United States
Department of
Agriculture

Forest Service

Northeastern Forest Experiment Station

General Technical Report NE-69

1982

Biomass Equations for Major Tree Species of the Northeast

Louise M. Tritton
James W. Hornbeck

The Authors

Louise M. Tritton is a Research Associate with the Connecticut Arboretum at Connecticut College, New London, CT.

James W. Hornbeck is a Forest Hydrologist, USDA Forest Service, Northeastern Forest Experiment Station, Durham, NH.

Manuscript received for publication 26 March 1981

Abstract

Regression equations are used in both forestry and ecosystem studies to estimate tree biomass from field measurements of dbh (diameter at breast height) or a combination of dbh and height. Literature on biomass is reviewed, and 178 sets of published equations for 25 species common to the northeastern United States are listed. On the basis of these equations, estimates of aboveground oven-dry weight of trees from 2.5 to 50.0 cm dbh for each species are presented and discussed. When general estimates of standing crop are required for commercial purposes or for assessment of nutrient removal by tree harvest, the published equations may be used with precaution instead of developing new equations. When statistical comparisons of productivity or the ecology of site types are required, published equations probably are not suitable and development of site-specific equations is recommended.

Contents

NOTE: Pages 17 & 20 were transposed during printing.

Introduction

Estimating tree biomass (weight) based on parameters that are easily measured in the field is becoming a fundamental task in forestry. Traditionally, cubic-foot or board-foot volume of merchantable products, such as sawlogs or pulpwood, adequately described forest stands. However, the intensity of forest utilization has increased in recent years because of whole-tree harvesting and the use of wood for energy. Branches, leaves, bark, small trees, and trees of poor form or vigor are now commonly included in the harvested product. Thus, biomass of either the whole tree or individual components is a useful stand parameter.

Numerous equations predicting tree biomass from dbh (diameter at breast height – 1.37 m) or dbh and height have been published during the past 20 years. This paper summarizes the equations for tree species common to the northeastern United States. The objectives are to:

- Present a general bibliography on biomass estimation
- Show the equations for each species in tabular form so that predicted biomass values may be compared
- Discuss applicability of the equations
- Demonstrate application of the equations by presenting estimates of stand biomass published by other authors

Methodology

Regression equations are used to estimate tree biomass in both forestry and ecosystem studies. These equations are typically developed in the following way: samples of major tree species are chosen for study, selected dimensions of each tree are recorded, the tree is felled and weighed either whole or in pieces, and subsamples are oven-dried and weighed again to determine tree moisture content. (Tree green weights are converted to dry weights by using moisture content values.) Because biomass is related to tree dimensions, regression analysis is used to estimate the constants or regression coefficients required for the actual calculation of biomass. The resultant regression equations may be used to estimate the biomass, by species, of all trees for which dimensional data are available.

We imposed certain constraints on our review of biomass regression equations. First, we included only those references that applied to the tree species of the northeast (Table

Table 1.—Nomenclature and number of sets of equations predicting above-ground biomass for tree species reviewed.

Species name[a]	Common name	Number of equation sets
Abies balsamea (L.) Mill.	Balsam fir	6
Acer rubrum L.	Red maple	21
A. saccharum Marsh.	Sugar maple	10
Betula alleghaniensis *Britt.*[b]	Yellow birch	7
B. lenta L.	Black birch	1
B. papyrifera Marsh.	Paper birch	12
B. populifolia Marsh.	Gray birch	4
Carya spp.	Hickory	8
Fagus grandifolia Ehrh.	Beech	6
Fraxinus americana L.	White ash	4
Liriodendron tulipifera L.	Yellow poplar	8
Picea spp.	Spruce	11
Pinus resinosa Ait.	Red pine	5
P. strobus L.	White pine	7
Populus spp.	Aspen	11
Prunus pensylvanica L.	Pin cherry	3
P. serotina Ehrh.	Black cherry	4
Quercus alba L.	White oak	11
Q. coccinea Muench.	Scarlet oak	4
Q. prinus L.	Chestnut oak	5
Q. rubra H.	Northern red oak	12
Q. velutina Lam.	Black oak	5
Tsuga canadensis (L.) Carr.	Hemlock	5
	General Hardwoods	7
	General Softwoods	2

[a] From Fernald (1950).
[b] From Britton and Brown (1970).

1). Other workers have reviewed biomass literature pertaining to different geographic regions (Art and Marks 1971, Hitchcock and McDonnell 1979, Keays 1971, Parde 1980, Stanek and State 1978, Young 1976). Because some species have broad natural ranges, we arbitrarily selected studies confined to the geographic region that included Georgia as the southern boundary, Minnesota as the western boundary, and New Brunswick, Canada, as the northern boundary. Second, only equations that predicted biomass based on measurements of dbh or a combination of dbh and height were included. Equations that use height alone (Young and Carpenter 1967), stand basal area (Frederick et al. 1979), or volume (Whittaker et al. 1974) as the independent variable were excluded. Although not considered in this review, regression equations for biomass of shrub species based on diameter at or near the ground have been developed by Edwards (1976), Grigal and Ohmann (1977), Ohmann and others (1976), Roussopoulos and Loomis (1980), Telfer (1969), and Whittaker and Woodwell (1968).

Third, oven-dry weight was chosen as the dependent variable because it is a replicable, constant base for comparison within and among species. Green weight is used in some studies (Craft 1976, Craft and Baumgras 1978, Craft and Baumgras 1979, Steinhilb and Erickson 1972, Steinhilb and Winsauer 1976), but because it can vary with environmental moisture conditions before cutting, we did not include equations for green weight in our review. Fourth, only those equations that predicted biomass of the whole tree (aboveground) or the major components of the whole tree were used. Not all of the published analyses included leaves but because leaves are a small proportion of total tree weight they should not account for major differences between biomass estimates. Equations that predicted complete tree weight (aboveground and belowground) (Young et al. 1980), top weights (Cassens and Fischer 1980, Wartluft 1978), or other tree components (Timson 1972) were not used. Fifth, each of the publications included had to specify the form of each biomass equation and list the appropriate coefficients.

We have not attempted to evaluate the accuracy of the statistical techniques used to develop the equations included in this review. Statistical and sampling problems related to studies of tree biomass are discussed in detail by Attiwill and Ovington (1968), Baskerville (1965b, 1972), Beauchamp and Olson (1973), Cunia (1979a, 1979b), Kozak (1970), Madgwick (1970), Madgwick and Satoo (1975), Swank and Schreuder (1974), Wiant (1979), Wiant and Harner (1979), and in the literature on volume tables (Furnival 1961).

With these limits in mind, major forestry, ecology and wood products journals, proceedings, notes, research reports, theses, and abstracts from the last 20 years were searched for biomass studies. In addition, a computer search was made by the National Agricultural Library (NAL). Next, tables were prepared for 25 tree species of the northeast listing the location of the study, reference, tree components measured, equations, number of samples (n), units of measure used by the author, and range of independent variables (dbh or both dbh and total height) (Appendix A). We then used the equations to calculate biomass estimates within the range of values for the independent variable specified by the author (Appendix B). To compare estimates from different equations, we arbitrarily selected dbh and height classes and converted all estimates to kilograms. Slight differences between our values and those given in the original reference may be attributed to rounding errors. Finally, we compiled a listing of biomass values for forest stands of different ages and vegetation types (Appendix C).

Results and Discussion

Equations of several different forms were used to predict biomass (y) from dbh or dbh and height (x). The most common forms were allometric ($y = ax^b$), exponential ($y = ae^{bx}$), and quadratic ($y = a + bx + cx^2$). Several authors compare the accuracy and suitability of these forms and the logarithmic transformations of them (Baskerville 1972, Beauchamp and Olson 1973, Goldsmith and Hocker 1978).

When viewed together, the equations provide a range of biomass values for a given diameter (Appendix B). Red maple with its wide geographic and ecological distribution illustrates the range of biomass values obtainable. Each of the curves shown in Figures 1a and 1b was fitted to selected biomass values for a particular red maple equation, and plotted over the extrapolated as well as actual range of dbh values for which the equation was developed. The majority of curves are close to one another, reflecting both the genetic constraints on red maple, wherever it grows, and the mathematical manipulation of the data, because regression analysis smoothes the relationship between weight and dbh for the trees measured in a particular stand. Outliers also occur (Reynolds et al. 1978, MacLean and Wein 1976), most likely due to environmental factors. These outliers are excluded in Table 2 which shows the means and ranges of the biomass values in each diameter class for three species. For a 15 cm dbh red maple, the mean of all predicted values is 72 kg, and the range is from 57 to 95 kg. For a 40 cm dbh tree, the mean is 750 kg and the range is from 574 to 969 kg. The relative variation between predicted biomass values for small trees is about the same as that for large trees.

Variation among biomass values predicted by different equations is not explained by differences

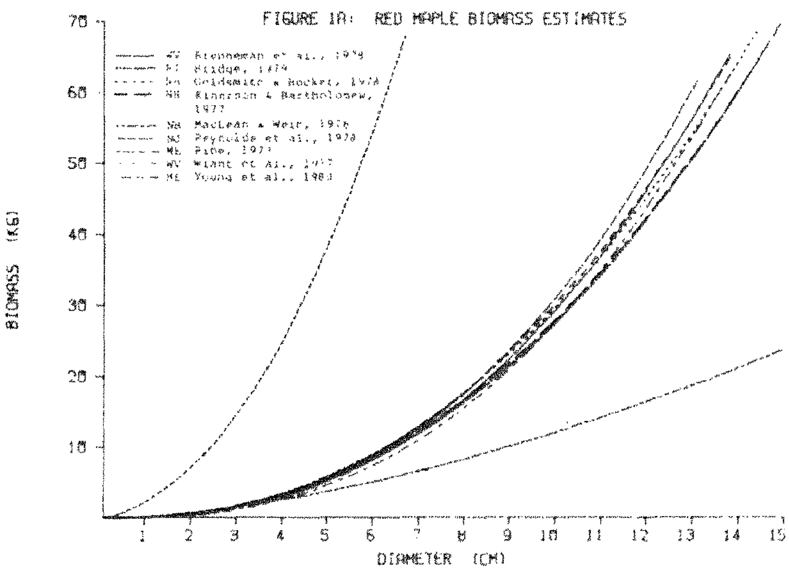

Figure 1a.—Curves fitted to biomass values obtained by using regression equations from different authors for 2.5- to 15.0-cm dbh red maple trees.

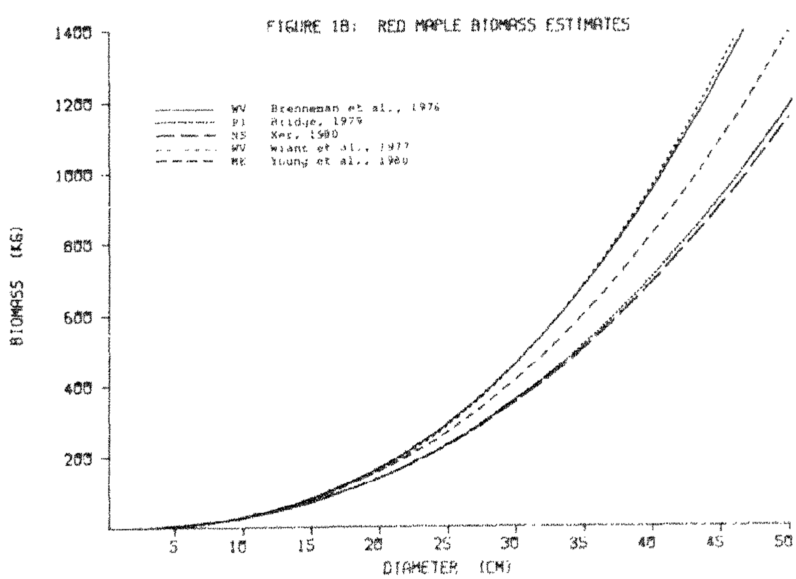

Figure 1b.—Curves fitted to biomass values obtained by using regression equations from different authors for 2.5- to 50.0-cm dbh red maple trees.

Table 2.—Mean and range of biomass estimates for selected dbh values.

Dbh (cm)	n	Mean	Range
Acer rubrum			
		- - - - - -*kg*- - - - - - -	
2.5	12	1.1	0.8- 1.4
5.0	16	5.0	3.2- 6.6
10.0	15	27.3	19.1- 30.6
15.0	12	72	57 - 95
25.0	11	244	188 - 313
40.0	8	750	574 - 969
50.0	4	1262	773 -1726
Quercus rubra			
2.5	6	1.6	0.2- 2.7
5.0	10	6.2	4.0- 8.9
10.0	9	32.9	28.6- 35.7
15.0	7	87	55 - 105
25.0	7	319	230 - 364
40.0	7	1034	831 -1182
50.0	5	1829	1641 -2086
General Hardwoods			
2.5	6	1.1	1.0- 1.2
5.0	6	5.6	5.1- 6.3
10.0	7	32.3	27.6- 37.5
15.0	6	90	81 - 103
25.0	5	312	270 - 326
40.0	4	968	822 -1097
50.0	4	1683	1394 -1933

in study site locations. Two separate sets of equations developed in West Virginia (Brenneman et al. 1978, Wiant et al. 1977) predict similar biomass values (Figure 1a), and values developed for New Hampshire (Goldsmith and Hocker 1978) are nearly identical to those developed for West Virginia (Brenneman et al. 1978 , Wiant et al. 1977). However, predictions made from equations developed in Maine (Ribe 1973, Young et al. 1964) differ by 66 percent for a 15-cm dbh tree. Thus, equations from studies done at similar latitudes or in the same forest type may or may not produce similar biomass estimates.

Height sometimes is used, together with dbh, as the independent variable in biomass predictions.

However, the advantages (for example, correlation with site type) of using height in the regression equations have been questioned due to the difficulties and time involved in making accurate height measurements in the field. The curves in Figures 1a and 1b suggest that biomass values obtained using height with dbh (Monteith 1979, Wiant et al. 1979, Young et al. 1964) may not be different from those obtained using dbh alone (Brenneman et al. 1978, Goldsmith and Hocker 1978, Wiant et al. 1977). Wiant and others (1979) found that inclusion of height does not necessarily improve the accuracy of biomass predictions. At present, not enough information is available to evaluate fully the usefulness of height as an independent variable.

Some attempts have been made to develop single biomass equations that fit several species (see General Hardwoods and General Softwoods in Appendixes A and B). Wiant (1979) found statistically significant differences between general and species-specific equations for oaks and concluded that species-specific equations are preferable. However, the ranges of predicted values for the few general hardwood equations available in our study were close to those for red maple and red oak (Table 2). This close range suggests that general hardwood equations could be used to provide a first approximation of stand biomass.

Estimates of stand biomass have been generated as part of several forestry and ecosystem studies. We have summarized these values (Appendix C) for stands with various geographic locations, ages, site types, and basal areas or densities. However, not enough information is available to determine if these values may be accurately applied to new study sites.

Conclusions and Recommendations

We conclude that the equations already developed for the species listed in Table 1 give similar estimates of tree biomass. In instances where expense and lack of time prohibit development of new equations, the published equations may be used to give general biomass estimates. Possible applications include estimation of standing crop, chip weight, or nutrient removal that results from tree harvest.

Several precautions should be emphasized concerning the use of published equations. First, the equations of more than one author should be used to make several estimates of the range of biomass values obtainable. Second, the user should carefully check the assumptions, procedures and site characteristics (species mix, soil type, stand age, and stand history) stated in the references used. Third, little can be said about how closely the actual and estimated values will compare for a given site.

In instances where statistical comparisons of the productivity or the ecology of site types are required, the published equations probably are not suitable and development of site-specific equations may be necessary. In such instances, we recommend that future work on biomass estimation include the following information. First, the bases for selection of sample trees in the field should be carefully considered and specified in the publication. The trees that represent increased utilization potential of forests are often those which are of poor form, diseased, or dead. Past efforts to develop biomass equations often have omitted these trees. Second, the site, forest type, soil type, land-use history (fire, agricultural usage, or silvicultural treatment), and age should be carefully described. Third, some attempt should be made to use rigorous statistical procedures, including publication of the mean square error of regression and the variance/covariance matrix of the coefficients, to facilitate comparison with other equations. Also, we recommend standardization of methods among biomass studies (Clark 1979, Cunia 1979b, Ware 1979).

Acknowledgments

This research was carried out by the Northeastern Forest Experiment Station, and was supported in part by the Biomass Energy Systems Division of the U.S. Department of Energy through the interagency agreement from Oak Ridge National Laboratory under contract W-7405-eng-26 with Union Carbide Corporation. We would like to thank the following people for their comments: B. Brenneman, A. Clark III, G. Furnival, and T. Siccama.

Literature Cited

Alban, O. H.; Perala, D. A.; Schlaegel, B. E. **Biomass and nutrient distribution in aspen, pine and spruce stands on the same soil type in Minnesota.** Can. J. For. Res. 8:290–299; 1978.

Art, H. W.; Marks, P. L. **A summary table of biomass and net annual primary production in forest ecosystems of the world.** *In:* IUFRO Biomass Studies. Orono, ME: Univ. of Maine, Life Sci. and Agric. Exp. Stn.; 1971. p. 3–32.

Attiwill, P. M.; Ovington, J. D. **Determination of forest biomass.** For. Sci. 14(1):13–15; 1968.

Baskerville, G. L. **Dry-matter production in immature balsam fir stands.** For. Sci. Monogr. 9:142; 1965a.

Baskerville, G. L. **Estimation of dry weight of tree components and total standing crop in conifer stands.** Ecology 46(6):867–869; 1965b.

Baskerville, G. L. **Use of logarithmic regression in the estimation of plant biomass.** Can. J. For. 2:49–53; 1972.

Beauchamp, J. J.; Olson, J. S. **Corrections for bias in regression estimates after logarithmic transformation.** Ecology 54(6): 1403–1407; 1973.

Berry, A. B. **Production of dry matter from aspen stands harvested on short rotations.** Young, H. E., ed. *In*: IUFRO Biomass Studies: Nancy, France, and Vancouver, B.C., Canada. Orono, ME: Univ. of Maine, Coll. Life Sci. and Agric.; 1973. p. 207–218.

Bickelhaupt, D. H.; Leaf, A. L.; Richards, N. A. **Effect of branching habit on aboveground dry weight estimates of *Acer saccharum* stands.** Young, H. E. ed. *In*: IUFRO Biomass Studies: Nancy, France, and Vancouver, B.C., Canada. Orono, ME: Univ. of Maine, Coll. Life Sci. and Agric.; 1973. p. 219–230.

Bray, J. R.; Dudkiewicz, D. A. **The composition, biomass and productivity of two *Populus* forests.** Bull. Torrey Bot. Club 90: 298–308; 1963.

Brenneman, B. B.; Frederick, D. J.; Gardner, W. E.; Schoenhofen, L. H.; Marsh, P. L. **Biomass of species and stands of West Virginia hardwoods.** Pope, P. E., ed. Proceedings Central Hardwood Forest Conference II. West LaFayette, IN: Purdue Univ.; 1978. p. 159–178.

Bridge, J. A. **Fuelwood production of mixed hardwoods on mesic sites in Rhode Island.** Kingston, RI: Univ. of Rhode Island; 1979. M.S. Thesis. 72 p.

Britton, N.; Brown, A. **An illustrated flora of the northern United States and Canada.** Vols. I–III. New York, NY: Dover Publications, Inc.; 1970.

Cassens, D. L.; Fischer, B. C. **Top weights for oak sawtimber.** West Lafayette, IN: Purdue Univ.; 1980; Coop. Ext. Serv. Bull. No. 162. p. 10–12.

Clark, A. III. **Suggested procedures for measuring tree biomass and reporting tree prediction equations.** Frayer, W. E., ed. Forest Resources Inventories Vol. II. Fort Collins, CO: Colorado State Univ.; 1979. p. 615–628.

Clark, A., III; Phillips, D. R.; Hitchcock, H. C. **Predicted weights and volumes of scarlet oak trees on the Tennessee Cumberland plateau.** 1980a; USDA For. Serv. Res. Pap. SE-214. 23 p.

Clark, A., III; Phillips, D. R.; Schroeder, J. G. **Predicted weights and volumes of northern red oak trees in western North Carolina.** 1980b; USDA For. Serv. Res. Pap. SE-209. 22 p.

Clark, A. III; Schroeder, J. G. **Biomass of yellow poplar in natural stands in western North Carolina.** 1977; USDA For. Serv. Res. Pap. SE-165. 41 p.

Craft, E. P. **Utilizing hardwood logging residue: a case study in the Appalachians.** 1976; USDA For. Serv. Res. Note NE-230. 7 p.

Craft, E. P.; Baumgras, J. E. **Products derived from thinning two hardwood timber stands in the Appalachians.** 1978; USDA For. Serv. Res. Pap. NE-422. 8 p.

Craft, E. P.; Baumgras, J. E. **Weight and volume yields from thinning two oak-hickory stands.** 1979; USDA For. Serv. Res. Pap. NE-488. 7 p.

Crow, T. R. **Biomass and production in three contiguous forests in northern Wisconsin.** Ecology 59(2):265–273; 1979.

Cunia, T. **On tree biomass tables and regression: some statistical comments.** Frayer, W. E., ed. Forest Resource Inventories Vol II. Fort Collins, CO: Colorado State Univ. 1979a. p. 629–642.

Cunia, T. **On sampling trees for biomass table construction: some statistical comments.** Frayer, W. E., ed. Forest Resource Inventories Vol. II. Fort Collins, CO: Colorado State Univ., 1979b. p. 643–664.

Dunlap, W. H.; Shipman, R. D. **Density and weight prediction of standing white oak, red maple, and red pine.** University Park, PA: Pennsylvania State Univ. School of For. Resour. 1967; Res. Briefs 2(3):66–69.

Edwards, M. B., Jr. **Weight prediction for 10 understory species in central Georgia.** 1976; USDA For. Serv. Res. Note. SE-235. 3 p.

Fernald, M. L. **Grays's manual of botany.** New York, NY: D. Van Nostrand Company 1950. 1632 p.

Frederick, D. J.; Gardner, W. E.; Kellison, R. C.; Brenneman, B. B.; Marsh, P. L. **Predicting weight yields of West Virginia mountain hardwoods.** J. For. 77(12):762–776; 1979.

Furnival, G. M. **An index for comparing equations used in constructing volume tables.** For. Sci. 7(4): 337–341; 1961.

Goldsmith, L. J.; Hocker, H. W., Jr. **Preliminary small-tree, aboveground biomass tables for five northern hardwoods.** 1978; New Hampshire Agric. Exp. Stn. Res. Rep. 68. 30 p.

Grigal, D. F.; Ohmann, L. F. **Biomass estimation for some shrubs from northeastern Minnesota.** 1971; USDA For. Serv. Res. Note NC-226. 3 p.

Harris, W. F.; Goldstein, R. A.; Henderson, G. S. **Analysis of forest biomass pools, annual primary production and turnover of biomass for a mixed deciduous forest watershed.** Young, H. E., ed. *In:* IUFRO Biomass Studies: Nancy, France, and Vancouver, B.C., Canada. Orono, ME: Univ. of Maine, Coll. Life Sci. and Agric.; 1973. p. 41–64.

Henderson, G. S.; Swank, W. T.; Waide, J. B.; Grier, C. C. **Nutrient budgets of Appalachian and Cascade region watersheds: a comparison.** For. Sci. 24:385–397; 1978.

Hitchcock, III, H. C. **Aboveground tree weight equations for hardwood seedlings and saplings.** TAPPI: 61(10):119–120; 1978.

Hitchcock, H. C. III; McDonnell, J. P. **Biomass measurements: a synthesis of the literature.** Frayer, W. E., ed. Forest Resources Inventories Vol II. Fort Collins, CO: Colorado State Univ.; 1979. p. 544–595.

Hornbeck, J. W. **Nutrients: a major consideration in intensive forest management.** Proceedings of the Symposium on intensive culture of northern forest types. 1977; USDA For. Serv. Gen. Tech. Rep. NE–29. p. 241–250.

Keays, J. L. **Complete-tree utilization; an analysis of the literature; in five parts.** Vancouver, B.C.: For. Prod. Lab. Can. For. Serv.; 1971.

Ker, M. F. **Tree biomass equations for ten major species in Cumberland County, Nova Scotia.** Fredericton, NB: Canadian For. Serv., Maritimes For. Res. Centre; 1980; Inf. Rep. M–X–108. 26 p.

Kinerson, R. S.; Bartholomew, I. **Biomass estimation equations and nutrient composition of white pine, white birch, red maple, and red oak in New Hampshire.** 1977; New Hampshire Agric. Exp. Stn. Res. Rep. 62. 8 p.

King, W. W.; Schnell, R. L. **Biomass estimates of black oak tree components.** Norris, TN: TVA Div. of For., Fisheries and Wildlife Management. 1972; Tech. Note B1. 24 p.

Koerper, G. J.; Richardson, C. J. **Biomass and net annual primary production regressions for *Populus grandidentata* on three sites in northern lower Michigan.** Can. J. For. Res. 10:92–101; 1980.

Kozak, A. **Methods for ensuring additivity of biomass components by regression analysis.** For. Chron., Oct. 1970. p. 402–404.

Lang, G. E.; Forman, R.T.T. **Detrital dynamics in a mature oak forest: Hutcheson Memorial Forest, New Jersey.** Ecology 59(3): 580–595; 1978.

MacLean, D. A.; Wein, R. W. **Biomass of jack pine and mixed hardwood stands in northeastern New Brunswick.** Can. J. For. Res. 6(4):441–447; 1976

Madgwick, H.A.I. **Biomass and productivity models of forest canopies.** Reichle, D. E., ed. Analysis of temperate forest ecosystems. New York, NY: Springer-Verlag; 1970. p. 47–54.

Madgwick, H.A.I.; Satoo, T. **On estimating the aboveground weights of tree stands.** Ecology 56:1446–1450; 1975.

Marks, P. L. **The role of pin cherry (*Prunus pensylvanica* L.) in the maintenance of stability in northern hardwood ecosystems.** Ecol. Monogr. 44:73–88; 1974.

Martin, C. W. **Distribution of tree species in an undisturbed northern hardwood-spruce-fir forest, the Bowl, N.H.** 1977; USDA For. Serv. Res. Note NE–244. 6 p.

Monk, C. D.; Child, G. I.; Nicholson, S. A. **Biomass, litter and leaf surface area estimates of an oak-hickory forest.** Oikos 21:138–141; 1970.

Monteith, D. B. **Whole-tree weight tables for New York.** Syracuse: Univ. of New York; 1979; AFRI Res. Rep. 40. 67 p.

Myers, C.; Polak, D. J.; Raisanen, D.; Schlesinger, R. C.; Storts, L. **Weight and volume equations and tables for selected upland hardwoods in Southern Illinois.** 1980; USDA For. Serv. Gen. Tech. Rep. NC–60. 17 p.

Norton, S. A. **Nutrient budgets of complete tree harvesting versus merchantable bole requirements.** Boston, MA: Annual Meeting American Inst. Chem. Eng.; Sept. 1975. 28 p.

Ohmann, L. F.; Grigal, D. F.; Brander, R. B. **Biomass estimation for five shrubs from northeastern Minnesota.** 1976; USDA For. Serv. Res. Pap. NC–133. 11 p.

Ovington, J. D.; Heitkamp, D.; Lawrence, D. B. **Plant biomass and productivity of prairie, savanna, oakwood, and maize field ecosystems in central Minnesota.** Ecology 44:52–63; 1963.

Parde, J. **Forest biomass.** For. Abstr. 41(8):343–362; 1980.

Patric, J. H.; Smith, D. W. **Forest management and nutrient cycling in eastern hardwoods.** 1975; USDA For. Serv. Res. Pap. NE–324. 12 p.

Phillips, D. R. **Total tree weights and volumes for understory hardwoods.** TAPPI 60(6):68–71; 1977.

Post, L. J. **Dry-matter production of mountain maple and balsam fir in northwestern New Brunswick.** Ecology 51(3):548–550; 1970.

Reiners, W. A. **Structure and energetics of three Minnesota forests.** Ecol. Monogr. 42(1):71–94; 1972.

Reynolds, P. E.; Carlson, K. G.; Fromm, T. W.; Gigliello, K. A.; Kaminski, R. J. **Phytosociology, biomass, productivity and nutrient budget for the tree stratum of a southern New Jersey hardwood**

swamp. Pope, P. E., ed. Proceedings Central Hardwood Forest Conference II, West LaFayette, IN: Purdue Univ.; 1978: 123–139.

Ribe, J. H. **Puckerbrush weight tables.** Orono, ME: Univ. of Maine, 1973; Life Sci. and Agric. Exp. Stn. Misc. Rep. 152. 92 p.

Rolfe, G. L.; Akhtar, M. A.; Arnold, L. E. **Nutrient distribution and flux in a mature oak-hickory forest.** For. Sci. 24(1):122–130; 1978.

Roussopoulos, P. J.; Loomis, R. M. **Weights and dimensional properties of shrubs and small trees of the Great Lakes Conifer Forest.** 1980; USDA For. Serv. Res. Pap. NC–178. 10 p.

Schlaegel, B. E. **Yields of four 40-year-old conifers and aspen in adjacent stands.** Can. J. For. Res. 5:278–280; 1975.

Schnell, R. L. **Biomass estimates of hickory tree components.** Norris, TN:TVA. Div. For., Fisheries and Wildlife Management. 1978; Tech. Note B30. 37 p.

Skeen, J. N. **Biomass and productivity estimates for a temperate mesic slope forest.** J. Tenn. Acad. Sci. 48(3):103–106; 1973.

Skeen, J. N. **Composition and biomass of tree species and maturity estimates of a suburban forest in Georgia.** Bull. Torrey Bot. Club 101:160–165; 1974.

Stanek, W.; State, D. **Equations predicting primary productivity (biomass) of trees, shrubs and lesser vegetation based on current literature.** 1978; Victoria, BC: Can. For. Serv. Pac. For. Res. Centre Publ. BC–X–183. 58 p.

Steinhilb, H. M.; Erickson, J. R. **Weights and centers of gravity for red pine, white spruce, and balsam fir.** 1972; USDA For. Serv. Res. Pap. NC–75. 7 p.

Steinhilb, H. M.; Winsauer, S. A. **Sugar maple: tree and bole weights, volumes, centers of gravity, and logging residue.** 1976; USDA For. Serv. Res. Pap. NC–132. 7 p.

Swank, W. T.; Schreuder, H. T. **Comparison of three methods of estimating surface area and biomass for a forest of young eastern white pine.** For. Sci. 20:91–100; 1974.

Telfer, E. S. **Weight-diameter relationships for 22 woody plant species.** Can. J. Bot. 47:1851–1855; 1969.

Telfer, E. S. **Understory biomass in five forest types in southwestern Nova Scotia.** Can. J. Bot. 50:1263–1267; 1972.

Timson, F. G.; **Sawlog weights for Appalachian hardwoods.** 1972; USDA For. Serv. Res. Pa. NE–222. 29 p.

Tritton, L. M. **Dead wood biomass in a northern hardwood forest ecosystem.** New Haven, CT: Yale Univ.; 1980. 268 p. Ph.D. Thesis.

Ware, K. D. **Statistical aspects in sampling for biomass inventory.** Frayer, W. E., ed. Forest Resources Inventories Vol. II. Fort Collins, CO: Colorado State University, 1979:745–756.

Wartluft, J. L. **Weights of small Appalachian hardwood trees and components.** 1977; USDA For. Serv. Res. Pap. NE–366. 4 p.

Wartluft, J. L. **Estimating top weights of hardwood sawtimber.** 1978; USDA For. Serv. Res. Pap. NE–427. 7 p.

Weaver, G. T.; DeSelm, H. R. **Biomass distribution pattern in adjacent coniferous and deciduous forest ecosystems.** Young, H. E., ed. *In:* IUFRO Biomass Studies. Nancy, France, and Vancouver, B.C., Canada. Orono, ME: Univ. of Maine, Coll. Life Sci. and Agric.; 1973. p. 411-427.

Weetman, G. F.; Webber, B. **The influence of wood harvesting on the nutrient status of two spruce stands.** Can. J. of For. Res. 2:351–369; 1972.

Whittaker, R. H. **Net production of heath balds and forest heaths in the Great Smoky Mountains.** Ecology 44(1):176–182; 1963.

Whittaker, R. H. **Forest dimensions and production in the Great Smoky Mountains.** Ecology 47(1):103–121; 1966.

Whittaker, R. H.; Woodwell, G. M. **Dimension and production relations of trees and shrubs in the Brookhaven Forest, New York.** J. Ecol. 56:1–25; 1968.

Whittaker, R. H.; Bormann, F. H.; Likens, G. E.; Siccama, T. G. **The Hubbard Brook ecosystem study: forest biomass and production.** Ecol. Monogr. 44:233–254; 1974.

Wiant, H. V., Jr. **Are separate weight equations needed for Appalachian hardwoods?** 1979; W. Va. For. Notes 7:20.

Wiant, H. V., Jr.; Castaneda, F.; Sheetz, C. E.; Colaninno, A.; DeMoss, J. C. **Equations for predicting weights of some Appalachian hardwoods.** 1979; W. Va. For. Notes 7:21–26.

Wiant, H. V., Jr.; Harner, E. J. **Percent bias and standard error in logarithmic regression.** For. Sci. 25(1):167–168; 1979.

Wiant, H. V., Jr.; Sheetz, C. E.: Colaninno, A.; DeMoss, J. C.; Castaneda, F. **Tables and procedures for estimating weights of some Appalachian hardwoods.** 1977; W. Va. Univ. Agric. and For. Exp. Stn. Bull. 659T. 36 p.

Wood, G. W.; Hutnik, R. J. **Biomass production, and nutrient distribution in mixed-oak stands after clear-cutting and fire.** 1972; Pa. State Univ. Sch. For. Resour. Res. Briefs 6(1):18–21.

Young, H. E. **A summary and analysis of weight table studies.** *In:* Oslo Biomass Studies. XVIth Int. Congr. of IUFRO. Orono, ME: Univ. of Maine, Coll. Life Sci. and Agric.; 1976. p. 251–282.

Young, H. E.; Carpenter, P. **Weight, nutrient element and productivity studies of seedlings and saplings of eight tree species in natural ecosystems.** Orono, ME: Univ. of Maine; 1967; Maine Agric. Exp. Stn. Tech. Bull. 28. 39 p.

Young, H. E.; Ribe, J. H.; Wainwright, K. **Weight tables for tree and shrub species in Maine.** Orono, ME: Univ. of Maine: 1980; Life Sci. and Agric. Exp. Stn. Misc. Rep. 230. 84 p.

Young, H. E.; Strand, L.; Altenberger, R. **Preliminary fresh and dry weight tables for seven tree species in Maine.** Orono, ME: Univ. of Maine; 1964; Maine Agric. Exp. Stn. Tech. Bull. 12. 76 p.

Appendixes

Key to Abbreviations in Appendixes

Lf -leaf biomass

Tw -twig biomass

Br -branch biomass

DdBr -dead branch biomass

St -stem biomass

St + Br -stem and branch biomass but not foliage

Rt -root and stump biomass

WT -whole tree biomass—all above-ground components including leaves, branches, and stem

CT -complete tree biomass—above-ground and below-ground components: whole tree plus roots and stump

LOG -logarithm to the base 10

LN -natural logarithm to the base e

wt -weight measured in pounds (lb), grams (gm), or kilograms (kg)

dbh -diameter at breast height (1.37 m) measured in inches (in), millimeters (mm), or centimeters (cm)

ht -tree height measured in feet (ft) or in meters (m)

ODW -oven-dry weight

† -oven-dry weight above stump greater than 5 cm in diameter, excluding bark

A -oak forest

B -cedar swamp

C -southern red oak

D -six regression equations of this form were used for WT estimate

E -these two equations apply to forked and nonforked stems, respectively

F -seven regressions of this form were used for WT estimate

G -white spruce

H -black spruce

I -red spruce

L -local

R -regional

GA -Georgia

IL -Illinois

KY -Kentucky

ME -Maine

MI -Michigan

MN -Minnesota

NB -New Brunswick, Canada

NC -North Carolina

NH -New Hampshire

NJ -New Jersey

NS -Nova Scotia, Canada

NY -New York

ON -Ontario, Canada

PA -Pennsylvania

QU -Quebec, Canada

RI -Rhode Island

TN -Tennessee

WV -West Virginia

WI -Wisconsin

Appendix A: Equations predicting biomass from dbh or a combination of dbh and total tree height.

Location	Reference	Component	Equation	n	Units	Range dbh (ht)
			Abies balsamea (L.) Mill. (Balsam fir)			
NB	Baskerville, 1965a	WT:	LOG wt = 0.086 + 2.53 LOG dbh	101	in lb	1-10 in
NS	Ker, 1980	WT:	LN wt = -1.8337 + 2.1283 LN dbh	50	cm kg	2-32 cm
NB	MacLean & Wein, 1976	WT:	LOG wt =-0.4081 + 1.6217 LOG dbh	20	cm kg	≤20 cm
ME	Young et al., 1964	St+Br:	[LN wt = 0.0511 + 2.1679 (LN dbh) + 0.4292 (LN ht)] x 0.21	23	in ft lb	6-13 in (42-65 ft)
ME	Young et al., 1980	WT:	LN wt = 0.5958 + 2.4017 LN dbh	95	in lb	1-20 in
			Acer rubrum L. (Red maple)			
WV	Brenneman et al., 1978	WT:	wt = 2.0772 $dbh^{2.5080}$	27	in lb	2-20 in
RI	Bridge, 1979	WT:	LN wt = 0.10594 + 2.33968 LN dbh	15	in kg	3-12 in
PA	Dunlap & Shipman, 1967	St:	wt = -527.993 + 111.583 (dbh)	55	in lb	>4 in
NH	Goldsmith & Hocker, 1978	St: Br: St+Br:	LN wt = 4.8183 + 2.3220 LN dbh LN wt = 2.8492 + 2.4285 LN dbh LN wt = 4.9828 + 2.3100 LN dbh	28	cm gm	<12 cm

TN	Hitchcock, 1978	St+Br:	$LOG\ wt = 1.9400 + 0.7557\ LOG\ (dbh^2 \times ht)$	16	cm m gm	<5 cm (<6 m)
NS	Ker, 1980	WT: WT:	$LN\ wt = -2.0274 + 2.3199\ LN\ dbh$ $LN\ wt = -2.4198 + 2.0986\ LN\ dbh + 0.3900\ LN\ ht$	49	cm m kg	1-30 cm
NH	Kinerson & Bartholomew, 1977	St: Br: Lf:	$LN\ wt = 4.856 + 2.294\ LN\ dbh$ $LN\ wt = 2.896 + 1.960\ LN\ dbh$ $LN\ wt = 0.582 + 2.777\ LN\ dbh$	7	cm gm	3-12 cm
NB	MacLean & Wein, 1976	WT:	$LOG\ wt = -0.5881 + 1.6728\ LOG\ dbh$	30	cm kg	≤10 cm
NY	Monteith, 1979	^{L}WT: ^{R}WT:	$wt = 6.1147 - (0.3598 \times dbh) + (0.006344 \times dbh^2)$ $wt = 1.3785 + 0.02279\ (dbh) - 0.3010\ (ht) + 0.0002469\ (dbh^2 \times ht)$	33	mm m kg	25-550 mm (5-30 m)
NC	Phillips, 1977	St+Br:	$LOG\ wt = -0.70853 + [0.91763\ LOG\ (dbh^2 \times ht)]$	12	in ft	1-5 in
GA		St+Br:	$LOG\ wt = -0.92222 + [1.00528\ LOG\ (dbh^2 \times ht)]$	12	lb	
MN	Reiners, 1972	^{F}Lf:	$LOG\ wt = 2.1328 + 1.8782\ LOG\ dbh$	--	in gm	--
NJ	Reynolds et al., 1978	St: Br: Lf:	$LOG\ wt = -0.2375 + 2.3151\ LOG\ dbh$ $LOG\ wt = 0.2294 + 1.3100\ LOG\ dbh$ $LOG\ wt = -1.9475 + 1.8989\ LOG\ dbh$	<20	cm kg	7-24 cm
ME	Ribe, 1973	Lf: Br: St:	$LOG\ wt = 2.1237 + 1.8015\ LOG\ dbh$ $LOG\ wt = 2.3088 + 1.9148\ LOG\ dbh$ $LOG\ wt = 2.8479 + 2.6522\ LOG\ dbh$	30	in gm	1-6 in
WV	Wiant et al., 1977	St+Br:	$wt = 1.81301\ dbh^{2.56226}$	19-22	in lb	2-16 in

Continued

Appendix A -- Continued

Location	Reference	Component	Equation	n	Units	Range dbh (ht)
			Acer rubrum (cont.)			
WV	Wiant et al., 1979	St+Br:	$wt = 0.07592 (dbh^2 \times ht)^{1.03160}$	19-22	in ft lb	2-16 in (18-94 ft)
ME	Young et al., 1964	St+Br:	$[LN\ wt = 0.1651 + 2.1679 (LN\ dbh) + 0.4292 (LN\ ht)] \times 0.47$	20	in ft lb	6-16 in (36-71 ft)
ME	Young et al., 1980	WT:	$LN\ wt = 0.9392 + 2.3804\ LN\ dbh$	66	in lb	1-26 in
			Acer saccharum Marsh. (Sugar maple)			
NY	Bickelhaupt et al., 1973	^{E}WT: WT:	$LN\ wt = 4.83 + 2.48\ LN\ dbh$ $LN\ wt = 5.33 + 2.33\ LN\ dbh$	10	cm gm	2-40 cm
WV	Brenneman et al., 1978	WT:	$wt = 2.4439\ dbh^{2.5735}$	119	in lb	2-20 in
NH	Goldsmith & Hocker, 1978	St: Br: St+Br:	$LN\ wt = 5.1826 + 2.2679\ LN\ dbh$ $LN\ wt = 3.6171 + 2.1503\ LN\ dbh$ $LN\ wt = 5.9106 + 2.2352\ LN\ dbh$	16	cm gm	<15 cm
NY	Monteith, 1979	^{L}WT:	$wt = 5.2480 - (0.3661 \times dbh) + (0.007605 \times dbh^2)$	33	mm kg m	25-550 mm (5-30 m)
		^{R}WT:	$wt = 0.06116 + 0.1752 (dbh) - 0.8988 (ht) + 0.0002761 (dbh^2 \times ht)$			
ME	Ribe, 1973	Lf: Br: St:	$LOG\ wt = 2.0383 + 1.6701\ LOG\ dbh$ $LOG\ wt = 2.4004 + 1.5571\ LOG\ dbh$ $LOG\ wt = 3.0609 + 2.4927\ LOG\ dbh$	30	in gm	1-6 in

NH	Whittaker et al., 1974	St:	LOG wt = 2.0877 + 2.3718 LOG dbh	14	cm gm	--
		Br:	LOG wt = 0.6266 + 2.9740 LOG dbh			
		DdBr:	LOG wt = 0.0444 + 2.2803 LOG dbh			
		Lf+Tw:	LOG wt = 1.0975 + 1.9329 LOG dbh			
ME	Young et al., 1980	WT:	LN wt = 1.2451 + 2.3329 LN dbh	42	in lb	1-26 in
			***Betula alleghaniensis* Britt. (Yellow Birch)**			
WV	Brenneman et al., 1978	WT:	$wt = 3.1042\ dbh^{2.3753}$	24	in lb	2-20 in
NY	Monteith, 1979	^{L}WT:	$wt = 9.3701 - (0.4489 \times dbh) + (0.007496 \times dbh^2)$	31	mm m kg	25-550 mm (5-30 m)
		^{R}WT:	$wt = -4.9178 + 0.02462\ (dbh) + 0.5461\ (ht) + 0.0002773\ (dbh^2 \times ht)$			
MN	Reiners, 1972	^{F}Lf:	LOG wt = 2.0610 + 1.7012 LOG dbh	--	in gm	--
ME	Ribe, 1973	Lf:	LOG wt = 1.9962 + 1.9683 LOG dbh	30	in gm	1-6 in
		Br:	LOG wt = 2.5345 + 1.6179 LOG dbh			
		St:	LOG wt = 2.9670 + 2.5330 LOG dbh			
NH	Whittaker et al., 1974	St:	LOG wt = 2.1413 + 2.2683 LOG dbh	14	cm gm	--
		Br:	LOG wt = 1.0535 + 2.7995 LOG dbh			
		DdBr:	LOG wt =-0.3437 + 2.7373 LOG dbh			
		Lf+Tw:	LOG wt = 1.0295 + 1.9443 LOG dbh			
ME	Young et al., 1980	WT:	LN wt = 1.1297 + 2.3376 LN dbh	42	in lb	1-26 in
			***Betula lenta* L. (Black birch)**			
WV	Brenneman et al., 1978	WT:	$wt = 1.6542\ dbh^{2.6606}$	8	in lb	2-20 in

Continued

Appendix A -- Continued

Location	Reference	Component	Equation	n	Units	Range dbh (ht)
			Betula papyrifera Marsh. (Paper Birch)			
NB	Baskerville, 1965a	WT:	LOG wt = 0.236 + 2.48 LOG dbh	24	in lb	1-3 in
NH	Goldsmith & Hocker, 1978	St: Br: St+Br:	LN wt = 5.2870 + 2.0657 LN dbh LN wt = 3.0259 + 2.0277 LN dbh LN wt = 5.3907 + 2.0676 LN dbh	15	cm gm	<8 cm
NS	Ker, 1980	WT: WT:	LN wt =-2.2308 + 2.4313 LN dbh LN wt =-2.5938 + 2.1868 LN dbh + 0.4031 LN ht	45	cm m kg	3-33 cm
NH	Kinerson & Bartholomew, 1977	St: Br:	LN wt = 3.720 + 2.877 LN dbh LN wt =-1.351 + 4.368 LN dbh	6	cm gm	5-8 cm
NB	MacLean & Wein, 1976	WT:	LOG wt =-0.5012 + 1.7284 LOG dbh	21	cm kg	≤15 cm
MN	Reiners, 1972	AFLf: BFLf:	LOG wt = 1.7264 + 2.1089 LOG dbh LOG wt = 1.400 + 2.4116 LOG dbh	-- --	in gm	-- --
ME	Ribe, 1973	Lf: Br: St:	LOG wt = 2.1587 + 1.7020 LOG dbh LOG wt = 2.4059 + 1.7304 LOG dbh LOG wt = 2.4481 + 3.2640 LOG dbh	30	in gm	1-6 in
ME	Young et al., 1964	St+Br:	[LN wt = 0.3062 + 2.1679 (LN dbh) + 0.4292 (LN ht)] x 0.42	17	in ft lb	6-12 in (47-78 ft)
ME	Young et al., 1980	WT:	LN wt = 0.4792 + 2.6634 LN dbh	51	in lb	1-20 in

			Betula populifolia Marsh. (Gray Birch)			
NS	Ker, 1980	WT: WT:	LN wt = -2.1053 + 2.3123 LN dbh LN wt = -2.3174 + 2.0483 LN dbh + 0.3728 LN ht	44	cm m kg	1-23 cm
ME	Ribe, 1973	Lf: Br: St:	LOG wt = 1.8730 + 1.6376 LOG dbh LOG wt = 2.4831 + 1.6163 LOG dbh LOG wt = 2.9508 + 2.5139 LOG dbh	30	in gm	1-6 in
ME	Young et al., 1980	WT:	LN wt = 1.0931 + 2.3146 LN dbh	30	in lb	1-9 in
			Carya spp. (Hickory)			
WV	Brenneman et al., 1978	WT:	$wt = 2.0340\ dbh^{2.6349}$	14	in lb	2-20 in
TN	Hitchcock, 1978	St+Br:	$LOG\ wt = 2.0088 + 0.8119\ LOG\ (dbh^2 \times ht)$	16	cm m gm	1-5 cm (<5 m)
IL	Myers et al., 1980	†WT:	$wt = 0.04974\ (dbh^{2.01833} \times ht^{0.74444})$	40	cm m kg	13-59 cm (12-29 m)
NC	Phillips, 1977	St+Br:	$LOG\ wt = {}_2{-0.65526} + [0.90460\ LOG\ (dbh^2 \times ht)]$	12	in ft	1-5 in
GA		St+Br:	$LOG\ wt = {}_2{-0.51369} + [0.87835\ LOG\ (dhb^2 \times ht)]$	11	lb	
TN	Schnell, 1978	St+Br:	LOG wt = 0.1900 + 2.7094 LOG dbh	37	in lb	2-28 in
WV	Wiant et al., 1977	St+Br:	$wt = 1.93378\ dbh^{2.62090}$	19-22	in lb	2-16 in

Continued

Appendix A -- Continued

Location	Reference	Component	Equation	n	Units	Range dbh (ht)
			Carya spp. (cont.)			
WV	Wiant et al., 1979	St+Br:	$wt = 0.10308\ (dbh^2 \times ht)^{1.01605}$	14	in ft lb	2-16 in (18-94 ft)
			Fagus grandifolia Ehrh. (Beech)			
WV	Brenneman et al., 1978	WT:	$wt = 2.0394\ dbh^{2.5715}$	56	in lb	2-20 in
NY	Monteith, 1979	^{L}WT:	$wt = 5.3373 - (0.3257 \times dbh) + (0.007173 \times dbh^2)$	32	mm m kg	25-550 mm (5-30 m)
		^{R}WT:	$wt = 0.7833 + 0.08899\ (dbh) - 0.5297\ (ht) + 0.0002996\ (dbh^2 \times ht)$			
ME	Ribe, 1973	Lf: Br: St:	LOG wt = 2.0660 + 1.8089 LOG dbh LOG wt = 2.5983 + 1.5402 LOG dbh LOG wt = 3.0692 + 2.4868 LOG dbh	19	in gm	1-6 in
NH	Whittaker et al., 1974	St: Br: DdBr: Lf+Tw:	LOG wt = 2.0280 + 2.3981 LOG dbh LOG wt = 1.4182 + 2.5509 LOG dbh LOG wt =-0.1289 + 2.9859 LOG dbh LOG wt = 1.4738 + 1.6169 LOG dbh	14	cm gm	--
ME	Young et al., 1980	WT:	LN wt = 1.3303 + 2.2988 LN dbh	29	in lb	1-26 in
			Fraxinus americana L. (White Ash)			
WV	Brenneman et al., 1978	WT:	$wt = 2.3626\ dbh^{2.4798}$	15	in lb	2-20 in

Appendix A -- Continued

Location	Reference	Component	Equation	n	Units	Range dbh (ht)
			Pinus strobus (cont.)			
ME	Young et al., 1980	WT:	LN wt = 0.4080 + 2.4490 LN dbh	35	in lb	1-26 in
			Populus spp. (Aspen)			
NH	Goldsmith & Hocker, 1978	St: Br: St+Br:	LN wt = 4.5855 + 2.1314 LN dbh LN wt = 2.2613 + 2.7212 LN dbh LN wt = 4.6946 + 2.2019 LN dbh	79	cm gm	<15 cm
NS	Ker, 1980	WT:	LN wt =-2.6224 + 2.4827 LN dbh	46	cm kg	2-33 cm
MI	Koerper & Richardson, 1980	^{D}Lf:	LN wt = 1.2846 + 2.1483 LN dbh	31	cm gm	---
NB	MacLean & Wein, 1976	WT:	LOG wt =-0.7891 + 2.0673 LOG dbh	15	cm kg	≤15 cm
NY	Monteith, 1979	^{L}WT: ^{R}WT:	wt = 9.1583 - (0.4291 x dbh) + (0.005799 x dbh^2) wt = 3.8124 + 0.09632 (dbh) - 1.3154 (ht) + 0.0002079 (dbh^2 x ht)	31	mm m kg	25-550 mm (5-30 m)
ME	Ribe, 1973	Lf: Br: St:	LOG wt = 2.0243 + 1.6796 LOG dbh LOG wt = 2.2178 + 1.8545 LOG dbh LOG wt = 2.6672 + 2.7859 LOG dbh	30	in gm	1-6 in
MN	Schlaegel, 1975	St:	LN wt = -4.151 + 0.969 [LN (dbh^2 x ht)]	10	cm m kg	5-34 cm
ME	Young et al., 1964	St+Br:	[LN wt = 0.2066 + 2.1679 (LN dbh) + 0.4292 (LN ht)] x 0.35	14	ft in lb	6-10 in (52-62 ft)

Appendix A -- Continued

Location	Reference	Component	Equation	n	Units	Range dbh (ht)
			***Picea* spp.** (Spruce)			
NB	Baskerville, 1965a	WT:	LOG wt = 0.150 + 2.48 LOG dbh	13	in lb	1-10 in
NS	Ker, 1980	[G]WT: [H]WT:	LN wt = -2.2662 + 2.2907 LN dbh LN wt = -1.7823 + 2.1777 LN dbh	44 49	cm kg	2-32 cm 2-34 cm
NB	MacLean & Wein, 1976	[I]WT:	LOG wt = -0.2112 + 1.5639 LOG dbh	30	cm kg	≤20 cm
NY	Monteith, 1979	[L]WT:	wt = 6.0177 - (0.2822 x dbh) + (0.004654 x dbh^2)	33	mm m kg	25-550 mm (5-30 m)
		[R]WT:	wt = 6.0040 + 0.08284 (dbh) − 2.2710 (ht) + 0.0002309 (dbh^2 x ht)			
MN	Schlaegel, 1975	[G]St:	LN wt = -3.616 + 0.902 [LN (dbh^2 x ht)]	10	cm m	5-29 cm
		[H]St:	LN wt = -3.503 + 0.895 [LN (dbh^2 x ht)]	10	kg	
NH	Whittaker et al., 1974	[I]St: Br: DdBr: Lf+Tw:	LOG wt = 1.9906 + 2.2046 LOG dbh LOG wt = 0.9115 + 2.5428 LOG dbh LOG wt = 1.1710 + 2.0936 LOG dbh LOG wt = 0.8703 + 1.6359 LOG dbh	15	cm gm	---
ME	Young et al., 1964	[I]St+Br:	[LN wt = 0.1922 + 2.1679 (LN dbh) + 0.4292 (LN ht)] x 0.40	25	in ft lb	8-15 in (32-71 ft)
ME	Young et al., 1980	WT:	LN wt = 0.8079 + 2.3316 LN dbh	111	in lb	1-26 in

			Pinus resinosa Ait. (Red pine)			
PA	Dunlap & Shipman, 1967	St:	wt = -113.954 + 35.265 (dbh)	26	in lb	>4 in
NS	Ker, 1980	WT: WT:	LN wt = -2.3684 + 2.3503 LN dbh LN wt = -2.5387 + 2.1289 LN dbh + 0.2881 LN ht	47	cm m kg	2-34 cm
MN	Schlaegel, 1975	St:	LN wt = -4.019 + 0.960 [LN (dbh^2 x ht)]	10	cm kg	5-34 cm
ME	Young et al., 1980	WT:	LN wt = 0.7157 + 2.3865 LN dbh	14	in lb	1-20 in
			Pinus strobus L. (White pine)			
NH	Kinerson & Bartholomew, 1977	St: Br: Lf:	LN wt = 4.274 + 2.269 LN dbh LN wt = 1.733 + 2.656 LN dbh LN wt =-0.952 + 2.586 LN dbh	23	cm gm	3-20 cm
NB	MacLean & Wein, 1976	WT:	LOG wt =-0.2008 + 1.3475 LOG dbh	10	cm kg	≤15 cm
NY	Monteith, 1979	^{L}WT:	wt = 4.1195 - (0.2367 x dbh) + (0.003820 x dbh^2)	31	mm m kg	25-550 mm (5-30 m)
		^{R}WT:	wt = 0.5209 + 0.07434 (dbh) - 0.5439 (ht) + 0.0001516 (dbh^2 x ht)			
NC	Swank & Schreuder, 1974	Lf: Br: St:	LN wt = 3.051 + 2.1354 LN dbh LN wt = 3.158 + 2.5328 LN dbh LN wt =-2.788 + 2.1338 LN dbh	20	cm kg	1-18 cm
ME	Young et al., 1964	St+Br:	[LN wt = 0.2150 + 2.1679 (LN dbh) + 0.4292 (LN ht)] x 0.36	27	in ft lb	6-15 in (46-79 ft)

Continued

IL	Myers et al., 1980	†WT:	wt = 0.01528 $(dbh^{2.23978} \times ht^{0.80092})$	40	cm m kg	14-59 cm (14-30 m)
NY	Monteith, 1979	^{L}WT:	wt = 3.2031 − (0.2337 x dbh) + (0.006061 x dbh^2)	32	mm m	25-550 mm (5-30 m)
		^{R}WT:	wt = −4.1776 + 0.2195 (dbh) − 0.4421 (ht) + 0.0002038 (dbh^2 x ht)		kg	
		***Liriodendron tulipifera* L. (Yellow poplar)**				
WV	Brenneman et al., 1978	WT:	wt = 1.0259 $dbh^{2.7324}$	12	in ft	2-20 in
NC	Clark & Schroeder, 1977	St+Br:	LOG wt = −1.22162 + [1.00962 LOG (dbh^2 x ht)]	39	in ft lb	6-28 in (53-147 ft)
TN	Hitchcock, 1978	St+Br:	LOG wt = 1.9167 + 0.7993 LOG (dbh^2 x ht)	17	cm m gm	<4 cm (<6 m)
IL	Myers et al., 1980	†WT:	wt = 0.00246 $(dbh^{1.84763} \times ht^{1.72350})$	40	cm m kg	15-57 cm (16-29 m)
NC	Phillips, 1977	St+Br:	LOG wt = −1.03700 + [0.96142 LOG (dbh^2 x ht)]	12	in ft lb	1-5 in
GA		St+Br:	LOG wt = −0.85956 + [0.92195 LOG (dbh^2 x ht)]	12		
WV	Wiant et al., 1977	St+Br:	wt = 1.57792 $dbh^{2.51532}$	19-22	in lb	2-16 in
WV	Wiant et al., 1979	St+Br:	wt = 0.07599 $(dbh^2 \times ht)^{0.99425}$	19-22	in ft lb	2-16 in (18-94 ft)

Continued

ME	Young et al., 1980	WT:	LN wt = 0.4689 + 2.6087 LN dbh	52	in lb	1-20 in
			***Prunus pensylvanica* L. (Pin Cherry)**			
NB	MacLean & Wein, 1976	WT:	LOG wt = -0.6657 + 1.7041 LOG dbh	17	cm kg	≤10 cm
ME	Ribe, 1973	Lf: Br: St:	LOG wt = 2.0974 + 1.9784 LOG dbh LOG wt = 2.4033 + 1.8755 LOG dbh LOG wt = 2.9117 + 2.2988 LOG dbh	30	in gm	1-6 cm
ME	Young et al., 1980	WT:	LN wt = 0.9758 + 2.1948 LN dbh	30	in lb	1-9 in
			***Prunus serotina* Ehrh. (Black Cherry)**			
WV	Brenneman et al., 1978	WT:	$wt = 1.8082\ dbh^{2.6174}$	26	in lb	2-20 in
TN	Hitchcock, 1978	St+Br:	$LOG\ wt = 2.0894 + 0.6768\ LOG\ (dbh^2 \times ht)$	17	cm m gm	<5 cm (1-7 m)
WV	Wiant et al., 1977	St+Br:	$wt = 2.58831\ dbh^{2.42530}$	19-22	in lb	2-16 in
WV	Wiant et al., 1979	St+Br:	$wt = 0.12968\ (dbh^2 \times ht)^{0.97028}$	19-22	in ft lb	2-16 in (18-94 ft)

Continued

Appendix A -- Continued

Location	Reference	Component	Equation	n	Units	Range dbh (ht)
			Quercus alba L. (White oak)			
WV	Brenneman et al., 1978	WT:	$wt = 1.5647\ (dbh^{2.6887})$	29	in lb	2-20 in
RI	Bridge, 1979	WT:	$LN\ wt = -0.82061 + 2.84694\ LN\ dbh$	15	in kg	3-12 in
PA	Dunlap & Shipman, 1967	St:	$wt = -4.763 + 0.082\ (dbh^2 \times ht)$	55	in ft lb	>4 in
TN	Hitchcock, 1978	St+Br:	$LOG\ wt = 2.4111 + 0.6096\ LOG\ (dbh^2 \times ht)$	16	cm m gm	<5 cm (≤6 m)
IL	Myers et al., 1980	†WT:	$wt = 0.09102\ (dbh^{2.47164} \times ht^{0.00113})$	40	cm m kg	14-60 cm (14-29 m)
NC	Phillips, 1977	St+Br:	$LOG\ wt = -0.57181 + 0.87060\ LOG\ (dbh^2 \times ht)$	12	in ft lb	1-5 in
GA		St+Br:	$LOG\ wt = -0.49047 + 0.82009\ LOG\ (dbh^2 \times ht)$	12		
MN	Reiners, 1972	FLf:	$LOG\ wt = 2.1426 + 1.6684\ LOG\ dbh$	--	in gm	--
NY	Whittaker & Woodwell, 1968	St+Br: Lf+Tw:	$LOG\ wt = 2.3058 + 2.1666\ LOG\ dbh$ $LOG\ wt = 1.5849 + 1.7380\ LOG\ dbh$	15	cm gm	0-18 cm
WV	Wiant et al., 1977	St+Br:	$wt = 1.28919\ dbh^{2.70096}$	19-22	in lb	2-16 in
WV	Wiant et al., 1979	St+Br:	$wt = 0.08782\ (dbh^2 \times ht)^{1.02060}$	19-22	in ft lb	2-16 in (18-94 ft)

			Quercus coccinea Muench. (Scarlet oak)			
TN	Clark et al., 1980a	St+Br:	$wt = 0.12161 (dbh^2 \times ht)^{1.00031}$	28	in ft lb	5-20 in 50-84 ft
NY	Whittaker & Woodwell, 1968	St+Br: Lf+Tw:	$LOG\ wt = 2.3948 + 2.1900\ LOG\ dbh$ $LOG\ wt = 1.8565 + 1.6436\ LOG\ dbh$	15	cm gm	1-23 cm
WV	Wiant et al., 1977	St+Br:	$wt = 2.65743\ dbh^{2.43948}$	19-22	in lb	2-16 in
WV	Wiant et at., 1979	St+Br:	$wt = 0.18982 (dbh^2 \times ht)^{0.94250}$	19-22	in ft lb	2-16 in (18-94 ft)
			Quercus prinus L. (Chestnut oak)			
WV	Brenneman et al., 1978	WT:	$wt = 1.5509\ dbh^{2.7276}$	13	in lb	2-20 in
TN	Hitchcock, 1978	St+Br:	$LOG\ wt = 2.1088 + 0.7606\ LOG\ (dbh^2 \times ht)$	15	cm m gm	<4 cm (<5 m)
NC	Phillips, 1977	St+Br:	$LOG\ wt = -0.47279 + 0.83411\ LOG\ (dbh^2 \times ht)$	11	in ft lb	1-5 in
WV	Wiant et al., 1977	St+Br:	$wt = 2.12015\ dbh^{2.53442}$	19-22	in lb	2-16 in
WV	Wiant et al., 1979	St+Br:	$wt = 0.06834 (dbh^2 \times ht)^{1.06370}$	19-22	in ft lb	2-16 in (18-94 ft)

Continued

Appendix A -- Continued

Location	Reference	Component	Equation	n	Units	Range dbh (ht)
			Quercus rubra L. (Northern red oak)			
WV	Brenneman et al., 1978	WT:	$wt = 2.4601\ (dbh^{2.4572})$	24	in lb	2-20 in
NC	Clark et al., 1980b	St+Br:	$wt = 0.10987\ (dbh^2 \times ht)^{1.00197}$	71	in ft lb	6-24 in (56-116 ft)
NH	Goldsmith & Hocker, 1978	St: Br: St+Br:	$LN\ wt = 5.1001 + 2.2451\ LN\ dbh$ $LN\ wt = 2.1435 + 2.7291\ LN\ dbh$ $LN\ wt = 5.1342 + 2.3008\ LN\ dbh$	25	cm gm	<14 cm
TN	Hitchcock, 1978	St+Br:	$LOG\ wt = 2.0890 + 0.8285\ LOG\ (dbh^2 \times ht)$	16	cm m gm	<5 cm (<6 m)
NH	Kinerson & Bartholomew, 1977	St: Br: Lf:	$LN\ wt = 4.578 + 2.477\ LN\ dbh$ $LN\ wt = 1.791 + 2.909\ LN\ dbh$ $LN\ wt = 2.318 + 2.187\ LN\ dbh$	8	cm gm	4-11 cm
IL	Myers et al., 1980	†WT:	$wt = 0.00898\ (dbh^{2.29601} \times ht^{0.92143})$	40	cm m kg	13-59 cm (12-29 m)
NY	Monteith, 1979	LWT:	$wt = 11.0417 - (0.5258 \times dbh) + (0.007678 \times dbh^2)$	32	mm m kg	25-550 mm (5-30 m)
		RWT:	$wt = 9.6829 + 0.4214\ (dbh) - 4.1658\ (ht) + 0.0002654\ (dbh^2 \times ht)$	5		
GA	Phillips, 1977	St+Br:	$LOG\ wt = -0.32779 + 0.78911\ LOG\ (dbh^2 \times ht)$	13	in ft lb	1-5 in
WV	Wiant et al., 1977	St+Br:	$wt = 1.68914\ dbh^{2.65978}$	19-22	in lb	2-16 in

WV	Wiant et al., 1979	St+Br: $wt = 0.11919\ (dbh^2 \times ht)^{0.99322}$	19-22	in ft lb	2-16 in (18-94 ft)
		***Quercus velutina* Lam. (Black oak)**			
RI	Bridge, 1979	WT: $LN\ wt = -0.34052 + 2.65803\ LN\ dbh$	15	in kg	3-12 in
NC, KY, TN	King & Schnell, 1972	CT: $LOG\ wt = 1.00005 + 2.10621\ LOG\ dbh$ - Rt: $LOG\ wt = 0.38000 + 2.12094\ LOG\ dbh$	26	in lb	12-35 in
IL	Myers et al., 1980	†WT: $0.00888\ (dbh^{2.23369} \times ht^{1.00040})$	40	cm m kg	13-55 cm (14-29 m)
WV	Wiant et al., 1977	St+Br: $wt = 2.14567\ dbh^{2.50304}$	19-22	in lb	2-16 in
WV	Wiant et al., 1979	St+Br: $wt = 0.14206\ (dbh^2 \times ht)^{0.97268}$	19-22	in ft lb	2-16 in (18-94 ft)
		***Tsuga canadensis* (L.) Carr. (Hemlock)**			
WV	Brenneman et al., 1978	WT: $wt = 1.3449\ dbh^{2.4500}$	21	in lb	2-20 in
NY	Monteith, 1979	^L^WT: $wt = 6.1371 - (0.2785 \times dbh) + (0.004286 \times dbh^2)$ ^R^WT: $wt = 1.4081 + 0.1824\ (dbh) - 1.4563\ (ht) + 0.0001842\ (dbh^2 \times ht)$	31	mm m kg	25-550 mm (5-30 m)
ME	Young et al., 1964	St+Br: $[LN\ wt = 0.1798 + 2.1679\ (LN\ dbh) + 0.4292\ (LN\ ht)] \times 0.31$	28	in ft lb	6-15 in (32-61 ft)
ME	Young et al., 1980	WT: $LN\ wt = 0.6803 + 2.3617\ LN\ dbh$	36	in lb	1-20 in

Continued

Appendix A -- Continued

Location	Reference	Component	Equation	n	Units	Range dbh (ht)
			General hardwoods			
TN	Harris et al., 1973	St:	LN wt = -2.437 + 2.418 LN dbh	298	cm	>10 cm
		Br:	LN wt = -3.188 + 2.226 LN dbh	298	kg	
		Lf:	LN wt = -3.498 + 1.695 LN dbh	302		
NH	Kinerson & Bartholomew, 1977	St:	LN wt = 4.623 + 2.428 LN dbh	44	cm	<12 cm
		Br:	LN wt = 1.914 + 2.676 LN dbh		gm	
		Lf:	LN wt = 1.356 + 2.527 LN dbh			
GA	Monk et al., 1970	WT:	LOG wt = 1.9757 + 2.5371 LOG dbh	87	cm gm	≥2 cm
NY	Monteith, 1979	^{L}WT:	wt = 5.5247 - (0.3352 x dbh) + (0.006551 x dbh^2)	279	mm m kg	25-250 mm (5-30 m)
		^{R}WT:	wt = 0.3167 + 0.04666 (dbh) - 0.2082 (ht) + 0.0002549 (dbh^2 x ht)			
ME	Ribe, 1973	Lf:	LOG wt = 2.0642 + 1.7450 LOG dbh	305	in	1-6 in
		Br:	LOG wt = 2.4362 + 1.6711 LOG dbh		gm	
		St:	LOG wt = 2.8155 + 2.6416 LOG dbh			
WV	Wartluft, 1977	WT:	LN wt = 0.95595 + 2.42640 LN dbh	200	in lb	1-10 in
			General Softwoods			
NY	Monteith, 1979	^{L}WT:	wt = 4.5966 - (0.2364 x dbh) + (0.00411 x dbh^2)	130	mm m kg	25-550 mm (5-30 m)
		^{R}WT:	wt = 1.5773 + 0.1304 (dbh) - 1.2192 (ht) + 0.0001774 (dbh^2 x ht)			

__Appendix B__: Biomass estimates (aboveground oven-dry weight in kg) of tree components based on selected dbh (cm) or, where indicated by an *, dbh and height (m) values. Biomass estimates were calculated only for dbh or dbh and height values that fell within the range indicated in Appendix A.

Reference	Component	2.5 cm (5 m)	5.0 cm (7 m)	10.0 cm (12 m)	15.0 cm (15 m)	25.0 cm (20 m)	40.0 cm (25 m)	50.0 cm (30 m)
				Abies balsamea (Balsam fir)				
Baskerville, 1965a	WT:	0.6	3.2	17.3	49	178		
Ker, 1980	WT:	1.1	4.9	21.5	51	151		
MacLean & Wein, 1976	WT:	1.7	5.3	16.4	32			
Young et al., 1964	*St+Br:				23	75		
Young et al., 1980	WT:	0.8	4.4	21.6	58	198	623	1097
				Acer rubrum (Red maple)				
Brenneman et al., 1978	WT:		5.4	28.6	81	288	956	1726
Bridge, 1979	WT:			26.8	71	232		
Dunlap & Shipman, 1967	St:				59	256	560	773
Goldsmith & Hocker, 1978	St:	1.0	5.2	26.0				
	Br:	0.2	0.9	4.6				
	Tot:	1.2	6.1	30.6				
	St+Br:	1.2	6.0	29.8				
Hitchcock, 1978	*St+Br:	1.2	3.8					

Ker, 1980	WT:	1.1	5.5	27.5	70	230		
"	*WT:	1.1	5.2	26.3	69	220		
Kinerson & Bartholomew, 1977	St:		5.2	25.3				
	Br:		0.4	1.6				
	Lf:		0.2	1.1				
	Tot:		5.8	28.0				
MacLean & Wein, 1976	WT:	1.2	3.8	12.2				
Monteith, 1979	LWT:	1.1	4.0	33.6	95	313	877	1412
	*RWT:	1.2	4.4	23.2	68	234	716	1303
Phillips, 1977	*St+Br:	1.1	5.0	24.4	68			
	*St+Br:	0.8	4.4	25.6	79			
Reiners, 1972	FLf:	0.1	0.5	1.8	4	10	24	38
	Other:	1.3	6.1	26.7	68	216	640	1098
	Tot:	1.4	6.6	28.5	72	226	664	1136
Reynolds et al., 1978	St:			119.6	306			
	Br:			34.6	59			
	Lf:			0.9	2			
	Tot:			155.1	367			
Ribe, 1973	Lf:	0.1	0.5	1.5	3			
	Br:	0.2	0.8	2.8	6			
	St:	0.7	4.4	26.0	78			
	Tot:	1.0	5.7	30.3	87			
Wiant et al., 1977	St+Br:		4.9	26.9	78	285	969	
Wiant et al., 1979	*St+Br:		3.2	19.1	59	212	687	
Young et al., 1964	*St+Br:				57	188	574	
Young et al., 1980	WT:	1.2	6.0	29.6	79	266	828	1451

Continued

Reference	Component	2.5 cm (5 m)	5.0 cm (7 m)	10.0 cm (12 m)	15.0 cm (15 m)	25.0 cm (20 m)	40.0 cm (25 m)	50.0 cm (30 m)
				Acer saccharum (Sugar maple)				
Bickelhaupt et al., 1973	^{E}WT:	1.2	6.8	37.8	103	367	1177	
	WT:	1.8	8.8	44.2	114	373	1116	
Brenneman et al., 1978	WT:		6.6	36.8	107	394	1347	2472
Goldsmith & Hocker, 1978	St:	1.4	6.8	33.0	83			
	Br:	0.3	1.2	5.3	13			
	Tot:	1.7	8.0	38.3	96			
	St+Br:	2.9	13.5	63.4	157			
Monteith, 1979	^{L}WT:	0.8	6.0	44.7	121	389	1076	1723
	*^{R}WT:	0.8	7.4	36.2	106	371	1152	2131
Ribe, 1973	Lf:	0.1	0.4	1.1	2			
	Br:	0.2	0.7	2.1	4			
	St:	1.2	6.5	34.2	96			
	Tot:	1.5	7.6	37.4	102			
Whittaker et al., 1974	St:	1.1	5.6	28.8	75	253	772	1310
	Br:	0.1	0.5	4.0	13	61	246	478
	DdBr:	0.0	0.0	0.2	0	2	5	8
	Lf+Tw:	0.1	0.3	1.1	2	6	16	24
	Tot:	1.3	6.4	34.1	90	322	1039	1820
Young et al., 1980	WT:	1.6	7.9	37.7	99	324	986	1708

			Betula alleghaniensis (Yellow birch)					
Brenneman et al., 1978	WT:		7.3	35.7	95	318	990	1734
Monteith, 1979	^{L}WT:	2.8	5.7	39.4	111	366	1029	1659
	*^{R}WT:	0	5.0	30.7	101	359	1128	2104
Reiners, 1972	^{F}Lf:	0.1	0.4	1.2	2	6	13	19
	Other:	1.6	7.4	32.7	83	257	747	1265
	Tot:	1.7	7.8	33.9	85	263	760	1284
Ribe, 1973	Lf:	0.1	0.4	1.4	3			
	Br:	0.3	1.0	3.1	6			
	St:	0.9	5.4	29.1	83			
	Tot:	1.3	6.8	33.6	92			
Whittaker et al., 1974	St:	1.1	5.3	25.7	64	205	596	989
	Br:	0.2	1.0	7.1	22	93	346	645
	DdBr:	0.0	0.0	0.2	1	3	11	20
	Lf+Tw:	0.1	0.2	0.9	2	6	14	22
	Tot:	1.4	6.5	33.9	89	307	967	1676
Young et al., 1980	WT:	1.4	7.1	33.8	89	291	890	1544
			Betula lenta (Black birch)					
Brenneman et al., 1978	WT:		4.7	28.0	84	326	1160	2172

Continued

Appendix B -- Continued

Reference	Component	2.5 cm (5 m)	5.0 cm (7 m)	10.0 cm (12 m)	15.0 cm (15 m)	25.0 cm (20 m)	40.0 cm (25 m)	50.0 cm (30 m)
				Betula papyrifera (Paper birch)				
Baskerville, 1965a	WT:	0.8	4.4					
Goldsmith & Hocker, 1978	St:	1.3	5.5					
	Br:	0.1	0.5					
	Tot:	1.4	6.0					
	St+Br:	1.5	6.1					
Ker, 1980	WT:		5.4	29.0	78	269		
	*WT:		5.5	31.3	83	285		
Kinerson & Bartholomew, 1977	St:		4.2	31.1				
	Br:		0.3	6.0				
	Tot:		4.5	37.1				
MacLean & Wein, 1976	WT:	1.5	5.1	16.9	34			
Reiners, 1972	^{F}Lf:	0.0	0.2	0.9	2	7	18	30
	Other:	1.9	8.3	34.2	83	256	762	1323
	^{A}Tot:	1.9	8.5	35.1	85	263	780	1353
	Lf:	0.0	0.1	0.7	2	6	20	34
	Other:	1.3	6.2	29.7	80	275	919	1692
	^{B}Tot:	1.3	6.3	30.4	82	281	939	1726
Ribe, 1973	Lf:	0.1	0.5	1.5	3			
	Br:	0.3	0.8	2.7	6			
	St:	0.3	2.7	23.8	92			
	Tot:	0.7	4.0	28.0	101			

Young et al., 1964	*St+Br:				64	220		
Young et al., 1980	WT:	0.7	4.6	27.5	83	320	1141	2138
			Betula populifolia **(Gray birch)**					
Ker, 1980	WT:	1.0	5.0	25.0	64			
	*WT:	1.2	5.5	26.0	64			
Ribe, 1973	Lf:	0.1	0.2	0.7	1			
	Br:	0.3	0.9	2.7	5			
	St:	0.9	5.1	27.3	77			
	Tot:	1.3	6.2	30.7	84			
Young et al., 1980	WT:	1.4	6.7	31.6	82			
			Carya spp. **(Hickory)**					
Brenneman et al., 1978	WT:		5.7	33.3	99	377	1328	2472
Hitchcock, 1978	*St+Br:	1.7	6.8					
Myers et al., 1980	*†WT:				88	307	935	1680
Phillips, 1977	*St+Br:	1.2	6.0	32.4				
	*St+Br:	1.6	7.4	37.9				
Schnell, 1978	St+Br:		4.6	28.1	86	341	1243	2353
Wiant et al., 1977	St+Br:		5.4	31.1	92	348	1215	
Wiant et al., 1979	*St+Br:		4.6	30.7	90	341	1122	

Continued

Appendix B -- Continued

Reference	Component	2.5 cm (5 m)	5.0 cm (7 m)	10.0 cm (12 m)	15.0 cm (15 m)	25.0 cm (20 m)	40.0 cm (25 m)	50.0 cm (30 m)
			Fagus grandifolia (Beech)					
Brenneman et al., 1978	WT:		5.5	30.6	89	327	1118	2050
Monteith, 1979	^{L}WT:	1.7	7.0	44.5	118	372	1023	1636
	*^{R}WT:	1.3	6.8	39.3	107	387	1222	2276
Ribe, 1973	Lf:	0.1	0.4	1.4	3			
	Br:	0.4	1.2	3.2	6			
	St:	1.2	6.6	34.6	97			
	Tot:	1.7	8.2	39.2	106			
Whittaker et al., 1974	St:	1.0	5.1	26.7	70	240	741	1266
	Br:	0.3	1.6	9.3	26	96	320	565
	DdBr:	0.0	0.1	0.7	2	11	45	88
	Lf+Tw:	0.1	0.4	1.2	2	5	12	17
	Tot:	1.4	7.2	37.9	100	352	1118	1936
Young et al., 1980	WT:	1.7	8.4	39.2	101	326	977	1680
			Fraxinus americana (White ash)					
Brenneman et al., 1978	WT:		6.0	31.3	87	308	1006	1804
Monteith, 1979	^{L}WT:	1.2	6.7	40.4	104	324	880	1402
	*^{R}WT:	0	7.3	36.9	91	297	888	1621
Myers et al., 1980	*†WT:				58	228	780	1488

		Liriodendron tulipifera (Yellow Poplar)						
Brenneman et al., 1978	WT:		3.1	19.2	59	238	877	1670
Clark & Schroeder, 1977	*St+Br:				50	188	613	1182
Hitchcock, 1978	*St+Br:	1.3						
Myers et al., 1980	*†WT:				39	164	576	1191
Phillips, 1977	*St+Br:	0.6	3.2	19.3				
	*St+Br:	0.8	4.0	22.6				
Wiant et al., 1977	St+Br:		4.1	22.0	62	223	741	
Wiant et al., 1979	*St+Br:		3.1	19.7	56	208	666	
		Picea spp. (Spruce)						
Baskerville, 1965a	WT:	0.6	3.6	18.7	52	184		
Ker, 1980	^{G}WT:	0.8	4.1	20.2	51	165		
	^{H}WT:	1.2	5.6	25.3	61	186		
MacLean & Wein, 1976	^{I}WT:	2.6	7.6	22.5	42			
Monteith, 1979	^{L}WT:	1.9	3.5	24.3	68	226	638	1028
	*^{R}WT:	0	0	14.7	54	209	663	1156
Schlaegel, 1975	*^{G}St:		2.8	13.7	34	103		
	*^{H}St:		4.3	14.6	36	108		

Continued

Appendix B -- Continued

Reference	Component	2.5 cm (5 m)	5.0 cm (7 m)	10.0 cm (12 m)	15.0 cm (15 m)	25.0 cm (20 m)	40.0 cm (25 m)	50.0 cm (30 m)
				Picea spp. (cont.)				
Whittaker et al., 1974	[I]St:	0.7	3.4	15.7	38	118	333	545
	Br:	0.1	0.5	2.8	8	29	97	170
	DdBr:	0.1	0.4	1.8	4	12	34	53
	Lf+Tw:	0.0	0.1	0.3	1	1	3	4
	Tot:	0.9	4.4	20.6	51	160	467	772
Young et al., 1964	*[I]St+Br:					165	502	
Young et al., 1980	WT:	1.0	5.1	24.3	64	208	634	1099
				Pinus resinosa (Red pine)				
Dunlap & Shipman, 1967	[E]St+Br:			10.7	43	105	201	268
Ker, 1980	WT:	0.8	4.1	21.0	54	181		
	*WT:	0.9	4.1	21.7	55	177		
Schlaegel, 1975	*St:		2.2	16.2	44	154		
Young et al., 1980	WT:	0.9	4.9	23.9	64	215	673	1181
				Pinus strobus (White pine)				
Kinerson & Bartholomew, 1977	St:		2.8	13.3	34			
	Br:		0.4	2.6	8			
	Lf:		0.0	0.2	0			
	Tot:		3.2	16.1	42			
MacLean & Wein, 1976	WT:	2.2	5.5	14.0	24			

Monteith, 1979	^{L}WT:	0.6	1.8	18.6	55	184	521	841
	*^{R}WT:	0.1	3.1	19.6	63	216	694	1158
Swank & Schreuder, 1974	Lf:	0.2	0.7	2.9	7			
	Br:	0.2	1.4	8.0	22			
	St:	0.4	1.9	8.4	20			
	Tot:	0.8	4.0	19.3	59			
Young et al., 1964	*St+Br:				55	179		
Young et al., 1980	WT:	0.7	3.7	19.1	53	183	588	1047
				Populus spp.	(Aspen)			
Goldsmith & Hocker, 1978	St:	0.7	3.0	13.3	32			
	Br:	0.1	0.8	5.0	15			
	Tot:	0.8	3.8	18.3	47			
	St+Br:	0.8	3.8	17.4	42			
Ker, 1980	WT:	0.7	4.0	22.1	60	215		
Koerper & Richardson, 1980	^{D}Lf:	0.0	0.1	0.5	1	4	10	16
	Other:	0.6	4.0	23.3	69	254	879	1586
	Tot:	0.6	4.1	23.8	70	258	889	1602
MacLean & Wein, 1976	WT:	1.1	4.5	19.0	44			
Monteith, 1979	^{L}WT:	2.1	2.2	24.2	75	264	765	1244
	*^{R}WT:	0.3	3.1	22.6	69	262	841	1572
Ribe, 1973	Lf:	0.1	0.3	1.0	2			
	Br:	0.2	0.6	2.1	4			
	St:	0.5	3.2	20.6	65			
	Tot:	0.8	4.1	23.7	71			
Schlaegel, 1975	*St:		2.4	15.2	41	147		

Continued

Appendix B -- Continued

Reference	Component	2.5 cm (5 m)	5.0 cm (7 m)	10.0 cm (12 m)	15.0 cm (15 m)	25.0 cm (20 m)	40.0 cm (25 m)	50.0 cm (30 m)
				Populus spp. (cont.)				
Young et al., 1964	*St+Br:				49	166		
Young et al., 1980	WT:	0.7	4.4	25.2	74	279	971	1796
				Prunus pensylvanica (Pin cherry)				
MacLean & Wein, 1976	WT:	1.0	3.4	10.9				
Ribe, 1973	Lf:	0.1	0.5	1.8	4			
	Br:	0.2	0.9	3.2	7			
	St:	0.8	5.4	18.6	48			
	Tot:	1.1	5.4	23.6	59			
Young et al., 1980	WT:	1.2	5.5	23.9	59			
				Prunus serotina (Black cherry)				
Brenneman et al., 1978	WT:		5.0	28.9	85	322	1125	2086
Hitchcock, 1978	*St+Br:	1.3	4.0					
Wiant et al., 1977	St+Br:		6.3	31.9	87	298	948	
Wiant et al., 1979	*St+Br:		4.7	28.9	80	287	896	
				Quercus alba (White oak)				
Brenneman et al., 1978	WT:		4.6	27.6	84	328	1186	2234
Bridge, 1979	WT:			21.2	69	292		

Dunlap & Shipman, 1967	*St+Br:			19.9	61	234	759	1456
Hitchcock, 1978	*St+Br:	2.1	6.0					
Myers et al., 1980	*†WT:				74	260	833	1446
Phillips, 1977	*St+Br:	1.4	6.2	31.6				
	*St+Br:	1.4	6.0	27.6				
Reiners, 1972	F_{Lf}:	0.1	0.4	1.3	3	6	14	21
	Other:	0.9	5.5	31.9	96	382	1415	2712
	Tot:	1.0	5.9	33.2	99	388	1429	2733
Whittaker & Woodwell, 1968	St+Br:	1.5	6.6	29.7	71			
	Lf+Tw:	0.2	0.6	2.1	4			
	Tot:	1.7	7.2	31.8	75			
Wiant et al., 1977	St+Br:		3.8	23.1	71	278	1010	
Wiant et al., 1979	*St+Br:		4.0	27.0	79	302	1000	
Quercus coccinea **(Scarlet oak)**								
Clark et al., 1980a	*St+Br:				94	351	1133	2170
Whittaker & Woodwell, 1968	St+Br:	1.8	8.4	38.4	93			
	Lf+Tw:	0.3	1.0	3.2	6			
	Tot:	2.1	9.4	41.6	99			
Wiant et al., 1977	St+Br:		6.5	33.3	92	316	1012	
Wiant et al., 1979	*St+Br:		6.1	35.4	96	330	996	

Continued

Appendix B -- Continued

Reference	Component	2.5 cm (5 m)	5.0 cm (7 m)	10.0 cm (12 m)	15.0 cm (15 m)	25.0 cm (20 m)	40.0 cm (25 m)	50.0 cm (30 m)
				Quercus prinus (Chestnut oak)				
Brenneman et al., 1978	WT:		4.7	28.8	89	356	1308	2489
Hitchcock, 1978	*St+Br:	1.8						
Phillips, 1977	*St+Br:	1.5	6.6	31.4				
Wiant et al., 1977	St+Br:		5.6	30.3	86	313	1049	
Wiant et al., 1979	*St+Br:		3.8	27.6	85	343	1194	
				Quercus rubra (Northern red oak)				
Brenneman et al., 1978	WT:		6.1	31.6	87	304	984	1756
Clark et al., 1980b	*St+Br:				86	321	1040	1995
Goldsmith & Hocker, 1978	St:	1.3	6.1	28.8				
	Br:	0.1	0.7	4.6				
	Tot:	1.4	6.8	33.4				
	St&Br:	1.4	6.9	33.9				
Hitchcock, 1978	*St&Br:	2.1	8.9					
Kinerson & Bartholomew, 1977	St:		5.2	29.2				
	Br:		0.6	4.9				
	Lf:		0.3	1.6				
	Tot:		6.1	35.7				
Myers et al., 1980	*†WT:				55	230	831	1641
Monteith, 1979	LWT:	2.7	4.0	35.2	105	360	1029	1668
	*RWT:	0.2	6.2	33.7	100	364	1136	2086

Phillips, 1977	*St+Br:	1.9	7.6	32.9				
Wiant et al., 1977	St+Br:		4.8	28.6	86	332	1182	
Wiant et al., 1979	*St+Br:		4.8	30.7	88	323	1035	
				Quercus velutina (Black oak)				
Bridge, 1979	WT:			26.5	80	307		
King & Schnell, 1972	CT:						1518	2494
	- Rt:						379	625
	Tot:						1139	1869
Myers et al., 1980	*†WT:				56	236	842	1663
Wiant et al., 1977	St+Br:		5.5	29.4	83	295	974	
Wiant et al., 1979	*St+Br:		5.2	32.1	90	322	1006	
				Tsuga canadensis (Hemlock)				
Brenneman et al., 1978	WT:		3.3	17.1	47	164	527	940
Monteith, 1979	^{L}WT:	1.8	2.9	21.3	61	204	580	938
	*^{R}WT:	0	3.6	23.5	61	198	579	984
Young et al., 1964	*St+Br:				38	127		
Young et al., 1980	WT:	0.9	4.6	22.3	59	196	607	1059

Continued

Appendix B -- Continued

Reference	Component	2.5 cm (5 m)	5.0 cm (7 m)	10.0 cm (12 m)	15.0 cm (15 m)	25.0 cm (20 m)	40.0 cm (25 m)	50.0 cm (30 m)
				General Hardwoods				
Harris et al., 1973	St:			22.9	61	210	654	1121
	Br:			6.9	17	53	152	250
	Lf:			1.5	3	7	16	23
	Tot:			31.3	81	270	822	1394
Kinerson & Bartholomew, 1977	St:	0.9	5.1	27.3				
	Br:	0.1	0.5	3.2				
	Lf:	0.0	0.2	1.3				
	Tot:	1.0	5.8	31.8				
Monk et al., 1970	WT:	1.0	5.6	32.6	91	333	1097	1933
Monteith, 1979	^{L}WT:	1.2	5.1	37.5	103	331	920	1476
	*^{R}WT:	1.2	5.6	33.1	90	326	1033	1929
Ribe, 1973	Lf:	0.1	0.4	1.2	13			
	Br:	0.3	0.9	2.6	5			
	St:	0.6	4.1	23.8	71			
	Tot:	1.0	5.4	27.6	89			
Wartluft, 1977	WT:	1.2	6.3	32.1	88	300		
				General Softwoods				
Monteith, 1979	^{L}WT:	1.3	3.0	22.1	62	202	568	914
	^{R}WT:	0	2.7	21.3	63	232	733	1361

Appendix C: Aboveground, living biomass of different forest types.

Reference	Vegetation Type	Location	Stand Age Years	Density Stems/ha	Basal Area m^2/ha	Stand Biomass t/ha
Alban et al., 1978	Aspen	MN	40	---	---	205
Baskerville, 1965a	Fir, spruce, birch	NB	40	283	---	114
				405	---	109
				607	---	121
				810	---	137
				1215	---	151
				2024	---	166
Baskerville, 1965b	Balsam fir	NB	42	---	28	79
Berry, 1973	Aspen	ON	1	59000	---	1
			2	49400	---	3
			3	29000	---	5
			4	23300	---	8
Bickelhaupt et al., 1973	Sugar maple	NY	40-45	---	23	154
Bray & Dudkiewicz, 1963	Aspen	WI	45	---	---	208
Bridge, 1979	Oak	RI	50	---	21	117
	Maple		52	---	19	94
	Oak-maple		36	---	21	110
Brenneman et al., 1978	Mixed hardwoods + hemlock	WV	63	---	32	197
Crow, 1978	Aspen	WI	<50	---	18	95
	Aspen-maple-birch		<50	---	16	96
	Maple-birch-aspen		<50	---	19	119

Frederick et al., 1979	Mixed hardwoods + hemlock	WV	63	---	28	205
Harris et al., 1973	Oak-hickory	TN	---	---	---	122
	Chestnut oak					138
	Yellow poplar					109
Henderson et al., 1978	Oak-hickory	TN	uneven	---	---	156
		NC	uneven	---	---	190
Hornbeck, 1977	Beech-birch-maple	NH	90	---	27	203
Koerper & Richardson, 1980	Aspen	MI	55	12690	---	309
Lang & Forman, 1978	Oak	NJ	>250	---	---	240
MacLean & Wein, 1976	Mixed hardwoods of fire origin	NB	7	1	---	1
			7	1	---	2
			7	1	---	9
			10	2	---	9
			13	2	---	10
			17	1	---	8
			18	2	---	8
			20	1	---	30
			25	2	---	22
			29	2	---	40
			37	4	---	32
Marks, 1974	Beech, birch, maple	NH	1	---	---	1
			4	---	---	4
			6	---	---	14
			14	---	---	72
Martin, 1977	Northern hardwood-spruce-fir	NH	>200	---	28	260
Monk et al., 1970	Oak-hickory	GA	--	---	---	145
Norton, 1975	Softwood	ME	mature	---	724	226

Continued

Appendix C -- Continued

Reference	Vegetation Type	Location	Stand Age Years	Density Stems/ha	Basal Area m^2/ha	Stand Biomass t/ha
Ovington et al., 1963	Oak	MN	60	---	---	164
Patric & Smith, 1975	Oak-maple	WV	75	---	---	94
Post, 1970	Mountain maple	NB	1	---	---	1
			3	---	---	2
			8	33300	---	13
			11	22800	---	16
			13	18300	---	23
			16	18400	---	26
			18	8500	---	22
			21	6700	---	34
			23	6700	---	31
			26	6800	---	40
Reiners, 1972	Oak forest	MN	45-50	---	26	125
	Marginal fen		45-50	---	25	99
	Cedar swamp		70-100	---	42	160
Reynolds et al., 1978	Red maple-magnolia-tupelo	NJ	>80	---	15	316
Rolfe et al., 1978	Oak-hickory	IL	~150	---	139	190-195
Schlaegel, 1975	Red pine	MN	40	---	52	147
	Aspen		40	---	35	104
	White spruce		40	---	41	88
	Black spruce		40	---	33	70
Skeen, 1973	Mixed deciduous	TN	mature	---	43	420
Skeen, 1974	Mixed hardwood-pine	GA	old	---	38	356
Swank & Schreuder, 1974	Eastern white pine	NC	10	---	7	17

Telfer, 1972	Coniferous	NS	--	---	34	120
				---	15	36
	Mixed-wood			---	27	102
				---	17	71
	Deciduous			---	19	80
Tritton, 1980	Beech-birch-maple	NH	10	---	---	51
			20	---	---	112
			30	---	---	142
			40	---	---	202
			57	---	---	287
			60	---	---	196
			83	---	---	217
			old	---	---	266
Weaver & DeSelm, 1973	Yellow birch	NC	40-60	---	---	103
	Yellow birch		≥100	---	---	153
	Red spruce-Fraser fir		40-60	---	---	180
Weetman & Webber, 1972	Black spruce (upland)	QU	65	---	---	107
Whittaker, 1963, 1966	Pine forest			---	35	184
	Pine forest			---	26	134
	Hemlock-beech forest			---	29	197
	Hemlock-rhododendron forest			---	61	514
	Spruce-rhododendron forest			---	56	324
	Deciduous forest			---	53	504
	Cove forest transition			---	27	174
	Oak-hickory transition			---	31	374
	Chestnut-oak forest			---	35	427
	Tulip tree forest			---	34	224
	Upper Cove forest			---	54	504
	Hemlock-mixed			---	64	614
	Gray beech, south			---	22	133
	Gray beech, north			---	28	173
	Red oak forest			---	24	140
	Red-white oak forest			---	22	90
	Spruce-fir forest, north			---	56	344
	Spruce-fir forest, south			---	50	313
	Spruce-fir forest			---	60	303

Continued

Appendix C -- Continued

Reference	Vegetation Type	Location	Stand Age Years	Density Stems/ha	Basal Area m^2/ha	Stand Biomass t/ha
Whittaker, cont.	Fir forest, north			---	40	212
	Fir forest, south			---	56	202
Whittaker et al., 1974	Beech-birch-maple	NH	50	---	---	131
Wood & Hutnik, 1972	Mixed-oak	PA	55	---	---	274

☆U.S. GOVERNMENT PRINTING OFFICE: 1982-505-012:14

Tritton, Louise M.; Hornbeck, James W. Biomass equations for major tree species of the Northeast. Broomall, PA: Northeast. For. Exp. Stn.; 1982; USDA For. Serv. Gen. Tech. Rep. NE-69. 46 p.

Literature on biomass is reviewed, and 178 sets of published equations for 25 species common to the Northeastern United States are listed. On the basis of these equations, estimates of aboveground oven-dry weight of trees from 2.5 to 50.0 cm dbh for each species are presented and discussed.

Keywords: whole-tree, weight estimation, regression equations, stand biomass, dimension analysis, standing crop