

FOREST BIOMASS AND NUTRIENT STUDIES IN
CENTRAL NOVA SCOTIA

by

B. Freedman, P.N. Duinker, H. Barclay,
R. Morash and U. Prager

Institute for Resource and Environment Studies
and
Department of Biology, Dalhousie University
Halifax, Nova Scotia B3H 4J1

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Canadian Forestry Service
P.O. Box 4000
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ABSTRACT

Logarithmic and quadratic equations are given for estimating the fresh and dry weights and nutrient contents (N, P, K, Ca, and Mg) for various components of ten tree species in central Nova Scotia. These species are: balsam fir, white spruce, black spruce, red spruce, red maple, sugar maple, yellow birch, white birch, large-tooth aspen and trembling aspen. The relative distributions of biomass and nutrient content among the various components are described for each species.

In Part 2, data are presented on the aboveground standing crops of biomass and nutrients (N, P, K, Ca, and Mg) in various tree compartments for eight softwood and eight hardwood stands in central Nova Scotia.

RESUME

Des équations logarithmiques et quadratiques sont données pour l'estimation du poids à l'état frais, du poids anhydre et de la teneur en éléments nutritifs (N, P, K, Ca, et Mg) de plusieurs parties de l'arbre pour chacune de dix essences dans la Nouvelle-Ecosse centrale, notamment le sapin baumier, l'épinette blanche, l'épinette noire, l'épinette rouge, l'érable rouge, l'érable à sucre, le merisier, le bouleau à papier, le grand tremble, et le tremble. Les distributions relatives de biomasse et du contenu en matière nutritive sont détaillées pour toutes ces essences.

La deuxième partie du rapport présente des données relatives à la biomasse sur pied et aux éléments nutritifs (N, P, K, Ca, et Mg) des diverses parties de l'arbre (exception faite du système radiculaire) pour huit peuplements de conifères et huit peuplements de feuillus en Nouvelle-Écosse centrale.

FOREWORD

ENFOR is the bilingual acronym for the Canadian Forestry Service's ENergy from FORest (ENergie de La FORêt) program of research and development aimed at securing the knowledge and technical competence to facilitate in the medium to long term a greatly increased contribution from forest biomass to our nation's primary energy production. This program is part of a much larger federal government initiative to promote the development and use of renewable energy as a means of reducing our dependence on petroleum and other non-renewable energy sources.

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Canadian Forestry Service
Department of the Environment
Ottawa, Ontario
K1A 1G5

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Part 1

**Biomass and Nutrient Standing Crop Equations
for Ten Tree Species in Central Nova Scotia**

by

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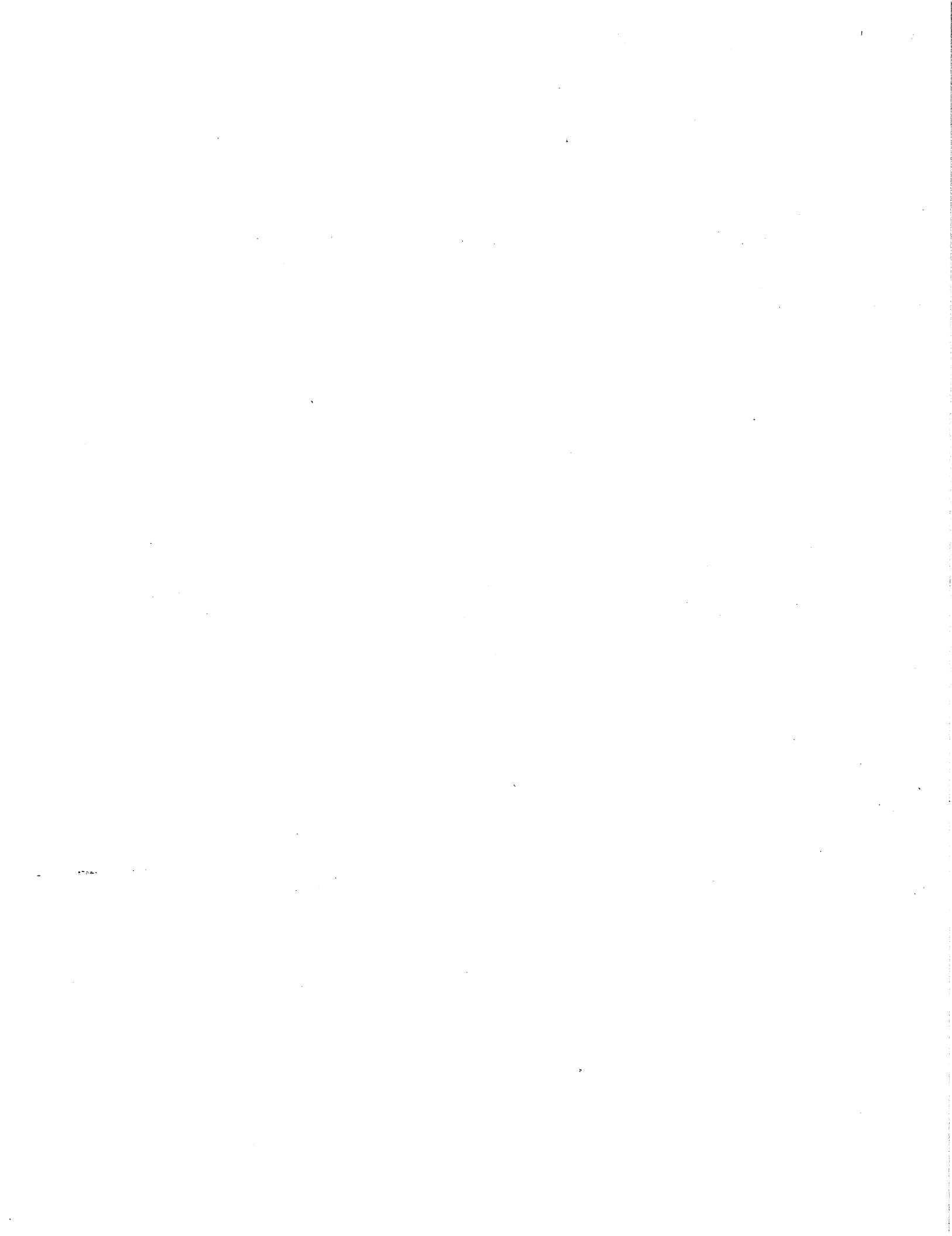


TABLE OF CONTENTS

PART 1.

	Page
INTRODUCTION.....	1
STUDY AREA.....	1
METHODS.....	1
Preliminary Procedures.....	1
Field Procedures.....	2
Laboratory Procedures.....	3
Data Analysis.....	5
RESULTS AND DISCUSSION.....	5
Component Distribution.....	5
Equations.....	7
Strength of Relationships.....	7
Height as a Predictor Variable.....	8
Bias Correction Factor.....	9
Additivity of Equations.....	9
REFERENCES.....	10
TABLES.....	12
APPENDIX 1.....	98
APPENDIX 2.....	99

INTRODUCTION

To maximize the short-term economic returns from forest management and harvest for energy or fibre, it appears likely that intensive removals of tree biomass will occur over increasingly larger tracts of forest. For example, whole-tree (above-ground), and possibly even complete-tree (above- and below-ground) clear-cut harvesting may become extensively used in some situations. Although these intensive harvests increase the yields of biomass per unit area of forest land, they increase nutrient removals by substantially larger factors. This occurs because the increased biomass yields accrue from relatively nutrient-rich tissues, such as foliage and branches. Several recent reviews have brought together much of the available information relevant to these processes, for a wide range of forest types (e.g. Kimmins *et al.* 1979; Freedman 1981; Kimmins 1981). At present, the ecological consequences of these potentially accelerated rates of nutrient removal from forest stands are not understood. This is largely due to a lack of site-, species-, and nutrient-specific data relevant to such factors as nutrient removals with harvested biomass, and the sizes of nutrient pools and rates of cycling in both disturbed and undisturbed stands. More importantly, even where these data are available, we have an incomplete understanding of how these and other factors interact to determine site productivity.

This report presents the results of part of a research project conducted under the ENFOR Programme to evaluate the effects of intensive harvesting of forests for energy purposes on the nutrient status and long-term productivity of selected forest sites in Nova Scotia. A major portion of this research involved the determination of the standing crops

of biomass and nutrients in various compartments (e.g. wood, bark, branches, foliage, etc.) of a variety of forest stands, so as to calculate the potential yields by conventional and whole-tree clear-cuts of these stands. These calculations were made using predictive regressions for the standing crops of biomass and nutrients for ten tree species. The regressions, and the methods used in their determination, are described in Part 1 of this report.

STUDY AREA

The location of the study area is central Nova Scotia. Nine of the forest stands from which trees were taken are located in Kings County, one stand is in Annapolis County, and two stands are in Hants County. All stands are within the Sugar Maple-Hemlock-Pine Zone of Loucks' (1962) classification, except the stands in Hants County, which are within the Sugar Maple - Yellow Birch - Fir Zone. The characteristics of the various stands are described in more detail in Part 2 of this report.

METHODS

Preliminary Procedures

Planning for the number of trees that would comprise the sample for each species was based partly on suggestions found in literature (Saucier 1979), but also on available time and manpower. In general, the number sampled for each species depended on its relative frequency in the stands for which biomass and nutrient standing crop estimates were desired. Table 1 shows the number of trees sampled for each species by diameter at breast height (DBH) size class, and Table 2 shows the ranges of DBH and height (H) for the sampled trees, and the dates of sampling for each species.

Field Procedures

On any day, the choice of individual trees to be sampled was based only on species and DBH size class. For stands in which the species of interest occurred at relatively high density, the following procedures were used to select sample trees:

- a) a straight-line transect was established through the stand;
- b) a size class of tree to be sampled (set arbitrarily before arriving at the stand) was assigned to a point along the transect using a random numbers table;
- c) from the random point, the second nearest eligible tree (correct species and DBH class) was identified as a sample tree. When eligible trees were scarce near the point, the nearest eligible stem was taken.

Apart from species and DBH size class, randomly selected trees were NOT rejected on the basis of form, apparent vigour, pest damage, crown position, or for any other reason. The following measurements were made on each tree prior to felling:

- a) DBH - with a diameter tape, to the nearest 0.1 cm;
- b) crown width - the average of two measurements taken at right angles, to the nearest 0.1 m;
- c) crown position - dominant, codominant, intermediate, or suppressed;
- d) height estimates - made by three or four different people using a Suunto clinometer. The sample trees were then cut as close as possible to ground level. Once on the ground, the following measurements were made:
- e) stump height - to the nearest cm;
- f) height - from the cut line to the tip of the highest branch or leader, to the nearest 0.1 m;
- g) crown length - from the tip of the highest branch or leader to the lowest live branch (excluding small branchlets as are found on

the stems of certain tolerant hardwoods), to the nearest 0.1 m.

Since the procedures for softwoods and hardwoods differed slightly beyond this point, they are discussed separately.

Softwoods - Live branches were severed from the stem and sorted according to the basal diameter limits: 0-2, 2-4, and 4-6 cm. Attached dead branches were severed from the stem and collected, as were those which broke from the tree on impact with the ground. The stem was then cut into 2.5 m sections, beginning from the cut line, and up to a "merchantability limit" of 8.0 cm.

All stem sections and branch classes were fresh-weighed using Chatillon spring scales (suspended, dial type). The limits of precision were as follows:

- fresh weight of 0 - 30 kg, to the nearest 0.05 kg;
- fresh weight of 30 - 60 kg, to the nearest 0.10 kg;
- fresh weight of 60 - 90 kg, to the nearest 0.5 kg;
- fresh weight of 90 - 180 kg, to the nearest 1.0 kg;

After weighing, a disc of 5 ± 1 cm thickness was cut from the bottom end of each stem section. These discs were marked for identification and sealed in doubled polyethylene bags. From each class of live branches a sample of one branch was taken. Since dead branches were not discrete after cutting and handling, a grab sample usually exceeding 0.2 kg fresh weight was taken. All branch samples were cut into small, manageable pieces and were sealed separately in doubled polyethylene bags. All samples were transported the same day to the field laboratory for further processing.

Hardwoods - All live branches were severed from the felled tree at the point of 2.0 cm diameter. Where smaller branches joined a branch greater

than 2.0 cm diameter, they were severed at the point of joining. These live branches, bearing all the foliage, were sorted into two classes based on basal diameter: 0 - 0.7, and 0.7 - 2.0 cm. For estimating the oven-dry weight of foliage of a tree, the smaller size class was deemed necessary to account for the expected higher foliage to branch weight ratio of the abundant branchlets occurring in the maples and birches. For the aspens, only one live branch class occurred.

Dead branches were also severed from the tree and collected. Then all unmerchantable stem and branch wood, within the diameter limits 2.0 - 8.0 cm, was severed from the larger portions of stem and collected. Beginning from the cut line, the remaining stem was cut into 2.0 m-long sections. Thus, merchantable stem for hardwoods was defined as all wood (plus bark) to a lower diameter limit of 8.0 cm.

All stem sections, unmerchantable wood, and branch classes were weighed separately in the fresh condition. After weighing, a disc of 5 ± 1 cm thickness was cut from the bottom end of each stem section. These discs were marked for identification and sealed in doubled polyethylene bags. From the dead branch class and smaller live branch class, grab samples usually exceeding 0.2 kg were taken and sealed in doubled polyethylene bags. From the larger live branch class, a grab sample of 2 branches from trees less than 10 cm DBH, or 3 branches from trees greater than 10 cm DBH was taken. Each sample branch was cut into manageable pieces and sealed in a doubled polyethylene bag. From the unmerchantable wood section, a sample of 5 discs, each about 10 cm long and of various diameters, was taken and sealed in a doubled polyethylene bag. All samples were transported the same day to the field laboratory for further processing.

Laboratory Procedures

The same day that the trees were felled, their subsamples were processed at the field laboratory. Discs were debarked with a knife, and wood and bark were weighed separately to the nearest 0.1 g using an Ainsworth electronic balance. Branch samples, both dead and live, were also weighed to the nearest 0.1 g. All samples were subsequently dried in a 0.3 m^3 forced-draft oven at 105°C for 24 h. Wood and bark from disc samples and dead branch samples were reweighed dry and then discarded. Live branch samples were defoliated by hand, and the wood plus bark, and leaves (plus fruit in some cases) were weighed separately and then discarded.

Using the weight data collected in the field, the following fresh weights (FW) were determined for each tree:

- a) merchantable stem;
- b) unmerchantable crown (comprising all above-ground components except merchantable stem);
- c) total above-ground tree (a + b).

Component oven-dry weights (ODW) for each tree were estimated using ratios of ODW/FW from the samples. In estimating ODW of merchantable stem sections, and unmerchantable stem sections of softwoods, data from both the disc from the bottom of any section and the disc from the bottom of the next section up were used in the calculation (except for the smallest stem section, whose dry weight was estimated using data from one disc only). The sum of such ODW estimates for any one tree yielded an estimate of ODW's merchantable stem wood, merchantable stem bark, and total merchantable stem.

For dead branches and unmerchantable wood of hardwoods, estimates of ODW were calculated as the product of FW and the ratio ODW/FW of the sample.

Oven-dry weight of foliage for any branch size class of any tree was

estimated by the product of FW of the branch class and the ratio ODW foliage/FW sample. For branch wood plus bark, the estimate was the product of FW of the branch class and the ratio(ODW wood + bark)/FW sample. The sum of ODW's of the various classes gave estimates of ODW foliage and branch wood plus bark for the tree.

For the hardwood live branch class 0.7 - 2.0 cm basal diameter, and for all softwood live branch classes, the ratios ODW foliage/FW sample and ODW (wood + bark)/FW sample were quite variable, even when comparing these ratios for trees of the same DBH class. Since the ultimate aim of the regression equations developed in this study was to estimate stand weights as opposed to single tree weights, it was decided to pool ratios for branches of the same size class taken from trees of the same DBH class, and to use the resultant mean ratios in the estimation of ODW foliage and ODW branch wood + bark for trees of that DBH class. For example, for any hardwood tree greater than 10 cm DBH, the estimate of ODW foliage on branches in the size class 0.7 - 2.0 cm, was the product of the FW of those branches and the mean of from 12 to 18 ratios of ODW sample foliage/FW sample. For softwoods the number of ratios contributing to each mean was smaller (from 4 - 6), since only one branch per size class was subsampled from any one tree.

Based on the calculations described above, estimates of ODW were obtained for various components of each tree sampled. For softwoods, these components included:

- a) wood, merchantable stem;
- b) bark, merchantable stem;
- c) wood + bark, merchantable stem;
- d) wood + bark, unmerchantable stem;
- e) wood, total stem;
- f) bark, total stem;
- g) wood + bark, total stem;
- h) dead branches;

- i) wood + bark, live branches;
- j) foliage;
- k) total crown 1 - foliage + all branches;
- l) total crown 2 - crown 1 + unmerchantable stem;
- m) total above-ground tree.

For hardwoods, ODW estimates were obtained for components a, b, c, h, j, and m as above, and i and k including unmerchantable wood less than 8 cm diameter (i.e. components d, e, f, g, and l were undefined for hardwoods).

Subsamples were also taken from each tree for measurement of nutrient concentration. Samples were taken of stem wood, stem bark, foliage, branch wood + bark, and dead branches. For each species, these subsamples were combined by 5 cm DBH class. These samples were then homogenized by chipping with a Mighty Mac 12-P Shredder-Chipper. A subsample of these chips was then ground and homogenized by passing through a Wiley mill fitted with a 20-mesh screen.

All subsamples were dried at 70°C and then forwarded to the Soil Laboratory, Soils and Crop Branch, Nova Scotia Department of Agriculture. The various analytical methods used were as follows:

- a) Nitrogen and Phosphorus: Biomass homogenate samples of 0.50 g were digested in a hot sulfuric acid-hydrogen peroxide mixture, and concentrations of nitrate and phosphate were analyzed by a Technicon Auto-Analyzer.
 - b) Potassium, Calcium, and Magnesium: Biomass samples of 0.50 g were dry-ashed at 535°C in a Luidbergh furnace. The residues were then dissolved in hydrochloric acid, and after appropriate dilutions, cations were determined by atomic absorption spectrophotometry.
- To determine the contents of nutrients in the various components of each tree, these nutrient concen-

trations were multiplied by the bio-mass weight.

Data Analysis

Raw data (i.e. the various biomass or nutrient weights) for each tree were coded on computer cards, and analysis and data manipulations were carried out on the Dalhousie University Computer using regression sub-programs of either the Statistical Package for the Social Sciences (Nie et al. 1975), or the Biomedical Computer Programs (Brown 1977).

Specifically, equations were developed using models of the form:

- a) $\ln W = a + b \ln D^2 H$
 - b) $\ln W = a + b \ln D$
 - c) $\ln W = a + b \ln D + c \ln H$
 - and
 - d) $W = a + bD + cD^2$,
- where

\ln = natural logarithm, W = the weight of biomass (kg) or nutrients (g) in each component, D = diameter at breast height in cm, and H = tree height in metres. These four equations are presented to:

- i) provide equations with both D alone, and D and H together,
- ii) provide an opportunity to compare results from applying equations of different forms, and
- iii) to give the reader/user an opportunity to use equations of a form that is most familiar and comfortable to him.

For equations of the model form $\ln W = a + b \ln X$, a correction factor c was calculated, where $c = e^{(s^2)^{1/2}}$, e is the base of the natural logarithm and s is the standard error of the estimate of the regression. This factor is designed to correct for the systematic under estimate of component weight that is obtained from the expression $w = e^a + b \ln X$. The corrected weight estimate W^* can be calculated as $W^* = e^{\ln W} X c$, where $\ln W$ is obtained from the regression equations.

RESULTS AND DISCUSSION

Component Distribution

Tables 3 and 4 show the relative distributions of the oven-dry weights of above-ground tree components for the ten species examined. Table 3 indicates percentage distribution calculated using all trees of each species, allowing quick comparisons among species. Table 4 shows the same percentages stratified by DBH size class.

Several trends in component biomass distribution are evident from these data. Except for large-tooth aspen, wood of the merchantable stem reached its maximum percentage in the DBH range of 15 - 25 cm. The relative percentage of this component for all size classes was lowest for balsam fir.

Bark of the merchantable stem generally accounted for 8 - 10% of the total above-ground dry weight for all tree size classes, except for aspens where bark percentage exceeded 15%. Unmerchantable stems, a component defined only for softwoods in this study, contributed 45% or more to total above-ground dry weight when DBH was less than 8 cm, but for the largest trees sampled of each coniferous species, it contributed less than 1%.

Softwoods generally had a higher percentage of dry weight in dead branches than did hardwoods. Among the softwoods black spruce had the highest overall percentage of dead branches (9.0%), while among the hardwoods trembling aspen had the highest percentage (5.3%).

Live branches of the softwoods, consisting of live, non-stem wood plus bark, generally occurred in greater proportions in the smaller than in the larger trees. However, white spruce trees did not follow this pattern. In the hardwoods, where live branches consisted of all live

wood plus bark less than 8 cm diameter (thus including all stem wood and bark of trees less than 8 cm DBH), small trees consisted of over 90% of this component. This decreased to the range 15 - 20% for most trees of the larger size classes.

Foliage of hardwood trees generally accounted for about 2% of total above-ground dry weight. However, small trees, especially aspen, had higher percentages. Softwoods generally had a higher proportion of foliage than hardwoods (range 7.7 - 16.3%, Table 3). Overall, balsam fir trees had the highest percentage of foliage.

Detailed comparisons of the data presented in Tables 3 and 4 with similar data in many other studies are almost impossible, for two reasons. Firstly, the definitions of the various components differ among studies, and in some studies a clear definition for some components is not given. For example, stem components in this study were defined on the basis of merchantability, while the stem components of Ker (1980a,b) were not. Whereas this study and that of Ker (1980a,b) treated foliage as a separate component, Crow and Blank (1978) grouped foliage and current twigs together into one component.

Secondly, many studies have reported component biomass distribution data on a stand basis (per unit area), rather than the same data based on only the sample trees of each species, as was done in this study and others (e.g., Crow and Blank 1978; Ker 1980a,b). One would only expect the data to be comparable if the size and species-specific densities of trees within the stands of other studies were similar to those in this study. However, this is highly unlikely, and in most cases unknown.

Comparisons can be made between this study and that of Ker (1980a) for the foliage component. Ker

(1980a) reported a foliage weight percentage for aspen, white birch and red maple of 2%, and this value closely corresponds to the values for the six hardwood species in this study (range 2.0 - 2.4%; Table 3). For softwoods, the white spruce and black spruce sample trees of Ker (1980a) averaged 11% of their dry weight in foliage, while the foliage percentages for the same species in this study were 7.9 and 8.5%, respectively. However, sample trees of balsam fir in this study averaged 14.6% of their dry weight in foliage, which is similar to the values of up to 16.4% reported by Baskerville (1965). However, Ker (1980a) found only 9% of total weight in the foliage of balsam fir trees sampled in Nova Scotia. The higher percentage in foliage found in our study is probably due to the relatively open-grown nature of many of the larger balsam fir trees sampled in this study, resulting in long and full live crowns. Honer (1971), studying balsam fir stands in Eastern Ontario, compared the component weights of an open-grown tree and a forest-grown (closed-canopy) tree of the same height (19.2 m). His data show that the open-grown tree had 14.0% of its total above-ground dry weight in foliage, whereas the forest-grown tree had a foliage percentage of only 7.8%.

Table 5 (a - e) shows the relative distribution of the weights of nutrients (N, P, K, Ca, and Mg) of above-ground components for trees > 15.0 cm DBH for the ten species examined. Although these data will not be discussed in detail here, inspection of the data indicates that a much higher percentage of the whole-tree nutrient content is in non-merchantable components (such as wood + bark of the unmerchantable stem, dead branches, live branches, and foliage) than was found for biomass. This occurs because these unmerchantable components

generally have much higher nutrient concentrations than those found in wood or bark of the merchantable stem.

In a whole-tree harvest, these unmerchantable components would be removed from the stand, in addition to the merchantable stems. In such a harvest, the increase in yield of biomass that would occur in the more intensive harvest would be obtained at the ecological "expense" of proportionately larger increases in nutrient removal. The significance of this phenomenon of accelerated nutrient removals from forests has been widely discussed in the literature in recent years, and has recently been reviewed by several authors (e.g. Kimmins 1977, 1981; Kimmins *et al.* 1979; Carlisle 1980; Freedman 1981).

Equations

Equations relating the weights of various tree components to the predictor variables D^2H , DBH, and H, for each of the ten tree species, are given in Tables 6 to 15. Two statistics are given with each equation. These are:

n - the number of cases in each regression; and

R^2 - the square of the correlation coefficient.

In addition, for the logarithmic regressions, the statistics s and c are given. The statistic s is the standard error of estimate of the regression, while c is a multiplicative correction which can be used to correct errors associated with anti-logarithmic transformations. Note that the standard error of the estimate for the nutrient regressions may be misleadingly small. This occurs because the nutrient weights were calculated using the biomass estimates, and the errors inherent in the latter are not represented in the standard errors calculated during the regression analysis.

For some components, a multiple regression equation using DBH and H as predictor variables is not given. The computer was instructed, in multiple regression, to enter DBH as the first variable, and H as the second variable. For the multiple regressions not given, the computer advised that the chance of committing an error by adding H to the regression as a significant variable, when in fact it was not, was extremely high ($P>0.95$). As a result, the program did not generate these multiple regressions. For many of the multiple regressions that are given, the chance of committing the same error was still very high, but these equations are nevertheless presented to serve as reference equations for those wishing to compare equations for the same species in different stands.

Although the relationships were tried, equations for the components of unmerchantable stem of softwoods and dead branches of hardwoods are not given. The relationships for these components were very weak, as indicated by very high variances and low correlation coefficients.

Strength of Relationships

Values of R^2 exceeded 0.800 in 94.1% of the 1473 equations presented. In fact, R^2 was greater than 0.900 for more than 73.3% of the equations reported, and greater than 0.950 in 46.3%. The lowest R^2 values were associated with equations for various crown components such as dead branches, foliage, and branches, and the highest R^2 values were associated with equations for stem components and the total tree above ground. In general, the R^2 values for the linear regressions were higher than those for the quadratic equations.

While the R^2 values in this study are high (as is expected when a wide range of tree sizes is sampled),

they are not, as a whole, as high as have been reported in other biomass studies. The main reason for this is that trees in this study were chosen as objectively and as randomly as practicable, and NO sample trees were rejected from the sample once located as described under METHODS. Thus, compared with some other studies where restrictive criteria were used when selecting sample trees, the samples in this study more closely represented the inherent variation of trees within the population, resulting in higher variances and lower R^2 values.

The R^2 values can be used to compare the goodness of fit for any set of equations predicting the weight of the same component. For example, of the 120 pairs of biomass linear regressions in which DBH and D^2H were used as predictors for the weight of the same component, 61 pairs had a higher R^2 value for the equation using DBH, whereas in only 50 was the R^2 value higher for the equation using D^2H (9 had equal R^2 values). In all cases of multiple linear regression equations where DBH and H were the predictors, the R^2 value was as high or higher than the corresponding equation with DBH alone. However, in all cases, DBH accounted for more variation in the weight variable than did H alone, and in most cases H accounted for very little of the variation in the weight variable beyond that accounted for by DBH. In fact, the chance of committing an error by adding H as a significant variable, when in fact it was not, was seldom less than 0.05.

Height as a Predictor Variable

Three or four estimates of tree height were made for 84 sample trees of balsam fir, black spruce, and red spruce. Each estimate for any one tree was made by a different person (in the same location) using a Suunto clinometer. A mean height estimate

was calculated for each tree, and it was found that these means differed from the measured tree height by an average of 3% of the measured tree height. The means differed from the measured tree height by 5% or more, for 18 of the 84 cases.

In almost 30% of the cases, the range of estimates for each tree did not encompass the measured height. The lower limit of ranges differed from the measured tree height by an average of 4% of the measured height, and the upper limit differed by an average of 5%.

Biomass regression equations which use H as a predictor variable are generally built upon a set of height measurements made with a tape when sample trees have been cut down. However, when the equations are applied to standing forest trees, the values for H are usually measurements made with a hand-held ocular instrument such as a clinometer, a hypsometer, or a Relaskop. As shown in this study, measurements of H made with a Suunto clinometer can show considerable variation from true H, and they have a small degree of bias (tending towards over estimation). Similar results have been reported by Omule (1980) for measurements of H in a forest inventory study in British Columbia. He found that measurements of H made with a Suunto clinometer were significantly biased (tending towards under estimation), and the among-crew coefficient of variation was 21.9%. Only 2% of all measurements were correct, and over 15% were in error by 6.0 m or more.

These results cast serious doubts on the usefulness of H as a predictor variable in biomass regression equations. Considering that the variable H explains so little of the variation in component weight beyond that accounted for by DBH, and considering that H values for standing trees are measurements with relatively large errors compared with DBH, there

appears to be little justification for the use of equations containing H as a predictor variable. Equations with D^2H , and with DBH and H , have been presented to improve the comparability of equations with those of other studies. The inclusion of H in biomass equations is also important for equations to be used on a regional basis (Monteith and Jacobs 1979). However, the equations involving DBH alone are considered the most appropriate for estimating the biomass of tree components for the stands examined in this study.

Bias Correction Factor

The correction for bias, given in the equation tables under the heading "c", has been calculated using the simple formula $e^{(s^2)/2}$ (Meyer 1941 in Madgwick and Satoo 1975; Baskerville 1972). This method of estimating the correction factor is considered to be approximate only, and more appropriate formulae have been published (e.g., Beauchamp and Olson 1973). According to Mountford and Bunce (1973), the approximation $e^{(s^2)/2}$ is suitable for equations with small variance relative to sample size, but is less suitable when the variance is large. As can be seen in Tables 5 to 14, the correction factors for some biomass crown component equations are large, ranging up to 1.37. It was found that only a very small change in the correction factor resulted from use of the bias correction formula of Finney (1941).

Because of the nature of the expression (inclusive of the correction factor) for the predicted weight of a component ($W = e^{a+b \ln X + (s^2)/2}$) the correction factor can be incorporated with the regression constant "a" ($W = e^{(a+(s^2)/2)+b \ln X}$) or it can be partitioned off to stand alone ($W = e^{a+b \ln X} \cdot e^{(s^2)/2}$), as in this study. The former option eliminates the need for an extra multiplication step in calculating a corrected prediction

of weight, but precludes the user of the equation knowing the magnitude of the correction factor (unless s , the standard error of estimate of the regression, is given, in which case $e^{(s^2)/2}$ can be calculated). When the correction factor stands alone, the equation user is made aware of its magnitude, and is offered the choice of using it or discarding it as unnecessary or insignificant.

Additivity of Equations

A common problem with biomass regression equations is that the predicted weights of various tree components for one tree do not sum up to the weight value predicted from the equation for the total tree. Kozak (1970) suggested three possible reasons for this problem:

- non-significant terms have been dropped from the equation when more than one term was used in the model;
- a non-linear data transformation, such as the logarithmic transformation, has been used prior to regression analysis; and
- there are missing observations for some components.

The problem of non-additivity of component weight is present in this study, and has resulted from the latter two reasons above. The logarithmic transformation has been used in three of the four models, and all equations for merchantable components were based on observations of fewer trees than were equations for crown components and the total tree above ground.

Table 16 presents an example of the nature of the non-additivity of component weights. Biomass estimates were computed for the components wood plus bark, merchantable stem, crown, and for the total tree above ground, using equations for red maple found in Table 10a. The final column, labelled E, indicates that for all five sizes of trees considered, the

sum of the predicted weights of the two components exceeds the predicted weight of the total tree above ground by a small percentage.

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Table 1. Number of trees sampled by DBH size class.

Table 2. Sample size, ranges of DBH and H, and sampling dates for each tree species.

Species	Sample Size	DBH range (cm)	H range (m)	Sampling Dates (1980)
Balsam Fir	30	2.5 - 28.3	2.9 - 17.0	June 9 - June 16
White Spruce	24	1.5 - 29.5	1.9 - 21.2	June 17 - June 20
Black Spruce	24	2.2 - 30.2	2.1 - 17.5	June 2 - June 6
Red Spruce	37	1.2 - 31.3	1.6 - 19.5	May 20 - May 29; Aug. 8
Red Maple	37	1.3 - 32.3	3.0 - 20.2	July 3-July 14; Aug. 14, 21
Sugar Maple	36	1.2 - 33.5	2.3 - 20.2	June 23 - July 3; Aug. 22
Yellow Birch	24	2.6 - 29.0	4.1 - 18.6	Aug. 11, 12, 18 - 20
White Birch	37	1.1 - 34.1	2.7 - 20.1	July 15 - 23; Aug. 14, 15
Large-tooth Aspen	30	1.2 - 33.8	3.2 - 19.4	July 24 - July 31
Trembling Aspen	26	0.8 - 26.5	2.0 - 15.8	Aug. 1 - Aug. 7

Table 3 - Distribution of dry weight by tree component, as mean percentages of whole-tree biomass.
 Percent distribution was calculated as the weighted average of sample trees having DBH
 greater than 15.0 cm. Whole-tree weights were calculated as an unweighted average.

Species	Wood, Merch. Stem	Bark, Merch. Stem	Wood & Bark, Unmerch. Stem	Dead Branches	Wood & Bark, Live Branches	Foliage	Whole-tree Weight (kg)
Balsam Fir	48.6	9.3	1.5	6.0	18.8	15.8	148.9
White Spruce	63.6	8.0	1.4	7.9	11.4	7.7	188.9
Black Spruce	57.5	8.4	1.5	8.9	15.8	8.5	197.1
Red Spruce	62.1	9.1	1.8	4.7	12.8	9.5	198.4
Red Maple	68.0	8.8	u	3.2	18.0	2.0	225.1
Sugar Maple	68.4	8.6	u	2.5	18.5	2.0	290.8
Yellow Birch	66.1	8.6	u	1.6	21.5	2.2	237.9
White Birch	68.4	10.7	u	2.1	16.9	1.9	246.7
Large-tooth Aspen	58.3	15.2	u	5.1	19.1	2.3	192.4
Trembling Aspen	58.4	17.6	u	5.3	16.6	2.1	137.0

u: wood + bark, unmerchantable stem is undefined for hardwood stems in this study.

Table 4 - Distribution of oven-dry weight of tree components, as mean percentages of total tree oven-dry weight, by DBH size class for each species.

DBH range (cm)	n	wood, merch. stem	bark, merch. stem	unmerch. stem	dead branches	wood + bark, live branches	foliage	total weight (kg)
Balsam Fir								
0- 8.0	8							
8.1-15.0	7	44.1	8.9	55.6	8.6	16.5	19.3	4.2
15.1-20.0	5	57.1	10.6	8.4	5.5	16.1	17.0	36.3
20.1-25.0	5	49.8	9.3	3.2	4.8	13.3	11.0	74.7
25.1 +	5	45.3	8.8	1.8	6.3	18.9	14.0	136.0
				0.8	6.2	20.4	18.7	236.1
White Spruce								
0- 8.0	5							
8.1-15.0	7	54.8	8.3	72.7	8.3	11.0	8.0	3.0
15.1-20.0	4	64.3	8.2	16.0	6.4	7.2	7.4	30.5
20.1-25.0	4	66.3	8.7	2.1	5.2	11.1	9.0	109.1
25.1 +	4	62.0	7.5	1.8	8.6	7.6	7.0	155.5
				0.9	8.5	13.4	7.6	302.1
Black Spruce								
0- 8.0	5							
8.1-15.0	7	44.5	44.4	44.4	8.6	27.7	19.4	3.7
15.1-20.0	4	60.5	8.2	13.8	10.2	14.9	8.4	32.4
20.1-25.0	4	60.1	8.8	3.8	6.1	11.2	9.5	95.2
25.1 +	4	54.8	9.0	1.6	11.3	11.4	6.7	193.5
			7.9	0.8	8.2	18.9	9.4	302.5
Red Spruce								
0- 8.0	9							
8.1-15.0	9	56.2	8.0	68.8	4.1	16.9	10.2	3.9
15.1-20.0	6	63.7	10.3	12.3	3.3	11.8	8.4	38.5
20.1-25.0	6	64.2	9.7	3.0	3.4	11.9	7.8	104.0
25.1 +	7	60.4	8.5	2.9	5.0	9.9	8.2	176.2
					0.9	5.0	14.6	298.4

Table 4 - continued

	DBH range (cm)	n	wood, merch. stem	bark, merch. stem	unmerch. stem	dead branches	wood + bark, live branches	foliage	total weight (kg)
Red Maple									
0- 8.0	11					2.3	92.8	4.9	6.0
8.1-15.0	7	58.3	8.9		6.0	24.8	2.1		52.7
15.1-20.0	6	64.3	9.0		2.3	22.0	2.4		130.0
20.1-25.0	6	70.6	8.9		2.7	16.1	1.8		189.4
25.1 +	7	67.9	8.6		3.8	17.6	2.0		337.1
Sugar Maple									
0- 8.0	10					3.2	93.8	3.0	5.0
8.1-15.0	8	60.3	7.8		1.5	28.1	2.4		62.3
15.1-20.0	6	67.4	8.1		1.2	21.1	2.2		151.9
20.1-25.0	6	69.2	8.3		1.1	19.2	2.2		261.7
25.1 +	6	68.1	9.0		3.7	17.3	1.9		458.8
Yellow Birch									
0- 8.0	7					5.0	92.1	2.9	6.9
8.1-15.0	5	58.9	8.0		1.4	29.7	1.9		53.9
15.1-20.0	4	65.4	9.2		1.9	21.5	2.1		136.1
20.1-25.0	4	69.1	8.9		1.2	18.7	2.1		222.2
25.1 +	4	64.5	8.1		1.7	23.4	2.3		355.4
White Birch									
0- 8.0	8					0.2	96.4	3.3	4.2
8.1-15.0	10	52.8	10.8		2.1	31.7	2.6		36.4
15.1-20.0	6	65.7	11.2		1.1	19.0	2.9		109.6
20.1-25.0	6	70.2	10.2		2.7	15.1	1.9		228.4
25.1 +	7	67.7	11.0		2.2	17.4	1.6		380.0

Table 4 - continued

DBH range (cm)	n	wood, merch. stem	bark, merch. stem	unmerch. stem	dead branches	wood + bark, live branches	foliage	total weight (kg)
Large-tooth Aspen								
0- 8.0	7				4.3	90.2		5.6
8.1-15.0	7	45.2	15.5		6.0	29.9		2.3
15.1-20.0	5	58.7	17.1	4.7	17.1		3.3	28.5
20.1-25.0	5	52.8	15.7	6.4	22.4		2.5	92.0
25.1 +	6	60.8	14.5	4.6	18.1		2.6	168.2
							2.1	296.1
Trembling Aspen								
0- 8.0	10				2.2	91.7		6.1
8.1-15.0	5	56.4	18.7		3.4	19.5		4.1
15.1-20.0	5	59.2	16.6	4.8	17.2		2.1	45.0
20.1 +	6	58.4	17.9	6.0	15.7		2.3	102.1
							2.1	166.0

Table 5a - Distribution of nitrogen by tree component, as mean percentages of whole-tree nitrogen.
 Percent distribution was calculated as the weighted average of sample trees having DBH
 greater than 15.0 cm. Whole-tree weight was calculated as an unweighted average.

Species	Wood, Merch. Stem	Bark, Merch. Stem	Wood + Bark, Unmerch. Stem	Dead Branches	Wood + Bark, Live Branches	Foliage	Whole-tree Weight (g)
Balsam Fir	9.7	11.7	0.6	6.2	22.9	48.9	426.5
White Spruce	26.5	14.2	1.0	5.8	17.6	34.9	374.6
Black Spruce	31.5	9.8	1.3	8.3	20.4	28.7	416.9
Red Spruce	26.9	12.8	1.2	5.1	20.4	33.6	443.2
Red Maple	35.1	19.9	u	3.2	24.1	17.7	449.6
Sugar Maple	32.4	18.5	u	2.2	30.4	16.5	727.2
Yellow Birch	31.3	16.1	u	1.8	34.4	16.4	760.7
White Birch	34.2	15.5	u	2.1	32.1	16.1	684.0
Large-tooth Aspen	26.5	17.6	u	4.6	30.3	21.0	559.4
Trembling Aspen	26.8	22.3	u	5.6	30.7	14.6	353.9

u: Wood + bark, unmerchantable stem is undefined for hardwood stems in this study.

Table 5b - Distribution of phosphorus by tree component, as mean percentages of whole-tree phosphorus.
 Percent distribution was calculated as the weighted average of sample trees having DBH
 greater than 15.0 cm. Whole-tree weight was calculated as an unweighted average.

Species	Wood, Merch. Stem	Bark, Merch. Stem	Wood + Bark, Unmerch. Stem	Dead Branches	Wood + Bark, Live Branches	Foliage	Whole-tree Weight (g)
Balsam Fir	11.4	12.6	0.7	3.9	32.8	38.6	65.97
White Spruce	25.0	16.4	1.0	4.0	19.6	34.0	48.44
Black Spruce	22.7	12.3	1.1	7.3	23.6	33.0	50.77
Red Spruce	20.5	12.1	1.0	3.1	20.3	43.0	55.24
Red Maple	34.0	14.9	u	1.6	31.3	18.2	49.27
Sugar Maple	32.8	13.4	u	1.2	36.1	16.5	66.53
Yellow Birch	22.2	8.7	u	1.5	56.8	10.8	71.09
White Birch	27.8	13.2	u	1.6	42.9	14.5	66.38
Large-tooth Aspen	28.8	15.7	u	1.6	38.1	15.8	61.66
Trembling Aspen	24.4	23.0	u	2.5	38.6	11.5	49.47

u: Wood + bark, unmerchantable stem is undefined for hardwood stems in this study.

Table 5c - Distribution of potassium by tree component, as mean percentages of whole-tree potassium.
 Percent distribution was calculated as the weighted average of sample trees having DBH
 greater than 15.0 cm. Whole-tree weight was calculated as an unweighted average.

Species	Wood, Merch. Stem	Bark, Merch. Stem	Wood + Bark, Unmerch. Stem	Dead Branches	Wood + Bark, Live Branches	Foliage	Whole-tree Weight (g)
Balsam Fir	22.1	13.9	1.1	1.0	27.7	34.2	228.6
White Spruce	8.4	20.9	1.1	2.5	26.0	41.1	143.9
Black Spruce	20.1	15.0	0.7	2.2	25.0	37.0	177.5
Red Spruce	19.0	16.0	1.1	1.2	17.4	45.3	20
Red Maple	38.0	12.4	u	0.6	32.3	16.7	196.8
Sugar Maple	35.1	13.8	u	0.8	32.5	240.3	333.5
Yellow Birch	28.9	12.2	u	0.9	37.0	17.8	207.4
White Birch	45.0	13.6	u	0.9	23.1	21.0	160.0
Large-tooth Aspen	31.6	18.5	u	1.4	32.3	17.4	347.9
Trembling Aspen	36.5	21.2	u	1.2	27.1	14.0	304.5

u: Wood + bark, unmerchantable stem is undefined for hardwood stems in this study.

Table 5d - Distribution of calcium by tree component, as mean percentages of whole-tree calcium.
 Percent distribution was calculated as the weighted average of sample trees having DBH
 greater than 15.0 cm. Whole-tree weight was calculated as an unweighted average.

Species	Wood, Merch. Stem	Bark, Merch. Stem	Wood + Bark, Unmerch. Stem	Dead Branches	Wood + Bark, Live Branches	Foliage	Whole-tree Weight (g)
Balsam Fir	9.7	22.1	1.0	7.8	23.9	35.5	449.7
White Spruce	18.2	37.1	0.9	9.5	18.3	16.0	486.8
Black Spruce	28.3	29.5	1.8	10.5	17.6	12.3	616.3
Red Spruce	19.2	36.5	1.7	5.5	21.9	15.2	536.5
Red Maple	20.0	44.9	u	4.2	27.1	3.8	639.7
Sugar Maple	24.7	43.2	u	2.6	26.0	3.5	887.7
Yellow Birch	23.3	36.7	u	2.5	32.2	5.3	614.2
White Birch	21.0	40.7	u	3.1	29.5	5.7	543.2
Large-tooth Aspen	12.3	40.4	u	8.0	34.8	4.5	660.2
Trembling Aspen	17.4	44.4	u	7.3	26.6	4.3	506.0

u: Wood+Bark, unmerchantable stem is undefined for hardwood stems in this study.

Table 5e - Distribution of magnesium by tree component, as mean percentages of whole-tree magnesium.
 Percent distribution was calculated as the weighted average of sample trees having DBH
 greater than 15.0 cm. Whole-tree weight was calculated as an unweighted average.

Species	Wood, Merch. Stem	Bark, Merch. Stem	Wood + Bark, Unmerch. Stem	Dead Branches	Wood + Bark, Live Branches	Foliage	Whole-tree Weight (g)
Balsam Fir	23.4	14.7	1.1	4.7	26.9	29.2	58.2
White Spruce	27.1	22.2	1.2	6.8	19.6	23.1	53.6
Black Spruce	24.5	18.6	1.3	8.2	23.6	23.8	61.2
Red Spruce	27.3	18.5	1.4	3.8	20.6	28.4	54.6
Red Maple	44.7	15.1	u	3.7	23.7	12.8	57.9
Sugar Maple	46.9	18.0	u	2.0	24.3	8.8	105.7
Yellow Birch	40.3	11.5	u	1.8	30.8	15.6	89.9
White Birch	48.3	16.1	u	2.4	22.7	10.5	69.3
Large-tooth Aspen	34.9	20.7	u	3.9	27.9	12.6	92.0
Trembling Aspen	32.5	27.9	u	4.2	27.4	8.0	91.7

u: Wood + bark, unmerchantable stem is undefined for hardwood stems in this study.

Table 6a - Biomass prediction equations for aboveground components of Balsam Fir.
 Weight (W) in kg, Diameter (D) in cm, and Height (H) in m.

Component	Equation	n	R ²	s	c
FRESH WEIGHT					
merchantable stem	$\ln W = -4.0866 + 1.0607 \ln D_H^2$	22	.975	.1584	1.01
	$\ln W = -2.9908 + 2.6593 \ln D$	22	.955	.2116	1.02
	$\ln W = -4.1573 + 2.0774 \ln D + 1.1398 \ln H$	22	.975	.1622	1.01
crown 2	$\ln W = -1.2114 + 0.6724 \ln D_H^2$	30	.918	.4031	1.08
	$\ln W = -0.9367 + 1.8305 \ln D$	30	.934	.3617	1.07
	$\ln W = -0.5071 + 2.4451 \ln D - 0.8878 \ln H$	30	.942	.3486	1.06
total aboveground	$\ln W = -2.0156 + 0.8769 \ln D_H^2$	30	.981	.2445	1.03
	$\ln W = -1.6182 + 2.3718 \ln D$	30	.985	.2157	1.02
	$\ln W = -1.6408 + 2.3394 \ln D - 0.0467 \ln H$	30	.985	.2212	1.02
OVEN-DRY WEIGHT					
wood, merchantable stem	$\ln W = -5.1289 + 1.0715 \ln D_H^2$	22	.978	.1499	1.01
	$\ln W = -4.0345 + 2.6909 \ln D$	22	.961	.1985	1.02
	$\ln W = -5.1138 + 2.1524 \ln D + 1.0546 \ln H_2$	22	.978	.1537	1.01
	$W = -8.6743 + 0.0460 D + 0.1670 D^2$	22	.945	-	-
bark, merchantable stem	$\ln W = -6.2341 + 1.0056 \ln D_H^2$	22	.927	.2619	1.03
	$\ln W = -5.2684 + 2.5467 \ln D$	22	.927	.2626	1.04
	$\ln W = -5.7971 + 2.2830 \ln D + 0.5166 \ln H_2$	22	.931	.2613	1.03
	$W = -0.2471 - 0.1491 D D + 0.036 D^2$	22	.868	-	-
wood + bark, merch. stem	$\ln W = -4.8493 + 1.0592 \ln D_H^2$	22	.974	.1608	1.01
	$\ln W = -3.7775 + 2.6635 \ln D$	22	.960	.1997	1.02
	$\ln W = -4.7650 + 2.1709 \ln D + 0.9649 \ln H_2$	22	.974	.1645	1.01
	$W = -8.9215 - 0.1031 D + 0.2030 D^2$	22	.938	-	-

Table 6a - continued

Component	Equation	n	R ²	s	c
OWEN-DRY WEIGHT					
wood, total stem	$\ln W = -3.5362 + 0.8893 \ln D_H^2$	30	.994	.1350	1.01
	$\ln W = -3.1144 + 2.3977 \ln D$	30	.992	.1563	1.01
	$\ln W = -3.4173 + 1.9644 \ln D + 0.6260 \ln H^2$	30	.995	.1333	1.01
	$W = -0.5120 - 0.6898 D + 0.185 D^2$	30	.965	-	-
bark, total stem	$\ln W = -4.4168 + 0.7994 \ln D_H^2$	30	.979	.2336	1.03
	$\ln W = -4.0499 + 2.1601 \ln D$	30	.982	.2190	1.02
	$\ln W = -4.1398 + 2.0315 \ln D + 0.1859 \ln H^2$	30	.982	.2231	1.03
	$W = -0.3596 - 0.1472 D + 0.0360 D^2$	30	.913	-	-
wood + bark, total stem	$\ln W = -3.2123 + 0.8722 \ln D_H^2$	30	.993	.1445	1.01
	$\ln W = -2.8010 + 2.3524 \ln D$	30	.992	.1564	1.01
	$\ln W = -3.0637 + 1.9766 \ln D + 0.5429 \ln H^2$	30	.994	.1407	1.01
	$W = -0.8716 - 0.8370 D + 0.2200 D^2$	30	.961	-	-
dead branches	$\ln W = -4.6883 + 0.7559 \ln D_H^2$	30	.869	.5882	1.19
	$\ln W = -4.3612 + 2.0505 \ln D$	30	.878	.5677	1.17
	$\ln W = -4.1504 + 2.3520 \ln D - 0.4355 \ln H^2$	30	.879	.5791	1.18
	$W = -1.7848 - 0.4702 D + 0.0360 D^2$	30	.784	-	-
wood + bark, live branches	$\ln W = -4.7201 + 0.8916 \ln D_H^2$	30	.908	.5668	1.17
	$\ln W = -4.3537 + 2.4263 \ln D$	30	.924	.5172	1.14
	$\ln W = -3.8165 + 3.1949 \ln D - 1.1102 \ln H^2$	30	.930	.5066	1.14
	$W = -5.6517 - 1.6655 D + 0.1230 D^2$	30	.833	-	-
foliage	$\ln W = -4.5297 + 0.8585 \ln D_H^2$	30	.901	.5700	1.18
	$\ln W = -4.1778 + 2.3367 \ln D$	30	.916	.5236	1.15
	$\ln W = -3.6458 + 3.0979 \ln D - 1.0995 \ln H^2$	30	.923	.5139	1.14
	$W = 6.7945 - 1.7714 D + 0.1170 D^2$	30	.846	-	-

Table 6a - continued

Component	Equation	n	R ²	s	c
OVEN-DRY WEIGHT					
crown 1					
	ln W = -3.4939 + 0.8461 ln D ² _H	30	.927	.4749	1.12
	ln W = -3.1432 + 2.3013 ln D	30	.942	.4244	1.09
	ln W = -2.6770 + 2.9683 ln D - 0.9634 ln H ₂	30	.948	.4133	1.09
	W = 14.2310 - 3.9071 D + 0.2760 D ²	30	.910	-	-
crown 2					
	ln W = -1.8647 + 0.6665 ln D ² _H	30	.922	.3879	1.08
	ln W = -1.5924 + 1.8144 ln D	30	.938	.3453	1.06
	ln W = -1.1675 + 2.4222 ln D - 0.8780 ln H ₂	30	.946	.3315	1.06
	W = 15.7522 - 3.7167 D + 0.2700 D ²	30	.906	-	-
total aboveground					
	ln W = -2.6169 + 0.8597 ln D ² _H	30	.982	.2335	1.03
	ln W = -2.2304 + 2.3263 ln D	30	.987	.1967	1.02
	ln W = -2.2073 + 2.3593 ln D - 0.0477 ln H ₂	30	.987	.2017	1.02
	W = 15.1027 - 4.7441 D + 0.4960 D ²	30	.983	-	-

Table 6b - Nutrient prediction equations for nitrogen in aboveground components of Balsam Fir. Weight in g, D in cm, and Height in m.

Component	Equation	n	R^2	s	c
Wood, Merch. Stem	$\ln N = -5.273 + 0.982 \ln D_H^2$	22	.985	.112	1.01
	$\ln N = -4.274 + 2.468 \ln D$	22	.969	.161	1.01
	$\ln N = -5.230 + 1.991 \ln D + 0.934 \ln H_2$	22	.985	.115	1.01
	$N = -1.582 - 0.167 D + 0.071 D^2$	22	.944	-	-
Bark, Merch. Stem	$\ln N = -5.740 + 1.096 \ln D_H^2$	22	.940	.257	1.03
	$\ln N = -4.687 + 2.776 \ln D$	22	.940	.258	1.03
	$\ln N = -5.264 + 2.488 \ln D + 0.564 \ln H_2$	22	.944	.254	1.03
	$N = -0.463 - 0.990 D + 0.152 D^2$	22	.878	-	-
Wood, Total Stem	$\ln N = -4.120 + 0.853 \ln D_H^2$	22	.975	.126	1.01
	$\ln N = -3.253 + 2.145 \ln D$	22	.960	.161	1.01
	$\ln N = -4.081 + 1.731 \ln D + 0.810 \ln H_2$	22	.975	.130	1.01
	$N = 1.491 - 0.382 D + 0.076 D^2$	22	.944	-	-
Bark, Total Stem	$\ln N = -4.414 + 0.949 \ln D_H^2$	22	.931	.241	1.03
	$\ln N = -3.504 + 2.405 \ln D$	22	.931	.241	1.03
	$\ln N = -3.988 + 2.163 \ln D + 0.474 \ln H_2$	22	.935	.239	1.03
	$N = 2.497 - 1.095 D + 0.154 D^2$	22	.878	-	-
Dead Branches	$\ln N = -3.283 + 0.719 \ln D_H^2$	30	.853	.597	1.20
	$\ln N = -2.965 + 1.948 \ln D$	30	.860	.584	1.19
	$\ln N = -2.870 + 2.083 \ln D - 0.196 \ln H_2$	30	.860	.599	1.20
	$N = 5.031 - 1.200 D + 0.097 D^2$	30	.760	-	-
Wood + Bark, Live branches	$\ln N = -3.391 + 0.891 \ln D_H^2$	30	.903	.585	1.19
	$\ln N = -3.030 + 2.426 \ln D$	30	.919	.533	1.15
	$\ln N = -2.421 + 3.298 \ln D - 1.259 \ln H_2$	30	.928	.517	1.14
	$N = 27.796 - 8.010 D + 0.538 D^2$	30	.842	-	-
Foliage	$\ln N = -2.417 + 0.878 \ln D_H^2$	30	.896	.598	1.20
	$\ln N = -2.062 + 2.398 \ln D$	30	.913	.547	1.16
	$\ln N = -1.449 + 3.270 \ln D - 1.267 \ln H_2$	30	.922	.532	1.15
	$N = 0.989 - 0.717 D + 0.394 D^2$	30	.832	-	-

TABLE 6c. Nutrient prediction equations for phosphorus in aboveground components of Balsam Fir. Weight in g, D in cm, and Height in m.

component	Equation	n	R ²	S	C
Merch. Stem	$\ln P = -7.442 + 1.073 \ln D^2 H$	22	.978	.150	1.01
	$\ln P = -6.346 + 2.694 \ln D$	22	.961	.199	1.02
	$\ln P = -7.428 + 2.154 \ln D + 1.057 \ln H$	22	.978	.154	1.01
	$P = -0.866 + 0.0042 D + 0.017 D^2$	22	.945	-	-
Merch. Stem	$\ln P = -6.803 + 1.008 \ln D^2 H$	22	.925	.267	1.04
	$\ln P = -5.850 + 2.557 \ln D$	22	.928	.262	1.04
	$\ln P = -6.269 + 2.348 \ln D + 0.409 \ln H$	22	.931	.263	1.04
	$P = 0.938 - 0.246 D + 0.026 D^2$	22	.869	-	-
Total Stem	$\ln P = -6.270 + 0.942 \ln D^2 H$	22	.986	.103	1.01
	$\ln P = -5.308 + 2.365 \ln D$	22	.969	.154	1.01
	$\ln P = -6.258 + 1.891 \ln D + 0.928 \ln H$	22	.986	.105	1.01
	$P = -0.421 - 0.018 D + 0.017 D^2$	22	.946	-	-
Total Stem	$\ln P = -5.484 + 0.862 \ln D^2 H$	22	.912	.249	1.03
	$\ln P = -4.673 + 2.188 \ln D$	22	.916	.243	1.03
	$\ln P = -5.001 + 2.024 \ln D + 0.321 \ln H$	22	.918	.246	1.03
	$P = 1.664 - 0.285 D + 0.027 D^2$	22	.869	-	-
Branches	$\ln P = -5.896 + 0.757 \ln D^2 H$	30	.870	.585	1.19
	$\ln P = -5.567 + 2.052 \ln D$	30	.879	.565	1.17
	$\ln P = -5.369 + 2.335 \ln D - 0.409 \ln H$	30	.880	.577	1.18
	$P = 0.536 - 0.141 D + 0.011 D^2$	30	.784	-	-
+ Bark, + branches	$\ln P = -4.883 + 0.888 \ln D^2 H$	30	.901	.591	1.19
	$\ln P = -4.517 + 2.417 \ln D$	30	.916	.545	1.16
	$\ln P = -3.996 + 3.162 \ln D - 1.077 \ln H$	30	.922	.537	1.16
	$P = 4.035 - 1.219 D + 0.095 D^2$	30	.815	-	-
age	$\ln P = -4.564 + 0.884 \ln D^2 H$	30	.892	.617	1.21
	$\ln P = -4.206 + 2.408 \ln D$	30	.908	.567	1.17
	$\ln P = -3.590 + 3.290 \ln D - 1.274 \ln H$	30	.917	.553	1.17
	$P = 10.319 - 2.677 D + 0.164 D^2$	30	.846	-	-

TABLE 6d. Nutrient prediction equations for potassium in aboveground components of Balsam Fir. Weight in g., D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem	$\ln K = -5.807 + 1.116 \ln D^2 H$	22	.964	.202	1.02
	$\ln K = -4.690 + 2.811 \ln D$	22	.953	.230	1.03
	$\ln K = -5.628 + 2.343 \ln D + 0.917 \ln H^2$	22	.964	.205	1.02
	$K = 9.212 - 2.099 D + 0.189 D^2$	22	.950	-	-
Bark, Merch. Stem	$\ln K = -5.710 + 1.044 \ln D^2 H$	22	.930	.266	1.04
	$\ln K = -4.692 + 2.639 \ln D$	22	.926	.273	1.04
	$\ln K = -5.357 + 2.308 \ln D + 0.649 \ln H$	22	.932	.268	1.04
	$K = -6.628 + 0.356 D + 0.066 D^2$	22	.916	-	-
Wood, Total Stem	$\ln K = -4.654 + 0.987 \ln D^2 H$	22	.975	.146	1.01
	$\ln K = -3.669 + 2.488 \ln D$	22	.965	.174	1.02
	$\ln K = -4.480 + 2.083 \ln D + 0.793 \ln H^2$	22	.976	.147	1.01
	$K = 11.993 - 2.221 D + 0.191 D^2$	22	.951	-	-
Bark, Total Stem	$\ln K = -4.430 + 0.902 \ln D^2 H$	22	.935	.221	1.02
	$\ln K = -3.548 + 2.280 \ln D + 0.581 \ln H^2$	22	.930	.229	1.02
	$\ln K = -4.143 + 1.984 \ln D + 0.067 D^2$	22	.937	.223	1.03
	$K = -5.083 + 0.331 D + 0.067 D^2$	22	.920	-	-
Dead Branches	$\ln K = -5.954 + 0.746 \ln D^2 H$	30	.863	.594	1.19
	$\ln K = -5.516 + 2.015 \ln D$	30	.866	.589	1.19
	$\ln K = -5.688 + 1.907 \ln D + 0.156 \ln H^2$	30	.866	.603	1.20
	$K = -0.066 + 0.005 D + 0.004 D^2$	30	.696	-	-
Wood + Bark, Live branches	$\ln K = -4.069 + 0.922 \ln D^2 H$	30	.891	.647	1.23
	$\ln K = -3.693 + 2.511 \ln D$	30	.907	.598	1.20
	$\ln K = -3.085 + 3.381 \ln D - 1.257 \ln H^2$	30	.915	.587	1.19
	$K = 17.014 - 5.028 D + 0.350 D^2$	30	.818	-	-
Foliage	$\ln K = -3.526 + 0.899 \ln D^2 H$	30	.898	.605	1.20
	$\ln K = -3.155 + 2.446 \ln D$	30	.913	.559	1.17
	$\ln K = -2.629 + 3.199 \ln D - 1.087 \ln H^2$	30	.920	.552	1.16
	$K = 29.123 - 7.773 D + 0.498 D^2$	30	.731	-	-

TABLE 6e. Nutrient prediction equations for Calcium in aboveground components of Balsam Fir. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem	$\ln \text{Ca} = -5.104 + 0.991 \ln D_H^2$	22	.969	.164	1.01
	$\ln \text{Ca} = -4.094 + 2.491 \ln D$	22	.954	.202	1.02
	$\ln \text{Ca} = -5.069 + 2.005 \ln D + 0.952 \ln H$	22	.969	.168	1.01
	$\text{Ca} = -2.016 - 0.092 D + 0.085 D^2$	22	.941	-	-
Bark, Merch. Stem	$\ln \text{Ca} = -3.515 + 0.900 \ln D_H^2$	22	.913	.258	1.03
	$\ln \text{Ca} = -2.637 + 2.273 \ln D$	22	.908	.265	1.03
	$\ln \text{Ca} = -3.227 + 1.979 \ln D + 0.577 \ln H$	22	.915	.262	1.03
	$\text{Ca} = -17.090 + 1.848 D + 0.122 D^2$	22	.848	-	-
Wood, Total Stem	$\ln \text{Ca} = -3.952 + 0.863 \ln D_H^2$	22	.978	.119	1.01
	$\ln \text{Ca} = -3.073 + 2.167 \ln D$	22	.962	.157	1.01
	$\ln \text{Ca} = -3.921 + 1.744 \ln D + 0.829 \ln H$	22	.978	.122	1.01
	$\text{Ca} = 1.016 - 0.272 D + 0.088 D^2$	22	.942	-	-
Bark, Total Stem	$\ln \text{Ca} = -2.197 + 0.753 \ln D_H^2$	22	.904	.228	1.03
	$\ln \text{Ca} = -1.467 + 1.905 \ln D$	22	.901	.231	1.03
	$\ln \text{Ca} = -1.919 + 1.679 \ln D + 0.442 \ln H$	22	.907	.231	1.03
	$\text{Ca} = -7.342 + 1.252 D + 0.135 D^2$	22	.846	-	-
Dead Branches	$\ln \text{Ca} = -3.230 + 0.748 \ln D_H^2$	30	.871	.575	1.18
	$\ln \text{Ca} = -2.899 + 2.025 \ln D$	30	.888	.560	1.18
	$\ln \text{Ca} = -2.803 + 2.162 \ln D - 0.198 \ln H$	30	.878	.574	1.18
	$\text{Ca} = 4.336 - 1.126 D + 0.113 D^2$	30	.759	-	-
Wood + Bark, Live branches	$\ln \text{Ca} = -3.096 + 0.861 \ln D_H^2$	30	.906	.554	1.17
	$\ln \text{Ca} = -2.736 + 2.342 \ln D$	30	.920	.513	1.14
	$\ln \text{Ca} = -2.310 + 2.950 \ln D - 0.879 \ln H$	30	.924	.511	1.14
	$\text{Ca} = 8.371 - 3.212 D + 0.351 D^2$	30	.792	-	-
Foliage	$\ln \text{Ca} = -2.744 + 0.886 \ln D_H^2$	30	.905	.574	1.18
	$\ln \text{Ca} = -2.375 + 2.411 \ln D$	30	.919	.530	1.15
	$\ln \text{Ca} = -1.906 + 3.082 \ln D + 0.969 \ln H$	30	.924	.526	1.15
	$\text{Ca} = 34.216 - 9.850 D + 0.760 D^2$	30	.855	-	-

TABLE 6f. Nutrient prediction equations for Magnesium in aboveground components of Balsam Fir. Weight in g, D in cm, and Height in m.

Component	Equation	n	R^2	S	C
Wood, Merch. Stem	$\ln Mg = -5.104 + 0.991 \ln D_H^2$	22	.969	.164	1.01
	$\ln Mg = -4.094 + 2.491 \ln D$	22	.954	.202	1.02
	$\ln Mg = -5.069 + 2.005 \ln D + 0.952 \ln H^2$	22	.969	.168	1.01
	$Mg = 10.341 - 1.456 D + 0.069 D^2$	22	.873	-	-
Bark, Merch. Stem	$\ln Mg = -3.515 + 0.900 \ln D_H^2$	22	.913	.258	1.03
	$\ln Mg = -2.637 + 2.273 \ln D + 0.577 \ln H^2$	22	.908	.265	1.03
	$\ln Mg = -3.227 + 1.979 \ln D + 0.021 \ln D^2$	22	.915	.262	1.03
	$Mg = -0.684 - 0.059 D$	22	.874	-	-
Wood, Total Stem	$\ln Mg = -3.952 + 0.863 \ln D_H^2$	22	.978	.119	1.01
	$\ln Mg = -3.073 + 2.167 \ln D + 0.829 \ln H^2$	22	.962	.157	1.01
	$\ln Mg = -3.921 + 1.744 \ln D + 0.073 \ln D^2$	22	.978	.122	1.01
	$Mg = 11.923 - 1.592 D$	22	.876	-	-
Bark, Total Stem	$\ln Mg = -2.197 + 0.753 \ln D_H^2$	22	.904	.228	1.03
	$\ln Mg = -1.467 + 1.905 \ln D + 0.442 \ln H^2$	22	.901	.231	1.03
	$\ln Mg = -1.919 + 1.679 \ln D + 0.021 \ln D^2$	22	.907	.231	1.03
	$Mg = -0.257 - 0.069 D$	22	.875	-	-
Dead Branches	$\ln Mg = -3.230 + 0.748 \ln D_H^2$	30	.871	.575	1.18
	$\ln Mg = -2.899 + 2.025 \ln D - 0.198 \ln H^2$	30	.888	.560	1.18
	$\ln Mg = -2.803 + 2.162 \ln D + 0.014 \ln D^2$	30	.878	.574	1.18
	$Mg = 0.845 - 0.220 D$	30	.853	-	-
Wood + Bark, Live branches	$\ln Mg = -3.096 + 0.861 \ln D_H^2$	30	.906	.554	1.17
	$\ln Mg = -2.736 + 2.342 \ln D - 0.879 \ln H^2$	30	.920	.513	1.14
	$\ln Mg = -2.310 + 2.950 \ln D + 0.077 \ln D^2$	30	.924	.511	1.14
	$Mg = 3.809 - 1.094 D$	30	.831	-	-
Foliage	$\ln Mg = -2.744 + 0.886 \ln D_H^2$	30	.905	.574	1.18
	$\ln Mg = -2.375 + 2.411 \ln D + 0.969 \ln H^2$	30	.919	.530	1.15
	$\ln Mg = -1.906 + 3.082 \ln D + 0.127 \ln D^2$	30	.924	.526	1.15
	$Mg = 10.618 - 2.365 D$	30	.839	-	-

Table 7a - Biomass prediction equations for aboveground components of White Spruce.
 Weight (W) in kg, Diameter (D) in cm, and Height (H) in m.

Component	Equation	n	R ²	S	C
FRESH WEIGHT					
merchantable stem	$\ln W = -5.3937 + 1.2114 \ln D_H^2$	19	.978	.2036	1.02
	$\ln W = -3.8524 + 3.0425 \ln D$	19	.970	.2402	1.03
	$\ln W = -5.5648 + 2.3480 \ln D + 1.3521 \ln H$	19	.978	.2094	1.02
crown 2	$\ln W = -0.9660 + 0.5921 \ln D_H^2$	24	.944	.3368	1.06
	$\ln W = -0.7495 + 1.6762 \ln D$	24	.958	.2907	1.04
	$\ln W = -0.5700 + 2.0036 \ln D - 0.4087 \ln H$	24	.961	.2893	1.04
total aboveground					
	$\ln W = -1.7510 + 0.8266 \ln D_H^2$	24	.976	.3043	1.05
	$\ln W = -1.4329 + 2.3337 \ln D$	24	.985	.2391	1.03
	$\ln W = -1.3427 + 2.4982 \ln D - 0.2054 \ln H$	24	.985	.2433	1.03
OVEN-DRY WEIGHT					
wood, merchantable stem	$\ln W = -5.7344 + 1.1571 \ln D_H^2$	19	.983	.1723	1.01
	$\ln W = -4.2667 + 2.9078 \ln D$	19	.975	.2065	1.02
	$\ln W = -5.7889 + 2.2904 \ln D + 1.2019 \ln H$	19	.983	.1776	1.02
	$W = -9.1184 - 0.5200 D + 0.2750 D^2$	19	.967	-	-
bark, merchantable stem	$\ln W = -7.0710 + 1.0777 \ln D_H^2$	19	.978	.1806	1.02
	$\ln W = -5.7144 + 2.7121 \ln D$	19	.973	.1996	1.02
	$\ln W = -6.8715 + 2.2427 \ln D + 0.9136 \ln H$	19	.978	.1854	1.02
	$W = -1.8989 + 0.1028 D + 0.0290 D^2$	19	.988	-	-
wood + bark, merch. stem	$\ln W = -5.5267 + 1.1475 \ln D_H^2$	19	.983	.1707	1.01
	$\ln W = -4.0722 + 2.8841 \ln D$	19	.976	.2036	1.02
	$\ln W = -5.5560 + 2.2823 \ln D + 1.1716 \ln H$	19	.983	.1759	1.02
	$W = -11.0173 - 0.4172 D + 0.3040 D^2$	19	.971	-	-

Table 7a - continued.

Component	Equation	n	R ²	S	C.
OVEN-DRY WEIGHT wood, total stem	$\ln W = -2.9709 + 0.8444 \ln D_H^2$ $\ln W = -2.6159 + 2.3715 \ln D$ $\ln W = -2.8267 + 1.9871 \ln D + 0.4799 \ln H$ $W = 1.9240 - 1.3503 D + 0.2940 D^2$	24	.991 .990 .992 .974	.1928 .2013 .1861 -	1.02 1.02 1.02 -
bark, total stem	$\ln W = -4.0071 + 0.7322 \ln D_H^2$ $\ln W = -3.7049 + 2.0588 \ln D$ $\ln W = -3.8315 + 1.8278 \ln D + 0.2884 \ln H$ $W = -0.0218 - 0.0350 D + 0.0320 D^2$	24	.986 .987 .988 .989	.2074 .1977 .1962 -	1.02 1.02 1.02 -
wood + bark, total stem	$\ln W = -2.6926 + 0.8268 \ln D_H^2$ $\ln W = -2.3463 + 2.3226 \ln D$ $\ln W = -2.5395 + 1.9702 \ln D + 0.4399 \ln H$ $W = 1.9022 - 1.3853 D + 0.3260 D^2$	24	.990 .989 .991 .977	.1973 .2010 .1894 -	1.02 1.02 1.02 -
dead branches	$\ln W = -4.3333 + 0.7326 \ln D_H^2$ $\ln W = -4.1245 + 2.0979 \ln D$ $\ln W = -3.3061 + 3.5908 \ln D - 1.8638 \ln H$ $W = 1.5188 - 0.5481 D + 0.0510 D^2$	24	.892 .926 .963 .855	.5970 .4926 .3618 -	1.20 1.13 1.07 -
wood + bark, live branches	$\ln W = -4.2909 + 0.7569 \ln D_H^2$ $\ln W = -4.1003 + 2.1778 \ln D - 2.5022 \ln H$ $\ln W = -3.0015 + 4.1821 \ln D + 0.0970 D^2$ $W = 4.9325 - 1.4654 D$	24	.834 .874 .932 .891	.7907 .6877 .5233 -	1.37 1.27 1.15 -
foliage	$\ln W = -4.5415 + 0.7615 \ln D_H^2$ $\ln W = -4.3267 + 2.1816 \ln D - 1.9889 \ln H$ $\ln W = -3.4534 + 3.7747 \ln D + 0.0390 D^2$ $W = 0.6208 - 0.2722 D$	24	.862 .896 .933 .904	.7134 .6191 .5125 -	1.29 1.21 1.14 -

Table 7a - continued.

Component	Equation	n	R ²	S	C
OVEN-DRY WEIGHT					
crown 1					
ln W = -3.1707 + 0.7411 ln D ² _H	24	.880	.6414	1.23	
ln W = -2.9743 + 2.1282 ln D	24	.919	.5265	1.15	
ln W = -1.9968 + 3.9113 ln D - 2.2261 ln H ₂	24	.969	.3369	1.06	
W = 7.0721 - 2.2857 D + 0.1870 D ²	24	.923	-	-	
crown 2					
ln W = -1.4154 + 0.5709 ln D ² _H	24	.933	.3590	1.06	
ln W = -1.2148 + 1.6194 ln D	24	.951	.3075	1.05	
ln W = -0.9596 + 2.0849 ln D - 0.5812 ln H ₂	24	.957	.2969	1.05	
W = 8.9455 - 1.9748 D + 0.1750 D ²	24	.919	-	-	
total aboveground					
ln W = -2.1353 + 0.7936 ln D ² _H	24	.977	.2842	1.04	
ln W = -1.8322 + 2.2413 ln D	24	.987	.2127	1.02	
ln W = -1.7222 + 2.4421 ln D - 0.2506 ln H ₂	24	.988	.2139	1.02	
W = 8.9743 - 3.6710 D + 0.5120 D ²	24	.982	-	-	

TABLE 7b Nutrient prediction equations for nitrogen in aboveground components of White Spruce. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem					
	ln N = -5.203 + 1.044 ln D _H	19	.977	.180	1.02
	ln N = -3.883 + 2.626 ln D	19	.971	.203	1.02
	ln N = -5.132 + 2.120 ln D + 0.986 ln H	19	.977	.185	1.02
	N = -2.503 - 0.371 D + 0.163 D ²	19	.964	-	-
Bark, Merch. Stem					
	ln N = -5.126 + 0.986 ln D _H	19	.966	.207	1.02
	ln N = -3.877 + 2.480 ln D	19	.960	.227	1.03
	ln N = -5.101 + 1.984 ln D + 0.966 ln H	19	.966	.214	1.02
	N = -5.728 + 0.583 D + 0.075 D ²	19	.972	-	-
Wood, Total Stem					
	ln N = -3.290 + 0.884 ln D _H	19	.992	.085	1.00
	ln N = -2.234 + 2.096 ln D	19	.985	.116	1.01
	ln N = -3.287 + 1.668 ln D + 0.831 ln H	19	.992	.087	1.00
	N = 5.563 - 0.969 D + 0.175 D ²	19	.962	-	-
Bark, Total Stem					
	ln N = -3.126 + 0.768 ln D _H	19	.986	.103	1.01
	ln N = -2.150 + 1.928 ln D	19	.978	.130	1.01
	ln N = -3.213 + 1.497 ln D + 0.839 ln H	19	.986	.106	1.01
	N = -0.138 + 0.220 D + 0.082 D ²	19	.969	-	-
Dead Branches					
	ln N = -2.085 + 0.550 ln D _H	24	.838	.567	1.17
	ln N = -1.855 + 1.546 ln D	24	.838	.567	1.17
	ln N = -1.975 + 1.329 ln D + 0.272 ln H	24	.839	.582	1.18
	N = 2.766 - 0.211 D + 0.046 D ²	24	.746	-	-
Wood + Bark, Live branches					
	ln N = -3.131 + 0.759 ln D _H	24	.870	.688	1.27
	ln N = -2.915 + 2.174 ln D	24	.903	.592	1.19
	ln N = -2.059 + 3.735 ln D - 1.949 ln H	24	.939	.483	1.12
	N = 14.068 - 4.156 D + 0.283 D ²	24	.896	-	-
Foliage					
	ln N = -2.505 + 0.779 ln D _H	24	.889	.644	1.23
	ln N = -2.270 + 2.225 ln D	24	.919	.552	1.16
	ln N = -1.538 + 3.560 ln D - 1.667 ln H	24	.944	.471	1.12
	N = 7.281 - 2.983 D + 0.369 D ²	24	.912	-	-

TABLE 7c Nutrient prediction equations for Phosphorus in aboveground components of
White Spruce. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem					
ln P =	-8.032 + 1.157 ln D ² _H	19	.983	.172	1.01
ln P =	-6.565 + 2.907 ln D	19	.975	.206	1.02
ln P =	-8.087 + 2.290 ln D + 1.201 ln H	19	.983	.178	1.02
P =	-0.745 - 0.079 D + 0.028 D ²	19	.967	-	-
Bark, Merch. Stem					
ln P =	-7.725 + 1.078 ln D ² _H	19	.966	.227	1.03
ln P =	-6.357 + 2.709 ln D	19	.958	.252	1.03
ln P =	-7.812 + 2.118 ln D + 1.149 ln H	19	.966	.234	1.03
P =	-1.987 + 0.213 D + 0.010 ln H D ²	19	.975	-	-
Wood, Total Stem					
ln P =	-6.124 + 0.946 ln D ² _H	19	.994	.084	1.00
ln P =	-4.920 + 2.377 ln D	19	.985	.130	1.01
ln P =	-6.245 + 1.839 ln D + 1.046 ln H	19	.994	.086	1.00
P =	0.188 - 0.144 D + 0.030 ln H D ²	19	.965	-	-
Bark, Total Stem					
ln P =	-4.615 + 0.740 ln D ² _H	19	.691	.556	1.17
ln P =	-3.648 + 1.849 ln D	19	.679	.567	1.17
ln P =	-5.335 + 1.165 ln D + 1.332 ln H	19	.694	.570	1.18
P =	3.326 - 0.158 D + 0.016 ln H D ²	19	.666	-	-
Dead Branches					
ln P =	-6.440 + 0.737 ln D ² _H	24	.910	.543	1.16
ln P =	-6.177 + 2.088 ln D	24	.926	.493	1.13
ln P =	-5.895 + 2.603 ln D - 0.642 ln H	24	.930	.493	1.13
P =	0.015 - 0.014 D + 0.004 ln H D ²	24	.820	-	-
Wood + Bark, Live branches					
ln P =	-5.056 + 0.756 ln D ² _H	24	.872	.677	1.26
ln P =	-4.842 + 2.164 ln D	24	.907	.579	1.18
ln P =	-3.983 + 3.730 ln D - 1.954 ln H	24	.943	.465	1.11
P =	1.663 - 0.504 D + 0.037 ln H D ²	24	.912	-	-
Foliage					
ln P =	-4.216 + 0.729 ln D ² _H	24	.887	.609	1.20
ln P =	-3.995 + 2.083 ln D	24	.917	.523	1.15
ln P =	-3.312 + 3.330 ln D - 1.557 ln H	24	.942	.449	1.11
P =	0.688 - 0.267 D + 0.039 ln H D ²	24	.903	-	-

TABLE 7d Nutrient prediction equations for potassium in aboveground components of White Spruce. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem	$\ln K = -8.567 + 1.322 \ln D^2_H$ $\ln K = -6.896 + 3.324 \ln D$ $\ln K = -8.477 + 2.683 \ln D + 1.248 \ln H_D^2$ $\ln K = 34.128 - 5.956 \ln D + 0.265$	19	.982 .975 .982 .929	.204 .236 .210 -	1.02 1.03 1.02 -
Bark, Merch. Stem	$\ln K = -6.925 + 1.145 \ln D^2_H$ $\ln K = -5.473 + 2.877 \ln D$ $\ln K = -6.971 + 2.270 \ln D + 1.183 \ln H_D^2$ $\ln K = -2.855 - 0.036 \ln D + 0.070$	19	.975 .968 .975 .976	.205 .233 .211 -	1.02 1.03 1.02 -
Wood, Total Stem	$\ln K = -6.660 + 1.112 \ln D^2_H$ $\ln K = -5.253 + 2.795 \ln D$ $\ln K = -6.640 + 2.233 \ln D + 1.095 \ln H_D^2$ $\ln K = 36.319 - 6.142 \ln D + 0.270$	19	.964 .958 .964 .927	.241 .262 .248 -	1.03 1.03 1.03 -
Bark, Total Stem	$\ln K = -4.926 + 0.926 \ln D^2_H$ $\ln K = -3.746 + 2.326 \ln D + 1.057 \ln H_D^2$ $\ln K = -5.085 + 1.783 \ln D + 0.073 \ln H_D^2$ $\ln K = -0.588 - 0.157 \ln D$	19	.987 .978 .988 .973	.118 .154 .121 -	1.01 1.01 1.01 -
Dead Branches	$\ln K = -5.283 + 0.679 \ln D^2_H$ $\ln K = -5.075 + 1.940 \ln D$ $\ln K = -4.460 + 3.062 \ln D - 1.401 \ln H_D^2$ $\ln K = 0.170 - 0.059 \ln D + 0.008$	24	.903 .933 .957 .841	.520 .434 .358 -	1.14 1.10 1.07 -
Wood + Bark, Live branches	$\ln K = -3.563 + 0.739 \ln D^2_H$ $\ln K = -3.355 + 2.119 \ln D - 1.959 \ln H_D^2$ $\ln K = -2.495 + 3.688 \ln D + 0.152 \ln H_D^2$ $\ln K = 7.551 - 2.233 \ln D$	24	.871 .906 .944 .913	.667 .570 .453 -	1.25 1.18 1.11 -
Foliage	$\ln K = -3.096 + 0.751 \ln D^2_H$ $\ln K = -2.886 + 2.146 \ln D - 1.566 \ln H_D^2$ $\ln K = -2.179 + 3.401 \ln D + 0.150 \ln H_D^2$ $\ln K = 2.992 - 1.133 \ln D$	24	.888 .918 .942 .905	.624 .536 .464 -	1.21 1.15 1.11 -

TABLE 7e

Nutrient prediction equations for calcium in aboveground components of
White Spruce Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem	$\ln \text{Ca} = -5.217 + 1.048 \ln D^2 H$ $\ln \text{Ca} = -3.875 + 2.630 \ln D$ $\ln \text{Ca} = -5.550 + 1.950 \ln D + 1.322 \ln H$ $\ln \text{Ca} = 19.016 - 3.680 \ln D + 0.273 D^2$	19	.969 .959 .970 .918	.210 .243 .215 -	1.02 1.03 1.02 -
Bark, Merch. Stem	$\ln \text{Ca} = -3.482 + 0.934 \ln D^2 H$ $\ln \text{Ca} = -2.309 + 2.351 \ln D$ $\ln \text{Ca} = -3.246 + 1.971 \ln D + 0.739 \ln H$ $\ln \text{Ca} = -35.353 + 4.408 \ln D + 0.164 D^2$	19	.981 .977 .981 .988	.148 .162 .151 -	1.01 1.01 1.01 -
Wood, Total Stem	$\ln \text{Ca} = -3.169 + 0.819 \ln D^2 H$ $\ln \text{Ca} = -2.111 + 2.051 \ln D$ $\ln \text{Ca} = -3.664 + 1.421 \ln D + 1.226 \ln H$ $\ln \text{Ca} = 24.434 - 3.690 \ln D + 0.260 D^2$	19	.963 .949 .965 .900	.181 .211 .182 -	1.02 1.02 1.02 -
Bark, Total Stem	$\ln \text{Ca} = -1.483 + 0.715 \ln D^2 H$ $\ln \text{Ca} = -0.582 + 1.799 \ln D$ $\ln \text{Ca} = -1.358 + 1.485 \ln D + 0.613 \ln H$ $\ln \text{Ca} = -12.831 + 2.808 \ln D + 0.198 D^2$	19	.995 .990 .995 .984	.055 .079 .056 -	1.00 1.00 1.00 -
Dead Branches	$\ln \text{Ca} = -3.263 + 0.743 \ln D^2 H$ $\ln \text{Ca} = -3.020 + 2.116 \ln D$ $\ln \text{Ca} = -2.501 + 3.061 \ln D - 1.180 \ln H$ $\ln \text{Ca} = -3.440 - 1.182 \ln D + 0.129 D^2$	24	.916 .940 .954 .847	.528 .445 .400 -	1.15 1.10 1.08 -
Wood + Bark, Live branches	$\ln \text{Ca} = -3.044 + 0.788 \ln D^2 H$ $\ln \text{Ca} = -2.824 + 2.260 \ln D$ $\ln \text{Ca} = -1.895 + 3.955 \ln D - 2.117 \ln H$ $\ln \text{Ca} = 18.758 - 5.685 \ln D + 0.398 D^2$	24	.863 .898 .937 .887	.735 .634 .514 -	1.31 1.22 1.14 -
Foliage	$\ln \text{Ca} = -3.290 + 0.814 \ln D^2 H$ $\ln \text{Ca} = -3.044 + 2.326 \ln D$ $\ln \text{Ca} = -2.272 + 3.734 \ln D - 1.758 \ln H$ $\ln \text{Ca} = 14.446 - 4.322 \ln D + 0.329 D^2$	24	.877 .907 .932 .895	.714 .622 .546 -	1.29 1.21 1.16 -

TABLE 7f Nutrient prediction equations for Magnesium in aboveground components of
White Spruce. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem					
	ln Mg = -8.032 + 1.157 ln D ² _H	19	.983	.172	1.01
	ln Mg = -6.565 + 2.907 ln D	19	.975	.206	1.02
	ln Mg = -8.087 + 2.290 ln D + 1.201 ln H ²	19	.983	.178	1.02
	Mg = -0.745 - 0.079 D + 0.028 ln D ²	19	.967	-	-
Bark, Merch. Stem					
	ln Mg = -7.046 + 1.046 ln D ² _H	19	.977	.179	1.02
	ln Mg = -5.731 + 2.634 ln D	19	.973	.194	1.02
	ln Mg = -6.784 + 2.207 ln D + 0.831 ln H ²	19	.978	.183	1.02
	Mg = -4.965 + 0.585 D + 0.007 ln D ²	19	.974	-	-
Wood, Total Stem					
	ln Mg = -6.124 + 0.946 ln D ² _H	19	.994	.084	1.00
	ln Mg = -4.920 + 2.377 ln D	19	.985	.130	1.01
	ln Mg = -6.245 + 1.839 ln D + 1.046 ln H ²	19	.994	.086	1.00
	Mg = 0.188 - 0.144 D + 0.030 ln D ²	19	.965	-	-
Bark, Total Stem					
	ln Mg = -5.056 + 0.829 ln D ² _H	19	.984	.117	1.01
	ln Mg = -4.013 + 2.085 ln D	19	.979	.135	1.01
	ln Mg = -4.910 + 1.721 ln D + 0.709 ln H ²	19	.984	.121	1.01
	Mg = -3.829 + 0.517 D + 0.008 ln D ²	19	.968	-	-
Dead Branches					
	ln Mg = -5.283 + 0.679 ln D ² _H	24	.903	.520	1.14
	ln Mg = -5.075 + 1.940 ln D	24	.933	.434	1.10
	ln Mg = -4.460 + 3.062 ln D - 1.401 ln H ²	24	.957	.358	1.07
	Mg = 0.170 - 0.059 D + 0.008 ln D ²	24	.841	-	-
Wood + Bark, Live branches					
	ln Mg = -4.742 + 0.728 ln D ² _H	24	.854	.706	1.28
	ln Mg = -4.548 + 2.090 ln D	24	.891	.608	1.20
	ln Mg = -3.599 + 3.822 ln D - 2.163 ln H ²	24	.939	.471	1.12
	Mg = 2.917 - 0.835 D + 0.051 ln D ²	24	.909	-	-
Foliage					
	ln Mg = -4.590 + 0.742 ln D ² _H	24	.884	.629	1.22
	ln Mg = -4.364 + 2.118 ln D	24	.913	.545	1.16
	ln Mg = -3.687 + 3.352 ln D - 1.541 ln H ²	24	.937	.478	1.12
	Mg = 0.021 - 0.055 D + 0.023 ln D ²	24	.906	-	-

Table 8a - Biomass prediction equations for aboveground components of Black Spruce.

Weight (W) in kg, Diameter (D) in cm, and Height (H) in m.

Component	Equation	n	R ²	s	c
FRESH WEIGHT					
merchantable stem	$\ln W = -3.8384 + 1.0284 \ln D H^2$	19	.991	.1199	1.01
	$\ln W = -3.2569 + 2.7749 \ln D$	19	.974	.1990	1.02
	$\ln W = -4.0906 + 1.6634 \ln D + 1.5658 \ln H$	19	.993	.1080	1.01
crown 2	$\ln W = -0.3220 + 0.5420 \ln D H^2$	24	.907	.4126	1.09
	$\ln W = -0.2328 + 1.5393 \ln D$	24	.921	.3790	1.07
	$\ln W = -0.0212 + 2.2759 \ln D - 0.9069 \ln H$	24	.931	.3668	1.07
total aboveground	$\ln W = -0.9417 + 0.7398 \ln D H^2$	24	.974	.2846	1.04
	$\ln W = -0.7955 + 2.0912 \ln D$	24	.981	.2464	1.03
	$\ln W = -0.7277 + 2.3272 \ln D - 0.2905 \ln H$	24	.981	.2503	1.03
OVEN-DRY WEIGHT					
wood, merchantable stem	$\ln W = -4.6106 + 1.0281 \ln D H^2$	19	.989	.1321	1.01
	$\ln W = -4.0178 + 2.7699 \ln D$	19	.969	.2169	1.02
	$\ln W = -4.9487 + 1.5288 \ln D + 1.7484 \ln H D^2$	19	.993	.1098	1.01
	$W = -26.0038 + 1.8441 \ln D + 0.1770 \ln H D^2$	19	.967	-	-
bark, merchantable stem	$\ln W = -5.7891 + 0.9487 \ln D H^2$	19	.984	.1450	1.01
	$\ln W = -5.2862 + 2.5716 \ln D$	19	.977	.1753	1.02
	$\ln W = -5.7725 + 1.9232 \ln D + 0.9133 \ln H D^2$	19	.984	.1494	1.01
	$W = -5.3866 + 0.5475 \ln D + 0.0170 \ln H D^2$	19	.973	-	-
Wood + bark, merch. stem	$\ln W = -4.3618 + 1.0162 \ln D H^2$	19	.991	.1137	1.01
	$\ln W = -3.7823 + 2.7403 \ln D$	19	.974	.1984	1.02
	$\ln W = -4.6475 + 1.5868 \ln D + 1.6249 \ln H D^2$	19	.994	.0953	1.00
	$W = -31.3904 + 2.3915 \ln D + 0.1940 \ln H D^2$	19	.974	-	-

Table 8a - continued.

Component	Equation	n	R^2	s	c
OPEN-DRY WEIGHT					
wood, total stem	$\ln W = -2.9099 + 0.8374 \ln D_H^2$	24	.993	.1681	1.01
	$\ln W = -2.7190 + 2.3570 \ln D$	24	.991	.1912	1.02
	$\ln W = -2.8727 + 1.8221 \ln D + 0.6584 \ln H_2$	24	.993	.1712	1.01
	$W = -1.5945 - 0.4950 D + 0.2330 D^2$	24	.973	-	-
bark, total stem	$\ln W = -3.8113 + 0.7281 \ln D_H^2$	24	.991	.1680	1.01
	$\ln W = -3.6607 + 2.0555 \ln D$	24	.995	.1284	1.01
	$\ln W = -3.6552 + 2.0747 \ln D - 0.0236 \ln H_2$	24	.995	.1323	1.01
	$W = -0.6611 + 0.1048 D + 0.0280 D^2$	24	.978	-	-
wood + bark, total stem	$\ln W = -2.5908 + 0.8177 \ln D_H^2$	24	.994	.1522	1.01
	$\ln W = -2.4075 + 2.3026 \ln D$	24	.993	.1645	1.01
	$\ln W = -2.5298 + 1.8771 \ln D + 0.5239 \ln H_2$	24	.994	.1507	1.01
	$W = -2.2556 - 0.3902 D + 0.2610 D^2$	24	.979	-	-
dead branches	$\ln W = -4.2738 + 0.7609 \ln D_H^2$	24	.881	.6651	1.25
	$\ln W = -4.1219 + 2.1504 \ln D$	24	.886	.6502	1.24
	$\ln W = -4.0661 + 2.3447 \ln D - 0.2391 \ln H_2$	24	.886	.6692	1.25
	$W = -0.6181 + 0.0114 D + 0.0330 D^2$	24	.622	-	-
wood + bark, live branches	$\ln W = -2.5177 + 0.6191 \ln D_H^2$	24	.803	.7204	1.30
	$\ln W = -2.4288 + 1.7374 \ln D$	24	.819	.6884	1.27
	$\ln W = -2.0861 + 2.9304 \ln D - 1.4686 \ln H_2$	24	.836	.6753	1.26
	$W = 7.1248 - 1.8043 D + 0.1190 D^2$	24	.744	-	-
foliage	$\ln W = -2.4595 + 0.5459 \ln D_H^2$	24	.822	.6033	1.20
	$\ln W = -2.3731 + 1.5518 \ln D$	24	.836	.5779	1.18
	$\ln W = -2.1288 + 2.4020 \ln D - 1.0466 \ln H_2$	24	.848	.5751	1.18
	$W = 2.0148 - 0.4841 D + 0.0470 D^2$	24	.761	-	-

Table 8a - continued.

Component	Equation	n	R ²	s	c
OVEN-DRY WEIGHT					
crown 1					
	ln W = -1.7706 + 0.6288 ln D _H ²	24	.911	.4664	1.11
	ln W = -1.6726 + 1.7882 ln D	24	.928	.4197	1.09
	ln W = -1.3774 + 2.8156 ln D - 1.2648 ln H ₂	24	.941	.3898	1.08
	W = .8.5215 - 2.2769 D + 0.1990 D ²	24	.904	-	-
crown 2					
	ln W = -0.9003 + 0.5448 ln D _H ²	24	.918	.3858	1.08
	ln W = -0.8092 + 1.5468 ln D	24	.932	.3509	1.06
	ln W = -0.6089 + 2.2438 ln D - 0.8581 ln H ₂	24	.941	.3386	1.06
	W = .9.0814 - 1.8062 D + 0.1850 D ²	24	.902	-	-
total aboveground					
	ln W = -1.4837 + 0.7328 ln D _H ²	24	.978	.2632	1.04
	ln W = -1.3371 + 2.0707 ln D	24	.983	.2270	1.03
	ln W = -1.2867 + 2.2461 ln D - 0.2160 ln H ₂	24	.984	.2318	1.03
	W = 6.2659 - 2.6671 D + 0.4610 D ²	24	.971	-	-

TABLE 8b. Nutrient prediction equations for Nitrogen in aboveground components of Black Spruce. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem	$\ln N = -4.375 + 1.009 \ln D_H^2$	19	.982	.165	1.01
	$\ln N = -3.781 + 2.714 \ln D$	19	.960	.245	1.03
	$\ln N = -4.793 + 1.365 \ln D + 1.900 \ln H_D^2$	19	.988	.137	1.01
	$N = -64.838 + 7.049 \ln D + 0.043 \ln H_D^2$	19	.928	-	-
Bark, Merch. Stem	$\ln N = -4.743 + 0.926 \ln D_H^2$	19	.987	.125	1.01
	$\ln N = -4.260 + 2.513 \ln D$	19	.982	.150	1.01
	$\ln N = -4.672 + 1.964 \ln D + 0.774 \ln H_D^2$	19	.988	.128	1.01
	$N = -13.837 + 1.453 \ln D + 0.036 \ln H_D^2$	19	.970	-	-
Wood, Total Stem	$\ln N = -3.127 + 0.873 \ln D_H^2$	19	.979	.154	1.01
	$\ln N = -2.627 + 2.354 \ln D$	19	.961	.210	1.02
	$\ln N = -3.386 + 1.342 \ln D + 1.425 \ln H_D^2$	19	.982	.147	1.01
	$N = -59.353 + 6.910 \ln D + 0.043 \ln H_D^2$	19	.925	-	-
Bark, Total Stem	$\ln N = -3.377 + 0.779 \ln D_H^2$	19	.989	.098	1.01
	$\ln N = -2.992 + 2.121 \ln D$	19	.991	.090	1.00
	$\ln N = -3.154 + 1.905 \ln D + 0.304 \ln H_D^2$	19	.992	.086	1.00
	$N = -11.441 + 1.404 \ln D + 0.036 \ln H_D^2$	19	.969	-	-
Dead Branches	$\ln N = -3.431 + 0.748 \ln D_H^2$	24	.862	.710	1.29
	$\ln N = -3.284 + 2.116 \ln D$	24	.868	.694	1.27
	$\ln N = -3.205 + 2.392 \ln D - 0.340 \ln H_D^2$	24	.869	.714	1.29
	$N = -2.689 + 0.364 \ln D + 0.057 \ln H_D^2$	24	.578	-	-
Wood + Bark, Live branches	$\ln N = -1.026 + 0.562 \ln D_H^2$	24	.797	.673	1.25
	$\ln N = -.941 + 1.598 \ln D$	24	.813	.646	1.26
	$\ln N = -.654 + 2.597 \ln D + 1.230 \ln H_D^2$	24	.827	.641	1.23
	$N = 18.486 - 4.308 \ln D + 0.301 \ln H_D^2$	24	.754	-	-
Foliage	$\ln N = -.607 + 0.559 \ln D_H^2$	24	.827	.606	1.20
	$\ln N = -.521 + 1.589 \ln D$	24	.843	.578	1.18
	$\ln N = -.251 + 2.530 \ln D - 1.158 \ln H_D^2$	24	.856	.570	1.18
	$N = 16.586 - 4.252 \ln D + 0.372 \ln H_D^2$	24	.804	-	-

TABLE 8c. Nutrient prediction equations for phosphorus in aboveground components of Black Spruce. Weight in g, D in cm, and Height in m.

Component	Equation	n	R^2	S	C
Wood, Merch. Stem	$\ln P = -6.911 + 1.028 \ln D_H^2$ $\ln P = -6.319 + 2.769 \ln D$ $\ln P = -7.245 + 1.534 \ln D + 1.740 \ln H_2^D$ $P = -2.607 + 0.185 \ln D + 0.018$	19 19 19 19	.989 .969 .993 .967	.132 .216 .110 -	1.01 1.02 1.01 -
Bark, Merch. Stem	$\ln P = -6.391 + 0.905 \ln D_H^2$ $\ln P = -5.892 + 2.446 \ln D$ $\ln P = -6.516 + 1.613 \ln D + 1.173 \ln H_2^D$ $P = -3.187 + 0.388 \ln D + 0.001$	19 19 19 19	.973 .961 .974 .950	.179 .217 .182 -	1.02 1.02 1.02 -
Wood, Total Stem	$\ln P = -5.666 + 0.892 \ln D_H^2$ $\ln P = -5.167 + 2.409 \ln D$ $\ln P = -5.846 + 1.504 \ln D + 1.275 \ln H_2^D$ $P = -2.054 + 0.165 \ln D + 0.018$	19 19 19 19	.985 .970 .987 .966	.131 .186 .128 -	1.01 1.02 1.01 -
Bark, Total Stem	$\ln P = -5.030 + 0.758 \ln D_H^2$ $\ln P = -4.630 + 2.055 \ln D$ $\ln P = -5.004 + 1.557 \ln D + 0.702 \ln H_2^D$ $P = -2.876 + 0.391 \ln D + 0.001$	19 19 19 19	.980 .973 .980 .946	.129 .149 .133 -	1.01 1.01 1.01 -
Dead Branches	$\ln P = -5.713 + 0.747 \ln D_H^2$ $\ln P = -5.558 + 2.107 \ln D$ $\ln P = -3.427 + 2.971 \ln D - 1.790 \ln H_2^D$ $P = -0.077 + 0.004 \ln D + 0.006$	24 24 24 24	.860 .863 .748 .615	.715 .708 .706 -	1.29 1.28 1.28 -
Wood + Bark, Live branches	$\ln P = -3.029 + 0.573 \ln D_H^2$ $\ln P = -2.938 + 1.629 \ln D$ $\ln P = -2.680 + 2.529 \ln D - 1.107 \ln H_2^D$ $P = 2.056 - 0.466 \ln D + 0.038$	24 24 24 24	.798 .813 .824 .673	.683 .658 .658 -	1.26 1.24 1.24 -
Foliage	$\ln P = -2.298 + 0.524 \ln D_H^2$ $\ln P = -2.222 + 1.493 \ln D$ $\ln P = -1.924 + 2.529 \ln D - 1.274 \ln H_2^D$ $P = 2.288 - 0.543 \ln D + 0.049$	24 24 24 24	.799 .817 .834 .762	.624 .596 .585 -	1.21 1.19 1.19 -

TABLE 8d. Nutrient prediction equations for Potassium in aboveground components of Black Spruce. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, March. Stem	$\ln K = -5.542 + 1.008 \ln D_H^2$	19	.914	.369	1.07
	$\ln K = -4.930 + 2.705 \ln D$	19	.889	.420	1.09
	$\ln K = -6.106 + 1.136 \ln D + 2.210 \ln \frac{H}{D^2}$	19	.925	.356	1.07
	$K = -38.837 + 4.567 D - 0.048$	19	.831	-	-
Bark, March. Stem	$\ln K = -4.888 + 0.898 \ln D_H^2$	19	.975	.171	1.01
	$\ln K = -4.401 + 2.430 \ln D$	19	.965	.204	1.02
	$\ln K = -4.954 + 1.693 \ln D + 1.038 \ln \frac{H}{D^2}$	19	.975	.176	1.02
	$K = -10.247 + 1.211 D + 0.015$	19	.974	-	-
Wood, Total Stem	$\ln K = -4.295 + 0.872 \ln D_H^2$	19	.901	.346	1.06
	$\ln K = -3.776 + 2.345 \ln D$	19	.879	.383	1.08
	$\ln K = -4.700 + 1.112 \ln D + 1.736 \ln \frac{H}{D^2}$	19	.908	.344	1.06
	$K = -37.685 + 4.590 D - 0.050$	19	.823	-	-
Bark, Total Stem	$\ln K = -3.521 + 0.750 \ln D_H^2$	19	.983	.118	1.01
	$\ln K = -3.133 + 2.037 \ln D$	19	.979	.131	1.01
	$\ln K = -3.435 + 1.635 \ln D + 0.556 \ln \frac{H}{D^2}$	19	.984	.120	1.01
	$K = -8.731 + 1.202 D + 0.014$	19	.971	-	-
Dead Branches	$\ln K = -5.990 + 0.769 \ln D_H^2$	24	.807	.892	1.49
	$\ln K = -5.873 + 2.187 \ln D$	24	.823	.854	1.44
	$\ln K = -5.484 + 3.541 \ln D - 1.666 \ln \frac{H}{D^2}$	24	.837	.845	1.43
	$K = 0.793 - 0.279 D + 0.020$	24	.539	-	-
Wood + Bark, Live branches	$\ln K = -2.056 + 0.613 \ln D_H^2$	24	.841	.632	1.22
	$\ln K = -1.960 + 1.742 \ln D$	24	.856	.601	1.20
	$\ln K = -1.683 + 2.706 \ln D - 1.187 \ln \frac{H}{D^2}$	24	.868	.594	1.19
	$K = 9.486 - 2.403 D + 0.170$	24	.747	-	-
Foliage	$\ln K = -1.088 + 0.546 \ln D_H^2$	24	.813	.622	1.21
	$\ln K = -1.005 + 1.554 \ln D$	24	.829	.594	1.19
	$\ln K = -728 + 2.515 \ln D - 1.184 \ln \frac{H}{D^2}$	24	.843	.587	1.19
	$K = 10.249 - 2.589 D + 0.217$	24	.715	-	-

TABLE 8e. Nutrient prediction equations for Calcium in aboveground components of Black Spruce. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem	$\ln \text{Ca} = -2.697 + 0.823 \ln D^2_H$ $\ln \text{Ca} = -2.338 + 2.258 \ln D$ $\ln \text{Ca} = -2.111 + 2.561 \ln D - 0.426 \ln H$ $\text{Ca} = 42.517 - 7.231 D + 0.469 D^2$	19	.805 .818 .819 .957	.485 .468 .480	1.12 1.12 1.12
Bark, Merch. Stem	$\ln \text{Ca} = -2.471 + 0.826 \ln D^2_H$ $\ln \text{Ca} = -2.027 + 2.238 \ln D$ $\ln \text{Ca} = -2.501 + 1.606 \ln D + 0.890 \ln H$ $\text{Ca} = -112.425 + 14.353 D - 0.118 D^2$	19	.980 .971 .980	.140 .170 .145	1.01 1.01 1.01
Wood, Total Stem	$\ln \text{Ca} = -1.531 + 0.699 \ln D^2_H$ $\ln \text{Ca} = -1.265 + 1.930 \ln D$ $\ln \text{Ca} = -0.749 + 2.618 \ln D - 0.969 \ln H$ $\text{Ca} = 83.558 - 11.476 D + 0.584 D^2$	19	.688 .709 .720 .940	.563 .543 .550	1.17 1.16 1.16
Bark, Total Stem	$\ln \text{Ca} = -1.101 + 0.678 \ln D$ $\ln \text{Ca} = -0.756 + 1.844 \ln D$ $\ln \text{Ca} = -97.981 + 13.786 D - 0.422 \ln H$ $\text{Ca} = -97.909 + 13.786 D - 0.111 D^2$	19	.975 .979 .977 .936	.129 .134 .130	1.01 1.01 1.01
Dead Branches	$\ln \text{Ca} = -2.895 + 0.758 \ln D^2_H$ $\ln \text{Ca} = -2.749 + 2.145 \ln D$ $\ln \text{Ca} = -2.650 + 2.489 \ln D - 0.423 \ln H$ $\text{Ca} = -0.679 - 0.600 D + 0.162 D^2$	24	.883 .889 .890	.656 .637 .653	1.24 1.22 1.24
Wood + Bark, Live branches	$\ln \text{Ca} = -1.025 + 0.594 \ln D^2_H$ $\ln \text{Ca} = -0.948 + 1.694 \ln D - 1.789 \ln H$ $\text{Ca} = 36.696 - 9.572 D + 0.579 D^2$	24	.547 .762 .807	— .788 .731	— 1.36 1.33
Foliage	$\ln \text{Ca} = -1.129 + 0.551 \ln D^2_H$ $\ln \text{Ca} = -1.021 + 1.558 \ln D - 0.241 \ln H$ $\ln \text{Ca} = -0.964 + 1.754 \ln D + 0.061 D^2$	24	.724 .729 .729	.808 .800 .824	1.39 1.38 1.40

TABLE 8F. Nutrient prediction equations for Magnesium in aboveground components of
Black Spruce. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem	$\ln \text{Mg} = -2.697 + 0.823 \ln D_H^2$	19	.805	.485	1.12
	$\ln \text{Mg} = -2.338 + 2.258 \ln D$	19	.818	.468	1.12
	$\ln \text{Mg} = -2.111 + 2.561 \ln D - 0.426 \ln H_D^2$	19	.819	.480	1.12
	$\text{Mg} = -1.072 + 0.034 D + 0.021 \ln H_D^2$	19	.963	-	-
Bark, Merch. Stem	$\ln \text{Mg} = -2.471 + 0.826 \ln D_H^2$	19	.980	.140	1.01
	$\ln \text{Mg} = -2.027 + 2.238 \ln D$	19	.971	.170	1.01
	$\ln \text{Mg} = -2.501 + 1.606 \ln D + 0.890 \ln H_D^2$	19	.980	.145	1.01
	$\text{Mg} = -6.323 + 0.787 D - 0.001 \ln H_D^2$	19	.963	-	-
Wood, Total Stem	$\ln \text{Mg} = -1.531 + 0.699 \ln D_H^2$	19	.688	.563	1.16
	$\ln \text{Mg} = -1.265 + 1.930 \ln D$	19	.709	.543	1.15
	$\ln \text{Mg} = -.749 + 2.618 \ln D - 0.969 \ln H_D^2$	19	.720	.550	1.16
	$\text{Mg} = 0.474 - 0.085 D + 0.024 D^2$	19	.959	-	-
Bark, Total Stem	$\ln \text{Mg} = -1.101 + 0.678 \ln D_H^2$	19	.975	.129	1.01
	$\ln \text{Mg} = -0.756 + 1.844 \ln D$	19	.974	.134	1.01
	$\ln \text{Mg} = -0.981 + 1.545 \ln D + 0.422 \ln H_D^2$	19	.977	.130	1.01
	$\text{Mg} = -5.769 + 0.796 D - 0.002 D^2$	19	.961	-	-
Dead Branches	$\ln \text{Mg} = -2.895 + 0.758 \ln D_H^2$	24	.883	.656	1.24
	$\ln \text{Mg} = -2.749 + 2.145 \ln D$	24	.889	.637	1.22
	$\ln \text{Mg} = -2.650 + 2.489 \ln D - 0.423 \ln H_D^2$	24	.890	.653	1.24
	$\text{Mg} = -0.186 + 0.004 D + 0.010 D^2$	24	.622	-	-
Wood + Bark, Live branches	$\ln \text{Mg} = -1.025 + 0.594 \ln D_H^2$	24	.762	.788	1.36
	$\ln \text{Mg} = -0.948 + 1.694 \ln D - 1.789 \ln H_D^2$	24	.781	.755	1.33
	$\ln \text{Mg} = -0.530 + 3.148 \ln D + 0.046 D^2$	24	.807	.731	1.31
	$\text{Mg} = 2.343 - 0.573 D + 0.041 D^2$	24	.809	-	-
Foliage	$\ln \text{Mg} = -1.129 + 0.551 \ln D_H^2$	24	.724	.808	1.39
	$\ln \text{Mg} = -1.029 + 1.558 \ln D$	24	.729	.800	1.38
	$\ln \text{Mg} = -0.964 + 1.754 \ln D - 0.241 \ln H_D^2$	24	.729	.824	1.40
	$\text{Mg} = 2.124 - 0.467 D + 0.041 D^2$	24	.696	-	-

Table 9a - Biomass prediction equations for aboveground components of Red Spruce.
 Weight in kg, DBH in cm, and Height in m, $D^2 H = (\text{DBH})^2 \times H$.

Component	Equation	n	R^2	s	c
FRESH WEIGHT					
merchantable stem	$\ln W = -4.4051 + 1.1042 \ln D^2 H$	28	.987	.1349	1.01
	$\ln W = -3.3963 + 2.8730 \ln DBH$	28	.972	.1977	1.02
	$\ln W = -4.9251 + 1.8120 \ln DBH + 1.7320 \ln H$	28	.989	.1250	1.01
crown 2	$\ln W = -0.7588 + 0.5742 \ln D^2 H$	37	.915	.3872	1.08
	$\ln W = -0.5815 + 1.6148 \ln DBH$	37	.930	.3507	1.06
	$\ln W = -0.2177 + 2.3658 \ln DBH - 0.9581 \ln H$	37	.940	.3317	1.06
total aboveground	$\ln W = -1.6310 + 0.8185 \ln D^2 H$	37	.967	.3350	1.06
	$\ln W = -1.3420 + 2.2873 \ln DBH$	37	.971	.3157	1.05
OVEN-DRY WEIGHT					
wood, merchantable stem	$\ln W = -4.9327 + 1.0793 \ln D^2 H$	28	.987	.1305	1.01
	$\ln W = -3.9454 + 2.8076 \ln DBH$	28	.971	.1934	1.02
	$\ln W = -5.4624 + 1.7546 \ln DBH + 1.7188 \ln H$	28	.990	.1195	1.01
	$W = 2.5545 - 2.0623 D + 0.3230 D^2$	28	.987	-	-
bark, merchantable stem	$\ln W = -6.6432 + 1.0560 \ln D^2 H$	28	.980	.1607	1.01
	$\ln W = -5.6819 + 2.7489 \ln DBH$	28	.965	.2093	1.02
	$\ln W = -7.0874 + 1.7734 \ln DBH + 1.5923 \ln H$	28	.981	.1563	1.01
	$W = -3.1675 + 0.2045 D + 0.0320 D^2$	28	.950	-	-
wood + bark, merch. stem	$\ln W = -4.7699 + 1.0765 \ln D^2 H$	28	.987	.1281	1.01
	$\ln W = -3.7858 + 2.8006 \ln DBH$	28	.972	.1909	1.02
	$\ln W = -5.2864 + 1.7592 \ln DBH + 1.7000 \ln H$	28	.990	.1175	1.01
	$W = -0.6131 - 1.8578 D + 0.3560 D^2$	28	.988	-	-

Tabel 9a - continued.

Component	Equation	n	R ²	s	c
OVEN-DRY WEIGHT					
wood, total stem	$\ln W = -2.8690 + 0.8448 \ln D_H^2$	37	.985	.2325	1.03
	$\ln W = -2.5529 + 2.3536 \ln D$	37	.983	.2487	1.03
	$\ln W = -2.8070 + 1.8291 \ln D + 0.6692 \ln H$	37	.985	.2358	1.03
	$W = 3.0474 - 1.5894 D + 0.3080 D^2$	37	.990	-	-
bark, total stem	$\ln W = -4.2769 + 0.7845 \ln D_H^2$	37	.975	.2782	1.04
	$\ln W = -3.9888 + 2.1879 \ln D$	37	.975	.2796	1.04
	$\ln W = -4.1474 + 1.8606 \ln D + 0.4176 \ln H$	37	.976	.2791	1.04
	$W = -0.0397 - 0.0989 D + 0.0400 D^2$	37	.965	-	-
wood + bark, total stem	$\ln W = -2.6549 + 0.8358 \ln D_H^2$	37	.984	.2373	1.03
	$\ln W = -2.3430 + 2.3288 \ln D$	37	.982	.2509	1.03
	$\ln W = -2.5822 + 1.8351 \ln D + 0.6299 \ln H$	37	.984	.2403	1.03
	$W = 3.0077 - 1.6883 D + 0.3480 D^2$	37	.991	-	-
dead branches	$\ln W = -5.0895 + 0.7689 \ln D_H^2$	37	.865	.6739	1.25
	$\ln W = -4.8780 + 2.1727 \ln D$	37	.888	.6143	1.21
	$\ln W = -4.0196 + 3.9447 \ln D - 2.2609 \ln H$	37	.916	.5412	1.16
	$W = 1.6965 - 0.5138 D + 0.0370 D^2$	37	.747	-	-
wood + bark, live branches	$\ln W = -3.7461 + 0.7434 \ln D_H^2$	37	.853	.6840	1.26
	$\ln W = -3.5289 + 2.0955 \ln D$	37	.871	.6400	1.23
	$\ln W = -2.8799 + 3.4353 \ln D - 1.7094 \ln H$	37	.888	.6075	1.20
	$W = 4.1960 - 1.1871 D + 0.0940 D^2$	37	.875	-	-
foliage	$\ln W = -4.4334 + 0.7873 \ln D_H^2$	37	.868	.6809	1.26
	$\ln W = -4.1968 + 2.2167 \ln D$	37	.884	.6368	1.23
	$\ln W = -3.6044 + 3.4395 \ln D - 1.5602 \ln H$	37	.897	.6119	1.21
	$W = 2.7802 - 0.8438 D + 0.0690 D^2$	37	.897	-	-

Table 9a - continued.

Component	Equation	n	R ²	s	c
OVEN-DRY WEIGHT					
crown 1					
	ln W = -3.0529 + 0.7494 ln D ² H	37	.883	.6033	1.20
	ln W = -2.8371 + 2.1136 ln D	37	.903	.5490	1.16
	ln W = -2.1388 + 3.5552 ln D - 1.8392 ln H	37	.924	.4976	1.13
	W = 8.6726 - 2.5447 D + 0.2000 D ²	37	.910	-	-
crown 2					
	ln W = -1.2445 + 0.5655 ln D ² H	37	.910	.3953	1.08
	ln W = -1.0730 + 1.5916 ln D	37	.926	.3572	1.07
	ln W = -0.6699 + 2.4235 ln D - 1.0615 ln H	37	.938	.3328	1.06
	W = 10.0775 - 2.1394 D + 0.1860 D ²	37	.906	-	-
total aboveground					
	ln W = -2.0784 + 0.8021 ln D ² H	37	.968	.3210	1.05
	ln W = -1.7957 + 2.2417 ln D	37	.972	.3004	1.05
	W = 11.6803 - 4.2331 D + 0.5480 D ²	37	.991	-	-

TABLE 9b Nutrient prediction equations for nitrogen in aboveground components of
Red Spruce. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem					
	ln N = -4.184 + 1.049 ln D _H	28	.982	.149	1.01
	ln N = -3.842 + 2.724 ln D	28	.963	.213	1.02
	ln N = -5.525 + 1.556 ln D + 1.906 ln H	28	.987	.130	1.01
	N = -16.816 + 1.1619 D + 0.184 D ²	28	.981	-	-
Bark, Merch. Stem					
	ln N = -5.159 + 1.008 ln D _H	28	.966	.198	1.02
	ln N = -4.227 + 2.618 ln D	28	.949	.245	1.03
	ln N = -5.801 + 1.526 ln D + 1.783 ln H	28	.970	.190	1.02
	N = -13.770 + 0.148 D + 0.061 D ²	28	.942	-	-
Wood, Total Stem					
	ln N = -3.345 + 0.888 ln D _H	28	.993	.081	1.00
	ln N = -2.547 + 2.314 ln D	28	.981	.130	1.01
	ln N = -3.573 + 1.602 ln D + 1.163 ln H	28	.993	.079	1.00
	N = -13.779 + 1.308 D + 0.177 D ²	28	.977	-	-
Bark, Total Stem					
	ln N = -3.566 + 0.830 ln D _H	28	.976	.137	1.01
	ln N = -2.830 + 2.169 ln D	28	.968	.158	1.01
	ln N = -3.609 + 1.628 ln D + 0.883 ln H	28	.976	.140	1.01
	N = -6.784 + 0.844 D + 0.076 D ²	28	.945	-	-
Dead Branches					
	ln N = -4.100 + 0.764 ln D _H	37	.844	.729	1.30
	ln N = -3.896 + 2.162 ln D	37	.868	.670	1.25
	ln N = +4.127 + 4.127 ln D - 2.507 ln H	37	.903	.586	1.19
	N = 1.311 - 0.630 D + 0.972 D ²	37	.709	-	-
Wood + Bark, Live branches					
	ln N = -2.446 + 0.748 ln D _H	37	.860	.669	1.25
	ln N = -2.222 + 2.107 ln D - 1.487 ln H	37	.876	.629	1.22
	ln N = -1.657 + 3.272 ln D + 0.276 D ²	37	.889	.607	1.20
	N = 7.470 - 2.453 D + 0.552 D ²	37	.853	-	-
Foliage					
	ln N = -2.418 + 0.801 ln D _H	37	.871	.683	1.26
	ln N = -2.176 + 2.255 ln D	37	.887	.639	1.25
	ln N = -1.596 + 3.453 ln D - 1.528 ln H	37	.899	.615	1.21
	N = 19.698 - 6.329 D + 0.552 D ²	37	.894	-	-

TABLE 9c • Nutrient prediction equations for Phosphorus in aboveground components of Red Spruce. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem					
$\ln P = -9.037 + 1.283 \ln D^2_H$	28	.945	.326	1.05	
$\ln P = -7.816 + 3.321 \ln D$	28	.921	.391	1.06	
$\ln P = -10.392 + 1.533 \ln D + 2.918 \ln H$	28	.956	.297	1.05	
$P = -0.316 - 0.151 D + 0.031 D^2$	28	.987	-	-	
Bark, Merch. Stem					
$\ln P = -7.630 + 1.043 \ln D^2_H$	28	.928	.306	1.05	
$\ln P = -6.620 + 2.695 \ln D$	28	.901	.360	1.07	
$\ln P = -8.982 + 1.056 \ln D + 2.676 \ln H$	28	.945	.274	1.04	
$P = -2.075 + 0.262 D + 0.004 D^2$	28	.925	-	-	
Wood, Total Stem					
$\ln P = -7.544 + 1.119 \ln D^2_H$	28	.962	.233	1.03	
$\ln P = -6.500 + 2.904 \ln D$	28	.943	.288	1.04	
$\ln P = -8.406 + 1.582 \ln D + 2.158 \ln H$	28	.958	.169	1.01	
$P = -0.460 - 0.089 D + 0.029 D^2$	28	.984	.218	1.02	
Bark, Total Stem					
$\ln P = -5.196 + 0.771 \ln D^2_H$	28	.970	.144	1.01	
$\ln P = -4.502 + 2.010 \ln D$	28	.958	.145	1.01	
$\ln P = -5.395 + 1.390 \ln D + 1.011 \ln H$	28	.970	.145	1.01	
$P = -1.012 + 0.163 D + 0.006 D^2$	28	.931	-	-	
Dead Branches					
$\ln P = -6.457 + 0.733 \ln D^2_H$	37	.785	.851	1.44	
$\ln P = -6.257 + 2.073 \ln D$	37	.806	.808	1.39	
$\ln P = -5.413 + 3.817 \ln D - 2.225 \ln H$	37	.834	.763	1.34	
$P = 0.011 - 0.024 D + 0.004 D^2$	37	.640	-	-	
Wood + Bark, Live branches					
$\ln P = -4.587 + 0.753 \ln D^2_H$	37	.871	.643	1.23	
$\ln P = -4.353 + 2.117 \ln D$	37	.885	.607	1.20	
$\ln P = -3.894 + 3.063 \ln D - 1.207 \ln H$	37	.893	.595	1.19	
$P = 0.765 - 0.245 D + 0.031 D^2$	37	.884	-	-	
Foliage					
$\ln P = -4.295 + 0.804 \ln D^2_H$	37	.861	.716	1.29	
$\ln P = -4.054 + 2.265 \ln D$	37	.878	.672	1.25	
$\ln P = -3.438 + 3.538 \ln D - 1.624 \ln H$	37	.891	.646	1.23	
$P = 4.287 - 1.283 D + 0.098 D^2$	37	.886	-	-	

TABLE 9d. Nutrient prediction equations for Potassium in aboveground components of Red Spruce. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem	$\ln K = -6.905 + 1.173 \ln D_H^2$	28	.959	.255	1.03
	$\ln K = -5.792 + 3.039 \ln D$	28	.936	.321	1.05
	$\ln K = -8.088 + 1.445 \ln D + 2.601 \ln H$	28	.970	.225	1.03
	$\ln K = -8.129 + 0.662 \ln D^2$	28	.977	-	-
Bark, Merch. Stem	$\ln K = -5.557 + 0.988 \ln D_H^2$	28	.964	.202	1.02
	$\ln K = -4.636 + 2.563 \ln D$	28	.944	.251	1.03
	$\ln K = -6.302 + 1.407 \ln D + 1.888 \ln H$	28	.969	.189	1.02
	$\ln K = -8.914 + 1.051 \ln D + 0.027 \ln D^2$	28	.933	-	-
Wood, Total Stem	$\ln K = -5.430 + 1.011 \ln D_H^2$	28	.976	.167	1.01
	$\ln K = -4.491 + 2.627 \ln D$	28	.957	.223	1.02
	$\ln K = -6.127 + 1.491 \ln D + 1.853 \ln H$	28	.981	.152	1.01
	$\ln K = -8.300 + 0.843 \ln D + 0.057 \ln D^2$	28	.974	-	-
Bark, Total Stem	$\ln K = -3.968 + 0.812 \ln D_H^2$	28	.974	.139	1.01
	$\ln K = -3.245 + 2.118 \ln D$	28	.965	.162	1.01
	$\ln K = -4.079 + 1.539 \ln D + 0.945 \ln H$	28	.974	.141	1.01
	$\ln K = -4.913 + 0.684 \ln D + 0.036 \ln D^2$	28	.938	-	-
Dead Branches	$\ln K = -6.321 + 0.757 \ln D_H^2$	37	.776	.902	1.50
	$\ln K = -6.109 + 2.137 \ln D$	37	.795	.862	1.45
	$\ln K = -5.320 + 3.766 \ln D - 2.078 \ln H$	37	.817	.830	1.41
	$\ln K = -0.119 + 0.007 \ln D + 0.004 \ln D^2$	37	.681	-	-
Wood + Bark, Live branches	$\ln K = -3.684 + 0.776 \ln D_H^2$	37	.861	.690	1.27
	$\ln K = -3.451 + 2.184 \ln D$	37	.878	.648	1.23
	$\ln K = -2.868 + 3.386 \ln D - 1.534 \ln H$	37	.891	.625	1.22
	$\ln K = 5.635 - 1.590 \ln D + 0.128 \ln D^2$	37	.902	-	-
Foliage	$\ln K = -2.616 + 0.757 \ln D_H^2$	37	.862	.672	1.25
	$\ln K = -2.390 + 2.133 \ln D$	37	.879	.629	1.22
	$\ln K = -1.789 + 3.374 \ln D - 1.584 \ln H$	37	.893	.602	1.20
	$\ln K = 17.265 - 4.786 \ln D + 0.351 \ln D^2$	37	.907	-	-

TABLE 9e. Nutrient prediction equations for Calcium in aboveground components of Red Spruce. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem					
ln Ca =	-4.955 + 1.050 ln D ² H	28	.992	.102	1.01
ln Ca =	-3.999 + 2.733 ln D	28	.977	.168	1.01
ln Ca =	-5.406 + 1.757 ln D	28	.994	.091	1.01
Ca =	-1.343 - 1.004 D	28	.972	-	-
Bark, Merch. Stem					
ln Ca =	-2.448 + 0.818 ln D ² H	28	.966	.162	1.01
ln Ca =	-1.687 + 2.123 ln D	28	.947	.202	1.02
ln Ca =	-3.036 + 1.187 ln D	28	.971	.152	1.01
Ca =	-40.476 + 5.884 D	28	.927	-	-
Wood, Total Stem					
ln Ca =	-3.486 + 0.889 ln D ² H	28	.991	.087	1.00
ln Ca =	-2.703 + 2.322 ln D	28	.985	.115	1.01
ln Ca =	-3.452 + 1.803 ln D	28	.991	.089	1.00
Ca =	1.980 - 0.958 D	28	.967	-	-
Bark, Total Stem					
ln Ca =	-0.857 + 0.642 ln D ² H	28	.965	.128	1.01
ln Ca =	-0.294 + 1.677 ln D	28	.959	.139	1.01
ln Ca =	-0.810 + 1.319 ln D	28	.965	.131	1.01
Ca =	-10.813 + 3.209 D	28	.925	-	-
Dead Branches					
ln Ca =	-4.080 + 0.786 ln D ² H	37	.788	.903	1.50
ln Ca =	-3.872 + 2.226 ln D	37	.812	.852	1.44
ln Ca =	-2.879 + 4.276 ln D	37	.845	.788	1.36
Ca =	4.701 - 1.491 D	37	.748	-	-
Wood + Bark, Live branches					
ln Ca =	-1.874 + 0.703 ln D ² H	37	.848	.658	1.24
ln Ca =	-1.667 + 1.981 ln D	37	.866	.619	1.21
ln Ca =	-1.084 + 3.184 ln D	37	.881	.594	1.19
Ca =	12.768 - 3.483 D	37	.869	-	-
Foliage					
ln Ca =	-3.104 + 0.815 ln D ² H	37	.880	.666	1.25
ln Ca =	-2.844 + 2.287 ln D	37	.892	.632	1.22
ln Ca =	-2.452 + 3.097 ln D	37	.898	.628	1.22
Ca =	5.779 - 2.064 D	37	.888	-	-

TABLE 9F. Nutrient prediction equations for Magnesium in aboveground components of Red Spruce. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem					
	ln Mg = -7.232 + 1.079 ln D ² _H	28	.987	.131	1.01
	ln Mg = -6.245 + 2.807 ln D	28	.971	.194	1.02
	ln Mg = -7.762 + 1.754 ln D + 1.718 ln H	28	.989	.120	1.01
	Mg = 0.252 - 0.206 D + 0.032 D ²	28	.987	-	-
Bark, Merch. Stem					
	ln Mg = -6.989 + 1.017 ln D ² _H	28	.983	.142	1.01
	ln Mg = -6.072 + 2.650 ln D	28	.971	.185	1.02
	ln Mg = -7.276 + 1.815 ln D + 1.363 ln H	28	.984	.141	1.01
	Mg = -1.431 + 0.088 D + 0.016 D ²	28	.950	-	-
Wood, Total Stem					
	ln Mg = -5.766 + 0.918 ln D ² _H	28	.994	.073	1.00
	ln Mg = -4.953 + 2.398 ln D	28	.986	.113	1.01
	ln Mg = -5.813 + 1.801 ln D + 0.974 ln H	28	.994	.074	1.00
	Mg = 0.605 - 0.192 D + 0.032 D ²	28	.985	-	-
Bark, Total Stem					
	ln Mg = -5.392 + 0.840 ln D ² _H	28	.976	.138	1.01
	ln Mg = -4.674 + 2.202 ln D	28	.976	.137	1.01
	ln Mg = -5.040 + 1.948 ln D + 0.414 ln H	28	.978	.135	1.01
	Mg = -0.227 - 0.023 D + 0.019 D ²	28	.947	-	-
Dead Branches					
	ln Mg = -6.494 + 0.760 ln D ² _H	37	.883	.614	1.21
	ln Mg = -6.269 + 2.141 ln D	37	.901	.564	1.17
	ln Mg = -5.638 + 3.444 ln D - 1.662 ln H	37	.917	.527	1.15
	Mg = 0.227 - 0.072 D + 0.007 D ²	37	.746	-	-
Wood + Bark, Live branches					
	ln Mg = -4.631 + 0.755 ln D ² _H	37	.868	.654	1.24
	ln Mg = -4.404 + 2.126 ln D	37	.884	.612	1.21
	ln Mg = -3.839 + 3.292 ln D - 1.488 ln H	37	.897	.588	1.19
	Mg = 1.574 - 0.452 D + 0.039 D ²	37	.915	-	-
Foliage					
	ln Mg = -4.352 + 0.758 ln D ² _H	37	.820	.787	1.36
	ln Mg = -4.123 + 2.135 ln D	37	.835	.753	1.33
	ln Mg = -3.564 + 3.290 ln D - 1.474 ln H	37	.847	.740	1.31
	Mg = 3.111 - 0.800 D + 0.059 D ²	37	.906	-	-

Table 10a - Biomass prediction equations for aboveground components of Red Maple
 Weight (W) in kg, Diameter (D) in cm, and Height (H) in m.

Component	Equation	n	R ²	s	c
FRESH WEIGHT					
merchantable stem	$\ln W = -4.5205 + 1.1139 \ln D_H^2$	26	.951	.2171	1.02
	$\ln W = -2.6336 + 2.6403 \ln D$	26	.962	.1921	1.02
crown l	$\ln W = -0.9610 + 0.5984 \ln D_H^2$	37	.946	.3071	1.05
	$\ln W = -0.3417 + 1.5501 \ln D$	37	.948	.2994	1.05
total, aboveground	$\ln W = -2.1302 + 0.8772 \ln D_H^2$	37	.990	.1881	1.02
	$\ln W = -1.2175 + 2.2704 \ln D$	37	.991	.1767	1.02
	$\ln W = -1.5101 + 2.1088 \ln D + 0.2774 \ln H$	37	.992	.1772	1.02
OVEN-DRY WEIGHT					
wood, merchantable stem	$\ln W = -5.1265 + 1.1090 \ln D_H^2$	26	.953	.2128	1.02
	$\ln W = -3.2348 + 2.6242 \ln D$	26	.960	.1955	1.02
	$\ln W = -3.5441 + 2.5641 \ln D + 0.1746 \ln H_2$	26	.960	.1991	1.02
	$W = 1.2023 - 1.8938 D + 0.3590 D^2$	26	.946	-	-
bark, merchantable stem	$\ln W = -6.1778 + 1.0007 \ln D_H^2$	26	.935	.2267	1.03
	$\ln W = -4.4824 + 2.3717 \ln D$	26	.945	.2078	1.02
	$W = -0.7879 - 0.0022 D + 0.038 D^2$	26	.904	-	-
wood + bark, merch. stem	$\ln W = -4.8824 + 1.0957 \ln D_H^2$	26	.952	.2115	1.02
	$\ln W = -3.0148 + 2.5932 \ln D$	26	.960	.1937	1.02
	$\ln W = -3.2870 + 2.5404 \ln D + 0.1537 \ln H_2$	26	.960	.1973	1.02
	$W = 0.4144 - 1.8960 D + 0.3970 D^2$	26	.945	-	-

Table 10a - continued.

Component	Equation	n	R ²	s	c
OVEN-DRY WEIGHT					
wood + bark, live branches	$\ln W = -1.7303 + 0.5891 \ln D_H^2$	37	.919	.3751	1.07
	$\ln W = -1.1101 + 1.5219 \ln D$	37	.916	.3806	1.08
	$\ln W = -1.6759 + 1.2094 \ln D + 0.5365 \ln H_2$	37	.919	.3831	1.08
	$W = 6.3161 - 0.6569 D + 0.0920 D^2$	37	.838	-	-
foliage					
	$\ln W = -4.2390 + 0.6084 \ln D_H^2$	37	.887	.4635	1.11
	$\ln W = -3.6477 + 1.5914 \ln D$	37	.908	.4201	1.09
	$\ln W = -1.7171 + 2.6580 \ln D - 1.8307 \ln H_2$	37	.933	.3646	1.07
	$W = 0.1425 - 0.0182 D + 0.0090 D^2$	37	.901	-	-
crown 1/4					
	$\ln W = -1.6873 + 0.6116 \ln D_H^2$	37	.938	.3364	1.06
	$\ln W = -1.0486 + 1.5820 \ln D$	37	.938	.3365	1.06
	$\ln W = -1.3744 + 1.4020 \ln D + 0.3090 \ln H_2$	37	.939	.3416	1.06
	$W = 8.3018 - 1.1061 D + 0.1300 D^2$	37	.863	-	-
total aboveground					
	$\ln W = -2.9178 + 0.9052 \ln D_H^2$	37	.993	.1667	1.01
	$\ln W = -1.9702 + 2.3405 \ln D$	37	.992	.1756	1.02
	$\ln W = -2.5688 + 2.0098 \ln D + 0.5676 \ln H_2$	37	.993	.1650	1.01
	$W = 8.1781 - 3.0779 D + 0.5300 D^2$	37	.962	-	-

TABLE 10b. Nutrient prediction equations for Nitrogen in aboveground components
of Red Maple. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem					
	$\ln N = -5.044 + 1.088 \ln D_H^2$	26	.962	.185	1.02
	$\ln N = -3.175 + 2.571 \ln D$	26	.967	.174	1.02
	$\ln N = -3.769 + 2.455 \ln D + 0.335 \ln H^2$	26	.968	.175	1.02
	$N = 2.166 - 1.805 D + 0.325 D^2$	26	.946	-	-
Bark, Merch. Stem					
	$\ln N = -5.431 + 1.091 \ln D_H^2$	26	.940	.238	1.03
	$\ln N = -3.583 + 2.568 \ln D$	26	.950	.216	1.02
	$\ln N = -4.160 + 2.465 \ln D + 1.100 \ln H^2$	26	.940	.238	1.03
	$N = -0.519 - 0.937 D + 0.217 D^2$	26	.908	-	-
Wood + Bark, Live Branches					
	$\ln N = -1.217 + 0.645 \ln D_H^2$	37	.935	.363	1.07
	$\ln N = -0.541 + 1.669 \ln D$	37	.935	.365	1.07
	$\ln N = -0.960 + 1.437 \ln D + 0.397 \ln H^2$	37	.936	.370	1.07
	$N = 21.496 - 3.709 D + 0.336 D^2$	37	.855	-	-
Foliage					
	$\ln N = -1.557 + 0.625 \ln D_H^2$	37	.868	.521	1.15
	$\ln N = -0.995 + 1.637 \ln D$	37	.890	.476	1.12
	$\ln N = +1.298 + 2.882 \ln D - 2.136 \ln H^2$	37	.923	.408	1.09
	$N = 6.697 - 1.631 D + 0.207 D^2$	37	.899	-	-

TABLE 10c. Nutrient prediction equations for Phosphorus in aboveground components of Red Maple. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem					
	ln P = -7.437 + 1.110 ln D H ²	26	.952	.214	1.02
	ln P = -5.544 + 2.626 ln D	26	.900	.197	1.02
	ln P = -5.843 + 2.569 ln D + 0.168 ln H ²	26	.960	.200	1.02
	P = 0.116 - 0.189 D + 0.036 D ²	26	.946	-	-
Bark, Merch. Stem					
	ln P = -8.322 + 1.134 ln D H ²	26	.948	.227	1.03
	ln P = -6.381 + 2.680 ln D	26	.954	.215	1.02
	ln P = -6.867 + 2.585 ln D + 0.275 ln H ²	26	.955	.218	1.02
	P = -1.221 + 0.059 D + 0.014 D ²	26	.910	-	-
Wood + Bark, Live Branches					
	ln P = -2.666 + 0.586 ln D H ²	37	.879	.464	1.11
	ln P = -2.049 + 1.515 ln D	37	.887	.469	1.12
	ln P = -2.606 + 1.207 ln D + 0.528 ln H ²	37	.879	.474	1.12
	P = 4.045 - 0.753 D + 0.057 D ²	37	.848	-	-
Foliage					
	ln P = -3.607 + 0.607 ln D H ²	37	.871	.500	1.13
	ln P = -3.021 + 1.588 ln D	37	.892	.457	1.11
	ln P = -0.916 + 2.752 ln D - 1.997 ln H ²	37	.922	.396	1.08
	P = 0.628 - 0.124 D + 0.020 D ²	37	.910	-	-

TABLE 10d. Nutrient prediction equations for Potassium in aboveground components
of Red Maple. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem					
	ln K = -6.633 + 1.232 ln D ² H	26	.956	.228	1.03
	ln K = -4.550 + 2.922 ln D	26	.968	.194	1.02
	ln K = -4.448 + 2.942 ln D	26	.968	.199	1.02
	K = 49.350 - 8.402 D + 0.464 ln H ₂ ^D	26	.951	-	-
Bark, Merch. Stem					
	ln K = -6.669 + 1.101 ln D ² H	26	.960	.193	1.02
	ln K = -4.763 + 2.595 ln D	26	.961	.192	1.02
	ln K = -5.710 + 2.411 ln D	26	.963	.189	1.02
	K = -15.489 + 1.531 D + 0.020 ln H ₂ ^D	26	.902	-	-
Wood + Bark, Live Branches					
	ln K = -1.251 + 0.605 ln D ² H	37	.913	.400	1.08
	ln K = -0.616 + 1.565 ln D	37	.912	.402	1.08
	ln K = -1.040 + 1.331 ln D	37	.913	.408	1.08
	K = 16.511 - 2.520 D + 0.222 ln H ₂ ^D	37	.852	-	-
Foliage					
	ln K = -2.045 + 0.602 ln D ² H	37	.884	.466	1.12
	ln K = -1.462 + 1.575 ln D	37	.905	.421	1.09
	ln K = 0.571 + 2.698 ln D -1.927 ln H ₂ ^D	37	.934	.358	1.07
	K = 1.391 - 0.246 D + 0.079	37	.895	-	-

TABLE 10e. Nutrient prediction equations for Calcium in aboveground components
of Red Maple. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem					
	ln Ca = -5.011 + 1.077 ln D _H ²	26	.882	.339	1.06
	ln Ca = -3.218 + 2.563 ln D	26	.899	.313	1.05
	ln Ca = -2.520 + 2.698 ln D	26	.901	.317	1.05
	Ca = 39.752 - 6.471 D + 0.442 D ²	26	.928	-	-
Bark, Merch. Stem					
	ln Ca = -2.292 + 0.860 ln D _H ²	26	.868	.288	1.04
	ln Ca = -0.859 + 2.046 ln D	26	.885	.269	1.04
	ln Ca = -0.344 + 2.146 ln D	26	.886	.274	1.04
	Ca = -142.652 + 20.421 D - 0.134 ln H _D ²	26	.852	-	-
Wood + Bark, Live Branches					
	ln Ca = -0.683 + 0.642 ln D _H ²	37	.925	.390	1.08
	ln Ca = -0.00294 + 1.656 ln D	37	.921	.401	1.08
	ln Ca = -0.826 + 1.202 ln D + 0.781 ln H _D ²	37	.925	.398	1.08
	Ca = 16.387 - 0.556 D + 0.328 D ²	37	.792	-	-
Foliage					
	ln Ca = -2.668 + 0.621 ln D _H ²	37	.891	.465	1.11
	ln Ca = -2.062 + 1.624 ln D	37	.910	.422	1.09
	ln Ca = -0.197 + 2.655 ln D -1.769 ln H _D ²	37	.933	.371	1.07
	Ca = 0.217 - 0.018 D + 0.043 D	37	.865	-	-

TABLE 10f. Nutrient prediction equations for Magnesium in aboveground components
of Red Maple. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem	$\ln Mg = -7.746 + 1.204 \ln D_H^2$ $\ln Mg = -5.739 + 2.865 \ln D$ $\ln Mg = -4.995 + 3.010 \ln D$ $\ln Mg = 9.404 - 1.730 \ln D + 0.108 \ln H_2^D$	26	.867	.405	1.09
Bark, Merch. Stem	$\ln Mg = -7.303 + 1.038 \ln D_H^2$ $\ln Mg = -5.524 + 2.453 \ln D$ $\ln Mg = -6.023 + 2.356 \ln D$ $\ln Mg = -1.526 + 0.155 \ln D + 0.013 \ln H_2^D$	26	.922	.259	1.03
Wood + Bark, Live Branches	$\ln Mg = -2.797 + 0.583 \ln D_H^2$ $\ln Mg = -2.178 + 1.505 \ln D$ $\ln Mg = -2.979 + 1.063 \ln D$ $\ln Mg = 1.386 + 0.018 \ln D + 0.021 \ln H_2^D$	37	.882	.457	1.11
Foliage	$\ln Mg = -3.470 + 0.571 \ln D_H^2$ $\ln Mg = -2.924 + 1.497 \ln D$ $\ln Mg = -.629 + 2.765 \ln D$ $\ln Mg = 0.606 - 0.077 \ln D + 0.015 \ln H_2^D$	37	.843	.527	1.15
				.867	.485
				.906	.417
				.872	.466
					1.12
					1.09
					61

Table 11a - Biomass prediction equations for aboveground components of Sugar Maple.
 Weight (W) in kg, Diameter (D) in cm, and Height (H) in m.

Component	Equation	n	R ²	s	c
FRESH WEIGHT					
merchantable stem	$\ln W = -5.2542 + 1.2122 \ln D_H^2$	26	.977	.1773	1.02
	$\ln W = -3.3240 + 2.9225 \ln D$	26	.964	.2204	1.02
	$\ln W = -5.1951 + 2.4420 \ln D + 1.1728 \ln H$	26	.977	.1810	1.02
crown 1	$\ln W = -1.3059 + 0.6551 \ln D_H^2$	36	.961	.2972	1.05
	$\ln W = -0.5813 + 1.6892 \ln D$	36	.958	.3076	1.05
	$\ln W = -1.2095 + 1.3625 \ln D + 0.5662 \ln H$	36	.961	.3033	1.05
total aboveground	$\ln W = -2.3367 + 0.9168 \ln D_H^2$	36	.992	.1809	1.02
	$\ln W = -1.3375 + 2.3700 \ln D$	36	.995	.1529	1.01
	$\ln W = -1.5671 + 2.2506 \ln D + 0.2069 \ln H$	36	.995	.1532	1.01
OVEN-DRY WEIGHT					
wood, merchantable stem	$\ln W = -5.5003 + 1.1765 \ln D_H^2$	26	.978	.1645	1.01
	$\ln W = -3.6137 + 2.8318 \ln D$	26	.963	.2171	1.02
	$\ln W = -5.6427 + 2.3108 \ln D + 1.2717 \ln H_2$	26	.979	.1677	1.01
	$W = -7.4045 - 1.8825 D + 0.4600 D^2$	26	.963	-	-
bark, merchantable stem	$\ln W = -7.5186 + 1.1698 \ln D_H^2$	26	.974	.1804	1.02
	$\ln W = -5.6530 + 2.8193 \ln D$	26	.960	.2222	1.03
	$\ln W = -7.5048 + 2.3437 \ln D + 1.1606 \ln H_2$	26	.974	.1843	1.02
	$W = 7.7223 - 1.3442 D + 0.0890 D^2$	26	.951	-	-
wood + bark, merch. stem	$\ln W = -5.3756 + 1.1758 \ln D_H^2$	26	.979	.1638	1.01
	$\ln W = -3.4914 + 2.8305 \ln D$	26	.963	.2156	1.02
	$\ln W = -5.4981 + 2.3153 \ln D + 1.2576 \ln H_2$	26	.979	.1670	1.01
	$W = -51.6840 + 3.5354 D + 0.3530 D^2$	26	.956	-	-

Table 11a - continued

Component	Equation	n	R ²	s	c
OVEN-DRY WEIGHT					
wood + bark, live branches	$\ln W = -1.7391 + 0.6169 \ln D_H^2$	36	.927	.3890	1.08
	$\ln W = -1.0333 + 1.5812 \ln D$	36	.913	.4241	1.09
	$\ln W = -2.6484 + 0.7412 \ln D + 1.4556 \ln H_2$	36	.934	.3781	1.07
	$W = -5.4821 + 2.1565 D + 0.0080 D^2$	36	.725	-	-
foliage					
	$\ln W = -5.3100 + 0.7555 \ln D_H^2$	36	.954	.3735	1.07
	$\ln W = -4.4929 + 1.9557 \ln D$	36	.958	.3543	1.06
	$\ln W = -4.4068 + 2.0005 \ln D - 0.0776 \ln H_2$	36	.958	.3617	1.07
	$W = 0.3627 - 0.0907 D + 0.0140 D^2$	36	.782	-	-
crown 1					
	$\ln W = -1.7964 + 0.6468 \ln D_H^2$	36	.954	.3181	1.05
	$\ln W = -1.0781 + 1.6667 \ln D$	36	.950	.3321	1.06
	$\ln W = -1.8234 + 1.2791 \ln D + 0.6717 \ln H_2$	36	.954	.3250	1.05
	$W = 9.8744 - 1.7463 D + 0.1810 D^2$	36	.867	-	-
total aboveground					
	$\ln W = -2.8908 + 0.9263 \ln D_H^2$	36	.994	.1551	1.01
	$\ln W = -1.8760 + 2.3924 \ln D$	36	.995	.1494	1.01
	$\ln W = -2.3386 + 2.1517 \ln D + 0.4170 \ln H_2$	36	.996	.1400	1.01
	$W = -3.1038 - 1.1242 D + 0.5740 D^2$	36	.966	-	-

TABLE IIIb. Nutrient prediction equations for Nitrogen in aboveground components of Sugar Maple. Weight in Σ , D in cm, and Height in m.

Component	Equation	n	R^2	S	C
Wood, Merch. Stem					
	$\ln N = -4.969 + 1.116 \ln D^2 H$	26	.974	.174	1.02
	$\ln N = -3.224 + 2.703 \ln D$	26	.969	.188	1.02
	$\ln N = -4.424 + 2.395 \ln D + 0.752 \ln H_2$	26	.975	.172	1.01
	$N = 56.863 - 10.273 D + 0.699 D^2$	26	.960	-	-
Bark, Merch. Stem					
	$\ln N = -3.871 + 1.183 \ln D^2 H$	26	.972	.188	1.02
	$\ln N = -1.991 + 2.852 \ln D$	26	.960	.225	1.02
	$\ln N = -3.767 + 2.396 \ln D + 1.113 \ln H_2$	26	.972	.192	1.02
	$N = 210.709 - 41.242 D + 3.330 D^2$	26	.961	-	-
Wood + Bark, Live Branches					
	$\ln N = -0.182 + 0.588 \ln D^2 H$	36	.953	.419	1.09
	$\ln N = +0.484 + 1.511 \ln D$	36	.899	.441	1.10
	$\ln N = -0.716 + 0.887 \ln D + 1.082 \ln H_2$	36	.911	.422	1.09
	$N = 37.402 - 6.6666 D + 0.611 D^2$	36	.734	-	-
Foliage					
	$\ln N = -2.180 + 0.734 \ln D^2 H$	36	.952	.371	1.07
	$\ln N = -1.385 + 1.899 \ln D$	36	.956	.336	1.06
	$\ln N = -2.970 + 1.398 \ln D + 1.103 \ln H_2$	36	.930	.294	1.05
	$N = 11.614 - 2.597 D + 0.290 D^2$	36	.749	-	-

Table 12a - continued.

Component	Equation	n	R ²	s	c
OVEN-DRY WEIGHT wood + bark, live branches	$\ln W = -1.5652 + 0.5984 \ln D_H^2$	24	.915	.3690	1.07
	$\ln W = -1.0478 + 1.5899 \ln D$	24	.919	.3600	1.07
	$W = -14.7402 + 4.4510 D - 0.1000 D^2$	24	.797	-	-
foliage	$\ln W = -5.7340 + 0.7953 \ln D_H^2$	24	.954	.3529	1.06
	$\ln W = -5.0552 + 2.1167 \ln D$	24	.961	.3227	1.05
	$W = -4.8287 + 2.2798 \ln D - 0.2530 \ln H_2$	24	.962	.3320	1.06
	$W = 0.5599 - 0.1634 D + 0.0170 D^2$	24	.884	-	-
crown 1	$\ln W = -1.5880 + 0.6186 \ln D_H^2$	24	.925	.3543	1.06
	$\ln W = -1.0549 + 1.6442 \ln D$	24	.930	.3423	1.06
	$W = 1.3.8780 - 2.4029 D + 0.2020 D^2$	24	.920	-	-
total aboveground	$\ln W = -2.9615 + 0.9269 \ln D_H^2$	24	.996	.1198	1.01
	$\ln W = -2.1306 + 2.4510 \ln D$	24	.991	.1800	1.02
	$W = -2.9903 + 1.8319 \ln D + 0.9602 \ln H_2$	24	.996	.1239	1.01
	$W = 4.4477 - 2.6436 D + 0.5870 D^2$	24	.994	-	-

TABLE 12b. Nutrient prediction equations for Nitrogen in aboveground components of Yellow Birch. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem	$\ln N = -4.525 + 1.075 \ln D_H^2$ $\ln N = -2.777 + 2.578 \ln D$ $\ln N = -6.125 + 1.700 \ln D$ $\ln N = -58.367 + 6.645 D$	17 17 17 17	.960 .942 .966 .990	.201 .244 .192 -	1.02 1.03 1.02 -
Bark, Merch. Stem	$\ln N = -5.133 + 1.089 \ln D_H^2$ $\ln N = -3.360 + 2.610 \ln D$ $\ln N = -6.853 + 1.694 \ln D$ $\ln N = -48.931 + 5.732 D$	17 17 17 17	.950 .931 .957 .968	.230 .270 .221 -	1.03 1.04 1.02 -
Wood + Bark, Live Branches	$\ln N = .149 + 0.576 \ln D_H^2$ $\ln N = .668 + 1.523 \ln D$ $\ln N = .0676 + 1.091 \ln D$ $\ln N = 53.156 - 7.958 D$	24 24 24 24	.815 .810 .815 .736	.554 .562 .574 -	1.17 1.17 1.17 -
Foliage	$\ln N = -2.543 + 0.792 \ln D_H^2$ $\ln N = -1.865 + 2.108 \ln D$ $\ln N = -1.675 + 2.246 \ln D$ $\ln N = 14.196 - 4.081 D$	24 24 24 24	.955 .962 .963 .884	.346 .318 .328 -	1.06 1.05 1.06 -
				66	

TABLE 12c. Nutrient prediction equations for Phosphorus in aboveground components of Yellow Birch. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem	$\ln P = -8.027 + 1.192 \ln D_H^2$	17	.964	.210	1.02
	$\ln P = -6.091 + 2.859 \ln D$	17	.946	.259	1.03
	$\ln P = -9.721 + 1.907 \ln D + 2.296 \ln H_2$	17	.970	.200	1.02
	$P = -3.869 + 0.312 D + 0.026 D^2$	17	.996	-	-
Bark, Merch. Stem	$\ln P = -8.429 + 1.132 \ln D_H^2$	17	.954	.230	1.03
	$\ln P = -6.589 + 2.715 \ln D$	17	.935	.271	1.04
	$\ln P = -10.115 + 1.790 \ln D + 2.230 \ln H_2$	17	.960	.222	1.02
	$P = -2.104 + 0.223 D + 0.007 D^2$	17	.972	-	-
Wood + Bark, Live Branches	$\ln P = -3.243 + 0.773 \ln D_H^2$	24	.849	.658	1.24
	$\ln P = -2.613 + 2.069 \ln D$	24	.866	.621	1.21
	$\ln P = -1.551 + 2.834 \ln D - 1.186 \ln H_2$	24	.875	.619	1.21
	$P = 50.311 - 1.204 D + 0.580 D^2$	24	.860	-	-
Foliage	$\ln P = -4.369 + 0.644 \ln D_H^2$	24	.826	.597	1.20
	$\ln P = -3.763 + 1.692 \ln D$	24	.810	.623	1.21
	$\ln P = -5.190 + 0.644 \ln D + 1.594 \ln H_2$	24	.835	.602	1.20
	$P = -3.343 + 0.796 D - 0.019 D^2$	24	.644	-	-

TABLE 12d. Nutrient prediction equations for Potassium in aboveground components of Yellow Birch. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem	$\ln K = -4.282 + 0.935 \ln D_H^2$ $\ln K = -2.911 + 2.294 \ln D$ $\ln K = -.709 + 2.872 \ln D -1.393 \ln H_2$ $K = 28.757 - 4.618 D +0.288$	17 17 17 17	.919 .944 .957 .994	.255 .213 .192 -	1.03 1.02 1.02 -
Bark, Merch. Stem	$\ln K = -7.609 + 1.206 \ln D_H^2$ $\ln K = -5.675 + 2.902 \ln D$ $\ln K = -8.506 + 2.160 \ln D +1.790 \ln H_2$ $K = 1.408 - 0.619 D +0.080$	17 17 17 17	.965 .953 .967 .979	.211 .246 .214 -	1.02 1.03 1.02 -
Wood + Bark, Live Branches	$\ln K = -1.865 + 0.691 \ln D_H^2$ $\ln K = -1.258 + 1.833 \ln D$ $\ln K = -1.528 + 1.639 \ln D +0.301 \ln H_2$ $K = 20.356 - 4.259 D +0.333$	24 24 24 24	.953 .954 .955 .930	.308 .306 .314 -	1.05 1.05 1.05 -
Foliage	$\ln K = -3.308 + 0.754 \ln D_H^2$ $\ln K = -2.667 + 2.006 \ln D$ $\ln K = -2.405 + 2.195 \ln D -0.293 \ln H_2$ $K = 5.125 - 1.374 D +0.132$	24 24 24 24	.951 .959 .960 .882	.347 .317 .325 -	1.06 1.05 1.05 -

TABLE 12e. Nutrient prediction equations for Calcium in aboveground components of
Yellow Birch. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem					
	ln Ca = -5.415 + 1.119 ln D _H ²	17	.987	.119	1.01
	ln Ca = -3.680 + 2.715 ln D	17	.989	.108	1.01
	ln Ca = -4.247 + 2.567 ln D + 0.359 ln H _D ²	17	.990	.108	1.01
	Ca = 5.466 - 2.728 D + 0.346 D ²	17	.996	-	-
Bark, Merch. Stem					
	ln Ca = -4.426 + 1.073 ln D _H ²	17	.937	.257	1.03
	ln Ca = -2.667 + 2.569 ln D	17	.915	.297	1.05
	ln Ca = -6.496 + 1.565 ln D + 2.422 ln H _D ²	17	.947	.244	1.03
	Ca = -164.543 + 20.501 D - 0.178 D ²	17	.920	-	-
Wood + Bark, Live Branches					
	ln Ca = -0.621 + 0.652 ln D _H ²	24	.944	.322	1.05
	ln Ca = -0.0346 + 1.724 ln D	24	.938	.337	1.06
	ln Ca = -0.685 + 1.255 ln D + 0.727 ln H _D ²	24	.944	.333	1.06
	Ca = 6.512 + 0.158 D + 0.315 D ²	24	.889	-	-
Foliage					
	ln Ca = -3.694 + 0.760 ln D _H ²	24	.957	.326	1.05
	ln Ca = -3.037 + 2.019 ln D + 0.038 D ²	24	.961	.310	1.05
	Ca = -1.708 + 0.404 D	24	.839	-	-

TABLE 12F. Nutrient prediction equations for Magnesium in aboveground components of Yellow Birch. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem					
$\ln Mg = -5.222 + 0.931 \ln D_H^2$	17	.889	.303	1.05	
$\ln Mg = -3.776 + 2.257 \ln D$	17	.890	.301	1.05	
$\ln Mg = -4.341 + 2.109 \ln D + 0.357 \ln H$	17	.891	.310	1.05	
$Mg = 18.782 - 2.566 D + 0.128 D^2$	17	.872	-	-	
Bark, Merch. Stem					
$\ln Mg = -7.473 + 1.067 \ln D_H^2$	17	.944	.240	1.03	
$\ln Mg = -5.734 + 2.560 \ln D$	17	.925	.278	1.04	
$\ln Mg = -9.159 + 1.661 \ln D + 2.166 \ln H$	17	.950	.233	1.03	
$Mg = -5.481 + 0.665 D - 0.001 D^2$	17	.939	-	-	
Wood + Bark, Live Branches					
$\ln Mg = -2.732 + 0.673 \ln D_H^2$	24	.935	.360	1.07	
$\ln Mg = -2.143 + 1.786 \ln D$	24	.936	.356	1.07	
$\ln Mg = -2.354 + 1.634 \ln D + 0.236 \ln H$	24	.937	.367	1.07	
$Mg = 6.470 - 1.168 D + 0.102 D^2$	24	.917	-	-	
Foliage					
$\ln Mg = -4.494 + 0.760 \ln D_H^2$	24	.950	.353	1.06	
$\ln Mg = -3.817 + 2.010 \ln D$	24	.946	.365	1.07	
$\ln Mg = -4.420 + 1.576 \ln D + 0.673 \ln H$	24	.950	.365	1.07	
$Mg = 0.015 - 0.004 D + 0.024 D^2$	24	.857	-	-	

TABLE IIc. Nutrient prediction equations for Phosphorus in aboveground components of Sugar Maple. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem					
ln P =	-7.792 + 1.175 ln D _H ²	26	.979	.164	1.01
ln P =	-5.907 + 2.829 ln D	26	.963	.216	1.02
ln P =	-7.962 + 2.309 ln D + 1.269 ln H ₂ ^D	26	.979	.167	1.01
P =	-0.745 - 0.187 D + 0.046 ln H ₂ ^D	26	.962	-	-
Bark, Merch. Stem					
ln P =	-6.260 + 1.143 ln D _H ²	26	.942	.267	1.04
ln P =	-4.425 + 2.750 ln D	26	.926	.302	1.05
ln P =	-6.428 + 2.235 ln D + 1.226 ln H ₂ ^D	26	.942	.273	1.04
P =	26.457 - 3.828 D + 0.236 ln H ₂ ^D	26	.931	-	-
Wood + Bark, Live Branches					
ln P =	-2.423 + 0.586 ln D _H ²	36	.895	.450	1.11
ln P =	-1.763 + 1.506 ln D	36	.886	.468	1.12
ln P =	-2.860 + 0.935 ln D + 0.989 ln H ₂ ^D	36	.897	.456	1.11
P =	6.618 - 1.347 D + 0.088 ln H ₂ ^D	36	.684	-	-
Foliage					
ln P =	-4.606 + 0.737 ln D _H ²	36	.952	.370	1.07
ln P =	-3.803 + 1.907 ln D	36	.955	.359	1.07
ln P =	-3.933 + 1.839 ln D + 0.117 ln H ₂ ^D	36	.955	.367	1.07
P =	1.334 - 0.293 D + 0.028 ln H ₂ ^D	36	.720	-	-

TABLE 11d. Nutrient prediction equations for Potassium in aboveground components
of Sugar Maple. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem	$\ln K = -6.996 + 1.250 \ln D^2_H$	26	.958	.245	1.03
	$\ln K = -5.103 + 3.048 \ln D$	26	.967	.218	1.02
	$\ln K = -5.466 + 2.955 \ln D + 0.228 \ln H^2_D$	26	.968	.221	1.02
	$K = 133.282 - 18.864 \ln D + 0.725 \ln H^2_D$	26	.901	-	-
Bark, Merch. Stem	$\ln K = -6.352 + 1.350 \ln D^2_H$	26	.982	.171	1.01
	$\ln K = -4.209 + 3.258 \ln D$	26	.971	.219	1.02
	$\ln K = -6.173 + 2.754 \ln D + 1.231 \ln H^2_D$	26	.982	.174	1.02
	$K = 87.739 - 21.296 \ln D + 1.535 \ln H^2_D$	26	.965	-	-
Wood + Bark, Live Branches	$\ln K = -.985 + 0.593 \ln D^2_H$	36	.883	.486	1.13
	$\ln K = -.321 + 1.527 \ln D$	36	.876	.498	1.13
	$\ln K = -1.211 + 1.065 \ln D + 0.801 \ln H^2_D$	36	.883	.495	1.13
	$K = 27.194 - 5.793 \ln D + 0.398 \ln H^2_D$	36	.762	-	-
Foliage	$\ln K = -3.168 + 0.775 \ln D^2_H$	36	.995	.377	1.07
	$\ln K = -2.327 + 2.003 \ln D$	36	.958	.363	1.07
	$\ln K = -2.409 + 1.960 \ln D + 0.0745 \ln H^2_D$	36	.958	.371	1.07
	$K = 0.703 - 0.151 \ln D + 0.111 \ln H^2_D$	36	.787	-	-

TABLE 11e. Nutrient prediction equations for Calcium in aboveground components of Sugar Maple. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem	$\ln Ca = -5.914 + 1.188 \ln D^2 H$ $\ln Ca = -4.076 + 2.881 \ln D$ $\ln Ca = -5.059 + 2.629 \ln D + 0.616 \ln H_2$ $Ca = 98.058 - 14.998 D + 0.730 \ln D^2 H_2$	26	.974	.181	1.02
Bark, Merch. Stem	$\ln Ca = -2.175 + 1.101 \ln D^2 H$ $\ln Ca = -.433 + 2.658 \ln D$ $\ln Ca = -1.952 + 2.268 \ln D + 0.952 \ln H_2$ $Ca = 878.597 - 137.301 D + 9.261 \ln D^2 H_2$	26	.967	.193	1.02
Wood + Bark, " Live Branches	$\ln Ca = -0.0842 + 0.583 \ln D^2 H$ $\ln Ca = 0.577 + 1.497 \ln D$ $\ln Ca = -0.694 + 0.836 \ln D + 1.146 \ln H_2$ $Ca = 24.311 - 3.203 D + 0.501 \ln D^2 H_2$	36	.902	.432	1.10
Foliage	$\ln Ca = -3.512 + 0.728 \ln D^2 H$ $\ln Ca = -2.719 + 1.883 \ln D$ $\ln Ca = -2.856 + 1.812 \ln D + 0.124 \ln H_2$ $Ca = 3.529 - 0.755 D + 0.076 \ln D^2 H_2$	36	.949	.379	1.07
		36	.951	.370	1.07
		36	.951	.377	1.07
		36	.710	-	-

TABLE 11f. Nutrient prediction equations for Magnesium in aboveground components of Sugar Maple. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem					
	ln Mg = -10.334 + 1.512 ln D _H	26	.969	.256	1.03
	ln Mg = -8.045 + 3.687 ln D	26	.978	.216	1.02
	ln Mg = -8.470 + 3.578 ln D + 0.266 ln H	26	.978	.219	1.02
	Mg = 36.909 - 6.071 D + 0.262 D ²	26	.958	-	-
Bark, Merch. Stem					
	ln Mg = -6.897 + 1.307 ln D _H ²	26	.975	.198	1.02
	ln Mg = -4.870 + 3.170 ln D	26	.973	.204	1.02
	ln Mg = -6.024 + 2.874 ln D + 0.723 ln H	26	.978	.191	1.02
	Mg = 133.579 - 20.685 D + 0.942 D ²	26	.950	-	-
Wood + Bark, Live Branches					
	ln Mg = -2.556 + 0.613 ln D _H ²	36	.901	.456	1.11
	ln Mg = -1.872 + 1.578 ln D	36	.895	.469	1.12
	ln Mg = -2.756 + 1.118 ln D + 0.797 ln H	36	.901	.465	1.11
	Mg = 5.783 - 1.257 D + 0.092 D ²	36	.741	-	-
Foliage					
	ln Mg = -4.645 + 0.720 ln D _H ²	36	.948	.379	1.07
	ln Mg = -3.870 + 1.865 ln D	36	.954	.355	1.07
	ln Mg = -3.615 + 1.999 ln D - 0.230 ln H	36	.955	.361	1.07
	Mg = 1.281 - 0.312 D + 0.027 D ²	36	.755	-	-

Table 12a - Biomass prediction equations for aboveground components of Yellow Birch
 Weight (W) in kg, Diameter (D) in cm, and Height (H) in m.

Component	Equation	n	R ²	S	C
FRESH WEIGHT					
merchantable stem	$\ln W = -5.0634 + 1.1924 \ln D_H^2$	17	.965	.2097	1.02
	$\ln W = -3.1288 + 2.8621 \ln D$	17	.947	.2571	1.03
	$\ln W = -6.6982 + 1.9260 \ln D + 2.2573 \ln H$	17	.970	.2008	1.02
crown 1	$\ln W = -1.0145 + 0.6257 \ln D_H^2$	24	.931	.3452	1.06
	$\ln W = -0.4774 + 1.6642 \ln D$	24	.937	.3299	1.06
	$\ln W = -0.3828 + 1.7324 \ln D - 0.1057 \ln H$	24	.937	.3412	1.06
total aboveground	$\ln W = -2.3211 + 0.9187 \ln D_H^2$	24	.996	.1184	1.01
	$\ln W = -1.5011 + 2.4308 \ln D$	24	.992	.1662	1.01
	$\ln W = -2.2510 + 1.8908 \ln D + 0.8376 \ln H$	24	.996	.1220	1.01
OVEN-DRY WEIGHT					
wood, merchantable stem	$\ln W = -5.7350 + 1.1929 \ln D_H^2$	17	.964	.2119	1.02
	$\ln W = -3.7975 + 2.8627 \ln D$	17	.946	.2600	1.03
	$\ln W = -7.4385 + 1.9078 \ln D + 2.3026 \ln H_2$	17	.970	.2018	1.02
	$W = -39.7457 + 3.2573 D + 0.254 D^2$	17	.996	-	-
bark, merchantable stem	$\ln W = -7.2195 + 1.1311 \ln D_H^2$	17	.954	.2291	1.03
	$\ln W = -5.3805 + 2.7136 \ln D$	17	.935	.2709	1.04
	$\ln W = -8.8987 + 1.7910 \ln D + 2.2248 \ln H_2$	17	.960	.2214	1.02
	$W = -7.0217 + 0.7439 D + 0.0220 D^2$	17	.971	-	-
wood + bark, merch. stem	$\ln W = -5.5414 + 1.1850 \ln D_H^2$	17	.964	.2106	1.02
	$\ln W = -3.6165 + 2.8437 \ln D$	17	.946	.2584	1.03
	$\ln W = -7.2408 + 1.8932 \ln D + 2.2920 \ln H_2$	17	.970	.2003	1.02
	$W = -46.7674 + 4.0012 D + 0.2760 D^2$	17	.995	-	-

Table 13a - Biomass prediction equations for aboveground components of White Birch.

Weight (W) in kg, Diameter (D) in cm, and Height (H) in m.

Component	Equation	n	R ²	s	c
FRESH WEIGHT merchantable stem	$\ln W = -4.8476 + 1.1708 \ln D_H^2$	29	.987	.1529	1.01
	$\ln W = -3.6113 + 3.0020 \ln D$	29	.984	.1693	1.01
	$\ln W = -4.4904 + 2.5445 \ln D + 0.8196 \ln H$	29	.987	.1517	1.01
crown 1	$\ln W = -1.3758 + 0.6550 \ln D_H^2$	37	.970	.2704	1.04
	$\ln W = -0.7476 + 1.7027 \ln D$	37	.970	.2692	1.04
	$\ln W = -1.0305 + 1.5286 \ln D + 0.2921 \ln H$	37	.971	.2720	1.04
total aboveground	$\ln W = -2.1634 + 0.8951 \ln D_H^2$	37	.989	.2248	1.03
	$\ln W = -1.3049 + 2.3268 \ln D$	37	.989	.2222	1.03
	$\ln W = -1.6923 + 2.0884 \ln D + 0.4002 \ln H$	37	.989	.2212	1.02
OVEN-DRY WEIGHT wood, merchantable stem	$\ln W = -5.6329 + 1.1793 \ln D_H^2$	29	.988	.1492	1.01
	$\ln W = -4.3827 + 3.0221 \ln D$	29	.983	.1720	1.01
	$\ln W = -4.3617 + 2.5126 \ln D + 0.9127 \ln H$	29	.988	.1496	1.01
	$W = 18.5171 - 5.6187 D + 0.5180 D^2$	29	.990	-	-
bark, merchantable stem	$\ln W = -6.1773 + 1.0369 \ln D_H^2$	29	.977	.1805	1.02
	$\ln W = -5.0932 + 2.6627 \ln D$	29	.977	.1810	1.02
	$\ln W = -5.6608 + 2.3673 \ln D + 0.5292 \ln H$	29	.978	.1767	1.02
	$W = 4.5530 - 0.9698 D + 0.0820 D^2$	29	.970	-	-
wood + bark, merch. stem	$\ln W = -5.2795 + 1.1568 \ln D_H^2$	29	.988	.1463	1.01
	$\ln W = -4.0550 + 2.9650 \ln D$	29	.984	.1666	1.01
	$\ln W = -4.9807 + 2.4833 \ln D + 0.8630 \ln H$	29	.988	.1461	1.01
	$W = 23.0702 - 6.5884 D + 0.6000 D^2$	29	.991	-	-

Table 13a - continued.

Component	Equation	n	R ²	S	C
OVEN-DRY WEIGHT wood + bark, live branches	$\ln W = -2.0511 + 0.6327 \ln D^2 H$	37	.955	.3199	1.05
	$\ln W = -1.4423 + 1.6429 \ln D$	37	.955	.3224	1.05
	$\ln W = -1.8357 + 1.4018 \ln D + 0.4064 \ln H_2$	37	.956	.3249	1.05
	$W = -4.4601 + 1.6730 D + 0.0060 D^2$	37	.702	-	-
foliage	$\ln W = -4.6427 + 0.6587 \ln D^2 H$	37	.894	.5310	1.15
	$\ln W = -4.0148 + 1.7139 \ln D$	37	.896	.5263	1.15
	$W = -0.0652 + 0.0280 D + 0.0070 D^2$	37	.894	-	-
crown 1	$\ln W = -2.0047 + 0.6489 \ln D^2 H$	37	.964	.2948	1.04
	$\ln W = -1.3820 + 1.6868 \ln D$	37	.964	.2942	1.04
	$\ln W = -1.6791 + 1.5039 \ln D + 0.3069 \ln H_2$	37	.964	.2975	1.05
	$W = 8.3277 - 1.5010 D + 0.1480 D^2$	37	.949	-	-
total aboveground	$\ln W = -2.8747 + 0.9089 \ln D^2 H$	37	.989	.2231	1.03
	$\ln W = -2.0045 + 2.3634 \ln D$	37	.990	.2147	1.02
	$\ln W = -2.3056 + 2.1781 \ln D + 0.3110 \ln H_2$	37	.990	.2156	1.02
	$W = 15.0069 - 6.0265 D + 0.6900 D^2$	37	.988	-	-

TABLE 13b. Nutrient prediction equations for Nitrogen in aboveground components of
White Birch. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem	$\ln N = -4.705 + 1.102 \ln D_H^2$	29	.986	.144	1.01
	$\ln N = -3.624 + 2.853 \ln D$	29	.988	.130	1.01
	$\ln N = -3.996 + 2.643 \ln D + 0.364 \ln H_D^2$	29	.989	.127	1.01
	$N = 116.369 - 20.556 D + 1.071 H_D^2$	29	.988	-	-
Bark, Merch. Stem	$\ln N = -4.937 + 1.058 \ln D_H^2$	29	.969	.207	1.02
	$\ln N = -3.882 + 2.732 \ln D$	29	.967	.211	1.02
	$\ln N = -4.516 + 2.376 \ln D + 0.620 \ln H_D^2$	29	.970	.206	1.02
	$N = -3.801 - 1.062 D + 0.260 H_D^2$	29	.949	-	-
Wood + Bark, Live Branches	$\ln N = -0.808 + 0.686 \ln D_H^2$	37	.964	.309	1.05
	$\ln N = -0.149 + 1.781 \ln D$	37	.964	.311	1.05
	$\ln N = -0.548 + 1.536 \ln D + 0.413 \ln H_D^2$	37	.965	.313	1.05
	$N = 34.001 - 6.358 D + 0.660 H_D^2$	37	.955	-	-
Foliage	$\ln N = -2.199 + 0.730 \ln D_H^2$	37	.886	.613	1.21
	$\ln N = -1.485 + 1.892 \ln D$	37	.881	.627	1.22
	$\ln N = -2.622 + 1.192 \ln D + 1.175 \ln H_D^2$	37	.887	.623	1.21
	$N = 3.992 - 1.075 D + 0.227 H_D^2$	37	.913	-	-

TABLE 13c. Nutrient prediction equations for Phosphorus in aboveground components of White Birch. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem	$\ln P = -8.794 + 1.301 \ln D_H^2$	29	.969	.254	1.03
	$\ln P = -7.521 + 3.369 \ln D$	29	.972	.239	1.03
	$\ln P = -7.883 + 3.166 \ln D + 0.354 \ln H_2$	29	.973	.241	1.03
	$P = -1.281 - 0.580 D + 0.073 D^2$	29	.931	-	-
Bark, Merch. Stem	$\ln P = -7.448 + 1.060 \ln D_H^2$	29	.963	.226	1.03
	$\ln P = -6.385 + 2.737 \ln D$	29	.960	.234	1.03
	$\ln P = -7.119 + 2.324 \ln D + 0.719 \ln H_2$	29	.964	.228	1.03
	$P = -1.987 + 0.166 D + 0.014 D^2$	29	.958	-	-
Wood + Bark, Live Branches	$\ln P = -2.905 + 0.693 \ln D_H^2$	37	.966	.305	1.05
	$\ln P = -2.239 + 1.800 \ln D$	37	.965	.307	1.05
	$\ln P = -2.616 + 1.568 \ln D + 0.389 \ln H_2$	37	.966	.309	1.05
	$P = 4.168 - 0.749 D + 0.083 D^2$	37	.951	-	-
Foliage	$\ln P = -4.388 + 0.704 \ln D_H^2$	37	.881	.605	1.20
	$\ln P = -3.697 + 1.825 \ln D$	37	.875	.620	1.21
	$\ln P = -4.924 + 1.069 \ln D + 1.268 \ln H_2$	37	.883	.613	1.21
	$P = -0.633 + 0.192 D + 0.009 D^2$	37	.870	-	-

TABLE 13d. Nutrient prediction equations for Potassium in aboveground components
of White Birch. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem					
	ln K = -7.457 + 1.296 ln D _H ²	29	.918	.420	1.10
	ln K = -6.135 + 3.336 ln D	29	.911	.438	1.10
	ln K = -7.421 + 2.614 ln D + 1.258 ln H ₂	29	.918	.428	1.10
	K = 11.025 - 2.494 D + 0.224 D ²	29	.932	-	-
Bark, Merch. Stem					
	ln K = -6.827 + 1.094 ln D _H	29	.956	.256	1.03
	ln K = -5.723 + 2.821 ln D	29	.951	.268	1.04
	ln K = -6.602 + 2.327 ln D + 0.860 ln H ₂	29	.956	.260	1.03
	K = -1.205 - 0.111 D + 0.049 D ²	29	.969	-	-
Wood + Bark, Live Branches					
	ln K = -4.006 + 0.816 ln D _H ²	37	.826	.877	1.47
	ln K = -3.227 + 2.124 ln D	37	.827	.874	1.47
	ln K = -3.370 + 2.035 ln D + 0.149 ln H ₂	37	.827	.891	1.49
	K = 22.955 - 6.461 D + 0.344 D ²	37	.926	-	-
Foliage					
	ln K = -2.940 + 0.657 ln D _H ²	37	.890	.530	1.15
	ln K = -2.313 + 1.708 ln D	37	.892	.526	1.15
	ln K = -2.370 + 1.674 ln D + 0.058 ln H ₂	37	.888	.533	1.15
	K = -3.318 - 0.208 D + 0.090 D ²	37	.764	-	-

TABLE 13e. Nutrient prediction equations for Calcium in aboveground components of White Birch. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem	$\ln \text{Ca} = -5.082 + 1.069 \ln D_H^2$	29	.977	.179	1.02
	$\ln \text{Ca} = -4.009 + 2.759 \ln D$	29	.974	.191	1.02
	$\ln \text{Ca} = -4.772 + 2.330 \ln D + 0.746 \ln H^2$	29	.977	.180	1.02
	$\text{Ca} = 2.175 - 1.626 D + 0.261 D^2$	29	.983	-	-
Bark, Merch. Stem	$\ln \text{Ca} = -2.696 + 0.879 \ln D_H^2$	29	.934	.262	1.03
	$\ln \text{Ca} = -1.751 + 2.246 \ln D$	29	.926	.279	1.03
	$\ln \text{Ca} = -1.287 + 0.123 \ln D + 0.282 \ln H^2$	29	.937	.262	1.03
	$\text{Ca} = -111.179 + 14.012 D - 0.014 D^2$	29	.879	-	-
Wood + Bark, Live Branches	$\ln \text{Ca} = -1.006 + 0.646 \ln D_H^2$	37	.878	.565	1.17
	$\ln \text{Ca} = -.387 + 1.680 \ln D$	37	.878	.565	1.17
	$\ln \text{Ca} = -.660 + 1.512 \ln D + 0.282 \ln H^2$	37	.878	.575	1.18
	$\text{Ca} = -90.470 - 21.448 D + 1.099 D^2$	37	.885	-	-
Foliage	$\ln \text{Ca} = -3.968 + 0.795 \ln D_H^2$	37	.889	.657	1.24
	$\ln \text{Ca} = -3.188 + 2.059 \ln D$	37	.883	.675	1.26
	$\ln \text{Ca} = -4.565 + 1.212 \ln D + 1.422 \ln H^2$	37	.890	.666	1.25
	$\text{Ca} = -2.319 + 0.128 D + 0.063 D^2$	37	.842	-	-

TABLE 13F. Nutrient prediction equations for Magnesium in aboveground components of White Birch. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem					
	ln Mg = -7.057 + 1.159 ln D ² _H	29	.989	.135	1.01
	ln Mg = -5.880 + 2.985 ln D	29	.982	.169	1.01
	ln Mg = -6.953 + 2.382 ln D	29	.989	.137	1.01
	Mg = 3.700 - 1.124 D + 0.104 D ²	29	.990	-	-
Bark, Merch. Stem					
	ln Mg = -6.096 + 0.926 ln D ² _H	29	.963	.198	1.02
	ln Mg = -5.156 + 2.386 ln D	29	.957	.214	1.02
	ln Mg = -6.003 + 1.910 ln D + 0.829 ln H	29	.963	.201	1.02
	Mg = -1.226 + 0.083 D + 0.018 D ²	29	.929	-	-
Wood + Bark, Live Branches					
	ln Mg = -3.530 + 0.681 ln D ² _H	37	.917	.479	1.12
	ln Mg = -2.876 + 1.770 ln D	37	.917	.479	1.12
	ln Mg = -3.193 + 1.576 ln D + 0.328 ln H	37	.918	.487	1.13
	Mg = 7.123 - 1.726 D + 0.096 D ²	37	.922	-	-
Foliage					
	ln Mg = -6.500 + 0.903 ln D ² _H	37	.859	.858	1.44
	ln Mg = -5.631 + 2.346 ln D	37	.858	.860	1.45
	ln Mg = -6.193 + 2.000 ln D + 0.580 ln H	37	.859	.874	1.47
	Mg = 0.321 - 0.311 D + 0.031 D ²	37	.867	-	-

Table 14a - Biomass prediction equations for aboveground components of Large-tooth Aspen.

Weight (W) in kg, Diameter (D) in cm, and Height (H) in m.

Component	Equation	n	R ²	S	C
FRESH WEIGHT merchantable stem	$\ln W = -5.1104 + 1.1784 \ln D^2 H$	23	.979	.1740	1.02
	$\ln W = -3.3293 + 2.8081 \ln D$	23	.970	.2082	1.02
	$\ln W = -4.7570 + 2.4595 \ln D + 0.9300 \ln H$	23	.980	.1752	1.02
crown 1	$\ln W = -1.6507 + 0.6782 \ln D^2 H$	30	.950	.3849	1.08
	$\ln W = -1.0974 + 1.7732 \ln D$	30	.970	.2963	1.04
	$\ln W = -0.4841 + 2.1638 \ln D - 0.6763 \ln H$	30	.977	.2671	1.04
total aboveground	$\ln W = -2.3246 + 0.8978 \ln D^2 H$	30	.995	.1572	1.01
	$\ln W = -1.5320 + 2.3230 \ln D$	30	.995	.1508	1.01
	$\ln W = -1.9169 + 2.0779 \ln D - 1.9169 \ln H$	30	.997	.1251	1.01
OVEN-DRY WEIGHT wood, merchantable stem	$\ln W = -6.2075 + 1.2040 \ln D^2 H$	23	.982	.1619	1.01
	$\ln W = -4.3575 + 2.8586 \ln D$	23	.966	.2246	1.03
	$\ln W = -6.2288 + 2.4017 \ln D + 1.2189 \ln H_2$	23	.982	.1659	1.01
	$W = 73.2794 - 11.5276 D + 0.5490 D^2$	23	.959	-	-
bark, merchantable stem	$\ln W = -6.4964 + 1.0922 \ln D^2 H$	23	.957	.2329	1.03
	$\ln W = -4.8831 + 2.6158 \ln D$	23	.958	.2313	1.03
	$\ln W = -5.6922 + 2.4182 \ln D + 0.5270 \ln H_2$	23	.961	.2267	1.03
	$W = -1.6447 - 0.0810 D + 0.0590 D^2$	23	.976	-	-
wood + bark, merch. stem	$\ln W = -5.7435 + 1.1802 \ln D^2 H$	23	.980	.1701	1.01
	$\ln W = -3.9507 + 2.8093 \ln D$	23	.969	.2123	1.02
	$\ln W = -5.5015 + 2.4307 \ln D + 1.0101 \ln H_2$	23	.980	.1728	1.02
	$W = 69.2705 - 11.3110 D + 0.6010 D^2$	23	.968	-	-

Table 14a - continued.

Component	Equation	n	R ²	s	c
OVEN-DRY WEIGHT wood + bark, live branches	$\ln W = -2.5285 + 0.6688 \ln D_H^2$	30	.940	.4165	1.09
	$\ln W = -1.9890 + 1.7510 \ln D$	30	.963	.3270	1.05
	$\ln W = -1.2629 + 2.2135 \ln D - 0.8007 \ln H_2$	30	.973	.2882	1.04
	$W = 3.4818 - 0.7029 D + 0.0910 D^2$	30	.936	-	-
foliage	$\ln W = -4.7066 + 0.6677 \ln D_H^2$	30	.940	.4142	1.09
	$\ln W = -4.1400 + 1.7369 \ln D$	30	.951	.3757	1.07
	$\ln W = -3.9705 + 1.8448 \ln D - 0.1869 \ln H_2$	30	.951	.3829	1.08
	$W = 0.0634 - 0.0203 D + 0.0090 D^2$	30	.936	-	-
crown 1	$\ln W = -2.4630 + 0.6978 \ln D_H^2$	30	.953	.3834	1.08
	$\ln W = -1.8933 + 1.8243 \ln D$	30	.973	.2893	1.04
	$\ln W = -1.2704 + 2.2210 \ln D - 0.6869 \ln H_2$	30	.980	.2576	1.03
	$W = 2.5561 - 0.5902 D + 0.1130 D^2$	30	.939	-	-
total aboveground	$\ln W = -3.1334 + 0.9192 \ln D_H^2$	30	.996	.1512	1.01
	$\ln W = -2.3200 + 2.3773 \ln D$	30	.995	.1557	1.01
	$\ln W = -2.7530 + 2.1016 \ln D + 0.4775 \ln H_2$	30	.997	.1227	1.01
	$W = 9.1652 - 3.9004 D + 0.4880 D^2$	30	.982	-	-

TABLE 14b. Nutrient prediction equations for Nitrogen in aboveground components of Large-toothed Aspen. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem	$\ln N = -5.656 + 1.153 \ln D_H^2$ $\ln N = -3.864 + 2.730 \ln D$ $\ln N = -5.938 + 2.224 \ln D + 1.351 \ln H_D^2$ $N = 83.227 - 12.915 \ln D + 0.609 \ln H_D^2$	23 23 23 23	.989 .968 .990 .959	.122 .210 .122 -	1.01 1.02 1.01 -
Bark, Merch. Stem	$\ln N = -5.763 + 1.147 \ln D_H^2$ $\ln N = -4.067 + 2.747 \ln D$ $\ln N = -4.930 + 2.537 \ln D - 4.930 \ln H_D^2$ $N = -22.983 + 1.786 \ln D + 0.148 \ln H_D^2$	23 23 23 23	.957 .958 .961 .970	.243 .242 .237 -	1.03 1.03 1.03 -
Wood + Bark, Live Branches	$\ln N = -1.064 + 0.679 \ln D_H^2$ $\ln N = -0.514 + 1.776 \ln D$ $\ln N = 0.171 + 2.213 \ln D - 0.756 \ln H_D^2$ $N = 11.051 - 2.031 \ln D + 0.376 \ln H_D^2$	30 30 30 30	.946 .968 .976 .941	.401 .310 .273 -	1.08 1.05 1.04 -
Foliage	$\ln N = -1.479 + 0.670 \ln D_H^2$ $\ln N = -0.909 + 1.742 \ln D$ $\ln N = -0.765 + 1.834 \ln D - 0.159 \ln H_D^2$ $N = -0.142 - 0.088 \ln D + 0.208 \ln H_D^2$	30 30 30 30	.943 .953 .953 .912	.407 .370 .376 -	1.09 1.07 1.07 -

TABLE 14c. Nutrient prediction equations for Phosphorus in aboveground components of Large-toothed Aspen. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem					
	ln P = -9.584 + 1.374 ln D _H ²	23	.927	.387	1.08
	ln P = -7.406 + 3.238 ln D	23	.899	.456	1.11
	ln P = -10.456 + 2.494 ln D + 1.986 ln H ₂	23	.930	.388	1.08
	P = 36.560 - 5.104 D + 0.181 D ²	23	.803	-	-
Bark, Merch. Stem					
	ln P = -7.660 + 1.095 ln D _H ²	23	.942	.272	1.04
	ln P = -6.012 + 2.612 ln D	23	.935	.289	1.04
	ln P = -7.248 + 2.310 ln D + 0.805 ln H ₂	23	.943	.277	1.04
	P = -1.879 + 0.192 D + 0.012 D ²	23	.960	-	-
Wood + Bark, Live Branches					
	ln P = -2.847 + 0.653 ln D _H ²	30	.949	.373	1.07
	ln P = -2.315 + 1.708 ln D	30	.970	.287	1.04
	ln P = -1.707 + 2.095 ln D - 0.671 ln H ₂	30	.977	.257	1.03
	P = 1.585 - 0.263 D + 0.050 D ²	30	.936	-	-
Foliage					
	ln P = -4.000 + 0.676 ln D _H ²	30	.942	.415	1.09
	ln P = -3.427 + 1.759 ln D	30	.953	.374	1.07
	ln P = -3.241 + 1.878 ln D - 0.206 ln H ₂	30	.953	.381	1.08
	P = -0.412 + 0.074 D + 0.015 D ²	30	.898	-	-

TABLE 14d. Nutrient prediction equations for Potassium in aboveground components of Large-toothed Aspen. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem	$\ln K = -7.062 + 1.306 \ln D_H^2$ $\ln K = -5.094 + 3.114 \ln D$ $\ln K = -6.591 + 2.749 \ln D + 0.975 \ln H_2$ $K = -18.519 - 0.835 D + 0.296 D^2$	23 23 23 23	.958 .950 .959 .786	.276 .299 .279 -	1.04 1.05 1.04 -
Bark, Merch. Stem	$\ln K = -7.014 + 1.241 \ln D_H^2$ $\ln K = -5.172 + 2.968 \ln D$ $\ln K = -6.222 + 2.712 \ln D + 0.684 \ln H_2$ $K = 2.460 - 1.648 D + 0.189 D^2$	23 23 23 23	.976 .975 .979 .979	.195 .202 .186 -	1.02 1.02 1.02 -
Wood + Bark, Live Branches	$\ln K = -1.545 + 0.687 \ln D_H^2$ $\ln K = -0.991 + 1.799 \ln D$ $\ln K = -0.247 + 2.273 \ln D - 0.820 \ln H_2$ $K = 6.490 - 1.300 D + 0.253 D^2$	30 30 30 30	.941 .964 .974 .923	.423 .330 .290 -	1.09 1.06 1.04 -
Foliage	$\ln K = -2.267 + 0.676 \ln D_H^2$ $\ln K = -1.695 + 1.760 \ln D$ $\ln K = -1.488 + 1.892 \ln D - 0.228 \ln H_2$ $K = 0.837 - 0.496 D + 0.123 D^2$	30 30 30 30	.936 .947 .948 .910	.437 .396 .403 -	1.10 1.08 1.08 -

TABLE 14e. Nutrient prediction equations for Calcium in aboveground components of Large-toothed Aspen. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem					
	ln Ca = -6.721 + 1.214 ln D _H ²	23	.985	.152	1.01
	ln Ca = -4.838 + 2.876 ln D	23	.964	.232	1.03
	ln Ca = -6.962 + 2.357 ln D + 1.383 ln H Ca = 37.694 - 6.264 D + 0.325 D ²	23	.985	.154	1.01
Bark, Merch. Stem					-
	ln Ca = -4.804 + 1.150 ln D _H ²	23	.954	.248	1.03
	ln Ca = -3.099 + 2.751 ln D	23	.953	.252	1.03
	ln Ca = -4.050 + 2.518 ln D + 0.620 ln H Ca = -60.345 + 1.642 D + 0.514 D ²	23	.955	.245	1.03
Wood + Bark, Live Branches					-
	ln Ca = -1.353 + 0.752 ln D _H ²	30	.942	.462	1.11
	ln Ca = -0.735 + 1.965 ln D	30	.960	.381	1.08
	ln Ca = -0.143 + 2.342 ln D - 0.652 ln H Ca = -12.017 + 1.154 D + 0.466 D ²	30	.965	.365	1.07
Foliage					-
	ln Ca = -3.125 + 0.703 ln D _H ²	30	.938	.446	1.10
	ln Ca = -2.529 + 1.828 ln D	30	.948	.407	1.09
	ln Ca = -2.351 + 1.942 ln D - 0.197 ln H Ca = 1.538 - 0.603 D + 0.080 D ²	30	.949	.415	1.09

TABLE 14f. Nutrient prediction equations for Magnesium in aboveground components of Large-toothed Aspen. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem	$\ln \text{Mg} = -7.164 + 1.172 \ln D_H^2$ $\ln \text{Mg} = -5.373 + 2.787 \ln D$ $\ln \text{Mg} = -7.043 + 2.380 \ln D + 1.088 \ln H^2$ $\text{Mg} = -0.134 - 0.474 D + 0.077 D^2$	23 23 23 23	.976 .963 .977 .943	.183 .230 .187 -	1.02 1.03 1.02 -
Bark, Merch. Stem	$\ln \text{Mg} = -6.601 + 1.066 \ln D_H^2$ $\ln \text{Mg} = -4.900 + 2.510 \ln D$ $\ln \text{Mg} = -7.415 + 1.896 \ln D + 1.638 \ln H^2$ $\text{Mg} = -34.838 + 4.954 D - 0.098 D^2$	23 23 23 23	.751 .726 .754 .603	.618 .648 .628 -	1.21 1.23 1.22 -
Wood + Bark, Live Branches	$\ln \text{Mg} = -3.088 + 0.697 \ln D_H^2$ $\ln \text{Mg} = -2.524 + 1.825 \ln D$ $\ln \text{Mg} = -1.802 + 2.285 \ln D - 0.796 \ln H^2$ $\text{Mg} = 1.486 - 0.302 D + 0.059 D^2$	30 30 30 30	.948 .971 .980 .938	.401 .301 .258 -	1.08 1.05 1.03 -
Foliage	$\ln \text{Mg} = -3.830 + 0.674 \ln D_H^2$ $\ln \text{Mg} = -3.257 + 1.754 \ln D$ $\ln \text{Mg} = -3.105 + 1.851 \ln D - 0.168 \ln H^2$ $\text{Mg} = 0.073 - 0.037 D + 0.022 D^2$	30 30 30 30	.945 .955 .948 .905	.402 .363 .401 -	1.08 1.07 1.08 -

Table 15a - Biomass prediction equations for aboveground components of Trembling Aspen.
 Weight (W) in kg, Diameter (D) in cm, and Height (H) in m.

Component	Equation	n	R ²	s	c
FRESH WEIGHT					
merchantable stem	$\ln W = -4.5756 + 1.1278 \ln D_H^2$	16	.974	.1079	1.01
	$\ln W = -2.4077 + 2.5379 \ln D$	16	.958	.1361	1.01
	$\ln W = -4.3091 + 2.2991 \ln D + 0.9796 \ln H$	16	.974	.1112	1.01
crown 1	$\ln W = -1.4022 + 0.6230 \ln D_H^2$	26	.936	.3964	1.08
	$\ln W = -0.7874 + 1.6078 \ln D$	26	.938	.3895	1.08
	$\ln W = -0.8787 + 1.5557 \ln D + 0.0909 \ln H$	26	.938	.4040	1.09
total aboveground	$\ln W = -2.3063 + 0.8862 \ln D_H^2$	26	.991	.2007	1.02
	$\ln W = -1.4339 + 2.2880 \ln D$	26	.995	.1599	1.01
OVEN-DRY WEIGHT					
wood, merchantable stem	$\ln W = -5.6606 + 1.1534 \ln D_H^2$	16	.965	.1275	1.01
	$\ln W = -3.4039 + 2.5816 \ln D$	16	.939	.1678	1.01
	$\ln W = -5.8881 + 2.2696 \ln D + 1.2799 \ln H_2$	16	.965	.1318	1.01
	$W = 9.3950 - 2.6743 D + 0.3030 D^2$	16	.926	-	-
bark, merchantable stem	$\ln W = -5.8409 + 1.0353 \ln D_H^2$	16	.929	.1659	1.01
	$\ln W = -3.9168 + 2.3528 \ln D$	16	.933	.1620	1.01
	$\ln W = -4.7631 + 2.2465 \ln D + 0.4360 \ln H_2$	16	.936	.1635	1.01
	$W = -22.1013 + 2.4030 D - 0.0360 D^2$	16	.938	-	-
wood + bark, merch. stem	$\ln W = -5.1623 + 1.1265 \ln D_H^2$	16	.971	.1132	1.01
	$\ln W = -2.9802 + 2.5293 \ln D$	16	.951	.1470	1.01
	$\ln W = -5.1052 + 2.2624 \ln D + 1.0948 \ln H_2$	16	.971	.1175	1.01
	$W = -12.7063 - 0.2714 D + 0.2980 D^2$	16	.949	-	-

Table 15a - continued.

Component	Equation	n	R ²	S	C
OVEN-DRY WEIGHT					
wood + bark, live branches	$\ln W = -2.4158 + 0.6320 \ln D_H^2$	26	.906	.4940	1.13
	$\ln W = -1.7812 + 1.6262 \ln D$	26	.903	.5024	1.13
	$\ln W = -2.4332 + 1.2537 \ln D + 0.6497 \ln H_2$	26	.906	.5126	1.13
	$W = 4.1032 - 0.6481 D + 0.0770 D^2$	26	.797	-	-
foliage					
	$\ln W = -4.6641 + 0.6254 \ln D_H^2$	26	.862	.6076	1.20
	$\ln W = -4.0359 + 1.6093 \ln D$	26	.859	.6145	1.21
	$\ln W = -4.6936 + 1.2334 \ln D + 0.6555 \ln H_2$	26	.862	.6305	1.22
	$W = 0.5135 - 0.1402 D + 0.0130 D^2$	26	.819	-	-
crown 1					
	$\ln W = -2.3950 + 0.6691 \ln D_H^2$	26	.941	.4077	1.09
	$\ln W = -1.7344 + 1.7266 \ln D$	26	.943	.4005	1.08
	$\ln W = -1.8522 + 1.6593 \ln D + 0.1174 \ln H_2$	26	.943	.4153	1.09
	$W = -5.3179 + 1.1235 \ln D + 0.1230 D$	26	.873	-	-
total aboveground					
	$\ln W = -3.2992 + 0.9333 \ln D_H^2$	26	.993	.1942	1.02
	$\ln W = -2.3778 + 2.4085 \ln D$	26	.995	.1622	1.01
	$\ln W = -2.5383 + 2.3167 \ln D + 0.1600 \ln H_2$	26	.995	.1667	1.01
	$W = 6.1625 - 3.0543 D + 0.4680 D^2$	26	.969	-	-

TABLE 15b. Nutrient prediction equations for Nitrogen in aboveground components of Trembling Aspen. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem	$\ln N = -4.318 + 0.986 \ln D_H^2$	16	.950	.132	1.01
	$\ln N = -2.359 + 2.198 \ln D$	16	.916	.170	1.01
	$\ln N = -4.885 + 1.880 \ln D + 1.302 \ln H_D^2$	16	.952	.134	1.01
	$N = -8.892 + 0.656 D + 0.163 D^2$	16	.909	-	-
Bark, Merch. Stem	$\ln N = -5.130 + 1.066 \ln D_H^2$	16	.940	.156	1.01
	$\ln N = -3.147 + 2.421 \ln D$	16	.943	.153	1.01
	$\ln N = -4.049 + 2.308 \ln D + 0.465 \ln H_D^2$	16	.947	.153	1.01
	$N = -20.358 + 1.549 D + 0.129 D^2$	16	.953	-	-
Wood + Bark, Live Branches	$\ln N = -0.811 + 0.627 \ln D_H^2$	26	.891	.532	1.15
	$\ln N = -0.812 + 1.615 \ln D$	26	.889	.539	1.15
	$\ln N = -0.784 + 1.271 \ln D + 0.599 \ln H_D^2$	26	.891	.552	1.16
	$N = 23.199 - 3.835 D + 0.396 D^2$	26	.796	-	-
Foliage	$\ln N = -2.557 + 0.717 \ln D_H^2$	26	.845	.745	1.32
	$\ln N = -1.842 + 1.846 \ln D$	26	.844	.746	1.32
	$\ln N = -2.332 + 1.563 \ln D + 0.494 \ln H_D^2$	26	.845	.772	1.33
	$N = 7.822 - 2.804 D + 0.266 D^2$	26	.826	-	-

TABLE 15c. Nutrient prediction equations for Phosphorus in aboveground components of Trembling Aspen. Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem					
$\ln P = -7.973 + 1.155 \ln D_H^2$	16	.965	.128	1.01	
$\ln P = -5.714 + 2.584 \ln D$	16	.939	.168	1.01	
$\ln P = -8.206 + 2.271 \ln D + 1.284 \ln H$	16	.965	.132	1.01	
$P = 0.928 - 0.267 D + 0.030 D^2$	16	.926	-	-	
Bark, Merch. Stem					
$\ln P = -8.924 + 1.286 \ln D_H^2$	16	.945	.180	1.02	
$\ln P = -6.552 + 2.929 \ln D$	16	.953	.167	1.01	
$\ln P = -7.354 + 2.828 \ln D + 0.413 \ln H$	16	.955	.169	1.01	
$P = -3.493 + 0.140 D + 0.026 D^2$	16	.968	-	-	
Wood + Bark, Live Branches					
$\ln P = -2.679 + 0.649 \ln D_H^2$	26	.921	.460	1.11	
$\ln P = -2.020 + 1.668 \ln D$	26	.915	.478	1.12	
$\ln P = -3.004 + 1.106 \ln D + 0.980 \ln H$	26	.922	.475	1.12	
$P = 1.026 + 0.190 D + 0.034 D^2$	26	.750	-	-	
Foliage					
$\ln P = -3.486 + 0.560 \ln D_H^2$	26	.874	.515	1.14	
$\ln P = -2.952 + 1.453 \ln D$	26	.876	.490	1.13	
$\ln P = -2.112 + 1.933 \ln D - 0.837 \ln H$	26	.893	.493	1.13	
$P = 0.890 - 0.201 D + 0.020 D^2$	26	.794	-	-	

TABLE 15d. Nutrient prediction equations for Potassium in aboveground components of Trembling Aspen.
Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem					
	ln K = -6.960 + 1.322 ln D _H ²	16	.904	.241	1.00
	ln K = -4.502 + 3.003 ln D	16	.907	.237	1.00
	ln K = -5.613 + 2.863 ln D + 0.572 ln H _D ²	16	.904	.241	1.00
	K = 232.387 - 26.488 D + 0.979 ln H _D ²	16	.769	-	-
Bark, Merch. Stem					
	ln K = -4.998 + 1.013 ln D _H ²	16	.939	.151	1.01
	ln K = -3.024 + 2.288 ln D	16	.930	.160	1.01
	ln K = -4.458 + 2.114 ln D + 0.713 ln H _D ²	16	.940	.154	1.01
	K = 34.008 - 4.565 D + 0.251 ln H _D ²	16	.939	-	-
Wood + Bark, Live Branches					
	ln K = -0.964 + 0.612 ln D _H ²	26	.902	.489	1.13
	ln K = -0.345 + 1.573 ln D	26	.896	.503	1.13
	ln K = -1.209 + 1.079 ln D + 0.861 ln H _D ²	26	.903	.506	1.14
	K = 11.127 - 0.845 D + 0.204 ln H _D ²	26	.774	-	-
Foliage					
	ln K = -1.677 + 0.578 ln D _H ²	26	.847	.569	1.18
	ln K = -1.091 + 1.486 ln D	26	.842	.607	1.20
	ln K = -1.942 + 1.000 ln D + 0.848 ln H _D ²	26	.848	.617	1.21
	K = 5.611 - 1.320 D + 0.144 ln H _D ²	26	.797	-	-
				94	

TABLE 15e. Nutrient prediction equations for Calcium in aboveground components of Trembling Aspen.
Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem	$\ln \text{Ca} = -3.157 + 0.876 \ln D^2_H$ $\ln \text{Ca} = -1.363 + 1.934 \ln D$ $\ln \text{Ca} = -4.331 + 1.561 \ln D + 1.529 \ln H_2$ $\text{Ca} = 167.835 - 20.185 D + 0.790 D^2$	16	.884	.185	1.02
Bark, Merch. Stem	$\ln \text{Ca} = -2.970 + 0.960 \ln D^2_H$ $\ln \text{Ca} = -1.146 + 2.169 \ln D$ $\ln \text{Ca} = -2.475 + 2.002 \ln D + 0.685 \ln H_2$ $\text{Ca} = -150.174 + 17.585 D + 0.038 D^2$	16	.929	.154	1.01
Wood + Bark, Live Branches'	$\ln \text{Ca} = -0.903 + 0.667 \ln D^2_H$ $\ln \text{Ca} = -0.235 + 1.716 \ln D$ $\ln \text{Ca} = -0.871 + 1.353 \ln D + 0.634 \ln H_2$ $\text{Ca} = 30.859 - 6.016 D + 0.569 D^2$	26	.899	.543	1.16
Foliage	$\ln \text{Ca} = -2.795 + 0.640 \ln D^2_H$ $\ln \text{Ca} = -2.148 + 1.643 \ln D$ $\ln \text{Ca} = -3.072 + 1.115 \ln D + 0.921 \ln H_2$ $\text{Ca} = 2.579 - 0.586 D + 0.073 D^2$	26	.859	.629	1.22
				.95	
				.853	1.23
				.641	
				.659	1.23
				.651	
					-
				.718	

TABLE 15F. Nutrient prediction equations for Magnesium in aboveground components of Trembling Aspen.
Weight in g, D in cm, and Height in m.

Component	Equation	n	R ²	S	C
Wood, Merch. Stem					
	ln Mg = -6.629 + 1.149 ln D _H ²	16	.945	.161	1.01
	ln Mg = -4.419 + 2.585 ln D	16	.929	.183	1.02
	ln Mg = -6.371 + 2.340 ln D + 1.005 ln H _D ²	16	.945	.167	1.01
	ln Mg = 33.875 - 4.827 ln D + 0.226	16	.953	-	-
Bark, Merch. Stem					
	ln Mg = -5.341 + 0.964 ln D _H ²	16	.933	.150	1.01
	ln Mg = -3.509 + 2.178 ln D + 0.680 ln H _D ²	16	.925	.159	1.01
	ln Mg = -4.829 + 2.012 ln D + 0.124 ln H _D ²	16	.935	.154	1.01
	ln Mg = 18.873 - 2.424 ln D	16	.940	-	-
Wood + Bark, Live Branches					
	ln Mg = -2.245 + 0.621 ln D _H ²	26	.914	.462	1.11
	ln Mg = -1.618 + 1.596 ln D + 0.801 ln H _D ²	26	.909	.474	1.12
	ln Mg = -2.422 + 1.137 ln D + 0.090 ln H _D ²	26	.914	.478	1.12
Foliage					
	ln Mg = -3.446 + 0.582 ln D _H ²	26	.845	.604	1.20
	ln Mg = -2.858 + 1.496 ln D + 0.781 ln H _D ²	26	.841	.613	1.21
	ln Mg = -3.642 + 1.048 ln D + 0.019 ln H _D ²	26	.846	.626	1.22
	ln Mg = 0.554 - 0.098 ln D	26	.761	-	-

Table 16 - Biomass estimates for the merchantable stem, crown, and total tree aboveground for Red Maple trees of selected sizes.

DBH	A	B	C	D	E
	Merchantable Stem (kg)	Crown (kg)	Total Aboveground (kg)	A + B (kg)	$\frac{D-C}{C} \times 100$
10	19.61	14.19	31.15	33.80	8.5
15	56.12	26.95	80.46	83.07	3.2
20	118.34	42.48	157.77	160.82	1.9
25	211.07	60.46	265.97	271.53	2.1
30	338.66	80.67	407.53	419.33	2.9

Appendix 1 - Binomials of the species of tree mentioned
in this report.

Balsam Fir	<u>Abies balsamea</u> (L.) Mill.
White Spruce	<u>Picea glauca</u> (Moench) Voss
Black Spruce	<u>Picea mariana</u> (Mill.) B.S.P.
Red Spruce	<u>Picea rubens</u> Sarg.
Red Maple	<u>Acer rubrum</u> L.
Sugar Maple	<u>Acer saccharum</u> Marsh.
Yellow Birch	<u>Betula allegheniensis</u> Britt.
White Birch	<u>Betula papyrifera</u> Marsh.
Large-tooth Aspen	<u>Populus grandidentata</u> Michx.
Trembling Aspen	<u>Populus tremuloides</u> Michx.

Appendix 2. Concentrations of nutrients in various biomass components of the ten tree species examined in this study.
All data are in % d.w., mean \pm S.E.

Species	Component	n	Nitrogen	Phosphorus	Potassium	Calcium	Magnesium
Balsam Fir	Wood	6	0.055 \pm 0.013	0.010 \pm 0.000	0.067 \pm 0.007	0.058 \pm 0.005	0.018 \pm 0.002
	Bark	6	0.347 \pm 0.015	0.058 \pm 0.002	0.222 \pm 0.012	0.695 \pm 0.058	0.060 \pm 0.005
	Dead Branches	6	0.308 \pm 0.021	0.030 \pm 0.000	0.026 \pm 0.002	0.406 \pm 0.022	0.032 \pm 0.002
	Live Branches	6	0.377 \pm 0.013	0.083 \pm 0.004	0.238 \pm 0.022	0.410 \pm 0.019	0.060 \pm 0.003
	Foliage	6	0.957 \pm 0.032	0.117 \pm 0.005	0.360 \pm 0.014	0.735 \pm 0.046	0.078 \pm 0.004
White Spruce	Wood	6	0.082 \pm 0.016	0.010 \pm 0.001	0.027 \pm 0.005	0.073 \pm 0.007	0.012 \pm 0.002
	Bark	6	0.347 \pm 0.023	0.052 \pm 0.002	0.197 \pm 0.011	1.18 \pm 0.11	0.078 \pm 0.004
	Dead Branches	6	0.170 \pm 0.022	0.014 \pm 0.002	0.026 \pm 0.002	0.332 \pm 0.027	0.026 \pm 0.002
	Live Branches	6	0.327 \pm 0.022	0.046 \pm 0.004	0.185 \pm 0.017	0.440 \pm 0.022	0.052 \pm 0.004
	Foliage	6	0.875 \pm 0.047	0.110 \pm 0.009	0.397 \pm 0.025	0.522 \pm 0.045	0.083 \pm 0.006
Black Spruce	Wood	7	0.114 \pm 0.011	0.010 \pm 0.000	0.031 \pm 0.004	0.113 \pm 0.010	0.013 \pm 0.002
	Bark	7	0.240 \pm 0.007	0.037 \pm 0.002	0.157 \pm 0.008	1.07 \pm 0.13	0.067 \pm 0.004
	Dead Branches	7	0.208 \pm 0.014	0.022 \pm 0.002	0.023 \pm 0.007	0.387 \pm 0.058	0.030 \pm 0.000
	Live Branches	7	0.313 \pm 0.021	0.044 \pm 0.003	0.163 \pm 0.014	0.399 \pm 0.020	0.053 \pm 0.003
	Foliage	7	0.713 \pm 0.024	0.100 \pm 0.005	0.393 \pm 0.014	0.456 \pm 0.046	0.087 \pm 0.004
Red Spruce	Wood	7	0.096 \pm 0.010	0.009 \pm 0.001	0.030 \pm 0.002	0.083 \pm 0.006	0.011 \pm 0.002
	Bark	7	0.304 \pm 0.018	0.036 \pm 0.002	0.169 \pm 0.007	1.05 \pm 0.164	0.054 \pm 0.003
	Dead Branches	7	0.254 \pm 0.019	0.019 \pm 0.002	0.027 \pm 0.003	0.331 \pm 0.016	0.023 \pm 0.002
	Live Branches	7	0.371 \pm 0.016	0.046 \pm 0.002	0.139 \pm 0.007	0.480 \pm 0.030	0.046 \pm 0.002
	Foliage	7	0.829 \pm 0.014	0.133 \pm 0.004	0.500 \pm 0.017	0.457 \pm 0.026	0.087 \pm 0.003
Red Maple	Wood	7	0.104 \pm 0.012	0.011 \pm 0.002	0.060 \pm 0.007	0.084 \pm 0.007	0.017 \pm 0.002
	Bark	7	0.451 \pm 0.020	0.037 \pm 0.002	0.150 \pm 0.011	1.45 \pm 0.08	0.044 \pm 0.002
	Dead Branches	7	0.212 \pm 0.015	0.012 \pm 0.002	0.022 \pm 0.003	0.398 \pm 0.021	0.032 \pm 0.002
	Live Branches	7	0.260 \pm 0.015	0.037 \pm 0.003	0.186 \pm 0.007	0.416 \pm 0.033	0.033 \pm 0.002
	Foliage	7	1.68 \pm 0.07	0.190 \pm 0.007	0.853 \pm 0.029	0.520 \pm 0.017	0.157 \pm 0.004

Sugar Maple	Wood	7	0.119 ± 0.014	0.011 ± 0.002	0.059 ± 0.014	0.111 ± 0.038	0.026 ± 0.010
	Bark	7	0.544 ± 0.013	0.036 ± 0.002	0.186 ± 0.018	1.55 ± 0.09	0.077 ± 0.008
	Dead Branches	7	0.274 ± 0.016	0.014 ± 0.002	0.048 ± 0.012	0.380 ± 0.024	0.036 ± 0.002
	Live Branches	7	0.396 ± 0.025	0.043 ± 0.004	0.194 ± 0.021	0.413 ± 0.029	0.046 ± 0.004
	Foliage	7	1.96 ± 0.06	0.186 ± 0.006	0.973 ± 0.028	0.503 ± 0.030	0.153 ± 0.008
Yellow Birch	Wood	6	0.145 ± 0.038	0.010 ± 0.000	0.040 ± 0.003	0.092 ± 0.020	0.023 ± 0.006
	Bark	6	0.590 ± 0.025	0.030 ± 0.000	0.122 ± 0.008	1.09 ± 0.09	0.050 ± 0.005
	Dead Branches	6	0.354 ± 0.030	0.028 ± 0.006	0.050 ± 0.005	0.396 ± 0.034	0.042 ± 0.005
	Live Branches	6	0.520 ± 0.019	0.080 ± 0.027	0.152 ± 0.016	0.392 ± 0.038	0.055 ± 0.004
	Foliage	6	2.38 ± 0.05	0.147 ± 0.026	0.833 ± 0.042	0.618 ± 0.060	0.267 ± 0.027
White Birch	Wood	6	0.140 ± 0.013	0.012 ± 0.002	0.043 ± 0.007	0.068 ± 0.004	0.020 ± 0.000
	Bark	6	0.398 ± 0.014	0.033 ± 0.002	0.082 ± 0.006	0.830 ± 0.114	0.042 ± 0.003
	Dead Branches	6	0.290 ± 0.042	0.022 ± 0.002	0.030 ± 0.008	0.345 ± 0.030	0.033 ± 0.008
	Live Branches	6	0.517 ± 0.032	0.067 ± 0.005	0.087 ± 0.031	0.376 ± 0.075	0.037 ± 0.006
	Foliage	6	2.12 ± 0.10	0.189 ± 0.007	0.536 ± 0.215	0.594 ± 0.102	0.140 ± 0.047
Large-tooth Aspen	Wood	7	0.134 ± 0.020	0.016 ± 0.003	0.099 ± 0.012	0.073 ± 0.010	0.029 ± 0.002
	Bark	7	0.327 ± 0.010	0.032 ± 0.002	0.213 ± 0.015	0.883 ± 0.035	0.063 ± 0.004
	Dead Branches	7	0.256 ± 0.010	0.010 ± 0.000	0.050 ± 0.009	0.530 ± 0.046	0.036 ± 0.002
	Live Branches	7	0.461 ± 0.014	0.064 ± 0.002	0.306 ± 0.008	0.626 ± 0.075	0.070 ± 0.002
	Foliage	7	2.55 ± 0.03	0.211 ± 0.007	1.22 ± 0.05	0.640 ± 0.040	0.250 ± 0.009
Trembling Aspen	Wood	6	0.118 ± 0.019	0.015 ± 0.004	0.138 ± 0.030	0.110 ± 0.012	0.037 ± 0.002
	Bark	6	0.323 ± 0.042	0.048 ± 0.008	0.272 ± 0.053	0.948 ± 0.096	0.108 ± 0.010
	Dead Branches	6	0.268 ± 0.039	0.017 ± 0.004	0.050 ± 0.010	0.498 ± 0.096	0.052 ± 0.008
	Live Branches	6	0.483 ± 0.012	0.085 ± 0.005	0.367 ± 0.015	0.598 ± 0.042	0.112 ± 0.004
	Foliage	6	1.72 ± 0.26	0.188 ± 0.010	1.42 ± 0.10	0.717 ± 0.054	0.243 ± 0.018

Part 2

**Standing Crops of Biomass and Nutrients in a Variety of Forest Stands in
Central Nova Scotia**

by

**B. Freedman, P.N. Duinker, R. Morash
and U. Prager**

TABLE OF CONTENTS

PART 2.

	Page
INTRODUCTION.....	1
STUDY AREA.....	1
Location and General Description of Sites.....	1
Geology and Soils.....	1
METHODS.....	2
Quantitative Descriptions of Forest Stands.....	2
Measurement of Standing Crops of Biomass and Nutrients in Trees.....	2
OBSERVATIONS AND DISCUSSION.....	3
Stand Descriptions.....	3
Standing Crops of Biomass and Nutrients.....	3
REFERENCES.....	4
TABLES.....	5
APPENDIX 1.....	26

TABLE OF CONTENTS

PART 2.

	Page
INTRODUCTION.....	1
STUDY AREA.....	1
Location and General Description of Sites.....	1
Geology and Soils.....	1
METHODS.....	2
Quantitative Descriptions of Forest Stands.....	2
Measurement of Standing Crops of Biomass and Nutrients in Trees.....	2
OBSERVATIONS AND DISCUSSION.....	3
Stand Descriptions.....	3
Standing Crops of Biomass and Nutrients.....	3
REFERENCES.....	4
TABLES.....	5
APPENDIX 1.....	26

INTRODUCTION

Intensive forest harvest, such as whole-tree (above-ground) clear-cutting, is known to have significant environmental impacts. One of the most significant of these impacts may be caused by the acceleration of nutrient removals from stands that are intensively harvested, due to the removals of relatively nutrient-rich tissues, such as foliage, small branches, etc. Much of the available literature that is relevant to this problem of potential site impoverishment has recently been reviewed and interpreted by several authors (Kimmens 1977, 1980; Kimmens *et al.* 1979; Carlisle 1980; Freedman 1981).

This report presents the results of part of a research project conducted under the ENFOR programme to evaluate the effects of intensive harvesting of forests for energy purposes on the nutrient status and long-term productivity of selected forest sites in Nova Scotia. A major portion of this research involved the determination of the above-ground standing crops of biomass and nutrients in various compartments (e.g. wood, bark, branches, foliage, etc.) of a variety of forest stands, so as to calculate the potential yields by conventional and whole-tree clear-cuts of these stands. These calculations were made using predictive regressions for the standing crops of biomass and nutrients for ten tree species. The regressions, and the methods used in their determination, are described by Freedman *et al.** In the present contribution, we quantitatively describe the forest stands that we examined, and present the data relevant to the standing crops of biomass and nutrients (N, P, K,

Ca, and Mg) in various above-ground tree compartments.

STUDY AREA

Location and General Description of Sites

All stands investigated in this study are located in central Nova Scotia, in Annapolis, Kings, and Hants counties. In total, eight softwood stands were selected, comprising four mature stands and four pole-sized stands. Similarly, eight hardwood stands were selected, consisting of five mature stands and three pole-sized stands. A brief description of each stand, in terms of site class, age class, and dominant tree species, is given in Table 1.

The elevation of the sites in Hants County is less than 150 m above sea level, while the others are 150 m to 300 m above sea level. Mean temperatures for all sites are between -2.5°C and -5.0°C in January, and exceed 17.5°C in July (Burgess 1977). Annual precipitation ranges from more than 140 cm for some of the sites in Kings County, to 100 - 200 cm for the sites in Hants County (Burgess 1977). All stands are within the Sugar Maple - Hemlock - Pine Zone of Loucks' (1962) classification, except the mixed hardwood stand in Hants County which is within the Sugar Maple - Yellow Birch - Fir Zone.

Geology and Soils

The bedrock below the sites in Kings County and Annapolis County is Devonian granite, while the sites in Hants County are underlain by Mississippian sandstone, shale, and conglomerate (Burgess 1977; Cann *et al.* 1954; Cann *et al.* 1965).

* Freedman, B., P.N. Duinker, H. Barclay, R. Morash, and U. Prager, 1981. Biomass and nutrient standing crop equations for ten tree species in Central Nova Scotia. Report on file at Maritimes Forest Research Centre, Fredericton, N.B.

Soils in all the stands in Kings County and the stand in Annapolis County are mapped in the Gibraltar series (Cann *et al.* 1965). This series belongs to the Ortstein Podzol subgroup, implying a cemented or weakly cemented B horizon at least 3 cm in thickness (Anon 1977). The soils have developed on a coarse sandy loam till derived mainly from granite (Cann *et al.* 1965). The land is generally undulating to rolling, and soil drainage is rapid. Cann *et al.* (1965, p. 48) described these soils as "unsuitable for agriculture because of excessive stoniness or shallowness".

The soils of the white spruce stand in Hants County have been mapped in the Queen's series (Cann *et al.* 1954). The series is described as a slightly mottled, imperfectly drained, moderately stony, clay loam, derived from clay loam tills of sandstone, shale, and mudstone. The soil is rated fair for use as cropland, and at this site was used as pasture prior to its regeneration into white spruce.

The soils of the mixed hardwood stand in Hants County are mapped in the Hansford catena (no series name given, Cann *et al.* 1954). This soil is described as a well-drained, stony, sandy loam derived from sandy loam till of sandstone. The inherent fertility of the soil is low and drought is common.

METHODS

Quantitative Descriptions of Forest Stands

At each site, the forest communities were described by measuring the sizes and densities of all trees within five 20 x 20 m (0.04 ha) plots. Within each plot, all trees were tallied for species, diameter at breast height (DBH) and height (H). These field measurements allow for subsequent calculations of various

quantitative descriptions of the stands, e.g. mean height and diameter at breast height, stem basal area per unit ground surface area, stem density, relative dominance, and relative frequency (Kershaw 1964; Husch *et al.* 1972; Smith 1974; Goldsmith and Harrison 1976).

Measurement of Standing Crops of Biomass and Nutrient in Trees

The standing crops of biomass and nutrients were calculated for individual trees using logarithmic regression equations (described in Part 1 of this report). These calculations were made for each tree in each of five 20 x 20 m plots per forest stand. These per tree data were summed for each plot, and the mean + standard deviation was calculated for the five plots. These data were then multiplied to per hectare values.

For each tree, the standing crops calculated in the following compartments were:

- a) live branches, wood + bark: calculated using the appropriate regression.
- b) live branches, foliage: calculated using the appropriate regression.
- c) dead branches: calculated (for softwoods) using the appropriate regression. For hardwoods, a mean-tree calculation was used, because of poor statistical correlations between dead branch standing crops and DBH or H.
- d) unmerchantable top: calculated (for softwoods only) by a stratified mean-tree approach.
- e) total crown: calculated by addition of a + b + c + d (above).
- f) merchantable stem, wood: calculated using the appropriate regression.
- g) merchantable stem, bark: calculated using the appropriate regression.

- h) merchantable stem, total: calculated by summation of f + g above. The appropriate regression was not used, due to errors inherent in non-additivity of regressions.
- i) whole tree: calculated by addition of e + h above. Again, the appropriate regression was not used due to errors inherent in non-additivity of regressions.

For some minor tree species, we did not have specific standing crop regressions. In these cases we substituted regressions for similar species. Specifically, we used regressions of Betula papyrifera for Betula populifolia; Acer saccharum for Quercus rubra, Fraxinus americana, and Fagus grandifolia; Acer rubrum for Acer pensylvanicum, Acer spicatum, Prunus pensylvanica, and Alnus rugosa; Picea glauca for Larix laricina; and Picea rubens for Pinus strobus and Tsuga canadensis. The errors inherent in these substitutions are believed to be relatively minor, as these species did not contribute a large amount of stem basal area to our stands.

OBSERVATIONS AND DISCUSSION

Stand Descriptions

General descriptions of the forest stands investigated in this study are presented in Table 1. More detailed, quantitative descriptions are given in Table 2 (a-p), in terms of total and species-specific mean height, mean diameter at breast height, stem basal area per unit ground area, density, relative dominance, and relative density.

Standing Crops of Biomass and Nutrients

For each of the eight softwood and eight hardwood stands, the standing crops of above-ground biomass and nutrients are presented in Table 3. In this table, data are presented of

the standing crops in each of the following compartments: wood plus bark of live branches, foliage, dead branches, total crown, wood of the merchantable stem, bark of the merchantable stem, total merchantable stem, and the whole-tree above-ground. For all hardwood species, the total crown was the sum of the standing crops in the live branches, foliage, and dead branches. For all softwood species, the unmerchantable stem also contributed to the total crown, in addition to the live and dead branches and foliage. For all tree species, the whole-tree standing crops were calculated as the sums of the total crown plus total merchantable stem compartments. Although data for individual tree species have not been presented here, they are available (see Freedman et al. 1981*).

Also presented in Table 19 are the calculated percent increases in yield by a theoretical whole-tree, relative to a conventional clear-cut of each stand (calculated as total crown ÷ merchantable stem standing crops). These calculations indicate that the theoretical whole-tree harvests would result in maximum increases of biomass yield ranging from about 29-65% among the various stands, compared with conventional clear-cutting. However, in all stands and for all nutrients, these increases in biomass yield would be accompanied by much larger increases in the rates of removals of nutrients. This is because the whole-tree biomass increments consist, in part, of relatively nutrient-rich tissues, such as foliage and small branches, compared with the nutrient contents of the merchantable stem. The increases in nutrient yields by the theoretical whole-tree harvests summarized in Table 19 range from 104 to 205% for nitrogen, from 134 to 288% for phosphorus, from 88 to 239% for potassium, from 59 to 118% for calcium, and from 66 to 165% for magnesium.

The wide range among the sites results from variation in stand age, species composition, stocking as it affects the architecture of biomass distribution within species (particularly with respect to the retention of lower branches in poorly-stocked situations), and possibly site quality, which may influence the nutrient contents of plant tissues. The influences of some of these factors was discussed in more detail in a recent review of forest nutrient standing crop literature (Freedman 1981).

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Table 1: General descriptions of forest stands selected for determinations of biomass and nutrient standing crops in year two of this study.

Site	County	C.L.I. Site Class	Age Class	Dominant Tree Species
S1	Kings	5.2	Mature	<u>Picea rubens</u> , <u>Abies balsamea</u>
S2	Kings	4.9	Pole	<u>Picea rubens</u> , <u>Abies balsamea</u>
S3	Kings	5.1	Pole	<u>Picea rubens</u> , <u>Abies balsamea</u>
S4	Kings	4.1	Mature	<u>Picea rubens</u> , <u>Abies balsamea</u>
S5	Kings	5.2	Pole	<u>Picea rubens</u> , <u>Abies balsamea</u>
S6	Annapolis	4.6	Pole	<u>Picea mariana</u>
S7	Hants	2.9	Mature	<u>Picea glauca</u>
S8	Kings	4.8	Mature	<u>Picea rubens</u> , <u>Abies balsamea</u>
H1	Kings	4.8	Pole	<u>Acer saccharum</u>
H2	Kings	5.5	Pole	<u>Betula papyrifera</u> , <u>Acer rubrum</u>
H3	Kings	5.7	Mature	<u>Populus grandidentata</u> , <u>P. tremuloides</u>
H4	Kings	4.4	Mature	<u>Populus grandidentata</u> , <u>P. tremuloides</u>
H5	Kings	4.3	Mature	<u>Acer saccharum</u> , <u>Betula papyrifera</u>
H6	Kings	3.3	Mature	<u>Acer saccharum</u> , <u>Fagus grandifolia</u>
H7	Kings	3.2	Pole	<u>Acer saccharum</u> , <u>A. rubrum</u>
H8	Hants	3.6	Mature	<u>Acer saccharum</u> , <u>A. rubrum</u> , <u>Betula lutea</u>

Table 2a - Site S1. Quantitative descriptions of mature softwood stand to be used for calculations of biomass and nutrient standing crops. Mean \pm S.D. of five 20 m \times 20 m (0.04 ha) plots per stand.

Species	Height (m)	DBH (cm)	SBA/Area (m ² ha ⁻¹)	Density (stems ha ⁻¹)	Relative Dominance (%)	Relative Density (%)
<u><i>Picea rubens</i></u>	6.6 \pm 0.9	10.1 \pm 2.1	13.4 \pm 3.4	1090 \pm 540	49.4	37.5
<u><i>Abies balsamea</i></u>	4.8 \pm 0.6	6.1 \pm 1.4	7.9 \pm 7.0	1200 \pm 840	29.2	41.3
<u><i>Acer rubrum</i></u>	6.3 \pm 1.4	7.7 \pm 2.7	4.1 \pm 2.4	560 \pm 320	15.1	19.3
<u><i>Tsuga canadensis</i></u>	11.7 \pm 8.5	24.7 \pm 29.8	0.8 \pm 1.8	13 \pm 24	3.0	0.4
<u><i>Pinus strobus</i></u>	11.3	22.4	0.6 \pm 1.4	15 \pm 34	2.2	0.5
<u><i>Betula papyrifera</i></u>	9.6 \pm 5.5	13.9 \pm 8.8	0.3 \pm 0.4	15 \pm 14	1.1	0.5
<u><i>Betula lutea</i></u>	5.9	4.5	<0.1	5 \pm 11	<0.1	0.2
<u><i>Picea mariana</i></u>	1.7	0.9	<0.1	5 \pm 11	<0.1	0.2
Total			27.1 \pm 7.8	2903 \pm 410		6

Table 2b - Site S2. Quantitative descriptions of pole softwood stand to be used for calculations of biomass and nutrient standing crops. n = five 20 m x 20 m (0.04 ha) plots per stand. Mean \pm S.D. (range).

Species	Height (m)	DBH (cm)	SBA/Area (m ² ha ⁻¹)	Density (stems ha ⁻¹)	Relative Dominance (%)	Relative Density (%)
<u>Picea rubens</u>	10.1 \pm 1.6	13.3 \pm 2.6	32.5 \pm 4.2	1915 \pm 470	86.4	74.8
<u>Abies balsamea</u>	6.5 \pm 1.0	7.9 \pm 1.1	3.1 \pm 1.2	460 \pm 110	8.2	18.0
<u>Acer rubrum</u>	9.7 \pm 0.9	8.7 \pm 1.4	1.2 \pm 1.0	145 \pm 95	3.2	5.7
<u>Populus tremuloides</u>	13.8 \pm 3.5	21.4 \pm 9.4	0.4 \pm 0.7	10 \pm 14	1.1	0.4
<u>Betula populifolia</u>	7.4 \pm 3.5	8.7 \pm 1.4	0.2 \pm 0.3	20 \pm 21	0.5	0.8
<u>Betula papyrifera</u>	11.2	8.7	0.2 \pm 0.4	5 \pm 11	0.5	0.2
<u>Picea mariana</u>	2.1	1.8	<0.1	5 \pm 11	<0.1	0.2
Total			37.6 \pm 4.7	2560 \pm 540		

Table 2 c - Site S3. Quantitative descriptions of pole softwood stand to be used for calculations of biomass and nutrient standing crops. Mean \pm S.D. of five 20 m \times 20 m (0.04 ha) plots per stand.

Species	Height (m)	DBH (cm)	SBA/Area (m ² ha ⁻¹)	Density (stems ha ⁻¹)	Relative Dominance (%)	Relative Density (%)
<i>Picea rubens</i>	7.9 \pm 2.4	11.9 \pm 3.6	16.7 \pm 1.6	1175 \pm 550	63.5	53.1
<i>Acer rubrum</i>	6.3 \pm 2.5	6.3 \pm 3.2	5.1 \pm 3.6	630 \pm 360	19.4	28.5
<i>Pinus strobus</i>	14.8 \pm 0.8	36.2 \pm 4.8	1.7 \pm 2.7	15 \pm 22	6.5	0.7
<i>Abies balsamea</i>	3.5 \pm 2.0	4.2 \pm 3.0	1.3 \pm 1.9	285 \pm 350	4.9	12.9
<i>Betula papyrifera</i>	11.0 \pm 0.4	12.6 \pm 0.3	0.5 \pm 1.0	45 \pm 76	1.9	2.0
<i>Picea glauca</i>	10.3 \pm 5.5	11.5 \pm 10.0	0.4 \pm 0.6	10 \pm 14	1.5	0.5
<i>Populus tremuloides</i>	9.9	10.8	0.4 \pm 0.8	30 \pm 67	1.5	1.4
<i>Betula populifolia</i>	5.5 \pm 2.6	7.0 \pm 6.6	0.2 \pm 0.4	19 \pm 24	0.8	0.9
<i>Acer spicatum</i>	5.8	5.9	0.01 \pm 0.03	5 \pm 11	<0.1	0.2
Total			26.3 \pm 5.5	2214 \pm 400		

Table 2d - Site S4. Quantitative descriptions of mature softwood stand to be used for calculation of biomass and nutrient standing crops. Mean \pm S.D. of five 20 m \times 20 m (0.04 ha) plots per stand.

Species	Height (m)	DBH (cm)	SBA/Area (m ² ha ⁻¹)	Density (stems ha ⁻¹)	Relative Dominance (%)	Relative Density (%)
<u>Picea rubens</u>	-	14.2 \pm 1.8	28.9 \pm 9.0	1030 \pm 290	67.5	56.0
<u>Acer rubrum</u>	-	17.0 \pm 2.6	7.9 \pm 4.1	340 \pm 270	18.5	18.5
<u>Abies balsamea</u>	-	16.5 \pm 7.1	2.6 \pm 0.7	130 \pm 90	6.1	7.1
<u>Betula lutea</u>	-	18.2 \pm 20.5	2.4 \pm 3.8	100 \pm 180	5.6	5.4
<u>Betula papyrifera</u>	-	12.0 \pm 3.8	0.5 \pm 0.6	35 \pm 42	1.2	1.9
<u>Pinus strobus</u>	-	32.2	0.4 \pm 0.9	5 \pm 11	0.9	0.3
<u>Fagus grandifolia</u>	-	2.2 \pm 2.5	0.1 \pm 0.2	200 \pm 300	0.2	10.9
Total			42.8 \pm 5.0	1840 \pm 500		

Table 2e - Site S5. Quantitative descriptions of pole softwood stand to be used for calculations of biomass and nutrient standing crops. Mean \pm S.D. of five 20 m \times 20 m (0.04 ha) plots per stand.

Species	Height (m)	DBH (cm)	SBA/Area (m ² ha ⁻¹)	Density (stems ha ⁻¹)	Relative Dominance (%)	Relative Density (%)
<u>Picea rubens</u>	-	9.5 \pm 0.7	19.4 \pm 3.0	1820 \pm 470	53.4	46.7
<u>Abies balsamea</u>	-	9.4 \pm 1.4	13.4 \pm 5.8	1440 \pm 470	36.9	36.9
<u>Acer rubrum</u>	-	4.9 \pm 1.6	1.6 \pm 1.8	570 \pm 450	4.4	14.6
<u>Betula lutea</u>	-	26.4 \pm 30.3	1.2 \pm 2.3	25 \pm 35	3.3	0.6
<u>Betula populifolia</u>	-	10.6	0.7 \pm 1.5	31 \pm 63	1.9	0.8
<u>Betula papyrifera</u>	-	3.9	0.02 \pm 0.03	13 \pm 25	0.1	0.3
Total		36.3 \pm 9.1		3900 \pm 530		

Table 2f - Site S6. Quantitative descriptions of pole softwood stand to be used for calculations of biomass and nutrient standing crops. Mean \pm S.D. of five 20 m \times 20 m (0.04 ha) plots per stand.

Species	Height (m)	DBH (cm)	SBA/Area (m ² ha ⁻¹)	Density (stems ha ⁻¹)	Relative Dominance (%)	Relative Density (%)
<u>Picea mariana</u>	10.9 \pm 0.9	14.7 \pm 1.6	23.5 \pm 4.1	1180 \pm 230	82.7	69.0
<u>Acer rubrum</u>	10.1 \pm 0.8	10.5 \pm 1.2	2.2 \pm 1.0	210 \pm 76	7.7	12.3
<u>Pinus strobus</u>	14.5 \pm 1.2	26.4 \pm 1.3	0.9 \pm 1.2	20 \pm 21	3.2	1.2
<u>Abies balsamea</u>	5.0 \pm 0.6	6.3 \pm 1.2	0.8 \pm 0.4	210 \pm 95	2.8	12.3
<u>Betula papyrifera</u>	11.8 \pm 5.6	10.7 \pm 4.5	0.6 \pm 0.8	60 \pm 70	2.1	3.5
<u>Populus tremuloides</u>	11.2	14.3	0.3 \pm 0.8	20 \pm 45	1.1	1.2
<u>Picea glauca</u>	6.5	8.1	0.1 \pm 0.2	10 \pm 22	0.4	0.6
Total			28.4 \pm 4.2	1710 \pm 350		

Table 2g - Site S7. Quantitative descriptions of mature softwood stand to be used for calculations of biomass and nutrient standing crops. Mean \pm S.D. of five 20 m \times 20 m (0.04 ha) plots per stand.

Species	Height (m)	DBH (cm)	SBA/Area (m ² ha ⁻¹)	Density (stems ha ⁻¹)	Relative Dominance (%)	Relative Density (%)
<u><i>Picea glauca</i></u>	13.3 \pm 1.1	15.6 \pm 1.3	23.5 \pm 2.3	1050 \pm 85	67.5	68.4
<u><i>Larix laricina</i></u>	16.3 \pm 1.3	17.0 \pm 1.3	7.5 \pm 3.9	310 \pm 150	21.6	20.2
<u><i>Abies balsamea</i></u>	11.5 \pm 1.2	14.4 \pm 2.5	3.7 \pm 2.1	155 \pm 90	10.6	10.1
<u><i>Betula populifolia</i></u>	11.0	8.2	0.1 \pm 0.2	20 \pm 45	0.3	1.3
Total			34.8 \pm 4.6	1535 \pm 75		

Table 2n - Site 58. Quantitative descriptions of mature softwood stand to be used for calculations of biomass and nutrient standing crops. Mean \pm S.D. of five 20 m \times 20 m (0.04 ha) plots per stand.

Species	Height (m)	DBH (cm)	SBA/Area (m ² ha ⁻¹)	Density (stems ha ⁻¹)	Relative Dominance (%)	Relative Density (%)
<u><i>Picea rubens</i></u>	11.3 \pm 0.9	15.6 \pm 1.9	36.8 \pm 5.7	1490 \pm 320	81.1	79.9
<u><i>Abies balsamea</i></u>	10.6 \pm 3.3	12.0 \pm 3.0	3.0 \pm 3.0	205 \pm 184	6.7	11.0
<u><i>Pinus strobus</i></u>	16.1 \pm 1.3	27.4 \pm 5.7	3.5 \pm 3.2	55 \pm 45	7.7	3.0
<u><i>Acer rubrum</i></u>	13.4 \pm 1.8	19.7 \pm 4.2	2.0 \pm 1.8	105 \pm 94	4.4	5.6
<u><i>Betula papyrifera</i></u>	12.3 \pm 0.3	11.7 \pm 4.4	0.1 \pm 0.2	10 \pm 14	0.2	0.5
Total			45.4 \pm 5.4	1865 \pm 287		13

Table 2i - Site H1. Quantitative descriptions of pole hardwood stand to be used for calculations of biomass and nutrient standing crops. Mean \pm S.D. of five 20 m \times 20 m (0.04 ha) plots per stand.

Species	Height (m)	DBH (cm)	SBA/Area (m ² ha ⁻¹)	Density (stems ha ⁻¹)	Relative Dominance (%)	Relative Density (%)
<u>Acer saccharum</u>	7.1 \pm 1.1	6.6 \pm 1.7	19.6 \pm 5.8	4655 \pm 1080	89.9	71.5
<u>Pinus rubens</u>	7.9 \pm 2.8	16.7 \pm 8.0	3.9 \pm 3.3	130 \pm 95	2.5	14.2
<u>Betula lutea</u>	8.0 \pm 2.3	13.3 \pm 6.7	2.5 \pm 2.2	120 \pm 50	2.3	9.1
<u>Acer rubrum</u>	7.9 \pm 4.5	10.8 \pm 8.7	0.9 \pm 0.9	105 \pm 140	2.0	3.3
<u>Fagus grandifolia</u>	4.3 \pm 1.6	4.8 \pm 2.0	0.4 \pm 0.5	120 \pm 55	2.3	1.5
<u>Abies balsamea</u>	4.6 \pm 3.0	5.2 \pm 3.5	0.1 \pm 0.1	40 \pm 45	0.8	0.4
<u>Betula papyrifera</u>	2.1	2.2	<0.1	10 \pm 20	0.2	<0.1
Total			27.4 \pm 5.3	5180 \pm 950		

Table 2j - Site H2. Quantitative descriptions of pole hardwood stand to be used for calculations of biomass and nutrient standing crops. Mean \pm S.D. of five 20 m \times 20 m (0.04 ha) plots per stand.

Species	Height (m)	DBH (cm)	SBA/Area (m ² ha ⁻¹)	Density (stems ha ⁻¹)	Relative Dominance (%)	Relative Density (%)
<u>Betula papyrifera</u>	9.1 \pm 1.4	9.6 \pm 1.5	14.4 \pm 2.7	1750 \pm 510	62.1	46.4
<u>Acer rubrum</u>	6.9 \pm 2.4	6.8 \pm 3.0	8.2 \pm 4.9	1690 \pm 640	35.3	44.8
<u>Quercus rubra</u>	3.9 \pm 0.7	2.9 \pm 2.2	0.4 \pm 0.9	130 \pm 97	1.7	3.4
<u>Fagus grandifolia</u>	2.1 \pm 0.8	2.0 \pm 0.2	0.1 \pm 0.2	130 \pm 280	0.4	3.4
<u>Pinus strobus</u>	5.2	12.1	0.1 \pm 0.1	5 \pm 11	0.4	0.1
<u>Betula lutea</u>	3.6 \pm 1.1	3.2 \pm 1.6	<0.1	30 \pm 45	<0.1	0.8
<u>Picea rubens</u>	6.3 \pm 3.5	4.7 \pm 1.3	<0.1	20 \pm 20	<0.1	0.5
<u>Acer spicatum</u>	4.2	4.9	<0.1	5 \pm 11	<0.1	0.1
<u>Fraxinus americana</u>	2.5	0.8	<0.1	5 \pm 11	<0.1	0.1
<u>Hammamelis virginiana</u>	1.6	1.5	<0.1	5 \pm 11	<0.1	0.1
Total			23.2 \pm 4.6	3770 \pm 700		

Table 2k - Site H3. Quantitative descriptions of mature hardwood stand to be used for calculations of biomass and nutrient standing crops. Mean \pm S.D. of five 20 m \times 20 m (0.04 ha) plots per stand.

Species	Height (m)	DBH (cm)	SBA/Area (m ² ha ⁻¹)	Density (stems ha ⁻¹)	Relative Dominance (%)	Relative Density (%)
<u><i>Populus grandidentata</i></u>	8.8 \pm 2.2	11.4 \pm 3.6	10.8 \pm 2.9	815 \pm 300	59.7	21.4
<u><i>Populus tremuloides</i></u>	5.2 \pm 1.1	5.0 \pm 1.4	2.9 \pm 2.8	605 \pm 620	16.0	15.9
<u><i>Betula papyrifera</i></u>	6.0 \pm 0.9	5.4 \pm 1.2	2.2 \pm 0.9	480 \pm 170	12.1	12.6
<u><i>Acer rubrum</i></u>	3.9 \pm 0.5	2.8 \pm 0.9	1.6 \pm 0.7	1720 \pm 1220	8.8	45.1
<u><i>Picea glauca</i></u>	7.7	15.1	0.4 \pm 0.8	20 \pm 45	2.2	0.5
<u><i>Betula populifolia</i></u>	3.4 \pm 1.5	2.6 \pm 2.0	0.1 \pm 0.1	130 \pm 97	0.6	3.4
<u><i>Picea rubens</i></u>	4.9	5.6	0.04 \pm 0.09	10 \pm 22	0.2	0.3
<u><i>Prunus pensylvanica</i></u>	4.0 \pm 1.9	3.3 \pm 2.6	0.02 \pm 0.02	15 \pm 14	0.1	0.4
<u><i>Abies balsamea</i></u>	4.9	6.3	0.02 \pm 0.03	5 \pm 11	0.1	0.1
<u><i>Betula lutea</i></u>	3.5	2.1	0.002 \pm 0.004	5 \pm 11	<0.1	0.1
<u><i>Fraxinus americana</i></u>	3.5	1.3	0.001 \pm 0.001	5 \pm 11	<0.1	0.1
Total			18.1 \pm 3.4	3810 \pm 1560		

Table 21 - Site H4. Quantitative descriptions of mature hardwood stand to be used for calculations of biomass and nutrient standing crops. Mean \pm S.D. of five 20 m \times 20 m (0.04 ha) plots per stand.

Species	Height (m)	DBH (cm)	SBA/Area (m ² ha ⁻¹)	Density (stems ha ⁻¹)	Relative Dominance (%)	Relative Density (%)
<u><i>Populus grandidentata</i></u>	10.2 \pm 2.0	14.1 \pm 4.5		12.2 \pm 5.8		
<u><i>Betula papyrifera</i></u>	8.2 \pm 1.3	7.6 \pm 1.3		7.1 \pm 1.7		
<u><i>Populus tremuloides</i></u>	6.5 \pm 1.5	7.5 \pm 3.2		3.5 \pm 1.7		
<u><i>Acer rubrum</i></u>	3.3 \pm 1.0	2.1 \pm 1.0		0.5 \pm 0.4		
<u><i>Betula lutea</i></u>	7.0	6.3		0.3 \pm 0.6		
<u><i>Abies balsamea</i></u>	2.1 \pm 0.2	1.8 \pm 0.6		0.1 \pm 0.2		
<u><i>Picea glauca</i></u>	5.5	1.5		0.1 \pm 0.2		
<u><i>Picea rubens</i></u>	2.7 \pm 0.9	2.0 \pm 1.3		0.03 \pm 0.06		
<u><i>Pinus strobus</i></u>	2.4 \pm 1.0	3.0 \pm 3.5		0.01 \pm 0.03		
Total				23.8 \pm 3.2	3655 \pm 1880	
						17
						1.4
						33.0
						12.4
						21.2
						15.9
						0.4
						0.1
						0.1
						1.4
						0.3

Table 2m - Site H5. Quantitative descriptions of mature hardwood stand to be used for calculations of biomass and nutrient standing crops. Mean \pm S.D. of five 20 m \times 20 m (0.04 ha) plots per stand.

Species	Height (m)	DBH (cm)	SBA/Area (m ² ha ⁻¹)	Density (stems ha ⁻¹)	Relative Dominance (%)	Relative Density (%)
<u>Acer rubrum</u>	13.0 \pm 1.6	15.2 \pm 1.5	13.4 \pm 6.7	700 \pm 430	41.4	32.8
<u>Acer saccharum</u>	9.5 \pm 0.9	9.4 \pm 0.6	8.5 \pm 5.3	820 \pm 460	26.3	38.4
<u>Betula papyrifera</u>	13.8 \pm 3.0	17.6 \pm 4.2	6.3 \pm 4.7	220 \pm 155	19.5	10.3
<u>Betula lutea</u>	9.3 \pm 2.5	9.8 \pm 3.2	3.9 \pm 3.9	300 \pm 190	12.1	14.1
<u>Fagus grandifolia</u>	4.1 \pm 0.8	5.9 \pm 1.2	0.2 \pm 0.2	50 \pm 50	0.6	2.3
<u>Picea rubens</u>	3.7 \pm 0.6	4.0 \pm 2.4	0.05 \pm 0.08	35 \pm 40	0.2	1.6
<u>Hammamelis virginiana</u>	2.5	2.5	<0.01	5 \pm 11	<0.1	0.2
<u>Acer pensylvanicum</u>	3.0	0.6	<0.01	5 \pm 11	<0.1	0.2
Total			32.4 \pm 4.2	2135 \pm 200		

Table 2n - Site H6. Quantitative descriptions of mature hardwood stand to be used for calculations of biomass and nutrient standing crops. Mean \pm S.D. of five 20 m \times 20 m (0.04 ha) plots per stand.

Species	Height (m)	DBH (cm)	SBA/Area (m ² ha ⁻¹)	Density ha ⁻¹ (stems ha ⁻¹)	Relative Dominance (%)	Relative Density (%)
<u>Acer saccharum</u>	-	7.8 \pm 3.2	10.4 \pm 4.6	1300 \pm 600	33.8	35.7
<u>Betula lutea</u>	-	15.5 \pm 1.9	9.2 \pm 5.9	410 \pm 300	29.9	11.2
<u>Fagus grandifolia</u>	-	3.4 \pm 1.7	6.2 \pm 7.4	1780 \pm 830	20.1	48.8
<u>Betula papyrifera</u>	-	13.3 \pm 4.9	2.7 \pm 2.8	125 \pm 115	8.8	3.4
<u>Fraxinus americana</u>	-	30.1 \pm 8.9	1.8 \pm 1.8	25 \pm 25	5.8	0.7
<u>Picea rubens</u>	-	36.8	0.5 \pm 1.2	5 \pm 11	1.6	0.1
Total			30.8 \pm 4.0	3645 \pm 970		

Table 2o - Site H7. Quantitative descriptions of pole hardwood stand to be used for calculations of biomass and nutrient standing crops. Mean \pm S.D. of five 20 m \times 20 m (0.04 ha) plots per stand.

Species	Height (m)	DBH (cm)	SBA/Area (m ² ha ⁻¹)	Density (stems ha ⁻¹)	Relative Dominance (%)	Relative Density (%)
<u>Acer saccharum</u>	-	8.4 \pm 2.1	14.4 \pm 6.8	2060 \pm 970	45.3	70.1
<u>Picea rubens</u>	-	20.3 \pm 6.9	10.5 \pm 12.6	230 \pm 220	33.0	7.8
<u>Acer rubrum</u>	-	22.1 \pm 3.5	4.0 \pm 4.1	110 \pm 130	12.6	3.7
<u>Betula lutea</u>	-	17.6 \pm 14.0	2.2 \pm 1.3	160 \pm 160	6.9	5.4
<u>Fagus grandifolia</u>	-	3.6 \pm 0.7	0.5 \pm 0.2	335 \pm 170	1.6	11.4
<u>Acer pensylvanicum</u>	-	7.3 \pm 1.9	0.2 \pm 0.3	35 \pm 49	0.6	1.2
<u>Abies balsamifera</u>	-	7.0	0.02 \pm 0.05	5 \pm 11	<0.1	0.2
Total		31.8 \pm 6.2	2940 \pm 990			

Table 2P - Site H8. Quantitative descriptions of mature hardwood stand to be used for calculations of biomass and nutrient standing crops. Mean \pm S.D. of five 20 m \times 20 m (0.04 ha) plots per stand.

Species	Height (m)	DBH (cm)	SBA/Area (m ² ha ⁻¹)	Density (stems ha ⁻¹)	Relative Dominance (%)	Relative Density (%)
<i>Acer saccharum</i>	8.1 \pm 1.6	5.4 \pm 0.9	3.8 \pm 2.6	1155 \pm 592	11.6	43.7
<i>Acer rubrum</i>	17.8 \pm 1.3	19.6 \pm 1.1	23.0 \pm 5.5	700 \pm 158	69.4	26.5
<i>Betula lutea</i>	9.3 \pm 1.3	8.5 \pm 1.0	4.3 \pm 5.6	580 \pm 690	13.1	21.9
<i>Fagus grandifolia</i>	8.6 \pm 1.0	10.6 \pm 3.0	0.9 \pm 1.3	80 \pm 100	2.7	3.0
<i>Abies balsamea</i>	7.8 \pm 1.6	10.3 \pm 2.9	0.6 \pm 0.2	80 \pm 50	1.8	3.0
<i>Picea rubens</i>	8.6 \pm 3.3	13.9 \pm 6.9	0.2 \pm 0.3	15 \pm 22	0.6	0.6
<i>Acer pensylvanicum</i>	7.1 \pm 4.2	5.4 \pm 3.6	0.06 \pm 0.08	30 \pm 54	0.2	1.1
<i>Picea glauca</i>	2.0	1.1	<0.01	5 \pm 1.1	<0.1	0.2
Total			32.9 \pm 4.4	2645 \pm 110		

Table 3. Standing crops of biomass and nutrients in various above-ground compartments of the forest stands examined in this study. TOTAL CROWN = live branches + foliage + dead branches + unmerchantable top. TOTAL MERCHANTABLE STEM = wood + bark, merchantable stem. % increase = Percent increase of whole-tree standing crop over merchantable stem. Mean \pm S.D. of five replicate 20 m \times 20 m plots.

	Biomass (Mg/ha)	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)	Calcium (kg/ha)	Magnesium (kg/ha)
Site S1. Mature Red Spruce-Balsam Fir stand:						
live branches	16.8 \pm 4.6	58.9 \pm 17.8	9.15 \pm 3.62	30.4 \pm 11.2	72.4 \pm 18.1	7.60 \pm 2.55
foliage	10.0 \pm 4.3	94.4 \pm 42.2	13.07 \pm 5.43	45.3 \pm 16.5	59.4 \pm 32.0	9.09 \pm 3.10
dead branches	4.7 \pm 1.9	12.8 \pm 4.6	1.05 \pm 0.47	1.3 \pm 0.5	1.6 \pm 7.4	1.26 \pm 0.39
TOTAL CROWN	39.5 \pm 11.6	173.8 \pm 80.3	24.58 \pm 11.77	82.6 \pm 37.8	160.9 \pm 74.4	19.52 \pm 7.94
wood, merch. stem	69.3 \pm 28.6	54.7 \pm 17.6	7.45 \pm 3.87	32.1 \pm 1.8	49.8 \pm 17.6	8.54 \pm 3.98
bark, merch. stem	10.5 \pm 4.4	34.4 \pm 14.6	4.10 \pm 2.00	18.2 \pm 8.4	86.8 \pm 21.7	5.33 \pm 2.34
TOTAL MERC. STEM	79.8 \pm 33.1	89.1 \pm 32.3	11.55 \pm 5.87	50.3 \pm 25.0	136.6 \pm 39.1	13.87 \pm 6.29
WHOLE-TREE	119.3 \pm 37.3	262.9 \pm 90.3	36.13 \pm 14.60	132.9 \pm 51.7	297.0 \pm 85.0	33.39 \pm 11.91
% increase	49.5	195.1	212.1	164.2	117.8	140.3
Site S2. Pole-sized Red Spruce-Balsam Fir stand:						
live branches	19.4 \pm 2.4	72.4 \pm 9.2	9.60 \pm 1.39	29.5 \pm 4.2	88.3 \pm 10.3	8.92 \pm 1.24
foliage	13.4 \pm 2.0	116.3 \pm 17.0	17.64 \pm 2.49	63.0 \pm 8.5	67.6 \pm 10.7	11.98 \pm 1.61
dead branches	5.9 \pm 0.8	16.0 \pm 2.3	1.21 \pm 0.18	1.8 \pm 0.3	20.3 \pm 3.1	1.46 \pm 0.19
TOTAL CROWN	47.9 \pm 6.3	214.6 \pm 32.8	29.77 \pm 4.55	99.3 \pm 15.0	190.7 \pm 28.6	23.82 \pm 3.52
wood, merch. stem	92.6 \pm 15.3	79.2 \pm 12.6	9.06 \pm 1.67	31.9 \pm 5.9	69.3 \pm 11.3	9.83 \pm 1.68
bark, merch. stem	14.1 \pm 2.4	41.3 \pm 6.6	4.84 \pm 0.81	23.3 \pm 3.9	119.4 \pm 15.5	7.09 \pm 1.19
TOTAL MERC. STEM	106.7 \pm 17.6	120.5 \pm 19.1	13.90 \pm 2.58	55.2 \pm 9.8	188.7 \pm 26.4	16.92 \pm 2.87
WHOLE-TREE	154.6 \pm 20.2	335.1 \pm 45.2	43.67 \pm 6.34	154.5 \pm 21.6	379.4 \pm 46.5	40.74 \pm 5.61
% increase	44.9	178.1	214.4	179.9	101.1	140.8
Site S3. Pole-sized Red Spruce-Red Maple stand:						
live branches	15.6 \pm 6.4	53.5 \pm 19.7	7.39 \pm 3.04	24.5 \pm 10.9	68.0 \pm 25.3	6.61 \pm 2.24
foliage	7.6 \pm 1.4	68.9 \pm 16.8	10.18 \pm 2.01	36.9 \pm 7.2	37.6 \pm 9.3	6.96 \pm 1.80
dead branches	4.0 \pm 1.0	9.9 \pm 1.8	0.75 \pm 0.11	1.0 \pm 0.2	13.0 \pm 2.4	1.00 \pm 0.20
TOTAL CROWN	32.9 \pm 5.9	138.4 \pm 24.1	19.15 \pm 3.34	65.6 \pm 11.8	127.9 \pm 22.7	15.49 \pm 3.12
wood, merch. stem	58.8 \pm 12.8	51.3 \pm 11.2	5.90 \pm 1.30	22.2 \pm 7.0	45.3 \pm 10.0	6.80 \pm 1.99
bark, merch. stem	9.1 \pm 2.0	28.0 \pm 8.2	3.07 \pm 0.78	15.0 \pm 3.2	84.2 \pm 27.6	4.52 \pm 0.94
TOTAL MERC. STEM	67.9 \pm 14.8	79.3 \pm 19.5	8.97 \pm 2.06	37.2 \pm 10.1	129.5 \pm 37.3	11.35 \pm 2.90
WHOLE-TREE	100.8 \pm 23.7	217.7 \pm 56.3	28.12 \pm 7.03	102.7 \pm 28.3	257.4 \pm 70.6	26.84 \pm 6.71
% increase	48.5	174.5	213.3	176.3	98.8	136.0
Site S4. Mature Red Spruce-Red Maple-Balsam Fir stand:						
live branches	28.3 \pm 5.6	101.1 \pm 10.8	14.81 \pm 4.67	46.7 \pm 11.0	123.2 \pm 24.1	12.58 \pm 2.66
foliage	14.5 \pm 2.8	136.5 \pm 17.8	14.46 \pm 3.90	68.2 \pm 10.6	74.7 \pm 14.0	12.49 \pm 1.60
dead branches	7.1 \pm 1.9	17.8 \pm 4.0	2.02 \pm 0.53	2.8 \pm 0.7	25.5 \pm 7.1	1.79 \pm 0.48
TOTAL CROWN	54.4 \pm 14.2	260.3 \pm 71.1	36.96 \pm 10.14	120.3 \pm 33.0	231.0 \pm 62.7	27.56 \pm 7.67
wood, merch. stem	165.7 \pm 22.1	138.7 \pm 20.5	19.51 \pm 2.77	68.1 \pm 9.5	120.7 \pm 16.1	19.03 \pm 2.96
bark, merch. stem	23.3 \pm 3.0	75.7 \pm 15.5	7.91 \pm 0.96	35.0 \pm 4.0	176.3 \pm 34.6	11.11 \pm 1.36
TOTAL MERC. STEM	189.0 \pm 25.1	214.4 \pm 34.5	27.32 \pm 3.65	103.1 \pm 13.6	297.0 \pm 46.8	30.14 \pm 2.13
WHOLE-TREE	243.4 \pm 30.9	474.7 \pm 56.4	64.28 \pm 7.45	223.4 \pm 25.7	528.0 \pm 72.1	57.70 \pm 7.28
% increase	28.8	121.4	135.5	116.7	77.8	91.7

Site S5. Pole-sized Red Spruce-Balsam Fir stand:

live branches	23.1 ± 6.9	88.5 ± 27.6
foliage	11.8 ± 4.6	113.8 ± 40.1
dead branches	4.8 ± 1.3	13.7 ± 3.7
TOTAL CROWN	51.0 ± 21.1	227.8 ± 94.4
wood, merch. stem	90.7 ± 24.9	68.5 ± 20.2
bark, merch. stem	12.4 ± 3.5	42.7 ± 14.1
TOTAL MERCH. STEM	93.1 ± 28.3	111.2 ± 33.9
WHOLE-TREE	144.1 ± 37.8	339.0 ± 87.4
% increase	54.8	204.9

Site S6. Mature Black Spruce stand:

live branches	16.9 ± 2.8	52.9 ± 8.0
foliage	8.8 ± 1.0	70.2 ± 9.6
dead branches	8.5 ± 1.3	17.2 ± 3.7
TOTAL CROWN	39.3 ± 4.7	146.4 ± 17.3
wood, merch. stem	63.4 ± 10.5	66.0 ± 11.6
bark, merch. stem	10.0 ± 1.6	27.3 ± 4.4
TOTAL MERCH. STEM	73.4 ± 12.1	93.3 ± 15.0
WHOLE-TREE	112.7 ± 16.4	239.7 ± 31.5
% increase	53.5	156.9

241.2

179.0

204.9

118.5

153.9

Site S7. Mature White Spruce-Tamarack stand:

live branches	11.9 ± 1.3	45.0 ± 4.5
foliage	12.5 ± 1.6	99.8 ± 12.6
dead branches	9.3 ± 1.4	18.6 ± 2.4
TOTAL CROWN	39.0 ± 4.8	168.2 ± 21.7
wood, merch. stem	91.7 ± 15.3	55.5 ± 9.4
bark, merch. stem	12.3 ± 1.8	38.9 ± 5.5
TOTAL MERCH. STEM	104.0 ± 17.1	94.4 ± 14.7
WHOLE-TREE	143.0 ± 20.1	262.6 ± 31.8
% increase	37.5	178.2

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Site H1. Pole-sized Sugar Maple stand:

live branches	41.9 ± 8.8	159.9 ± 26.7	18.63 ± 3.79	73.3 ± 15.5	171.7 ± 31.0	18.10 ± 3.70
foliage	5.5 ± 1.5	72.6 ± 15.0	7.08 ± 1.50	35.3 ± 6.7	22.4 ± 6.0	6.09 ± 1.30
dead branches	3.2 ± 0.6	8.7 ± 2.7	0.38 ± 0.09	1.6 ± 0.5	11.9 ± 3.4	1.52 ± 0.44
TOTAL CROWN	51.2 ± 9.3	241.9 ± 44.3	26.20 ± 4.80	110.6 ± 20.2	207.0 ± 37.7	25.84 ± 4.75
wood, merch. stem	77.2 ± 31.7	76.1 ± 28.0	7.98 ± 3.43	29.5 ± 9.5	55.3 ± 21.1	9.47 ± 2.99
bark, merch. stem	9.8 ± 3.8	46.9 ± 18.2	3.35 ± 1.24	16.7 ± 6.5	121.8 ± 39.7	6.17 ± 2.37
TOTAL MERCHANT. STEM	87.0 ± 35.6	123.0 ± 50.3	11.33 ± 4.67	46.2 ± 18.9	177.1 ± 55.2	15.64 ± 6.43
WHOLE-TREE	138.2 ± 34.4	364.9 ± 66.9	37.53 ± 9.30	156.8 ± 36.2	384.1 ± 110.1	41.48 ± 10.33
% increase	58.9	196.7	231.9	239.4	116.9	165.4

Site H2. Pole-sized White Birch-Red Maple stand:

live branches	30.3 ± 4.6	123.3 ± 14.1	16.58 ± 2.09	31.5 ± 10.7	105.2 ± 20.0	9.93 ± 1.74
foliage	2.7 ± 0.5	50.3 ± 8.4	5.00 ± 0.88	15.0 ± 4.9	14.7 ± 2.7	3.38 ± 0.87
dead branches	3.0 ± 0.7	7.9 ± 1.8	0.58 ± 0.13	0.9 ± 0.2	12.3 ± 2.8	0.97 ± 0.19
TOTAL CROWN	36.1 ± 4.8	181.6 ± 24.0	22.17 ± 2.94	47.6 ± 6.2	132.4 ± 17.5	14.30 ± 1.85
wood, merch. stem	47.2 ± 15.0	57.4 ± 15.8	4.93 ± 1.66	22.0 ± 8.5	37.6 ± 12.2	8.76 ± 2.66
bark, merch. stem	8.4 ± 2.2	34.6 ± 9.1	2.81 ± 0.80	12.8 ± 7.5	100.1 ± 26.2	3.89 ± 1.00
TOTAL MERCHANT. STEM	55.6 ± 17.2	92.0 ± 28.5	7.74 ± 3.04	34.8 ± 15.2	137.7 ± 42.6	12.65 ± 3.82
WHOLE-TREE	91.7 ± 20.8	273.6 ± 62.3	29.91 ± 6.18	82.4 ± 29.5	270.1 ± 61.3	26.95 ± 8.29
% increase	64.9	197.4	288.3	136.8	96.2	112.6

Site H3. Mature Large-toothed Aspen-White Birch stand:

live branches	17.5 ± 7.3	71.0 ± 12.8	10.97 ± 2.69	43.7 ± 11.3	93.2 ± 21.5	11.09 ± 2.98
foliage	2.0 ± 0.3	40.6 ± 6.9	3.82 ± 0.64	19.5 ± 4.0	11.6 ± 2.0	4.00 ± 0.78
dead branches	2.6 ± 0.6	7.1 ± 1.6	0.35 ± 0.07	1.3 ± 0.3	12.2 ± 2.7	1.06 ± 0.23
TOTAL CROWN	22.6 ± 4.8	118.8 ± 25.2	15.16 ± 3.22	64.6 ± 13.8	117.2 ± 24.8	16.17 ± 3.36
wood, merch. stem	32.8 ± 7.3	36.8 ± 7.9	4.20 ± 1.00	32.7 ± 11.2	25.6 ± 8.2	9.21 ± 2.64
bark, merch. stem	8.8 ± 2.2	29.3 ± 6.9	2.91 ± 0.77	20.0 ± 7.1	83.2 ± 22.0	6.09 ± 1.90
TOTAL MERCHANT. STEM	41.6 ± 9.5	66.1 ± 14.8	7.11 ± 1.74	52.7 ± 18.5	108.8 ± 30.0	15.30 ± 4.54
WHOLE-TREE	64.2 ± 13.6	184.9 ± 34.4	22.27 ± 4.92	117.3 ± 32.9	226.0 ± 54.4	31.47 ± 8.42
% increase	54.3	179.7	214.1	122.6	107.7	105.9

Site H4. Mature Large-toothed Aspen-White Birch stand:

live branches	23.1 ± 2.1	101.9 ± 11.0	15.17 ± 1.14	47.7 ± 10.9	116.6 ± 20.6	13.61 ± 1.99
foliage	2.4 ± 0.3	50.9 ± 8.5	4.63 ± 0.69	21.0 ± 5.0	14.5 ± 2.2	4.62 ± 1.21
dead branches	2.0 ± 0.3	5.9 ± 1.0	0.29 ± 0.04	0.9 ± 0.2	9.3 ± 1.6	0.84 ± 0.17
TOTAL CROWN	27.5 ± 3.4	158.7 ± 19.5	20.12 ± 2.48	69.8 ± 8.6	140.4 ± 17.2	19.09 ± 2.38
wood, merch. stem	51.7 ± 10.5	58.5 ± 12.0	6.97 ± 1.98	47.9 ± 12.8	38.9 ± 6.1	14.20 ± 2.74
bark, merch. stem	13.2 ± 2.7	44.9 ± 10.2	4.42 ± 0.72	31.6 ± 4.3	122.7 ± 25.2	8.49 ± 1.53
TOTAL MERCHANT. STEM	64.9 ± 13.3	103.4 ± 22.3	11.39 ± 2.68	79.5 ± 16.8	161.6 ± 31.1	22.69 ± 4.28
WHOLE-TREE	92.4 ± 13.1	262.1 ± 41.4	31.51 ± 4.49	149.3 ± 32.0	302.0 ± 53.3	41.78 ± 7.47
% increase	42.4	153.5	176.3	87.8	86.9	84.1

Site H5. Mature Red Maple-Sugar Maple-White Birch stand:

live branches	39.5 ± 3.4	148.0 ± 42.8	19.70 ± 4.08	62.8 ± 1.3	158.9 ± 35.2	15.70 ± 2.13
foliage	3.5 ± 0.3	68.0 ± 8.2	6.18 ± 0.69	29.3 ± 1.3	19.3 ± 2.5	5.75 ± 0.71
dead branches	1.4 ± 0.2	8.9 ± 1.2	0.52 ± 0.06	0.9 ± 0.1	5.0 ± 1.1	1.51 ± 0.24
TOTAL CROWN	44.6 ± 6.0	225.1 ± 29.9	26.42 ± 3.52	93.1 ± 12.4	183.4 ± 24.5	22.98 ± 1.28
wood, merch. stem	106.0 ± 18.4	111.0 ± 22.9	11.19 ± 2.30	55.1 ± 9.5	80.3 ± 12.1	18.28 ± 3.90
bark, merch. stem	14.7 ± 2.8	70.7 ± 13.5	5.23 ± 0.99	20.8 ± 4.0	184.5 ± 35.1	7.65 ± 1.47
TOTAL MERCH. STEM	120.7 ± 21.1	181.7 ± 33.3	16.42 ± 2.89	75.9 ± 13.3	264.8 ± 50.4	25.93 ± 4.57
WHOLE-TREE	165.3 ± 22.1	406.8 ± 74.6	42.84 ± 5.71	169.0 ± 31.3	448.2 ± 125.2	48.88 ± 6.52
% increase	37.0	123.9	161.0	122.7	69.3	88.8

Site H6. Mature Sugar Maple-Yellow Birch-Beech stand:

live branches	40.2 ± 2.7	161.0 ± 35.4	22.66 ± 5.75	66.5 ± 1.5	160.7 ± 51.5	19.00 ± 2.07
foliage	3.9 ± 0.7	76.3 ± 12.4	5.84 ± 0.54	33.5 ± 2.5	19.6 ± 4.1	6.45 ± 1.32
dead branches	3.0 ± 0.5	7.2 ± 1.3	0.39 ± 0.06	1.2 ± 0.2	9.4 ± 1.6	1.01 ± 0.17
TOTAL CROWN	47.2 ± 8.3	244.6 ± 43.1	28.93 ± 4.60	101.2 ± 17.9	189.7 ± 33.4	26.48 ± 4.66
wood, merch. stem	139.7 ± 39.4	140.8 ± 35.8	14.24 ± 4.12	61.6 ± 17.0	100.8 ± 27.0	29.07 ± 12.58
bark, merch. stem	17.9 ± 4.8	94.2 ± 24.0	6.06 ± 1.63	30.3 ± 8.1	222.9 ± 59.8	11.15 ± 2.99
TOTAL MERCH. STEM	157.6 ± 44.1	235.0 ± 71.6	20.30 ± 5.44	91.9 ± 25.4	323.8 ± 90.6	40.22 ± 11.25
WHOLE-TREE	204.8 ± 36.1	479.6 ± 84.5	49.23 ± 7.82	193.1 ± 34.1	513.5 ± 90.6	66.70 ± 11.80
% increase	29.9	104.1	142.4	110.1	58.6	65.9

Site H7. Pole-sized Sugar Maple-Red Spruce stand:

live branches	36.2 ± 5.8	134.3 ± 20.7	16.11 ± 2.19	62.7 ± 12.7	150.2 ± 30.6	15.72 ± 2.02
foliage	6.7 ± 4.2	85.3 ± 27.4	10.03 ± 5.31	43.2 ± 14.5	33.3 ± 20.6	7.46 ± 2.83
dead branches	4.2 ± 0.9	10.9 ± 3.5	0.58 ± 0.12	6.0 ± 1.3	14.0 ± 3.0	1.22 ± 0.26
TOTAL CROWN	48.0 ± 9.8	231.5 ± 73.8	26.86 ± 5.50	107.7 ± 22.0	199.1 ± 40.7	24.56 ± 5.02
wood, merch. stem	111.2 ± 36.1	104.0 ± 29.4	12.02 ± 4.87	48.8 ± 16.2	82.8 ± 26.6	16.44 ± 7.88
bark, merch. stem	14.8 ± 5.1	63.5 ± 21.9	5.14 ± 2.57	25.1 ± 8.6	163.8 ± 56.4	8.72 ± 2.48
TOTAL MERCH. STEM	126.0 ± 41.3	167.5 ± 76.8	17.16 ± 6.05	73.9 ± 24.2	246.6 ± 80.8	25.16 ± 8.25
WHOLE-TREE	174.0 ± 35.4	399.0 ± 126.7	44.02 ± 9.02	181.6 ± 37.0	445.7 ± 91.0	49.72 ± 10.14
% increase	38.1	138.2	156.4	145.7	80.7	97.6

Site H8. Mature Red Maple-Yellow Birch-Sugar Maple stand:

live branches	38.2 ± 4.9	130.5 ± 19.4	17.10 ± 3.72	68.3 ± 8.3	168.7 ± 34.0	15.14 ± 2.57
foliage	3.7 ± 0.4	63.2 ± 8.2	6.12 ± 0.79	29.4 ± 3.5	19.3 ± 2.4	5.78 ± 0.97
dead branches	1.2 ± 0.2	3.0 ± 0.6	0.15 ± 0.03	0.5 ± 0.1	3.3 ± 0.5	0.87 ± 0.12
TOTAL CROWN	43.3 ± 6.0	196.0 ± 27.0	23.42 ± 3.26	98.5 ± 13.6	191.7 ± 26.4	21.85 ± 3.02
wood, merch. stem	100.3 ± 14.3	94.9 ± 13.6	10.02 ± 1.43	64.5 ± 10.3	81.9 ± 12.4	17.18 ± 2.79
bark, merch. stem	13.1 ± 2.0	64.5 ± 9.9	5.01 ± 0.79	20.1 ± 3.1	174.5 ± 26.6	6.34 ± 1.01
TOTAL MERCH. STEM	113.4 ± 16.3	159.4 ± 22.9	15.03 ± 2.18	84.6 ± 12.2	256.4 ± 36.9	23.52 ± 3.40
WHOLE-TREE	156.7 ± 21.5	355.4 ± 44.6	38.45 ± 4.17	183.1 ± 22.7	448.1 ± 61.4	45.37 ± 6.22
% increase	38.2	123.0	156.0	145.7	116.4	74.8

Appendix 1. Common names and binomials of tree species mentioned in this study.

<u>Abies balsamea</u> (L.) Mill.	Balsam Fir
<u>Larix laricina</u> (Du Roi) K. Koch.	Larch
<u>Picea glauca</u> (Moench) Voss.	White Spruce
<u>Picea mariana</u> (Mill.) BSP	Black Spruce
<u>Picea rubens</u> Sarg.	Red Spruce
<u>Pinus strobus</u> L.	White Pine
<u>Tsuga canadensis</u> (L.) Carr.	Eastern Hemlock
<u>Acer pensylvanicum</u> L.	Striped Maple
<u>Acer rubrum</u> L.	Red Maple
<u>Acer saccharum</u> Marsh.	Sugar Maple
<u>Acer spicatum</u> Lam.	Mountain Maple
<u>Betula lutea</u> Michx. f.	Yellow Birch
<u>Betula papyrifera</u> Marsh.	Paper Birch
<u>Betula populifolia</u> Marsh.	Wire Birch
<u>Fagus grandifolia</u> Ehrh.	Beech
<u>Fraxinus americana</u> L.	White Ash
<u>Hamemelis virginiana</u> L.	Witch Hazel
<u>Populus grandidentata</u> Michx.	Large-toothed Aspen
<u>Populus tremuloides</u> Michx.	Trembling Aspen
<u>Prunus pensylvanica</u> L.f.	Pin Cherry
<u>Quercus rubra</u> L.	Red Oak

