.6
23	0	3.0	0	0.0	0.0	0.1	0	0	28.6
24	0	10.0	0	0.0	0.0	0.1	0	8	21.5
25	0	10.0	0	0.0	0.0	5.0	0	35	22.0
26	0	5.0	0	0.0	0.0	0.1	0	2	27.1
27	0	3.0	0	0.0	0.0	0.0	0	8	46.1
28	0	5.0	0	0.0	0.0	0.1	0	45	9.0
29	0	10.0	0	0.0	0.0	1.0	0	10	19.0
30	0	15.0	0	0.0	0.0	0.0	0	5	23.5
31	0	15.0	0	0.0	0.0	0.1	0	30	20.0
32	0	10.0	0	0.1	0.1	0.0	0	50	26.0
33	0	0.0	0	0.0	0.0	2.0	0	10	43.0
34	0	15.0	0	0.0	0.0	0.1	0	30	27.0
35	0	10.0	0	0.0	1.0	5.0	0	30	43.0
36	0	10.0	0	0.0	0.0	0.0	0	20	25.0
37	0	1.0	0	0.0	1.0	0.5	0	10	47.0
38	0	15.0	0	0.0	0.0	2.0	0	25	40.0
39	0	10.0	0	0.0	0.0	1.0	0	15	67.0
40	0	10.0	1	0.0	0.0	0.0	0	35	16.2

 SITE=E55-BURNED

PLOTNUM	SUMB	SUMC	SUMVEG
1	32.4	10.5	42.9
2	45.6	15.3	60.9
3	44.3	8.3	52.6
4	52.2	16.9	69.1
5	50.3	36.1	86.4
6	20.7	41.7	62.4
7	23.7	20.2	43.9
8	27.4	23.1	50.5
9	27.0	27.5	54.5
10	35.1	39.0	74.1
11	73.6	33.1	106.7
12	36.5	38.1	74.6
13	30.2	45.0	75.2
14	41.3	38.0	79.3
15	29.5	32.0	61.5
16	20.6	34.2	54.8
17	50.2	29.5	79.7
18	31.0	29.7	60.7
19	47.0	30.0	77.0
20	73.0	37.1	110.1
21	22.1	31.6	53.7
22	16.6	54.0	70.6
23	28.6	43.7	72.3
24	25.5	33.4	62.9
25	57.0	45.5	102.5
26	29.1	82.4	111.5
27	54.1	30.2	84.3
28	54.0	33.2	87.2
29	29.0	66.1	95.1
30	28.5	48.7	77.2
31	50.0	51.2	101.2
32	76.0	52.3	128.3
33	53.0	114.0	167.0
34	57.0	101.2	158.2
35	73.0	74.1	147.1
36	45.0	58.6	103.6
37	57.0	63.5	120.5
38	65.0	80.1	145.1
39	82.0	68.3	150.3
40	51.2	70.1	121.3

SITE=E55-UNBURNED

PLOTNUM	A1ALRU87	A1HW87	B1BA87	B1CR87	B1DF87	B1HW87	B1SS87	B2BA87	B2CR87	B2DF87
1	0	0	0.0	0.0	0.00	55	0.00	0.50	0.20	0.00
2	10	0	0.0	0.0	0.00	90	0.00	0.00	0.10	0.00
3	25	0	0.0	0.0	0.00	60	0.00	0.10	0.00	0.00
4	20	0	0.0	0.0	0.00	80	0.00	0.50	0.02	0.00
5	0	0	1.0	0.0	0.00	85	0.00	1.00	0.00	0.00
6	10	0	0.0	0.0	0.00	95	0.00	1.00	0.00	0.00
7	10	0	0.0	0.0	0.00	70	0.00	0.00	0.20	0.00
8	0	0	1.0	0.0	0.00	40	0.00	0.00	0.50	0.00
9	10	0	0.0	0.0	0.00	60	0.00	0.20	0.20	0.00
10	5	0	0.0	0.0	0.00	90	0.00	0.20	0.00	0.00
11	0	0	0.0	0.0	0.00	90	0.00	0.00	0.02	0.00
12	0	0	0.0	0.0	0.00	70	0.00	0.00	0.10	0.02
13	30	0	0.0	0.0	0.00	90	0.00	0.00	0.00	0.00
14	40	0	5.0	0.0	0.00	75	0.00	0.10	0.02	0.00
15	0	0	0.0	0.0	0.00	80	0.00	0.00	0.02	0.00
16	30	0	2.0	0.0	0.00	55	5.00	0.00	0.10	0.00
17	0	0	0.0	0.0	0.00	80	0.00	0.00	0.10	0.00
18	0	0	2.0	0.0	0.00	70	0.00	0.00	0.02	0.00
19	0	0	0.0	0.0	0.00	50	0.00	0.20	0.20	0.00
20	0	0	0.0	0.0	0.00	90	0.00	0.00	0.20	0.00
21	20	0	0.5	1.0	0.00	90	0.00	0.00	0.20	0.00
22	20	0	0.2	0.0	0.00	70	0.00	0.00	0.10	0.02
23	10	0	0.0	0.0	0.00	90	0.00	0.00	0.50	0.00
24	0	0	2.0	0.0	0.00	90	0.00	0.00	0.50	0.02
25	0	0	0.5	0.5	0.02	65	0.02	0.00	0.00	0.00
26	15	0	0.0	0.0	0.00	85	2.00	2.00	0.20	0.00
27	0	0	0.0	0.0	0.00	95	0.00	0.50	0.20	0.00
28	0	0	0.0	0.0	5.00	80	0.00	0.00	1.00	0.00
29	0	0	0.0	0.0	0.00	70	0.00	0.02	0.20	0.00
30	0	0	0.0	0.0	0.00	70	0.00	0.00	0.50	0.20
31	0	0	0.0	0.0	1.00	80	0.00	0.50	0.20	0.00
32	10	0	5.0	0.0	0.00	90	0.00	1.00	0.50	0.00
33	5	0	5.0	0.2	0.00	80	5.00	0.00	0.00	0.00
34	0	0	0.0	0.0	0.00	70	0.00	1.00	0.50	0.00
35	0	0	45.0	0.0	0.00	70	0.00	5.00	1.00	0.00
36	0	15	1.0	0.0	0.00	85	0.00	0.00	0.20	0.00
37	0	0	0.5	0.0	0.00	90	10.00	0.20	0.50	0.00
38	0	0	0.0	0.0	0.00	75	0.00	2.00	2.00	0.00
39	25	0	2.0	0.0	0.00	70	2.00	0.50	0.50	0.00
40	25	0	0.0	0.0	0.00	70	10.00	0.10	0.10	0.00

----- SITE=E55-UNBURNED -----

PLOTNUM	B2HW87	B2SS87	GAUSHAB7	MENFER87	RIBES87	RUBLEU87	RUBPAR87	RUBSPE87	SALSI87
1	25	0.00	0.00	0.00	0.0	0.00	5.00	10.0	0
2	10	0.02	0.00	0.00	0.5	0.00	0.02	2.0	0
3	10	0.00	0.00	0.00	0.0	0.00	0.00	0.0	0
4	10	0.02	0.10	0.00	0.0	0.00	0.00	0.0	0
5	10	0.00	0.00	0.00	0.0	0.00	0.00	0.5	0
6	5	0.00	0.00	0.00	0.0	0.00	0.00	0.2	0
7	10	0.00	0.00	0.00	0.2	0.00	1.00	10.0	0
8	25	0.02	0.00	0.00	0.0	0.00	0.20	1.0	0
9	20	0.02	0.00	0.00	0.0	0.00	0.00	0.1	0
10	5	0.00	0.00	0.00	0.0	0.00	0.00	0.0	0
11	10	1.00	0.00	0.00	0.0	0.00	0.10	2.0	0
12	10	0.00	0.00	0.00	0.0	0.00	0.50	5.0	0
13	5	0.00	0.00	0.00	0.0	0.00	0.00	0.5	0
14	10	0.02	0.10	0.00	0.0	0.00	0.00	0.5	0
15	5	0.00	0.00	0.00	0.0	0.00	0.10	5.0	0
16	5	0.00	0.00	0.00	0.0	0.02	0.00	2.0	0
17	10	0.00	0.00	0.00	0.0	0.00	0.02	1.0	0
18	5	0.50	0.00	0.00	0.0	0.00	1.00	0.2	0
19	20	0.20	0.00	0.00	0.0	0.00	5.00	5.0	0
20	10	0.00	0.00	0.00	0.0	0.00	1.00	10.0	0
21	10	0.00	0.00	0.00	0.0	0.00	2.00	5.0	0
22	10	0.00	0.00	0.00	0.0	0.00	2.00	2.0	0
23	10	0.00	0.00	0.00	0.0	0.00	0.20	5.0	0
24	10	0.00	0.00	0.00	0.0	0.00	0.10	1.0	0
25	20	0.00	0.00	0.00	0.0	0.00	0.00	10.0	0
26	10	0.50	0.00	0.00	0.0	0.00	1.00	5.0	0
27	20	0.00	0.20	0.00	0.0	0.00	0.00	0.2	0
28	10	0.10	0.00	0.00	0.0	0.00	0.20	1.0	0
29	20	0.20	0.00	0.00	0.0	0.00	0.00	5.0	0
30	15	0.00	0.00	0.00	0.2	0.00	1.00	10.0	0
31	10	0.02	0.00	0.00	0.0	0.00	0.20	0.2	0
32	10	0.02	0.00	0.00	0.0	0.00	0.00	1.0	0
33	10	0.00	0.00	0.00	0.0	0.00	0.00	2.0	0
34	15	0.20	0.00	0.00	0.0	0.00	0.00	0.0	0
35	15	0.00	0.00	0.00	0.0	0.00	0.00	0.2	0
36	10	0.00	0.00	0.00	0.0	0.00	0.00	1.0	0
37	2	0.00	0.02	0.00	0.0	0.02	0.00	1.0	0
38	15	0.00	0.00	0.00	0.0	0.00	0.00	10.0	0
39	10	0.00	0.00	0.02	0.0	0.00	0.50	5.0	0
40	5	0.00	0.00	0.00	0.0	0.00	0.00	0.1	0

SITE=E55-UNBURNED

PLOTNUM	SAMRAC87	TAXBRE87	VACPAR87	VALASK87	VMEMB87	ACHTRI87	ADIANIUM	AGRTEN87	ANAMAR87
1	0.50	0	10.00	0.0	0.0	2.00	0	0	0.00
2	0.20	0	2.00	0.0	0.0	0.00	0	0	0.02
3	0.00	0	0.20	0.0	0.0	0.00	0	0	0.00
4	0.00	0	0.50	0.0	0.0	0.00	0	0	0.00
5	0.00	0	0.50	0.0	0.0	0.00	0	0	0.00
6	0.02	0	0.00	0.0	0.0	0.00	0	0	0.00
7	0.20	0	0.00	0.0	0.0	0.00	0	0	0.50
8	0.00	0	0.50	0.0	0.0	0.00	0	0	1.00
9	0.00	0	0.20	0.0	0.0	0.00	0	0	0.00
10	0.00	0	0.20	0.0	0.0	0.00	0	0	0.00
11	0.20	0	0.20	0.0	0.0	0.00	0	0	0.00
12	0.02	0	5.00	0.0	0.0	0.00	0	0	0.00
13	0.50	0	0.02	0.0	0.0	0.00	0	0	0.00
14	0.50	0	0.10	0.0	0.0	0.00	0	0	0.10
15	0.10	0	0.20	0.0	0.0	0.00	0	0	0.02
16	0.50	0	0.50	0.0	0.0	0.02	0	0	0.00
17	0.00	0	0.20	0.0	0.0	0.00	0	0	0.00
18	0.50	0	1.00	0.0	0.0	0.00	0	0	0.02
19	0.00	0	2.00	0.0	0.0	40.00	0	0	0.00
20	0.20	0	5.00	0.0	0.0	10.00	0	0	0.00
21	0.00	0	2.00	0.0	0.0	0.20	0	0	1.00
22	0.20	0	0.50	0.0	0.0	0.20	0	0	0.00
23	0.20	0	0.20	0.0	0.0	0.00	0	0	0.00
24	0.02	0	2.00	0.0	0.0	0.00	0	0	0.00
25	0.20	0	1.00	0.0	0.0	0.00	0	0	0.00
26	0.50	0	2.00	0.0	0.0	0.00	0	0	0.00
27	0.10	0	0.20	0.0	0.0	0.00	0	0	0.00
28	0.20	0	0.50	0.0	0.0	0.00	0	0	0.02
29	0.20	0	5.00	0.0	0.0	0.00	0	0	0.00
30	0.50	0	2.00	0.0	0.0	0.00	0	0	0.02
31	0.00	0	0.20	0.0	0.0	0.00	0	0	0.00
32	0.20	0	2.00	0.0	0.0	2.00	0	0	0.00
33	0.20	0	2.00	0.2	0.0	0.00	0	0	0.00
34	0.50	0	1.00	0.0	0.0	0.00	0	0	0.00
35	0.00	0	2.00	0.2	0.0	0.00	0	0	0.00
36	0.20	0	0.50	0.0	0.0	0.00	0	0	0.00
37	0.20	0	2.00	0.0	0.0	0.10	0	0	0.02
38	0.50	0	5.00	0.0	0.0	0.00	0	0	0.02
39	0.50	0	5.00	0.5	1.1	0.00	0	0	0.00
40	0.00	0	0.10	0.0	0.0	0.00	0	0	0.00

SITE=ES5-UNBURNED

PLOTNUM	ATHEL87	BLESPI87	CARNER87	CIRSARVE	CORCAN87	DESELO87	DRYAUS87	ELYGLA87	EPIANG87
1	1.00	15.00	0.00	0.00	10.00	0.1	2.00	0.02	5.00
2	0.10	2.00	0.00	0.00	0.00	0.0	1.00	0.50	1.00
3	0.00	0.02	0.00	0.00	0.00	0.0	0.02	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.10
5	0.00	0.02	0.00	0.00	0.00	0.0	0.00	0.00	0.02
6	0.00	0.50	0.00	0.00	0.00	0.0	0.02	0.00	0.02
7	0.50	1.00	0.00	0.00	0.00	0.0	0.20	0.00	2.00
8	0.00	0.20	0.02	0.00	0.00	0.0	0.50	1.00	2.00
9	0.00	0.20	0.00	0.00	0.00	0.0	0.02	0.00	0.50
10	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.00
11	0.00	1.00	0.00	0.00	0.02	0.0	0.00	0.00	0.00
12	0.02	2.00	0.00	0.00	0.00	0.0	0.02	0.02	0.00
13	0.00	0.20	0.00	0.00	0.00	0.0	0.02	0.02	0.00
14	0.00	1.00	0.02	0.00	0.00	0.0	0.02	0.02	0.50
15	0.20	0.20	0.00	0.00	0.50	0.0	0.20	0.50	1.00
16	1.02	2.00	0.02	0.00	0.00	0.0	0.02	0.00	0.02
17	0.00	2.00	0.00	0.00	0.00	0.0	0.02	0.00	0.50
18	0.00	5.00	0.02	0.00	0.00	0.0	0.02	1.00	0.50
19	0.00	5.00	0.00	0.00	0.00	0.0	0.00	0.00	0.20
20	0.00	2.00	0.00	0.00	0.00	0.0	0.10	0.00	0.00
21	0.50	5.00	0.00	0.00	1.00	0.0	2.00	0.00	1.00
22	0.00	0.20	0.00	0.00	0.00	0.0	0.20	0.00	0.02
23	0.00	0.20	0.00	0.00	0.00	0.0	0.50	0.00	0.02
24	0.00	1.00	0.02	0.00	0.00	0.0	0.10	0.00	0.50
25	0.00	5.00	0.00	0.00	0.00	0.0	1.00	0.00	2.00
26	0.20	2.00	0.00	0.00	0.00	0.0	0.50	0.02	0.00
27	0.00	5.00	0.00	0.00	0.00	0.0	0.00	0.00	0.02
28	0.00	5.00	0.02	0.00	2.00	0.0	0.10	0.00	1.00
29	0.00	5.00	0.00	0.02	0.00	0.0	0.20	0.02	2.00
30	0.02	5.00	0.00	0.00	0.20	0.0	0.50	0.00	1.00
31	0.00	0.50	0.00	0.00	0.00	0.0	0.00	0.00	0.50
32	0.20	1.00	0.00	0.00	0.00	0.0	0.50	0.00	0.00
33	0.00	2.00	0.02	0.00	0.00	0.0	0.10	0.02	0.02
34	0.02	1.00	0.00	0.00	0.00	0.0	0.50	0.00	5.00
35	0.00	1.00	0.00	0.00	0.00	0.0	0.00	0.00	0.00
36	0.00	1.00	0.00	0.00	0.00	0.0	0.02	0.02	0.00
37	0.00	10.00	0.00	0.00	0.00	0.0	0.20	0.02	0.00
38	0.50	10.00	0.00	0.00	0.00	0.0	1.00	0.00	1.00
39	0.00	2.00	0.00	0.00	0.02	0.0	0.10	0.00	1.00
40	0.00	0.10	0.00	0.00	0.00	0.0	0.10	0.00	0.00

SITE=E55-UNBURNED

PLOTNUM	MIADL87	POLMUN87	PTEAQUB7	STELLA87	TIAREL87	TRISSET87	SUMA	SUMB1	SUMB2
1	0.00	10.00	0	0.00	0.02	0.50	0	55.00	51.20
2	0.00	5.00	0	0.00	0.00	0.02	10	90.00	14.84
3	0.00	0.00	0	0.00	0.00	0.00	25	60.00	10.30
4	0.00	0.00	0	0.00	0.00	0.00	20	80.00	11.14
5	0.00	0.02	0	0.00	0.00	0.02	0	86.00	12.00
6	0.00	0.20	0	0.00	0.00	0.02	10	95.00	6.42
7	0.00	10.00	0	0.00	0.00	0.02	10	70.00	21.60
8	0.00	0.50	0	0.00	0.02	0.02	0	41.00	27.22
9	0.00	0.20	0	0.00	0.00	0.02	10	60.00	20.54
10	0.00	0.00	0	0.00	0.00	0.00	5	90.00	5.40
11	0.00	1.00	0	0.00	0.02	0.00	0	90.00	13.52
12	0.00	10.00	0	0.00	0.02	0.50	0	70.00	20.64
13	0.00	0.50	0	0.00	0.00	0.02	30	90.00	6.02
14	0.00	1.00	0	0.00	0.00	0.02	40	80.00	11.34
15	0.02	5.00	0	0.00	0.00	0.02	0	80.00	10.42
16	0.00	5.00	0	0.00	0.50	0.02	30	62.00	8.12
17	0.00	1.00	0	0.00	0.00	0.00	0	80.00	11.32
18	0.00	2.00	0	0.00	0.02	0.02	20	72.00	8.22
19	0.00	10.00	0	0.00	0.20	0.02	0	50.00	32.60
20	0.00	5.00	0	0.00	0.00	0.02	0	90.00	26.60
21	0.00	5.00	0	0.00	0.20	0.00	20	91.50	19.20
22	0.00	5.00	0	0.02	0.02	0.00	20	70.20	14.82
23	0.00	5.00	0	0.00	0.00	0.00	10	90.00	16.10
24	0.00	1.00	0	0.00	0.00	0.02	0	92.00	13.63
25	0.00	10.00	0	0.00	0.00	0.02	0	66.04	31.20
26	0.00	5.00	0	0.00	0.00	0.00	15	87.00	21.20
27	0.00	0.50	0	0.00	0.00	0.00	0	95.00	21.40
28	0.00	5.00	0	0.00	0.00	0.00	0	85.00	13.00
29	0.00	5.00	0	0.00	0.00	0.00	0	70.00	30.62
30	0.00	10.00	0	0.00	0.00	0.02	0	70.00	29.40
31	0.00	1.00	0	0.00	0.00	0.02	0	90.50	11.32
32	0.00	5.00	0	0.00	0.00	0.02	10	86.00	14.72
33	0.00	1.00	0	0.00	0.00	0.02	5	90.20	14.40
34	0.00	2.00	0	0.00	0.00	0.00	0	70.00	18.20
35	0.00	0.10	0	0.00	0.00	0.00	0	115.00	23.40
36	0.00	0.50	0	0.00	0.00	0.00	15	86.00	11.90
37	0.00	5.00	0	0.00	0.00	0.02	0	100.50	5.94
38	0.00	10.00	0	0.00	0.10	0.00	0	75.00	34.50
39	0.00	5.00	0	0.00	0.00	0.00	25	74.00	23.62
40	0.00	1.00	0	0.00	0.00	0.00	25	80.00	5.40

----- SITE=E55-UNBURNED -----

PLOTNUM	SUMB	SUMC	SUMVEG
1	106.20	46.20	152.40
2	104.84	9.84	124.68
3	70.30	0.04	95.34
4	91.14	0.10	111.24
5	98.00	0.08	98.08
6	101.42	0.76	112.18
7	91.60	15.24	116.84
8	68.22	5.78	74.00
9	80.54	0.94	91.48
10	95.40	0.00	100.40
11	103.52	2.08	105.60
12	90.64	15.24	105.88
13	96.02	0.78	126.80
14	91.34	3.78	135.12
15	90.42	7.60	98.02
16	70.12	10.78	110.90
17	91.32	3.66	94.98
18	80.22	10.14	110.36
19	82.60	55.44	138.04
20	116.60	7.16	123.76
21	110.70	24.70	155.40
22	85.02	9.94	114.96
23	106.10	5.94	122.04
24	105.64	2.68	108.32
25	97.24	19.06	116.30
26	108.20	8.12	131.32
27	116.40	0.56	116.96
28	98.00	11.26	109.26
29	100.62	14.26	114.88
30	99.40	17.08	116.48
31	101.82	2.26	104.08
32	100.72	8.78	119.50
33	104.60	3.70	113.30
34	88.20	8.56	96.76
35	138.40	1.10	139.50
36	97.90	1.56	114.46
37	106.44	16.70	123.14
38	109.50	26.62	136.12
39	97.62	8.16	130.78
40	85.40	1.20	111.60

----- SITE=TN48-BURNED -----

PLOTNUM	A1HW87	B1BA87	B1CR87	B1HW87	B1SS87	B2BA87	B2CR87	B2CY87	B2HW87	B2SS87
1	0	0	0	8	0	0	10	0.0	0	0
2	0	0	0	0	0	0	5	0.0	10	0
3	0	0	0	0	0	0	2	0.0	15	0
4	0	0	0	5	0	0	2	0.0	10	0
5	0	0	0	0	0	0	2	0.0	10	0
6	0	0	0	35	0	0	2	0.0	5	0
7	0	0	0	20	0	0	10	1.0	5	0
8	0	0	0	30	0	0	5	0.0	0	0
9	0	0	0	20	0	0	2	0.0	1	0
10	0	0	0	30	0	0	1	0.0	10	0
11	0	0	0	0	0	0	1	0.0	10	0
12	0	0	0	0	0	0	10	0.0	10	0
13	0	0	0	10	0	0	10	0.0	1	0
14	0	0	0	20	0	0	5	0.0	2	0
15	0	0	0	25	0	0	10	0.0	10	0
17	0	0	0	10	0	0	2	0.0	15	0
18	0	0	0	2	0	0	2	0.0	15	0
20	0	0	0	10	0	0	20	0.0	2	0
21	0	0	0	0	0	0	40	0.0	5	0
22	0	0	0	0	0	0	5	0.0	5	0
29	0	0	0	0	0	0	10	0.0	2	0
30	0	0	0	10	0	0	25	0.0	2	0
31	0	0	0	25	0	0	15	0.0	5	0
32	0	0	0	10	0	0	20	0.0	10	0
33	0	0	0	0	0	0	25	0.0	5	0
34	0	0	0	0	0	0	2	0.0	5	0
35	0	0	0	0	0	0	10	0.0	1	0
36	0	0	0	8	0	0	20	0.0	5	0
39	0	0	0	10	0	0	15	0.0	2	0
40	0	0	0	25	0	0	10	0.0	5	0
41	0	0	0	75	0	0	30	0.0	5	0
42	0	0	0	0	0	0	2	0.0	10	0
48	0	0	0	0	0	0	10	0.1	5	0
49	0	0	0	15	0	0	4	0.0	10	0
50	0	0	0	0	0	0	2	0.0	5	0
51	0	0	0	0	0	0	20	0.0	10	0
52	0	0	0	0	0	0	10	0.0	2	0
53	0	0	0	0	0	0	2	0.0	2	0
54	0	0	0	0	0	0	5	0.0	5	0
55	0	0	0	10	0	0	40	0.0	10	0

----- SITE=TN48-BURNED -----

PLOTNUM	GAUHA87	MENFER87	RIBES87	RUBPAR87	RUBSPE87	SAMRAC87	VACOVA87	VACPAR87	VALASK87
1	0	0.0	0	0	5	3.0	0	15.0	5.0
2	0	0.1	0	0	5	0.0	0	0.0	0.0
3	0	0.0	0	0	10	2.0	0	0.0	0.0
4	0	0.0	0	0	5	0.0	0	2.0	2.0
5	0	0.0	0	0	35	0.0	0	2.0	2.0
6	0	0.0	0	0	5	1.0	0	2.0	2.0
7	0	0.0	0	0	5	1.0	0	10.0	0.0
8	0	0.0	0	1	5	2.0	0	5.0	0.0
9	0	0.0	0	0	20	0.1	0	1.0	1.0
10	0	0.0	0	1	15	0.0	0	0.5	0.0
11	0	0.0	0	0	20	0.0	0	0.0	0.0
12	0	0.0	0	0	2	0.0	0	1.0	1.0
13	0	0.0	0	0	5	0.0	0	0.0	0.0
14	0	0.0	1	2	20	0.1	0	2.0	1.0
15	0	0.0	0	0	10	1.0	0	0.5	0.0
17	0	0.0	0	0	10	0.0	0	0.5	0.0
18	0	0.0	0	C	15	0.0	0	5.0	0.0
20	0	0.0	0	0	0	0.0	0	0.0	1.0
21	0	0.0	0	0	5	0.0	0	0.1	0.0
22	0	0.0	0	0	5	0.0	0	2.0	0.0
29	0	0.0	0	0	15	0.0	0	0.0	1.0
30	0	0.0	0	0	10	0.0	0	5.0	10.0
31	0	0.0	0	0	2	0.0	0	0.0	5.0
32	0	0.0	0	0	25	0.0	0	2.0	0.1
33	0	2.0	0	0	2	0.0	0	10.0	0.0
34	0	0.0	0	0	2	0.0	0	2.0	2.0
35	0	0.0	0	0	10	0.0	0	15.0	0.0
36	0	0.0	0	0	0	1.0	0	1.0	1.0
39	0	0.0	0	0	0	0.0	0	0.0	5.0
40	0	0.0	0	0	10	0.1	0	1.0	0.0
41	0	0.0	0	0	1	0.0	0	2.0	0.0
42	0	0.0	0	0	0	2.0	0	0.0	1.0
48	0	0.0	0	0	0	0.0	0	2.0	0.0
49	0	0.0	0	0	2	5.0	0	5.0	0.0
50	0	0.0	0	1	30	0.0	0	0.0	0.0
51	0	0.0	0	0	1	0.0	0	5.0	0.0
52	0	0.0	0	1	0	0.0	0	0.0	0.0
53	0	0.0	0	0	0	0.0	0	5.0	0.0
54	0	0.0	0	0	0	0.0	0	2.0	0.0
55	0	0.0	0	2	5	0.1	0	25.0	0.0

----- SITE=TN48-BURNED -----

PLOTNUM	ADIANTUM	AGRTEN87	ANAMAR87	ATHFEL87	BLESP187	BOTMUL87	CARMER87	CIRVUL87
1	0.0	3.0	0.0	5.0	5.0	0.0	1.0	0
2	0.0	1.0	2.0	0.0	5.0	0.0	0.5	0
3	0.0	0.0	0.0	5.0	5.0	0.0	0.0	0
4	0.0	0.5	1.0	10.0	10.0	0.0	0.0	0
5	0.0	0.5	0.5	5.0	10.0	0.0	2.0	0
6	0.0	5.0	0.1	5.0	5.0	0.0	1.0	2
7	0.0	0.0	5.0	0.0	1.0	0.0	0.5	0
8	0.0	0.0	2.0	5.0	1.0	0.0	0.0	0
9	0.0	0.1	2.0	1.0	2.0	0.0	1.0	0
10	0.0	0.5	2.0	5.0	10.0	0.0	1.0	0
11	0.0	0.1	0.0	2.0	2.0	0.0	0.1	0
12	0.0	0.0	0.1	5.0	10.0	0.0	1.0	0
13	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0
14	0.0	0.0	5.0	0.0	5.0	0.0	0.0	0
15	0.0	0.0	2.0	1.0	2.0	0.0	0.0	0
17	0.0	1.0	0.1	5.0	25.0	0.0	0.1	0
18	0.0	0.0	2.0	2.0	5.0	0.0	2.0	0
20	0.0	0.0	2.0	0.1	5.0	0.0	0.0	0
21	5.0	0.0	2.0	1.0	2.0	0.0	0.0	0
22	0.0	0.0	5.0	0.1	5.0	0.0	1.0	0
29	2.0	1.0	2.0	1.0	5.0	0.0	2.0	0
30	0.0	0.0	2.0	1.0	1.0	0.0	2.0	0
31	0.0	0.0	1.0	5.0	2.0	0.0	0.0	0
32	0.0	0.0	1.0	0.0	5.0	0.0	2.0	0
33	0.0	0.0	0.0	0.0	10.0	0.0	0.0	0
34	0.0	0.0	1.0	0.0	2.0	0.0	1.0	0
35	1.0	0.0	0.0	0.0	5.0	0.1	0.0	0
36	0.0	0.0	1.0	0.0	0.5	0.0	2.0	0
39	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0
40	0.0	0.0	0.0	2.0	5.0	0.0	1.0	0
41	0.5	0.0	2.0	0.0	5.0	0.0	0.0	0
42	0.0	0.0	0.0	10.0	10.0	0.0	1.0	0
48	0.0	0.0	1.0	0.0	5.0	0.0	0.0	0
49	0.0	0.5	0.5	0.0	5.0	0.0	0.0	0
50	0.0	10.0	10.0	2.0	10.0	0.0	0.0	0
51	0.0	0.0	2.0	0.0	2.0	0.0	1.0	0
52	5.0	0.0	2.0	0.0	10.0	0.0	1.0	0
53	0.0	0.0	0.0	0.0	20.0	0.0	0.0	0
54	0.0	0.0	1.0	0.0	1.0	0.0	0.0	0
55	0.0	0.1	2.0	1.0	5.0	0.0	0.1	0

-----SITE=TN48-BURNED-----

PLOTNUM	COPASP87	CORCAN87	DESELG87	DRYAUS87	EPIANG87	EQUISET	FRAGAR87	GALTRI87	GYMDRY87
1	0.0	0	0	3.0	20	0	0	0.0	0
2	0.0	2	0	0.0	5	0	0	0.0	0
3	0.0	0	0	1.0	35	0	0	0.0	0
4	0.0	0	0	5.0	15	0	0	0.0	0
5	0.0	5	0	2.0	5	0	0	0.0	0
6	0.0	0	0	5.0	10	0	0	0.0	0
7	0.0	0	0	10.0	25	0	0	0.0	1
8	0.0	5	0	2.0	5	0	0	0.0	0
9	0.0	60	0	0.0	30	0	0	0.0	0
10	0.0	2	1	5.0	15	0	0	0.0	0
11	0.0	0	0	0.0	25	0	0	0.0	0
12	0.0	40	0	0.0	15	0	0	0.0	0
13	0.0	5	0	0.0	25	0	0	0.0	0
14	0.0	0	0	0.1	10	0	0	0.0	0
15	0.0	0	1	1.0	25	0	0	0.0	0
17	0.0	35	0	1.0	0	0	0	0.0	0
18	0.0	50	0	1.0	10	0	0	0.0	2
20	0.0	15	0	1.0	25	0	0	0.0	0
21	0.0	2	0	0.0	10	0	0	0.0	0
22	5.0	30	0	0.0	25	0	0	0.0	0
29	0.0	20	0	0.0	30	0	0	1.0	0
30	0.0	25	0	2.0	15	0	0	0.1	0
31	0.0	50	0	0.1	15	0	0	0.1	0
32	0.0	2	0	2.0	10	0	0	0.0	0
33	0.5	35	0	0.0	15	0	0	0.0	0
34	0.0	45	0	0.5	25	0	0	0.0	0
35	0.5	30	0	0.0	15	0	0	0.0	0
36	0.0	45	0	0.0	30	0	0	0.1	0
39	0.0	50	0	0.0	20	0	0	0.0	0
40	0.0	25	0	2.0	20	0	0	0.0	0
41	1.0	0	0	0.0	20	0	0	0.0	0
42	0.0	0	0	2.0	20	0	0	0.0	0
48	1.0	15	0	0.0	30	0	0	0.0	0
49	0.0	0	0	2.0	25	0	0	0.0	0
50	0.0	0	0	0.0	10	0	0	0.0	0
51	0.0	15	0	0.0	15	0	0	0.0	0
52	2.0	2	0	0.0	25	0	0	0.1	0
53	1.0	60	0	0.0	35	0	0	0.0	0
54	0.0	65	0	0.0	30	0	0	0.0	0
55	0.0	0	0	0.0	10	0	0	0.0	0

----- SITE=TN48-BURNED -----

PLOTNUM	LACER87	LINNEA87	LUZPAR87	LYCCLAB7	PLANTAGO	POLMUN87	SENTRI87	STREPT87	TIAREL87
1	10.0	0	0.0	0.0	0.0	5.0	0	0	0.1
2	5.0	0	0.0	0.0	0.1	2.0	0	0	0.0
3	10.0	0	0.0	0.0	0.0	5.0	0	0	0.0
4	5.0	0	1.0	0.0	0.0	10.0	0	0	1.0
5	5.0	0	0.0	0.0	0.0	10.0	0	0	0.5
6	5.0	0	0.0	0.0	0.0	5.0	0	0	0.0
7	10.0	0	0.0	0.0	0.0	5.0	0	0	0.0
8	5.0	0	0.0	0.0	0.0	5.0	0	0	0.0
9	10.0	0	0.0	0.0	0.0	2.0	0	0	0.1
10	5.0	0	2.0	0.0	0.0	10.0	0	0	0.0
11	5.0	0	0.1	0.0	0.0	10.0	0	0	0.0
12	2.0	0	0.0	0.0	0.0	10.0	0	0	1.0
13	10.0	0	0.0	0.0	0.0	0.0	0	0	0.1
14	10.0	0	0.0	0.0	0.0	2.0	0	0	0.0
15	10.0	0	1.0	0.0	0.0	5.0	0	0	0.5
17	2.0	0	0.5	0.0	0.0	5.0	0	0	0.0
18	1.0	0	0.0	0.0	0.0	5.0	0	0	0.0
20	0.1	0	0.0	0.0	0.0	5.0	0	0	0.0
21	1.0	30	0.0	0.0	0.0	1.0	0	0	0.0
22	1.0	0	0.0	0.0	0.0	0.1	0	0	0.0
29	5.0	0	0.0	0.0	0.0	2.0	0	0	0.0
30	5.0	0	0.0	0.0	0.0	5.0	0	0	0.0
31	5.0	0	1.0	0.0	0.0	5.0	0	0	0.0
32	5.0	0	0.0	0.0	0.0	2.0	0	0	0.0
33	0.1	0	0.1	0.0	0.0	0.0	0	0	1.0
34	5.0	0	1.0	0.0	0.0	5.0	0	0	0.5
35	0.0	5	0.0	0.0	0.0	1.0	0	0	1.0
36	1.0	1	0.0	0.0	0.0	2.0	0	0	0.0
39	1.0	0	0.0	0.0	0.0	0.0	0	0	0.0
40	2.0	0	0.0	0.0	0.0	10.0	0	0	0.0
41	5.0	0	0.1	0.5	0.0	1.0	0	0	0.0
42	2.0	0	0.1	0.0	0.0	2.0	0	0	0.0
48	5.0	0	0.0	0.0	0.0	1.0	0	0	0.0
49	15.0	0	0.0	0.0	0.0	10.0	0	0	0.0
50	5.0	0	0.0	0.0	0.0	2.0	0	0	0.0
51	0.1	0	0.0	0.0	0.0	0.1	0	0	1.0
52	2.0	0	0.0	0.0	0.0	2.0	0	0	0.0
53	0.0	25	0.0	0.0	0.0	0.0	0	0	0.0
54	0.0	0	0.0	0.0	0.0	0.0	0	0	0.1
55	2.0	0	0.0	0.0	0.0	0.0	0	0	0.0

----- SITE=TN48-BURNED -----

PLOTNUM	TRISSET87	SUMA	SUMB1	SUMB2	SUMB	SUMC	SUMVEG
1	0.0	0	8	38.0	46.0	52.1	98.1
2	0.0	0	0	20.1	20.1	22.6	42.7
3	0.5	0	0	29.0	29.0	61.5	90.5
4	0.0	0	5	21.0	26.0	58.5	84.5
5	0.0	0	0	51.0	51.0	45.5	96.5
6	1.0	0	35	17.0	52.0	45.1	97.1
7	15.0	0	20	32.0	52.0	71.5	123.5
8	0.1	0	30	18.0	48.0	30.1	78.1
9	0.0	0	20	25.1	45.1	108.2	153.3
10	1.0	0	30	27.5	57.5	59.5	117.0
11	0.1	0	0	31.0	31.0	44.4	75.4
12	0.1	0	0	24.0	24.0	84.2	108.2
13	1.0	0	10	17.0	27.0	46.1	73.1
14	0.1	0	20	32.1	52.1	32.2	84.3
15	1.0	0	25	31.5	56.5	49.5	106.0
17	1.0	0	10	27.5	37.5	77.7	115.2
18	0.1	0	2	37.0	39.0	78.1	117.1
20	0.0	0	10	23.0	33.0	53.2	86.2
21	0.1	0	0	50.1	50.1	54.1	104.2
22	0.1	0	0	17.0	17.0	72.3	89.3
29	0.0	0	0	28.0	28.0	71.0	99.0
30	0.5	0	10	52.0	62.0	58.6	120.6
31	2.0	0	25	27.0	52.0	86.2	138.2
32	1.0	0	10	57.1	67.1	30.0	97.1
33	0.0	0	0	44.0	44.0	60.7	104.7
34	0.5	0	0	13.0	13.0	87.0	100.0
35	0.0	0	8	36.0	44.0	58.1	102.1
36	1.0	0	0	28.0	28.0	84.6	112.6
39	0.1	0	10	22.0	32.0	76.1	108.1
40	0.1	0	25	26.1	51.1	67.1	118.2
41	0.1	0	0	38.0	38.0	45.2	83.2
42	2.0	0	75	15.0	90.0	49.1	139.1
48	1.0	0	0	17.1	17.1	59.0	139.1
49	0.0	0	15	26.0	41.0	58.0	76.1
50	0.0	0	0	38.0	38.0	59.0	99.0
51	0.0	0	0	36.0	36.0	35.2	97.0
52	0.0	0	0	14.0	14.0	52.1	71.2
53	0.0	0	0	9.0	9.0	141.0	66.1
54	0.0	0	0	12.0	12.0	97.1	150.0
55	0.0	0	10	82.1	92.1	20.2	109.1
							112.3

----- SITE=TN48-UNBURNED -----

PLOTNUM	A1HW87	B1BA87	B1CR87	B1HW87	B1SS87	B2BA87	B2CR87	B2CY87	B2HW87	B2SS87
1	0	0	0	55	0	0.0	2.0	0	1.0	0
3	0	5	2	50	0	0.0	15.0	0	5.0	0
4	0	2	0	80	0	2.0	1.0	0	5.0	0
5	0	25	0	25	0	0.0	1.0	0	2.0	0
7	0	10	0	25	0	0.0	0.1	0	5.0	0
8	0	0	0	20	0	0.1	0.1	0	0.1	0
9	0	10	0	35	5	0.0	1.0	0	2.0	0
10	0	20	0	25	0	2.0	2.0	0	10.0	0
12	0	15	0	45	0	0.1	0.1	0	0.1	0
13	0	60	0	5	0	0.0	1.0	0	0.1	0
14	0	2	0	20	0	0.0	5.0	0	1.0	0
15	0	0	0	15	0	1.0	2.0	0	10.0	0
16	0	15	2	30	0	2.0	0.0	0	5.0	0
18	0	10	2	55	0	0.5	5.0	0	1.0	0
19	0	25	0	10	0	15.0	2.0	0	2.0	0
20	0	0	0	10	0	0.0	10.0	0	2.0	0
22	0	2	0	20	0	0.0	1.0	0	2.0	0
23	0	0	0	50	0	2.0	10.0	0	1.0	0
24	0	0	0	45	0	1.0	0.1	0	2.0	0
25	0	20	0	75	0	0.1	0.1	0	0.1	0
26	0	0	0	35	0	2.0	2.0	0	0.1	2
28	0	15	0	30	0	0.0	2.0	0	5.0	0
30	0	0	0	25	0	0.0	2.0	0	1.0	0
32	0	0	0	40	0	0.0	5.0	0	3.0	0
33	0	25	0	25	0	0.1	0.1	0	0.1	0
35	0	2	0	90	0	2.0	1.0	0	5.0	0
36	10	0	0	80	0	5.0	0.1	0	5.0	0
37	0	15	0	95	0	5.0	1.0	0	10.0	0
40	0	2	1	50	0	0.0	5.0	0	1.0	0
41	0	0	0	45	0	1.0	1.0	0	1.0	0
42	0	10	0	35	0	2.0	1.0	0	10.0	0
44	0	10	0	40	0	0.0	0.0	0	5.0	0
45	0	0	0	45	0	0.0	2.0	0	0.1	0
46	0	5	5	35	0	1.0	5.0	0	10.0	0
47	0	5	0	45	0	0.0	5.0	0	10.0	0
48	0	5	0	40	0	0.0	1.0	0	0.1	0
51	0	25	2	75	0	1.0	2.0	0	2.0	0
52	0	5	5	60	0	2.0	5.0	0	15.0	0
53	0	20	0	35	0	0.1	1.0	0	10.0	0
54	0	10	5	35	0	2.0	5.0	0	10.0	0

SITE-TN48-UNBURNED

PLOTNUM	GAUSHAB7	MENFER87	RIBES87	RUEPAR87	RUBSPF87	SAMRAC87	VACDVAB7	VACPAR87	VALASK87
1	0	0	0.0	0.0	5	0.5	0.0	1	0.5
3	5	0	0.0	0.0	10	0.0	0.0	1	0.0
4	0	0	0.0	0.0	5	0.0	0.0	15	2.0
5	0	0	0.0	0.0	5	0.0	0.0	10	1.0
7	0	0	0.0	0.0	5	0.0	0.0	5	0.0
8	0	0	0.0	0.0	5	0.0	0.0	5	0.0
9	0	0	0.0	0.0	15	0.0	0.5	2	0.0
10	0	0	0.0	0.0	10	0.0	0.0	25	0.0
12	0	1	0.0	0.0	10	0.0	5.0	10	5.0
13	0	0	0.0	0.0	5	0.0	0.0	10	5.0
14	0	0	0.0	0.0	5	0.0	5.0	15	5.0
15	0	0	0.0	0.0	5	0.0	0.0	10	10.0
16	0	0	0.0	0.0	15	0.0	0.0	5	5.0
18	0	0	0.0	0.0	10	0.5	0.0	20	5.0
19	0	0	0.0	0.0	10	0.0	0.0	15	10.0
20	0	0	0.0	0.0	10	0.0	0.0	15	20.0
22	0	0	0.0	0.0	10	0.5	0.0	10	10.0
23	0	0	0.0	0.0	15	0.0	0.0	10	1.0
24	0	0	0.0	0.0	1	0.1	0.0	5	1.0
25	0	0	0.1	0.0	0	0.0	0.0	2	0.0
26	0	0	0.0	0.0	15	0.0	0.0	5	1.0
28	0	0	0.0	0.0	10	0.0	0.0	5	1.0
30	0	0	0.0	0.0	10	0.0	0.0	10	2.0
32	0	0	0.0	0.1	10	1.0	0.0	10	0.0
33	0	0	0.0	0.0	10	0.0	0.0	10	0.0
35	0	0	0.0	0.0	1	0.0	0.0	10	0.0
36	0	0	0.0	0.0	1	0.0	0.0	1	2.0
37	0	0	0.0	0.0	5	0.0	0.0	5	2.0
40	0	0	0.0	0.0	5	0.0	0.0	5	2.0
41	0	0	0.0	0.0	5	0.1	0.0	5	2.0
42	0	0	0.0	0.0	1	0.0	0.0	10	0.0
44	0	0	0.0	0.0	2	0.0	0.0	2	0.1
45	0	0	0.0	0.1	10	0.0	0.0	2	2.0
46	0	0	0.0	0.0	5	0.0	0.0	10	0.5
47	0	0	0.0	0.0	5	0.0	0.0	5	1.0
48	0	0	0.0	0.0	5	0.0	0.0	1	0.0
51	0	0	0.0	0.0	10	0.5	0.0	5	2.0
52	0	0	0.0	0.0	5	0.0	0.0	5	0.5
53	0	0	0.0	0.0	10	0.0	0.0	5	0.5
54	0	0	0.0	0.5	5	0.0	0.0	5	0.5

----- SITE=TN48-UNBURNED -----

PLOTNUM	ADIANIUM	AGRTENS /	ANAMAR87	ATHFEL87	BLESPI87	BOTMUL87	CARMER87	CIRVUL87
1	0.0	0.0	2.0	1.0	15.0	0.0	0.5	0.0
3	0.0	0.0	0.0	0.1	10.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	10.0	0.0	0.5	0.0
5	0.0	0.0	1.0	1.0	30.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	15.0	0.0	0.1	0.0
8	0.0	0.0	0.1	0.0	10.0	0.0	0.0	0.0
9	0.0	0.1	2.0	1.0	15.0	0.0	0.0	0.0
10	0.0	0.0	0.1	0.5	20.0	0.0	0.0	0.0
12	0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0
15	0.0	0.0	0.1	0.5	15.0	0.0	2.0	0.0
16	0.0	0.0	0.0	5.0	10.0	0.0	0.0	0.0
18	0.0	0.0	0.0	1.0	5.0	0.0	0.0	0.0
19	0.0	0.0	0.0	1.0	20.0	0.0	0.0	0.0
20	5.0	0.0	0.0	0.0	10.0	0.0	2.0	0.0
22	0.0	0.0	1.0	1.0	20.0	0.0	1.0	0.0
23	5.0	0.0	5.0	5.0	15.0	0.1	2.0	0.1
24	0.0	0.0	0.1	0.1	15.0	0.0	0.1	0.0
25	0.0	0.0	0.1	0.1	1.0	0.0	0.0	0.0
26	10.0	0.0	1.0	2.0	20.0	0.0	1.0	0.0
28	0.0	0.0	5.0	0.5	10.0	0.0	5.0	0.0
30	0.0	0.0	0.0	5.0	5.0	0.0	0.0	0.0
32	0.0	0.0	0.0	2.0	5.0	0.0	0.0	0.0
33	0.0	0.1	0.0	0.0	10.0	0.0	0.0	0.0
35	0.0	0.0	0.0	1.0	2.0	0.0	0.1	0.0
36	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0
37	0.0	0.0	0.0	0.5	5.0	0.0	0.0	0.0
40	0.0	0.0	0.0	2.0	15.0	0.0	0.0	0.0
41	0.0	0.0	0.0	10.0	5.0	0.0	0.0	0.0
42	0.0	0.0	0.0	2.0	15.0	0.0	0.0	0.0
44	0.5	0.0	0.1	5.0	15.0	0.0	0.0	0.0
45	0.0	0.0	0.0	1.0	25.0	0.0	0.0	0.0
46	0.0	0.0	0.0	0.5	15.0	0.0	0.0	0.0
47	0.0	0.0	0.0	0.0	20.0	0.0	1.0	0.0
48	0.0	0.0	0.0	0.1	5.0	0.0	0.0	0.0
51	0.0	0.0	0.0	0.1	10.0	0.0	0.0	0.0
52	0.0	0.0	0.0	0.5	5.0	0.0	0.5	0.0
53	0.0	0.0	0.0	0.1	5.0	0.0	0.5	0.0
54	0.0	0.0	0.1	5.0	5.0	0.1	2.0	0.1

SITE=TN48-UNBURNED

PLOTNUM	COPASP87	CORCAN87	DESELO87	DRVAUS87	EPIANG87	EQUISET	FRAGAR87	GALTRI87	GYMDRY87
1	0	1.0	0	5.0	10.0	0	0.0	0.0	0.0
3	0	0.1	0	0.1	10.0	0	0.0	0.0	0.0
4	0	10.0	0	0.1	1.0	0	0.0	0.0	0.0
5	0	0.0	0	0.0	5.0	0	0.0	0.0	0.0
7	0	30.0	0	0.0	10.0	0	0.0	0.0	0.0
8	0	50.0	0	0.0	10.0	0	0.0	0.0	0.0
9	0	25.0	0	0.0	15.0	0	0.0	0.0	0.0
10	0	20.0	0	0.1	5.0	0	0.0	0.0	0.0
12	0	25.0	0	0.0	10.0	0	0.0	0.0	0.0
13	0	40.0	0	0.1	1.0	0	0.0	0.0	0.0
14	0	50.0	0	1.0	2.0	0	0.0	0.0	0.0
15	0	50.0	0	5.0	5.0	0	0.0	0.0	0.0
16	0	35.0	0	5.0	5.0	0	0.0	0.0	0.0
18	0	15.0	0	5.0	10.0	0	0.0	0.0	0.0
19	2	50.0	0	5.0	2.0	0	0.0	0.0	0.0
20	5	20.0	0	0.5	5.0	0	0.0	0.0	0.0
22	1	0.1	0	0.5	10.0	0	0.0	0.0	0.1
23	0	2.0	0	0.5	2.0	0	0.0	0.0	2.0
24	0	1.0	0	0.1	10.0	0	0.0	0.0	0.0
25	0	0.1	0	0.0	1.0	0	0.0	0.0	0.0
26	5	5.0	0	0.5	2.0	0	0.0	0.0	5.0
28	0	20.0	0	2.0	1.0	0	0.0	0.0	0.0
30	0	10.0	0	0.0	5.0	0	0.0	0.0	0.0
32	0	70.0	0	0.1	10.0	0	0.0	0.0	0.0
33	0	45.0	0	0.0	5.0	0	0.0	0.0	0.0
35	0	0.0	0	0.0	1.0	0	0.0	0.0	0.0
36	0	1.0	0	0.1	0.1	0	0.0	0.0	0.0
37	0	2.0	0	0.5	1.0	0	0.0	0.0	0.0
40	0	15.0	0	0.0	5.0	0	0.0	0.0	0.0
41	0	20.0	0	0.5	5.0	0	0.0	0.0	0.0
42	0	2.0	0	0.1	5.0	0	0.0	0.0	0.0
44	0	0.0	0	0.1	1.0	0	0.0	0.0	0.0
45	0	0.0	0	0.0	15.0	0	0.0	0.0	0.0
46	0	40.0	0	0.1	2.0	0	0.0	0.0	0.0
47	0	25.0	0	0.5	2.0	0	0.0	0.0	0.0
48	0	5.0	0	0.1	10.0	0	0.0	0.0	0.0
51	0	0.5	0	0.5	2.0	0	0.0	0.0	0.0
52	0	0.0	0	5.0	10.0	0	0.0	0.0	0.0
53	0	10.0	0	0.5	0.5	0	0.0	0.0	0.0
54	0	5.0	0	0.5	2.0	0	0.0	0.1	0.1

----- SITE - IN48-UNBURNED -----

PLOTNUM	LACER87	LJNNE87	LUZPAR87	LYCCLA87	PLANTAGO	POLMUN87	SENTRI87	STREPT87	TIAREL87
1	2.0	0.0	0.0	0	0	1.0	0	0.0	0.0
3	0.0	0.0	0.0	0	0	0.0	0	0.0	0.0
4	0.0	0.0	0.0	0	0	0.0	0	0.0	0.0
5	0.1	0.0	0.0	0	0	0.1	0	0.0	0.0
7	0.0	0.0	0.0	0	0	0.0	0	0.0	0.0
8	0.1	0.0	0.0	0	0	0.0	0	0.0	0.0
9	0.0	0.0	0.0	0	0	1.0	0	0.0	0.0
10	0.1	0.0	0.0	0	0	1.0	0	0.0	0.0
12	0.0	0.0	0.0	0	0	0.0	0	0.0	0.0
13	0.0	0.0	0.0	0	0	0.0	0	0.0	0.0
14	0.1	0.0	0.0	0	0	0.1	0	0.0	0.0
15	2.0	0.0	0.0	0	0	0.5	0	0.0	0.0
16	1.0	0.0	0.0	0	0	2.0	0	0.0	0.0
18	1.0	0.0	0.0	0	0	10.0	0	0.0	0.5
19	0.0	0.0	0.0	0	0	0.0	0	0.0	0.0
20	0.1	2.0	0.0	0	0	2.0	0	0.0	0.1
22	2.0	0.0	0.0	0	0	10.0	0	0.0	0.1
23	0.1	0.0	0.1	0	0	1.0	0	0.0	0.5
24	1.0	0.0	0.0	0	0	1.0	0	0.0	0.0
25	0.0	0.0	0.0	0	0	0.0	0	0.0	0.0
26	1.0	0.0	0.0	0	0	5.0	0	0.1	0.5
28	1.0	0.0	0.0	0	0	1.0	0	0.0	0.0
30	1.0	0.0	0.0	0	0	5.0	0	0.0	0.0
32	1.0	0.0	0.0	0	0	0.1	0	0.0	0.0
33	0.0	0.0	0.0	0	0	0.1	0	0.0	0.1
35	0.0	0.0	0.0	0	0	0.0	0	0.0	0.1
36	0.0	0.0	0.0	0	0	0.1	0	0.0	0.1
37	0.0	0.0	0.0	0	0	1.0	0	0.0	0.0
40	0.0	0.0	0.0	0	0	0.0	0	0.0	0.0
41	0.1	0.0	0.0	0	0	1.0	0	0.0	0.0
42	0.0	0.0	0.0	0	0	0.0	0	0.0	0.0
44	0.1	0.1	0.0	0	0	5.0	0	0.0	0.0
45	0.1	0.0	0.1	0	0	0.0	0	0.0	0.0
46	0.0	0.0	0.0	0	0	0.5	0	0.0	0.0
47	0.1	0.0	0.0	0	0	0.5	0	0.0	0.0
48	0.1	0.0	0.0	0	0	0.1	0	0.0	0.0
51	0.5	0.0	0.0	0	0	2.0	0	0.0	0.0
52	0.1	0.0	0.1	0	0	2.0	0	0.0	0.0
53	0.5	0.0	0.0	0	0	0.0	0	0.0	0.0
54	0.1	5.0	0.0	0	0	2.0	0	0.0	0.1

SITE=TN48-UNBURNED

PLOTNUM	TRISSET87	SUMA	SUMB1	SUMB2	SUMB	SUMC	SUMVEG
1	1.0	0	55	10.0	65.0	38.5	103.5
3	0.0	0	57	36.0	93.0	20.3	113.3
4	0.1	0	82	30.0	112.0	21.7	133.7
5	0.1	0	50	19.0	69.0	37.3	106.3
7	0.0	0	35	22.0	57.0	55.1	112.1
8	0.0	0	20	10.3	30.3	70.2	100.5
9	0.0	0	50	20.5	70.5	59.1	129.6
10	0.1	0	45	51.0	96.0	46.9	142.9
12	0.0	0	60	31.3	91.3	37.0	128.3
13	0.0	0	65	18.1	83.1	43.1	126.2
14	0.0	0	22	36.0	58.0	54.3	112.3
15	1.0	0	15	38.0	53.0	77.1	130.1
16	0.0	0	47	37.0	84.0	63.0	147.0
18	0.5	0	67	42.0	109.0	48.0	157.0
19	0.0	0	35	54.0	89.0	74.0	163.0
20	0.1	0	10	47.0	57.0	54.8	111.8
22	0.1	0	22	24.5	46.5	46.9	93.4
23	0.1	0	50	34.0	84.0	41.5	125.5
24	0.1	0	45	6.2	51.2	28.5	79.7
25	0.0	0	95	6.4	101.4	2.2	103.6
26	0.1	0	35	27.1	62.1	58.2	120.3
28	0.0	0	45	29.0	74.0	45.5	119.5
30	0.0	0	25	24.1	49.1	31.0	80.1
32	0.0	0	40	28.0	68.0	88.3	156.3
33	0.0	0	50	11.3	61.3	60.1	121.4
35	0.0	0	92	12.0	104.0	4.2	108.2
36	0.0	10	80	13.1	93.1	1.6	104.7
37	0.0	0	110	28.0	138.0	10.5	148.5
40	0.0	0	53	16.0	69.0	37.0	106.0
41	0.0	0	45	9.1	54.1	41.6	95.7
42	0.0	0	45	35.0	80.0	24.1	104.1
44	0.0	0	50	9.1	59.1	26.8	85.9
45	0.0	0	45	16.2	61.2	41.3	102.5
46	0.0	0	45	31.5	76.5	58.1	134.6
47	0.0	0	50	26.0	76.0	49.6	125.6
48	0.0	0	45	12.1	57.1	20.4	77.5
51	0.1	0	102	17.5	119.5	15.7	135.2
52	0.0	0	70	37.5	107.5	23.2	130.7
53	0.1	0	55	21.6	76.6	17.2	93.8
54	0.0	0	50	37.5	87.5	27.2	114.7

Appendix II

Tree and site variables used in the correlation analysis of Chapter 1.

The data are sorted by sites. The abbreviations are explained below. The criteria for plant strata are explained in Chapter 1.

AVLEADER	Average leader growth for previous three years (cm/yr)
CFRAGS2	Content of coarse fragments in 0-20 cm depth of mineral soil (%)
D10	Diameter of plot center tree at 10 cm above point of germination (mm)
D10AGE	Age of plot center tree at 10 cm above point of germination (yr)
D10INCR	Incremental growth in diameter (mm/yr). This value was calculated by dividing the diameter at 10 cm above point of germination by the age at the same location.
DWOOD	Surface cover of decaying wood within plot (%)
HGHTINCR	Incremental growth in height for entire tree (cm/yr). This value was calculated by dividing the tree height by the age at 10 cm above point of germination.
PLOTNUM	The number of the sample point within a site
SEEDLING	Seedling density (no./root zone)
SLOPE	Slope at point of germination (%)
SUMB2	Sum of the cover for plant species in the B2 strata (%)
SUMBAS1	Sum of the basal area at 10 cm above the germination point for all trees in the root zone (m ² /root zone)
SUMC	Sum of the cover for plant species in the C strata (%)
SUMVEG	Sum of the cover for plant species in the A1, B1, B2, and C strata (%)
THICK1	Depth of forest floor at point of germination (cm)
TREEHGHT	Height of plot center tree (cm)
VOL1	Stem volume of plot center tree (m ³)
VOL1INCR	Incremental growth in stem volume for plot center tree (m ³ /yr). This value was calculated by dividing the stem volume by the age at 10 cm above point of germination.

SITE=E55-BURNED

PLOTNUM	AVLEADER	CFRAGS2	D10	D10AGE	D10INCR	DWOOD	HGHTINCR	SEEDLING	SLOPE
1	32.6667	30	14	6	2.33333	10	25.3333	7	42
2	51.3333	15	47	7	6.71429	13	38.5714	10	5
3	38.3333	37	42	10	4.20000	50	27.7000	14	22
4	20.0000	40	17	8	2.12500	10	18.8750	17	37
5	36.0000	20	31	6	5.16667	0	33.5000	13	5
6	22.3333	30	22	8	2.75000	25	21.0000	8	43
7	38.0000	60	31	8	3.87500	20	30.5000	11	26
8	13.6667	27	23	9	2.55556	35	12.0000	13	33
9	34.6667	20	24	6	4.00000	10	28.6667	14	14
10	35.0000	20	36	9	4.00000	10	22.6667	25	52
11	37.6667	25	26	8	3.25000	8	25.5000	29	38
12	39.3333	5	34	6	5.66667	5	42.1667	10	19
13	35.0000	25	33	7	4.71429	25	28.2857	33	54
14	25.0000	51	13	6	2.16667	25	23.1667	12	22
15	56.3333	49	53	7	7.57143	35	49.7143	15	60
16	27.6667	15	32	8	4.00000	35	27.8750	22	45
17	50.0000	40	46	7	6.57143	10	43.1429	21	15
18	28.3333	50	22	8	2.75000	35	25.1250	41	0
19	57.0000	5	37	8	4.62500	15	36.5000	18	21
20	45.6667	30	48	9	5.33333	40	37.5556	10	35
21	14.0000	45	26	8	3.25000	30	23.6250	27	25
22	18.3333	10	20	6	3.33333	20	19.1667	21	20
23	19.0000	50	15	8	1.87500	10	15.3750	11	15
24	19.6667	20	18	5	3.60000	40	28.8000	17	6
25	34.0000	10	25	6	4.16667	10	34.6667	11	54
26	18.3333	10	15	7	2.14286	15	16.2857	16	30
27	17.3333	44	18	9	2.00000	15	16.1111	31	106
28	17.6667	21	22	9	2.44444	25	16.5556	8	59
29	19.3333	10	16	8	2.00000	10	15.8750	10	100
30	19.0000	18	20	9	2.22222	40	12.3333	27	82
31	63.3333	40	71	8	8.87500	25	53.0000	14	29
32	16.6667	20	15	8	1.87500	25	15.0000	22	0
33	25.3333	40	37	8	4.62500	20	23.0000	14	9
34	11.0000	40	10	6	1.66667	5	18.0000	19	0
35	64.3333	40	53	10	5.30000	35	40.9000	26	14
36	46.0000	35	48	9	5.33333	60	37.5556	21	0
37	52.6667	29	33	11	3.00000	10	24.0909	22	22
38	32.6667	40	44	9	4.88889	40	35.2222	23	67
39	26.0000	40	15	8	1.87500	15	27.5000	16	0
40	35.6667	30	25	7	3.57143	30	29.2857	17	13

SITE=E55-UNBURNED

PLOTNUM	AVLEADER	CFRAGS2	D10	D10AGE	D10INCR	DWOOD	HGHTINCR	SEEDLING	SLOPE
1	62.6667	25	91	11	8.2727	20	51.8182	49	44
2	63.3333	40	145	14	10.3571	20	64.3571	47	55
3	35.3333	28	88	17	5.1765	15	38.2353	102	150
4	25.0000	40	43	13	3.3077	20	32.6923	98	33
5	27.6667	30	48	13	3.6923	10	33.3077	135	26
6	31.6667	20	39	18	2.1667	10	26.4444	52	27
7	56.6667	20	58	11	5.2727	10	45.1818	49	45
8	40.6667	30	82	13	6.3077	30	49.9231	48	46
9	28.6667	25	44	12	3.6667	15	35.7500	137	51
10	54.0000	35	135	43	3.1395	15	27.8837	25	50
11	53.3333	30	134	16	8.3750	15	54.6250	81	90
12	39.0000	35	38	13	2.9231	10	25.8462	42	52
13	36.3333	40	70	17	4.1176	10	47.5882	9	0
14	51.0000	35	118	23	5.1304	40	38.3478	86	76
15	48.6667	10	63	12	5.2500	15	38.5833	41	76
16	47.3333	20	28	11	2.5455	10	33.3636	45	61
17	65.0000	10	115	14	8.2143	15	59.8571	52	40
18	78.3333	10	191	20	9.5500	10	55.5500	60	38
19	58.6667	25	54	13	4.1538	20	37.1538	97	0
20	60.6667	35	105	14	7.5000	20	54.4286	83	0
21	51.0000	30	114	13	8.7692	25	48.6923	55	85
22	69.3333	20	66	11	6.0000	20	50.7273	47	0
23	55.6667	25	38	12	3.1667	50	39.4167	38	0
24	59.3333	40	135	16	8.4375	15	53.1250	40	14
25	57.0000	10	37	11	3.3636	20	42.6364	81	43
26	66.3333	24	64	15	4.2667	15	46.6667	51	45
27	47.0000	33	26	11	2.3636	25	39.1818	157	12
28	52.3333	31	39	11	3.5455	30	42.8571	74	67
29	60.0000	40	58	14	4.1429	30	42.8571	56	30
30	69.6667	43	72	11	6.5455	50	56.1818	37	33
31	49.3333	22	57	13	4.3846	15	41.6923	109	22
32	77.0000	5	92	14	6.5714	30	52.3571	79	14
33	61.0000	30	76	15	5.0667	15	34.6000	79	108
34	58.6667	53	85	13	6.5385	30	39.4615	60	42
35	39.6667	50	57	16	3.5625	15	43.0625	45	19
36	74.6667	40	177	15	11.8000	15	60.0000	47	50
37	62.6667	30	95	13	7.3077	15	53.4615	82	33
38	47.0000	25	38	14	2.7143	15	36.3571	83	63
39	31.6667	20	49	12	4.0833	15	34.9167	64	0
40	52.6667	45	117	25	4.6800	10	37.1600	44	37

----- SITE=TN48-BURNED -----

PLOTNUM	AVLEADER	CFRAGS2	D10	D10AGE	D10INCR	DWOOD	HGHTINCR	SEEDLING	SLOPE
1	44.6667	63	40	8	5.00000	20	35.5000	9	30
2	33.3333	40	17	5	3.40000	10	28.2000	17	46
3	19.6667	65	14	7	2.00000	10	17.1429	10	30
4	28.6667	65	25	6	4.16667	20	30.5000	19	22
5	33.6667	60	23	5	4.60000	15	29.0000	11	53
6	46.0000	45	48	7	6.85714	20	31.4286	25	56
7	36.3333	50	25	8	3.12500	30	23.5000	26	7
8	23.3333	45	35	7	5.00000	40	21.1429	19	44
9	49.3333	65	47	9	5.22222	15	40.6667	9	35
10	34.6667	35	10	5	2.00000	5	24.6000	12	65
11	35.3333	45	15	4	3.75000	10	34.2500	9	49
12	25.0000	65	22	8	2.75000	30	22.1250	38	45
13	25.6667	45	33	8	4.12500	15	27.0000	25	0
14	56.3333	60	32	6	5.33333	15	36.6667	18	22
15	61.0000	40	40	8	5.00000	25	39.0000	19	64
17	31.0000	25	13	6	2.16667	5	23.6667	40	38
18	24.0000	51	12	5	2.40000	10	22.6000	46	44
20	36.0000	55	11	6	1.83333	30	20.0000	52	30
21	24.6667	60	11	7	1.57143	15	17.5714	69	38
22	27.6667	65	16	7	2.28571	30	20.1429	21	8
29	12.3333	60	10	7	1.42857	30	14.8571	43	41
30	48.0000	80	40	8	5.00000	35	34.3750	25	47
31	37.3333	55	46	8	5.75000	30	32.7500	24	90
32	34.3333	60	28	5	5.60000	30	31.0000	30	19
33	14.3333	60	15	8	1.87500	20	16.3750	72	0
34	29.6667	65	17	6	2.83333	10	29.1667	12	49
35	8.0000	65	37	12	3.08333	75	21.2500	22	114
36	18.6667	60	39	8	4.87500	30	30.2500	55	41
39	26.0000	50	32	8	4.00000	10	27.1250	26	55
40	21.0000	60	13	8	1.62500	25	13.8750	45	11
41	20.6667	55	15	8	1.87500	20	14.8750	87	46
42	58.3333	55	67	8	8.37500	2	46.0000	24	86
48	20.3333	42	16	8	2.00000	25	17.8750	43	39
49	20.3333	60	25	8	3.12500	20	20.0000	12	70
50	13.6667	60	18	8	2.25000	10	17.2500	12	90
51	20.6667	65	21	8	2.62500	35	18.1250	57	28
52	20.0000	60	12	7	1.71429	15	15.7143	13	33
53	9.6667	64	14	9	1.55556	15	11.4444	8	36
54	17.3333	70	14	8	1.75000	15	13.7500	67	0
55	31.6667	60	21	9	2.33333	15	22.4444	26	4

----- SITE=TN48-UNBURNED -----

PLOTNUM	AVLEADER	CFRAGS2	D10	D10AGE	D10INCR	DWDD	HGHTINCR	SEEDLING	SLOPE
1	67.3333	55	78	12	6.5000	15	51.0000	51	38
3	60.6667	65	172	14	12.2857	15	50.2143	59	146
4	49.0000	40	140	42	3.3333	5	16.3571	23	160
5	54.3333	60	96	11	8.7273	10	54.0909	43	76
7	22.3333	40	46	17	2.7059	10	20.0000	63	78
8	55.6667	60	118	29	4.0690	20	24.0345	9	96
9	43.6667	41	131	14	9.3571	15	42.0000	31	98
10	25.3333	65	75	13	5.7692	35	34.6923	42	100
12	56.0000	60	101	13	7.7692	10	46.2308	14	100
13	40.6667	55	58	12	4.8333	20	43.0833	31	66
14	31.0000	56	75	14	5.3571	15	28.4286	52	66
15	62.0000	44	60	8	7.5000	15	50.5000	66	51
16	31.6667	55	48	9	5.3333	40	35.5556	40	49
18	54.0000	50	175	47	3.7234	25	14.9362	45	144
19	28.3333	55	94	34	2.7647	20	14.1176	58	71
20	26.6667	80	50	10	5.0000	10	32.5000	144	130
22	41.6667	55	124	18	6.8889	15	30.6667	22	58
23	44.0000	60	127	31	4.0968	15	23.0645	81	110
24	63.3333	45	153	12	12.7500	20	53.0000	21	68
25	29.3333	60	117	45	2.6000	25	14.1556	17	43
26	37.6667	58	95	14	6.7857	30	39.9286	29	48
28	69.0000	60	74	10	7.4000	5	52.9000	56	53
30	44.6667	52	50	9	5.5556	20	41.6667	39	13
32	42.6667	45	79	9	8.7778	25	42.0000	36	71
33	40.0000	60	54	13	4.1538	25	35.0000	26	116
35	24.6667	55	56	15	3.7333	5	36.4000	68	90
36	20.0000	45	76	15	5.0667	10	37.8667	45	62
37	29.6667	40	76	14	5.4286	20	46.4286	65	27
40	29.0000	55	60	10	6.0000	20	37.0000	52	20
41	19.0000	50	46	10	4.6000	30	30.2000	20	146
42	51.6667	54	166	37	4.4865	15	16.7568	53	86
44	36.6667	55	42	8	5.2500	20	41.6250	50	118
45	20.0000	65	70	15	4.6667	25	34.8000	75	124
46	22.6667	40	68	15	4.5333	5	26.3333	173	53
47	12.0000	55	30	10	3.0000	20	31.1000	88	66
48	53.6667	50	170	17	10.0000	10	48.8235	29	80
51	20.0000	60	44	13	3.3846	15	31.8462	77	57
52	62.6667	60	192	12	16.0000	25	61.6667	71	68
53	17.0000	60	47	10	4.7000	30	31.3000	67	15
54	13.6667	55	60	12	5.0000	35	25.2500	124	45

----- SITE=E55-BURNED -----

PLOTNUM	SUMB2	SUMBAS1	SUMC	SUMVEG	THICK1	TREEHGT	VOL1	VOL1INCR
1	17.4	0.0071251	10.5	42.9	10	152	0.00007746	0.000012910
2	20.6	0.0049559	15.3	60.9	16	270	0.00155072	0.000221531
3	24.3	0.0099738	8.3	52.6	23	277	0.00127043	0.000127043
4	12.2	0.0149838	16.9	69.1	6	151	0.00011346	0.000014183
5	40.3	0.0000785	36.1	86.4	8	201	0.00050222	0.000083703
6	19.7	0.0033866	41.7	62.4	46	168	0.00021141	0.000026426
7	8.7	0.0055292	20.2	43.9	11	244	0.00060966	0.000076207
8	17.4	0.0031769	23.1	50.5	16	108	0.00014854	0.000016505
9	12.0	0.0027458	27.5	54.5	38	172	0.00025759	0.000042931
10	10.1	0.0082585	39.0	74.1	7	204	0.00068740	0.000076378
11	28.6	0.0226854	33.1	106.7	1	204	0.00035855	0.000044819
12	11.5	0.0039985	38.1	74.6	11	253	0.00076042	0.000126736
13	20.2	0.0030654	45.0	75.2	28	198	0.00056062	0.000080088
14	11.3	0.0117221	38.0	79.3	17	139	0.00006108	0.000010179
15	14.5	0.0010838	32.0	61.5	36	348	0.00254158	0.000363083
16	12.6	0.0009464	34.2	54.8	8	223	0.00059372	0.000074214
17	17.2	0.0137963	29.5	79.7	28	302	0.00166148	0.000237355
18	13.0	0.0069091	29.7	60.7	38	201	0.00025294	0.000031617
19	12.0	0.0070482	30.0	77.0	36	292	0.00103934	0.000129918
20	33.0	0.0108189	37.1	110.1	35	338	0.00202476	0.000224973
21	18.1	0.0009386	31.6	53.7	16	189	0.00033219	0.000041523
22	6.6	0.0044728	54.0	70.6	7	115	0.00011960	0.000019933
23	28.6	0.0031188	43.7	72.3	24	123	0.00007195	0.000008954
24	21.5	0.0021543	33.4	62.9	30	144	0.00012131	0.000024261
25	22.0	0.0066248	45.5	102.5	15	208	0.00033800	0.000056333
26	27.1	0.0023625	82.4	111.5	5	114	0.00006669	0.000009527
27	46.1	0.0028070	30.2	84.3	8	149	0.00012552	0.000013946
28	9.0	0.0110160	33.2	87.2	70	145	0.00018247	0.000020274
29	19.0	0.0036348	66.1	95.1	9	127	0.00008453	0.000010566
30	23.5	0.0010972	48.7	77.2	38	111	0.00011544	0.000012827
31	20.0	0.0014781	51.2	101.2	30	424	0.00555720	0.000694650
32	26.0	0.0066013	52.3	128.3	10	120	0.00007020	0.000008775
33	43.0	0.0032005	114.0	167.0	24	184	0.00065493	0.000081866
34	27.0	0.0077299	101.2	158.2	20	108	0.00002808	0.000004680
35	43.7	0.0013022	74.1	147.1	9	409	0.00298709	0.000298709
36	25.0	0.0028062	58.6	103.6	24	338	0.00202476	0.000224973
37	47.0	0.0026570	63.5	120.5	23	265	0.00075032	0.000068211
38	40.0	0.0025306	80.1	145.1	24	317	0.00159565	0.000177295
39	67.0	0.0010092	68.3	150.3	30	220	0.00012870	0.000016087
40	16.2	0.0069767	70.1	121.3	6	205	0.00033312	0.000047589

-----SITE=E55-UNBURNED-----

PLOTNUM	SUMB2	SUMBAS1	SUMC	SUMVEG	THICK1	TREEHGT	VOL1	VOL1INCR
1	51.20	0.027573	46.20	152.40	3	570	0.012272	0.00111568
2	14.84	0.128612	9.84	124.68	55	901	0.049253	0.00351808
3	10.30	0.191936	0.04	95.34	38	650	0.013087	0.00076984
4	11.14	0.137482	0.10	111.24	23	425	0.002043	0.00015716
5	12.00	0.167458	0.08	98.08	9	433	0.002594	0.00019953
6	6.42	0.283327	0.76	112.18	10	476	0.001882	0.00010458
7	21.60	0.094011	15.24	116.84	13	497	0.004347	0.00039518
8	27.22	0.059367	5.78	74.00	30	649	0.011346	0.00087278
9	20.54	0.065213	0.94	91.48	11	429	0.002159	0.00017995
10	5.40	0.310734	0.00	100.40	50	1199	0.056815	0.00132127
11	13.52	0.175715	2.08	105.60	15	874	0.040803	0.00255020
12	20.64	0.070225	15.24	105.88	7	336	0.001261	0.00009704
13	6.02	0.453446	0.78	126.80	32	809	0.010307	0.00063627
14	11.34	0.270372	3.78	135.12	14	882	0.031931	0.00138828
15	10.42	0.205753	7.60	98.02	18	463	0.004778	0.00039816
16	8.12	0.053420	10.78	110.90	60	367	0.000748	0.00006801
17	11.32	0.222882	3.66	94.98	2	838	0.028815	0.00205819
18	8.22	0.228012	10.14	110.36	5	1111	0.105379	0.00526895
19	32.60	0.095487	55.44	138.04	23	483	0.003662	0.00028169
20	26.60	0.206800	7.16	123.76	42	762	0.021843	0.00156019
21	19.20	0.127918	24.70	155.40	33	633	0.021389	0.00164529
22	14.82	0.104455	9.94	114.96	44	558	0.006320	0.00057452
23	16.10	0.240657	5.94	122.04	28	473	0.001776	0.00014799
24	13.64	0.128607	2.68	108.32	25	850	0.040277	0.00251733
25	31.20	0.100880	19.06	116.30	3	469	0.001669	0.00015176
26	21.20	0.226304	8.12	131.32	8	700	0.007455	0.00049698
27	21.40	0.205241	0.56	116.96	21	431	0.000758	0.00006887
28	13.00	0.119530	11.26	109.26	3	480	0.001898	0.00017256
29	30.62	0.091687	14.26	114.88	12	600	0.005248	0.00037485
30	29.40	0.075568	17.08	116.48	13	618	0.008330	0.00075724
31	11.32	0.133412	2.26	104.08	2	542	0.004578	0.00035219
32	14.72	0.166063	8.78	119.50	34	733	0.016131	0.00115219
33	14.40	0.196256	3.70	113.30	2	519	0.007794	0.00051961
34	18.20	0.089026	8.56	96.76	13	513	0.009637	0.00074128
35	23.40	0.409030	1.10	139.50	49	689	0.005820	0.00036377
36	11.90	0.153239	1.56	114.46	70	900	0.073310	0.00488732
37	5.94	0.089439	16.70	123.14	38	695	0.016308	0.00125447
38	34.50	0.175422	26.62	136.12	3	509	0.001911	0.00013650
39	23.62	0.182559	8.16	130.78	70	419	0.002616	0.00021797
40	5.40	0.325311	1.20	111.60	38	929	0.033064	0.00132258

----- SITE=TN48-BURNED -----

PLOTNUM	SUMB2	SUMBAS1	SUMC	SUMVEG	THICK1	TREEHGT	VOL1	VOL1INCR
1	38.0	0.00080425	52.3	98.1	26	284	0.00118144	0.000147680
2	20.1	0.00000000	22.6	42.7	1	141	0.00010595	0.000021189
3	29.0	0.00063460	61.5	90.5	16	120	0.00006115	0.000008736
4	21.0	0.00038013	58.5	84.5	34	183	0.00029737	0.000049562
5	51.0	0.00000000	45.5	96.5	19	145	0.00019943	0.000039887
6	17.0	0.00086786	45.1	97.1	17	220	0.00131789	0.000188270
7	32.0	0.00066366	71.5	123.5	12	188	0.00030550	0.000038187
8	18.0	0.00562031	30.1	78.1	68	148	0.00047138	0.000067340
9	25.1	0.00000000	108.2	153.3	34	366	0.00210208	0.000233565
10	27.5	0.00237661	59.5	117.0	50	123	0.00003198	0.000006396
11	31.0	0.00000000	44.4	75.4	24	137	0.00008014	0.000020036
12	24.0	0.00009503	84.2	108.2	70	177	0.00022274	0.000027842
13	17.0	0.00000000	46.1	73.1	18	216	0.00061158	0.000076448
14	32.1	0.00000000	32.2	84.3	27	220	0.00058573	0.000097621
15	31.5	0.00056549	49.5	106.0	18	312	0.00129792	0.000162240
17	27.5	0.00111291	77.7	115.2	43	142	0.00006239	0.000010399
18	37.0	0.00211429	78.1	117.1	52	113	0.00004231	0.000008461
20	23.0	0.00115454	53.2	86.2	26	120	0.00003775	0.000006292
21	50.1	0.00356649	54.1	104.2	3	123	0.00003870	0.000005528
22	17.0	0.00000000	72.3	89.3	50	141	0.00009385	0.000013407
29	28.0	0.00017671	71.0	99.0	40	104	0.00002704	0.000003863
30	52.0	0.00253134	58.6	120.6	58	275	0.00114400	0.000143000
31	27.0	0.00069900	86.2	138.2	73	262	0.00144142	0.000180177
32	57.1	0.00000000	30.0	97.1	46	155	0.00031595	0.000063190
33	44.0	0.00009503	60.7	104.7	27	131	0.00007663	0.000009579
34	12.0	0.00000000	87.0	100.0	33	175	0.00013149	0.000021916
35	36.0	0.00037856	58.1	102.1	120	255	0.00090765	0.000075637
36	28.0	0.00029610	84.6	112.6	40	242	0.00095701	0.000119627
39	22.0	0.00041548	76.1	108.1	23	217	0.00057774	0.000072218
40	26.1	0.00163756	67.1	118.2	21	111	0.00004877	0.000006097
41	38.0	0.00091813	45.2	83.2	2	119	0.00006961	0.000008702
42	15.0	0.00186768	49.1	139.1	17	368	0.00429508	0.000536884
48	17.1	0.00000000	59.0	76.1	3	143	0.00009518	0.000011898
49	26.0	0.00066052	58.0	99.0	5	160	0.00026000	0.000032500
50	38.0	0.00000000	59.0	97.0	1	138	0.00011625	0.000014531
51	36.0	0.00079247	35.2	71.2	12	145	0.00016626	0.000020782
52	14.0	0.00038013	52.1	66.1	8	110	0.00004118	0.000005883
53	9.0	0.00000000	141.0	150.0	9	103	0.00005249	0.000005832
54	12.0	0.00005027	97.1	109.1	26	110	0.00005606	0.000007007
55	82.1	0.00199884	20.2	112.3	31	202	0.00023161	0.000025735

SITE-TN48-UNBURNED

PLOTNUM	SUMB2	SUMBAS1	SUMC	SUMVEG	THICK1	TREEHGT	VOL1	VOL1INCR
1	10.0	0.085452	38.5	103.5	77	612	0.0096809	0.00080674
3	36.0	0.061903	20.3	113.3	33	703	0.0540736	0.00386240
4	30.0	0.164415	21.7	133.7	10	687	0.0350095	0.00083356
5	19.0	0.057408	37.3	106.3	30	595	0.0142572	0.00129610
7	22.0	0.032168	55.1	112.1	37	340	0.0018705	0.00011003
8	10.3	0.000000	70.2	100.5	24	697	0.0252331	0.00087011
9	20.5	0.045225	59.1	129.6	50	588	0.0262357	0.00187393
10	51.0	0.045316	46.9	142.9	55	451	0.0065959	0.00050737
12	31.3	0.075831	37.0	128.3	40	601	0.0159401	0.00122616
13	18.1	0.160056	43.1	126.2	79	517	0.0045219	0.00027682
14	36.0	0.011417	54.3	112.3	53	398	0.0058207	0.00041577
15	38.0	0.000000	77.1	130.1	64	404	0.0037814	0.00047268
16	37.0	0.019063	63.0	147.0	51	320	0.0019169	0.00021299
18	42.0	0.026055	48.0	157.0	16	702	0.0558967	0.00118929
19	54.0	0.035236	74.0	163.0	26	480	0.0110273	0.00032433
20	47.0	0.076775	54.8	111.8	18	325	0.0021125	0.00021125
22	24.5	0.043110	46.9	93.4	34	552	0.0220676	0.00122598
23	34.0	0.069583	41.5	125.5	25	715	0.0299838	0.00096722
24	6.2	0.041745	28.5	79.7	37	636	0.0387091	0.00322576
25	6.4	0.212766	2.2	103.6	26	637	0.0226717	0.00050382
26	27.1	0.085391	58.2	120.3	28	559	0.0131169	0.00093692
28	29.0	0.060659	45.5	119.5	65	529	0.0075317	0.00075317
30	24.1	0.000000	0	80.1	36	375	0.0024375	0.00027083
32	28.0	0.018596	44.3	156.3	45	378	0.0061337	0.00068152
33	11.3	0.076842	50.1	121.4	85	455	0.0034495	0.00026536
35	12.0	0.281556	4.2	105.2	66	546	0.0044519	0.00029679
36	13.1	0.283845	1.6	104.7	44	568	0.0085300	0.00056867
37	28.0	0.442989	10.5	148.5	40	650	0.0097614	0.00069725
40	16.0	0.068749	37.0	106.0	37	370	0.0034632	0.00034632
41	9.1	0.104800	41.6	95.7	80	302	0.0016615	0.00016615
42	35.0	0.066425	24.1	104.1	37	620	0.0444203	0.00120255
44	9.1	0.076100	26.8	85.9	24	333	0.0015273	0.00019091
45	16.2	0.190265	41.3	102.5	26	522	0.0066503	0.00044335
46	31.5	0.076993	58.1	134.6	65	395	0.0047488	0.00031659
47	26.0	0.127695	49.6	125.6	21	311	0.0007277	0.00007277
48	12.1	0.129752	20.4	77.5	4	830	0.0623662	0.00366860
51	17.5	0.254921	15.7	135.2	55	414	0.0020839	0.00016030
52	37.5	0.052053	23.2	130.7	50	740	0.0709263	0.00591053
53	21.6	0.186938	17.2	93.8	72	313	0.0017977	0.00017977
54	37.5	0.022102	27.2	114.7	46	303	0.0028361	0.00023634

Appendix III

Correlation coefficients for variables used in the correlation analysis of Chapter 1.

The data are sorted by sites. The abbreviations are explained below. The criteria for plant strata are explained in Chapter 1.

AVLEADER	Average leader growth for previous three years (cm/yr)
CFRAGS2	Content of coarse fragments in 0-20 cm depth of mineral soil (%)
D10	Diameter of plot center tree at 10 cm above point of germination (mm)
D10AGE	Age of plot center tree at 10 cm above point of germination (yr)
D10INCR	Incremental growth in diameter (mm/yr). This value was calculated by dividing the diameter at 10 cm above point of germination by the age at the same location.
D10LOG	Logarithm of diameter of plot center tree at 10 cm above point of germination (mm).
DWOOD	Surface cover of decaying wood within plot (%)
HGHTINCR	Incremental growth in height for entire tree (cm/yr). This value was calculated by dividing the tree height by the age at 10 cm above point of germination.
SEEDLING	Seedling density (no./root zone)
SLOPE	Slope at point of germination (%)
SUMB2	Sum of the cover for plant species in the B2 strata (%)
SUMBAS1	Sum of the basal area at 10 cm above the germination point for all trees in the root zone (m ² /root zone)
SUMC	Sum of the cover for plant species in the C strata (%)
THICK1	Depth of forest floor at point of germination (cm)
TREEHGHT	Height of plot center tree (cm)
VOL1	Stem volume of plot center tree (m ³)
VOL1INCR	Incremental growth in stem volume for plot center tree (m ³ /yr). This value was calculated by dividing the stem volume by the age at 10 cm above point of germination.
VOL1LOG	Logarithm of stem volume of plot center tree (m ³)

SITE #55-BURNED

PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / N = 40

	VOL1LOG	VOL1	VOL1INCR	D1OLOG	D10	D10INCR	TREEHGT	HGHTINCR	AVLEADER	D10AGE
VOL1LOG	1.00000 0.0000	0.81959 0.0001	0.81059 0.0001	0.99003 0.0001	0.97029 0.0001	0.89437 0.0001	0.93456 0.0001	0.83540 0.0001	0.86077 0.0001	0.34109 0.0312
VOL1	0.81959 0.0001	1.00000 0.0000	0.98923 0.0001	0.80122 0.0001	0.91555 0.0001	0.84017 0.0001	0.88166 0.0001	0.79368 0.0001	0.78043 0.0001	0.25106 0.1181
VOL1INCR	0.81059 0.0001	0.98923 0.0001	1.00000 0.0000	0.79537 0.0001	0.90929 0.0001	0.88183 0.0001	0.85898 0.0001	0.82768 0.0001	0.77650 0.0001	0.15206 0.3489
D1OLOG	0.99003 0.0001	0.80122 0.0001	0.79537 0.0001	1.00000 0.0000	0.96989 0.0001	0.89734 0.0001	0.88307 0.0001	0.78402 0.0001	0.81674 0.0001	0.34668 0.0284
D10	0.97029 0.0001	0.91555 0.0001	0.90929 0.0001	0.96989 0.0001	1.00000 0.0000	0.92553 0.0001	0.92393 0.0001	0.82833 0.0001	0.84116 0.0001	0.31498 0.0477
D10INCR	0.89437 0.0001	0.84017 0.0001	0.88183 0.0001	0.89734 0.0001	0.92553 0.0001	1.00000 0.0000	0.82920 0.0001	0.91349 0.0001	0.80560 0.0001	-0.04715 0.7726
TREEHGT	0.93456 0.0001	0.88166 0.0001	0.85898 0.0001	0.88307 0.0001	0.92393 0.0001	0.82920 0.0001	1.00000 0.0000	0.88893 0.0001	0.90144 0.0001	0.32437 0.0411
HGHTINCR	0.83540 0.0001	0.79368 0.0001	0.82768 0.0001	0.78402 0.0001	0.82833 0.0001	0.91349 0.0001	0.88893 0.0001	1.00000 0.0000	0.85870 0.0001	-0.12588 0.4390
AVLEADER	0.86077 0.0001	0.78043 0.0001	0.77650 0.0001	0.81674 0.0001	0.84116 0.0001	0.80560 0.0001	0.90144 0.0001	0.85870 0.0001	1.00000 0.0000	0.19434 0.2295
D10AGE	0.34109 0.0312	0.25106 0.1181	0.15206 0.3489	0.34668 0.0284	0.31498 0.0477	-0.04715 0.7726	0.32437 0.0411	-0.12588 0.4390	0.19434 0.2295	1.00000 0.0000

SITE=E55-UNBURNED

PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER H0:RHO=0 / N = 40

	VOL1LOG	VOL1	VOL1INCR	D1OLOG	D10	D10INCR	TREEHGT	HGHTINCR	AVLEADER	D10AGE
VOL1LOG	1.00000 0.0000	0.83670 0.0001	0.82959 0.0001	0.99368 0.0001	0.96548 0.0001	0.80212 0.0001	0.91166 0.0001	0.62411 0.0001	0.53535 0.0004	0.50480 0.0009
VOL1	0.83670 0.0001	1.00000 0.0000	0.94552 0.0001	0.82290 0.0001	0.93265 0.0001	0.68950 0.0001	0.85576 0.0001	0.48159 0.0017	0.49680 0.0011	0.51852 0.0006
VOL1INCR	0.82959 0.0001	0.94552 0.0001	1.00000 0.0000	0.83311 0.0001	0.93271 0.0001	0.85513 0.0001	0.75892 0.0001	0.67201 0.0001	0.55644 0.0002	0.25296 0.1153
D1OLOG	0.99368 0.0001	0.82290 0.0001	0.83311 0.0001	1.00000 0.0000	0.96642 0.0001	0.83872 0.0001	0.86360 0.0001	0.62252 0.0001	0.53173 0.0004	0.45155 0.0034
D10	0.96548 0.0001	0.93265 0.0001	0.93271 0.0001	0.96642 0.0001	1.00000 0.0000	0.83883 0.0001	0.88205 0.0001	0.60938 0.0001	0.54439 0.0003	0.46549 0.0025
D10INCR	0.80212 0.0001	0.68990 0.0001	0.85513 0.0001	0.83872 0.0001	0.83883 0.0001	1.00000 0.0000	0.56461 0.0001	0.84531 0.0001	0.61554 0.0001	-0.05325 0.7442
TREEHGT	0.91166 0.0001	0.85576 0.0001	0.75892 0.0001	0.86360 0.0001	0.88205 0.0001	0.56461 0.0001	1.00000 0.0000	0.49417 0.0012	0.46634 0.0024	0.70860 0.0001
HGHTINCR	0.62411 0.0001	0.48159 0.0017	0.67201 0.0001	0.62252 0.0001	0.60938 0.0001	0.84531 0.0001	0.49417 0.0012	1.00000 0.0000	0.67091 0.0001	-0.23263 0.1486
AVLEADER	0.53535 0.0004	0.49680 0.0011	0.55644 0.0002	0.53173 0.0004	0.54439 0.0003	0.61554 0.0001	0.46634 0.0024	0.67091 0.0001	1.00000 0.0000	0.01929 0.9060
D10AGE	0.50480 0.0009	0.51852 0.0006	0.25296 0.1153	0.45155 0.0034	0.46549 0.0025	-0.05325 0.7442	0.70860 0.0001	-0.23263 0.1486	0.01929 0.9060	1.00000 0.0000

SITE=TN48-BURNED

PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER H0:RHO=0 / N = 40

	VOL1LOG	VOL1	VOL1INCR	D1OLOG	D10	D10INCR	TREEHGHT	HGHTINCR	AVLEADER	D10AGE
VOL1LOG	1.00000 0.0000	0.80545 0.0001	0.80509 0.0001	0.99440 0.0001	0.97068 0.0001	0.88653 0.0001	0.92686 0.0001	0.78059 0.0001	0.59192 0.0001	0.38152 0.0151
VOL1	0.80545 0.0001	1.00000 0.0000	0.99412 0.0001	0.78698 0.0001	0.90252 0.0001	0.80308 0.0001	0.87080 0.0001	0.73627 0.0001	0.61836 0.0001	0.30354 0.0569
VOL1INCR	0.80509 0.0001	0.99412 0.0001	1.00000 0.0000	0.79138 0.0001	0.90544 0.0001	0.84230 0.0001	0.85096 0.0001	0.76328 0.0001	0.65803 0.0001	0.22770 0.1576
D1OLOG	0.99440 0.0001	0.78698 0.0001	0.79138 0.0001	1.00000 0.0000	0.97025 0.0001	0.89831 0.0001	0.88644 0.0001	0.74629 0.0001	0.55431 0.0002	0.37221 0.0180
D10	0.97068 0.0001	0.90252 0.0001	0.90544 0.0001	0.97025 0.0001	1.00000 0.0000	0.91754 0.0001	0.91394 0.0001	0.77242 0.0001	0.60361 0.0001	0.35411 0.0250
D10INCR	0.88653 0.0001	0.80308 0.0001	0.84230 0.0001	0.89831 0.0001	0.91754 0.0001	1.00000 0.0000	0.78275 0.0001	0.87265 0.0001	0.71549 0.0001	-0.02359 0.8851
TREEHGHT	0.92686 0.0001	0.87080 0.0001	0.85096 0.0001	0.88644 0.0001	0.91394 0.0001	0.78275 0.0001	1.00000 0.0000	0.82581 0.0001	0.67585 0.0001	0.40256 0.0100
HGHTINCR	0.78059 0.0001	0.73627 0.0001	0.76328 0.0001	0.74629 0.0001	0.77242 0.0001	0.87265 0.0001	0.82581 0.0001	1.00000 0.0000	0.85940 0.0001	-0.16773 0.3009
AVLEADER	0.59192 0.0001	0.61836 0.0001	0.65803 0.0001	0.55431 0.0002	0.60361 0.0001	0.71549 0.0001	0.67585 0.0001	0.85940 0.0001	1.00000 0.0000	-0.23906 0.1374
D10AGE	0.38152 0.0151	0.30354 0.0569	0.22770 0.1576	0.37221 0.0180	0.35411 0.0250	-0.02359 0.8851	0.40256 0.0100	-0.16773 0.3009	-0.23906 0.1374	1.00000 0.0000

SITE=TN48-UNBURNED

PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER H0:RHO=0 / N = 40

	VOL1LOG	VOL1	VOL1INCR	D1OLOG	D10	D10INCR	TREEHGT	HGHTINCR	AVLEADER	D10AGE
VOL1LOG	1.00000 0.0000	0.88648 0.0001	0.72500 0.0001	0.99223 0.0001	0.96385 0.0001	0.49034 0.0013	0.92385 0.0001	0.07935 0.6265	0.65613 0.0001	0.56025 0.0002
VOL1	0.88648 0.0001	1.00000 0.0000	0.85982 0.0001	0.89378 0.0001	0.96525 0.0001	0.55999 0.0002	0.81707 0.0001	0.10478 0.5199	0.59335 0.0001	0.47635 0.0019
VOL1INCR	0.72500 0.0001	0.85982 0.0001	1.00000 0.0000	0.73231 0.0001	0.80266 0.0001	0.86653 0.0001	0.66607 0.0001	0.50656 0.0009	0.59043 0.0001	0.01783 0.9130
D1OLOG	0.99223 0.0001	0.89378 0.0001	0.73231 0.0001	1.00000 0.0000	0.97566 0.0001	0.51066 0.0008	0.87152 0.0001	0.04800 0.7687	0.64027 0.0001	0.55803 0.0002
D10	0.96385 0.0001	0.96525 0.0001	0.80266 0.0001	0.97566 0.0001	1.00000 0.0000	0.53974 0.0003	0.85028 0.0001	0.05192 0.7503	0.62731 0.0001	0.54617 0.0003
D10INCR	0.49034 0.0013	0.55999 0.0002	0.86653 0.0001	0.51066 0.0008	0.53974 0.0003	1.00000 0.0000	0.39200 0.0124	0.78549 0.0001	0.60734 0.0001	-0.37348 0.0176
TREEHGT	0.92385 0.0001	0.81707 0.0001	0.66607 0.0001	0.87152 0.0001	0.85028 0.0001	0.39200 0.0124	1.00000 0.0000	0.16528 0.3081	0.63236 0.0001	0.51253 0.0007
HGHTINCR	0.07935 0.6265	0.10478 0.5199	0.50656 0.0009	0.04800 0.7687	0.05192 0.7503	0.78549 0.0001	0.16528 0.3081	1.00000 0.0000	0.49017 0.0013	-0.70562 0.0001
AVLEADER	0.65613 0.0001	0.59335 0.0001	0.59043 0.0001	0.64027 0.0001	0.62731 0.0001	0.60734 0.0001	0.63236 0.0001	0.49017 0.0013	1.00000 0.0000	0.12268 0.4508
D10AGE	0.56025 0.0002	0.47635 0.0019	0.01783 0.9130	0.55803 0.0002	0.54617 0.0003	-0.37348 0.0176	0.51253 0.0007	-0.70562 0.0001	0.12268 0.4508	1.00000 0.0000

SITE=E55-BURNED

PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / N = 40

	SLOPE	THICK1	CFRAGS2	SEEDLING	SUMBAS1	SUMB2	SUMC	DWOOD
SLOPE	1.00000 0.0000	0.02729 0.8673	-0.12659 0.4363	0.06840 0.6749	-0.02936 0.8573	-0.06607 0.6854	-0.10949 0.5012	0.00073 0.9964
THICK1	0.02729 0.8673	1.00000 0.0000	0.09721 0.5507	-0.11990 0.4612	-0.07717 0.6360	-0.06632 0.6843	-0.07136 0.6617	0.29765 0.0621
CFRAGS2	-0.12659 0.4363	0.09721 0.5507	1.00000 0.0000	0.15990 0.3243	0.05723 0.7258	0.20151 0.2124	0.00093 0.9955	0.23053 0.1524
SEEDLING	0.06840 0.6749	-0.11990 0.4612	0.15990 0.3243	1.00000 0.0000	0.01188 0.9420	0.13115 0.4199	0.09676 0.5526	0.20889 0.1958
SUMBAS1	-0.02936 0.8573	-0.07717 0.6360	0.05723 0.7258	0.01188 0.9420	1.00000 0.0000	-0.26593 0.0972	-0.28499 0.0747	-0.19520 0.2274
SUMB2	-0.06607 0.6854	-0.06632 0.6843	0.20151 0.2124	0.13115 0.4199	-0.26593 0.0972	1.00000 0.0000	0.47999 0.0017	-0.03635 0.8238
SUMC	-0.10949 0.5012	-0.07136 0.6617	0.00093 0.9955	0.09676 0.5526	-0.28499 0.0747	0.47999 0.0017	1.00000 0.0000	-0.02248 0.8905
DWOOD	0.00073 0.9964	0.29765 0.0621	0.23053 0.1524	0.20889 0.1958	-0.19520 0.2274	-0.03635 0.8238	-0.02248 0.8905	1.00000 0.0000

SITE=E55-UNBURNED

PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / N = 40

	SLOPE	THICK1	CFRAGS2	SEEDLING	SUMBAS1	SUMB2	SUMC	DWOOD
SLOPE	1.00000 0.0000	-0.16371 0.3128	-0.02109 0.8972	0.08592 0.5981	-0.12227 0.4523	-0.14533 0.3709	-0.08514 0.6014	-0.12680 0.4356
THICK1	-0.16371 0.3128	1.00000 0.0000	0.22785 0.1573	-0.30052 0.0595	0.17709 0.2743	-0.24447 0.1284	-0.19223 0.2347	-0.06242 0.7020
CFRAGS2	-0.02109 0.8972	0.22785 0.1573	1.00000 0.0000	-0.17131 0.2905	0.15960 0.3253	-0.00012 0.9994	-0.17892 0.2693	0.17612 0.2770
SEEDLING	0.08592 0.5981	-0.30052 0.0595	-0.17131 0.2905	1.00000 0.0000	-0.21616 0.1804	0.06396 0.6950	-0.06202 0.7038	-0.04614 0.7774
SUMBAS1	-0.12227 0.4523	0.17709 0.2743	0.15960 0.3253	-0.21616 0.1804	1.00000 0.0000	-0.43762 0.0047	-0.47192 0.0021	-0.17105 0.2913
SUMB2	-0.14533 0.3709	-0.24447 0.1284	-0.00012 0.9994	0.06396 0.6950	-0.43762 0.0047	1.00000 0.0000	0.69426 0.0001	0.29203 0.0675
SUMC	-0.08514 0.6014	-0.19223 0.2347	-0.17892 0.2693	-0.06202 0.7038	-0.47192 0.0021	0.69426 0.0001	1.00000 0.0000	0.11877 0.4654
DWOOD	-0.12680 0.4356	-0.06242 0.7020	0.17612 0.2770	-0.04614 0.7774	-0.17105 0.2913	0.29203 0.0675	0.11877 0.4654	1.00000 0.0000

SITE=TN48-BURNED

PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / N = 40

	SLOPE	THICK1	CFRAGS2	SEEDLING	SUMBAS1	SUMB2	SUMC	DWOOD
SLOPE	1.00000 0.0000	0.29828 0.0616	-0.13395 0.4099	-0.29715 0.0626	0.08086 0.6199	-0.08901 0.5849	0.02180 0.8938	0.17874 0.2698
THICK1	0.29828 0.0616	1.00000 0.0000	0.13765 0.3970	-0.08928 0.5838	0.19721 0.2226	0.09233 0.5710	0.12765 0.4325	0.62545 0.0001
CFRAGS2	-0.13395 0.4099	0.13765 0.3970	1.00000 0.0000	0.05069 0.7561	-0.14953 0.3571	0.19314 0.2325	0.23401 0.1461	0.30221 0.0580
SEEDLING	-0.29715 0.0626	-0.08928 0.5838	0.05069 0.7561	1.00000 0.0000	0.12708 0.4346	0.15764 0.3313	-0.00143 0.9930	0.13626 0.4018
SUMBAS1	0.08086 0.6199	0.19721 0.2226	-0.14953 0.3571	0.12708 0.4346	1.00000 0.0000	0.19847 0.2196	-0.26482 0.0987	0.08111 0.6188
SUMB2	-0.08901 0.5849	0.09233 0.5710	0.19314 0.2325	0.15764 0.3313	0.19847 0.2196	1.00000 0.0000	-0.44073 0.0044	0.11631 0.4748
SUMC	0.02180 0.8938	0.12765 0.4325	0.23401 0.1461	-0.00143 0.9930	-0.26482 0.0987	-0.44073 0.0044	1.00000 0.0000	-0.07236 0.6572
DWOOD	0.17874 0.2698	0.62545 0.0001	0.30221 0.0580	0.13626 0.4018	0.08111 0.6188	0.11631 0.4748	-0.07236 0.6572	1.00000 0.0000

SITE=TN48-UNBURNED

PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER H0:RHO=0 / N = 40

	SLOPE	THICK1	CFRAGS2	SEEDLING	SUMBAS1	SUMR2	SUMC	DWOOD
SLOPE	1.00000 0.0000	-0.26196 0.1025	0.16914 0.2968	-0.10186 0.5317	-0.11468 0.4810	0.10548 0.5171	0.07855 0.6299	-0.14200 0.3821
THICK1	-0.26196 0.1025	1.00000 0.0000	-0.06482 0.6911	0.05129 0.7533	0.06186 0.7045	-0.15648 0.3349	0.08120 0.6184	0.14054 0.3871
CFRAGS2	0.16914 0.2968	-0.06482 0.6911	1.00000 0.0000	0.13233 0.4157	-0.10952 0.5011	0.18787 0.2457	-0.03977 0.8075	0.19085 0.2382
SEEDLING	-0.10186 0.5317	0.05129 0.7533	0.13233 0.4157	1.00000 0.0000	0.05858 0.7196	0.39361 0.0120	0.02373 0.8844	-0.16368 0.3129
SUMBAS1	-0.11468 0.4810	0.06186 0.7045	-0.10952 0.5011	0.05858 0.7196	1.00000 0.0000	-0.33594 0.0341	-0.66337 0.0001	-0.16138 0.3198
SUMR2	0.10548 0.5171	-0.15648 0.3349	0.18787 0.2457	0.39361 0.0120	-0.33594 0.0341	1.00000 0.0000	0.35868 0.0230	0.11950 0.4627
SUMC	0.07855 0.6299	0.08120 0.6184	-0.03977 0.8075	0.02373 0.8844	-0.66337 0.0001	0.35868 0.0230	1.00000 0.0000	0.16440 0.3107
DWOOD	-0.14200 0.3821	0.14054 0.3871	0.19085 0.2382	-0.16368 0.3129	-0.16138 0.3198	0.11950 0.4627	0.16440 0.3107	1.00000 0.0000

SITE=E55-BURNED

PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / N = 40

	VOL1LOG	VOL1	VOL1INCR	D1OLOG	D1O	D1OINCR	TREEHGT	HGHTINCR	AVLEADER	D1OAGE
SLOPE	-0.07355 0.6520	-0.06904 0.6721	-0.06741 0.6794	-0.04104 0.8015	-0.06826 0.6756	-0.13383 0.4103	-0.13545 0.4047	-0.21692 0.1788	-0.17111 0.2911	0.24290 0.1310
THICK1	0.13801 0.3957	0.14235 0.3809	0.15132 0.3513	0.14067 0.3866	0.14372 0.3763	0.11418 0.4830	0.12703 0.4347	0.09259 0.5699	0.06787 0.6773	0.14171 0.3831
CFRAGS2	0.09339 0.5665	0.20765 0.1985	0.18401 0.2557	0.04471 0.7841	0.11886 0.4651	0.00748 0.9634	0.21450 0.1838	0.09135 0.5751	0.04435 0.7858	0.23179 0.1501
SEEDLING	0.05261 0.7471	-0.03017 0.8534	-0.06322 0.6984	0.05392 0.7411	0.01122 0.9452	-0.08799 0.5893	0.03388 0.8356	-0.10420 0.5223	-0.02577 0.8746	0.26434 0.0993
SUMBAS1	-0.08548 0.6000	-0.14222 0.3814	-0.14363 0.3766	-0.10402 0.5230	-0.11449 0.4818	-0.13548 0.4045	-0.07306 0.6542	-0.08260 0.6124	0.01160 0.9434	-0.00190 0.9907
SUMB2	0.05517 0.7353	0.07159 0.6607	0.01779 0.9132	0.00936 0.9543	0.04038 0.8046	-0.09296 0.5683	0.16523 0.3082	-0.00588 0.9713	0.05835 0.7206	0.34876 0.0274
SUMC	-0.09231 0.5711	0.04255 0.7943	0.00471 0.9770	-0.09510 0.5594	-0.03051 0.8517	-0.09717 0.5509	-0.02102 0.8976	-0.10557 0.5168	-0.11943 0.4630	0.06219 0.7031
DWOOD	0.32397 0.0414	0.30406 0.0565	0.24520 0.1273	0.33605 0.0340	0.33396 0.0352	0.16986 0.2947	0.31490 0.0478	0.12806 0.4310	0.08020 0.6227	0.37820 0.0161

SITE=E55-UNBURNED

PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER H0:RHO=0 / N = 40

	VOL1LOG	VOL1	VOL1INCR	D1OLOG	D10	D10INCR	TREEHGT	HGHTINCR	AVLEADER	D10AGE
SLOPE	0.16706 0.3028	0.11626 0.4750	0.10915 0.5026	0.19475 0.2285	0.18635 0.2496	0.12555 0.4401	0.06128 0.7072	-0.09987 0.5398	-0.08554 0.5997	0.12888 0.4280
THICK1	0.23144 0.1507	0.22962 0.1541	0.24286 0.1310	0.22442 0.1639	0.25343 0.1146	0.20607 0.2021	0.25122 0.1179	0.13967 0.3900	-0.00455 0.9778	0.19460 0.2289
CFRAGS2	0.16571 0.3068	0.04132 0.8001	0.04076 0.8028	0.15730 0.3324	0.12552 0.4403	0.04855 0.7661	0.16379 0.3125	-0.02184 0.8936	-0.16560 0.3072	0.19962 0.2168
SEEDLING	-0.31139 0.0505	-0.23060 0.1523	-0.20333 0.2083	-0.29938 0.0606	-0.26581 0.0974	-0.20331 0.2083	-0.32987 0.0376	-0.18155 0.2622	-0.28046 0.0796	-0.25713 0.1092
SUMBAS1	0.22783 0.1574	0.20306 0.2089	0.06560 0.6875	0.15694 0.3335	0.15463 0.3408	-0.19322 0.2323	0.44836 0.0037	-0.13182 0.4175	-0.17395 0.2831	0.54428 0.0003
SUMB2	-0.24588 0.1262	-0.32971 0.0377	-0.23714 0.1407	-0.22595 0.1609	-0.27488 0.0861	-0.00955 0.9534	-0.33879 0.0325	0.10911 0.5027	0.10914 0.5026	-0.40762 0.0090
SUMC	-0.12145 0.4554	-0.16519 0.3084	-0.10143 0.5334	-0.08991 0.5811	-0.12250 0.4514	0.08829 0.5880	-0.23815 0.1389	0.09144 0.5747	0.28449 0.0752	-0.29233 0.0672
DWOOD	-0.01416 0.9309	-0.14264 0.3799	-0.10621 0.5142	-0.01709 0.9166	-0.06364 0.6964	0.04745 0.7712	-0.05577 0.7325	0.18040 0.2653	0.25892 0.1067	-0.14717 0.3648

SITE=TN48-BURNED

PEARSON CORRELATION COEFFICIENTS / PRDB > |R| UNDER HO:RHO=0 / N = 40

	VOL1LOG	VOL1	VOL1INCR	D1OLOG	D10	D10INCR	TREEHGT	HGHTINCR	AVLEADER	D10AGE
SLOPE	0.32027 0.0439	0.39292 0.0121	0.36938 0.0190	0.31610 0.0469	0.37588 0.0168	0.30430 0.0562	0.32509 0.0407	0.26159 0.1030	0.07519 0.6447	0.17282 0.2862
THICK1	0.25535 0.1118	0.12025 0.4599	0.08491 0.6024	0.24683 0.1247	0.23508 0.1442	0.15744 0.3319	0.23432 0.1456	0.13794 0.3960	-0.05046 0.7571	0.21193 0.1892
CFRAGS2	0.09334 0.5667	0.04337 0.7904	0.02107 0.8973	0.10014 0.5387	0.06264 0.7010	-0.04784 0.7694	0.08731 0.5922	-0.11383 0.4843	-0.18246 0.2598	0.36063 0.0223
SEEDLING	-0.32893 0.0382	-0.21420 0.1844	-0.22207 0.1684	-0.32188 0.0428	-0.28882 0.0707	-0.35873 0.0230	-0.31223 0.0498	-0.43178 0.0054	-0.32648 0.0398	0.11363 0.4851
SUMBAS1	0.00311 0.9848	0.09616 0.5550	0.10031 0.5380	0.01664 0.9188	0.08171 0.6162	0.06712 0.6807	-0.02130 0.8962	-0.04427 0.7862	0.09275 0.5692	-0.04000 0.8064
SUMB2	0.03259 0.8418	-0.11670 0.4733	-0.11701 0.4721	0.01493 0.9271	-0.04607 0.7777	-0.01691 0.9175	0.04223 0.7958	0.05120 0.7537	0.08669 0.5948	0.01687 0.9177
SUMC	-0.10339 0.5255	0.01083 0.9471	-0.03079 0.8504	-0.11741 0.4706	-0.07757 0.6343	-0.23008 0.1532	0.00716 0.9650	-0.18117 0.2632	-0.26414 0.0996	0.27991 0.0802
DWOOD	0.23455 0.1452	-0.01990 0.9030	-0.06319 0.6985	0.25296 0.1153	0.18099 0.2637	0.02016 0.9018	0.12499 0.4422	-0.14765 0.3632	-0.23814 0.1389	0.51415 0.0007

SITE=TN48-UNBURNED

PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / N = 40

	VOL1LOG	VOL1	VOL1INCR	D1OLOG	D1O	D1OINCR	TREEHGT	HGHTINCR	AVLEADER	D1OAGE
SLOPE	0.26500 0.0984	0.32895 0.0382	0.14833 0.3610	0.26839 0.0940	0.31124 0.0506	-0.02527 0.8770	0.24698 0.1244	-0.21479 0.1832	0.12271 0.4507	0.32459 0.0410
THICK1	-0.39085 0.0126	-0.43008 0.0056	-0.21251 0.1880	-0.40011 0.0105	-0.43299 0.0053	0.00432 0.9789	-0.36305 0.0213	0.26098 0.1038	-0.07139 0.6616	-0.46663 0.0024
CFRAGS2	-0.06944 0.6703	-0.03562 0.8273	0.02089 0.8982	-0.07405 0.6437	-0.06333 0.6978	0.01060 0.9482	-0.04656 0.7754	0.04965 0.7609	-0.02716 0.8679	-0.09195 0.5726
SEEDLING	-0.34496 0.0293	-0.22835 0.1564	-0.16142 0.3197	-0.32126 0.0432	-0.28847 0.0710	-0.15048 0.3540	-0.36782 0.0195	-0.11608 0.4757	-0.39696 0.0112	-0.19412 0.2300
SUMBAS1	-0.07890 0.6284	-0.12805 0.4310	-0.14086 0.3860	-0.15644 0.3351	-0.16683 0.3035	-0.25420 0.1135	0.16607 0.3058	0.01173 0.9427	-0.38044 0.0154	0.04014 0.8057
SUMB2	0.07853 0.6301	0.10132 0.5339	0.03172 0.8460	0.13187 0.4173	0.13063 0.4217	0.01431 0.9302	-0.10040 0.5376	-0.19447 0.2292	-0.00397 0.9806	0.14422 0.3746
SUMC	-0.17628 0.2766	-0.24626 0.1256	-0.22369 0.1653	-0.13305 0.4131	-0.17773 0.2726	-0.04392 0.7878	-0.31753 0.0459	-0.08165 0.6165	0.10646 0.5132	-0.12431 0.4447
DWOOD	-0.20995 0.1935	-0.11825 0.4674	-0.08175 0.6160	-0.16587 0.3063	-0.14053 0.3871	-0.01872 0.9087	-0.30427 0.0563	-0.09515 0.5592	-0.28628 0.0733	-0.09568 0.5570

Appendix IV

Tree, site, foliar, and soil variables for the subset of plots with laboratory analysis in Chapter I.

The data are sorted by site. The abbreviations are explained below. The variables are ordered alphabetically within each group.

PLOTNUM The sample point number within a site

Foliar

ACTFE	Active iron (mg/kg)
B	Boron (mg/kg)
CA	Calcium (%)
CU	Copper (mg/kg)
FE	Total iron (mg/kg)
K	Potassium (%)
MG	Magnesium (%)
MN	Manganese (mg/kg)
N	Nitrogen (%)
P	Phosphorus (%)
PPMSO4	Sulfate sulfur (mg/kg)
TOTALS	Total sulfur (%)
ZN	Zinc (mg/kg)

Forest floor

LCA87	Exchangeable calcium (meq/100g)
LCARB87	Carbon concentration (%)
LCEC87	Cation exchange capacity (meq/100g)
LEXAL87	Exchangeable aluminum (meq/100g)
LK87	Exchangeable potassium (meq/100g)
LMG87	Exchangeable magnesium (meq/100g)
LMINN87	Mineralizable N (mg/kg)
LOM87	Organic matter (%)
L_P87	Extractable phosphorus (mg/kg)
LTOTN87	Nitrogen concentration (%)

Mineral soil (0-20 cm)

MCA87	Exchangeable calcium (meq/100g)
MCARB87	Carbon (%)
MCEC87	Cation exchange capacity (meq/100g)
MEXAL87	Exchangeable aluminum (meq/100g)
MK87	Exchangeable potassium (meq/100g)
MMG87	Exchangeable magnesium (meq/100g)
MMINN87	Mineralizable nitrogen (mg/kg)
MOM87	Organic matter (%)
M_P87	Extractable phosphorus (mg/kg)
MTOTN87	Total nitrogen (%)

Site

CFRAGS2 Content of coarse fragments in 0-20 cm depth of mineral soil (%)
 DWOOD Surface cover of decaying wood within plot (%)
 SEEDLING Seedling density (no./root zone)
 SLOPE Slope at point of germination (%)
 SUMB2 Sum of the cover for plant species in the B2 strata (%)
 SUMBAS1 Sum of the basal area at 10 cm above the germination point for all trees in the root zone (m²/root zone)
 SUMC Sum of the cover for plant species in the C strata (%)
 SUMVEG Sum of the cover for plant species in the A1, B1, B2, and C stratas (%)
 THICK1 Depth of forest floor at point of germination (cm)

Tree

AVLEADER Average leader growth for previous three years (cm/yr)
 D10 Diameter of plot center tree at 10 cm above point of germination (mm)
 D10AGE Age of plot center tree at 10 cm above point of germination (yr)
 D10LOG Transformation of diameter at 10 cm above point of germination using natural logarithms
 TREEHGHT Height of plot center tree (cm)
 VOL1 Stem volume of plot center tree (m³)
 VOL1LOG Transformation of stem volume using natural logarithms
 WT Needle weight (mg)

SITE=E55-BURNED

PLOTNUM	ACTFE	B	CA	CU	FE	K	MG	MN	N	P	PPMS04	TOTALS	ZN
3	35	10	0.19	0	50	0.63	0.08	1125	0.94	0.14	164	0.077	6
8	43	16	0.45	0	70	0.59	0.09	3125	0.71	0.20	376	0.086	8
14	48	20	0.45	0	72	0.44	0.11	4450	0.83	0.09	370	0.097	12
15	55	15	0.20	2	59	0.75	0.08	1475	1.02	0.16	242	0.098	8
17	67	17	0.28	1	79	0.51	0.11	1400	1.13	0.18	206	0.116	8
23	66	13	0.26	1	51	0.77	0.10	975	1.18	0.16	91	0.088	9
27	51	21	0.24	0	42	0.65	0.11	1125	1.02	0.14	182	0.083	11
28	31	10	0.18	2	58	0.72	0.08	1025	0.85	0.14	127	0.071	6
30	34	18	0.25	0	41	0.69	0.11	875	0.77	0.14	158	0.067	6
37	47	15	0.21	1	36	0.57	0.08	1075	0.91	0.13	139	0.074	9

SITE=E55-UNBURNED

PLOTNUM	ACTFE	B	CA	CU	FE	K	MG	MN	N	P	PPMS04	TOTALS	ZN
3	27	14	0.28	1	31	0.39	0.12	1125	1.02	0.16	91	0.077	7
12	21	11	0.19	2	34	0.51	0.11	975	1.20	0.17	42	0.083	9
26	32	15	0.24	2	40	0.47	0.13	1075	1.33	0.18	176	0.103	10
27	26	8	0.26	3	47	0.57	0.13	1000	1.34	0.25	176	0.103	10
28	23	13	0.27	1	39	0.53	0.13	1675	1.18	0.19	139	0.094	8
29	35	13	0.22	2	64	0.56	0.12	1075	1.22	0.18	70	0.091	8
30	42	16	0.25	2	48	0.69	0.10	1775	1.17	0.18	109	0.089	9
31	25	12	0.28	3	52	0.39	0.12	600	1.27	0.22	73	0.082	7
34	22	18	0.23	1	48	0.50	0.09	1550	0.88	0.16	61	0.062	7
36	38	12	0.25	2	42	0.47	0.15	800	1.18	0.19	121	0.092	7

SITE=TN48-BURNED

PLOTNUM	ACTFE	B	CA	CU	FF	K	MG	MN	N	P	PPMS04	TOTALS	ZN
1	55	13	0.17	4	110	0.70	0.07	1010	1.34	0.17	42	0.107	10
7	64	19	0.32	5	106	0.66	0.09	1200	1.47	0.19	90	0.122	25
15	100	16	0.20	4	171	0.50	0.07	1688	1.22	0.17	66	0.093	11
18	59	25	0.23	6	67	0.50	0.06	2129	1.36	0.11	90	0.115	15
30	46	17	0.18	5	42	0.62	0.06	1211	0.88	0.15	125	0.073	9
33	142	36	0.29	3	304	0.65	0.10	1661	0.73	0.12	125	0.074	9
39	49	18	0.20	2	60	0.79	0.10	1475	0.72	0.18	174	0.065	6
48	151	17	0.20	2	307	0.89	0.09	881	0.73	0.17	143	0.064	8
51	72	19	0.26	3	114	0.82	0.12	587	0.70	0.19	203	0.067	6
53	124	21	0.41	5	210	0.69	0.12	2261	0.75	0.19	185	0.068	14

----- SITE=E55-BURNED -----

PLOTNUM	LCA87	LCARB87	LCEC87	LEXAL87	LK87	LMG87	LMINN87	LOM87	L_P87	LTOTN87
3	18.12	61.61	75.00	1.2543	0.58	3.13	198	106.22	9.5	1.01
8	11.63	53.07	93.80	5.4501	0.33	2.00	141	91.49	6.7	1.00
14	22.37	64.40	159.40	1.0989	0.58	4.37	255	111.03	16.6	0.94
15	22.63	60.65	81.30	1.0434	0.71	3.00	239	104.56	54.1	1.00
17	20.00	60.01	109.40	0.8769	0.46	2.50	178	103.46	36.2	0.70
23	18.87	60.81	90.60	1.5873	0.71	5.50	181	104.84	33.1	0.96
27	23.50	56.42	75.00	1.3764	0.58	4.25	143	97.27	19.1	1.17
28	10.75	61.85	97.22	1.0878	0.33	2.63	95	106.63	14.8	0.69
30	22.63	61.45	78.10	2.6529	0.33	3.25	157	105.94	16.2	0.66
37	19.25	64.40	81.30	3.4410	0.58	6.25	106	111.03	21.7	0.69

----- SITE=E55-UNBURNED -----

PLOTNUM	LCA87	LCARB87	LCEC87	LEXAL87	LK87	LMG87	LMINN87	LOM87	L_P87	LTOTN87
3	11.75	59.93	78.1	2.3088	2.08	3.13	304	103.32	68.1	0.81
12	24.63	54.82	112.5	1.7205	2.83	4.75	452	94.51	71.7	1.35
26	20.38	51.63	65.6	1.3764	3.08	8.00	452	89.01	58.2	1.10
27	15.13	57.93	81.3	2.1312	1.83	3.88	360	99.87	45.0	0.92
28	10.50	57.14	59.4	5.6277	0.83	1.63	269	98.51	48.6	0.86
29	14.25	56.34	90.6	1.5096	1.46	2.63	584	97.13	40.7	1.06
30	13.63	57.54	78.1	1.4985	1.96	2.63	343	99.20	77.4	1.29
31	15.38	48.84	65.6	2.9970	1.46	4.13	292	84.20	149.4	0.70
34	10.75	57.38	90.6	1.7871	1.58	1.50	312	98.92	62.4	1.04
36	9.00	71.42	61.5	2.8305	0.71	4.38	222	123.13	34.6	0.90

----- SITE=TN48-BURNED -----

PLOTNUM	LCA87	LCARB87	LCEC87	LEXAL87	LK87	LMG87	LMINN87	LOM87	L_P87	LTOTN87
1	30.51	47.62	68.75	0.7770	1.63	4.38	209	82.10	15.2	1.09
7	46.11	49.01	96.25	0.2775	1.00	6.25	200	84.49	22.5	1.23
15	43.81	49.01	111.25	0.2220	1.63	7.13	303	84.49	29.5	1.17
18	25.46	49.41	92.50	2.3643	0.50	3.25	134	85.18	9.0	0.77
30	36.01	48.22	95.00	0.3441	1.13	3.00	392	83.13	94.2	0.85
33	27.08	53.01	75.00	0.3885	0.75	6.00	105	91.39	23.7	0.67
39	28.02	50.62	108.75	0.7104	1.50	11.25	204	87.27	40.0	0.97
48	41.31	47.22	108.75	0.4551	1.50	7.50	378	81.41	42.4	0.87
51	72.82	46.02	143.75	0.3108	1.75	10.38	608	79.34	39.4	1.17
53	53.66	51.22	133.75	0.4551	2.63	10.38	387	88.30	88.6	1.12

 SITE=E55-BURNED

PLOTNUM	MCA87	MCARB87	MCEC87	MEXAL87	MK87	MMG87	MMINN87	MQM87	M_P87	MTOTN87
3	0.46	5.27	16.9	0.3219	0.05	0.10	2	9.09	1.5	0.18
8	0.44	7.18	18.7	2.2977	0.08	0.08	18	12.38	1.8	0.24
14	0.59	9.27	15.6	1.0545	0.08	0.20	10	15.98	3.4	0.23
15	1.26	14.47	31.3	1.4319	0.08	0.28	48	24.95	0.3	0.42
17	0.94	10.39	24.4	1.4985	0.03	0.18	21	17.91	0.3	0.32
23	0.31	5.87	11.3	0.7992	0.05	0.08	8	10.12	0.6	0.19
27	1.06	9.83	25.6	1.2765	0.03	0.25	29	16.95	0.2	0.33
28	1.06	9.20	13.8	0.0999	0.08	0.23	1	15.86	0.9	0.09
30	6.41	8.05	28.8	0.0888	0.10	0.68	50	13.88	1.2	0.31
37	0.11	3.82	20.6	0.1443	0.03	0.03	1	6.59	0.5	0.12

 SITE=E55-UNBURNED

PLOTNUM	MCA87	MCARB87	MCEC87	MEXAL87	MK87	MMG87	MMINN87	MQM87	M_P87	MTOTN87
3	0.46	7.87	22.5	0.8769	0.03	0.20	20	13.57	0.5	0.23
12	0.69	5.51	13.1	0.6993	0.05	0.18	16	9.50	1.9	0.21
26	0.66	8.18	16.9	1.0989	0.13	0.23	35	14.10	1.2	0.30
27	0.69	9.60	15.6	0.9435	0.05	0.15	28	16.55	1.6	0.35
28	0.81	7.25	15.0	0.1554	0.15	0.13	11	12.50	2.0	0.30
29	1.39	6.62	19.4	0.7659	0.10	0.30	21	11.41	1.9	0.22
30	1.74	9.83	16.3	1.9536	0.18	0.30	54	16.95	1.4	0.37
31	1.16	10.63	13.1	0.8436	0.05	0.15	13	18.33	6.9	0.33
34	3.74	7.78	18.7	0.3996	0.08	0.58	11	13.41	5.0	0.21
36	0.91	3.75	13.8	0.0999	0.05	0.18	3	6.47	4.1	0.16

 SITE=TN48-BURNED

PLOTNUM	MCA87	MCARB87	MCEC87	MEXAL87	MK87	MMG87	MMINN87	MQM87	M_P87	MTOTN87
1	4.86	7.23	32.00	0.1443	0.13	1.83	46	12.46	0.0	0.21
7	2.68	7.97	27.75	0.4440	0.10	0.88	54	13.74	1.0	0.24
15	1.49	6.13	31.00	0.1332	0.20	0.75	23	10.57	0.0	0.15
18	4.17	12.03	33.75	0.9990	0.10	1.45	19	20.74	1.0	0.21
30	2.87	1.97	7.50	0.0999	0.03	0.60	1	3.40	7.0	0.06
33	1.15	6.87	22.75	1.2432	0.10	0.55	16	11.84	0.0	0.14
39	3.21	8.81	32.50	0.2664	0.15	1.08	39	15.19	1.3	0.23
48	3.72	8.57	25.50	0.3885	0.13	0.70	57	14.77	1.8	0.23
51	9.00	8.81	24.25	0.2997	0.25	1.50	73	15.19	19.6	0.30
53	4.09	7.17	25.23	0.3330	0.10	0.85	31	12.36	1.2	0.20

 SITE=E55-BURNED

PLOTNUM	CFRAGS2	DWOOD	SEEDLING	SLOPE	SUMB2	SUMBAS1	SUMC	SUMVEG	THICK1
3	37	50	14	22	24.3	0.0099738	8.3	52.6	23
8	27	35	13	33	17.4	0.0031769	23.1	50.5	16
14	51	25	12	22	11.3	0.0117221	38.0	79.3	17
15	49	35	15	60	14.5	0.0010838	32.0	61.5	36
17	40	10	21	15	17.2	0.0137963	29.5	79.7	28
23	50	10	11	15	28.6	0.0031188	43.7	72.3	24
27	44	15	31	106	46.1	0.0028070	30.2	84.3	8
28	21	25	8	59	9.0	0.0110160	33.2	87.2	70
30	18	40	27	82	23.5	0.0010972	48.7	77.2	38
37	29	10	22	22	47.0	0.0026570	63.5	120.5	23

 SITE=E55-UNBURNED

PLOTNUM	CFRAGS2	DWOOD	SEEDLING	SLOPE	SUMB2	SUMBAS1	SUMC	SUMVEG	THICK1
3	28	15	102	150	10.30	0.191936	0.04	95.34	38
12	35	10	42	52	20.64	0.070225	15.24	105.88	7
26	24	15	51	45	21.20	0.226304	8.12	131.32	8
27	33	25	157	12	21.40	0.205241	0.56	116.96	21
28	31	20	74	67	13.00	0.119530	11.26	109.26	3
29	40	30	56	30	30.62	0.091687	14.26	114.88	12
30	43	50	37	33	29.40	0.075568	17.08	116.48	13
31	22	15	109	22	11.32	0.133412	2.26	104.08	2
34	53	30	60	42	18.20	0.089026	8.56	96.76	13
36	40	15	47	50	11.90	0.153239	1.56	114.46	70

 SITE=TN48-BURNED

PLOTNUM	CFRAGS2	DWOOD	SEEDLING	SLOPE	SUMB2	SUMBAS1	SUMC	SUMVEG	THICK1
1	63	20	9	30	38.0	0.00080425	52.1	98.1	26
7	50	30	26	7	32.0	0.00066366	71.5	123.5	12
15	40	25	19	64	31.5	0.00056549	49.5	106.0	18
18	51	10	46	44	37.0	0.00211429	78.1	117.1	52
30	80	35	25	47	52.0	0.00253134	58.6	120.6	58
33	60	20	72	0	44.0	0.00009503	60.7	104.7	27
39	50	10	26	55	22.0	0.00041548	76.1	108.1	23
48	42	25	43	39	17.1	0.00000000	59.0	76.1	3
51	65	35	57	28	36.0	0.00079247	35.2	71.2	12
53	64	15	8	36	9.0	0.00000000	141.0	150.0	9

 SITE=E55-BURNED

PLOTNUM	AVLEADER	D10	D10AGE	D10LOG	TREEHGT	VOL1	VOL1LOG	WT
3	38.3333	42	10	3.73767	277	0.00127043	-6.6684	2.5
8	13.6667	23	9	3.13549	108	0.00014854	-3.8146	1.6
14	25.0000	13	6	2.56495	139	0.00006108	-9.7034	1.8
15	56.3333	53	7	3.97029	348	0.00254158	-5.9750	2.8
17	50.0000	46	7	3.82864	302	0.00166148	-6.4000	1.5
23	19.0000	15	8	2.70805	123	0.00007195	-9.5395	1.9
27	17.3333	18	9	2.89037	149	0.00012552	-8.9831	1.7
28	17.6667	22	9	3.09104	145	0.00018247	-8.6089	2.7
30	19.0000	20	9	2.99573	111	0.00011544	-9.0668	2.0
37	52.6667	33	11	3.49651	265	0.00075032	-7.1980	2.2

 SITE=E55-UNBURNED

PLOTNUM	AVLEADER	D10	D10AGE	D10LOG	TREEHGT	VOL1	VOL1LOG	WT
3	35.3333	88	17	4.47734	650	0.0130874	-4.3361	2.7
12	39.0000	38	13	3.63759	336	0.0012615	-6.6755	1.9
26	66.3333	64	15	4.15888	700	0.0074547	-4.8989	2.0
27	47.0000	26	11	3.25810	431	0.0007575	-7.1855	1.6
28	52.3333	39	11	3.66356	480	0.0018982	-6.2668	2.6
29	60.0000	58	14	4.06044	600	0.0052478	-5.2499	2.2
30	69.6667	72	11	4.27667	618	0.0083297	-4.7879	2.6
31	49.3333	57	13	4.04305	542	0.0045785	-5.3864	2.6
34	58.6667	85	13	4.44265	513	0.0096367	-4.6422	2.0
36	74.6667	177	15	5.17615	900	0.0733099	-2.6131	2.4

 SITE=TN48-BURNED

PLOTNUM	AVLEADER	D10	D10AGE	D10LOG	TREEHGT	VOL1	VOL1LOG	WT
1	44.6667	40	8	3.68888	284	0.00118144	-6.741	2.2
7	36.3333	25	8	3.21888	188	0.00030550	-8.094	2.5
15	61.0000	40	8	3.68888	312	0.00129792	-6.647	3.1
18	24.0000	12	5	2.48491	113	0.00004231	-10.071	2.1
30	48.0000	40	8	3.68888	275	0.00114400	-6.773	3.3
33	14.3333	15	8	2.70805	131	0.00007663	-9.476	2.6
39	26.0000	32	8	3.46574	217	0.00057774	-7.456	2.4
48	20.3333	16	8	2.77259	143	0.00009518	-9.260	2.5
51	20.6667	21	8	3.04452	145	0.00016626	-8.702	2.3
53	9.6667	14	9	2.63906	103	0.00005249	-9.855	2.3

SITE=TN48-UNBURNED

PLOTNUM	ACTFE	B	CA	CU	FE	K	MG	MN	N	P	PPMSO4	TOTALS	ZN
1	40	20	0.26	9	42	0.67	0.09	2429	1.49	0.17	149	0.127	13
9	84	15	0.24	7	135	0.74	0.09	1211	0.90	0.10	161	0.082	17
14	92	23	0.18	5	171	0.64	0.08	680	0.77	0.13	113	0.079	11
15	74	21	0.27	3	144	0.64	0.06	1959	1.06	0.11	84	0.075	6
26	43	18	0.35	5	13	0.68	0.10	1151	0.98	0.08	191	0.088	22
30	68	21	0.24	5	114	0.70	0.09	1838	1.08	0.15	66	0.091	17
32	58	21	0.25	6	81	0.46	0.07	1808	1.16	0.18	78	0.093	16
36	32	22	0.34	5	27	0.45	0.16	1190	0.98	0.10	233	0.101	15
42	49	20	0.27	5	78	0.60	0.09	953	0.87	0.12	364	0.095	3
53	163	22	0.20	8	300	0.57	0.09	1124	0.87	0.09	125	0.065	11

PLOTNUM	LCAB7	LCARB7	LCEC7	LEXAL7	LK7	LMG7	LMINN7	LQB7	L_P7	LTOTN7
1	15.16	53.21	50.00	0.3441	1.13	3.88	161	91.73	37.2	0.60
9	23.71	46.42	83.75	0.6216	3.00	6.00	569	80.03	58.1	1.40
14	16.16	45.61	43.75	0.3219	0.75	3.13	102	78.63	49.4	0.64
15	28.64	51.33	75.00	0.9324	1.00	5.00	153	88.49	28.0	0.85
26	17.41	47.74	66.25	2.0313	2.25	3.38	241	82.30	44.0	0.88
30	26.89	46.55	75.00	0.3441	1.00	7.13	92	80.25	30.0	0.80
32	17.60	46.96	47.50	2.1090	0.25	5.50	57	93.00	5.4	0.80
36	26.15	49.14	72.50	0.6660	1.00	5.00	203	84.72	20.5	1.21
42	17.53	51.73	65.00	0.5994	1.50	2.63	182	89.18	18.8	0.67
53	20.22	51.93	68.75	0.5994	0.75	2.38	87	89.53	15.8	0.67

PLOTNUM	MCA7	MCARB7	MCEC7	MEXAL7	MK7	MMG7	MMINN7	MOM7	M_P7	MTOTN7
1	9.35	9.64	35.50	0.2775	0.08	2.08	60	16.62	0.0	0.28
9	5.08	15.39	31.50	1.1433	0.18	0.85	52	26.53	1.5	0.29
14	1.79	10.47	29.75	1.5429	0.05	0.53	21	18.05	0.0	0.22
15	3.25	14.13	29.25	2.0202	0.10	0.60	56	24.36	0.0	0.33
26	8.81	14.46	37.75	0.3774	0.35	1.60	117	24.93	0.0	0.38
30	0.75	3.29	19.75	0.0333	0.10	0.40	2	5.67	0.0	0.09
32	0.00	0.00	0.00	0.0000	0.00	0.00	0	0.00	0.0	0.00
36	0.90	7.38	28.75	0.3663	0.03	0.28	19	12.72	0.0	0.24
42	3.34	6.72	26.75	0.9990	0.03	0.75	9	11.59	0.0	0.16
53	7.66	10.27	32.75	0.2220	0.08	1.75	54	17.71	0.0	0.33

 SITE=TN48-UNBURNED

PLOTNUM	AVLEADER	D10	D10AGE	D10LOG	TREEHGT	VOL1	VOL1LOG	WT
1	67.3333	78	12	4.35671	612	0.0096809	-4.6376	2.3
9	43.6667	131	14	4.87520	588	0.0262357	-3.6406	2.5
14	31.0000	75	14	4.31749	398	0.0058207	-5.1463	2.3
15	62.0000	60	8	4.09434	404	0.0037814	-5.5777	2.6
26	37.6667	95	14	4.55338	559	0.0131169	-4.3339	2.4
30	44.6667	50	9	3.91202	375	0.0024375	-6.0168	3.2
32	42.6667	79	9	4.36945	378	0.0061337	-5.0940	2.4
36	20.0000	76	15	4.33073	568	0.0085300	-4.7642	2.7
42	51.6667	166	37	5.11199	620	0.0444203	-3.1141	3.8
53	17.0000	47	10	3.85015	313	0.0017977	-6.3213	2.0

PLOTNUM	CFRAGS2	DWOOD	SEEDLING	SLOPE	SUMB2	SUMBAS1	SUMC	SUMVEG	THICK1
1	55	15	51	38	10.0	0.085452	38.5	103.5	77
9	41	15	31	98	20.5	0.045225	59.1	129.6	50
14	56	15	52	66	36.0	0.011417	54.3	112.3	53
15	44	15	66	51	38.0	0.000000	77.1	130.1	64
26	59	30	29	48	27.1	0.085391	58.2	120.3	28
30	52	20	39	13	24.1	0.000000	31.0	80.1	36
32	45	25	36	71	28.0	0.018596	88.3	156.3	45
36	45	10	45	62	13.1	0.283845	1.6	104.7	44
42	54	15	53	86	35.0	0.066425	24.1	104.1	37
53	60	30	67	15	21.6	0.186938	17.2	93.8	72

Appendix V

Foliar, forest floor, and mineral soil nutrients for 12 sites.

The data are sorted by burn condition and foliar color. The abbreviations used are explained below. Variables are arranged alphabetically within the three groups indicated.

SITE Sample site with 1=PC12-unburned, 2=PC12-burned, 3=TN5-burned, 4=E25-burned, 5=E25H-unburned, 6=TNLOW-unburned, 7=TNHI-unburned, 8=E55-burned, 9=E55-unburned, 10=E44-burned, 11=TN48-burned, and 12=TN48-unburned

Foliar properties

ACTFE	Active iron (mg/kg)
B	Boron (mg/kg)
CA	Calcium (%)
CU	Copper (mg/kg)
FE	Total iron (mg/kg)
K	Potassium (%)
MG	Magnesium (%)
MN	Manganese (mg/kg)
N	Nitrogen (%)
P	Phosphorus (%)
PPMSO4	Sulfate sulfur (mg/kg)
TOTALS	Total sulfur (%)
WT	Needle weight (mg)
ZN	Zinc (mg/kg)

Forest floor properties

LFH_AL	Extractable aluminum (mg/kg)
LFH_B	Extractable boron (mg/kg)
LFH_C	Carbon (%)
LFH_CA	Exchangeable calcium (meq/100g)
LFH_CEC	Cation exchange capacity (meq/100g)
LFH_CU	Extractable copper (mg/kg)
LFH_EXAL	Exchangeable aluminum (meq/100g)
LFH_K	Exchangeable potassium (meq/100g)
LFH_MG	Exchangeable magnesium (meq/100g)
LFH_MINN	Mineralizable nitrogen (mg/kg)
LFH_N	Total nitrogen (%)
LFH_P	Extractable phosphorus (mg/kg)
LFH_TOTS	Total sulfur (%)
LFH_ZN	Extractable zinc (mg/kg)

Mineral soil properties (0-20 cm)

MIN_AL	Extractable aluminum (mg/kg)
MIN_B	Extractable boron (mg/kg)
MIN_C	Carbon (%)
MIN_CA	Exchangeable calcium (meq/100g)
MIN_CEC	Cation exchange capacity (meq/100g)
MIN_CU	Extractable copper (mg/kg)
MIN_EXAL	Exchangeable aluminum (meq/100g)
MIN_K	Exchangeable potassium (meq/100g)
MIN_MINN	Mineralizable nitrogen (mg/kg)
MIN_MG	Exchangeable magnesium (meq/100g)
MIN_N	Total nitrogen (%)
MIN_P	Extractable phosphorus (mg/kg)
MIN_TOTS	Total sulfur (%)
MIN_ZN	Extractable zinc (mg/kg)

BURN=UNBURNED COLOR=CHLOROTIC

SITE	ACTFE	B	CA	CU	FE	K	MG	MN	N	P	PPMS04	TOTALS	WT	ZN
5	41	22	0.30	2	57	0.50	0.13	1494	0.75	0.11	334	0.099	1.8	8
6	35	18	0.31	2	33	0.66	0.14	1470	0.79	0.11	263	0.089	1.7	7
7	36	21	0.28	2	48	0.81	0.11	2190	0.83	0.17	197	0.080	1.8	6

BURN=UNBURNED COLOR=GREEN

SITE	ACTFE	B	CA	CU	FE	K	MG	MN	N	P	PPMS04	TOTALS	WT	ZN
1	37	13	0.32	3	60	0.56	0.14	1578	1.22	0.16	161	0.100	2.1	6
9	29	13	0.25	2	45	0.51	0.12	1165	1.18	0.19	106	0.088	2.2	8
12	70	20	0.26	6	111	0.62	0.09	1434	1.02	0.12	156	0.090	2.6	13

BURN=BURNED COLOR=CHLOROTIC

SITE	ACTFE	B	CA	CU	FE	K	MG	MN	N	P	PPMS04	TOTALS	WT	ZN
8	48	16	0.27	1	56	0.63	0.10	1665	0.94	0.15	206	0.086	2.1	8
10	51	19	0.25	2	68	0.75	0.10	1300	0.77	0.12	182	0.070	2.5	6
11	86	20	0.25	4	149	0.68	0.09	1410	0.99	0.16	124	0.085	2.5	11

BURN=BURNED COLOR=GREEN

SITE	ACTFE	B	CA	CU	FE	K	MG	MN	N	P	PPMS04	TOTALS	WT	ZN
4	40	12	0.32	2	45	0.58	0.10	1599	1.11	0.17	197	0.100	2.0	12
2	36	11	0.33	4	96	0.70	0.13	1836	1.39	0.22	245	0.137	2.2	14
3	100	17	0.31	2	51	0.65	0.14	1494	1.18	0.12	346	0.134	2.0	9

----- BURN=UNBURNED COLOR=CHLOROTIC -----

SITE	LFH_AL	LFH_B	LFH_C	LFH_CA	LFH_CEC	LFH_CU	LFH_EXAL	LFH_K	LFH_MG	LFH_MINN
5	98	0.96	49.54	24.90	81.25	0.88	1.0878	1.00	5.13	286
6	189	1.33	48.34	21.65	107.50	1.12	2.0979	1.25	6.38	289
7	156	0.88	49.74	23.03	102.50	1.60	1.7316	1.63	6.38	225

----- BURN=UNBURNED COLOR=NONCHLOROTIC -----

SITE	LFH_AL	LFH_B	LFH_C	LFH_CA	LFH_CEC	LFH_CU	LFH_EXAL	LFH_K	LFH_MG	LFH_MINN
1	160	2.92	50.53	16.97	65.00	1.36	1.7760	2.50	4.38	527
9	214	2.30	57.30	14.54	78.33	3.00	2.3751	1.78	3.67	359
12	77	2.40	49.06	20.95	54.75	0.96	0.8547	1.26	4.40	185

----- BURN=BURNED COLOR=CHLOROTIC -----

SITE	LFH_AL	LFH_B	LFH_C	LFH_CA	LFH_CEC	LFH_CU	LFH_EXAL	LFH_K	LFH_MG	LFH_MINN
8	179	1.00	60.47	18.98	94.11	3.00	1.9869	0.52	3.69	169
10	85	1.00	55.45	20.38	56.30	4.00	0.9435	0.58	3.75	150
11	57	1.29	49.14	40.48	103.38	1.12	0.6327	1.40	6.95	292

----- BURN=BURNED COLOR=NONCHLOROTIC -----

SITE	LFH_AL	LFH_B	LFH_C	LFH_CA	LFH_CEC	LFH_CU	LFH_EXAL	LFH_K	LFH_MG	LFH_MINN
2	59	2.18	46.75	29.70	67.50	0.16	0.6549	1.38	6.13	588
3	154	2.72	41.97	22.28	50.00	2.48	1.7094	1.63	7.50	319
4	196	1.90	40.58	17.22	63.75	1.04	2.1756	2.50	4.63	325

----- BURN=UNBURNED COLOR=CHLOROTIC -----

SITE	LFH_N	LFH_P	LFH_TOTS	LFH_ZN	MIN_AL	MIN_B	MIN_C	MIN_CA	MIN_CEC	MIN_CU
5	1.11	19.8	0.141	19	87	0.25	4.90	1.06	17.50	0.94
6	1.08	23.2	0.157	15	394	0.51	11.30	2.27	31.75	0.54
7	0.83	33.6	0.106	15	89	0.37	7.24	2.71	23.00	1.14

----- BURN=UNBURNED COLOR=NONCHLOROTIC -----

SITE	LFH_N	LFH_P	LFH_TOTS	LFH_ZN	MIN_AL	MIN_B	MIN_C	MIN_CA	MIN_CEC	MIN_CU
1	1.240	35.4	0.149	22.00	44	0.36	4.77	7.70	31.75	1.64
9	1.010	65.6	0.110	27.96	71	0.10	7.70	1.22	16.44	3.00
12	0.852	30.7	0.121	20.52	63	0.27	9.18	4.19	27.18	0.86

----- BURN=BURNED COLOR=CHLOROTIC -----

SITE	LFH_N	LFH_P	LFH_TOTS	LFH_ZN	MIN_AL	MIN_P	MIN_C	MIN_CA	MIN_CEC	MIN_CU
8	0.88	22.8	0.107	23.56	81	0.05	8.34	1.26	20.70	2.00
10	0.90	20.9	0.102	17.80	57	0.30	8.19	2.86	18.80	4.00
11	0.99	40.5	0.132	27.32	39	0.50	7.56	3.72	26.22	0.86

----- BURN=BURNED COLOR=NONCHLOROTIC -----

SITE	LFH_N	LFH_P	LFH_TOTS	LFH_ZN	MIN_AL	MIN_B	MIN_C	MIN_CA	MIN_CEC	MIN_CU
2	1.02	49.0	0.109	24	41	0.33	14.05	7.39	33.50	1.44
3	1.00	25.6	0.120	18	24	0.30	9.20	5.94	27.50	1.04
4	0.81	94.8	0.084	22	87	0.17	5.00	1.19	18.25	1.08

----- BURN=UNBURNED COLOR=CHLOROTIC -----

SITE	MIN_EXAL	MIN_K	MIN_MINN	MIN_MG	MIN_N	MIN_P	MIN_TOTS	MIN_ZN
5	0.9657	0.05	14	0.28	0.12	2.4	0.017	0.69
6	4.3734	0.08	25	1.05	0.27	1.0	0.043	0.33
7	0.9879	0.10	63	1.05	0.23	1.3	0.030	0.95

----- BURN=UNBURNED COLOR=NONCHLOROTIC -----

SITE	MIN_EXAL	MIN_K	MIN_MINN	MIN_MG	MIN_N	MIN_P	MIN_TOTS	MIN_ZN
1	0.4884	0.15	58	2.18	0.16	1.7	0.042	1.63
9	0.7881	0.09	21	0.24	0.27	2.7	0.032	1.35
12	0.6993	0.10	39	0.88	0.23	0.2	0.054	3.79

----- BURN=BURNED COLOR=CHLOROTIC -----

SITE	MIN_EXAL	MIN_K	MIN_MINN	MIN_MG	MIN_N	MIN_P	MIN_TOTS	MIN_ZN
8	0.8991	0.06	19	0.21	0.24	1.1	0.031	0.79
10	0.6327	0.05	31	0.73	0.27	0.8	0.029	0.89
11	0.4329	0.13	36	1.02	0.20	3.3	0.034	2.07

----- BURN=BURNED COLOR=NONCHLOROTIC -----

SITE	MIN_EXAL	MIN_K	MIN_MINN	MIN_MG	MIN_N	MIN_P	MIN_TOTS	MIN_ZN
2	0.4551	0.20	63	1.88	0.47	1.8	0.052	1.27
3	0.2664	0.15	26	1.65	0.32	0.9	0.064	1.09
4	0.9657	0.13	25	0.45	0.15	6.9	0.006	0.77

Appendix VI

Vegetation cover of the treatment plots.

The data are sorted by site and treatment. The abbreviations used, including plant species, are explained below. The plant species are sorted alphabetically by abbreviation within each strata. The criteria for plant strata are explained in chapter 1.

PLOTNUM The sample point number within a site and the block number for ANOVA
 TREAT The treatment code with CONTR=control, BRUSH=brush reduction, THIN=thinning, COMBO=brush reduction plus thinning (combined), and TRENCH=trenching

B1 stratum

B1DF87 Pseudotsuga menziesii
 B1HW87 Tsuga heterophylla
 B1SS87 Picea sitchensis

B2 stratum

B2BA87 Abies amabilis
 B2CR87 Thuja plicata
 B2DF87 Pseudotsuga menziesii
 B2HW87 Tsuga heterophylla
 B2SS87 Picea sitchensis
 GAUSHA87 Gaultheria shallon
 MENFER87 Rhododendron albiflorum
 RIBES87 Ribes laxiflorum
 RUBLEU87 Rubus leucodermis
 RUBPAR87 Rubus parviflorus
 RUBSPE87 Rubus spectabilis
 SALSIT87 Salix sitchensis
 SAMRAC87 Sambucus racemosa
 TAXBRE87 Taxus brevifolia
 VACPAR87 Vaccinium parvifolium
 VALASK87 Vaccinium alaskaense

C stratum

ACHTRI87 Achlys triphylla
 ADIANTUM Adiantum pedatum
 AGRTEN87 Agrostis scabra
 ANAMAR87 Anaphalis margaritacea
 ATHFEL87 Athyrium filix-femina
 BLESPI87 Blechnum spicant
 BROMINER Bromus inermis
 CARDEWE Carex deweyana
 CARMER87 Carex mertensii

CIRSARVE	<u>Cirsium arvense</u>
CORCAN87	<u>Cornus canadensis</u>
DESELO87	<u>Deschampsia elongata</u>
DRYAUS87	<u>Dryopteris austriaca</u>
ELYGLA87	<u>Elymus glaucus</u>
EPIANG87	<u>Epilobium angustifolium</u>
GALTRI87	<u>Galium triflorum</u>
HOLCUS	<u>Holcus lanatus</u>
HYPORADI	<u>Hypochaeris radicata</u>
LACCER87	<u>Lactuca muralis</u>
LINNEA87	<u>Linnaea borealis</u>
LUZCAM87	<u>Luzula campestris</u>
LUZPAR87	<u>Luzula parviflora</u>
LYCCLA87	<u>Lycopodium clavatum</u>
MIADL87	<u>Maianthemum dilatatum</u>
POLMUN87	<u>Polystichum munitum</u>
TIAREL87	<u>Tiarella trifoliata</u>
TRISET87	<u>Trisetum canescens</u>

Strata totals

SUMB1	Sum of the cover for all species in stratum B1
SUMB2	Sum of the cover for all species in stratum B2
SUMB	Sum of the cover for all species in stratum B
SUMC	Sum of the cover for all species in stratum C
SUMVEG	Sum of the cover for all species in strata A1, B1, B2, and C

----- SITE=E55 -----

PLOTNUM	TREAT	B1DF87	B1HW87	B1SS87	B2BA87	B2CR87	B2DF87	B2HW87	B2SS87	GAUSHA87
3	CONTR	0	40	0	0.1	1.0	0.2	20	0.2	0.00
8	CONTR	0	5	0	0.0	5.0	0.0	20	2.0	0.00
14	CONTR	0	45	0	0.0	1.0	0.0	15	0.0	0.00
15	CONTR	0	20	0	0.0	0.5	0.2	15	0.0	10.00
17	CONTR	0	60	0	0.0	1.0	0.1	15	0.0	0.00
23	CONTR	0	0	0	0.0	1.0	0.0	20	2.0	0.00
27	CONTR	0	2	0	0.0	0.5	0.0	15	0.5	0.00
28	CONTR	0	35	0	0.0	2.0	2.0	10	0.0	0.00
30	CONTR	0	15	0	0.0	2.0	0.5	25	0.0	0.00
37	CONTR	0	5	0	0.0	0.5	0.0	10	0.0	0.00
3	BRUSH	0	5	0	0.0	1.0	0.0	5	0.5	0.00
8	BRUSH	0	15	0	0.0	0.5	0.0	5	0.1	0.00
14	BRUSH	0	35	0	0.0	0.5	2.0	20	2.0	0.00
15	BRUSH	0	35	0	0.0	0.5	0.2	10	0.0	2.00
17	BRUSH	0	30	0	0.0	0.5	0.0	10	0.1	0.00
23	BRUSH	0	5	0	0.0	0.5	0.0	20	0.0	0.00
27	BRUSH	0	5	0	0.0	0.5	0.2	25	5.0	0.00
28	BRUSH	0	20	0	0.0	2.0	0.0	20	0.1	0.00
30	BRUSH	0	5	0	0.0	0.5	0.0	25	5.0	0.00
37	BRUSH	0	10	0	0.0	0.5	0.0	10	0.0	0.00
3	THIN	0	30	0	0.0	0.5	0.0	30	0.0	0.00
8	THIN	0	15	0	0.0	0.5	0.2	5	0.5	0.00
14	THIN	0	40	0	0.0	0.5	0.2	15	0.0	0.00
15	THIN	0	20	0	0.0	1.0	0.2	25	0.0	0.00
17	THIN	0	15	0	0.0	0.5	0.3	10	0.0	0.00
23	THIN	0	2	10	0.0	0.2	0.0	20	0.0	0.00
27	THIN	0	20	0	0.0	0.1	0.1	10	0.0	0.00
28	THIN	0	45	0	0.0	1.0	0.0	10	0.1	0.00
30	THIN	0	0	0	0.0	1.0	0.0	15	0.0	0.00
37	THIN	0	0	0	0.0	0.5	0.0	5	0.0	0.00
3	COMBO	10	40	0	0.0	0.1	0.0	10	0.0	0.00
8	COMBO	0	15	0	0.0	0.5	0.0	5	0.2	0.05
14	COMBO	0	25	5	0.0	1.0	0.1	15	1.0	0.00
15	COMBO	0	65	0	0.0	0.5	0.0	15	0.0	0.00
17	COMBO	0	20	20	0.0	0.5	2.0	15	0.0	0.00
23	COMBO	0	20	0	0.0	0.5	0.0	30	0.0	0.00
27	COMBO	0	15	0	0.0	2.0	0.0	10	0.0	0.00
28	COMBO	0	30	0	0.0	5.0	0.0	10	2.0	0.00
30	COMBO	0	0	0	0.0	2.0	0.0	30	0.0	0.00
37	COMBO	0	20	0	0.0	2.0	0.2	5	0.0	0.00

SITE=ES5

PLOTNUM	TREAT	MENFER87	RIBES87	RUBLEU87	RUBPAR87	RUBSPE87	SALSTI87	SAMRAC87	TAXBRE87
3	CONTR	0	0.00	0.1	0.0	10.0	0.00	0.0	0
8	CONTR	0	0.00	0.0	0.0	1.0	0.00	0.0	0
14	CONTR	0	0.00	0.0	0.1	0.0	0.10	0.1	0
15	CONTR	0	0.00	0.0	2.0	2.0	0.00	0.0	0
17	CONTR	0	0.00	0.1	0.0	2.0	0.00	0.0	0
23	CONTR	0	0.00	0.5	0.5	5.0	0.00	0.0	0
27	CONTR	0	0.00	0.0	0.0	2.0	0.00	0.0	0
28	CONTR	0	0.00	0.0	0.0	10.0	0.00	0.0	0
30	CONTR	0	0.00	0.0	10.0	5.0	0.00	0.2	0
37	CONTR	0	0.00	0.5	1.0	10.0	0.00	0.0	0
3	BRUSH	0	0.00	0.0	1.0	10.0	0.00	0.0	0
8	BRUSH	0	0.05	0.0	1.0	15.0	0.00	0.0	0
14	BRUSH	0	0.00	0.0	2.0	2.0	0.00	0.0	0
15	BRUSH	0	0.00	0.0	2.0	5.0	0.00	0.0	0
17	BRUSH	0	0.00	0.0	2.0	2.0	0.00	0.2	0
23	BRUSH	0	0.00	0.2	0.0	15.0	0.00	0.0	0
27	BRUSH	0	0.00	0.0	0.0	10.0	0.00	0.0	0
28	BRUSH	0	0.00	0.0	0.0	1.0	0.00	0.0	0
30	BRUSH	0	0.00	0.0	0.0	10.0	0.00	0.0	0
37	BRUSH	0	0.00	0.2	2.0	5.0	0.00	0.0	0
3	THIN	0	0.00	0.1	0.0	20.0	0.00	0.0	0
8	THIN	0	0.00	0.0	0.0	2.0	0.00	0.0	0
14	THIN	0	0.00	0.1	0.0	5.0	0.00	1.0	0
15	THIN	0	0.00	0.0	0.5	10.0	0.00	0.0	0
17	THIN	0	0.00	0.0	0.0	10.0	0.00	0.0	0
23	THIN	0	0.00	0.5	0.0	5.0	0.00	0.0	0
27	THIN	0	0.00	0.0	0.0	5.0	0.00	0.0	0
28	THIN	0	0.00	0.2	0.0	3.0	0.00	0.0	0
30	THIN	0	0.00	0.0	1.0	10.0	0.00	0.0	0
57	THIN	0	0.00	0.0	10.0	10.0	0.00	0.0	0
3	COMBO	0	0.00	0.1	0.0	0.5	0.00	0.0	0
8	COMBO	0	0.00	0.1	0.0	5.0	0.00	0.5	0
14	COMBO	0	0.00	0.0	0.0	5.0	0.00	0.0	0
15	COMBO	0	0.00	0.0	0.0	10.0	0.00	0.1	0
17	COMBO	0	0.50	0.1	0.0	10.0	0.00	0.0	0
23	COMBO	0	0.00	0.5	0.0	2.0	0.00	0.0	0
27	COMBO	0	0.00	0.0	5.0	5.0	0.00	0.0	0
28	COMBO	0	0.00	0.0	0.0	1.0	0.00	0.0	0
30	COMBO	0	0.00	0.0	10.0	5.0	0.00	0.0	0
37	COMBO	0	0.00	0.0	2.0	10.0	0.00	0.0	0

SITE=E55

PLOTNUM	TREAT	VACPAR87	VALASK87	ACHTRI87	ADIANIUM	AGRTEN87	ANAMAR87	ATHFEL87	BLESPI87
3	CONTR	2.00	0.0	0.0	0.0	0	0.0	0.0	5.0
8	CONTR	0.10	0.0	0.0	0.0	0	0.0	0.2	10.0
14	CONTR	0.00	0.0	0.0	0.0	0	2.0	0.0	0.0
15	CONTR	5.00	0.0	0.0	0.0	0	0.0	0.0	5.0
17	CONTR	5.00	0.0	0.0	0.0	0	0.0	0.2	10.0
23	CONTR	2.00	0.0	0.5	0.0	0	5.0	0.5	0.1
27	CONTR	2.00	0.0	0.0	0.0	0	10.0	0.0	2.0
28	CONTR	10.00	1.0	0.0	0.0	0	0.1	0.0	10.0
30	CONTR	10.00	0.5	2.0	0.0	0	2.0	2.0	10.0
37	CONTR	2.00	0.5	0.0	0.0	0	1.0	0.5	15.0
3	BRUSH	1.00	0.0	0.0	0.0	0	0.5	0.5	5.0
8	BRUSH	0.00	0.0	0.0	0.0	0	0.5	0.5	2.0
14	BRUSH	0.00	0.0	0.0	0.0	0	2.0	0.0	5.0
15	BRUSH	5.00	0.0	0.0	0.0	0	0.1	0.0	5.0
17	BRUSH	5.00	0.0	0.0	0.0	0	5.0	0.5	5.0
23	BRUSH	2.00	0.0	0.0	0.0	0	5.0	2.0	5.0
27	BRUSH	0.00	0.0	0.0	0.0	0	5.0	0.0	5.0
28	BRUSH	5.00	0.0	0.0	0.0	0	5.0	0.0	10.0
29	BRUSH	0.00	0.0	0.0	0.0	0	5.0	0.0	5.0
30	BRUSH	5.00	0.0	35.0	0.0	0	10.0	0.0	0.1
37	BRUSH	1.00	0.0	0.0	0.0	0	2.0	2.0	5.0
3	THIN	1.00	0.0	0.0	0.0	0	0.0	0.5	5.0
8	THIN	0.05	0.0	0.0	0.0	0	1.0	0.0	2.0
14	THIN	0.00	0.0	0.0	0.0	0	0.0	0.0	2.0
15	THIN	5.00	0.0	0.0	0.2	0	0.1	0.0	5.0
17	THIN	0.10	0.0	0.0	0.0	0	0.0	1.0	5.0
23	THIN	0.00	0.0	30.0	0.0	0	0.0	0.0	5.0
27	THIN	1.00	0.0	0.0	0.0	0	2.0	0.0	5.0
28	THIN	2.00	2.0	0.0	0.0	0	0.0	0.0	5.0
30	THIN	1.00	0.0	5.0	0.0	0	2.0	5.0	10.0
37	THIN	2.00	0.0	0.0	0.0	0	10.0	0.0	1.0
3	COMBO	2.00	0.0	0.0	0.0	0	0.0	0.0	5.0
8	COMBO	10.00	0.0	0.0	0.0	0	0.5	0.0	5.0
14	COMBO	0.50	0.0	0.0	0.0	0	2.0	0.0	5.0
15	COMBO	2.00	0.0	0.0	0.0	0	0.2	0.0	5.0
17	COMBO	5.00	0.0	0.0	0.0	0	2.0	0.0	5.0
23	COMBO	0.50	1.0	0.0	0.0	0	2.0	0.0	2.0
27	COMB30	1.00	0.0	0.0	0.0	0	1.0	2.0	10.0
28	COMB0	0.00	0.0	0.0	0.0	0	1.0	2.0	5.0
30	COMB0	2.00	0.0	0.0	0.0	0	5.0	0.2	5.0
37	COMBO	2.00	1.0	0.0	0.0	0	0.5	2.0	1.0

----- SITE-E55 -----

PLOTNUM	TREAT	BROLINER	CARDEWE	CARMER87	CIRSARVE	CORCAN87	DESELO87	DRYAUS87	ELYGL87
3	CONTR	0	0	2.0	0.00	0.00	0.00	1.0	0.0
3	CONTR	0	0	0.0	0.00	0.00	0.00	0.2	0.5
14	CONTR	0	0	0.0	0.00	0.00	0.00	0.2	0.0
15	CONTR	0	0	0.0	0.00	0.00	0.00	0.0	0.0
17	CONTR	0	0	0.0	0.00	0.00	0.00	0.5	0.0
23	CONTR	0	0	0.0	0.00	0.00	0.20	0.1	0.1
27	CONTR	0	0	0.0	0.00	0.00	0.00	0.0	10.0
28	CONTR	0	0	0.0	0.00	1.00	0.00	1.0	0.1
30	CONTR	0	0	0.2	0.10	0.50	0.00	0.2	0.1
37	CCNTR	0	0	0.0	0.00	30.00	0.50	0.2	0.0
3	BRUSH	0	0	0.0	0.00	0.00	0.00	0.1	0.0
8	BRUSH	0	0	0.0	0.00	0.00	0.00	2.0	1.0
14	BRUSH	0	0	0.0	0.00	0.10	0.00	1.0	0.0
15	BRUSH	0	0	0.0	0.00	1.00	0.00	1.0	0.0
17	BRUSH	0	0	0.0	0.00	0.00	0.00	0.0	0.0
23	BRUSH	0	0	0.0	0.00	0.00	0.00	0.1	5.0
27	BRUSH	0	0	0.0	0.00	0.00	0.00	0.1	5.0
28	BRUSH	0	0	0.2	0.00	0.00	0.00	0.2	0.5
30	BRUSH	0	0	0.0	0.00	0.00	0.00	0.0	5.0
37	BRUSH	0	0	0.5	0.05	60.00	0.00	0.5	0.0
3	THIN	0	0	0.0	0.00	0.00	0.00	1.0	0.0
8	THIN	0	0	0.0	0.00	0.00	0.00	0.5	0.5
14	THIN	0	0	0.0	0.00	0.00	0.00	0.5	0.0
15	THIN	0	0	0.0	0.00	2.00	0.00	1.0	0.0
17	THIN	0	0	0.0	0.00	0.00	0.00	0.0	0.5
23	THIN	0	0	0.0	0.00	0.00	0.50	0.0	15.0
27	THIN	0	0	0.0	0.00	0.00	0.00	0.0	15.0
28	THIN	0	0	0.0	0.00	0.00	0.00	0.1	0.2
30	THIN	0	0	0.0	0.00	5.00	2.00	0.2	2.0
37	THIN	0	0	0.0	0.05	0.05	1.00	0.0	15.0
3	COMBO	0	0	0.1	0.00	0.00	0.00	0.1	0.0
3	COMBO	0	0	0.0	0.00	0.00	0.00	2.0	0.0
14	COMBO	0	0	0.0	0.00	0.00	0.00	0.0	0.2
15	COMBO	0	0	0.0	0.00	0.00	0.00	0.0	0.0
17	COMBO	0	0	0.0	0.00	0.00	0.00	0.0	5.0
23	COMBO	0	0	0.0	0.00	0.00	0.00	0.2	0.0
27	COMBO	0	0	0.0	0.00	0.00	0.00	0.5	1.0
28	COMBO	0	0	0.0	0.00	0.00	0.00	2.0	0.0
30	COMBO	0	0	0.0	0.00	0.00	0.00	0.0	0.5
37	COMBO	0	0	0.0	0.00	25.00	0.05	0.2	2.0

----- SITE = E55 -----

PLOTNUM	TREAT	EPIANG87	GALTRI87	HOLCUS	HYPORADI	LACCR87	LINNEA87	LUZCAM87	LUZPAR87
3	CONTR	15	0.00	0	0	0.1	0.0	0	0.00
8	CONTR	30	0.00	0	0	0.0	0.0	0	0.00
14	CONTR	20	0.00	0	0	0.5	0.0	0	0.00
15	CONTR	40	0.00	0	0	1.0	0.0	0	0.00
17	CONTR	15	0.00	0	0	0.1	0.0	0	0.00
23	CONTR	40	0.00	0	0	1.0	0.0	0	0.10
27	CONTR	20	0.00	0	0	0.5	0.0	0	0.10
28	CONTR	10	0.00	0	0	0.0	0.1	0	0.00
30	CONTR	15	0.05	0	0	1.0	0.0	0	0.00
37	CONTR	20	0.00	0	0	1.0	0.0	0	0.10
3	BRUSH	30	0.00	0	0	0.5	0.0	0	0.00
8	BRUSH	30	0.00	0	0	1.0	0.0	0	0.00
14	BRUSH	20	0.00	0	0	1.0	0.0	0	0.00
15	BRUSH	25	0.00	0	0	0.5	0.0	0	0.00
17	BRUSH	15	0.00	0	0	1.0	0.0	0	0.00
23	BRUSH	25	0.00	0	0	1.0	0.0	0	0.00
27	BRUSH	15	0.00	0	0	1.0	0.0	0	1.00
28	BRUSH	20	0.00	0	0	1.0	0.0	0	0.00
30	BRUSH	15	0.00	0	0	2.0	0.0	0	0.00
37	BRUSH	15	0.00	0	0	0.2	0.0	0	0.10
3	THIN	25	0.00	0	0	0.2	0.0	0	0.50
8	THIN	40	0.00	0	0	2.0	0.0	0	0.00
14	THIN	20	0.00	0	0	0.5	0.0	0	0.00
15	THIN	25	0.00	0	0	0.5	0.0	0	0.00
17	THIN	25	0.00	0	0	0.5	0.0	0	0.00
23	THIN	30	0.00	0	0	0.1	0.0	0	0.00
27	THIN	15	0.00	0	0	0.2	0.0	0	0.00
28	THIN	20	0.00	0	0	0.5	0.0	0	0.00
30	THIN	25	0.05	0	0	1.0	0.0	0	2.00
37	THIN	20	0.50	0	0	0.2	0.0	0	0.00
3	COMBO	15	0.00	0	0	1.0	0.0	0	0.00
8	COMBO	35	0.00	0	0	0.1	0.0	0	0.00
14	COMBO	25	0.00	0	0	0.5	0.0	0	0.00
15	COMBO	15	0.00	0	0	2.0	0.0	0	0.00
17	COMBO	25	0.00	0	0	0.5	0.0	0	0.00
23	COMBO	40	0.00	0	0	1.0	0.0	0	0.00
27	COMBO	20	0.00	0	0	1.0	0.0	0	0.00
28	COMBO	25	0.05	0	0	0.2	0.0	0	0.05
30	COMBO	20	0.00	0	0	2.0	0.0	0	0.00
37	COMBO	15	0.20	0	0	0.5	0.0	0	0.00

----- SITE=E55 -----

PLOTNUM	TREAT	LYCCLA87	MIADL87	POLMUN87	TIAREL87	TRISSET87	SUMB1	SUMB2	SUMB	SUMC	SUMVEG
3	CONTR	0.0	0	2.0	0.0	0.1	40	33.60	73.60	25.20	98.80
8	CONTR	0.0	0	2.0	0.0	0.5	5	28.10	33.10	43.40	76.50
14	CONTR	0.0	0	2.0	0.0	1.0	45	16.30	61.30	25.70	87.00
15	CONTR	0.0	0	1.0	0.0	0.2	20	34.70	54.70	47.20	101.90
17	CONTR	0.0	0	5.0	0.1	0.2	60	23.20	83.20	31.10	114.30
23	CONTR	0.0	0	10.0	0.0	0.1	0	31.00	31.00	57.70	88.70
27	CONTR	2.0	0	5.0	0.0	0.2	2	20.00	22.00	49.80	71.80
28	CONTR	0.0	0	2.0	0.0	0.1	35	35.00	70.00	24.40	94.40
30	CONTR	0.0	0	10.0	0.0	0.1	15	52.70	67.70	43.25	110.95
37	CONTR	0.0	0	1.0	0.0	0.5	5	24.50	29.50	69.80	99.30
3	BRUSH	0.0	0	2.0	0.0	0.1	5	17.50	22.50	68.20	90.70
8	BRUSH	0.0	0	5.0	0.0	0.1	15	21.65	36.65	42.10	78.75
14	BRUSH	0.0	0	2.0	0.0	0.1	35	28.50	63.50	28.40	91.90
15	BRUSH	0.5	0	2.0	0.0	0.2	35	22.70	57.70	37.20	94.90
17	BRUSH	2.0	0	2.0	0.0	0.2	30	19.80	49.80	30.70	80.50
23	BRUSH	1.0	0	15.0	0.0	0.1	5	37.70	42.70	60.20	102.90
27	BRUSH	0.0	0	5.0	0.0	0.1	5	40.70	45.70	41.20	86.90
28	BRUSH	0.0	0	5.0	0.0	0.2	20	28.10	48.10	38.10	86.20
30	BRUSH	0.0	0	0.1	0.0	0.1	5	38.70	43.70	65.60	109.30
37	BRUSH	0.0	0	2.0	0.0	0.1	10	15.70	25.70	87.85	113.55
3	THIN	5.0	0	5.0	0.0	0.1	30	51.60	81.60	43.60	125.20
8	THIN	2.0	2	5.0	0.0	0.2	15	8.25	23.25	53.70	76.95
14	THIN	0.0	0	2.0	0.0	2.0	40	21.80	61.80	29.00	90.80
15	THIN	0.2	0	10.0	0.0	0.2	20	31.90	51.90	44.20	96.10
17	THIN	0.0	0	2.0	0.0	0.1	15	20.90	35.90	33.70	69.60
23	THIN	0.0	0	2.0	0.0	0.1	12	25.70	37.70	79.80	117.50
27	THIN	0.0	0	2.0	0.0	0.2	20	16.20	36.20	42.80	79.00
28	THIN	0.0	0	2.0	0.0	0.2	45	17.30	62.30	32.40	94.70
30	THIN	0.0	0	10.0	0.0	0.1	0	28.00	28.00	66.55	94.55
37	THIN	0.0	0	5.0	0.0	1.0	0	37.50	37.50	54.60	92.10
3	COMBO	2.0	0	2.0	0.0	0.1	50	12.72	62.72	24.40	87.12
8	COMBO	0.0	0	10.0	0.0	1.0	15	21.35	36.35	54.00	90.35
14	COMBO	0.0	0	1.0	0.0	0.2	30	22.60	52.60	35.40	88.00
15	COMBO	0.0	0	5.0	0.0	0.1	65	27.60	92.60	27.80	120.40
17	COMBO	0.5	0	2.0	0.0	0.1	40	25.10	65.10	40.60	105.70
23	COMBO	0.0	0	10.0	0.0	1.0	20	34.50	54.50	56.20	110.70
27	COMBO	0.0	0	10.0	0.0	0.0	15	23.00	38.00	45.70	83.70
28	COMBO	0.0	0	10.0	0.0	0.2	30	18.00	48.00	45.80	93.80
30	COMBO	0.0	0	10.0	0.0	0.2	0	49.00	49.00	42.90	91.90
37	COMBO	0.1	0	10.0	0.0	0.1	20	22.20	42.20	36.65	98.85

SITE=E44

PLOTNUM	TREAT	B1DF87	B1HW87	B1SS87	B2BA87	B2CR87	B2DF87	B2HW87	B2SS87	GAUSHA87
8	CONTR	0	15	0	0.0	2.0	0.0	5	0.0	0.0
12	CONTR	0	0	0	0.0	0.2	0.0	5	0.0	0.0
13	CONTR	0	6	0	0.0	0.2	0.0	10	0.0	0.0
28	CONTR	0	10	0	0.0	1.0	0.0	10	0.0	0.0
31	CONTR	0	0	0	0.0	0.5	0.0	10	0.0	1.0
40	CONTR	0	10	0	0.1	2.0	0.2	40	0.0	0.0
43	CONTR	0	8	0	0.0	0.5	0.0	10	0.0	0.2
47	CONTR	0	10	0	0.0	2.0	0.2	10	0.0	0.0
56	CONTR	0	5	0	0.0	2.0	0.0	10	0.0	0.0
57	CONTR	0	6	0	0.0	0.5	0.0	15	0.0	1.0
8	BRUSH	0	5	0	0.0	1.0	0.0	2	0.0	0.0
12	BRUSH	0	10	0	0.0	0.2	0.2	15	0.0	0.0
13	BRUSH	0	0	0	0.0	0.5	0.0	15	0.0	0.0
28	BRUSH	0	15	0	0.1	0.5	0.1	15	0.0	0.0
31	BRUSH	0	0	0	0.0	0.5	0.1	2	0.0	1.0
40	BRUSH	0	10	0	0.0	0.5	0.0	30	0.0	0.2
43	BRUSH	0	20	0	0.0	0.5	0.0	15	0.0	0.0
47	BRUSH	0	6	0	0.0	2.0	0.0	5	0.2	0.1
56	BRUSH	0	6	0	0.0	0.5	0.2	20	0.0	0.0
57	BRUSH	0	15	0	0.0	0.5	0.0	15	0.0	0.0
8	THIN	0	5	0	0.0	0.2	0.0	1	0.0	0.1
12	THIN	0	8	0	0.0	0.5	0.1	15	0.0	1.0
13	THIN	0	6	0	0.0	1.0	0.0	10	0.0	0.0
28	THIN	0	15	0	0.0	1.0	0.0	25	0.0	0.0
31	THIN	0	0	0	0.0	1.0	0.0	10	0.0	0.0
40	THIN	0	8	0	0.0	0.5	0.0	10	0.0	0.0
43	THIN	0	6	0	0.0	0.5	2.0	15	0.0	0.2
47	THIN	0	6	0	0.0	0.5	0.2	20	0.0	0.0
56	THIN	0	5	0	0.0	0.2	0.0	25	0.0	0.0
57	THIN	0	15	0	0.0	0.5	0.0	15	0.0	0.0
8	COMBO	0	10	0	0.0	1.0	0.0	15	0.0	0.0
12	COMBO	0	0	0	0.0	0.1	0.1	10	0.0	0.0
13	COMBO	0	10	0	0.0	1.0	0.0	15	0.0	0.0
28	COMBO	0	15	0	0.0	1.0	0.5	15	0.0	0.0
31	COMBO	0	0	0	0.0	0.1	0.0	2	0.0	0.2
40	COMBO	0	20	0	0.0	1.0	0.0	15	0.0	0.0
43	COMBO	0	8	0	2.0	1.0	0.0	5	0.0	0.1
47	COMBO	0	30	0	0.1	0.1	0.0	10	0.0	0.0
56	COMBO	0	0	0	0.0	1.0	0.5	15	0.0	0.0
57	COMBO	0	8	0	0.0	0.5	0.0	15	0.0	0.0

----- SITE=E44 -----

PLOTNUM	TREAT	MENFER87	RIBES87	RUBLEU87	RUBPAR87	RUBSPE87	SALSIT87	SAMRAC87	TAXBRE87
8	CONTR	0	0	0.1	2.0	5.0	0.0	0.2	0.0
12	CONTR	0	0	0.0	0.0	2.0	0.0	0.0	0.0
17	CONTR	0	0	0.0	0.0	2.0	0.0	0.0	0.0
28	CONTR	0	0	0.2	5.0	0.0	0.0	0.0	0.0
31	CONTR	0	0	0.0	1.0	2.0	0.1	0.0	0.0
40	CONTR	0	0	0.1	10.0	2.0	0.2	0.0	0.0
43	CONTR	0	0	0.0	5.0	10.0	0.0	0.0	0.0
47	CONTR	0	0	0.0	0.1	5.0	0.0	0.0	0.0
56	CONTR	0	0	0.2	15.0	5.0	0.0	0.0	0.0
57	CONTR	0	0	0.1	0.0	2.0	0.0	0.0	0.0
8	BRUSH	0	0	0.5	0.0	2.0	0.0	0.0	0.0
12	BRUSH	0	0	0.0	0.0	2.0	0.0	0.0	0.0
13	BRUSH	0	0	0.1	0.0	2.0	0.0	0.1	0.0
28	BRUSH	0	0	0.0	5.0	0.1	0.2	0.2	0.0
31	BRUSH	0	0	0.0	0.1	5.0	0.0	0.0	0.0
40	BRUSH	0	0	0.5	0.0	5.0	0.0	0.0	0.0
43	BRUSH	0	0	0.0	1.0	5.0	0.0	0.0	0.0
47	BRUSH	0	0	2.0	5.0	10.0	0.0	0.0	0.0
56	BRUSH	0	0	0.0	0.0	2.0	0.0	0.0	0.0
57	BRUSH	2	0	0.5	5.0	5.0	0.0	0.0	0.1
8	THIN	0	0	0.1	0.1	0.0	0.0	0.0	0.0
12	THIN	0	0	0.0	0.0	0.0	0.5	0.0	0.0
13	THIN	0	0	0.0	0.0	1.0	0.0	0.0	0.0
28	THIN	0	0	0.1	0.0	0.0	0.0	0.0	0.0
31	THIN	0	0	0.5	0.0	2.0	0.0	0.0	0.0
40	THIN	0	0	0.0	5.0	20.0	0.0	0.0	0.1
43	THIN	0	0	0.2	2.0	15.0	0.2	0.0	0.0
47	THIN	0	0	0.0	25.0	10.0	0.2	0.0	0.0
56	THIN	0	0	0.1	10.0	10.0	0.0	0.0	0.0
57	THIN	0	0	0.0	0.0	20.0	0.0	0.0	0.0
8	COMBO	0	0	2.0	0.0	0.0	0.0	0.0	0.0
12	COMBO	0	0	0.0	0.0	0.0	0.0	0.0	0.0
13	COMBO	0	0	0.0	0.0	0.0	0.0	0.0	0.0
28	COMBO	0	0	0.1	0.0	0.0	0.0	0.0	0.1
31	COMBO	0	0	0.0	0.0	5.0	0.0	0.0	0.0
40	COMBO	0	0	0.0	0.0	10.0	0.0	0.0	0.0
43	COMBO	0	0	0.5	0.0	5.0	0.0	0.2	0.0
47	COMBO	0	0	0.2	2.0	20.0	0.0	0.0	0.0
56	COMBO	0	0	0.2	10.0	2.0	0.0	0.0	0.1
57	COMBO	0	0	0.0	5.0	10.0	0.0	0.0	0.0

SITE=E44

PLOTNUM	TREAT	VACPAR87	VALASK87	ACHTRI87	ADJANTUM	AGRTEN87	ANAMAR87	ATHFEL87	BLESPI87
8	CONTR	15.0	0.0	0	0.0	0.00	1	0.00	10
12	CONTR	10.0	0.0	0	0.0	0.10	10	2.00	20
13	CONTR	10.0	0.0	0	0.0	0.20	10	0.20	2
28	CONTR	2.0	0.0	0	0.0	0.00	10	1.00	5
31	CONTR	5.0	0.0	5	0.0	0.10	5	0.20	25
40	CONTR	0.0	0.0	0	0.0	0.00	10	0.00	2
43	CONTR	2.0	0.0	2	0.0	0.00	5	5.00	0
47	CONTR	1.0	0.0	0	0.0	0.00	2	0.00	0
56	CONTR	10.0	0.0	0	0.0	0.00	2	1.00	2
57	CONTR	10.0	1.0	0	0.0	0.00	0	5.00	25
8	BRUSH	2.0	0.0	0	0.0	0.00	5	0.10	1
12	BRUSH	15.0	0.0	0	0.0	0.00	15	1.00	5
13	BRUSH	10.0	0.0	0	0.0	0.20	5	0.00	10
28	BRUSH	2.0	0.0	0	0.1	0.05	15	0.00	5
31	BRUSH	2.0	0.0	0	0.0	0.00	15	0.00	1
40	BRUSH	0.0	0.0	0	0.0	0.00	5	0.00	2
43	BRUSH	5.0	0.2	0	0.0	0.00	2	0.20	5
47	BRUSH	0.1	0.0	0	0.0	0.20	15	0.00	0
56	BRUSH	10.0	0.0	0	0.0	0.00	10	0.50	1
57	BRUSH	15.0	0.1	0	0.0	0.00	1	0.10	15
8	THIN	0.0	0.0	0	0.0	0.00	15	0.50	0
12	THIN	15.0	0.0	0	0.0	0.00	15	0.00	5
13	THIN	1.0	0.0	0	0.0	0.20	5	0.05	10
28	THIN	10.0	2.0	0	0.0	0.00	1	0.20	5
31	THIN	2.0	0.0	25	0.0	0.00	2	2.00	15
40	THIN	1.0	0.1	0	0.0	0.00	5	1.00	1
43	THIN	2.0	0.0	2	0.0	0.00	2	5.00	10
47	THIN	2.0	0.0	0	0.0	2.00	10	0.50	0
56	THIN	5.0	0.0	0	2.0	0.00	2	5.00	1
57	THIN	5.0	0.0	0	0.0	0.00	2	2.00	10
8	COMBO	15.0	0.0	0	0.0	0.00	2	0.00	15
12	COMBO	5.0	0.0	0	0.0	0.00	15	0.00	5
13	COMBO	15.0	0.0	0	2.0	0.00	5	2.00	2
28	COMBO	5.0	0.0	0	0.0	0.00	5	0.20	5
31	COMBO	5.0	0.0	15	0.0	0.50	15	0.00	10
40	COMBO	0.0	0.0	0	0.0	0.00	10	0.00	5
43	COMBO	2.0	0.0	0	0.0	0.00	5	2.00	5
47	COMBO	0.0	0.0	0	0.0	0.00	2	1.00	1
56	COMBO	5.0	0.0	0	0.0	0.00	5	0.00	0
57	COMBO	2.0	0.0	0	0.0	0.00	5	2.00	5

SITE=E44

PLO:NUM	TREAT	BROMINER	CARDEWE	CARMER87	CIRSARVE	CORCANB7	DESELOB7	DRYAUS87	ELYGLA87
8	CONTR	0	0.0	0.0	0.00	0	0.00	0.10	0.0
12	CONTR	0	0.0	0.0	0.00	15	0.10	0.00	0.0
13	CONTR	0	0.0	0.0	0.00	2	0.20	0.00	2.0
28	CGNTR	0	0.0	0.0	0.00	0	0.00	0.00	0.0
31	CONTR	0	0.0	0.5	0.00	20	1.00	0.00	0.0
40	CONTR	0	0.0	0.5	0.10	0	0.00	0.00	0.0
43	CONTR	0	0.0	0.0	0.10	0	0.50	0.00	0.0
47	CONTR	0	0.0	0.0	0.20	0	0.00	0.00	20.0
56	CONTR	0	0.0	0.0	0.00	0	0.00	0.10	0.0
57	CONTR	0	0.0	0.0	0.00	0	0.00	5.00	0.0
8	BRUSH	0	0.0	0.0	0.20	25	0.50	0.10	0.0
12	BRUSH	0	0.0	0.0	0.00	0	0.00	0.00	0.0
13	BRUSH	0	0.0	0.0	0.20	5	0.05	0.00	0.2
28	BRUSH	0	0.0	0.0	0.10	5	0.00	0.00	0.0
31	BRUSH	0	0.0	5.0	1.00	10	0.50	0.10	0.0
40	BRUSH	0	0.0	0.0	0.20	0	0.00	0.00	0.0
43	BRUSH	0	0.0	0.0	0.00	35	0.20	0.10	0.0
47	BRUSH	0	0.0	0.0	2.00	0	0.00	0.00	2.0
56	BRUSH	0	0.0	0.5	2.00	0	0.00	0.10	5.0
57	BRUSH	0	0.0	0.0	0.00	10	0.00	0.10	0.0
8	THIN	0	0.5	0.0	0.50	0	2.00	0.00	10.0
12	THIN	0	0.0	0.5	0.20	20	0.00	0.05	1.0
13	THIN	0	0.0	0.0	0.00	5	0.10	0.00	1.0
28	THIN	0	0.0	0.0	0.00	0	0.00	0.20	0.0
31	THIN	0	0.0	0.2	0.00	20	0.10	0.10	0.0
40	THIN	1	0.0	0.0	0.00	0	0.00	0.10	10.0
43	THIN	0	0.0	0.0	0.00	0	2.00	2.00	0.0
47	THIN	0	0.0	0.0	1.00	0	0.00	2.00	5.0
56	THIN	0	0.0	2.0	0.20	0	0.00	0.00	1.0
57	THIN	0	0.0	0.0	0.00	0	0.00	5.00	0.0
8	COMBO	0	0.0	0.0	0.00	0	0.00	1.00	0.0
12	COMBO	0	0.0	0.0	2.00	10	1.00	0.00	0.0
13	COMBO	0	0.0	0.0	0.20	15	0.00	0.00	0.0
28	COMBO	0	0.0	0.0	0.00	5	0.00	0.00	2.0
31	COMBO	0	0.0	0.2	0.05	0	0.20	0.50	5.0
40	COMBO	0	0.0	0.0	1.00	30	0.00	0.00	0.0
43	COMBO	0	0.0	0.0	0.00	0	0.20	1.00	0.0
47	COMBO	0	0.0	0.0	0.20	0	0.00	1.00	0.0
56	COMBO	0	0.0	0.0	0.20	0	0.00	0.00	35.0
57	COMBO	0	0.0	0.0	0.10	0	0.00	0.00	1.0
57	COMBO	0	0.0	0.0	0.10	0	0.00	1.00	0.5

SITE=E44

PLOTNUM	TREAT	EPIANG87	GALTRI87	HOLCUS	HYPORADI	LACCR87	LINNEA87	LUZCAM87	LUZPAR87
8	CONTR	30	0.0	0	0.0	1.0	0	0.00	0.00
12	CONTR	10	0.0	0	0.0	1.0	0	0.00	0.00
13	CONTR	25	0.0	0	0.0	2.0	0	0.00	0.00
28	CONTR	10	0.0	0	0.0	1.0	0	0.00	0.00
31	CONTR	10	0.0	0	0.0	0.1	0	0.00	0.00
40	CONTR	10	0.0	0	0.0	0.5	0	0.00	0.00
43	CONTR	30	0.0	0	0.0	10.0	0	0.00	1.00
47	CONTR	15	0.0	0	0.0	1.0	0	0.00	0.00
56	CONTR	20	0.0	0	0.0	0.0	0	0.00	0.00
57	CONTR	15	0.0	0	0.0	0.0	0	0.00	0.00
8	BRUSH	35	0.1	0	0.1	5.0	0	0.00	0.50
12	BRUSH	30	0.0	0	0.0	0.1	0	0.50	0.00
13	BRUSH	15	0.0	0	0.0	5.0	0	0.00	0.00
28	BRUSH	2	0.0	0	0.0	1.0	0	0.00	0.00
31	BRUSH	15	0.0	0	0.0	10.0	0	0.00	0.50
40	BRUSH	10	0.0	0	0.0	1.0	0	0.00	0.00
43	BRUSH	10	0.0	0	0.0	2.0	0	0.00	0.20
47	BRUSH	15	0.0	10	0.0	15.0	0	0.01	0.10
56	BRUSH	10	0.0	0	0.0	10.0	0	0.10	0.10
57	BRUSH	10	0.0	0	0.0	0.2	0	0.00	0.00
8	THIN	5	0.0	0	0.5	1.0	0	0.00	0.00
12	THIN	15	0.0	0	0.0	0.5	0	0.00	0.00
13	THIN	25	0.0	0	0.0	2.0	0	0.00	0.20
28	THIN	15	0.0	0	0.0	1.0	0	0.00	0.00
31	THIN	25	0.0	0	0.0	1.0	2	0.00	0.50
40	THIN	15	0.2	0	0.0	1.0	0	0.00	0.00
43	THIN	20	0.0	0	0.0	1.0	0	0.00	0.20
47	THIN	2	0.0	0	0.0	2.0	0	0.05	0.00
56	THIN	10	0.0	0	0.0	2.0	0	0.00	0.20
57	THIN	30	0.0	0	0.0	0.1	20	0.00	0.00
8	COMBO	25	0.0	0	0.0	0.5	0	0.00	0.00
12	COMBO	5	0.0	0	0.0	0.5	0	0.00	0.00
13	COMBO	15	0.0	0	0.0	2.0	0	0.00	0.00
28	COMBO	10	0.0	0	0.0	0.5	0	0.10	0.00
31	COMBO	10	0.0	0	0.0	0.1	2	0.10	0.05
40	COMBO	5	0.0	0	0.0	1.0	0	0.00	0.00
43	COMBO	10	0.0	0	0.0	2.0	0	0.00	0.20
47	COMBO	2	0.0	0	0.0	1.0	0	0.00	0.00
56	COMBO	10	0.0	0	0.0	5.0	0	0.00	0.00
57	COMBO	30	0.0	0	0.0	2.0	0	0.00	0.00

SITE=E44

PLGTNUM	TREAT	LYCCLAB7	MIADL87	POLMUN87	TIAREL87	TRISSET87	SUMB1	SUMB2	SUMB	SUMC	SUMVEG
8	CONTR	0.0	0	10	0.1	2.00	15	29.3	44.3	54.20	98.50
12	CONTR	0.0	0	2	0.2	0.50	0	17.2	17.2	60.90	78.10
13	CONTR	0.0	0	12	0.0	0.10	6	22.2	28.2	55.70	83.90
28	CONTR	0.0	0	2	0.0	0.00	10	18.2	28.2	29.00	57.20
31	CONTR	0.0	0	5	0.0	1.00	0	19.6	19.6	72.90	92.50
40	CONTR	0.0	0	10	0.0	0.00	10	54.6	64.6	33.10	97.70
43	CONTR	0.0	0	10	1.0	0.50	8	27.7	35.7	55.20	90.90
47	CONTR	0.2	0	5	0.0	0.00	10	18.3	28.3	52.40	80.70
56	CONTR	2.0	0	10	0.0	0.10	5	42.2	47.2	38.20	85.40
57	CONTR	0.0	0	20	0.0	0.05	6	29.6	35.6	70.05	105.65
8	BRUSH	0.0	0	20	0.0	0.20	5	7.5	12.5	67.80	80.30
12	BRUSH	5.0	0	10	0.0	0.20	10	32.4	42.4	91.90	134.30
13	BRUSH	0.0	0	10	0.2	0.20	0	27.7	27.7	51.00	78.70
28	BRUSH	0.0	0	2	0.0	0.05	15	23.2	38.2	30.85	69.05
31	BRUSH	0.5	0	15	0.0	1.00	0	15.7	15.7	74.70	90.40
40	BRUSH	0.1	0	10	0.0	1.00	10	36.2	46.2	29.30	75.50
43	BRUSH	0.0	0	2	0.0	0.20	20	26.7	46.7	56.90	103.60
47	BRUSH	0.0	0	5	0.0	2.00	6	24.4	30.4	66.31	96.71
56	BRUSH	0.0	0	15	0.0	5.00	6	34.7	40.7	59.30	100.00
57	BRUSH	0.0	0	5	0.0	0.20	15	42.7	57.7	41.60	99.30
8	THIN	0.5	0	5	0.0	0.00	5	1.8	6.8	40.50	47.30
12	THIN	0.0	0	5	0.0	0.20	8	32.3	40.3	62.45	102.75
13	THIN	2.0	0	5	0.0	0.00	6	13.0	19.0	55.55	74.55
28	THIN	0.0	0	10	0.0	0.00	15	33.0	53.0	32.40	85.40
31	THIN	0.0	0	10	0.0	0.50	0	15.1	15.1	103.40	118.50
40	THIN	0.0	0	15	0.0	5.00	8	14.1	22.1	54.30	76.40
43	THIN	0.0	0	5	0.1	0.20	6	44.8	50.8	49.50	100.30
47	THIN	0.0	0	20	0.0	0.20	6	40.1	46.1	42.75	88.85
56	THIN	0.0	0	20	0.5	0.10	5	65.4	70.4	48.00	118.40
57	THIN	0.0	0	10	0.0	0.10	15	40.6	55.6	79.20	134.80
8	COMBO	0.0	0	15	0.0	0.00	10	51.0	61.0	68.50	129.50
12	COMBO	0.0	0	10	0.0	0.00	0	17.2	17.2	53.50	70.70
13	COMBO	0.0	0	10	0.0	0.20	10	31.0	41.0	45.40	86.40
28	COMBO	0.0	0	5	0.0	0.05	15	21.5	36.5	31.55	68.05
31	COMBO	0.0	0	2	0.1	0.10	0	12.5	12.5	85.40	97.90
40	COMBO	0.0	0	2	0.0	0.50	20	26.0	46.0	24.70	70.70
43	COMBO	0.0	0	5	0.0	0.50	8	15.3	23.3	30.90	54.20
47	COMBO	0.0	0	2	0.0	0.10	30	32.7	62.7	44.30	107.00
56	COMBO	0.0	0	15	0.0	0.20	0	33.8	33.8	35.40	70.20
57	COMBO	0.0	0	10	0.0	0.20	8	32.5	40.5	55.80	96.30

-----SITE=E55-----

PLOTNUM	TREAT	B1DF87	B1HW87	B1SS87	B2BA87	B2CR87	B2DF87	B2HW87	B2SS87	GAUSHA87
3	TRENCH	0	35	0	0	0.5	0.0	10	0	0.0
14	TRENCH	0	40	0	0	0.5	0.0	20	0	0.0
15	TRENCH	0	30	0	0	2.0	0.5	10	0	0.0
17	TRENCH	0	25	0	0	0.2	0.5	5	1	0.0
23	TRENCH	0	2	0	0	0.1	0.5	20	0	0.0
27	TRENCH	0	10	0	0	0.5	0.0	15	0	0.5
28	TRENCH	0	40	0	0	1.0	0.0	10	0	0.0
PLOTNUM	TREAT	MENFER87	RIBES87	RUBLEU87	RUBPAR87	RUBSPE87	SALSIT87	SAMRAC87	TAXBRE87	
3	TRENCH	0	0	0.0	0.5	2.0	0.0	0.0	0	
14	TRENCH	0	0	0.2	0.0	5.0	0.0	0.1	0	
15	TRENCH	0	0	0.0	0.0	5.0	0.0	0.0	0	
17	TRENCH	0	0	0.0	0.0	0.2	0.0	0.2	0	
23	TRENCH	0	0	0.1	0.0	5.0	0.0	0.0	0	
27	TRENCH	0	0	0.0	0.1	0.0	0.2	0.0	0	
28	TRENCH	0	0	0.0	0.0	0.5	0.0	2.0	0	
PLOTNUM	TREAT	VACPAR87	VALASK87	ACHTRI87	ADIANUM	AGRTE87	ANAMAR87	ATHFEL87	BLESPI87	
3	TRENCH	2	0	0	0	0	0.0	0.5	5.0	
14	TRENCH	0	0	0	0	0	0.1	0.0	5.0	
15	TRENCH	10	0	0	0	0	0.2	0.2	2.0	
17	TRENCH	0	0	0	0	0	1.0	0.0	5.0	
23	TRENCH	0	0	10	0	0	5.0	0.5	0.5	
27	TRENCH	1	0	15	0	0	10.0	0.5	2.0	
28	TRENCH	1	0	0	0	0	1.0	1.0	5.0	
PLOTNUM	TREAT	BROMINER	CARDEWE	CARMER87	CIRSARVE	CORCAN87	DESELO87	DRY AUS87	ELYGLA87	
3	TRENCH	0	0	0.00	0.0	60	0.0	0.5	0.0	
14	TRENCH	0	0	0.00	0.0	0	0.0	0.0	0.0	
15	TRENCH	0	0	0.00	0.0	0	0.0	0.5	0.5	
17	TRENCH	0	0	0.00	0.0	0	0.0	1.0	0.5	
23	TRENCH	0	0	0.00	0.1	0	0.0	0.0	5.0	
27	TRENCH	0	0	2.00	0.0	0	0.0	0.1	2.0	
28	TRENCH	0	0	0.05	0.0	0	0.1	0.1	0.0	

----- SITE=E55 -----

PLOTNUM	TREAT	EPIANG87	GALTRI87	HOLCUS	HYPORADI	LACCER87	LINNEA87	LUZCAM87	LUZPAR87		
3	TRENCH	25	0	0	0	0.0	0	0	0		
14	TRENCH	10	0	0	0	2.0	0	0	0		
15	TRENCH	25	0	0	0	0.2	0	0	0		
17	TRENCH	25	0	0	0	0.1	0	0	0		
23	TRENCH	25	0	0	0	1.0	0	0	0		
27	TRENCH	15	0	0	0	0.1	0	0	0		
28	TRENCH	30	0	0	0	2.0	0	0	0		1

PLOTNUM	TREAT	LYCCLA87	MIADL87	POLMUN87	TIAREL87	TRISSET87	SUMB1	SUMB2	SUMB	SUMC	SUMVEG
3	TRENCH	0	0	5	0	0.1	35	15.0	50.0	96.10	146.10
14	TRENCH	0	0	2	0	1.0	40	25.8	65.8	20.10	85.90
15	TRENCH	5	0	2	0	0.1	30	27.5	57.5	35.70	93.20
17	TRENCH	2	0	2	0	0.5	25	7.1	32.1	37.10	69.20
23	TRENCH	0	0	5	0	1.0	2	25.7	27.7	53.10	80.80
27	TRENCH	0	0	2	0	0.5	10	17.3	27.3	49.20	76.50
28	TRENCH	0	0	10	0	0.1	40	14.5	54.5	50.35	104.85

Appendix VII**Seedling density and basal area of competing trees for the treatment plots.**

The data are sorted by site and treatment. The abbreviations used are explained below.

MBASAL1	Mean basal area at 10 cm above germination point for competing trees within the 2 m radius plot (m ²)
MVOL1	Mean stem volume for competing trees within the 2 m radius plot (m ³)
NTREE	Number of competing trees ≥1 m tall within 2 m radius plot
PLOTNUM	The sample point number within a site and the block number for ANOVA
SEEDLING	Number of competing seedlings (trees <1 m tall) in the 2 m radius plot
SUMBAS1	Total basal area at 10 cm above germination point for competing trees in the plot (m ²)
SUMVOL1	Total stem volume for competing trees in the plot (m ³)
TREAT	The treatment code with CONTR=control, BRUSH=brush reduction, THIN=thinning, BRUSH=brush reduction plus thinning (combined), and TRENCH=trenching

SITE=E55 TREAT=CONTR

PLOTNUM	NTREE	MBASAL1	MVOL1	SUMBAS1	SUMVOL1	SEEDLING
3	14	0.000657042	0.000576791	0.0091986	0.0080751	23
8	5	0.000398354	0.000243527	0.0019918	0.0012176	23
14	21	0.000739695	0.000737954	0.0155336	0.0154970	31
15	15	0.000294734	0.000169468	0.0044210	0.0025420	25
17	21	0.000504450	0.000461006	0.0105935	0.0096811	50
23	3	0.000261276	0.000111283	0.0007838	0.0003339	30
27	5	0.000242060	0.000114927	0.0012103	0.0005746	40
28	14	0.000378356	0.000882948	0.0122970	0.0123613	43
30	16	0.000355933	0.000246679	0.0056949	0.0039469	51
37	3	0.000142419	0.000062206	0.0004273	0.0001866	21

SITE=E55 TREAT=BRUSH

PLOTNUM	NTREE	MBASAL1	MVOL1	SUMBAS1	SUMVOL1	SEEDLING
3	3	0.00049166	0.000290006	0.0014750	0.0008708	11
8	6	0.00069442	0.00059288	0.0041665	0.0035573	20
14	18	0.00056898	0.00049010	0.0102416	0.0088218	33
15	6	0.00081132	0.00073719	0.0048679	0.0044231	26
17	9	0.00132619	0.00186910	0.0119357	0.0168219	21
23	9	0.00025395	0.00013095	0.0022855	0.0011785	27
27	6	0.00045972	0.00024311	0.0027583	0.0014587	24
28	8	0.00038347	0.00023653	0.0030678	0.0018922	28
30	7	0.00048089	0.00029511	0.0033662	0.0020658	25
37	6	0.00019033	0.00009778	0.0011420	0.0005867	18

SITE=E55 TREAT=THIN

PLOTNUM	NTREE	MBASAL1	MVOL1	SUMBAS1	SUMVOL1	SEEDLING
3	11	0.000890713	0.000875892	0.0097978	0.0096348	13
8	4	0.000400749	0.000209839	0.0016030	0.0008394	20
14	16	0.000752461	0.000679636	0.0120394	0.0108742	8
15	15	0.000408093	0.000271166	0.0061214	0.0040675	35
17	7	0.000726269	0.000670401	0.0050839	0.0046928	29
23	6	0.000393223	0.000283789	0.0023593	0.0017027	18
27	7	0.000594210	0.00040002	0.0041595	0.0030800	33
28	11	0.000903493	0.000884246	0.0099384	0.0097267	24
30	5	0.000169960	0.000073563	0.0008498	0.0003678	35
37	2	0.000143335	0.000051615	0.0002867	0.0001032	23

----- SITE=E55 TREAT=COMBO -----

PLOTNUM	NTREE	MBASAL1	MVOL1	SUMBAS1	SUMVOL1	SEEDLING
3	18	0.00063338	0.00051943	0.0114008	0.0093498	15
8	4	0.00056608	0.00048191	0.0022643	0.0019276	14
14	6	0.00105021	0.00090600	0.0063012	0.0054360	18
15	17	0.00117491	0.00136869	0.0193735	0.0232677	26
17	15	0.00072262	0.00071000	0.0108393	0.010650C	38
23	12	0.00049258	0.00044567	0.0059109	0.0053480	47
27	5	0.00043448	0.00027173	0.0021724	0.0013586	61
28	10	0.00096211	0.00088917	0.0096211	0.0088917	28
30	12	0.00021749	0.00009363	0.0026099	0.0011236	40
37	10	0.00026499	0.00015405	0.0026499	0.0015405	35

----- SITE=E55 TREAT=TRENCH -----

PLOTNUM	NTREE	MBASAL1	MVOL1	SUMBAS1	SUMVOL1	SEEDLING
3	6	0.00118032	0.00118933	0.0070819	0.0071360	28
14	15	0.00054323	0.00045584	0.0081485	0.0068377	30
15	10	0.00068864	0.00058371	0.0058864	0.0058371	33
17	4	0.00135265	0.00137892	0.0054106	0.0055157	29
23	3	0.00028117	0.00014067	0.0008435	0.0004220	17
27	7	0.00030608	0.00015348	0.0021426	0.0010744	27
28	14	0.00083639	0.00088681	0.0117095	0.0124153	30

----- SITE=E44 TREAT=CONTR -----

PLOTNUM	NTREE	MBASAL1	MVOL1	SUMBAS1	SUMVOL1	SEEDLING
8	3	0.000459196	0.000404637	0.00137759	0.00121391	16
12	0	0.000000000	0.000000000	0.000000000	0.000000000	6
13	3	0.000184830	0.000077953	0.00055449	0.00023386	9
28	9	0.000153327	0.000065985	0.00137994	0.00059386	29
31	1	0.000132732	0.000048773	0.00013273	0.00004877	45
40	22	0.000306555	0.000167942	0.0067421	0.00369471	38
43	2	0.000443750	0.000249920	0.00088750	0.00049984	45
47	11	0.000213914	0.000101245	0.00235305	0.00111370	36
56	4	0.000174751	0.000078396	0.00069900	0.00031358	49
57	8	0.000195270	0.000097609	0.00156216	0.00078087	27

SITE=E44 TREAT=BRUSH

PLOTNUM	NITREE	MBASAL 1	MVDL 1	SUMBAS 1	SUMVOL 1	SEEDLING
8	0	0.000000000	0.000000000	0.000000000	0.000000000	9
12	7	0.000119829	0.000047240	0.000083881	0.000033068	19
13	5	0.000192255	0.000097429	0.000096133	0.000048715	14
28	7	0.000388435	0.000220188	0.00271905	0.00154132	49
31	0	0.000000000	0.000000000	0.000000000	0.000000000	18
40	15	0.000218969	0.000124019	0.00328454	0.00186028	29
43	14	0.000309896	0.000194785	0.00433854	0.00272699	47
47	2	0.000157080	0.000279323	0.00031416	0.00055865	22
56	7	0.000181764	0.000079886	0.00127235	0.00055920	10
57	8	0.000273711	0.000188743	0.00218969	0.00150994	39

SITE=E44 TREAT=THIN

PLOTNUM	NITREE	MBASAL 1	MVDL 1	SUMBAS 1	SUMVOL 1	SEEDLING
8	0	0.000000000	0.000000000	0.000000000	0.000000000	4
12	7	0.000224624	0.000100780	0.00157237	0.00070546	25
13	3	0.000175406	0.000081438	0.00052622	0.00024431	17
28	17	0.000309170	0.000188514	0.00525588	0.00320473	35
31	2	0.000214021	0.000096775	0.00042804	0.00019355	23
40	4	0.000123308	0.000049746	0.00049323	0.00019898	18
43	7	0.000172675	0.000090980	0.00120873	0.00063686	47
47	16	0.000205872	0.000099787	0.00329396	0.00159659	26
56	15	0.000146293	0.000071166	0.00219440	0.00106743	36
57	7	0.000206111	0.000096431	0.00144278	0.00067502	22

SITE=E44 TREAT=COMBO

PLOTNUM	NITREE	MBASAL 1	MVDL 1	SUMBAS 1	SUMVOL 1	SEEDLING
8	8	0.000152760	0.000060990	0.00122208	0.00048792	23
12	1	0.000153938	0.000058604	0.00015394	0.00005860	7
13	8	0.000214414	0.000104190	0.00171531	0.00083352	15
28	12	0.000367370	0.000224087	0.00440844	0.00268904	43
31	C	0.000000000	0.000000000	0.000000000	0.000000000	10
40	1	0.000314159	0.000128960	0.00031416	0.00012896	27
43	3	0.000193470	0.000083563	0.00058041	0.00025069	29
47	13	0.000405145	0.000319453	0.00526688	0.00415289	14
56	1	0.000113097	0.000041558	0.00011310	0.00004156	50
57	7	0.000279602	0.000149138	0.00195721	0.00104397	58

Appendix VIII

Tree dimensions and foliar nutrients for the treatment plots.

The trees are at the center of the treatment plots. The data are sorted by site and treatment. The variables are alphabetically ordered within each group. The abbreviations used are explained below.

The treatments were applied during July and August 1987. Time zero measurements were made before July 15, 1987. The end of first and second growing seasons were September of 1988 and 1989, respectively.

PLOTNUM The sample point number within a site and the block number for ANOVA
TREAT The treatment code with CONTR=control, BRUSH=brush reduction, THIN=thinning, COMEO=brush reduction plus thinning (combined), and TRENCH=trenching

Tree dimensions

AVLEADER Average leader growth for previous three years at beginning of treatments (cm/yr)
BASAL88 Basal area at 10 cm above germination point at end of first growing season (m²)
BASAL89 Basal area at 10 cm above germination point at end of second growing season (m²)
BASAREA1 Basal area at 10 cm above germination point at beginning of treatment (m²)
D10 Diameter at 10 cm above germination point at beginning of treatments (mm)
D10_88 Diameter at 10 cm above germination point at end of first growing season (mm)
D10_89 Diameter at 10 cm above germination point at end of second growing season (mm)
DBH Diameter at breast height at beginning of treatments (mm)
DBH88 Diameter at breast height at end of first growing season (mm)
DBH89 Diameter at breast height at end of second growing season (mm)
HGHT88 Tree height at end of first growing season (cm)
HGHT89 Tree height at end of second growing season (cm)
HGHTJULY Tree height at the beginning of treatment (cm)
VOL1_88 Tree volume at end of first growing season (m³)
VOL1_89 Tree volume at end of second growing season (m³)
VOL1JULY Tree volume at beginning of treatment (m³)
WT Needle weight at the beginning of treatments (mg)
WT88 Needle weight at the end of the first growing season (mg)

WT89 Needle weight at the end of second growing season
(mg)

Foliar nutrients

ACTFE Active iron concentration at beginning of
treatments (mg/kg)
ACTFE88 Active iron concentration at end of first growing
season (mg/kg)
ACTFE89 Active iron concentration at end of second growing
season (mg/kg)
B Boron concentration at beginning of treatments
(mg/kg)
B88 Boron concentration at end of first growing season
(mg/kg)
B89 Boron concentration at end of second growing
season (mg/kg)
CA Calcium concentration at beginning of treatments
(%)
CA88 Calcium concentration at end of first growing
season (%)
CA89 Calcium concentration at end of second growing
season (%)
CU Copper concentration at beginning of treatments
(mg/kg)
CU88 Copper concentration at end of first growing
season (mg/kg)
CU89 Copper concentration at end of second growing
season (mg/kg)
FE Total iron concentration at beginning of
treatments (mg/kg)
FE88 Total iron concentration at end of first growing
season (mg/kg)
FE89 Total iron concentration at end of second growing
season (mg/kg)
K Potassium concentration at beginning of treatments
(%)
K88 Potassium concentration at end of first growing
season (%)
K89 Potassium concentration at end of second growing
season (%)
MG Magnesium concentration at beginning of treatments
(%)
MG88 Magnesium concentration at end of first growing
season (%)
MG89 Magnesium concentration at end of second growing
season (%)
MN Manganese concentration at beginning of treatments
(mg/kg)
MN88 Manganese concentration at end of first growing
season (mg/kg)

MN89	Manganese concentration at end of second growing season (mg/kg)
N	Nitrogen concentration at beginning of treatments (%)
N88	Nitrogen concentration at end of first growing season (%)
N89	Nitrogen concentration at end of second growing season (%)
P	Phosphorus concentration at beginning of treatments (%)
P88	Phosphorus concentration at end of first growing season (%)
P89	Phosphorus concentration at end of second growing season (%)
PPMSO4	Sulfate sulfur concentration at beginning of treatments (mg/kg)
PPMSO488	Sulfate sulfur concentration at end of first growing season (mg/kg)
PPMSO489	Sulfate sulfur concentration at end of second growing season (mg/kg)
TOTALS	Total sulfur concentration at beginning of treatments (%)
TOTALS88	Total sulfur concentration at end of first growing season (%)
TOTALS89	Total sulfur concentration at end of second growing season (%)
ZN	Zinc concentration at beginning of treatments (mg/kg)
ZN88	Zinc concentration at end of first growing season (mg/kg)
ZN89	Zinc concentration at end of second growing season (mg/kg)

SITE=E55

PLOTNUM	TREAT	A/LEADER	BASAL88	BASAL89	BASAREA1	D10	D10_88	D10_89	DBH	DBH88
3	CONTR	36.3333	0.00152053	0.00166190	0.00101788	36	44	46	12	20
8	CONTR	26.6667	0.00066052	0.00090792	0.00049087	25	29	34	10	13
14	CONTR	53.0000	0.00152053	0.00188574	0.00107521	37	44	49	22	28
15	CONTR	36.6667	0.00159043	0.00212372	0.00075477	31	45	52	13	26
17	CONTR	28.6667	0.00246301	0.00237583	0.00132025	41	56	55	17	23
23	CONTR	39.0000	0.00085530	0.00125664	0.00045239	24	33	40	9	18
27	CONTR	32.0000	0.00085530	0.00113411	0.00057256	27	33	38	10	14
28	CONTR	31.3333	0.00096211	0.00113411	0.00061575	28	35	38	18	25
30	CONTR	17.3333	0.00066052	0.00080425	0.00041548	23	29	32	10	16
37	CONTR	38.0000	0.00125664	0.00204282	0.00045239	24	40	51	14	20
3	BRUSH	32.6667	0.00246301	0.00352565	0.00113411	38	56	67	14	24
8	BRUSH	36.6667	0.00090792	0.00152053	0.00061575	28	34	44	12	21
14	BRUSH	27.0000	0.00061575	0.00075477	0.00045239	24	28	31	13	18
15	BRUSH	34.6667	0.00311725	0.00395919	0.00166190	46	63	71	20	36
17	BRUSH	49.0000	0.00090792	0.00132025	0.00080425	32	34	41	14	18
23	BRUSH	34.0000	0.00096211	0.00107521	0.00041548	23	35	37	9	14
27	BRUSH	31.3333	0.00173494	0.00273397	0.00075477	31	47	59	12	20
28	BRUSH	37.0000	0.00125664	0.00196350	0.00066052	29	40	50	15	23
28	BRUSH	34.6667	0.00090792	0.00119459	0.00041548	23	34	39	7	12
30	BRUSH	25.3333	0.00125664	0.00145220	0.00070686	30	40	43	12	15
37	BRUSH	25.0000	0.00246301	0.00384845	0.00101788	36	56	70	17	28
8	THIN	47.6667	0.00311725	0.00418539	0.00173494	47	63	73	16	29
14	THIN	46.6667	0.00352565	0.00541061	0.00159043	45	67	83	27	39
15	THIN	34.6667	0.00301907	0.00453646	0.00107521	37	62	76	21	38
17	THIN	59.0000	0.00196350	0.00255176	0.00075477	31	50	57	12	24
23	THIN	39.3333	0.00096211	0.00159043	0.00034636	21	35	45	10	15
27	THIN	33.3333	0.00125664	0.00188574	0.00061575	28	40	49	12	19
28	THIN	32.6667	0.00096211	0.00132025	0.00061575	28	35	41	12	15
30	THIN	19.6667	0.00107521	0.00107521	0.00017671	15	37	37	6	11
37	THIN	40.0000	0.00096211	0.00107521	0.00028353	19	35	37	11	16
3	COMBO	31.6667	0.00321699	0.00477836	0.00152053	44	64	78	17	30
8	COMBO	44.3333	0.00273397	0.00490167	0.00138544	42	59	79	17	34
14	COMBO	42.6667	0.00204282	0.00220618	0.00090792	34	51	53	1	20
15	COMBO	46.0000	0.00273397	0.00515300	0.00085530	33	59	81	24	37
17	COMBO	35.3333	0.00107521	0.00173494	0.00034636	21	37	47	14	23
23	COMBO	17.0000	0.00273397	0.00477836	0.00080425	32	59	78	10	23
27	COMBO	28.6667	0.00173494	0.00331831	0.00070686	30	47	65	14	21
28	COMBO	36.6667	0.00159043	0.00255176	0.00070686	30	45	57	17	27
30	COMBO	31.3333	0.00173494	0.00321699	0.00070686	30	47	64	10	20
37	COMBO	26.0000	0.00096211	0.00204282	0.00034636	21	35	51	8	15

SITE=E55

PLOTNUM	TREAT	DBH89	HGHT88	HGHT89	HGHTJULY	VOL1_88	VOL1_89	VOLI JULY	WT	WT88
3	CONTR	27	339	419	259	0.00170639	0.00230517	0.00087273	1.7	2.0
8	CONTR	18	229	273	206	0.00050073	0.00082053	0.00033475	1.5	2.0
14	CONTR	37	379	433	313	0.00190773	0.00270305	0.00111409	1.5	2.1
15	CONTR	37	363	401	257	0.00191119	0.00281919	0.00064214	2.3	1.9
17	CONTR	31	333	395	270	0.00271515	0.00310667	0.00118006	2.0	2.3
23	CONTR	19	269	317	206	0.00076165	0.00131872	0.00030851	2.2	1.5
27	CONTR	23	257	323	208	0.00072767	0.00121267	0.00039424	1.6	2.1
28	CONTR	28	344	415	285	0.00109564	0.00155808	0.00058094	2.1	2.2
30	CONTR	23	270	283	199	0.00059038	0.00075346	0.00027370	2.0	1.7
37	CONTR	32	350	428	247	0.00145600	0.00289439	0.00036891	2.2	2.8
3	BRUSH	37	338	422	244	0.00275592	0.00492533	0.00091607	1.6	2.1
8	BRUSH	31	303	382	229	0.00091070	0.00192284	0.00046679	1.4	2.0
14	BRUSH	20	313	358	249	0.00063802	0.00089450	0.00037290	2.0	1.8
15	BRUSH	47	414	506	306	0.00427223	0.00663194	0.00168349	2.3	2.1
17	BRUSH	26	312	362	276	0.00093775	0.00158216	0.00073482	2.1	2.0
23	BRUSH	14	222	215	201	0.00070707	0.00076527	0.00027646	2.3	2.0
27	BRUSH	35	342	430	232	0.00196424	0.00389176	0.00057968	2.4	2.2
28	BRUSH	35	378	466	262	0.00157248	0.00302900	0.00057289	2.0	2.5
30	BRUSH	22	254	299	198	0.00076342	0.00118243	0.00027233	2.0	2.5
37	BRUSH	25	248	329	212	0.00103168	0.00158163	0.00049608	1.5	2.3
3	THIN	45	360	440	248	0.002339530	0.00560560	0.00083566	1.8	2.1
8	THIN	39	360	437	265	0.00371498	0.00605481	0.00152200	1.9	1.9
14	THIN	56	400	456	317	0.00466855	0.00816760	0.00166900	1.7	1.7
15	THIN	51	432	463	316	0.00431758	0.00695315	0.00112477	2.5	2.1
17	THIN	34	342	412	265	0.00222300	0.00348033	0.00066213	2.1	1.9
23	THIN	23	263	348	194	0.00083765	0.00183222	0.00022244	1.7	2.6
27	THIN	28	303	359	231	0.00126048	0.00224109	0.00047067	2.4	2.3
28	THIN	21	254	313	222	0.00080899	0.00136800	0.00045252	1.3	1.9
30	THIN	20	249	331	185	0.00088629	0.00117816	0.00010822	2.0	1.9
37	THIN	25	300	338	218	0.00095550	0.00120308	0.00020461	1.8	2.3
3	COMBO	39	345	421	252	0.00367411	0.00665955	0.00126847	2.4	2.8
8	COMBO	46	412	512	285	0.00372885	0.00830802	0.00130712	2.8	2.8
14	COMBO	28	297	372	226	0.00200849	0.00271686	0.00067927	2.3	2.1
15	COMBO	54	419	503	301	0.00379220	0.00858048	0.00085225	2.1	3.4
17	COMBO	35	329	413	237	0.00117104	0.00237202	0.00027174	3.1	2.7
23	COMBO	40	290	386	195	0.00262467	0.00610590	0.00051917	1.4	1.8
27	COMBO	34	298	387	246	0.00171153	0.00425119	0.00057564	2.2	2.6
28	COMBO	41	343	431	262	0.00180589	0.00364083	0.00061308	2.0	2.9
30	COMBO	36	325	398	210	0.00186660	0.00423854	0.00049140	2.5	3.4
37	COMBO	25	260	361	185	0.00082810	0.00244130	0.00021212	1.6	3.2

SITE=E55

PLOTNUM	TREAT	WT89	ACTFE	ACTFE88	ACTFE89	B	B88	B89	CA	CA88	CA89	CU	CUB8
3	CONTR	2.2	39	35	31	15	15	13	0.20	0.25	0.25	4	2
8	CONTR	2.5	29	34	30	19	21	19	0.23	0.29	0.22	1	2
14	CONTR	2.8	23	28	26	15	16	16	0.20	0.25	0.19	4	2
15	CONTR	2.9	32	45	30	16	18	14	0.20	0.37	0.29	8	3
17	CONTR	2.4	22	35	37	11	11	12	0.15	0.25	0.24	3	2
23	CONTR	2.4	28	46	41	15	23	20	0.19	0.26	0.22	4	3
27	CONTR	2.3	37	37	40	13	17	14	0.17	0.31	0.27	2	3
28	CONTR	2.3	30	32	30	12	21	17	0.22	0.28	0.23	1	2
30	CONTR	2.3	30	40	41	18	27	24	0.22	0.34	0.28	3	7
37	CONTR	3.2	26	35	41	14	22	17	0.14	0.22	0.20	0	2
3	BRUSH	1.8	30	40	29	15	12	11	0.21	0.14	0.14	3	2
8	BRUSH	2.2	28	39	42	16	20	18	0.20	0.26	0.31	1	0
14	BRUSH	2.2	23	34	25	15	16	13	0.20	0.29	0.33	3	3
15	BRUSH	1.8	39	43	33	13	15	11	0.16	0.24	0.25	4	3
17	BRUSH	1.6	34	36	35	17	20	16	0.19	0.20	0.21	2	4
23	BRUSH	2.3	26	30	30	15	13	20	0.19	0.15	0.31	1	1
27	BRUSH	2.5	33	64	58	19	23	20	0.17	0.22	0.26	1	3
28	BRUSH	2.7	26	35	32	18	25	16	0.18	0.20	0.23	3	3
30	BRUSH	1.8	33	38	33	18	21	15	0.21	0.25	0.21	2	2
37	BRUSH	2.2	26	36	26	22	27	19	0.30	0.25	0.24	1	2
3	THIN	2.8	31	40	38	14	14	15	0.25	0.28	0.29	4	2
8	THIN	2.0	33	35	34	23	23	25	0.29	0.35	0.34	0	3
14	THIN	2.1	27	60	44	15	14	14	0.16	0.27	0.25	2	3
15	THIN	2.9	26	47	35	14	13	13	0.18	0.27	0.22	0	2
17	THIN	2.3	32	46	30	15	19	15	0.14	0.20	0.17	0	1
23	THIN	2.7	30	35	25	13	16	16	0.27	0.28	0.25	3	3
27	THIN	2.2	28	43	37	14	18	15	0.23	0.21	0.22	3	3
28	THIN	2.2	30	35	30	13	16	12	0.26	0.22	0.19	3	3
30	THIN	2.5	27	58	41	14	20	19	0.28	0.33	0.29	5	2
37	THIN	2.1	30	48	42	13	31	24	0.20	0.32	0.22	0	1
3	COMBO	1.9	35	42	23	9	8	7	0.20	0.19	0.19	3	3
8	COMBO	2.1	29	47	40	13	16	13	0.25	0.20	0.16	4	2
14	COMBO	2.0	30	34	32	11	11	11	0.34	0.20	0.28	4	4
15	COMBO	3.6	22	48	38	15	14	12	0.21	0.23	0.24	5	4
17	COMBO	2.0	44	45	39	14	20	22	0.24	0.31	0.39	6	2
23	COMBO	2.2	25	56	61	14	17	12	0.20	0.31	0.23	4	3
27	COMBO	2.3	35	51	40	14	28	20	0.22	0.30	0.34	5	2
28	COMBO	2.6	17	41	26	10	15	12	0.20	0.19	0.23	4	3
30	COMBO	3.8	23	43	40	14	23	17	0.22	0.31	0.30	5	4
37	COMBO	2.0	37	59	49	16	25	17	0.23	0.31	0.28	3	4

SITE=E55

PLOTNUM	TREAT	CU89	FE	FE88	FE89	K	K88	K89	MG	MG88	MG89	MN	MN88
3	CONTR	0	46	63	53	0.61	0.57	0.50	0.10	0.12	0.12	1350	1398
8	CONTR	2	39	54	53	0.77	0.76	0.73	0.10	0.11	0.12	1650	2019
14	CONTR	2	26	51	41	0.62	0.60	0.62	0.09	0.12	0.10	1175	1718
15	CONTR	3	38	62	68	0.58	0.79	0.68	0.07	0.10	0.09	1475	2876
17	CONTR	2	28	54	68	0.50	0.42	0.46	0.11	0.16	0.18	775	1401
23	CONTR	0	36	80	65	0.60	0.74	0.70	0.09	0.11	0.11	800	1298
27	CONTR	0	36	66	62	0.72	0.76	0.67	0.10	0.13	0.13	1225	2262
28	CONTR	0	27	60	51	0.70	0.82	0.68	0.09	0.11	0.10	1525	2070
30	CONTR	3	26	86	68	0.74	0.75	0.71	0.10	0.15	0.14	975	1076
37	CONTR	1	36	50	56	0.72	0.80	0.77	0.10	0.13	0.10	875	1817
3	BRUSH	6	23	84	101	0.66	1.01	0.78	0.09	0.07	0.08	1250	1053
8	BRUSH	6	26	48	131	0.75	0.90	0.82	0.10	0.12	0.12	1200	1907
14	BRUSH	6	31	72	158	0.67	0.82	0.67	0.09	0.13	0.15	1425	1712
15	BRUSH	4	27	75	62	0.67	0.99	0.75	0.08	0.11	0.11	1325	2088
17	BRUSH	6	24	80	62	0.56	0.74	0.66	0.10	0.14	0.10	525	641
23	BRUSH	4	28	62	62	0.68	0.65	0.79	0.10	0.10	0.22	1000	785
27	BRUSH	7	46	99	98	0.57	0.83	0.67	0.10	0.12	0.11	450	780
28	BRUSH	6	30	54	89	0.69	1.08	0.81	0.10	0.11	0.12	775	1044
30	BRUSH	5	34	81	101	0.71	1.05	0.78	0.09	0.10	0.09	900	1089
37	BRUSH	6	24	57	80	0.74	1.05	0.83	0.10	0.11	0.09	1575	1953
3	THIN	4	27	69	59	0.58	0.67	0.70	0.10	0.13	0.17	574	941
8	THIN	4	35	69	56	0.60	0.68	0.59	0.11	0.14	0.16	1600	2474
14	THIN	4	36	93	74	0.51	0.88	0.67	0.07	0.09	0.12	1350	2610
15	THIN	4	33	83	59	0.60	0.86	0.69	0.08	0.10	0.10	1100	1610
17	THIN	3	26	81	53	0.69	0.80	0.60	0.08	0.10	0.10	1000	1313
23	THIN	1	34	63	53	0.76	0.70	0.67	0.11	0.08	0.08	875	1269
27	THIN	5	24	107	77	0.65	0.75	0.68	0.08	0.08	0.11	1300	2168
28	THIN	4	22	60	74	0.68	0.76	0.64	0.09	0.09	0.13	1450	2577
30	THIN	3	23	87	68	0.74	1.08	0.98	0.09	0.10	0.10	700	1289
37	THIN	3	29	89	74	0.71	1.06	0.96	0.08	0.10	0.11	1225	1445
3	COMBO	4	30	78	51	0.56	0.78	0.56	0.08	0.10	0.09	750	948
8	COMBO	5	24	87	81	0.64	1.08	0.83	0.07	0.10	0.10	1325	2051
14	COMBO	4	25	51	45	0.52	0.79	0.65	0.08	0.09	0.13	1100	1227
15	COMBO	2	22	80	51	0.57	0.95	0.74	0.07	0.07	0.08	1050	1727
17	COMBO	4	38	66	60	0.50	0.86	0.67	0.08	0.13	0.18	850	1380
23	COMBO	2	27	90	54	0.55	0.96	0.72	0.08	0.09	0.08	1150	1713
27	COMBO	3	28	87	51	0.65	1.18	0.85	0.08	0.10	0.11	1050	2258
28	COMBO	3	22	63	42	0.52	1.04	0.76	0.07	0.07	0.08	675	1212
30	COMBO	1	24	69	42	0.50	0.91	0.56	0.09	0.11	0.12	1000	1452
37	COMBO	2	29	99	60	0.67	0.88	0.61	0.09	0.07	0.08	1100	2655

SITE=E55

PLOTNUM	TREAT	MNB9	N	N88	N89	P	P88	P89	PPMS04	PPMS0488	PPMS0489
3	CONTR	1314	0.95	1.05	1.08	0.13	0.10	0.09	242	222	113
5	CONTR	1818	0.83	0.96	1.01	0.21	0.20	0.18	291	258	257
14	CONTR	1458	1.02	1.00	1.07	0	0.14	0.16	230	191	197
15	CONTR	1848	1.01	1.28	1.18	0.16	0.14	0.12	182	129	72
17	CONTR	1224	0.87	1.08	1.21	0.13	0.11	0.12	176	332	287
23	CONTR	999	1.01	1.17	1.22	0.13	0.14	0.15	148	148	101
27	CONTR	1866	0.99	1.08	1.21	0.16	0.14	0.13	224	307	209
28	CONTR	1788	0.83	0.96	0.96	0.15	0.14	0.10	255	203	137
30	CONTR	1119	0.92	1.16	1.16	0.13	0.14	0.11	212	203	143
37	CONTR	1524	0.92	1.04	0.89	0.15	0.12	0.11	170	215	173
3	BRUSH	1044	1.00	0.99	0.80	0.14	0.10	0.09	260	314	293
8	BRUSH	1617	0.81	1.16	1.05	0.18	0.19	0.19	224	228	275
14	BRUSH	1404	0.99	1.07	1.06	0.13	0.12	0.13	212	240	173
15	BRUSH	1623	0.96	1.08	0.96	0.12	0.10	0.10	176	225	197
17	BRUSH	480	0.95	1.01	1.16	0.15	0.12	0.12	170	178	179
23	BRUSH	1386	0.95	0.65	0.91	0.14	0.11	0.13	197	166	137
27	BRUSH	654	0.95	1.28	1.25	0.15	0.19	0.18	206	265	227
28	BRUSH	939	0.91	1.32	1.16	0.14	0.16	0.16	200	154	125
30	BRUSH	837	0.88	1.02	0.91	0.16	0.15	0.14	145	191	185
37	BRUSH	1737	0.78	1.17	1.02	0.17	0.16	0.13	230	160	155
3	THIN	996	1.04	1.28	1.26	0.16	0.18	0.19	182	160	167
8	THIN	2301	1.02	1.16	1.13	0.17	0.15	0.16	279	258	251
14	THIN	1869	0.94	1.76	1.16	0.16	0.20	0.17	200	178	269
15	THIN	1113	0.80	1.21	0.99	0.12	0.16	0.14	255	332	245
17	THIN	1500	1.00	1.05	0.91	0.18	0.17	0.13	242	332	257
23	THIN	1092	0.91	1.08	0.80	0.17	0.21	0.16	182	86	72
27	THIN	1773	0.98	1.22	0.92	0.16	0.16	0.14	176	92	101
28	THIN	2166	0.86	1.25	1.06	0.15	0.15	0.13	182	252	203
30	THIN	1257	0.89	1.21	0.92	0.18	0.22	0.18	218	178	143
37	THIN	1224	0.91	1.12	0.95	0.14	0.16	0.17	152	222	221
3	COMBO	834	1.00	1.14	1.01	0.13	0.13	0.13	152	209	155
8	COMBO	1797	0.95	1.39	1.16	0.15	0.20	0.23	170	123	125
14	COMBO	1254	1.00	1.13	1.29	0.15	0.13	0.14	176	154	161
15	COMBO	1149	1.15	1.36	1.13	0.17	0.18	0.18	133	117	161
17	COMBO	1236	1.08	1.28	1.54	0.16	0.24	0.23	188	265	340
23	COMBO	1797	1.07	1.44	1.04	0.17	0.17	0.18	164	295	251
27	COMBO	1968	0.90	1.56	1.27	0.15	0.19	0.19	158	86	155
28	COMBO	1119	0.89	1.19	0.94	0.15	0.21	0.19	212	271	263
30	COMBO	1122	0.79	1.17	0.90	0.12	0.19	0.16	170	234	185
37	COMBO	2073	0.89	1.56	1.05	0.16	0.20	0.19	194	117	137

SITE=E55

PLOTNUM	TREAT	TOTALS	TOTALS88	TOTALS89	ZN	ZN88	ZN89
3	CONTR	0.088	0.108	0.086	10	4	2
8	CONTR	0.084	0.106	0.102	7	3	2
14	CONTR	0.091	0.094	0.100	8	5	2
15	CONTR	0.093	0.109	0.091	8	10	6
17	CONTR	0.080	0.121	0.114	6	5	2
23	CONTR	0.089	0.097	0.101	7	7	2
27	CONTR	0.088	0.108	0.108	5	3	4
28	CONTR	0.087	0.094	0.082	4	5	0
30	CONTR	0.084	0.100	0.095	6	7	8
37	CONTR	0.076	0.097	0.080	6	11	5
3	BRUSH	0.095	0.107	0.080	5	8	7
8	BRUSH	0.076	0.108	0.096	4	0	9
14	BRUSH	0.080	0.096	0.086	6	6	6
15	BRUSH	0.080	0.105	0.087	6	6	9
17	BRUSH	0.079	0.097	0.105	6	2	7
23	BRUSH	0.084	0.060	0.080	6	7	12
27	BRUSH	0.084	0.121	0.126	9	10	13
28	BRUSH	0.077	0.102	0.097	8	4	10
30	BRUSH	0.074	0.090	0.085	12	8	10
37	BRUSH	0.075	0.096	0.089	3	6	8
3	THIN	0.088	0.108	0.109	13	10	12
8	THIN	0.098	0.108	0.099	6	8	12
14	THIN	0.083	0.142	0.104	6	14	7
15	THIN	0.084	0.132	0.104	4	10	6
17	THIN	0.089	0.113	0.091	5	4	0
23	THIN	0.081	0.082	0.065	9	14	8
27	THIN	0.089	0.099	0.078	4	21	0
28	THIN	0.075	0.113	0.097	5	10	2
30	THIN	0.081	0.102	0.082	4	11	8
37	THIN	0.079	0.099	0.094	4	6	5
3	COMBO	0.083	0.102	0.086	2	4	3
8	COMBO	0.081	0.107	0.097	0	11	7
14	COMBO	0.089	0.098	0.110	2	6	5
15	COMBO	0.088	0.115	0.099	1	J	5
17	COMBO	0.095	0.122	0.149	6	10	10
23	COMBO	0.089	0.133	0.102	5	12	4
27	COMBO	0.080	0.109	0.098	4	14	6
28	COMBO	0.081	0.113	0.083	4	15	4
30	COMBO	0.072	0.114	0.082	4	12	7
37	COMBO	0.080	0.131	0.090	4	17	12

-----SITE=E44-----

PLOTNUM	TREAT	AVLEADER	BASAL88	BASAL89	BASAREA1	D10	D10_88	D10_89	DBH	DBH88
8	CONTR	35.6667	0.00096211	0.00119459	0.00053093	26	35	39	15	20
12	CONTR	25.0000	0.00075477	0.00145220	0.00070686	30	31	43	9	12
13	CONTR	36.3333	0.00107521	0.00159043	0.00070686	30	37	45	13	17
28	CONTR	39.3333	0.00061575	0.00152053	0.00049087	25	28	44	13	15
31	CONTR	19.0000	0.00113411	0.00125664	0.00057256	27	38	40	8	12
40	CONTR	39.3333	0.00090792	0.00107521	0.00061575	28	34	37	13	15
43	CONTR	22.0000	0.00085530	0.00107521	0.00070686	30	33	37	10	10
47	CONTR	37.3333	0.00159043	0.00229022	0.00096211	35	45	54	19	25
56	CONTR	25.3333	0.00049087	0.00080425	0.00041548	23	25	32	9	10
57	CONTR	31.3333	0.00159043	0.0012372	0.00132025	41	45	52	19	22
8	BRUSH	34.3333	0.00125664	0.00188574	0.00090792	34	40	49	15	19
12	BRUSH	41.3333	0.00152053	0.00246301	0.00070686	30	44	56	13	20
13	BRUSH	26.0000	0.00101788	0.00196350	0.00049087	25	36	50	9	15
28	BRUSH	29.3333	0.00145220	0.00188574	0.00085530	33	43	49	14	25
31	BRUSH	28.0000	0.00049087	0.00070686	0.00025447	18	25	30	6	7
40	BRUSH	32.0000	0.00173494	0.00282743	0.00096211	35	47	60	15	22
43	BRUSH	39.3333	0.00145220	0.00246301	0.00090792	34	43	56	14	20
47	BRUSH	37.6667	0.00173494	0.00237583	0.00085530	33	47	55	14	23
56	BRUSH	40.6667	0.00173494	0.00352565	0.00085530	33	47	67	14	22
57	BRUSH	18.0000	0.00145220	0.00204282	0.00107521	37	43	51	14	19
8	THIN	43.3333	0.00125664	0.00180956	0.00075477	31	40	48	14	17
12	THIN	36.3333	0.00101788	0.00188574	0.00057256	27	36	49	13	20
13	THIN	27.0000	0.00159043	0.00255176	0.00085530	33	45	57	15	25
28	THIN	26.3333	0.00113411	0.00246301	0.00090792	34	38	56	13	18
31	THIN	10.0000	0.00041548	0.00080425	0.00020106	16	23	32	6	6
40	THIN	47.3333	0.00173494	0.00301907	0.00080425	32	47	62	12	24
43	THIN	31.0000	0.00152053	0.00229022	0.00107521	37	44	54	22	28
47	THIN	37.6667	0.00125664	0.00188574	0.00075477	31	40	49	14	21
56	THIN	17.6667	0.00085530	0.00152053	0.00049087	25	33	44	9	14
57	THIN	19.0000	0.00152053	0.00229022	0.00107521	37	44	54	18	22
8	COMBO	18.0000	0.00321699	0.00528102	0.00212372	52	64	82	32	39
12	COMBO	28.0000	0.00237583	0.00384845	0.00125664	40	55	70	14	18
13	COMBO	23.6667	0.00125664	0.00212372	0.00075477	31	40	52	12	14
28	COMBO	33.0000	0.00212372	0.00384845	0.00138544	42	52	70	16	25
31	COMBO	21.0000	0.00031416	0.00075477	0.00022698	17	20	31	4	5
40	COMBO	16.3333	0.00237583	0.00384845	0.00159043	45	55	70	17	25
43	COMBO	47.6667	0.00212372	0.00363168	0.00107521	37	52	68	12	22
47	COMBO	48.3333	0.00204282	0.00395919	0.00075477	31	51	71	19	33
56	COMBO	22.3333	0.00090792	0.00173494	0.00041548	23	34	47	8	14
57	COMBO	51.6667	0.00085530	0.00166190	0.00049087	25	33	46	14	21

----- SITE=E44 -----

PLOTNUM	TREAT	DBH89	HGHT88	HGHT89	HGHTJULY	VOL1_88	VOL1_89	VOL1JULY	WT	WT88
8	CONTR	28	293	341	251	0.00093320	0.00134852	0.00044116	2.5	2.4
12	CONTR	19	226	284	193	0.00056468	0.00136530	0.00045162	1.7	1.7
13	CONTR	24	300	356	260	0.00106782	0.00187434	0.00060840	1.9	1.8
28	CONTR	20	278	315	252	0.00056668	0.00158558	0.00040950	1.8	1.8
31	CONTR	21	281	368	176	0.00105499	0.00153088	0.00033359	2.0	2.0
40	CONTR	21	273	298	241	0.00082053	0.00106070	0.00049125	2.1	1.7
43	CONTR	15	234	249	228	0.00066255	0.00088629	0.00053352	1.9	1.2
47	CONTR	34	329	386	268	0.00173218	0.00292650	0.00085358	1.5	2.3
56	CONTR	14	222	230	214	0.00036075	0.00061235	0.00029434	1.4	1.7
57	CONTR	29	300	352	272	0.00157950	0.00247470	0.00118880	1.8	2.5
8	BRUSH	28	257	316	246	0.00106912	0.00197266	0.00073938	1.4	2.0
12	BRUSH	35	313	358	233	0.00157552	0.00291899	0.00054522	2.7	3.5
13	BRUSH	26	269	350	204	0.00090642	0.00227500	0.00033150	2.0	2.1
28	BRUSH	33	353	432	256	0.00169701	0.00269680	0.00072484	1.8	2.1
31	BRUSH	15	218	253	173	0.00035425	0.00059202	0.00014574	1.9	2.2
40	BRUSH	31	309	402	257	0.00177471	0.00376272	0.00081854	1.7	2.1
43	BRUSH	32	331	410	276	0.00159125	0.00334298	0.00082955	1.9	2.6
47	BRUSH	34	318	365	254	0.00182640	0.00287072	0.00071918	2.2	2.0
56	BRUSH	37	345	447	271	0.00198147	0.00521712	0.00076731	1.9	2.2
57	BRUSH	24	272	326	250	0.00130761	0.00220461	0.00088985	2.0	2.9
8	THIN	27	287	320	236	0.00119392	0.00191693	0.00058967	1.7	1.8
12	THIN	30	277	348	231	0.00093338	0.00217242	0.00043784	2.3	2.7
13	THIN	32	302	369	243	0.00159003	0.00311709	0.00068803	1.8	1.9
28	THIN	28	309	396	256	0.00116011	0.00322883	0.00076943	1.4	1.9
31	THIN	13	198	268	156	0.00027233	0.00071352	0.00010383	1.6	2.0
40	THIN	36	333	426	265	0.00191255	0.00425761	0.00070554	2.4	2.5
43	THIN	38	344	427	293	0.00173156	0.00323734	0.00104290	1.5	2.3
47	THIN	29	334	389	257	0.00138944	0.00242837	0.00064214	1.5	3.2
56	THIN	26	271	362	210	0.00076731	0.00182216	0.00034125	1.8	2.1
57	THIN	34	309	329	271	0.00155538	0.00249435	0.00096460	2.0	2.0
8	COMBO	52	407	463	309	0.00433439	0.00809435	0.00217239	2.0	2.8
12	COMBO	29	254	320	199	0.00199771	0.00407680	0.00082784	2.0	2.6
13	COMBO	26	270	341	227	0.00112320	0.00239737	0.00056718	1.6	1.9
28	COMBO	38	360	465	268	0.00253094	0.00592410	0.00122916	2.2	3.4
31	COMBO	9	155	205	155	0.00016120	0.00051221	0.00011647	1.9	1.8
40	COMBO	41	326	417	246	0.00256399	0.00531258	0.00129519	1.8	2.1
43	COMBO	35	342	455	256	0.00240440	0.00547019	0.00091121	2.0	2.0
47	COMBO	52	384	418	308	0.00259684	0.00547856	0.00076957	1.6	3.4
56	COMBO	23	232	282	190	0.00069730	0.00161964	0.00026133	1.4	2.2
57	COMBO	31	330	403	257	0.00093436	0.00221714	0.00041762	2.0	2.3

----- SITE=E44 -----

PLOTNUM	TREAT	WT89	ACTFE	ACTFE88	ACTFE89	B	B88	B89	CA	CA88	CA89	CU	CU88
8	CONTR	2.3	18	30	26	18	27	23	0.23	0.32	0.27	2	3
12	CONTR	2.2	22	36	30	14	18	18	0.26	0.30	0.22	4	1
13	CONTR	1.8	21	29	32	16	21	24	0.25	0.25	0.20	3	2
28	CONTR	2.2	23	33	29	13	21	21	0.18	0.23	0.20	3	2
31	CONTR	2.5	40	40	39	18	25	23	0.21	0.38	0.29	3	2
40	CONTR	1.9	30	27	22	14	19	20	0.18	0.22	0.23	4	3
43	CONTR	1.9	26	35	39	15	26	21	0.19	0.42	0.26	3	1
47	CONTR	2.3	30	34	34	17	23	18	0.22	0.26	0.21	3	3
56	CONTR	1.6	32	30	27	18	25	21	0.37	0.42	0.28	3	3
57	CONTR	3.1	37	27	23	19	28	21	0.21	0.25	0.16	1	1
8	BRUSH	2.0	25	28	29	21	8	28	0.24	0.31	0.37	1	2
12	BRUSH	2.1	20	41	37	13	15	14	0.18	0.16	0.16	2	2
13	BRUSH	2.1	25	44	33	18	22	17	0.24	0.21	0.18	1	4
28	BRUSH	1.7	14	38	42	15	18	18	0.18	0.19	0.25	1	4
31	BRUSH	1.5	35	34	27	17	19	17	0.27	0.34	0.21	2	3
40	BRUSH	1.8	34	48	44	17	24	21	0.22	0.24	0.23	1	3
43	BRUSH	2.0	29	34	32	14	17	14	0.19	0.22	0.21	2	5
47	BRUSH	1.9	20	34	35	13	19	16	0.23	0.21	0.23	1	6
56	BRUSH	2.2	27	44	41	17	19	15	0.19	0.22	0.24	1	4
57	BRUSH	2.7	21	25	22	19	25	19	0.23	0.24	0.21	1	2
8	THIN	1.8	28	33	40	17	23	20	0.28	0.47	0.47	2	3
12	THIN	3.4	24	36	34	16	17	11	0.21	0.23	0.20	1	3
13	THIN	2.3	24	39	46	19	21	25	0.16	0.21	0.20	3	4
28	THIN	2.6	26	32	37	19	20	19	0.20	0.21	0.20	1	3
31	THIN	2.2	23	33	32	19	24	17	0.20	0.28	0.21	1	2
40	THIN	2.2	22	48	40	17	24	19	0.19	0.28	0.23	3	3
43	THIN	2.9	32	32	25	16	23	19	0.18	0.20	0.19	1	2
47	THIN	2.7	32	31	23	18	15	14	0.23	0.24	0.23	1	2
56	THIN	2.3	13	33	39	16	26	27	0.25	0.36	0.31	1	3
57	THIN	2.3	18	33	26	14	19	18	0.20	0.25	0.24	1	3
8	COMBO	2.4	18	36	32	15	27	20	0.19	0.21	0.25	1	3
12	COMBO	2.6	20	35	37	12	15	13	0.18	0.18	0.20	1	4
13	COMBO	2.0	20	29	24	18	24	18	0.21	0.30	0.21	2	4
28	COMBO	3.0	25	39	30	13	13	13	0.21	0.26	0.27	1	5
31	COMBO	1.6	13	25	25	19	28	21	0.25	0.31	0.25	0	3
40	COMBO	1.9	17	50	39	18	20	16	0.18	0.24	0.24	1	4
43	COMBO	1.3	26	33	25	9	16	14	0.19	0.17	0.31	1	3
47	COMBO	1.9	24	52	31	16	17	14	0.24	0.28	0.20	2	3
56	COMBO	1.5	22	36	25	19	21	16	0.27	0.27	0.24	1	4
57	COMBO	2.6	29	36	28	18	25	18	0.22	0.37	0.30	0	3

SITE=E44

PLOTNUM	TREAT	CUB9	FE	FE88	FE89	K	K88	K89	MG	MG88	MG89	MN	MN88
8	CONTR	4	16	59	41	0.61	0.76	0.65	0.08	0.12	0.13	1725	2885
12	CONTR	5	22	56	44	0.72	0.86	0.88	0.11	0.11	0.10	1475	2012
13	CONTR	5	25	57	53	0.80	0.94	0.95	0.09	0.11	0.14	1025	1259
28	CONTR	4	50	59	50	0.82	0.90	1.03	0.08	0.11	0.11	725	1402
31	CONTR	5	66	66	68	0.84	1.07	0.99	0.09	0.10	0.11	1425	2705
40	CONTR	0	61	57	41	0.75	0.79	0.67	0.08	0.11	0.15	675	1151
43	CONTR	0	54	90	56	0.81	0.91	0.79	0.09	0.15	0.15	575	1405
47	CONTR	1	54	78	68	0.87	0.93	0.85	0.09	0.11	0.12	1150	1371
56	CONTR	0	47	69	44	0.80	0.87	0.97	0.15	0.17	0.18	700	1673
57	CONTR	0	45	45	65	0.85	0.92	0.84	0.08	0.06	0.08	1450	2163
8	BRUSH	5	53	51	50	0.76	0.93	0.97	0.10	0.13	0.15	1275	1530
12	BRUSH	4	46	68	57	0.69	0.89	0.81	0.08	0.08	0.08	625	764
13	BRUSH	4	53	77	95	0.82	0.99	0.86	0.10	0.11	0.09	500	710
28	BRUSH	5	54	63	71	0.74	0.99	0.85	0.10	0.13	0.16	1025	1059
31	BRUSH	6	40	63	47	0.69	0.85	0.85	0.11	0.13	0.14	400	515
40	BRUSH	1	62	84	74	0.73	1.14	1.01	0.09	0.11	0.09	1300	1850
43	BRUSH	3	52	63	116	0.79	0.96	0.86	0.08	0.09	0.08	1250	1661
47	BRUSH	3	51	77	62	0.58	0.85	0.89	0.11	0.12	0.14	500	539
56	BRUSH	5	68	131	92	0.65	0.77	0.75	0.08	0.10	0.10	900	1220
57	BRUSH	3	52	54	77	0.66	0.85	0.71	0.07	0.08	0.07	1500	1638
8	THIN	9	60	98	140	0.57	0.86	0.71	0.08	0.10	0.11	400	889
12	THIN	8	38	68	62	0.82	1.01	0.71	0.09	0.11	0.09	925	1190
13	THIN	8	41	74	89	0.70	0.77	0.82	0.10	0.13	0.15	375	605
28	THIN	10	30	60	137	0.80	0.93	0.72	0.08	0.11	0.13	1200	1530
31	THIN	7	42	57	57	0.74	0.94	0.83	0.08	0.10	0.10	1675	2453
40	THIN	13	36	111	89	0.51	0.76	0.70	0.10	0.13	0.14	1350	1953
43	THIN	9	29	51	65	0.80	0.94	0.71	0.08	0.08	0.09	1200	1848
47	THIN	10	57	48	65	0.65	0.61	0.48	0.10	0.09	0.10	875	891
56	THIN	11	21	63	110	0.52	0.60	0.61	0.11	0.16	0.19	475	995
57	THIN	9	30	45	44	0.72	0.81	0.71	0.09	0.10	0.09	1175	1764
8	COMBO	1	44	57	54	0.92	1.25	0.79	0.08	0.08	0.10	1050	1467
12	COMBO	2	50	74	51	0.74	1.05	0.75	0.09	0.09	0.08	1175	1241
13	COMBO	2	47	105	42	0.89	1.02	0.88	0.11	0.08	0.11	800	1938
28	COMBO	2	52	63	57	0.79	1.00	0.88	0.09	0.10	0.09	750	1248
31	COMBO	1	46	41	42	0.73	1.19	1.21	0.10	0.13	0.12	325	506
40	COMBO	4	46	90	78	0.69	0.95	1.00	0.08	0.11	0.11	925	1136
43	COMBO	3	47	51	57	0.77	1.09	0.59	0.08	0.09	0.10	1100	1446
47	COMBO	3	45	99	60	0.48	0.67	0.94	0.08	0.09	0.10	750	1482
56	COMBO	3	43	68	54	0.80	1.06	0.90	0.11	0.10	0.09	725	740
57	COMBO	5	48	63	54	0.65	0.88	0.70	0.09	0.10	0.08	1350	3330

SITE=E44

PLOTNUM	TREAT	MN89	N	N88	N89	P	P88	P89	PPMS04	PPMS0488	PPMS0489
8	CONTR	2418	0.83	1.08	1.03	0.14	0.17	0.16	79	43	39
12	CONTR	1638	0.78	0.98	0.98	0.13	0.10	0.10	181	172	107
13	CONTR	1044	0.81	0.83	0.80	0.11	0.10	0.11	151	209	327
28	CONTR	1335	0.66	0.79	0.80	0.12	0.09	0.09	200	289	237
31	CONTR	2199	0.86	1.16	1.17	0.15	0.14	0.13	188	265	310
40	CONTR	1029	0.76	0.98	0.99	0.09	0.08	0.08	121	228	146
43	CONTR	1083	0.66	0.71	0.75	0.12	0.09	0.09	206	215	276
47	CONTR	1146	0.91	1.23	1.02	0.14	0.12	0.11	115	123	96
56	CONTR	1554	0.69	0.87	0.92	0.14	0.15	0.16	142	246	248
57	CONTR	1467	0.73	0.90	0.85	0.15	0.14	0.12	218	252	173
8	BRUSH	1632	0.69	0.84	1.02	0.13	0.14	0.17	170	203	208
12	BRUSH	792	0.85	1.13	0.95	0.15	0.15	0.14	91	68	79
13	BRUSH	606	0.83	1.10	0.88	0.14	0.14	0.11	194	203	158
28	BRUSH	1077	1.03	1.45	1.16	0.09	0.10	0.08	139	80	124
31	BRUSH	363	0.81	0.93	1.15	0.11	0.13	0.08	242	240	158
40	BRUSH	1572	0.83	1.36	1.07	0.12	0.13	0.13	170	209	276
43	BRUSH	1563	0.67	1.06	0.92	0.11	0.11	0.11	309	295	349
47	BRUSH	687	0.89	1.27	1.18	0.10	0.10	0.09	158	74	73
56	BRUSH	1005	0.90	1.22	1.15	0.12	0.13	0.12	97	80	131
57	BRUSH	1554	0.62	0.96	0.72	0.11	0.13	0.10	206	209	203
8	THIN	912	1.14	1.16	1.06	0.12	0.12	0.11	67	129	107
12	THIN	990	0.85	0.92	0.79	0.15	0.14	0.13	170	105	68
13	THIN	783	0.87	1.08	1.07	0.14	0.11	0.14	152	135	192
28	THIN	1536	0.89	1.11	1.02	0.15	0.18	0.17	267	185	130
31	THIN	2142	0.89	1.11	0.82	0.14	0.18	0.15	194	148	175
40	THIN	1788	1.12	1.26	1.07	0.13	0.13	0.13	109	166	186
43	THIN	1647	0.84	1.11	0.78	0.16	0.14	0.11	224	271	231
47	THIN	744	0.92	1.02	0.79	0.10	0.09	0.08	164	215	124
56	THIN	990	0.82	1.38	1.30	0.09	0.11	0.11	176	179	221
57	THIN	1626	0.90	1.11	0.92	0.13	0.12	0.09	170	197	137
8	COMBO	1512	0.79	1.13	0.87	0.14	0.20	0.16	158	209	124
12	COMBO	1431	0.86	1.27	1.16	0.10	0.09	0.09	194	185	124
13	COMBO	1434	0.80	1.53	0.94	0.16	0.18	0.15	212	209	186
28	COMBO	1299	0.75	1.11	1.18	0.10	0.11	0.10	200	154	146
31	COMBO	378	0.68	0.74	0.89	0.13	0.09	0.09	164	302	287
40	COMBO	1296	0.82	1.29	1.28	0.08	0.12	0.12	236	197	220
43	COMBO	1407	0.80	1.02	1.03	0.13	0.13	0.09	152	222	208
47	COMBO	1608	0.90	1.32	0.89	0.08	0.10	0.13	115	62	163
56	COMBO	1023	0.70	1.20	0.95	0.14	0.18	0.17	67	277	251
57	COMBO	2643	0.88	1.32	1.04	0.11	0.13	0.11	188	80	149

SITE=E44

PLOTNUM	TREAT	TOTALS	TOTALS88	TOTALS89	ZN	ZN88	ZN89
8	CONTR	0.060	0.079	0.079	0	5	0
12	CONTR	0.065	0.086	0.085	1	4	1
13	CONTR	0.063	0.079	0.088	5	6	2
28	CONTR	0.064	0.084	0.083	7	16	7
31	CONTR	0.083	0.116	0.116	9	10	6
40	CONTR	0.066	0.085	0.100	10	19	2
43	CONTR	0.063	0.071	0.077	7	8	0
47	CONTR	0.083	0.097	0.078	8	8	4
56	CONTR	0.073	0.082	0.084	9	25	0
57	CONTR	0.069	0.085	0.082	5	2	0
8	BRUSH	0.062	0.080	0.104	8	4	8
12	BRUSH	0.070	0.082	0.076	8	8	8
13	BRUSH	0.084	0.103	0.079	12	22	9
28	BRUSH	0.073	0.105	0.098	10		7
31	BRUSH	0.081	0.092	0.104	15		12
40	BRUSH	0.075	0.103	0.091	14	7	9
43	BRUSH	0.078	0.111	0.100	7	8	12
47	BRUSH	0.079	0.104	0.082	7	9	11
56	BRUSH	0.068	0.110	0.095	12	5	7
57	BRUSH	0.064	0.075	0.074	1	2	8
8	THIN	0.088	0.097	0.092	12	18	9
12	THIN	0.066	0.079	0.068	5	5	7
13	THIN	0.071	0.093	0.102	7	16	10
28	THIN	0.075	0.103	0.089	7	8	11
31	THIN	0.077	0.099	0.069	7	11	8
40	THIN	0.086	0.104	0.093	12	17	15
43	THIN	0.073	0.109	0.077	8	8	10
47	THIN	0.066	0.094	0.068	9	2	9
56	THIN	0.067	0.116	0.118	7	12	11
57	THIN	0.081	0.095	0.078	8	2	0
8	COMBO	0.069	0.092	0.074	7	6	8
12	COMBO	0.077	0.113	0.094	7	5	10
13	COMBO	0.074	0.100	0.089	8	13	9
28	COMBO	0.072	0.129	0.106	7	9	9
31	COMBO	0.073	0.080	0.088	6	0	8
40	COMBO	0.075	0.116	0.105	7	7	6
43	COMBO	0.076	0.092	0.079	10	4	8
47	COMBO	0.073	0.112	0.082	10	9	9
56	COMBO	0.073	0.126	0.088	6	10	7
57	COMBO	0.078	0.101	0.083	8	13	11

SITE=E55

PLOTNUM	TREAT	AVLEADER	BASAL88	BASAL89	BASAREA1	D10	D10_88	D10_89	DBH	DBH88
3	TRENCH	20.6667	0.00159043	0.00407150	0.00066052	29	45	72	6	13
14	TRENCH	43.6667	0.00220618	0.00373928	0.00070686	30	53	69	12	28
15	TRENCH	43.0000	0.00180956	0.00363168	0.00075477	31	48	68	15	26
17	TRENCH	57.6667	0.00373928	0.00554177	0.00085530	33	69	84	17	34
23	TRENCH	31.0000	0.00101788	0.00173494	0.00034636	21	36	47	3	15
27	TRENCH	37.0000	0.00166190	0.00352565	0.00061575	28	46	67	12	22
28	TRENCH	45.3333	0.00282743	0.00430084	0.00113411	38	60	74	20	32

PLOTNUM	TREAT	DBH89	HGHT88	HGHT89	HGHTJULY	VOL1_88	VOL1_89	VOL1JULY	WT	WT88
3	TRENCH	35	265	364	178	0.00139522	0.00490614	0.00038921	1.9	2.7
14	TRENCH	45	365	440	268	0.00266574	0.00544658	0.00062712	2.1	3.4
15	TRENCH	45	342	427	244	0.00204872	0.00513356	0.00060966	1.7	2.1
17	TRENCH	57	446	542	304	0.00552086	0.00994332	0.00086075	2.5	2.8
23	TRENCH	26	267	306	166	0.00089968	0.00175748	0.00019034	2.3	2.7
27	TRENCH	42	319	407	224	0.00175501	0.00475026	0.00045660	2.7	2.1
28	TRENCH	54	435	553	311	0.00407160	0.00787339	0.00116762	2.1	2.7

PLOTNUM	TREAT	WT89	ACTFE	ACTFE88	ACTFE89	B	B88	B89	CA	CA88	CA89	CU	CU88
3	TRENCH	2.8	31	58	55	16	13	9	0.24	0.24	0.22	3	3
14	TRENCH	2.8	29	41	32	11	8	6	0.23	0.27	0.23	6	3
15	TRENCH	2.2	27	47	37	12	12	7	0.20	0.24	0.18	5	2
17	TRENCH	2.6	27	61	47	13	13	11	0.29	0.25	0.25	6	2
23	TRENCH	2.8	23	55	43	14	22	14	0.23	0.32	0.29	2	3
27	TRENCH	3.0	25	59	40	14	14	11	0.22	0.28	0.24	4	4
28	TRENCH	2.0	25	57	48	11	15	14	0.24	0.30	0.29	3	4

PLOTNUM	TREAT	CU89	FE	FE88	FE89	K	K88	K89	MG	MG88	MG89	MN	MN88
3	TRENCH	4	32	96	78	0.72	0.92	0.76	0.10	0.08	0.07	1025	1145
14	TRENCH	5	29	66	60	0.62	0.84	0.65	0.08	0.09	0.10	1025	1185
15	TRENCH	2	27	66	54	0.55	0.91	0.72	0.09	0.10	0.09	1000	1457
17	TRENCH	4	26	39	57	0.57	1.12	0.69	0.08	0.12	0.08	1400	1362
23	TRENCH	2	25	81	69	0.69	1.10	0.84	0.07	0.09	0.09	1050	2361
27	TRENCH	4	34	75	57	0.62	1.02	0.74	0.07	0.06	0.07	825	1017
28	TRENCH	3	32	96	57	0.61	0.98	0.71	0.09	0.10	0.11	925	1220

----- SITE=E55 -----

PLOTNUM	TREAT	MN89	N	N88	N89	P	P88	P89	PPMS04	PPMS0488	PPMS0489
3	TRENCH	804	0.84	1.56	1.16	0.17	0.21	0.21	224	203	269
14	TRENCH	984	0.89	1.47	1.16	0.14	0.14	0.15	242	67	185
15	TRENCH	1065	0.95	1.80	1.19	0.15	0.23	0.22	164	148	316
17	TRENCH	1065	1.07	1.17	1.27	0.16	0.17	0.19	248	129	143
23	TRENCH	1929	1.09	1.74	1.27	0.17	0.26	0.21	109	271	245
27	TRENCH	633	0.93	1.39	0.96	0.13	0.17	0.14	91	135	209
28	TRENCH	921	0.91	1.48	1.10	0.16	0.25	0.22	236	228	281

PLOTNUM	TREAT	TOTALS	TOTALS88	TOTALS89	ZN	ZN88	ZN89
3	TRENCH	0.083	0.140	0.114	4	10	1
14	TRENCH	0.105	0.104	0.100	4	8	16
15	TRENCH	0.079	0.144	0.125	4	17	2
17	TRENCH	0.098	0.124	0.108	5	7	9
23	TRENCH	0.079	0.157	0.113	8	19	16
27	TRENCH	0.067	0.110	0.085	5	8	10
28	TRENCH	0.081	0.131	0.108	5	17	7

Appendix IX

Mean and standard error for tree dimensions and foliar nutrients at 0, 1, and 2 years.

Statistics are calculated for trees at the center of the treatment plots ($n=10$ for all values). The data are sorted by site and treatment. The values for the subset of blocks with trenching are included in Appendix X. The abbreviations are the same as those used in Appendix VIII.

VARIABLE	MEAN	STD ERROR OF MEAN	MEAN	STD ERROR OF MEAN	MEAN	STD ERROR OF MEAN	MEAN	STD ERROR OF MEAN
----- SITE=E55 TREAT=CONTR -----			TREAT=BRUSH -----		TREAT=THIN -----		TREAT=COMBO -----	
AVLEADER	33.900000	2.954407	34.233333	2.039759	37.800000	3.623040	33.966667	2.845594
BASAL88	0.001234	0.000177	0.001413	0.000253	0.001931	0.000324	0.002056	0.000243
BASAL89	0.001533	0.000176	0.001950	0.000345	0.002748	0.000509	0.003468	0.000420
BASAREA1	0.000717	0.000100	0.000762	0.000121	0.000821	0.000168	0.000829	0.000120
D10	29.600000	2.012185	30.400000	2.266667	30.700000	3.383128	31.700000	2.361967
D10_88	38.800000	2.715388	41.100000	3.494281	48.000000	4.139243	50.300000	3.120007
D10_89	43.500000	2.565801	48.200000	4.210569	56.800000	5.503130	65.300000	4.107040
DBH	13.500000	1.351953	12.800000	1.103530	14.400000	1.916014	14.200000	1.504069
DBH88	20.300000	1.626516	20.100000	2.147091	23.400000	3.124100	25.000000	2.180724
DBH89	27.500000	2.151227	29.200000	3.061590	34.200000	4.111772	37.800000	2.649109
HGHT88	313.300000	16.410735	312.400000	18.849226	326.300000	19.879107	331.800000	16.208914
HGHT89	368.700000	19.811360	376.900000	26.799440	389.700000	18.170825	418.400000	16.334150
HGHTJULY	245.000000	12.346839	240.900000	10.790376	246.100000	14.405593	239.900000	11.815668
VOL1_88	0.001337	0.000229	0.001555	0.000369	0.002261	0.000487	0.002321	0.000343
VOL1_89	0.001949	0.000288	0.002641	0.000617	0.003808	0.000839	0.004931	0.000740
VOL1JULY	0.000607	0.000107	0.000637	0.000132	0.000727	0.000175	0.000679	0.000117
WT	1.910000	0.097125	1.960000	0.110755	1.920000	0.111355	2.240000	0.161383
WT88	2.060000	0.110755	2.150000	0.071880	2.070000	0.084393	2.770000	0.164012
WT89	2.530000	0.103333	2.110000	0.111006	2.380000	0.101980	2.450000	0.218200
ACTFE	29.600000	1.720465	29.800000	1.547758	29.400000	0.733333	30.100000	2.705755
ACTFE88	36.700000	1.764149	39.500000	2.944864	44.700000	2.859876	46.600000	2.334286
ACTFE89	35.700000	1.838175	34.800000	3.057959	35.600000	1.904381	38.800000	3.434466
B	14.800000	0.785988	16.800000	0.813770	14.800000	0.940449	13.000000	0.714920
B88	19.100000	1.456403	19.200000	1.604161	18.400000	1.707500	17.700000	1.989137
B89	16.600000	1.156623	15.900000	1.079609	16.800000	1.412641	14.300000	1.445683
CA	0.192000	0.009522	0.201000	0.012152	0.226000	0.016746	0.231000	0.013287
CA88	0.282000	0.014667	0.220000	0.015202	0.273000	0.016197	0.255000	0.018028
CA89	0.239000	0.010588	0.249000	0.018102	0.244000	0.016207	0.264000	0.021766
CU	3.000000	0.714920	2.100000	0.348010	2.000000	0.596285	4.300000	0.300000
CU88	2.800000	0.489898	2.300000	0.366667	2.300000	0.260342	3.100000	0.276887
CU89	1.300000	0.395811	5.600000	0.305505	3.500000	0.341565	3.000000	0.394405
FE	33.800000	2.133333	29.300000	2.155355	28.900000	1.662996	26.900000	1.516209
FE88	64.700000	4.323193	71.200000	4.995109	80.100000	4.677250	77.000000	4.618802
FE89	57.900000	2.734349	94.400000	9.527739	64.700000	3.047950	53.700000	3.645545
K	0.656000	0.027252	0.670000	0.019889	0.652000	0.024891	0.568000	0.020155
K88	0.701000	0.040701	0.912000	0.046614	0.824000	0.046624	0.943000	0.040361
K89	0.652000	0.031369	0.756000	0.020774	0.718000	0.043558	0.695000	0.032566
MG	0.095000	0.003416	0.095000	0.002236	0.089000	0.004333	0.079000	0.002333
MG88	0.124000	0.006000	0.111000	0.006046	0.101000	0.006227	0.093000	0.006155
MG89	0.119000	0.008360	0.119000	0.012863	0.118000	0.008919	0.105000	0.010138

VARIABLE	MEAN	STD ERROR OF MEAN	MEAN	STD ERROR OF MEAN	MEAN	STD ERROR OF MEAN	MEAN	STD ERROR OF MEAN
----- SITE=E44 TREAT=CONTR -----			TREAT=BRUSH -----		TREAT=THIN -----		TREAT=COMBO -----	
AVLEADER	31.066667	2.409241	32.666667	2.366954	29.566667	3.759121	31.000000	4.257455
BASAL88	0.000998	0.000116	0.001385	0.000122	0.001230	0.000125	0.001759	0.000281
BASAL89	0.201438	0.000148	0.002214	0.000232	0.002052	0.000195	0.003069	0.000445
BASAREA1	0.000703	0.000084	0.000787	0.000077	0.000749	0.000085	0.001007	0.000187
D10	23.500000	1.654959	31.200000	1.787612	30.300000	1.994715	34.300000	3.435275
D10_88	35.100000	2.062630	41.500000	2.130467	39.000000	2.245984	45.600000	4.224795
D10_89	42.300000	2.160504	52.300000	3.047950	50.500000	2.634177	60.700000	4.982302
DBH	12.800000	1.254326	12.800000	0.928559	13.600000	1.392041	14.800000	2.356080
DBH88	15.800000	1.631632	19.200000	1.604161	19.500000	1.979057	21.600000	3.091925
DBH89	22.500000	1.995829	29.500000	2.061553	29.300000	2.196209	33.600000	4.158525
HGHT88	273.600000	11.259761	298.500000	13.607392	296.400000	13.400000	306.000000	24.438130
HGHT89	317.900000	16.439417	365.300000	18.660386	363.400000	15.677443	376.900000	27.554975
HGHTJULY	235.500000	10.217904	242.000000	9.959920	241.800000	12.004444	241.500000	15.741841
VOL1_88	0.000934	0.000140	0.001408	0.000159	0.001251	0.000156	0.001934	0.000397
VOL1_89	0.001567	0.000223	0.002785	0.000384	0.002539	0.000310	0.004110	0.000745
VOL1JULY	0.000561	0.000086	0.000551	0.000076	0.000629	0.000089	0.000857	0.000190
WT	1.860000	0.097980	1.950000	0.106719	1.800000	0.107497	1.850000	0.077817
WT88	1.910000	0.125122	2.370000	0.154955	2.240000	0.140000	2.450000	0.185143
WT89	2.180000	0.133996	2.000000	0.102198	2.470000	0.141461	2.080000	0.174356
ACTFE	27.900000	2.267892	25.000000	2.076322	24.200000	1.854724	21.400000	1.507021
ACTFE88	32.100000	1.337078	37.000000	2.328567	35.000000	1.619328	37.100000	2.643441
ACTFE89	30.100000	1.888268	34.200000	2.225109	34.200000	2.402776	29.600000	1.661325
B	16.200000	0.663325	16.400000	0.832666	17.100000	0.525991	15.700000	1.075484
B88	23.300000	1.085766	18.600000	1.528979	21.200000	1.093415	20.600000	1.667999
B89	21.000000	0.632456	17.900000	1.320353	18.900000	1.471583	16.300000	0.907377
CA	0.230000	0.017764	0.217000	0.009667	0.210000	0.011055	0.214000	0.009798
CAB88	0.305000	0.024324	0.234000	0.017010	0.273000	0.026502	0.259000	0.019462
CAB89	0.232000	0.013233	0.229000	0.017854	0.248000	0.026990	0.247000	0.012115
CU	2.900000	0.276887	1.300000	0.152753	1.500000	0.268742	1.000000	0.210819
CU88	2.100000	0.276887	3.500000	0.428174	2.800000	0.200000	3.600000	0.221108
CU89	2.400000	0.748331	3.900000	0.458258	9.400000	0.541603	2.600000	0.400000
FE	44.000000	5.424225	53.100000	2.428763	38.400000	3.902136	46.800000	0.853750
FE88	63.600000	4.044750	73.100000	7.216416	67.500000	6.839834	71.100000	6.618912
FE89	53.000000	3.435113	74.100000	6.900000	85.800000	10.632027	54.900000	3.195309
K	0.787000	0.024223	0.711000	0.022630	0.683000	0.036729	0.746000	0.039418
K88	0.895000	0.027049	0.922000	0.032992	0.823000	0.044373	1.016000	0.051255
K89	0.862000	0.041091	0.856000	0.028410	0.700000	0.031376	0.862000	0.054890
MG	0.094000	0.006864	0.092000	0.004422	0.091000	0.003480	0.092000	0.003590
MG88	0.115000	0.009220	0.108000	0.006289	0.111000	0.007371	0.097000	0.004726
MG89	0.127000	0.009195	0.110000	0.010646	0.119000	0.010483	0.098000	0.004163

VARIABLE	MEAN	STD ERROR OF MEAN	MEAN	STD ERROR OF MEAN
----- SITE=E55 TREAT=CONTR -----			SITE=E55 TREAT=THIN -----	
MN	1182.500000	100.072890	1117.400000	104.610303
MN88	1793.500000	169.825286	1829.600000	191.387460
MN89	1495.800000	102.644240	1529.100000	148.804603
N	0.935000	0.023202	0.935000	0.023956
N88	1.078000	0.032000	1.234000	0.062932
N89	1.099000	0.037771	1.010000	0.044247
P	0.153000	0.008307	0.159000	0.005859
P88	0.137000	0.008439	0.176000	0.008055
P89	0.129000	0.008750	0.157000	0.006675
PPMS04	213.000000	13.945927	206.800000	12.799132
PPMS0488	220.800000	20.128366	209.000000	27.450562
PPMS0489	168.900000	21.842085	192.900000	21.884774
TOTALS	0.086000	0.001619	0.084700	0.002060
TOTALS88	0.103400	0.002709	0.109800	0.005399
TOTALS89	0.095900	0.003532	0.092300	0.004321
ZN	6.700000	0.538516	6.000000	0.918937
ZN88	6.000000	0.869227	10.800000	1.504069
ZN89	3.300000	0.760847	6.000000	1.374369
----- SITE=E55 TREAT=BRUSH -----			SITE=E55 TREAT=COMBO -----	
MN	1042.500000	119.724800	1005.000000	61.779177
MN88	1305.200000	174.044937	1662.300000	167.483203
MN89	1172.100000	139.457556	1374.900000	131.482356
N	0.918000	0.023324	0.972000	0.034442
N88	1.075000	0.059015	1.322000	0.052235
N89	1.028000	0.043482	1.133000	0.060737
P	0.148000	0.005735	0.151000	0.005044
P88	0.142000	0.010306	0.184000	0.010770
P89	0.137000	0.010116	0.182000	0.010414
PPMS04	202.000000	10.395512	171.700000	7.105632
PPMS0488	212.100000	16.398814	187.100000	24.194329
PPMS0489	194.600000	17.554487	193.300000	21.764421
TOTALS	0.080400	0.001950	0.083800	0.002059
TOTALS88	0.098200	0.005046	0.114400	0.003634
TOTALS89	0.093100	0.004423	0.099600	0.006170
ZN	6.500000	0.819892	3.200000	0.592546
ZN88	5.700000	0.943398	11.000000	1.256096
ZN89	9.100000	0.706321	6.300000	0.895048

VARIABLE	MEAN	STD ERROR OF MEAN	MEAN	STD ERROR OF MEAN
----- SITE=E44 TREAT=CONTR -----				
MN	1092.500000	130.120137	965.000000	138.403597
MN88	1803.000000	194.313893	1411.800000	186.299568
MN89	1491.300000	153.109405	1315.800000	154.422278
N	0.769000	0.026934	0.924000	0.035628
N88	0.953000	0.052452	1.126000	0.039502
N89	0.931000	0.041431	0.962000	0.054238
P	0.129000	0.006046	0.131000	0.007063
P88	0.118000	0.009638	0.132000	0.009286
P89	0.115000	0.008851	0.122000	0.008667
PPMS04	160.100000	14.459484	169.300000	17.518910
PPMS0488	204.200000	23.390786	173.000000	15.203070
PPMS0489	195.900000	31.009121	157.100000	16.533098
TOTALS	0.068900	0.002605	0.075000	0.002530
TOTALS88	0.086400	0.003894	0.098900	0.003181
TOTALS89	0.087200	0.003815	0.085400	0.005220
ZN	6.100000	1.069268	8.300000	0.667499
ZN88	10.300000	2.333571	9.900000	1.870532
ZN89	2.200000	0.827312	9.000000	1.211060

VARIABLE	MEAN	STD ERROR OF MEAN	MEAN	STD ERROR OF MEAN
----- SITE=E44 TREAT=BRUSH -----				
MN	927.500000	126.351032	895.000000	91.727253
MN88	1148.600000	158.673963	1453.400000	243.859577
MN89	1085.100000	148.558440	1403.100000	176.715619
N	0.812000	0.038781	0.798000	0.022940
N88	1.132000	0.061623	1.223000	0.069794
N89	1.020000	0.047842	1.023000	0.044822
P	0.118000	0.005735	0.117000	0.008570
P88	0.126000	0.005416	0.133000	0.012654
P89	0.113000	0.008950	0.121000	0.009597
PPMS04	177.600000	20.675912	168.600000	15.648358
PPMS0488	166.100000	26.122128	189.700000	23.970375
PPMS0489	175.900000	27.300163	185.800000	17.401022
TOTALS	0.073400	0.002320	0.074000	0.000830
TOTALS88	0.096500	0.004177	0.106100	0.004992
TOTALS89	0.090300	0.003679	0.088800	0.003303
ZN	9.400000	1.301281	7.600000	0.452155
ZN88	8.000000	1.712598	7.600000	1.284091
ZN89	9.100000	0.604612	8.500000	0.453382

Appendix X

Mean and standard error for tree dimensions and foliar nutrients, for the treatment blocks with trenching, at 0, 1, and 2 years.

Statistics are calculated for trees at the center of the treatment plots in the subset of blocks with trenching ($n=7$ for all values). The data are sorted by treatment. The abbreviations are the same as those used in Appendix VIII.

VARIABLE	MEAN	STD ERROR OF MEAN	MEAN	STD ERROR OF MEAN	MEAN	STD ERROR OF MEAN	MEAN	STD ERROR OF MEAN
	TREAT=CONTR		TREAT=BRUSH		TREAT=THIN		TREAT=COMBO	
AVLEADER	36.714286	3.033698	35.095238	2.600076	38.666667	4.211976	34.000000	3.621657
BASAL88	0.001395	0.000217	0.001580	0.000346	0.002022	0.000387	0.002161	0.000288
BASAL89	0.001653	0.000189	0.002190	0.000471	0.003021	0.000600	0.003503	0.000528
BASAREA1	0.000830	0.000119	0.000840	0.000164	0.000859	0.000154	0.000835	0.000133
D10	32.000000	2.329929	31.857143	3.034944	32.285714	2.941609	32.000000	2.572751
D10_88	41.428571	3.168725	43.285714	4.789444	49.285714	4.916998	51.714286	3.590426
D10_89	45.428571	2.617315	50.857143	5.808158	60.142857	6.173787	65.571429	5.172533
DBH	14.428571	1.784285	13.857143	1.261680	15.857143	2.344483	15.285714	1.768969
DBH88	22.000000	1.864454	21.857143	2.676428	25.428571	3.810119	25.857143	2.272282
DBH89	28.857143	2.548843	30.571429	4.247448	36.857143	5.261851	38.714286	3.052823
HGHT88	326.285714	17.409240	331.285714	22.800078	336.285714	25.385330	331.571429	16.911333
HGHT89	386.142857	17.711213	394.142857	35.912876	398.714286	22.249360	416.142857	16.550685
HGHTJULY	256.857143	14.715441	252.857143	12.593325	256.142857	17.654662	245.571429	12.342063
VOL1_88	0.001546	0.000274	0.001835	0.000497	0.002436	0.000606	0.002398	0.000381
VOL1_89	0.002146	0.000293	0.003103	0.000832	0.004235	0.001015	0.004904	0.000863
VOL1JULY	0.000728	0.000128	0.000734	0.000178	0.000777	0.000185	0.000683	0.000118
WT	1.914286	0.118379	2.100000	0.102353	1.928571	0.161414	2.214286	0.192018
WT88	2.014286	0.098630	2.100000	0.081650	2.085714	0.112183	2.614286	0.199319
WT89	2.471429	0.101686	2.128571	0.153862	2.457143	0.125085	2.371429	0.223302
ACTFE	30.142857	2.443929	30.142857	2.109260	29.142857	0.828900	30.285714	3.649620
ACTFE88	36.857143	2.482592	40.285714	4.257846	43.714286	3.263903	45.285714	2.723044
ACTFE89	35.000000	2.246691	34.571429	4.087479	34.142857	2.384759	37.000000	4.710677
B	13.857143	0.704698	16.000000	0.786796	14.000000	0.308607	12.428571	0.895947
B88	17.285714	1.491472	17.714286	1.898800	15.714286	0.837066	16.142857	2.463337
B89	15.142857	1.033454	15.285714	1.442786	14.285714	0.521641	13.714286	2.008485
CA	0.190000	0.008729	0.185714	0.006494	0.212857	0.019726	0.230000	0.019149
CAB88	0.281429	0.016963	0.205714	0.019501	0.247143	0.013401	0.247143	0.021681
CAB89	0.241429	0.012427	0.247143	0.023976	0.227143	0.015231	0.271429	0.026675
CU	3.714286	0.837066	2.428571	0.428571	2.142857	0.594762	4.428571	0.368856
CU88	2.428571	0.202031	2.714286	0.359516	2.428571	0.297381	3.000000	0.308607
CU89	1.000000	0.487950	5.571429	0.428571	3.571429	0.480929	3.142857	0.340068
FE	33.857143	2.746674	29.857143	2.906713	28.857143	2.052044	27.428571	2.091447
FE88	65.285714	4.617329	75.142857	5.565320	79.428571	6.391427	73.571429	5.322267
FE89	57.428571	3.591373	90.285714	13.057956	64.142857	3.966698	50.571429	2.213133
K	0.618571	0.027982	0.642857	0.020437	0.638571	0.031124	0.552857	0.018736
K88	0.671429	0.055051	0.874286	0.059235	0.774286	0.029428	0.937143	0.054016
K89	0.615714	0.036506	0.732857	0.024370	0.664286	0.012884	0.707143	0.034759
MG	0.092857	0.004738	0.094286	0.002974	0.087143	0.005216	0.077143	0.001844
MGB88	0.121429	0.007377	0.111429	0.008571	0.095714	0.006494	0.092857	0.007781
MGB89	0.118571	0.011429	0.127143	0.017418	0.115714	0.010880	0.107143	0.014094

VARIABLE	MEAN	STD ERROR OF MEAN
----- TREAT=TRENCH -----		
AVLEADER	39.761905	4.435734
BASAL88	0.002122	0.000343
BASAL89	0.003792	0.000429
BASAREA1	0.000725	0.000091
D10	30.000000	1.951800
D10_88	51.000000	4.094131
D10_89	68.714286	4.218521
DBH	12.142857	2.261779
DBH88	24.285714	3.045014
DBH89	43.428571	4.016971
HGHT88	348.428571	27.510913
HGHT89	434.142857	33.778994
HGHTJULY	242.142857	21.536711
VOL1_88	0.002622	0.000618
VOL1_89	0.005687	0.000978
VOL1JULY	0.000614	0.000122
WT	2.185714	0.129887
WT88	2.642857	0.168830
WT89	2.600000	0.138013
ACTFE	26.714286	1.016865
ACTFE88	54.000000	2.751623
ACTFE89	43.142857	2.890284
B	13.000000	0.690066
B88	13.857143	1.595060
B89	10.285714	1.189523
CA	0.235714	0.010433
CA88	0.271429	0.011635
CA89	0.242857	0.014754
CU	3.142857	0.594762
CU88	3.000000	0.308607
CU89	3.428571	0.428571
FE	29.285714	1.304101
FE88	74.142857	7.513254
FE89	61.714286	3.263903
K	0.625714	0.022976
K88	0.984286	0.038905
K89	0.730000	0.022678
MG	0.082857	0.004206
MG88	0.091429	0.007047
MG89	0.087143	0.005654

VARIABLE	MEAN	STD ERROR OF MEAN	MEAN	STD ERROR OF MEAN	MEAN	STD ERROR OF MEAN
----- TREAT=CONTR -----			----- TREAT=THIN -----		----- TREAT=TRENCH -----	
MN	1189.285714	113.894419	105.714286	115.668804	1035.714286	67.448645
MN88	1860.428571	218.113760	1869.714286	240.532318	1392.428571	170.304469
MN89	1499.571429	129.241350	1501.285714	170.746500	1057.285714	156.457923
N	0.954286	0.028607	0.932857	0.031526	0.954286	0.035041
N88	1.088571	0.040616	1.264286	0.088771	1.515714	0.080441
N89	1.132857	0.037271	1.014286	0.059756	1.158571	0.040440
P	0.148571	0.007377	0.157143	0.007143	0.154286	0.005714
P88	0.130000	0.006547	0.175714	0.008411	0.204286	0.017163
P89	0.124286	0.009476	0.151429	0.008571	0.191429	0.012617
PPMSO4	208.142857	14.964129	202.714286	12.233277	187.714286	25.043500
PPMSO488	218.857143	28.744713	204.571429	39.081634	168.714286	26.113957
PPMSO489	159.428571	28.393374	187.714286	29.383113	235.428571	22.663015
TOTALS	0.088000	0.001543	0.084143	0.001933	0.084571	0.004840
TOTALS88	0.104429	0.003760	0.112714	0.007533	0.130000	0.007135
TOTALS89	0.097429	0.004407	0.092571	0.006027	0.107571	0.004735
ZN	6.857143	0.769309	6.571429	1.250850	5.000000	0.534522
ZN88	5.571429	0.868966	11.857143	1.981204	12.285714	1.948312
ZN89	2.571429	0.719032	5.000000	1.704336	8.714286	2.264785
----- TREAT=BRUSH -----			----- TREAT=COMBO -----			
MN	964.285714	147.887621	946.428571	70.379196		
MN88	1157.571429	203.840374	1495.000000	165.318164		
MN89	1075.714286	158.563899	1251.000000	130.835775		
N	0.958571	0.011218	1.012857	0.036103		
N88	1.057143	0.083373	1.300000	0.061296		
N89	1.042857	0.060581	1.174286	0.078402		
P	0.138571	0.004041	0.154286	0.005281		
P88	0.131429	0.012037	0.178571	0.015186		
P89	0.130000	0.011952	0.177143	0.012671		
PPMSO4	203.000000	11.129112	169.000000	9.746794		
PPMSO488	220.285714	21.996444	199.571429	31.003730		
PPMSO489	190.142857	21.531183	212.285714	27.691080		
TOTALS	0.082714	0.002265	0.086429	0.002022		
TOTALS88	0.098286	0.007110	0.113143	0.004490		
TOTALS89	0.094429	0.006282	0.103857	0.008296		
ZN	6.571429	0.528121	3.428571	0.685119		
ZN88	6.142857	0.986301	10.000000	1.527525		
ZN89	9.142857	1.010153	5.285714	0.865043		

Appendix XI

Mean and standard error for dimension and foliar differences, for the treatment blocks with trenching, after 1 and 2 years.

Variables	Year	Treatment				
		Control	Brush	Thin	Combined	Trench
Basal diameter (cm)	1	0.94 (0.14)	1.14 (0.24)	1.70 (0.24)	1.97 (0.19)	2.10 (0.27)
	2	1.34 (0.15)	1.90 (0.34)	2.79 (0.36)	3.36 (0.40)	3.87 (0.29)
Height (m)	1	0.69 (0.07)	0.78 (0.15)	0.80 (0.11)	0.86 (0.08)	1.06 (0.07)
	2	1.29 (0.07)	1.41 (0.28)	1.43 (0.11)	1.71 (0.08)	1.92 (0.14)
Stem volume (m ³ x10 ⁻³)	1	0.82 (0.17)	1.10 (0.34)	1.66 (0.43)	1.72 (0.29)	2.01 (0.52)
	2	1.41 (0.19)	2.37 (0.68)	3.46 (0.84)	4.22 (0.80)	5.07 (0.88)
Needle weight (mg)	1	0.10 (0.18)	0.00 (0.13)	0.16 (0.18)	0.40 (0.22)	0.46 (0.22)
	2	0.56 (0.14)	0.03 (0.16)	0.53 (0.17)	0.16 (0.33)	0.41 (0.13)
N (%)	1	0.134 (0.035)	0.099 (0.088)	0.331 (0.094)	0.287 (0.070)	0.561 (0.090)
	2	0.179 (0.035)	0.084 (0.068)	0.081 (0.060)	0.161 (0.078)	0.204 (0.035)
P (%)	1	-0.019 (0.006)	-0.007 (0.011)	0.019 (0.014)	0.024 (0.014)	0.050 (0.014)
	2	-0.024 (0.009)	-0.009 (0.011)	-0.006 (0.010)	0.023 (0.011)	0.037 (0.009)
K (%)	1	0.053 (0.040)	0.231 (0.055)	0.136 (0.053)	0.384 (0.044)	0.359 (0.045)
	2	-0.003 (0.030)	0.090 (0.016)	0.026 (0.039)	0.154 (0.029)	0.104 (0.020)
S (%)	1	0.016 (0.005)	0.016 (0.007)	0.029 (0.008)	0.027 (0.004)	0.045 (0.010)
	2	0.009 (0.005)	0.012 (0.007)	0.008 (0.006)	0.017 (0.007)	0.023 (0.006)

Appendix XI (continued)

Variables	Year	Treatment				
		Control	Brush	Thin	Combined	Trench
SO ₄ ²⁻ -S (mg/kg)	1	10.7 (30.0)	17.3 (15.9)	1.9 (29.3)	30.6 (26.4)	-19.0 (41.2)
	2	-48.7 (31.6)	-12.9 (16.7)	-15.0 (22.8)	43.3 (22.5)	47.7 (37.1)
Cu (mg/kg)	1	-1.3 (0.8)	0.3 (0.5)	0.3 (0.5)	-1.4 (0.6)	-1.1 (0.8)
	2	-2.7 (0.6)	3.1 (0.7)	1.4 (0.8)	-1.3 (0.5)	-0.7 (0.5)

NOTE: Changes in tree dimensions and nutrient concentrations were calculated by subtracting the initial values from the values at the end of each growing season. n=7 for all values.

Appendix XII

Plots with fertilizer and vegetation reduction

Introduction

A fertilizer trial was started in 1988 on sites E55 and E44. The sites are described in Chapter 2. Tree measurements and foliar samples were collected. A flaw in the field layout of this study yielded ambiguous results. The dimension and foliar data are presented.

Materials and methods

Study sites, field methods, and laboratory analysis

The plots are located on sites E55 and E44. Four contiguous plots with similar site, soil, and vegetation characteristics were selected at each site. Site E55 had seven trees per plot within a 6.5 m radius of plot center. Site E44 had 10 trees per plot within a 10 m radius of plot center. The trees selected were $3.0 \text{ m} \pm 0.25 \text{ m}$ tall on site E55 and $2.0 \text{ m} \pm 0.25 \text{ m}$ tall on site E44. The trees were at least 4.0 m apart. A single treatment was assigned to each plot. Within each plot, treatment was applied to a 2 m radius subplot around individual trees. The four treatments included: total vascular plant removal (thinning + herbicide), fertilization with 200 kg N + 75 kg P, a combination of the above treatments, and an untreated control. Thinning and herbicide treatments are described in greater detail in Chapter 2.

Pretreatment measurements included height and diameter at 10 cm above the germination point. Stem volume was calculated using the formula for a cone. Foliar samples were collected and composited for each plot on both sites. Pretreatment data was collected during August 1987. Herbicide was applied during August 1987. Fertilization and conifer removal were applied during April 1988. Height and basal diameter were remeasured in September of 1988 and 1989. Composite samples of foliage were collected at these times. Laboratory methods for foliar samples are described in Chapter 1. The nutrients measured were N (total), P (total), K (total), S (total and $\text{SO}_4^{2-}\text{-S}$), and Cu (total).

Data analysis

Changes in tree dimensions and concentrations of foliar nutrients were calculated by subtracting the initial values from the values at the end of each growing season. Plot means and standard errors were calculated for initial dimensions and for dimension differences after one and two

growing seasons. Foliar concentrations and nutrient differences after each growing season were tabulated. Confounding of initial plot differences with treatment response precludes further analysis of this data. The results are summarized in two tables. The dimension data is included in this appendix. The foliar data is included in Appendix XIII.

Appendix XII (continued)

Plot means (with standard errors in parentheses) for initial dimensions and change in dimensions after one and two growing seasons, for fertilizer study.

Variables	Treatment			
	Control	Complete vegetation removal	N + P fertilizer	Combined
E55				
<u>Initial dimensions</u>				
Basal diameter (cm)	5.88 ^a (0.26)	5.16 (0.35)	4.73 (0.22)	5.49 (0.20)
Height (m)	3.54 (0.15)	3.44 (0.11)	3.35 (0.15)	3.46 (0.08)
Stem volume (m ³ x 10 ⁻³)	3.26 (0.38)	2.47 (0.40)	1.99 (0.22)	2.72 (0.21)
<u>Change after one growing season^b</u>				
Basal diameter (cm)	1.87 (0.24)	1.70 (0.29)	1.49 (0.11)	1.89 (0.19)
Height (m)	1.16 (0.14)	1.28 (0.17)	1.13 (0.07)	1.04 (0.12)
Stem volume (m ³ x 10 ⁻³)	4.36 (0.79)	3.40 (0.51)	2.53 (0.18)	3.68 (0.47)
<u>Change after two growing seasons^b</u>				
Basal diameter (cm)	2.21 (0.36)	3.13 (0.26)	2.70 (0.25)	3.79 (0.22)
Height (m)	1.91 (0.17)	1.89 (0.21)	1.88 (0.07)	1.90 (0.08)
Stem volume (m ³ x 10 ⁻³)	6.35 (0.98)	7.12 (0.65)	5.66 (0.68)	9.36 (0.84)

Appendix XII (continued)

Variables	Treatment			
	Control	Complete vegetation removal	N + P fertilizer	Combined
E44				
<u>Initial dimensions</u>				
Basal diameter (cm)	2.52 (0.09)	2.60 (0.15)	2.71 (0.10)	2.56 (0.13)
Height (m)	1.94 (0.03)	1.82 (0.04)	1.97 (0.05)	1.96 (0.04)
Stem volume (m ³ x 10 ⁻³)	0.33 (0.03)	0.33 (0.05)	0.39 (0.04)	0.34 (0.04)
<u>Change after one growing season^b</u>				
Basal diameter (cm)	0.28 (0.06)	0.70 (0.08)	0.82 (0.08)	0.93 (0.06)
Height (m)	0.49 (0.08)	0.81 (0.13)	0.53 (0.06)	0.67 (0.06)
Stem volume (m ³ x 10 ⁻³)	0.18 (0.04)	0.46 (0.09)	0.43 (0.05)	0.51 (0.05)
<u>Change after two growing seasons^b</u>				
Basal diameter (cm)	0.68 (0.11)	2.32 (0.17)	2.19 (0.15)	2.98 (0.12)
Height (m)	0.88 (0.12)	1.65 (0.19)	1.26 (0.07)	1.49 (0.08)
Stem volume (m ³ x 10 ⁻³)	0.47 (0.09)	2.00 (0.33)	1.67 (0.17)	2.45 (0.18)

NOTE: n=7 for E55 and n=10 for E44.

^aIt is not a legitimate statistical test to compare these means using the standard error. This would be an example of pseudoreplication (Hurlbert 1984).

Appendix XII (continued)

^bChanges in dimension values were calculated by subtracting the values at the beginning of the study from the values after each growing season.

Appendix XIII

Foliar analyses for composited samples from plots
with fertilizer treatments.

Variables	Treatment			
	Control	Complete vegetation removal	N + P fertilizer	Combined
E55				
<u>Initial foliar concentrations</u>				
N (%)	0.98	0.98	0.89	0.94
P (%)	0.15	0.16	0.16	0.16
K (%)	0.71	0.65	0.69	0.68
S (%)	0.085	0.088	0.086	0.092
SO ₄ ²⁻ -S (mg/kg)	206	194	188	218
Cu (mg/kg)	1	1	1	1
<u>Change after one growing season^a</u>				
N (%)	0.10	0.10	0.65	0.92
P (%)	0.01	0.03	0.11	0.12
K (%)	0.11	0.10	-0.05	0.04
S (%)	0.032	0.037	0.013	0.009
SO ₄ ²⁻ -S (mg/kg)	114	120	-139	-193
Cu (mg/kg)	1	4	3	1
<u>Change after two growing seasons^a</u>				
N (%)	0.06	0.05	0.42	0.39
P (%)	0.00	0.02	0.09	0.11
K (%)	0.03	0.14	-0.25	-0.14
S (%)	0.012	0.005	0.013	0.010
SO ₄ ²⁻ -S (mg/kg)	-3	33	-110	-104
Cu (mg/kg)	0	4	4	0

Appendix XIII (continued)

Variables	Treatment			
	Control	Complete vegetation removal	N + P fertilizer	Combined
E44				
<u>Initial foliar concentrations</u>				
N (%)	0.85	0.97	0.83	0.86
P (%)	0.11	0.12	0.09	0.12
K (%)	0.78	0.77	0.75	0.76
S (%)	0.072	0.080	0.070	0.075
SO ₄ ²⁻ -S (mg/kg)	176	133	121	176
Cu (mg/kg)	1	1	2	1
<u>Change after one growing season^a</u>				
N (%)	0.10	0.35	0.96	1.22
P (%)	0.00	-0.01	0.14	0.14
K (%)	0.09	0.33	-0.15	0.11
S (%)	0.019	0.028	0.009	0.024
SO ₄ ²⁻ -S (mg/kg)	9	-28	-103	-151
Cu (mg/kg)	2	4	1	1
<u>Change after two growing seasons^a</u>				
N (%)	0.14	0.11	0.22	0.33
P (%)	0.00	0.00	0.10	0.10
K (%)	-0.01	0.18	-0.31	-0.01
S (%)	0.020	0.006	0.005	0.005
SO ₄ ²⁻ -S (mg/kg)	55	19	-48	-137
Cu (mg/kg)	0	4	-2	1

NOTE: Each value is for a composite sample of 7 subsamples on E55 and 10 subsamples on E44.
^aChanges in nutrient concentrations were calculated by subtracting the values at the beginning of the study from the values at the end of each growing season.

Appendix XIV

Monthly climatic moisture deficits for Eve River
drainage: 1987-89 growing seasons.

Year/ month	Energy limited transpiration ^a	Precipitation ^b	Climatic moisture deficit ^c
-----mm-----			
1987			
April	28.7	127.8	-
May	56.7	93.6	-
June	70.7	104.4	-
July	80.9	57.3	-23.6
August	64.5	17.6	-46.9
September	42.1	98.5	-
1988			
April	31.4	87.8	-
May	52.7	58.3	-
June	57.9	76.6	-
July	68.5	27.0	-41.5
August	60.2	49.0	-11.2
September	36.4	77.2	-
1989			
April	39.0	93.3	-
May	63.0	43.4	-19.6
June	75.9	41.3	-34.6
July	67.4	39.4	-28.0
August	57.8	39.2	-18.6
September	41.3	14.2	-27.1

^aEnergy limited transpiration (E_{MAX}) is calculated from total monthly sunshine hours and mean monthly air temperatures. Values for the closest climate station (Alert Bay) were used (Environment Canada, 1987-1989). The calculation is described in Spittlehouse (1989).

^bMonthly precipitation was measured with a rain gauge at the Eve River Divisional Office.

^cMonthly climate deficit is the difference between E_{MAX} and monthly precipitation. It is calculated for months where E_{MAX} is greater than precipitation.