TREE BIOMASS EQUATIONS FOR TEN MAJOR SPECIES IN CUMBERLAND COUNTY, NOVA SCOTIA

by

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ABSTRACT

Logarithmic equations are given for estimating fresh and dry weights of several tree components for ten common Nova Scotian tree species - balsam fir, white spruce, black spruce, jack pine, red pine, larch, red maple, white birch, aspen and grey(wire) birch. Separate equations are given for each of 12 biomass variables:

1) dry stem wood, 2) dry stem bark, 3) total dry stem, 4) dry branches, 5) dry foliage, 6) total dry crown, 7) total dry above-ground, 8) fresh stem wood, 9) fresh stem bark, 10) total fresh stem, 11) total fresh crown, and 12) total fresh above-ground. For each of these components the best (i.e. highest R^2) one- and two-variable equations are given. Independent variables tested for predictive ability were DBH, height, crown width and crown length. Stem wood comprised from 62-77% of total dry above-ground weight, stem bark 6-14%, branches 13-19% and foliage 2-11%, based on the mean weights of each component. Average DBH of sample trees ranged from 10.1 cm for grey birch to 17.7 cm for red pine. Average total dry above-ground weights ranged from 38.9 kg for grey birch to 144.1 kg for white birch. Also included in this report is information on % moisture content, ratios of dry weight to fresh weight for different components, mean weights of each component by species, and softwood branch equations. Results are based on data from 42-50 sample trees per species. Sample discs and sample branches from these trees were dried at 105°C for 24 h and provided the basis for conversion of total fresh weight to oven-dry weights.

RESUME

Des équations logarithmiques sont données pour l'estimation du poids à l'état frais et du poids anhydre de plusieurs parties de l'arbre pour chacune des dix essences végétales communes dans la Nouvelle Ecosse - le sapin baumier, l'épinette blanche, l'épinette noire, le pin gris, le pin rouge, le mélèze, l'érable rouge, le bouleau à papier, le bouleau gris et le tremble. Des équations distinctes sont données pour chacune des 12 variables de la biomasse: - 1) bois du fût sec, 2) écorce sèche du fût, 3) tige entière sèche, 4) branches sèches, 5) feuillage sec, 6) houppier entier sec, 7) ensemble des parties aériennes sèches, 8) bois de fût à l'état frais, 9) écorce du fût à l'état frais, 10) tige entière à l'état frais, 11) houppier entier à l'état frais et 12) ensemble des parties aériennes à l'état frais. Pour chacune de ces parties sont données les meilleures (c.à.d. ayant la plus haute valeur R^2) équations à une et à deux variables. Les variables indépendantes dont la capacité de prédiction a été vérifée étaient le dhp, la hauteur, la largeur et la longueur du pouppier. Le bois du fût représentait 62-77% du poids sec de l'ensemble des parties aériennes, l'écorce du fût 6-14%, les branches 13-19% et le feuillage 2-11% (base: poids moyen de chaque partie). Le dhp moyen des arbres d'échantillonnage se situait entre 10.1 cm pour le bouleau gris et 17.7 cm pour le pin rouge. Les poids secs moyens de l'ensemble des parties aériennes se chiffraient de 38.9 kg pour le bouleau gris à 144.1 kg pour le bouleau à papier. Ont été également insérées dans le présent rapport des informations sur le % de teneur en humidité, les rapports du poids sec au poids à

l'état frais pour les différentes parties, les poids moyens de chaque partie par essence et les équations de branches des résineux. Les résultats sont étayés sur les données recueillies pour 42-50 arbres d'échantillonnage par essence. Les rondelles et branches d'échantillonnage prélevées sur ces arbres ont été séchées pendant 24 h à 105°C pour servir de base à la conversion du poids total à l'état frais aux poids anhydres.

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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INTRODUCTION

This report describes the results of a study conducted under the ENFOR program to develop tree biomass equations for use in a biomass inventory in part of Cumberland County, Nova Scotia.

To develop such equations, one needs data on the oven-dry weights of the major tree components (for this study: stem wood, stem bark, branches, and foliage). These data are usually obtained through a subsampling system whereby sample stem discs and branches are dried and used to estimate the dry component weights for each sample tree.

METHODS FOR SUBSAMPLING INDIVIDUAL TREES

The following 10 major species were sampled:

Softwoods

Balsam fir (*Abies balsamea*)
White spruce (*Picea glauca*)
Black spruce (*Picea mariana*)
Jack pine (*Pinus banksiana*)
Red pine (*Pinus resinosa*)
Larch (*Larix laricina*)

Hardwoods

Red maple (*Acer rubrum*)
White birch (*Betula papyrifera*)
Aspen (*Populus tremuloides*)
Grey birch (*Betula populifolia*)

Between 45 and 50 sample trees of each species were selected from the range of tree sizes throughout the inventoried area, and for each tree the following information was recorded:

1) tree identification number
2) species group: hardwood or softwood
3) species
4) map number: number of the corresponding Nova Scotia Forest Inventory map series (1:15840)
5) latitude and longitude of sample tree location
6) diameter outside bark (cm) at 1.3 m above ground
7) total height (m)
8) crown width (m)
9) crown length (m)
10) cover type : hardwood, mixedwood, softwood
11) crown class: dominant, codominant, intermediate, suppressed.

The methods used to estimate oven-dry biomass of each sample tree are described in the following section.

Estimation of Stem Biomass

Field and laboratory methods:

Each sample tree was felled, leaving as short a stump as possible, and then delimbed. Starting at the base of the stem, discs were cut at 1.5 m intervals and labelled by tree number and disc number. They were subsequently taken to a laboratory trailer near the field operations where the bark was separated from the wood, and the fresh weight of each obtained. The fresh weight of each stem section was measured using a 1000-lb capacity dynamometer and a 50-lb capacity field scale.

The disc samples were taken to the Maritimes Forest Research Centre laboratory, Fredericton, where they were dried at 105°C for at least 24h. Dry weights of disc wood and bark were then measured to the nearest 0.1 g.

Analysis of data:

The notation used for stem disc and stem section weights is

	Fresh Weight	Dry Weight
Disc		
Wood	w	w'
Bark	b	b'
Total	t	t'
Section		
Wood	W	W'
Bark	B	B'
Total	T	T'

The fresh and dry weights of the i^{th} stem section were calculated as:

$$W_i = [(w_i + w_{i+1})/(t_i + t_{i+1})]\ T_i$$
$$B_i = T_i - W_i$$
$$W'_i = [w'_i + w'_{i+1})/(t_i + t_{i+1})]\ T_i$$
$$T'_i = [t'_i + t'_{i+1})/(t_i + t_{i+1})]\ T_i$$
$$B'_i = T'_i - W'_i$$

For top sections the weight ratios observed in the last (top) disc were used, e.g.,

$$W_i = (w_i/t_i)\ T_i$$

Total stem component weights are then simply:

	Fresh	Dry
Wood	$\Sigma w + \Sigma W$	$\Sigma w' + \Sigma W'$
Bark	$\Sigma b + \Sigma B$	$\Sigma b' + \Sigma B'$
Total	$\Sigma t + \Sigma T$	$\Sigma t' + \Sigma T'$

Estimation of Crown Biomass: Softwoods

Field and laboratory methods:

Live softwood branches were classified into two strata: 1) those with basal diameter d <3 cm (measured 3 cm from the base) and 2) those remaining, d $\geq$ 3 cm. The total fresh weight of the smaller branches (d <3) was obtained and two sample branches were selected at random for dry weight determinations.

Two sample branches were also selected from the other stratum (d $\geq$3), and the diameter and fresh weight of each branch were measured.

Sample branches were identified by tree number and sample number; the fresh weight of each was determined, either in the woods or at the field laboratory. At the Fredericton laboratory, the branch samples were dried at 105°C for at least 24 h, and then the foliage was separated from the wood and bark using a winnowing machine fitted with suitable screens. Dry weights of foliage and wood plus bark were measured to the nearest 0.1 g.

Analysis of data:

For the small branch (d <3cm) stratum, the dry weights of foliage (F) and wood plus bark (WB) for each sample tree were estimated as

$$F = TFW \cdot (a_0 + \Sigma\ a_i\ X_i)$$
and
$$WB = TFW \cdot (b_0 + \Sigma\ b_i\ X_i)$$

where

TFW = total fresh weight of stratum

a_0 , a_i , b_0 , b_i = coefficients derived from least-squares analysis of the small branch sample data

X_i = stratum weight and measures of tree size such as basal area, height, etc.

This model represents an attempt to quantify the changes in the ratios of dry foliage and wood plus bark to fresh weight which occur as a result of differences in tree size, crown size, branch size distribution, stand density, and other factors. Separate equations were developed for each species.

For the crown stratum d $\geq$ 3, regression estimates of the dry foliage

and dry wood plus bark weights were made for each branch, using equations derived from the large branch sample data. These equations took the general form

$$W = b_0 + b_1\, d + b_2 \cdot FW + b_3 d^2 + b_4\, d \cdot FW + b_5\, (FW)^2 + b_6\, (d \cdot FW)^2 + b_7\, d^2 \cdot (FW)^{-1}$$

where

W = oven-dry weight of foliage (or wood plus bark) for a given branch
d = branch diameter, measured 3 cm from the base
FW = fresh weight of branch
$b_0 .. b_7$ = regression coefficients

Estimation of Crown Biomass: Hardwoods

Field and laboratory methods:

Hardwood crowns were cut into sections less than 2 m in length and sorted into four strata based on the estimated mid-diameter (d) of the section. Diameter limits for these strata were: 1) $d < 2$ cm, 2) $2 \leq d < 6$, 3) $6 \leq d < 10$ and 4) $d \geq 10$ cm. Samples were taken from each stratum as follows:

1) Two branches were selected from stratum 1 (0-2 cm) as a basis for estimating proportions of foliage and woody material. This stratum contained 100% of the foliage.
2) Five discs were cut at random from each of the remaining three strata for dry weight determinations.

The aggregate fresh weight of the samples for each stratum was obtained at the field laboratory and the samples were subsequently transported to Fredericton where they were dried at 105°C for 24 h. After drying, the foliage was separated and weighed. The total weight of dry wood and bark was obtained for the sample material from each stratum.

Analysis of data:

The approach used in estimating oven-dry hardwood crown weights was similar to that used for the small softwood branches. For each stratum, equations were derived for estimating the ratio of dry branch weight to fresh branch weight, and, for stratum 1 ($d < 2$), the ratio of dry foliage weight to fresh branch weight. Thus, the oven-dry weight of wood and bark (WB) for a given stratum was estimated as

$$WB = TFW \cdot (b_0 + \Sigma b_i\, X_i)$$

where

TFW = total fresh weight of the stratum
X_i = measures of tree size such as basal area, height, and dummy (0,1) variables for species and stratum differences
b_0, b_i = regression coefficients derived from sample branch and disc data

Dry foliage weight for each sample tree was estimated in a similar fashion, except that only data from stratum 1 ($d < 2$ cm) were needed.

DERIVATION OF TREE BIOMASS EQUATIONS

After the dry component weights for each sample tree had been calculated, a set of equations was derived for predicting fresh and oven-dry weights of various biomass components for each of the 10 species. The general model used in this analysis was

$$\ln W = b_0 + b_1 \ln D + b_2 \ln H + b_3 \ln CW + b_4 \ln CL$$

where

W = weight of biomass component (kg)
D = diameter at 1.3 m above ground (cm)
H = total tree height (m)
CW = crown width (m)
CL = live crown length (m)

ln = natural logarithm (base e)

$b_0 \ldots b_4$ = regression coefficients

The coefficients of this model were calculated using a computer program (Dixon 1977, Furnival and Wilson 1974) that examines all possible subsets of the independent variables and reports the regression coefficients for the "best" regressions for each subset size using one of three criteria. In this report, we include the best one-and two-variable regressions (using the R^2 criterion) for each of 12 biomass variables: fresh and oven-dry weights of stem wood, stem bark, total stem, total crown, and total above-ground, and oven-dry weight of foliage and of branches.

RESULTS AND DISCUSSION

Equations for each of the 12 biomass components and 10 species are listed in Tables 1-10. Also given in these tables are the sample sizes (n), R^2 values, range of tree diameters occurring in each sample, and a correction factor (c) associated with the use of logarithmic regression (Beauchamp and Olson 1973). The corrected weight estimate W* is given by

$$W^* = c \cdot e^{\ln W}$$

where ln W is the mean logarithm of weight as given by the logarithmic equations.

In addition to the biomass equations, other results, such as moisture contents, mean values, and weight ratios were calculated and are discussed in the following sections.

Stem Biomass

The equations for biomass of stem components (Tables 1-10) consistently showed the highest R^2 values of any component (usually .98 or higher). The inclusion of height as a second independent variable (in addition to dbh) generally resulted in a statistically significant improvement in the model.

Mean values of stem component weights for each species are given in Table 11, together with average moisture content (based on mean fresh and dry weights). Average moisture content of the stem for the 10 species is 95% (dry basis), indicating that almost one-half of the fresh stem is water.

The average specific gravities of the softwood and hardwood groups, based on the mean volumes (Honer 1967) and mean oven-dry stem wood weights in Table 11, are 0.38 and 0.50, respectively. These figures are in good agreement with corresponding averages of 0.40 and 0.48 derived from other studies of wood properties (Anon. 1951).

Crown Biomass: Softwoods

Small branches (d <3):

Analysis of the small branch weight data resulted in two sets of equations, one for estimating the ratio of the weight of oven-dry wood and bark to fresh weight (Table 12), and the other for estimating the ratio of the weight of oven-dry foliage to fresh weight (Table 13).

For some species, no significant trends could be detected; in such cases a single mean ratio was applied to all sample trees of that species. The average values of these two ratios for all species are summarized in Table 14. For most softwood species, the oven-dry weight of branch wood and bark was 25-30% of the fresh weight. This ratio for larch was 35%, the highest of any species.

Oven-dry weight of foliage was generally 15-23% of fresh branch weight, dropping to 9% for larch.

Moisture content of small branches, based on the mean weight ratios (Table 14), ranged from 102 to 130% of dry weight, with an average for the six species of 120%.

Large branches (d $\geq$3):

For the large branch stratum, equations were derived for estimating oven- dry weight of wood plus bark (Table 15) and of foliage (Table 16) for individual branches. These equations were used to estimate the dry weights of the large branch stratum of each sample tree.

Average fresh and oven-dry weights of the large branch samples are summarized in Table 17, along with means of moisture content and diameter. Oven-dry weight of wood plus bark was 30-41% of the fresh branch weight, while dry foliage weight was 5-12% of the fresh weight. The larger branches have a higher proportion of biomass in the form of wood and bark than the small branches with a correspondingly lower proportion of foliage. Average moisture content of large branches for the six species was 121% of dry weight.

Crown biomass equations:

Equations for the biomass of crown components are given in Tables 1-6. Separate equations were derived for each of four crown weight variables: 1) oven-dry weight of branches (wood plus bark), 2) oven-dry weight of foliage, 3) oven-dry weight of crown (branches plus foliage), and 4) fresh weight of crown.

Mean crown component weights for each species are given in Table 18. The oven-dry weight of crown wood and bark averaged 28-37% of fresh crown weight, depending on the species, and dry foliage weight was 7-18% of fresh crown weight. Average crown moisture content for the six softwood species was 124%, based on mean fresh and dry weights.

Crown Biomass: Hardwoods

Equations were derived from the hardwood branch data for estimating, by crown stratum, the ratios of 1) oven-dry weight of foliage to fresh branch weight, and 2) oven-dry weight of wood plus bark to fresh branch weight. The resulting equations are

$$RWB = 0.6017 - 0.04035\ z_1 - 0.03367\ z_2 - 0.06711\ z_3 - 0.2170\ z_4 - 0.04461\ z_5 \quad (n = 352,\ R^2 = .46)$$

and

$$RF = 0.2216 - 0.02010\ H - 0.0005159\ FW + 0.0008554\ H^2 + 0.02791\ z_2 \quad (n = 185,\ R^2 = .13)$$

where

RWB = estimated ratio of oven-dry weight of wood and bark to fresh branch weight

RF = estimated ratio of oven-dry weight of foliage to fresh branch weight

z_1 = 1 for red maple; 0 for other species

z_2 = 1 for white birch; 0 for other species

z_3 = 1 for aspen; 0 for other species

z_4 = 1 for stratum 1 (0-2 cm); 0 for other strata

z_5 = 1 for stratum 2 (2-6 cm); 0 for other strata

H = tree height (m)

FW = fresh weight of stratum 1 (0-2 cm)

These equations show some significant differences in dry:fresh weight ratios between species and crown strata. The mean ratio of oven-dry

weight of wood and bark to fresh branch weight, based on samples from all strata and all species, was 0.43. For dry foliage, the corresponding ratio, based on all samples from stratum 1 (0-2 cm), was 0.12.

Crown biomass equations:

Results of the analysis of crown biomass data for hardwoods are presented in Tables 7-10 (crown biomass equations) and Table 18 (mean crown weights and moisture content).

The oven-dry weight of crown wood and bark was 42-44% of fresh crown weight, significantly higher than for softwoods, while dry foliage weights, as a percentage of fresh crown weights, were lower than those for softwoods, ranging from 5-7%. The average crown moisture content for the four hardwood species was 105%, compared to 124% for the softwood species.

Total Above-Ground Biomass

Equations for total above- ground biomass (fresh and oven- dry) are listed in Tables 1-10. A comparison of fresh above-ground weights predicted by these equations with data for 6-inch trees in Maine published by Young (1976) showed differences of 1% for fir, 3% for red maple, 6% for white birch, 7% for red spruce and 11% for aspen. Young's data included stump and root biomass and were converted to above-ground biomass for this comparison using a factor of 80%.

The mean values of above-ground biomass (fresh and oven-dry) for each species are summarized in Table 19. The mean oven-dry weight of the above-ground components was 47% of mean fresh above-ground weight for softwoods and 56% for hardwoods. Moisture content of the above-ground components was 113% for softwoods and 79% for hardwoods.

Distribution of above-ground biomass:

The distribution of total above-ground biomass among the different components depends on tree size, species, site quality, age, stand density, and other factors. We can, however, get a general idea of how biomass is distributed from the mean values of the weights of the different components which are referred to in previous sections of this report. This approach was used in deriving Fig. 1, which shows the distribution of above-ground biomass for each species, based on the mean oven-dry weights of each component. The mean diameters associated with these proportions ranged from 10.1 cm for grey birch to 17.7 cm for red pine (Table 11). In smaller trees the crown components will comprise a larger proportion of the above-ground biomass, and vice versa for larger trees. For example, a 5-cm fir tree has 45% of its total above-ground biomass in the form of crown components, while for a 25-cm tree it drops to 24%.

Another breakdown of above-ground biomass, this one in terms of species group (softwoods or hardwoods) is given in Table 20. For hardwoods, the stem and crown components make up 81 and 19% of the above-ground biomass, respectively, while for softwoods the corresponding percentages are 75 and 25.

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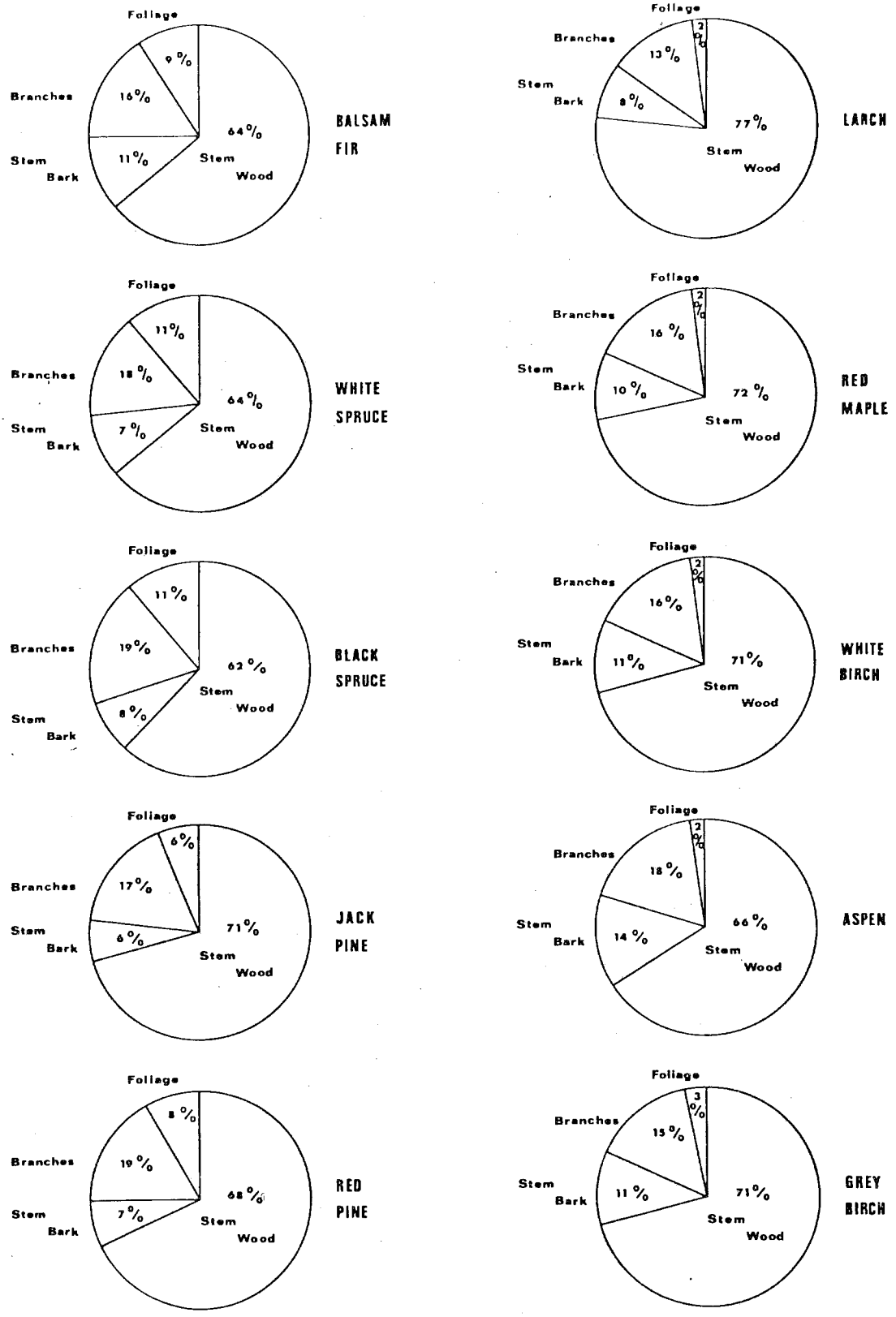

Figure 1. Distribution of above-ground biomass for 10 species in Cumberland County, Nova Scotia, based on mean oven-dry weights of each component.

Table 1. Tree biomass equations for balsam fir (dbh 1.5-32.1 cm) in Cumberland County, Nova Scotia

Component	Equation	n	R^2	c
	Oven-dry weight in kg			
Stem wood	ln W = -3.2027 + 2.4228 ln D	50	.98	1.02
	ln W = -3.3889 + 1.7234 ln D + 0.8983 ln H	50	.99	
Stem bark	ln W = -4.4204 + 2.2391 ln D	50	.95	1.06
	ln W = -4.6609 + 1.3359 ln D + 1.1601 ln H	50	.96	
Stem	ln W = -2.9476 + 2.3932 ln D	50	.98	1.02
	ln W = -3.1444 + 1.6540 ln D + 0.9495 ln H	50	.99	
Branches	ln W = -2.6293 + 1.7793 ln D	50	.89	1.05
	ln W = -2.2448 + 1.0808 ln D + 1.4976 ln CW	50	.95	
Foliage	ln W = -2.7854 + 1.6737 ln D	50	.90	1.05
	ln W = -2.4873 + 1.1320 ln D + 1.1614 ln CW	50	.94	
Crown	ln W = -2.0259 + 1.7433 ln D	50	.90	1.05
	ln W = -1.6731 + 1.1023 ln D + 1.3743 ln CW	50	.96	
Total (a.g.)*	ln W = -1.8337 + 2.1283 ln D	50	.97	1.03
	ln W = -1.6768 + 1.8432 ln D + 0.6113 ln CW	50	.97	
	Fresh weight in kg			
Stem wood	ln W = -2.1468 + 2.3328 ln D	50	.98	1.02
	ln W = -2.3587 + 1.5373 ln D + 1.0217 ln H	50	.99	
Stem bark	ln W = -3.4641 + 2.1742 ln D	50	.97	1.03
	ln W = -3.6793 + 1.3662 ln D + 1.0377 ln H	50	.98	
Stem	ln W = -1.9088 + 2.3055 ln D	50	.98	1.02
	ln W = -2.1216 + 1.5065 ln D + 1.0262 ln H	50	.99	
Crown	ln W = -1.3184 + 1.7808 ln D	50	.90	1.04
	ln W = -0.9440 + 1.1005 ln D + 1.4586 ln CW	50	.96	
Total (a.g.)	ln W = -0.9710 + 2.1056 ln D	50	.97	1.03
	ln W = -0.8350 + 1.8586 ln D + 0.5296 ln CW	50	.98	

* a.g. = above-ground

Table 2. Tree biomass equations for white spruce (dbh 2.1-32.3 cm) in Cumberland County, Nova Scotia

Component	Equation	n	R^2	c
	Oven-dry weight in kg			
Stem wood	ln W = -3.3668 + 2.4847 ln D	44	.99	1.02
	ln W = -3.6074 + 2.7904 ln D - 0.5667 ln CW	44	.99	
Stem bark	ln W = -4.5138 + 2.1547 ln D	44	.98	1.03
	ln W = -4.6944 + 2.3842 ln D - 0.4255 ln CW	44	.98	
Stem	ln W = -3.1114 + 2.4370 ln D	44	.99	1.02
	ln W = -3.3493 + 2.7394 ln D - 0.5606 ln CW	44	.99	
Branches	ln W = -3.4995 + 2.1368 ln D	44	.94	1.06
	ln W = -3.1538 + 1.6973 ln D + 0.8145 ln CW	44	.95	
Foliage	ln W = -3.2985 + 1.9103 ln D	44	.93	1.05
	ln W = -2.9500 + 1.4674 ln D + 0.8209 ln CW	44	.95	
Crown	ln W = -2.7323 + 2.0433 ln D	44	.94	1.05
	ln W = -2.3875 + 1.6050 ln D + 0.8124 ln CW	44	.95	
Total (a.g.)*	ln W = -2.2662 + 2.2907 ln D	44	.99	1.01
	ln W = -2.2162 + 2.0782 ln D + 0.3019 ln CL	44	.99	
	Fresh weight in kg			
Stem wood	ln W = -2.5767 + 2.4875 ln D	44	.99	1.01
	ln W = -2.7171 + 2.6659 ln D - 0.3307 ln CW	44	.99	
Stem bark	ln W = -3.6164 + 2.1542 ln D	44	.98	1.02
	ln W = -3.7825 + 2.3653 ln D - 0.3913 ln CW	44	.98	
Stem	ln W = -2.2997 + 2.4363 ln D	44	.99	1.01
	ln W = -2.4453 + 2.6214 ln D - 0.3431 ln CW	44	.99	
Crown	ln W = -1.8580 + 2.0217 ln D	44	.94	1.05
	ln W = -1.4727 + 1.5321 ln D + 0.9076 ln CW	44	.95	
Total (a.g.)	ln W = -1.4195 + 2.2747 ln D	44	.99	1.01
	ln W = -1.3707 + 2.0668 ln D + 0.2952 ln CL	44	.99	

* a.g. = above-ground

Table 3. Tree biomass equations for black spruce (dbh 1.6-33.8 cm) in Cumberland County, Nova Scotia

Component	Equation	n	R^2	c
	Oven-dry weight in kg			
Stem wood	ln W = -3.2073 + 2.4743 ln D	49	.98	1.01
	ln W = -3.4209 + 1.6398 ln D + 1.0749 ln H	49	.99	
Stem bark	ln W = -4.3913 + 2.1815 ln D	49	.98	1.02
	ln W = -4.5578 + 1.5310 ln D + 0.8379 ln H	49	.98	
Stem	ln W = -2.9601 + 2.4321 ln D	49	.98	1.01
	ln W = -3.1668 + 1.6243 ln D + 1.0405 ln H	49	.99	
Branches	ln W = -2.7616 + 1.9421 ln D	49	.92	1.04
	ln W = -2.4825 + 3.0328 ln D - 1.4049 ln H	49	.94	
Foliage	ln W = -2.5387 + 1.7206 ln D	49	.91	1.05
	ln W = -2.3233 + 2.5626 ln D - 1.0846 ln H	49	.92	
Crown	ln W = -2.0000 + 1.8570 ln D	49	.92	1.04
	ln W = -1.7442 + 2.8565 ln D - 1.2874 ln H	49	.94	
Total (a.g.)*	ln W = -1.7823 + 2.1777 ln D	49	.99	1.02
	Fresh weight in kg			
Stem wood	ln W = -2.4185 + 2.4291 ln D	49	.99	1.01
	ln W = -2.5726 + 1.8267 ln D + 0.7760 ln H	49	.99	
Stem bark	ln W = -3.4711 + 2.1273 ln D	49	.98	1.01
	ln W = -3.6277 + 1.5153 ln D + 0.7882 ln H	49	.99	
Stem	ln W = -2.1389 + 2.3799 ln D	49	.99	1.01
	ln W = -2.2934 + 1.7759 ln D + 0.7780 ln H	49	.99	
Crown	ln W = -1.3256 + 1.8724 ln D	49	.92	1.04
	ln W = -1.0638 + 2.8954 ln D - 1.3177 ln H	49	.94	
Total (a.g.)	ln W = -1.0327 + 2.1529 ln D	49	.99	1.02
	ln W = -0.9120 + 1.9927 ln D + 0.2895 ln CW	49	.99	

* a.g. = above-ground

Table 4. Tree biomass equations for jack pine (dbh 2.5-33.9 cm) in Cumberland County, Nova Scotia

Component	Equation	n	R^2	c
	Oven-dry weight in kg			
Stem wood	ln W = -3.2143 + 2.5578 ln D	42	.97	1.01
	ln W = -3.7310 + 1.8810 ln D + 0.9564 ln H	42	.99	
Stem bark	ln W = -3.9655 + 1.9916 ln D	42	.98	1.01
	ln W = -4.1902 + 1.6973 ln D + 0.4159 ln H	42	.99	
Stem	ln W = -2.9216 + 2.4883 ln D	42	.98	1.01
	ln W = -3.3961 + 1.8668 ln D + 0.8782 ln H	42	.99	
Branches	ln W = -4.0101 + 2.2443 ln D	42	.82	1.06
	ln W = -3.3946 + 1.5981 ln D + 1.1826 ln CW	42	.95	
Foliage	ln W = -4.2862 + 2.0512 ln D	42	.87	1.08
	ln W = -3.5306 + 3.0408 ln D - 1.3985 ln H	42	.93	
Crown	ln W = -3.3964 + 2.1595 ln D	42	.83	1.06
	ln W = -2.8591 + 1.5954 ln D + 1.0324 ln CW	42	.95	
Total (a.g.)*	ln W = -2.2136 + 2.3291 ln D	42	.98	1.01
	ln W = -2.3637 + 2.1325 ln D + 0.2779 ln H	42	.99	
	Fresh weight in kg			
Stem wood	ln W = -2.3555 + 2.5189 ln D	42	.98	1.01
	ln W = -2.7772 + 1.9666 ln D + 0.7806 ln H	42	.99	
Stem bark	ln W = -3.1090 + 1.9640 ln D	42	.99	1.01
	ln W = -3.3044 + 1.7081 ln D + 0.3617 ln H	42	.99	
Stem	ln W = -2.0638 + 2.4504 ln D	42	.98	1.01
	ln W = -2.4509 + 1.9434 ln D + 0.7165 ln H	42	.99	
Crown	ln W = -2.6604 + 2.1903 ln D	42	.87	1.07
	ln W = -1.7948 + 3.3240 ln D - 1.6022 ln H	42	.94	
Total (a.g.)	ln W = -1.5163 + 2.3503 ln D	42	.99	1.01
	ln W = -1.6358 + 2.1937 ln D + 0.2213 ln H	42	.99	

* a.g. = above-ground

Table 5. Tree biomass equations for red pine (dbh 2.3-34.3 cm) in Cumberland County, Nova Scotia

Component	Equation	n	R^2	c
	Oven-dry weight in kg			
Stem wood	ln W = -3.1049 + 2.4418 ln D	47	.99	1.00
	ln W = -3.3227 + 1.7560 ln D + 0.8923 ln H	47	.99	
Stem bark	ln W = -4.1568 + 2.0701 ln D	47	.99	1.01
	ln W = -4.2362 + 1.8200 ln D + 0.3254 ln H	47	.99	
Stem	ln W = -2.8368 + 2.3892 ln D	47	.99	1.00
	ln W = -3.0334 + 1.7701 ln D + 0.8055 ln H	47	.99	
Branches	ln W = -4.8438 + 2.4631 ln D	47	.91	1.07
	ln W = -4.3926 + 3.8839 ln D - 1.8485 ln H	47	.95	
Foliage	ln W = -4.4257 + 2.1220 ln D	47	.93	1.04
	ln W = -4.0864 + 3.1906 ln D - 1.3904 ln H	47	.96	
Crown	ln W = -3.9952 + 2.3287 ln D	47	.92	1.05
	ln W = -3.5761 + 3.6484 ln D - 1.7169 ln H	47	.96	
Total (a.g.)*	ln W = -2.4684 + 2.3503 ln D	47	.99	1.01
	ln W = -2.5387 + 2.1289 ln D + 0.2881 ln H	47	.99	
	Fresh weight in kg			
Stem wood	ln W = -2.5649 + 2.5396 ln D	47	.99	1.00
	ln W = -2.7343 + 2.0060 ln D + 0.6941 ln H	47	.99	
Stem bark	ln W = -3.2380 + 1.9934 ln D	47	.99	1.01
	ln W = -3.2878 + 1.8365 ln D + 0.2041 ln H	47	.99	
Stem	ln W = -2.2351 + 2.4616 ln D	47	.99	1.00
	ln W = -2.3827 + 1.9969 ln D + 0.6046 ln H	47	.99	
Crown	ln W = -3.2406 + 2.3534 ln D	47	.92	1.05
	ln W = -2.8144 + 3.6954 ln D - 1.7460 ln H	47	.96	
Total (a.g.)	ln W = -1.8214 + 2.4071 ln D	47	.99	1.01
	ln W = -1.6215 + 2.1105 ln D + 0.4011 ln CL	47	.99	

* a.g. = above-ground

Table 6. Tree biomass equations for larch (dbh 2.0-30.7 cm) in Cumberland County, Nova Scotia

Component	Equation	n	R^2	c
	Oven-dry weight in kg			
Stem wood	ln W = -3.0695 + 2.5050 ln D	47	.98	1.01
	ln W = -3.5548 + 1.6512 ln D + 1.1292 ln H	47	.99	
Stem bark	ln W = -4.0854 + 2.0868 ln D	47	.99	1.01
	ln W = -4.3236 + 1.6678 ln D + 0.5542 ln H	47	.99	
Stem	ln W = -2.7985 + 2.4472 ln D	47	.98	1.01
	ln W = -3.2486 + 1.6550 ln D + 1.0476 ln H	47	.99	
Branches	ln W = -4.0294 + 2.1727 ln D	47	.80	1.06
	ln W = -2.9457 + 1.2193 ln D + 1.4934 ln CW	47	.92	
Foliage	ln W = -5.0986 + 1.9790 ln D	47	.77	1.11
	ln W = -4.0977 + 1.0985 ln D + 1.3793 ln CW	47	.88	
Crown	ln W = -3.7419 + 2.1363 ln D	47	.80	1.07
	ln W = -2.6712 + 1.1943 ln D + 1.4756 ln CW	47	.91	
Total (a.g.)*	ln W = -2.3583 + 2.3572 ln D	47	.99	1.01
	ln W = -2.6227 + 1.8919 ln D + 0.6154 ln H	47	.99	
	Fresh weight in kg			
Stem wood	ln W = -2.3517 + 2.4725 ln D	47	.99	1.01
	ln W = -2.7092 + 1.7931 ln D + 0.8832 ln H	47	.99	
Stem bark	ln W = -3.1533 + 2.0438 ln D	47	.99	1.01
	ln W = -3.3564 + 1.6864 ln D + 0.4727 ln H	47	.99	
Stem	ln W = -2.0018 + 2.3884 ln D	47	.99	1.01
	ln W = -2.3731 + 1.7350 ln D + 0.8641 ln H	47	.99	
Crown	ln W = -2.9710 + 2.1530 ln D	47	.80	1.07
	ln W = -1.9141 + 1.2232 ln D + 1.4566 ln CW	47	.92	
Total (a.g.)	ln W = -1.5787 + 2.3140 ln D	47	.99	1.01
	ln W = -1.7503 + 2.0120 ln D + 0.3993 ln H	47	.99	

* a.g. = above-ground

Table 7. Tree biomass equations for red maple (dbh 1.1-29.6 cm) in Cumberland County, Nova Scotia

Component	Equation	n	R^2	c
	Oven-dry weight in kg			
Stem wood	ln W = -2.5475 + 2.3795 ln D	49	.98	1.02
	ln W = -3.3397 + 1.9328 ln D + 0.7874 ln H	49	.99	
Stem bark	ln W = -3.8218 + 2.1419 ln D	50	.97	1.03
	ln W = -4.3998 + 1.8191 ln D + 0.5716 ln H	50	.98	
Stem	ln W = -2.3065 + 2.3418 ln D	49	.98	1.02
	ln W = -3.0664 + 1.9133 ln D + 0.7552 ln H	49	.99	
Branches	ln W = -4.0186 + 2.3506 ln D	49	.94	1.06
	ln W = -3.1242 + 2.8631 ln D - 0.8963 ln H	49	.95	
Foliage	ln W = -4.0486 + 1.6529 ln D	50	.92	1.04
	ln W = -3.5018 + 1.9583 ln D - 0.5407 ln H	50	.93	
Crown	ln W = -3.5382 + 2.2289 ln D	49	.94	1.05
	ln W = -2.6536 + 2.7358 ln D - 0.8864 ln H	49	.95	
Total (a.g.)*	ln W = -2.0274 + 2.3199 ln D	49	.99	1.01
	ln W = -2.4198 + 2.0986 ln D + 0.3900 ln H	49	.99	
	Fresh weight in kg			
Stem wood	ln W = -2.0060 + 2.3618 ln D	50	.98	1.01
	ln W = -2.8106 + 1.9124 ln D + 0.7956 ln H	50	.99	
Stem bark	ln W = -3.0324 + 2.0859 ln D	50	.98	1.02
	ln W = -3.6864 + 1.7207 ln D + 0.6466 ln H	50	.98	
Stem	ln W = -1.7167 + 2.3138 ln D	50	.98	1.01
	ln W = -2.4955 + 1.8788 ln D + 0.7701 ln H	50	.99	
Crown	ln W = -3.1075 + 2.3485 ln D	50	.94	1.06
	ln W = -2.2062 + 2.8520 ln D - 0.8913 ln H	50	.95	
Total (a.g.)	ln W = -1.4517 + 2.3137 ln D	50	.99	1.01
	ln W = -1.8244 + 2.1056 ln D + 0.3685 ln H	50	.99	

* a.g. = above-ground

Table 8. Tree biomass equations for white ~~spruce~~ birch (dbh 2.7–32.8 cm) in Cumberland County, Nova Scotia

Component	Equation	n	R^2	c
	Oven-dry weight in kg			
Stem wood	ln W = -2.7623 + 2.4931 ln D	45	.99	1.01
	ln W = -3.4647 + 2.0199 ln D + 0.7800 ln H	45	.99	
Stem bark	ln W = -3.9298 + 2.2795 ln D	45	.99	1.01
	ln W = -4.6249 + 1.7980 ln D + 0.7847 ln H	45	.99	
Stem	ln W = -2.5071 + 2.4594 ln D	45	.99	1.01
	ln W = -3.1958 + 1.9956 ln D + 0.7647 ln H	45	.99	
Branches	ln W = -4.4464 + 2.5073 ln D	45	.92	1.11
	ln W = -4.5527 + 2.1574 ln D + 0.6257 ln CL	45	.93	
Foliage	ln W = -4.2579 + 1.8735 ln D	45	.91	1.06
	ln W = -4.3523 + 1.5626 ln D + 0.5559 ln CL	45	.92	
Crown	ln W = -3.8769 + 2.3756 ln D	45	.92	1.09
	ln W = -3.9800 + 2.0363 ln D + 0.6069 ln CL	45	.93	
Total (a.g.)*	ln W = -2.2308 + 2.4313 ln D	45	.99	1.01
	ln W = -2.5938 + 2.1868 ln D + 0.4031 ln H	45	.99	
	Fresh weight in kg			
Stem wood	ln W = -2.2553 + 2.5055 ln D	45	.99	1.01
	In W = -3.0579 + 1.9649 ln D + 0.8913 ln H	45	.99	
Stem bark	ln W = -3.3263 + 2.2487 ln D	45	.99	1.01
	ln W = -3.9916 + 1.8006 ln D + 0.7388 ln H	45	.99	
Stem	ln W = -1.9827 + 2.4643 ln D	45	.99	1.01
	ln W = -2.7524 + 1.9459 ln D + 0.8547 ln H	45	.99	
Crown	ln W = -3.1785 + 2.3732 ln D	45	.92	1.09
	ln W = -3.2870 + 2.0159 ln D + 0.6389 ln CL	45	.93	
Total (a.g.)	ln W = -1.6631 + 2.4312 ln D	45	.99	1.01
	ln W = -2.0752 + 2.1536 ln D + 0.4577 ln H	45	.99	

* a.g. = above-ground

Table 9. Tree biomass equations for aspen (dbh 1.8-33.3 cm) in Cumberland County, Nova Scotia

Component	Equation	n	R^2	c
	Oven-dry weight in kg			
Stem wood	ln W = -3.1729 + 2.5325 ln D	46	.99	1.01
	ln W = -3.3596 + 2.3670 ln D + 0.2548 ln H	46	.99	
Stem bark	ln W = -4.2765 + 2.4007 ln D	46	.98	1.03
Stem	ln W = -2.8857 + 2.5046 ln D	46	.99	1.01
	ln W = -3.0560 + 2.3536 ln D + 0.2326 ln H	46	.99	
Branches	ln W = -4.9158 + 2.5995 ln D	46	.95	1.09
	ln W = -3.8543 + 1.6577 ln D + 1.3098 ln CW	46	.96	
Foliage	ln W = -4.6192 + 1.8405 ln D	46	.93	1.06
	ln W = -3.9835 + 1.2765 ln D + 0.7843 ln CW	46	.94	
Crown	ln W = -4.3605 + 2.4629 ln D	46	.94	1.09
	ln W = -3.3473 + 1.5640 ln D + 1.2501 ln CW	46	.96	
Total (a.g.)*	ln W = -2.6224 + 2.4827 ln D	46	.99	1.01
	Fresh weight in kg			
Stem wood	ln W = -2.5698 + 2.5356 ln D	46	.99	1.01
	ln W = -2.7256 + 2.3975 ln D + 0.2127 ln H	46	.99	
Stem bark	ln W = -3.3511 + 2.2991 ln D	46	.99	1.02
Stem	ln W = -2.2109 + 2.4842 ln D	46	.99	1.01
	ln W = -2.3528 + 2.3584 ln D + 0.1937 ln H	46	.99	
Crown	ln W = -3.4997 + 2.4358 ln D	46	.95	1.08
	ln W = -2.4361 + 1.4921 ln D + 1.3124 ln CW	46	.96	
Total (a.g.)	ln W = -1.9234 + 2.4646 ln D	46	.99	1.01

* a.g. = above-ground

Table 10. Tree biomass equations for grey birch (dbh 1.1-22.7 cm) in Cumberland County, Nova Scotia

Component	Equation	n	R^2	c
	Oven-dry weight in kg			
Stem wood	$\ln W = -2.7033 + 2.4240 \ln D$	44	.99	1.01
	$\ln W = -3.1622 + 1.8529 \ln D + 0.8065 \ln H$	44	.99	
Stem bark	$\ln W = -3.9876 + 2.2080 \ln D$	44	.97	1.03
	$\ln W = -4.4519 + 1.6302 \ln D + 0.8160 \ln H$	44	.98	
Stem	$\ln W = -2.4604 + 2.3875 \ln D$	44	.99	1.01
	$\ln W = -2.9151 + 1.8216 \ln D + 0.7991 \ln H$	44	.99	
Branches	$\ln W = -3.9519 + 2.1922 \ln D$	44	.91	1.09
	$\ln W = -3.3001 + 1.6320 \ln D + 0.8501 \ln CW$	44	.93	
Foliage	$\ln W = -4.3471 + 1.7477 \ln D$	44	.90	1.06
	$\ln W = -3.7831 + 2.4496 \ln D - 0.9912 \ln H$	44	.92	
Crown	$\ln W = -3.5002 + 2.0938 \ln D$	44	.90	1.09
	$\ln W = -2.8690 + 2.8793 \ln D - 1.1093 \ln H$	44	.92	
Total (a.g.)*	$\ln W = -2.1053 + 2.3123 \ln D$	44	.99	1.01
	$\ln W = -2.3174 + 2.0483 \ln D + 0.3728 \ln H$	44	.99	
	Fresh weight in kg			
Stem wood	$\ln W = -2.2647 + 2.4779 \ln D$	44	.99	1.02
	$\ln W = -2.6670 + 1.9772 \ln D + 0.7071 \ln H$	44	.99	
Stem bark	$\ln W = -3.3947 + 2.1687 \ln D$	44	.97	1.03
	$\ln W = -3.8046 + 1.6586 \ln D + 0.7203 \ln H$	44	.97	
Stem	$\ln W = -1.9946 + 2.4264 \ln D$	44	.99	1.02
	$\ln W = -2.3878 + 1.9371 \ln D + 0.6910 \ln H$	44	.99	
Crown	$\ln W = -3.0851 + 2.2171 \ln D$	44	.92	1.09
	$\ln W = -2.4584 + 2.9971 \ln D - 1.1015 \ln H$	44	.93	
Total (a.g.)	$\ln W = -1.6290 + 2.3574 \ln D$	44	.99	1.01
	$\ln W = -1.6108 + 2.2929 \ln D + 0.1030 \ln CL$	44	.99	

* a.g. = above-ground

Table 11. Mean values of stem biomass and related variables for 10 species in Cumberland County, Nova Scotia

Variable	Species									
	Balsam Fir	White Spruce	Black Spruce	Jack Pine	Red Pine	Larch	Red Maple	White Birch	Aspen	Grey Birch
No. of trees	50	44	49	42	47	47	50	45	46	44
Dbh (cm)	15.2	16.6	16.2	16.4	17.7	15.1	15.1	16.4	16.8	10.1
Height (m)	10.0	9.7	10.3	12.2	11.3	11.8	12.5	13.0	12.7	8.8
Total volume (m^3)	0.154	0.168	0.169	0.178	0.207	0.136	0.140	0.187	0.195	0.053
Fresh stem wood(kg)	109.3	131.1	122.5	151.4	168.6	116.9	116.9	175.8	145.9	50.3
Oven-dry stem wood(kg)	50.6	60.6	65.5	72.4	71.4	64.2	72.3	101.7	79.0	27.7
Moisture content(%) (stem wood)	116	116	87	109	136	82	62	73	85	82
Fresh stem bark(kg)	18.1	16.5	17.0	13.1	15.4	14.6	18.3	26.6	31.7	7.4
Oven-dry stem bark(kg)	8.9	6.8	8.1	6.1	7.8	6.6	10.0	16.1	17.3	4.5
Moisture content(%) (stem bark)	104	143	109	115	97	122	83	65	83	65
Fresh bole(kg)	127.4	147.7	139.5	164.5	184.0	131.5	135.2	202.4	177.7	57.7
Oven-dry bole(kg)	59.4	67.4	73.6	78.5	79.2	70.7	82.4	117.8	96.3	32.2
Moisture content(%) (bole)	114	119	90	110	132	86	64	72	84	79

Table 12. Equations for estimating the ratio of oven-dry weight of wood plus bark to total fresh weight for small (d <3 cm) softwood branches

Species	n	R^2	Equation or mean ratio
Balsam fir	50	.42	$RWB = 0.1727 - 0.03939\ D + 0.05925\ H - 0.06106\ CL - 4.949 \times 10^{-6}\ TFW \cdot D^2 + 0.2449\ CR^2 + 0.02950\ CW^2 - 0.003270\ CW^2\ CL + 0.002231\ D^2 \cdot CR$
White spruce	46	.42	$RWB = 0.1082 - 0.004427\ TFW + 0.04003\ D - 0.01509\ H + 0.01998\ CL - 0.001069\ D^2 + 8.875 \times 10^{-6}\ TFW \cdot D^2 - 9.384 \times 10^{-4} CW^2 \cdot CL - 2.452 \times 10^{-4}\ D^2 \cdot CR$
Black spruce	51	NS	$RWB = 0.268$
Jack pine	42	.91	$RWB = - 0.09548 + 0.04977\ H + 2.008 \times 10^{-4}\ TFW^2 + 0.4733\ CR^2 + 0.01810\ CW^2 - 0.001759\ CW^2 \cdot CL - 0.001880\ H^2 - 0.02133\ TFW \cdot Cr$
Red pine	47	.32	$RWB = 0.2230 - 0.06737\ D + 0.07102\ H + 0.002102\ D^2 - 1.978 \times 10^{-5}\ TWF \cdot D^2 + 0.02825\ CW^2 - 0.004976\ CW^2 \cdot CL - 0.002599\ H^2 + 0.02424\ TFW \cdot CR$
Larch	47	NS	$RWB = 0.349$

RWB = estimated ratio of oven-dry weight of wood and bark to fresh branch weight.
D = tree diameter (cm).
H = tree height (m).
CL = crown length (m).
TFW = total fresh weight of small branch stratum (kg).
CR = crown ratio (CL/H).
CW = crown width (m).
NS = non-significant.

Table 13. Equations for estimating the ratio of oven-dry weight of foliage to total fresh weight for small (d <3 cm) softwood branches

Species	n	R^2	Equation or mean ratio
Balsam fir	48	NS	RF = 0.190
White spruce	44	NS	RF = 0.195
Black spruce	51	NS	RF = 0.226
Jack pine	39	NS	RF = 0.151
Red pine	45	.40	RF = 0.5037 + 0.02424 D - 0.06677 H + 0.04601 CL - 0.4514 CR - 0.01621 CW^2 + 0.002752 CW^2 CL + 0.001520 H^2 - 0.001337 D^2• CR
Larch	44	.34	RF = 0.1547 + 0.008846 TFW - 0.3884 CR + 0.3975 CR^2 - 0.01275 TFW• CR

RF = estimated ratio of oven-dry weight of foliage to fresh branch weight.
D = tree diameter (cm).
H = tree height (m).
CL = crown length (m).
TFW = total fresh weight of small branch stratum (kg).
CR = crown ratio (CL/H).
CW = crown width (m).
NS = non-significant.

Table 14. Mean ratios of oven-dry weight of wood and bark to total fresh weight (RWB) and oven-dry weight of foliage to total fresh weight (RF), based on samples from the small (d <3) branch stratum

Species	n	RWB	n	RF	Moisture content (%)[1]
Balsam fir	50	0.270	48	0.190	117
White spruce	46	0.258	44	0.195	121
Black spruce	51	0.268	51	0.226	102
Jack pine	42	0.298	39	0.151	123
Red pine	47	0.248	45	0.199	124
Larch	47	0.349	44	0.085	130

[1]Derived from the formula MC (%) = 100 $[(RWB + RF)^{-1} - 1]$.

Table 15. Equations for predicting oven-dry weight of wood and bark for large (d $\geq$3) softwood branches

Species	n	R^2	Equation
Balsam fir	32	.90	$WB = -0.4084 + 0.3567\ d - 0.06275\ FW \cdot d + 0.08903\ FW^2$
White spruce	51	.75	$WB = -4.6798 + 3.6533\ d - 0.8229\ FW - 0.4159\ d^2 + 0.1219\ FW^2 - 0.1675\ d^2\ FW^{-1}$
Black spruce	43	.92	$WB = -1.3686 + 0.9223\ d - 0.1415\ d^2 + 0.08685\ FW \cdot d$
Jack pine	38	.88	$WB = -0.1456 + 0.4150\ FW$
Red pine	49	.97	$WB = 2.3396 - 1.2337\ d + 0.1926\ d^2 + 0.04465\ FW \cdot d - 0.0004532\ (FW \cdot d)^2$
Larch	46	.88	$WB = 0.07554 + 0.03446\ d^2 + 0.09427\ FW^2 - 0.001859\ (FW \cdot d)^2$

WB = oven-dry weight (kg) of wood and bark per branch.
d = branch diameter (cm), measured 3 cm from base.
FW = fresh weight of branch (kg).

Table 16. Equations for predicting oven-dry weight of foliage for large (d $\geq$3) softwood branches

Species	n	R^2	Equation
Balsam fir	32	.37	$F = 0.2208 - 0.04256\ d^2 + 0.09938\ FW \cdot d - 0.05343\ FW^2$
White spruce	51	.72	$F = 2.1859 - 1.3772\ d + 0.2196\ d^2 + 0.09499\ FW^2 - 0.004795\ (FW \cdot d)^2$
Black spruce	43	.67	$F = 0.2656 - 0.1507\ d + 0.2562\ FW - 0.01146\ FW^2$
Jack pine	36	.57	$F = 0.2090 + 0.0002947\ (FW \cdot d)^2$
Red pine	51	.82	$F = -0.4377 + 0.6002\ d - 0.09734\ d^2 + 0.02777\ FW \cdot d - 0.07333\ d^2\ FW^{-1}$
Larch	46	.46	$F = -0.1538 + 0.3391\ FW - 0.04171\ FW \cdot d - 0.04889\ FW^2 + 0.001524\ (FW \cdot d)^2$

F = oven-dry weight (kg) of foliage per branch.
d = branch diameter (cm), measured 3 cm from base.
FW = fresh weight of branch (kg).

Table 17. Mean diameters and weights of large (d ≥3) softwood branches.

Species	n	Diameter (cm)	Fresh weight (kg)	Wood and Bark		Foliage		Total		Moisture content (%)
				ODW	% Fresh	ODW	% Fresh	ODW	% Fresh	
Balsam fir	32	3.38	2.22	0.81	36	0.19	9	1.00	45	122
White spruce	51	3.47	2.49	0.85	34	0.29	12	1.14	46	118
Black spruce	43	3.90	3.66	1.34	37	0.42	11	1.76	48	108
Jack pine	38	4.09	3.70	1.39	38	0.31	8	1.70	46	118
Red pine	49	4.01	3.87	1.15	30	0.45	12	1.60	41	142
Larch	46	3.83	2.75	1.12	41	0.13	5	1.25	45	120

ODW = mean oven-dry weight (kg).
% Fresh = mean oven-dry weight as a percentage of mean fresh weight.

Table 18. Mean crown weights and crown moisture content for 10 species in Cumberland County, N.S.

Characteristic	Species									
	Balsam Fir	White Spruce	Black Spruce	Jack Pine	Red Pine	Larch	Red Maple	White Birch	Aspen	Grey Birch
No. of trees	50	44	49	42	47	47	49	45	46	44
ODW branches (kg)	12.7	17.5	20.5	17.2	17.4	10.9	16.4	22.8	21.3	5.7
Percent of fresh crown	28	28	31	34	29	37	44	44	43	42
ODW foliage (kg)	7.3	10.2	11.7	6.2	8.0	2.0	1.8	3.5	2.3	1.0
Percent of fresh crown	16	16	18	12	14	7	5	7	5	7
ODW crown (kg)	20.0	27.7	32.2	23.4	25.4	13.0	18.2	26.3	23.5	6.7
Fresh crown weight (kg)	46.0	63.5	66.5	50.9	59.1	29.2	37.5	52.0	50.0	13.7
Crown moisture content (%)	130	129	107	117	133	125	105	98	113	104

ODW = oven-dry weight.

Table 19. Mean values of total above-ground biomass for 10 species in Cumberland County, N.S.

Characteristic	Species									
	Balsam Fir	White Spruce	Black Spruce	Jack Pine	Red Pine	Larch	Red Maple	White Birch	Aspen	Grey Birch
ODW total above-ground (kg)	79.4	95.0	105.7	101.9	104.5	83.7	100.6	144.1	119.9	38.9
Fresh total above-ground (kg)	173.4	211.1	205.9	215.3	243.1	160.7	172.7	254.4	227.7	71.4
Oven-dry weight: fresh weight	0.46	0.45	0.51	0.47	0.43	0.52	0.58	0.57	0.53	0.54
Moisture content total above-ground, (%)	118	122	95	111	133	92	72	76	90	84

ODW = Oven-dry weight.

Table 20. Mean oven-dry component weights for softwood and hardwood groups based on 279 softwood and 181 hardwood trees

Component	Hardwoods		Softwoods	
	Mean ODW (kg)	Percent of total above-ground	Mean ODW (kg)	Percent of total above-ground
Stem wood	70.4	70	63.8	67
Stem bark	12.0	12	7.4	8
Stem	82.4	81	71.2	75
Branches (wood and bark)	16.7	17	16.0	17
Foliage	2.1	2	7.6	8
Crown	18.8	19	23.6	25
Total above-ground	101.2	100	94.8	100

ODW = Oven-dry weight.