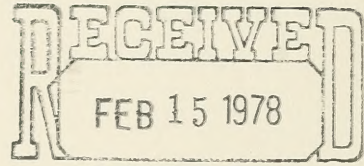


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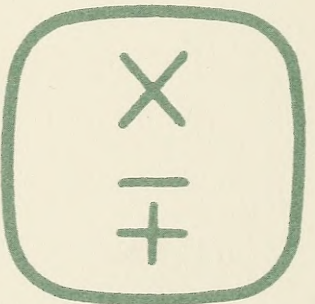
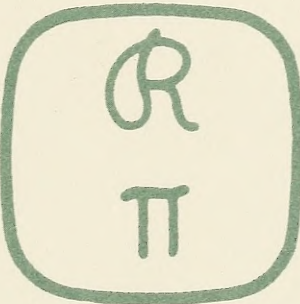
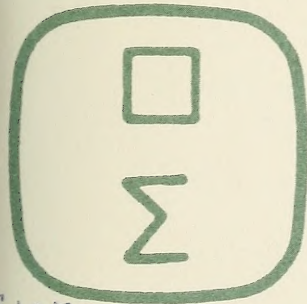
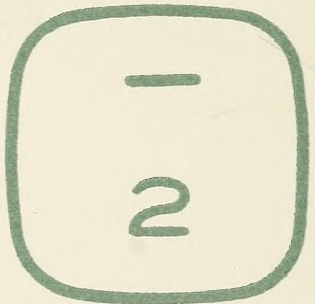
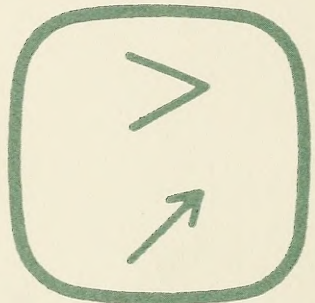
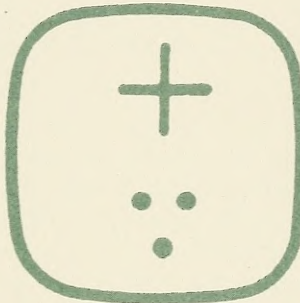
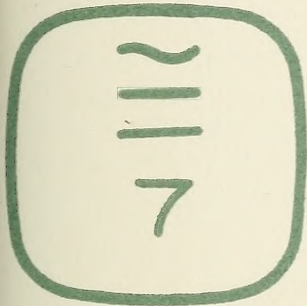
# Tables and Procedures for Estimating Weights of Some Appalachian Hardwoods

Bulletin 659T  
December 1977

West Virginia University  
Agricultural and Forestry Experiment Station



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## **ACKNOWLEDGMENTS**

Appreciation is extended to the Westvaco Corporation, and especially Mr. Bruce B. Brenneman, Research Center Leader at Rupert, West Virginia, for their cooperation and review of the manuscript and to the West Virginia Department of Natural Resources for the use of the West Virginia University Forest. Thanks are expressed to others who reviewed the manuscript, including Dr. Harold E. Young, University of Maine; Mr. Jeffrey L. Wartluft, USDA Forest Service; and Professor William R. Maxey, West Virginia University

**West Virginia University  
Agricultural and Forestry Experiment Station  
College of Agriculture and Forestry  
Dale W. Zinn, Director  
Morgantown**

## PREFACE

The weight tables in this publication, while based on data collected in northern West Virginia, may prove useful in other areas of the Appalachian region; however, they should be adequately tested before they are utilized elsewhere. The sampling procedures described are of more general utility.



# Contents

|  |    |
|--|----|
| Weight Tables . . . . .                                | 1  |
| Procedure . . . . .                                    | 1  |
| Results . . . . .                                      | 2  |
| Field Estimates of Weight . . . . .                    | 2  |
| Weight Estimates When Marking Timber . . . . .         | 15 |
| Weight Estimates Using Fixed-Area Plots . . . . .      | 15 |
| Weight Estimates Using Point Samples . . . . .         | 17 |
| Weight Estimates Using Point and 3P Sampling . . . . . | 18 |
| Computerized Approach . . . . .                        | 21 |
| Combined Equations for Red and White Oaks . . . . .    | 22 |
| Selected References . . . . .                          | 36 |

## TABLES

|   |    |
|---|----|
| 1. Total tree green weight . . . . .  | 3  |
| 2. Total tree dry weight . . . . .  | 4  |
| 3. Total tree dry weight without bark . . . . .                                       | 5  |
| 4. Total tree dry weight of bark . . . . .  | 6  |
| 5. Green weight of branches . . . . .   | 7  |
| 6. Dry weight of branches . . . . .   | 8  |
| 7. Dry weight of branches without bark . . . . .                                      | 9  |
| 8. Dry weight of branch bark . . . . .  | 10 |
| 9. Green weight to a 4-inch dob . . . . .   | 11 |
| 10. Dry weight to a 4-inch dob . . . . .  | 12 |
| 11. Dry weight without bark to a 4-inch dob . . . . .                                 | 13 |
| 12. Dry weight of bark to a 4-inch dob . . . . .                                      | 14 |
| 13. Total tree green weight per acre per in-tree (BAF = 10) . . . . .                 | 23 |
| 14. Total tree dry weight per acre per in-tree (BAF = 10) . . . . .                   | 24 |
| 15. Total tree dry weight without bark per acre per in-tree (BAF = 10) . . . . .      | 25 |
| 16. Total tree dry weight of bark per acre per in-tree (BAF = 10) . . . . .           | 26 |
| 17. Green weight of branches per acre per in-tree (BAF = 10) . . . . .                | 27 |
| 18. Dry weight of branches per acre per in-tree (BAF = 10) . . . . .                  | 28 |
| 19. Dry weight of branches without bark per acre per in-tree (BAF = 10) . . . . .     | 29 |
| 20. Dry weight of branch bark per acre per in-tree (BAF = 10) . . . . .               | 30 |
| 21. Green weight to a 4-inch dob per acre per in-tree (BAF = 10) . . . . .            | 31 |
| 22. Dry weight to a 4-inch dob per acre per in-tree (BAF = 10) . . . . .              | 32 |
| 23. Dry weight without bark to a 4-inch dob per acre per in-tree (BAF = 10) . . . . . | 33 |
| 24. Dry weight of bark to a 4-inch dob per acre per in-tree (BAF = 10) . . . . .      | 34 |
| 25. Weight equations for the red oak and white oak groups . . . . .                   | 35 |

# Contents

|     |                                     |
|-----|-------------------------------------|
| 1   | Introduction                        |
| 2   | 1.1. The problem                    |
| 3   | 1.2. The method                     |
| 4   | 1.3. The results                    |
| 5   | 1.4. The conclusions                |
| 6   | 2. The theory                       |
| 7   | 2.1. The general case               |
| 8   | 2.2. The special case               |
| 9   | 2.3. The asymptotic expansion       |
| 10  | 2.4. The numerical solution         |
| 11  | 2.5. The error analysis             |
| 12  | 3. The application                  |
| 13  | 3.1. The physical model             |
| 14  | 3.2. The mathematical model         |
| 15  | 3.3. The numerical results          |
| 16  | 3.4. The comparison with experiment |
| 17  | 3.5. The discussion                 |
| 18  | 4. The summary                      |
| 19  | 4.1. The main results               |
| 20  | 4.2. The conclusions                |
| 21  | 4.3. The future work                |
| 22  | 5. The references                   |
| 23  | 5.1. The list of references         |
| 24  | 5.2. The bibliography               |
| 25  | 5.3. The references cited           |
| 26  | 5.4. The references consulted       |
| 27  | 5.5. The references used            |
| 28  | 5.6. The references mentioned       |
| 29  | 5.7. The references given           |
| 30  | 5.8. The references referred to     |
| 31  | 5.9. The references alluded to      |
| 32  | 5.10. The references pointed out    |
| 33  | 5.11. The references noted          |
| 34  | 5.12. The references observed       |
| 35  | 5.13. The references perceived      |
| 36  | 5.14. The references felt           |
| 37  | 5.15. The references known          |
| 38  | 5.16. The references understood     |
| 39  | 5.17. The references appreciated    |
| 40  | 5.18. The references valued         |
| 41  | 5.19. The references honored        |
| 42  | 5.20. The references revered        |
| 43  | 5.21. The references respected      |
| 44  | 5.22. The references admired        |
| 45  | 5.23. The references looked up to   |
| 46  | 5.24. The references followed       |
| 47  | 5.25. The references imitated       |
| 48  | 5.26. The references copied         |
| 49  | 5.27. The references plagiarized    |
| 50  | 5.28. The references parodied       |
| 51  | 5.29. The references spoofed        |
| 52  | 5.30. The references mimicked       |
| 53  | 5.31. The references parodied       |
| 54  | 5.32. The references spoofed        |
| 55  | 5.33. The references mimicked       |
| 56  | 5.34. The references parodied       |
| 57  | 5.35. The references spoofed        |
| 58  | 5.36. The references mimicked       |
| 59  | 5.37. The references parodied       |
| 60  | 5.38. The references spoofed        |
| 61  | 5.39. The references mimicked       |
| 62  | 5.40. The references parodied       |
| 63  | 5.41. The references spoofed        |
| 64  | 5.42. The references mimicked       |
| 65  | 5.43. The references parodied       |
| 66  | 5.44. The references spoofed        |
| 67  | 5.45. The references mimicked       |
| 68  | 5.46. The references parodied       |
| 69  | 5.47. The references spoofed        |
| 70  | 5.48. The references mimicked       |
| 71  | 5.49. The references parodied       |
| 72  | 5.50. The references spoofed        |
| 73  | 5.51. The references mimicked       |
| 74  | 5.52. The references parodied       |
| 75  | 5.53. The references spoofed        |
| 76  | 5.54. The references mimicked       |
| 77  | 5.55. The references parodied       |
| 78  | 5.56. The references spoofed        |
| 79  | 5.57. The references mimicked       |
| 80  | 5.58. The references parodied       |
| 81  | 5.59. The references spoofed        |
| 82  | 5.60. The references mimicked       |
| 83  | 5.61. The references parodied       |
| 84  | 5.62. The references spoofed        |
| 85  | 5.63. The references mimicked       |
| 86  | 5.64. The references parodied       |
| 87  | 5.65. The references spoofed        |
| 88  | 5.66. The references mimicked       |
| 89  | 5.67. The references parodied       |
| 90  | 5.68. The references spoofed        |
| 91  | 5.69. The references mimicked       |
| 92  | 5.70. The references parodied       |
| 93  | 5.71. The references spoofed        |
| 94  | 5.72. The references mimicked       |
| 95  | 5.73. The references parodied       |
| 96  | 5.74. The references spoofed        |
| 97  | 5.75. The references mimicked       |
| 98  | 5.76. The references parodied       |
| 99  | 5.77. The references spoofed        |
| 100 | 5.78. The references mimicked       |
| 101 | 5.79. The references parodied       |
| 102 | 5.80. The references spoofed        |
| 103 | 5.81. The references mimicked       |
| 104 | 5.82. The references parodied       |
| 105 | 5.83. The references spoofed        |
| 106 | 5.84. The references mimicked       |
| 107 | 5.85. The references parodied       |
| 108 | 5.86. The references spoofed        |
| 109 | 5.87. The references mimicked       |
| 110 | 5.88. The references parodied       |
| 111 | 5.89. The references spoofed        |
| 112 | 5.90. The references mimicked       |
| 113 | 5.91. The references parodied       |
| 114 | 5.92. The references spoofed        |
| 115 | 5.93. The references mimicked       |
| 116 | 5.94. The references parodied       |
| 117 | 5.95. The references spoofed        |
| 118 | 5.96. The references mimicked       |
| 119 | 5.97. The references parodied       |
| 120 | 5.98. The references spoofed        |
| 121 | 5.99. The references mimicked       |
| 122 | 5.100. The references parodied      |



# Tables and Procedures for Estimating Weights of Some Appalachian Hardwoods

Harry V. Wiant, Jr., Carter E. Sheetz, Andrew Colaninno,  
James C. DeMoss, and Froylan Castaneda

## WEIGHT TABLES

The introduction of whole-tree chipping operations in West Virginia forests has stimulated interest in the development of weight tables for field use. These tables facilitate the estimation of weight of standing trees to be chipped and eliminate the need to convert from cords or cubic feet to weight. Weight tables were developed for some Appalachian hardwoods in northern West Virginia.

### Procedure

Nineteen to 22 trees, ranging from 2 to 16 inches in diameter at 4.5 feet (dbh), were selected for study on or near the West Virginia University Forest<sup>1</sup> near Morgantown for each of the following species:

| Code | Species  |
|------|--|
| NRO  | northern red oak ( <i>Quercus rubra</i> )        |
| BO   | black oak ( <i>Q. velutina</i> )                 |
| SO   | scarlet oak ( <i>Q. coccinea</i> )               |
| WO   | white oak ( <i>Q. alba</i> )                     |
| CO   | chestnut oak ( <i>Q. prinus</i> )                |
| YP   | yellow-poplar ( <i>Liriodendron tulipifera</i> ) |
| H    | hickories ( <i>Carya</i> spp.)                   |
| BC   | black cherry ( <i>Prunus serotina</i> )          |
| RM   | red maple ( <i>Acer rubrum</i> )                 |

Trees were felled, sectioned, and weighed in the field, and oven-dried weights were determined from wedge-shaped samples taken at 4-foot bucking points and from branch samples. All stem material less than 4 inches, diameter outside bark (dob), and limbs were considered as branches. Stumps, approximately ½-foot, roots, and leaves were not included in this study.

<sup>1</sup>The West Virginia University Forest is evenaged, about 45 years old, with an average site index, using Schnur's (1937) curves, of 73.

## Results

Analyses indicated dbh accounted for most of the variation in total oven-dry weight. Inclusion of total or merchantable heights did not improve relationships appreciably. This indicates the value of local weight tables, using dbh alone, for weight estimations. Tables 1 to 12 give green and dry weights for the various species.

Regression models tested included:

$$W = a + bD^2$$

$$W = a + bD + cD^2$$

$$W = aD^b$$

where: W = weight in pounds

D = dbh

a, b, and c = regression constants

Although there are more sophisticated statistical procedures, models providing the best  $R^2$ -values (or  $r^2$ ) were accepted and are given with their standard errors and standard errors as a percent of the W-means below each table. It should be noted that the reliability of equations, as indicated by standard errors, was better for total tree weights than for branch material.

If weights for species not included in this study are desired, it may be possible to use values for a closely related species in terms of growth habit, wood density, etc. For example, four trees for each of several minor species, selected to span the dbh-range, indicated total weights of cucumbertree (*Magnolia acuminata*) and bigtooth aspen (*Populus grandidentata*) are approximated by yellow-poplar; and sweet birch (*Betula lenta*) by black cherry.

## FIELD ESTIMATES OF WEIGHT

Weight estimates in the field can be made using the same basic techniques utilized for cubic-foot or board-foot volume determinations. An unrealistically simple example will be used to illustrate the procedures, much of which could be computerized. Assume we are interested in total dry weights of species A and B, and that those species occur in only two diameter classes, 5 and 10 inches, as follows:

| Dbh | Total dry weight (lbs.) |           |
|-----|-------------------------|-----------|
|     | Species A               | Species B |
| 5   | 100                     | 125       |
| 10  | 650                     | 730       |

Table 1  
Total tree green weight.\*

| Dbh (in.) | Species                         |      |      |      |      |      |      |      |      |  |  | H              | BC          | RM |  |  |  |
|-----------|---------------------------------|------|------|------|------|------|------|------|------|--|--|----------------|-------------|----|--|--|--|
|           | NRO                             | BO   | SO   | WO   | CO   | YP   | H    | BC   | RM   |  |  |                |             |    |  |  |  |
| 2         | 18                              | 22   | 25   | 14   | 20   | 21   | 18   | 26   | 21   |  |  |                |             |    |  |  |  |
| 3         | 54                              | 60   | 67   | 42   | 56   | 57   | 53   | 67   | 59   |  |  |                |             |    |  |  |  |
| 4         | 116                             | 123  | 136  | 92   | 118  | 113  | 113  | 133  | 122  |  |  |                |             |    |  |  |  |
| 5         | 211                             | 215  | 233  | 170  | 208  | 192  | 202  | 227  | 213  |  |  |                |             |    |  |  |  |
| 6         | 343                             | 338  | 363  | 281  | 332  | 297  | 326  | 350  | 336  |  |  |                |             |    |  |  |  |
| 7         | 518                             | 496  | 529  | 429  | 492  | 430  | 489  | 504  | 494  |  |  |                |             |    |  |  |  |
| 8         | 740                             | 691  | 731  | 619  | 693  | 591  | 694  | 693  | 691  |  |  |                |             |    |  |  |  |
| 9         | 1013                            | 926  | 974  | 855  | 936  | 784  | 945  | 916  | 927  |  |  |                |             |    |  |  |  |
| 10        | 1342                            | 1204 | 1258 | 1142 | 1226 | 1008 | 1246 | 1177 | 1207 |  |  |                |             |    |  |  |  |
| 11        | 1731                            | 1526 | 1586 | 1484 | 1564 | 1266 | 1600 | 1476 | 1533 |  |  |                |             |    |  |  |  |
| 12        | 2184                            | 1895 | 1960 | 1885 | 1954 | 1559 | 2011 | 1815 | 1906 |  |  |                |             |    |  |  |  |
| 13        | 2704                            | 2313 | 2381 | 2348 | 2398 | 1888 | 2481 | 2195 | 2329 |  |  |                |             |    |  |  |  |
| 14        | 3296                            | 2781 | 2850 | 2878 | 2898 | 2253 | 3014 | 2617 | 2804 |  |  |                |             |    |  |  |  |
| 15        | 3952                            | 3302 | 3371 | 3479 | 3458 | 2658 | 3612 | 3083 | 3333 |  |  |                |             |    |  |  |  |
| 16        | 4707                            | 3877 | 3943 | 4154 | 4078 | 3101 | 4278 | 3594 | 3918 |  |  |                |             |    |  |  |  |
| Species   | Equation used                   |      |      |      |      |      |      |      |      |  |  | Standard error |             |    |  |  |  |
| NRO       | W = 2.87249D <sup>2.66958</sup> |      |      |      |      |      |      |      |      |  |  | Pounds         | % of W-mean |    |  |  |  |
| BO        | W = 3.91058D <sup>2.48832</sup> |      |      |      |      |      |      |      |      |  |  | 129            | 10          |    |  |  |  |
| SO        | W = 4.66811D <sup>2.43058</sup> |      |      |      |      |      |      |      |      |  |  | 86             | 7           |    |  |  |  |
| WO        | W = 2.04530D <sup>2.74698</sup> |      |      |      |      |      |      |      |      |  |  | 81             | 6           |    |  |  |  |
| CO        | W = 3.39314D <sup>2.55778</sup> |      |      |      |      |      |      |      |      |  |  | 127            | 10          |    |  |  |  |
| YP        | W = 4.09609D <sup>2.39108</sup> |      |      |      |      |      |      |      |      |  |  | 109            | 9           |    |  |  |  |
| H         | W = 2.96160D <sup>2.62410</sup> |      |      |      |      |      |      |      |      |  |  | 63             | 6           |    |  |  |  |
| BC        | W = 4.95555D <sup>2.37562</sup> |      |      |      |      |      |      |      |      |  |  | 145            | 13          |    |  |  |  |
| RM        | W = 3.78003D <sup>2.50438</sup> |      |      |      |      |      |      |      |      |  |  | 75             | 7           |    |  |  |  |
|           |                                 |      |      |      |      |      |      |      |      |  |  | 123            | 12          |    |  |  |  |

\*Weights in tables 1 to 12 are in pounds.

Table 2

Total tree dry weight.

| Dbh (in.) | Species                         |                |        |             |      |      |      |      |      |      |                | RM |
|-----------|---------------------------------|----------------|--------|-------------|------|------|------|------|------|------|----------------|----|
|           | NRO                             | BO             | SO     | WO          | CO   | YP   | H    | BC   | RM   |      |                |    |
| 2         | 11                              | 12             | 14     | 8           | 12   | 9    | 12   | 14   | 11   | 11   |                |    |
| 3         | 31                              | 34             | 39     | 25          | 34   | 25   | 34   | 37   | 30   | 30   |                |    |
| 4         | 67                              | 69             | 78     | 55          | 71   | 52   | 73   | 75   | 63   | 63   |                |    |
| 5         | 122                             | 121            | 135    | 100         | 125  | 90   | 131  | 128  | 112  | 112  |                |    |
| 6         | 198                             | 190            | 210    | 163         | 199  | 143  | 212  | 200  | 179  | 179  |                |    |
| 7         | 299                             | 280            | 306    | 247         | 294  | 211  | 317  | 290  | 265  | 265  |                |    |
| 8         | 426                             | 391            | 424    | 354         | 412  | 295  | 450  | 401  | 374  | 374  |                |    |
| 9         | 583                             | 525            | 565    | 487         | 556  | 397  | 613  | 534  | 505  | 505  |                |    |
| 10        | 772                             | 683            | 731    | 648         | 726  | 517  | 808  | 689  | 662  | 662  |                |    |
| 11        | 994                             | 867            | 922    | 838         | 924  | 657  | 1037 | 868  | 845  | 845  |                |    |
| 12        | 1253                            | 1078           | 1141   | 1060        | 1152 | 818  | 1303 | 1072 | 1056 | 1056 |                |    |
| 13        | 1551                            | 1318           | 1386   | 1315        | 1411 | 1000 | 1607 | 1302 | 1296 | 1296 |                |    |
| 14        | 1888                            | 1586           | 1661   | 1607        | 1703 | 1205 | 1951 | 1559 | 1567 | 1567 |                |    |
| 15        | 2269                            | 1885           | 1966   | 1936        | 2028 | 1433 | 2338 | 1842 | 1870 | 1870 |                |    |
| 16        | 2694                            | 2216           | 2301   | 2305        | 2388 | 1686 | 2769 | 2155 | 2206 | 2206 |                |    |
|           |                                 |                |        |             |      |      |      |      |      |      | Standard error |    |
| Species   | Equation used                   | R <sup>2</sup> | Pounds | % of W-mean |      |      |      |      |      |      |                |    |
| NRO       | W = 1.68914D <sup>2.65978</sup> | .988           | 79     | 11          |      |      |      |      |      |      |                |    |
| BO        | W = 2.14567D <sup>2.50304</sup> | .994           | 50     | 7           |      |      |      |      |      |      |                |    |
| SO        | W = 2.65743D <sup>2.43948</sup> | .993           | 60     | 8           |      |      |      |      |      |      |                |    |
| WO        | W = 1.28919D <sup>2.70096</sup> | .988           | 72     | 10          |      |      |      |      |      |      |                |    |
| CO        | W = 2.12015D <sup>2.53442</sup> | .991           | 65     | 9           |      |      |      |      |      |      |                |    |
| YP        | W = 1.57792D <sup>2.51532</sup> | .995           | 37     | 7           |      |      |      |      |      |      |                |    |
| H         | W = 1.93378D <sup>2.62090</sup> | .987           | 91     | 12          |      |      |      |      |      |      |                |    |
| BC        | W = 2.58831D <sup>2.42530</sup> | .994           | 45     | 7           |      |      |      |      |      |      |                |    |
| RM        | W = 1.81301D <sup>2.56226</sup> | .981           | 78     | 13          |      |      |      |      |      |      |                |    |

Table 3  
Total tree dry weight without bark.

| Dbh (in.) | Species                         |                |        |             |      |      |      |                |      |      | RM |
|-----------|---------------------------------|----------------|--------|-------------|------|------|------|----------------|------|------|----|
|           | NRO                             | BO             | SO     | WO          | CO   | YP   | H    | BC             | BC   | RM   |    |
| 2         | 8                               | 10             | 11     | 7           | 10   | 8    | 10   | 12             | 12   | 9    |    |
| 3         | 25                              | 27             | 31     | 22          | 28   | 21   | 29   | 33             | 33   | 26   |    |
| 4         | 55                              | 57             | 64     | 48          | 58   | 43   | 62   | 66             | 66   | 55   |    |
| 5         | 101                             | 99             | 112    | 87          | 103  | 76   | 113  | 114            | 114  | 98   |    |
| 6         | 165                             | 157            | 176    | 143         | 164  | 121  | 183  | 178            | 178  | 157  |    |
| 7         | 250                             | 231            | 258    | 216         | 244  | 178  | 276  | 259            | 259  | 233  |    |
| 8         | 358                             | 323            | 360    | 310         | 344  | 249  | 394  | 358            | 358  | 328  |    |
| 9         | 492                             | 434            | 482    | 427         | 465  | 335  | 539  | 478            | 478  | 444  |    |
| 10        | 655                             | 566            | 626    | 567         | 610  | 437  | 713  | 618            | 618  | 583  |    |
| 11        | 847                             | 719            | 794    | 734         | 779  | 555  | 920  | 779            | 779  | 744  |    |
| 12        | 1071                            | 894            | 986    | 929         | 975  | 691  | 1160 | 964            | 964  | 931  |    |
| 13        | 1330                            | 1093           | 1203   | 1153        | 1198 | 846  | 1435 | 1171           | 1171 | 1143 |    |
| 14        | 1624                            | 1317           | 1446   | 1409        | 1449 | 1019 | 1749 | 1404           | 1404 | 1383 |    |
| 15        | 1957                            | 1566           | 1716   | 1698        | 1731 | 1213 | 2102 | 1661           | 1661 | 1651 |    |
| 16        | 2330                            | 1842           | 2015   | 2022        | 2043 | 1427 | 2496 | 1944           | 1944 | 1948 |    |
|           |                                 |                |        |             |      |      |      | Standard error |      |      |    |
| Species   | Equation used                   | R <sup>2</sup> | Pounds | % of W-mean |      |      |      |                |      |      |    |
| NRO       | W = 1.30152D <sup>2.70150</sup> | .988           | 67     | 11          |      |      |      |                |      |      |    |
| BO        | W = 1.73952D <sup>2.51206</sup> | .994           | 42     | 7           |      |      |      |                |      |      |    |
| SO        | W = 2.04644D <sup>2.48586</sup> | .993           | 52     | 8           |      |      |      |                |      |      |    |
| WO        | W = 1.12046D <sup>2.70442</sup> | .987           | 65     | 11          |      |      |      |                |      |      |    |
| CO        | W = 1.63332D <sup>2.57224</sup> | .989           | 60     | 9           |      |      |      |                |      |      |    |
| YP        | W = 1.32004D <sup>2.51950</sup> | .996           | 29     | 6           |      |      |      |                |      |      |    |
| H         | W = 1.54470D <sup>2.66452</sup> | .983           | 95     | 14          |      |      |      |                |      |      |    |
| BC        | W = 2.24220D <sup>2.44004</sup> | .994           | 40     | 7           |      |      |      |                |      |      |    |
| RM        | W = 1.57279D <sup>2.56866</sup> | .982           | 67     | 13          |      |      |      |                |      |      |    |

Table 4  
Total tree dry weight of bark.

| Dbh (in.) | Species                         |     |     |     |     |     |     |     |     |                |        | Standard error |        |             |
|-----------|---------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|----------------|--------|----------------|--------|-------------|
|           | NRO                             | BO  | SO  | WO  | CO  | YP  | H   | BC  | RM  | R <sup>2</sup> | Pounds | % of W-mean    |        |             |
| 2         | 2                               | 2   | 3   | 1   | 3   | 2   | 2   | 2   | 1   |                |        |                |        |             |
| 3         | 6                               | 6   | 7   | 3   | 7   | 4   | 6   | 4   | 4   |                |        |                |        |             |
| 4         | 12                              | 12  | 14  | 7   | 13  | 8   | 11  | 9   | 8   |                |        |                |        |             |
| 5         | 21                              | 21  | 22  | 12  | 22  | 15  | 18  | 14  | 14  |                |        |                |        |             |
| 6         | 33                              | 33  | 34  | 20  | 34  | 23  | 27  | 22  | 22  |                |        |                |        |             |
| 7         | 48                              | 49  | 47  | 30  | 49  | 33  | 39  | 31  | 32  |                |        |                |        |             |
| 8         | 67                              | 68  | 63  | 44  | 68  | 46  | 53  | 43  | 45  |                |        |                |        |             |
| 9         | 89                              | 91  | 82  | 60  | 89  | 62  | 70  | 56  | 60  |                |        |                |        |             |
| 10        | 116                             | 117 | 104 | 79  | 115 | 80  | 89  | 71  | 79  |                |        |                |        |             |
| 11        | 146                             | 149 | 128 | 103 | 144 | 101 | 111 | 88  | 100 |                |        |                |        |             |
| 12        | 181                             | 184 | 155 | 130 | 177 | 125 | 136 | 108 | 125 |                |        |                |        |             |
| 13        | 221                             | 224 | 185 | 161 | 214 | 152 | 164 | 130 | 152 |                |        |                |        |             |
| 14        | 265                             | 269 | 218 | 196 | 255 | 182 | 194 | 154 | 183 |                |        |                |        |             |
| 15        | 314                             | 319 | 253 | 236 | 300 | 215 | 228 | 181 | 218 |                |        |                |        |             |
| 16        | 367                             | 374 | 292 | 281 | 349 | 252 | 265 | 210 | 257 |                |        |                |        |             |
| Species   | Equation used                   |     |     |     |     |     |     |     |     |                |        | R <sup>2</sup> | Pounds | % of W-mean |
| NRO       | W = 0.40617D <sup>2.45522</sup> |     |     |     |     |     |     |     |     |                |        | .982           | 14     | 13          |
| BO        | W = 0.40547D <sup>2.46200</sup> |     |     |     |     |     |     |     |     |                |        | .993           | 9      | 8           |
| SO        | W = 0.64595D <sup>2.20532</sup> |     |     |     |     |     |     |     |     |                |        | .991           | 9      | 9           |
| WO        | W = 0.16388D <sup>2.68560</sup> |     |     |     |     |     |     |     |     |                |        | .985           | 10     | 12          |
| CO        | W = 0.48999D <sup>2.36930</sup> |     |     |     |     |     |     |     |     |                |        | .983           | 14     | 12          |
| YP        | W = 0.28558D <sup>2.44660</sup> |     |     |     |     |     |     |     |     |                |        | .971           | 13     | 16          |
| H         | W = 0.43532D <sup>2.31178</sup> |     |     |     |     |     |     |     |     |                |        | .936           | 17     | 22          |
| BC        | W = 0.35434D <sup>2.30212</sup> |     |     |     |     |     |     |     |     |                |        | .987           | 6      | 10          |
| RM        | W = 0.24022D <sup>2.51544</sup> |     |     |     |     |     |     |     |     |                |        | .968           | 13     | 18          |

Table 5  
Green weight of branches.

| Dbh (in.) | Species |     |     |     |     |     |      |     |     |     | H    | BC  | RM  |
|-----------|---------|-----|-----|-----|-----|-----|------|-----|-----|-----|------|-----|-----|
|           | NRO     | BO  | SO  | WO  | CO  | YP  | H    | BC  | RM  |     |      |     |     |
| 5         | 107     | 65  | 93  | 70  | 79  | 73  | 79   | 73  | 73  | 73  | 79   | 73  | 93  |
| 6         | 133     | 97  | 107 | 77  | 91  | 52  | 87   | 89  | 89  | 89  | 87   | 89  | 120 |
| 7         | 168     | 135 | 134 | 94  | 113 | 43  | 112  | 110 | 110 | 110 | 112  | 110 | 151 |
| 8         | 212     | 181 | 173 | 122 | 148 | 46  | 153  | 135 | 135 | 135 | 153  | 135 | 186 |
| 9         | 266     | 234 | 225 | 160 | 193 | 61  | 209  | 165 | 165 | 165 | 209  | 165 | 224 |
| 10        | 328     | 294 | 289 | 208 | 249 | 87  | 281  | 199 | 199 | 199 | 281  | 199 | 267 |
| 11        | 400     | 362 | 366 | 266 | 317 | 126 | 368  | 238 | 238 | 238 | 368  | 238 | 314 |
| 12        | 481     | 437 | 456 | 335 | 396 | 176 | 472  | 282 | 282 | 282 | 472  | 282 | 365 |
| 13        | 571     | 521 | 558 | 414 | 487 | 237 | 591  | 330 | 330 | 330 | 591  | 330 | 419 |
| 14        | 670     | 612 | 673 | 503 | 588 | 311 | 726  | 382 | 382 | 382 | 726  | 382 | 478 |
| 15        | 779     | 711 | 800 | 603 | 701 | 396 | 877  | 439 | 439 | 439 | 877  | 439 | 541 |
| 16        | 896     | 818 | 940 | 712 | 825 | 493 | 1043 | 501 | 501 | 501 | 1043 | 501 | 608 |

| Species | Equation used                             | R <sup>2</sup> | Standard error |             |
|---------|---|----------------|----------------|-------------|
|         |   |                | Pounds         | % of W-mean |
| NRO     | $W = 116.07240 + 4.58936D^2 - 24.665151D$ | .848           | 109            | 30          |
| BO      | $W = 1.95802D^2 - 1.7664$                 | .892           | 84             | 24          |
| SO      | $W = 212.75897 + 6.30761D^2 - 55.44747D$  | .952           | 65             | 18          |
| WO      | $W = 190.10052 + 5.14752D^2 - 49.71524D$  | .959           | 44             | 16          |
| CO      | $W = 189.61831 + 5.62049D^2 - 50.21763D$  | .955           | 52             | 17          |
| YP      | $W = 352.07486 + 5.87535D^2 - 85.21641D$  | .839           | 61             | 39          |
| H       | $W = 270.38361 + 7.87893D^2 - 77.76552D$  | .838           | 120            | 38          |
| BC      | $W = 59.17315 + 2.26508D^2 - 8.62607D$    | .820           | 62             | 29          |
| RM      | $W = 20.05467 + 2.00411D^2 + 4.66393D$    | .827           | 68             | 26          |

Table 6  
Dry weight of branches.

| Dbh (in.) | Species                                  |                |     |        |     |             |     |     |    |     | Standard error |
|-----------|--|----------------|-----|--------|-----|-------------|-----|-----|----|-----|----------------|
|           | NRO                                      | BO             | SO  | WO     | CO  | YP          | H   | BC  | RM |     |                |
| 5         | 62                                       | 48             | 58  | 46     | 45  | 33          | 50  | 39  |    | 49  |                |
| 6         | 78                                       | 58             | 64  | 45     | 51  | 26          | 54  | 49  |    | 64  |                |
| 7         | 99                                       | 75             | 78  | 51     | 65  | 23          | 69  | 62  |    | 82  |                |
| 8         | 126                                      | 99             | 101 | 64     | 85  | 25          | 95  | 76  |    | 101 |                |
| 9         | 158                                      | 129            | 132 | 83     | 111 | 33          | 131 | 93  |    | 122 |                |
| 10        | 196                                      | 166            | 172 | 110    | 145 | 45          | 178 | 112 |    | 145 |                |
| 11        | 239                                      | 211            | 220 | 143    | 185 | 62          | 236 | 133 |    | 170 |                |
| 12        | 287                                      | 262            | 276 | 184    | 232 | 85          | 304 | 156 |    | 197 |                |
| 13        | 342                                      | 320            | 340 | 231    | 285 | 112         | 383 | 181 |    | 225 |                |
| 14        | 401                                      | 385            | 413 | 285    | 345 | 144         | 473 | 209 |    | 256 |                |
| 15        | 466                                      | 456            | 494 | 346    | 412 | 182         | 574 | 238 |    | 288 |                |
| 16        | 537                                      | 535            | 584 | 413    | 486 | 224         | 685 | 270 |    | 323 |                |
| Species   | Equation used                            | R <sup>2</sup> |     | Pounds |     | % of W-mean |     |     |    |     |                |
| NRO       | $W = 66.63842 + 2.75334D^2 - 14.64401D$  | .845           |     | 66     |     | 30          |     |     |    |     |                |
| BO        | $W = 101.75993 + 3.43396D^2 - 27.87506D$ | .888           |     | 54     |     | 26          |     |     |    |     |                |
| SO        | $W = 152.09258 + 4.16948D^2 - 39.72114D$ | .943           |     | 44     |     | 20          |     |     |    |     |                |
| WO        | $W = 153.17470 + 3.42784D^2 - 38.59326D$ | .902           |     | 41     |     | 26          |     |     |    |     |                |
| CO        | $W = 112.26122 + 3.35130D^2 - 30.27026D$ | .961           |     | 29     |     | 16          |     |     |    |     |                |
| YP        | $W = 146.29742 + 2.49589D^2 - 35.08911D$ | .732           |     | 38     |     | 51          |     |     |    |     |                |
| H         | $W = 191.16897 + 5.36555D^2 - 54.98699D$ | .842           |     | 78     |     | 38          |     |     |    |     |                |
| BC        | $W = 20.48931 + 1.07958D^2 - 1.67602D$   | .811           |     | 35     |     | 29          |     |     |    |     |                |
| RM        | $W = 0.93846D^2 + 5.18726D - 0.55683$    | .793           |     | 41     |     | 29          |     |     |    |     |                |



Table 7  
Dry weight of branches without bark.

| Dbh (in.) | Species                                  |                |     |     |     |     |        |             |     |  | Standard error |
|-----------|--|----------------|-----|-----|-----|-----|--------|-------------|-----|--|----------------|
|           | NRO                                      | BO             | SO  | WO  | CO  | YP  | H      | BC          | RM  |  |                |
| 5         | 49                                       | 39             | 47  | 39  | 35  | 29  | 41     | 34          | 42  |  |                |
| 6         | 63                                       | 46             | 53  | 37  | 42  | 22  | 44     | 43          | 55  |  |                |
| 7         | 82                                       | 59             | 65  | 41  | 53  | 18  | 56     | 54          | 70  |  |                |
| 8         | 104                                      | 78             | 85  | 51  | 70  | 19  | 78     | 67          | 86  |  |                |
| 9         | 130                                      | 102            | 111 | 66  | 91  | 25  | 110    | 81          | 103 |  |                |
| 10        | 161                                      | 132            | 143 | 86  | 117 | 34  | 151    | 98          | 122 |  |                |
| 11        | 196                                      | 168            | 183 | 112 | 149 | 48  | 202    | 110         | 142 |  |                |
| 12        | 234                                      | 209            | 229 | 144 | 184 | 67  | 262    | 136         | 164 |  |                |
| 13        | 277                                      | 256            | 282 | 181 | 225 | 89  | 332    | 158         | 187 |  |                |
| 14        | 324                                      | 308            | 341 | 223 | 270 | 117 | 412    | 182         | 212 |  |                |
| 15        | 375                                      | 366            | 407 | 271 | 321 | 148 | 501    | 208         | 239 |  |                |
| 16        | 430                                      | 430            | 480 | 325 | 376 | 184 | 599    | 235         | 266 |  |                |
| Species   | Equation used                            | R <sup>2</sup> |     |     |     |     | Pounds | % of W-mean |     |  |                |
| NRO       | $W = 39.29224 + 2.04075D^2 - 8.24105D$   | .816           |     |     |     |     | 59     | 33          |     |  |                |
| BO        | $W = 85.31269 + 2.80528D^2 - 23.37203D$  | .882           |     |     |     |     | 45     | 27          |     |  |                |
| SO        | $W = 118.21699 + 3.35382D^2 - 31.02921D$ | .925           |     |     |     |     | 42     | 23          |     |  |                |
| WO        | $W = 130.01049 + 2.76475D^2 - 32.04423D$ | .882           |     |     |     |     | 35     | 29          |     |  |                |
| CO        | $W = 72.16416 + 2.40804D^2 - 19.54757D$  | .967           |     |     |     |     | 20     | 14          |     |  |                |
| YP        | $W = 132.85928 + 2.17263D^2 - 31.58192D$ | .763           |     |     |     |     | 29     | 48          |     |  |                |
| H         | $W = 169.72489 + 4.78279D^2 - 49.67281D$ | .868           |     |     |     |     | 61     | 35          |     |  |                |
| BC        | $W = 16.54155 + 0.92717D^2 - 1.15620D$   | .803           |     |     |     |     | 31     | 30          |     |  |                |
| RM        | $W = 0.37005 + 0.744554D^2 + 4.69733D$   | .779           |     |     |     |     | 35     | 30          |     |  |                |

Table 8  
Dry weight of branch bark.

| Dbh (in.) | Species |     |     |    |     |    |    |    |    |  | RM |
|-----------|---------|-----|-----|----|-----|----|----|----|----|--|----|
|           | NRO     | BO  | SO  | WO | CO  | YP | H  | BC | RM |  |    |
| 5         | 13      | 10  | 11  | 7  | 10  | 3  | 9  | 5  |    |  | 6  |
| 6         | 15      | 12  | 11  | 8  | 10  | 4  | 12 | 6  |    |  | 9  |
| 7         | 17      | 16  | 13  | 10 | 11  | 6  | 15 | 8  |    |  | 12 |
| 8         | 22      | 21  | 17  | 13 | 15  | 8  | 19 | 10 |    |  | 15 |
| 9         | 27      | 27  | 22  | 18 | 20  | 9  | 22 | 12 |    |  | 19 |
| 10        | 35      | 34  | 29  | 24 | 27  | 12 | 26 | 14 |    |  | 23 |
| 11        | 43      | 43  | 37  | 31 | 36  | 14 | 30 | 17 |    |  | 28 |
| 12        | 53      | 53  | 47  | 40 | 47  | 16 | 35 | 20 |    |  | 33 |
| 13        | 65      | 64  | 59  | 50 | 60  | 19 | 39 | 23 |    |  | 38 |
| 14        | 77      | 77  | 72  | 61 | 75  | 22 | 43 | 27 |    |  | 44 |
| 15        | 92      | 90  | 87  | 74 | 91  | 25 | 48 | 30 |    |  | 50 |
| 16        | 107     | 105 | 104 | 88 | 110 | 29 | 53 | 35 |    |  | 56 |

| Species | Equation used                           | R <sup>2</sup> | Standard error |             |
|---------|---|----------------|----------------|-------------|
|         |   |                | Pounds         | % of W-mean |
| NRO     | $W = 27.34618 + 0.71259D^2 - 6.40296D$  | .898           | 10             | 25          |
| BO      | $W = 16.44324 + 0.62868D^2 - 4.50303D$  | .904           | 10             | 24          |
| SO      | $W = 33.87559 + 0.81566D^2 - 8.69193D$  | .920           | 9              | 24          |
| WO      | $W = 23.16421 + 0.66309D^2 - 6.54903D$  | .936           | 7              | 22          |
| CO      | $W = 40.30200 + 0.94524D^2 - 10.76888D$ | .904           | 10             | 27          |
| YP      | $W = 0.14059D^{1.91598}$                | .788           | 7              | 46          |
| H       | $W = 0.84828D^{1.49152}$                | .599           | 17             | 58          |
| BC      | $W = 3.94776 + 0.15241D^2 - 0.51982D$   | .822           | 4              | 28          |
| RM      | $W = 0.19292D^2 + 0.48994D - 0.92688$   | .830           | 7              | 29          |

Table 9  
Green weight to a 4-inch dob.

| Dbh (in.) | Species                                    |      |      |      |      |      |      |      |      |  | H              | BC             | RM          |  |  |
|-----------|--|------|------|------|------|------|------|------|------|--|----------------|----------------|-------------|--|--|
|           | NRO  | BO   | SO   | WO   | CO   | YP   | H    | BC   | RM   |  |                |                |             |  |  |
| 5         | 162  | 222  | 184  | 116  | 144  | 121  | 92   | 165  | 203  |  |                |                |             |  |  |
| 6         | 273  | 280  | 286  | 236  | 258  | 221  | 168  | 264  | 239  |  |                |                |             |  |  |
| 7         | 415  | 375  | 417  | 384  | 400  | 349  | 280  | 396  | 326  |  |                |                |             |  |  |
| 8         | 589  | 507  | 578  | 560  | 571  | 505  | 435  | 561  | 464  |  |                |                |             |  |  |
| 9         | 794  | 677  | 767  | 765  | 769  | 690  | 641  | 758  | 653  |  |                |                |             |  |  |
| 10        | 1032                                       | 885  | 985  | 998  | 996  | 904  | 907  | 988  | 893  |  |                |                |             |  |  |
| 11        | 1301                                       | 1130 | 1232 | 1259 | 1252 | 1146 | 1241 | 1251 | 1185 |  |                |                |             |  |  |
| 12        | 1602                                       | 1413 | 1508 | 1549 | 1535 | 1416 | 1653 | 1547 | 1528 |  |                |                |             |  |  |
| 13        | 1935                                       | 1733 | 1812 | 1866 | 1846 | 1716 | 2152 | 1875 | 1922 |  |                |                |             |  |  |
| 14        | 2300                                       | 2091 | 2146 | 2213 | 2186 | 2044 | 2747 | 2236 | 2368 |  |                |                |             |  |  |
| 15        | 2696                                       | 2486 | 2509 | 2587 | 2554 | 2400 | 3448 | 2630 | 2864 |  |                |                |             |  |  |
| 16        | 3124                                       | 2919 | 2901 | 2990 | 2950 | 2785 | 4226 | 3057 | 3412 |  |                |                |             |  |  |
|           |  |      |      |      |      |      |      |      |      |  |                |                |             |  |  |
| Species   | Equation used                              |      |      |      |      |      |      |      |      |  | R <sup>2</sup> | Pounds         | % of W-mean |  |  |
| NRO       | $W = 88.21958 + 15.90187D^2 - 64.67165D$   |      |      |      |      |      |      |      |      |  | .988           | 108            | 9           |  |  |
| BO        | $W = 497.81493 + 18.76768D^2 - 148.94424D$ |      |      |      |      |      |      |      |      |  | .985           | 104            | 9           |  |  |
| SO        | $W = 108.22596 + 14.48597D^2 - 57.22531D$  |      |      |      |      |      |      |      |      |  | .979           | 136            | 12          |  |  |
| WO        | $W = 14.14272D^2 - 35.74697D - 58.95854$   |      |      |      |      |      |      |      |      |  | .983           | 127            | 12          |  |  |
| CO        | $W = 14.10156D^2 - 41.01997D - 3.56707$    |      |      |      |      |      |      |      |      |  | .992           | 82             | 8           |  |  |
| YP        | $W = 52.83929 + 14.27865D^2 - 57.70586D$   |      |      |      |      |      |      |      |      |  | .971           | 151            | 14          |  |  |
| H         | $W = 0.45983D^3 - 2.9484D$                 |      |      |      |      |      |      |      |      |  | .969           | 171            | 17          |  |  |
| BC        | $W = 162.72473 + 16.39759D^2 - 81.44786D$  |      |      |      |      |      |      |      |      |  | .987           | 105            | 9           |  |  |
| RM        | $W = 794.01142 + 25.61191D^2 - 246.17225D$ |      |      |      |      |      |      |      |      |  | .979           | 132            | 13          |  |  |
|           |  |      |      |      |      |      |      |      |      |  |                | Standard error |             |  |  |

Table 10  
Dry weight to a 4-inch dob.

| Dbh (in.) | Species                                    |      |      |      |      |      |      |      |      |                | RM             |        |             |
|-----------|--|------|------|------|------|------|------|------|------|----------------|----------------|--------|-------------|
|           | NRO  | BO   | SO   | WO   | CO   | YP   | H    | BC   | RM   |                |                |        |             |
| 5         | 91   | 124  | 88   | 85   | 99   | 64   | 61   | 93   | 105  |                |                |        |             |
| 6         | 156  | 156  | 142  | 138  | 157  | 114  | 110  | 161  | 129  |                |                |        |             |
| 7         | 238  | 209  | 212  | 207  | 232  | 180  | 183  | 245  | 180  |                |                |        |             |
| 8         | 338  | 284  | 301  | 294  | 325  | 261  | 284  | 346  | 259  |                |                |        |             |
| 9         | 455  | 380  | 409  | 400  | 438  | 358  | 417  | 462  | 366  |                |                |        |             |
| 10        | 590  | 499  | 539  | 528  | 571  | 471  | 590  | 595  | 500  |                |                |        |             |
| 11        | 743  | 639  | 691  | 678  | 726  | 600  | 806  | 744  | 662  |                |                |        |             |
| 12        | 913  | 800  | 868  | 852  | 904  | 745  | 1073 | 909  | 851  |                |                |        |             |
| 13        | 1101                                       | 984  | 1070 | 1052 | 1107 | 905  | 1395 | 1091 | 1069 |                |                |        |             |
| 14        | 1307                                       | 1189 | 1299 | 1278 | 1334 | 1082 | 1779 | 1288 | 1314 |                |                |        |             |
| 15        | 1530                                       | 1416 | 1556 | 1532 | 1588 | 1274 | 2231 | 1502 | 1586 |                |                |        |             |
| 16        | 1771                                       | 1665 | 1842 | 1815 | 1869 | 1482 | 2758 | 1732 | 1887 |                |                |        |             |
|           |  |      |      |      |      |      |      |      |      | Standard error |                |        |             |
| Species   | Equation used                              |      |      |      |      |      |      |      |      |                | R <sup>2</sup> | Pounds | % of W-mean |
| NRO       | $W = 33.10060 + 8.81566D^2 - 32.45835D$    |      |      |      |      |      |      |      |      |                | .984           | 70     | 11          |
| BO        | $W = 293.09646 + 10.86577D^2 - 88.11460D$  |      |      |      |      |      |      |      |      |                | .987           | 55     | 9           |
| SO        | $W = 1.30430D^{2.61602}$                   |      |      |      |      |      |      |      |      |                | .979           | 76     | 11          |
| WO        | $W = 1.24354D^{2.62792}$                   |      |      |      |      |      |      |      |      |                | .989           | 55     | 8           |
| CO        | $W = 1.71389D^{2.52260}$                   |      |      |      |      |      |      |      |      |                | .983           | 69     | 10          |
| YP        | $W = 53.24629 + 7.91561D^2 - 37.34973D$    |      |      |      |      |      |      |      |      |                | .964           | 90     | 16          |
| H         | $W = 0.30832D^{3.28170}$                   |      |      |      |      |      |      |      |      |                | .972           | 106    | 16          |
| BC        | $W = 8.09971D^2 - 21.14376D + 3.40207$     |      |      |      |      |      |      |      |      |                | .982           | 70     | 11          |
| RM        | $W = 402.37775 + 13.83454D^2 - 128.58822D$ |      |      |      |      |      |      |      |      |                | .976           | 78     | 14          |

Table 11  
Dry weight without bark to a 4-inch dob.

| Dbh (in.) | Species                                    |      |      |      |      |      |      |      |      |      | RM             |             |
|-----------|--|------|------|------|------|------|------|------|------|------|----------------|-------------|
|           | NRO  | BO   | SO   | WO   | CO   | YP   | H    | BC   | BC   | RM   |                |             |
| 5         | 74   | 101  | 75   | 78   | 87   | 55   | 51   | 83   | 51   | 91   |                |             |
| 6         | 133  | 129  | 121  | 126  | 138  | 94   | 94   | 143  | 94   | 114  |                |             |
| 7         | 206  | 175  | 182  | 188  | 206  | 148  | 158  | 218  | 148  | 162  |                |             |
| 8         | 293  | 239  | 259  | 266  | 289  | 216  | 248  | 309  | 216  | 233  |                |             |
| 9         | 396  | 321  | 354  | 361  | 387  | 298  | 298  | 415  | 369  | 328  |                |             |
| 10        | 514  | 421  | 468  | 474  | 502  | 396  | 527  | 536  | 527  | 448  |                |             |
| 11        | 646  | 539  | 602  | 607  | 631  | 508  | 726  | 672  | 726  | 591  |                |             |
| 12        | 793  | 674  | 758  | 761  | 777  | 634  | 974  | 823  | 974  | 759  |                |             |
| 13        | 956  | 828  | 937  | 937  | 938  | 776  | 1276 | 990  | 1276 | 951  |                |             |
| 14        | 1133                                       | 1000 | 1140 | 1135 | 1115 | 932  | 1639 | 1171 | 1639 | 1167 |                |             |
| 15        | 1325                                       | 1190 | 1368 | 1358 | 1308 | 1102 | 2068 | 1369 | 2068 | 1407 |                |             |
| 16        | 1531                                       | 1398 | 1623 | 1606 | 1516 | 1287 | 2572 | 1581 | 2572 | 1671 |                |             |
|           |  |      |      |      |      |      |      |      |      |      |                |             |
| Species   | Equation used                              |      |      |      |      |      |      |      |      |      | Standard error |             |
| NRO       | $W = 6.58230 + 7.43060D^2 - .23.59697D$    |      |      |      |      |      |      |      |      |      | Pounds         | % of W-mean |
| BO        | $W = 231.83292 + 8.99921D^2 - 71.11076D$   |      |      |      |      |      |      |      |      |      | 66             | 12          |
| SO        | $W = 1.05188D^{2.64786}$                   |      |      |      |      |      |      |      |      |      | 47             | 9           |
| WO        | $W = 1.20296D^{2.59564}$                   |      |      |      |      |      |      |      |      |      | 68             | 12          |
| CO        | $W = 64.04694 + 7.83580D^2 - 34.61206D$    |      |      |      |      |      |      |      |      |      | 49             | 8           |
| YP        | $W = 80.80178 + 7.31852D^2 - 41.68462D$    |      |      |      |      |      |      |      |      |      | 58             | 10          |
| H         | $W = 0.22240D^{3.37432}$                   |      |      |      |      |      |      |      |      |      | 75             | 16          |
| BC        | $W = 11.10259 + 7.61082D^2 - 23.66809D$    |      |      |      |      |      |      |      |      |      | 101            | 17          |
| RM        | $W = 336.79891 + 12.04526D^2 - 109.34929D$ |      |      |      |      |      |      |      |      |      | 65             | 11          |
|           |  |      |      |      |      |      |      |      |      |      | 69             | 14          |

Table 12  
Dry weight of bark to a 4-inch dob.

| Dbh (in.) | Species                                 |                |        |                |     |             |     |     |     |  | RM |
|-----------|---|----------------|--------|----------------|-----|-------------|-----|-----|-----|--|----|
|           | NRO                                     | BO             | SO     | WO             | CO  | YP          | H   | BC  | RM  |  |    |
| 5         | 17                                      | 23             | 13     | 7              | 15  | 9           | 9   | 10  | 14  |  |    |
| 6         | 23                                      | 26             | 21     | 12             | 24  | 15          | 15  | 18  | 14  |  |    |
| 7         | 32                                      | 34             | 30     | 19             | 35  | 23          | 23  | 27  | 19  |  |    |
| 8         | 44                                      | 45             | 41     | 28             | 48  | 33          | 33  | 37  | 26  |  |    |
| 9         | 59                                      | 59             | 55     | 39             | 64  | 45          | 45  | 48  | 37  |  |    |
| 10        | 76                                      | 78             | 70     | 53             | 83  | 60          | 60  | 60  | 52  |  |    |
| 11        | 97                                      | 100            | 89     | 70             | 104 | 77          | 77  | 72  | 71  |  |    |
| 12        | 120                                     | 126            | 109    | 91             | 129 | 110         | 97  | 86  | 93  |  |    |
| 13        | 145                                     | 156            | 133    | 115            | 156 | 130         | 120 | 101 | 118 |  |    |
| 14        | 174                                     | 189            | 159    | 143            | 187 | 150         | 146 | 117 | 147 |  |    |
| 15        | 205                                     | 226            | 187    | 175            | 221 | 172         | 176 | 133 | 180 |  |    |
| 16        | 239                                     | 267            | 219    | 212            | 259 | 195         | 208 | 151 | 216 |  |    |
| Species   | Equation used                           | R <sup>2</sup> | Pounds | Standard error |     | % of W-mean |     |     |     |  |    |
| NRO       | $W = 26.51830 + 1.38506D^2 - 8.86139D$  | .952           | 16     | 18             |     | 18          |     |     |     |  |    |
| BO        | $W = 61.26354 + 1.86656D^2 - 17.00383D$ | .981           | 11     | 11             |     | 11          |     |     |     |  |    |
| SO        | $W = 0.27263D^2 + 2.41252$              | .967           | 11     | 13             |     | 13          |     |     |     |  |    |
| WO        | $W = 0.06135D^2 + 9.3810$               | .970           | 10     | 14             |     | 14          |     |     |     |  |    |
| CO        | $W = 0.31466D^2 + 2.42068$              | .971           | 13     | 13             |     | 13          |     |     |     |  |    |
| YP        | $W = 0.59710D^2 + 4.33490D - 27.55549$  | .939           | 16     | 19             |     | 19          |     |     |     |  |    |
| H         | $W = 0.13192D^2 + 2.65648$              | .934           | 14     | 23             |     | 23          |     |     |     |  |    |
| BC        | $W = 0.48890D^2 + 2.52433D - 14.50465$  | .960           | 9      | 14             |     | 14          |     |     |     |  |    |
| RM        | $W = 65.38536 + 1.79223D^2 - 19.23660D$ | .965           | 11     | 18             |     | 18          |     |     |     |  |    |

## Weight Estimates When Marking Timber

Weight estimates are easily derived when each tree to be harvested is visited and marked with paint. A tally of the number of trees by species and diameter is made. For example:

|     | Number of trees |   |           |   |
|-----|-----------------|---|-----------|---|
| Dbh | Species A       |   | Species B |   |
| 5   | ☒               | ☒ | ☒         | ☒ |
| 10  | —               | — | ☒         | ☒ |

Weight estimates are:

| Dbh    | Species A               | Species B                | Totals |
|--------|-------------------------|--------------------------|--------|
| 5      | (23) (100) = 2300       | (21) (125) = 2625        | 4925   |
| 10     | (5) (650) = <u>3250</u> | (12) (730) = <u>8760</u> | 12010  |
| Totals | 5550                    | 11385                    | 16935  |

Our total weight estimate is 16935 pounds, and, as each member of the population of interest has been measured, there is no sampling error in the statistical sense.

## Weight Estimates Using Fixed-Area Plots

If cruising is done using fixed-area plots, a separate tally of trees by species and diameter class is made at each plot. Suppose the following data are collected on 1/10-acre plots:

|      | Number of trees |           |           |   |
|------|-----------------|-----------|-----------|---|
| Plot | Dbh             | Species A | Species B |   |
| 1    | 5               | ☒         | ☒         | ☒ |
|      | 10              | ☒         | ☒         | ☒ |
| 2    | 5               | ☒         | ☒         | ☒ |
|      | 10              | ☒         | ☒         | ☒ |
| 3    | 5               | ☒         | ☒         | ☒ |
|      | 10              | ☒         | ☒         | ☒ |
| 4    | 5               | ☒         | ☒         | ☒ |
|      | 10              | ☒         | ☒         | ☒ |

Weight estimates for plots are:

| Plot   | Dbh | Species A        | Species B        | Totals |        |
|--------|-----|------------------|------------------|--------|--------|
| 1      | 5   | (6) (100) = 600  | (2) (125) = 250  | 850    | } 2230 |
|        | 10  | (1) (650) = 650  | (1) (730) = 730  | 1380   |        |
| 2      |     | —                | —                | 0      | } 0    |
| 3      | 5   | (1) (100) = 100  | —                | 100    | } 3020 |
|        | 10  | —                | (4) (730) = 2920 | 2920   |        |
| 4      | 5   | (1) (100) = 100  | (1) (125) = 125  | 225    | } 1525 |
|        | 10  | (2) (650) = 1300 | —                | 1300   |        |
| Totals |     | 2750             | 4025             | 6775   |        |

Average per-acre estimates are:

| Dbh    | Species A  | Species B                                       | Total   |
|--------|--|---|---------|
| 5      | (10) $\left[ \frac{600+100+100}{4} \right] = 2000$ | (10) $\left[ \frac{250+125}{4} \right] = 937.5$ | 2937.5  |
| 10     | (10) $\left[ \frac{650+1300}{4} \right] = 4875$    | (10) $\left[ \frac{730+2920}{4} \right] = 9125$ | 14000   |
| Totals |  | 6875  | 10062.5 |

The average 1/10-acre estimate is  $6775/4 = 1694$  pounds. The standard error ( $S_{\bar{x}}$ ) for that estimate is:

$$S_{\bar{x}} = \sqrt{\frac{\sum X^2 - (\sum X)^2/n}{n(n-1)}}$$

where:  $X$  = weight estimate for a given plot  
 $n$  = number of plots

Therefore:

$$S_{\bar{x}} = \sqrt{\frac{(2230)^2 + (0)^2 + (3020)^2 + (1525)^2 - (6775)^2/4}{4(4-1)}} = 642$$

Expressed as a percent of the mean, our sampling error is:

$$\left[ \frac{642}{1694} \right] (100) = 38\%$$



On an acre basis, our weight estimate is:

$$(10) (1694 \pm 642) = 16940 \pm 6420 \text{ pounds}$$

$$\text{or } 16940 \pm 38\%$$

About two in three times we expect the true population mean to be within these limits. Limits are doubled for a 19 in 20 chance or tripled for a 99 in 100 chance. The usual assumptions of random sampling are made here, of course.

### Weight Estimates Using Point Samples

If point sampling (BAF=10) is to be used, weights in the basic table are multiplied by the appropriate conversion factors (see Kulow 1965), as follows:

#### Total dry weight (lbs.) per acre per in-tree<sup>2</sup>

| <u>Dbh</u> | <u>Species A</u>      | <u>Species B</u>      |
|------------|-----------------------|-----------------------|
| 5          | (73.34) (100) = 7334  | (73.34) (125) = 9168  |
| 10         | (18.34) (650) = 11921 | (18.34) (730) = 13388 |

The following data are collected:

| <u>Point</u> | <u>Dbh</u> | <u>Number of in-trees</u> |                  |
|--------------|------------|---------------------------|------------------|
|              |            | <u>Species A</u>          | <u>Species B</u> |
| 1            | 5          | • •                       | •                |
|              | 10         | •                         | •                |
| 2            | 5          |                           |                  |
|              | 10         |                           |                  |
| 3            | 5          |                           |                  |
|              | 10         |                           | • •              |
| 4            | 5          | —                         |                  |
|              | 10         | • •                       |                  |

<sup>2</sup>An "in-tree" is a tree selected as "in" with a prism or similar instrument.

Weight estimates per acre for points are:

| Point  | Dbh | Species A           | Species B           | Totals |
|--------|-----|---------------------|---------------------|--------|
| 1      | 5   | (2) (7334) = 14668  | (1) (9168) = 9168   | 23836  |
|        | 10  | (1) (11921) = 11921 | (1) (13388) = 13388 | 25309  |
| 2      |     | —                   | —                   | 0      |
|        |     |                     |                     |        |
| 3      | 5   | —                   | —                   |        |
|        | 10  | —                   | (4) (13388) = 53552 | 53552  |
| 4      | 5   | (5) (7334) = 36670  | —                   | 36670  |
|        | 10  | —                   | —                   |        |
| Totals |     | 63259               | 76108               | 139367 |

Average per-acre estimates are:

| Dbh    | Species A                                      | Species B                                      | Totals |
|--------|--|--|--------|
| 5      | $\left[ \frac{14668+36670}{4} \right] = 12835$ | $\left[ \frac{9168}{4} \right] = 2292$         | 15127  |
| 10     | $\left[ \frac{11921}{4} \right] = 2980$        | $\left[ \frac{13388+53552}{4} \right] = 16735$ | 19715  |
| Totals |  | 15815  | 19027  |

The average per-acre estimate is 34842 pounds. The standard error is:

$$S_x^- = \sqrt{\frac{(49145)^2 + (0)^2 + (53552)^2 + (36670)^2 - (139367)^2/4}{4(4-1)}} = 12152$$

Sampling error, as a percent, is:

$$\left[ \frac{12152}{34842} \right] (100) = 35\%$$

### Weight Estimates Using Point and 3P Sampling

Much time can be saved in the field by combining 3P and point sampling. Again, we will assume BAF=10. Before the cruise, determine:

- (1) the number of point samples desired. This can be done statistically (see Wiant 1976), but in most situations will be at least 30 and not more than 100.
- (2) the number of 3P sample points needed for the desired accuracy. Wiant (1976) provides a formula for a statistical determination, but 15 to 20 should suffice in most cases.
- (3) the approximate sum of basal areas ( $\approx$ KPI) expected at the point samples. For example, if you assume point samples will average 40 square feet of basal area, and you plan to have 100 point samples:  
 $\approx$ KPI = (40) (100) = 4000

Develop a list of random numbers, one for each point sample, from 1 through KZ, where:

$$KZ = \frac{\approx KPI}{\text{number of 3P samples desired}}$$

If 20, 3P samples are desired:

$$\begin{aligned} KZ &= \frac{4000}{20} \\ &= 200 \end{aligned}$$

In the field, record the number of in-trees by species on a point sample. Then, total the number of in-trees and multiply by 10 to obtain the per-acre basal area estimate for that point sample.

If that basal area is less than the random number for that point sample, go the next point. If that basal area equals or exceeds the random number for that point, measure the dbh of each in-tree.

After field work is completed, calculate:

- (1) the ratio of per-acre weight (Y) at each 3P point sample to the basal area at that point sample, or Y/KPI.
- (2) the total per-acre volume estimate, which equals the average basal area on all point samples times the average Y/KPI-ratio. That ratio times the average basal area for a given species provides a per-acre weight estimate for that species; however, if there are sufficient data, an average Y/KPI-ratio should be calculated for the individual species to provide a better estimate.
- (3) the approximate sampling error, which includes that due to the point samples and that related to 3P, plus a covariance term which will be ignored in this paper as is usually done in practice.

As an illustration of calculations, the example in the previous section will be used:

| Point   | Random no. | $\Sigma$ KPI |           |       | Y     | Y/KPI |
|---------|------------|--------------|-----------|-------|-------|-------|
|         |            | Species A    | Species B | Total |       |       |
| 1       | 23         | 30           | 20        | 50    | 49145 | 983   |
| 2       | 11         | 0            | 0         | 0     | —     | —     |
| 3       | 8          | 0            | 40        | 40    | 53552 | 1339  |
| 4       | 64         | 50           | 0         | 50    | —     | —     |
| Total   |            | 80           | 60        | 140   |       | 2322  |
| Average |            | 20           | 15        | 35    |       | 1161  |

Total per-acre weight = (35) (1161) = 40635

Species A per-acre weight = (20) (1161) = 23220

If there were sufficient data, a better estimate for Species A is obtained by calculating its own average Y/KPI-ratio, as:

| Point   | $\Sigma$ KPI | Y     | Y/KPI |
|---------|--------------|-------|-------|
| 1       | 30           | 26589 | 886   |
| Average |              |       | 886   |

Per-acre weight = (20) (886) = 17720

Species B per-acre weight = (15) (1161) = 17415

Again, a better estimate for species B is:

| Point   | $\Sigma$ KPI | Y     | Y/KPI |
|---------|--------------|-------|-------|
| 1       | 20           | 22556 | 1128  |
| 3       | 40           | 53552 | 1339  |
| Average |              |       | 1234  |

Per-acre weight = (15) (1234) = 18510

When separate Y/KPI-ratios are calculated for the different species for weight estimates, the sums of per-acre weight estimates for all species may not equal the total per-acre estimate, but the difference should be minor.

The standard error for point samples is based on basal area values:

$$S_{\bar{x}} = \sqrt{\frac{(50)^2 + (0)^2 + (40)^2 + (50)^2 - (140)^2/4}{4(4-1)}}$$

$$= 11.9$$

The standard error for 3P samples is based on the Y/KPI-ratios:

$$S_{\bar{x}} = \sqrt{\frac{(983)^2 + (1339)^2 - (2322)^2/2}{2(2-1)}} \\ = 178$$

The sampling error as a percent for the cruise

$$= (100) \sqrt{\left[ \frac{S_{\bar{x}} \text{ for point samples}}{\text{average basal area}} \right]^2 + \left[ \frac{S_{\bar{x}} \text{ for Y/KPI-ratios}}{\text{average Y/KPI-ratio}} \right]^2} \\ = (100) \sqrt{\left[ \frac{11.9}{35} \right]^2 + \left[ \frac{178}{1161} \right]^2} \\ = 37\%$$

The per-acre weight estimate is, then, 40635 ± 37%.

Tables 13 to 24 are provided for point sample estimates using these techniques (BAF=10).

### Computerized Approach

As Lenhart *et al.* (1973) point out, formulae, such as those in tables 1 to 12, can be modified for computerized applications. Using the one for total tree green weight for northern red oak as an example:

$$W = 2.87249D^{2.66958}$$

which is divided by 0.00545415D<sup>2</sup>, the basal area (BA) in square feet for a diameter class, expressed in inches:

$$\frac{W}{0.00545415D^2} = \frac{2.87249D^{2.66958}}{0.00545415D^2}$$

giving:

$$W/BA = 526.66135D^{0.66958}$$

Suppose a single point sample tally (BAF=10) of northern red oak is as follows:

| <u>Dbh</u> | <u>No. in-trees</u> |
|------------|---------------------|
| 5          | • •                 |
| 6          | • •                 |
| 7          | •                   |

Using Table 13, the per-acre total tree green weight estimate is:

| <u>Dbh</u> | <u>Per-acre weight</u>     |
|------------|----------------------------|
| 5          | (2) (15472) = 30944        |
| 6          | (3) (17481) = 52443        |
| 7          | (1) (19382) = <u>19382</u> |
|            | Total      102769          |

Using the formula approach, W/BA is calculated for each tree, summed, and multiplied by the BAF, as follows:

$$\begin{aligned}
 W/BA &= [526.66135(5)^{0.66958}] (2) = 3094.4 \\
 &= [526.66135(6)^{0.66958}] (3) = 5244.3 \\
 &= [526.66135(7)^{0.66958}] (1) = \underline{1938.2} \\
 &10276.9
 \end{aligned}$$

(BAF=10) (10276.9) = 102769 pounds per acre, the same answer obtained using Table 13.

In actual practice, in-trees should be measured to the nearest tenth inch.

Equations of the form exemplified by the green weight of branches for northern-red oak are modified as follows:

$$W = 116.07240 + 4.58936D^2 - 24.66151D$$

$$\begin{aligned}
 W/BA &= \frac{116.07240}{0.00545415D^2} + \frac{4.58936D^2}{0.00545415D^2} - \frac{24.66151D}{0.00545415D^2} \\
 &= 21281.48291D^{-2} + 841.44367 - 4521.60465D^{-1}
 \end{aligned}$$

A simpler method for BAF=10 is to multiply equations given in tables 1 to 12 by  $\frac{1833.46495}{D^2}$  to obtain per-acre estimates. The per-acre total green weight for a 7-inch northern red oak, for example, is:

$$\begin{aligned}
 W \text{ per acre} &= \left[ \frac{1833.46495}{(7)^2} \right] [2.87249(7)^{2.66958}] \\
 &= 19382
 \end{aligned}$$

This procedure was used to produce tables 13 to 24.

### Combined Equations for Red and White Oaks

Data for the red oaks (northern red oak, black oak, and scarlet oak) and white oaks (white oak and chestnut oak) were combined to yield equations shown in Table 25. Foresters wishing to tally oaks in these two groups rather than by species will find these equations useful and can develop local or point sampling weight tables using the procedures previously discussed.

**Table 13**  
**Total tree green weight per acre per in-tree (BAF=10).\***

| Dbh (in.) | Species |       |       |       |       |       |       |       |       |  |  |
|-----------|---------|-------|-------|-------|-------|-------|-------|-------|-------|--|--|
|           | NRO     | BO    | SO    | WO    | CO    | YP    | H     | BC    | RM    |  |  |
| 2         | 8377    | 10058 | 11535 | 6294  | 9158  | 9848  | 8369  | 11788 | 9831  |  |  |
| 3         | 10990   | 12260 | 13736 | 8520  | 11482 | 11541 | 10779 | 13727 | 12062 |  |  |
| 4         | 13325   | 14110 | 15547 | 10562 | 13480 | 12915 | 12899 | 15294 | 13946 |  |  |
| 5         | 15472   | 15734 | 17115 | 12478 | 15267 | 14093 | 14826 | 16631 | 15607 |  |  |
| 6         | 17481   | 17199 | 18513 | 14299 | 16901 | 15134 | 16613 | 17810 | 17110 |  |  |
| 7         | 19382   | 18544 | 19783 | 16044 | 18418 | 16075 | 18290 | 18871 | 18493 |  |  |
| 8         | 21194   | 19793 | 20954 | 17726 | 19843 | 16936 | 19880 | 19842 | 19782 |  |  |
| 9         | 22934   | 20965 | 22044 | 19357 | 21190 | 17735 | 21396 | 20739 | 20993 |  |  |
| 10        | 24610   | 22072 | 23067 | 20942 | 22473 | 18481 | 22851 | 21577 | 22138 |  |  |
| 11        | 26232   | 23123 | 24033 | 22487 | 23700 | 19183 | 24251 | 22363 | 23229 |  |  |
| 12        | 27805   | 24127 | 24951 | 23997 | 24878 | 19847 | 25604 | 23106 | 24271 |  |  |
| 13        | 29336   | 25088 | 25826 | 25476 | 26014 | 20478 | 26916 | 23811 | 25271 |  |  |
| 14        | 30829   | 26013 | 26663 | 26926 | 27112 | 21080 | 28190 | 24483 | 26233 |  |  |
| 15        | 32286   | 26904 | 27467 | 28350 | 28176 | 21656 | 29430 | 25126 | 27162 |  |  |
| 16        | 33712   | 27766 | 28241 | 29750 | 29208 | 22210 | 30640 | 25743 | 28061 |  |  |

\*Weights in tables 13 to 24 are in pounds.

Table 14  
Total tree dry weight per acre per in-tree (BAF=10).

| Dbh (in.) | Species |       |       |       |       |       |       |       |       |  |  |
|-----------|---------|-------|-------|-------|-------|-------|-------|-------|-------|--|--|
|           | NRO     | BO    | SO    | WO    | CO    | YP    | H     | BC    | RM    |  |  |
| 2         | 4893    | 5575  | 6607  | 3842  | 5630  | 4135  | 5452  | 6373  | 4908  |  |  |
| 3         | 6393    | 6837  | 7896  | 5105  | 6992  | 5096  | 7013  | 7572  | 6165  |  |  |
| 4         | 7730    | 7901  | 8960  | 6246  | 8154  | 5910  | 8385  | 8557  | 7247  |  |  |
| 5         | 8956    | 8840  | 9884  | 7304  | 9187  | 6631  | 9631  | 9409  | 8216  |  |  |
| 6         | 10101   | 9689  | 10708 | 8299  | 10127 | 7284  | 10785 | 10168 | 9103  |  |  |
| 7         | 11182   | 10470 | 11459 | 9246  | 10997 | 7886  | 11869 | 10857 | 9927  |  |  |
| 8         | 12212   | 11198 | 12151 | 10154 | 11811 | 8448  | 12895 | 11491 | 10701 |  |  |
| 9         | 13199   | 11881 | 12797 | 11027 | 12578 | 8976  | 13873 | 12082 | 11434 |  |  |
| 10        | 14149   | 12528 | 13403 | 11873 | 13306 | 9477  | 14811 | 12635 | 12132 |  |  |
| 11        | 15067   | 13143 | 13977 | 12693 | 14002 | 9954  | 15714 | 13158 | 12800 |  |  |
| 12        | 15957   | 13731 | 14522 | 13491 | 14668 | 10411 | 16586 | 13654 | 13442 |  |  |
| 13        | 16823   | 14295 | 15041 | 14270 | 15309 | 10849 | 17431 | 14127 | 14060 |  |  |
| 14        | 17666   | 14838 | 15539 | 15031 | 15928 | 11271 | 18252 | 14579 | 14659 |  |  |
| 15        | 18488   | 15362 | 16018 | 15775 | 16526 | 11679 | 19051 | 15013 | 15238 |  |  |
| 16        | 19293   | 15869 | 16479 | 16506 | 17106 | 12074 | 19830 | 15431 | 15802 |  |  |



Table 15  
Total tree dry weight without bark per acre per in-tree (BAF=10).

| Dbh (in.) | Species |       |       |       |       |       |       |       |       |  |  |
|-----------|---------|-------|-------|-------|-------|-------|-------|-------|-------|--|--|
|           | NRO     | BO    | SO    | WO    | CO    | YP    | H     | BC    | RM    |  |  |
| 2         | 3881    | 4548  | 5254  | 3347  | 4453  | 3469  | 4489  | 5577  | 4277  |  |  |
| 3         | 5157    | 5598  | 6399  | 4454  | 5615  | 4283  | 5877  | 6667  | 5386  |  |  |
| 4         | 6311    | 6486  | 7358  | 5455  | 6620  | 4973  | 7115  | 7566  | 6343  |  |  |
| 5         | 7380    | 7271  | 8201  | 6383  | 7522  | 5584  | 8253  | 8347  | 7201  |  |  |
| 6         | 8387    | 7983  | 8961  | 7258  | 8349  | 6139  | 9316  | 9044  | 7988  |  |  |
| 7         | 9345    | 8639  | 9658  | 8090  | 9119  | 6651  | 10321 | 9679  | 8720  |  |  |
| 8         | 10262   | 9250  | 10305 | 8888  | 9843  | 7129  | 11278 | 10265 | 9408  |  |  |
| 9         | 11146   | 9825  | 10912 | 9657  | 10529 | 7579  | 12196 | 10811 | 10060 |  |  |
| 10        | 12001   | 10370 | 11485 | 10401 | 11184 | 8005  | 13081 | 11324 | 10681 |  |  |
| 11        | 12831   | 10888 | 12029 | 11124 | 11811 | 8411  | 13936 | 11809 | 11276 |  |  |
| 12        | 13639   | 11384 | 12549 | 11827 | 12414 | 8800  | 14766 | 12270 | 11848 |  |  |
| 13        | 14426   | 11861 | 13046 | 12513 | 12995 | 9174  | 15572 | 12709 | 12399 |  |  |
| 14        | 15196   | 12319 | 13525 | 13183 | 13558 | 9534  | 16358 | 13131 | 12933 |  |  |
| 15        | 15950   | 12762 | 13986 | 13840 | 14104 | 9882  | 17126 | 13535 | 13451 |  |  |
| 16        | 16688   | 13191 | 14431 | 14484 | 14635 | 10219 | 17876 | 13925 | 13953 |  |  |

Table 16  
Total tree dry weight of bark per acre per in-tree (BAF=10).

| Dbh (in.) | Species |      |      |      |      |      |      |      |      |  |  |
|-----------|---------|------|------|------|------|------|------|------|------|--|--|
|           | NRO     | BO   | SO   | WO   | CO   | YP   | H    | BC   | RM   |  |  |
| 2         | 1021    | 1024 | 1365 | 483  | 1160 | 714  | 991  | 801  | 630  |  |  |
| 3         | 1228    | 1235 | 1484 | 638  | 1348 | 855  | 1124 | 905  | 776  |  |  |
| 4         | 1400    | 1411 | 1574 | 777  | 1499 | 972  | 1230 | 988  | 900  |  |  |
| 5         | 1549    | 1564 | 1648 | 906  | 1628 | 1074 | 1318 | 1056 | 1010 |  |  |
| 6         | 1683    | 1701 | 1711 | 1026 | 1741 | 1166 | 1395 | 1116 | 1109 |  |  |
| 7         | 1806    | 1827 | 1766 | 1141 | 1843 | 1249 | 1464 | 1170 | 1201 |  |  |
| 8         | 1919    | 1943 | 1815 | 1250 | 1936 | 1325 | 1526 | 1218 | 1286 |  |  |
| 9         | 2025    | 2052 | 1860 | 1355 | 2022 | 1397 | 1583 | 1262 | 1367 |  |  |
| 10        | 2124    | 2154 | 1900 | 1457 | 2103 | 1464 | 1636 | 1303 | 1443 |  |  |
| 11        | 2218    | 2251 | 1938 | 1555 | 2178 | 1528 | 1686 | 1341 | 1516 |  |  |
| 12        | 2308    | 2343 | 1973 | 1651 | 2249 | 1588 | 1732 | 1376 | 1585 |  |  |
| 13        | 2394    | 2431 | 2005 | 1744 | 2317 | 1646 | 1776 | 1410 | 1652 |  |  |
| 14        | 2476    | 2516 | 2036 | 1835 | 2381 | 1702 | 1817 | 1442 | 1716 |  |  |
| 15        | 2555    | 2598 | 2065 | 1924 | 2442 | 1755 | 1857 | 1472 | 1779 |  |  |
| 16        | 2631    | 2676 | 2093 | 2011 | 2501 | 1806 | 1895 | 1501 | 1839 |  |  |

Table 17  
Green weight of branches per acre per in-tree (BAF=10).

| Dbh (in.) | Species |      |      |      |      |      |      |      |      |  |  |
|-----------|---------|------|------|------|------|------|------|------|------|--|--|
|           | NRO     | BO   | SO   | WO   | CO   | YP   | H    | BC   | RM   |  |  |
| 5         | 7884    | 4770 | 6836 | 5149 | 5797 | 5345 | 5759 | 5330 | 6855 |  |  |
| 6         | 6790    | 4927 | 5457 | 3928 | 4617 | 2663 | 4453 | 4531 | 6121 |  |  |
| 7         | 6298    | 5063 | 5003 | 3529 | 4247 | 1626 | 4194 | 4108 | 5646 |  |  |
| 8         | 6088    | 5183 | 4952 | 3490 | 4228 | 1328 | 4369 | 3871 | 5318 |  |  |
| 9         | 6018    | 5292 | 5085 | 3613 | 4367 | 1381 | 4724 | 3735 | 5079 |  |  |
| 10        | 6021    | 5392 | 5300 | 3808 | 4574 | 1603 | 5145 | 3656 | 4897 |  |  |
| 11        | 6063    | 5483 | 5547 | 4032 | 4808 | 1903 | 5581 | 3612 | 4756 |  |  |
| 12        | 6124    | 5568 | 5802 | 4262 | 5047 | 2235 | 6007 | 3588 | 4642 |  |  |
| 13        | 6196    | 5648 | 6053 | 4489 | 5280 | 2573 | 6411 | 3578 | 4550 |  |  |
| 14        | 6271    | 5722 | 6294 | 4705 | 5502 | 2906 | 6791 | 3577 | 4473 |  |  |
| 15        | 6346    | 5792 | 6521 | 4910 | 5712 | 3225 | 7144 | 3581 | 4408 |  |  |
| 16        | 6420    | 5858 | 6735 | 5102 | 5908 | 3529 | 7471 | 3588 | 4353 |  |  |

**Table 18**  
**Dry weight of branches per acre per in-tree (BAF=10).**

| Dbh (in.) | Species |      |      |      |      |      |      |      |      |  |  |
|-----------|---------|------|------|------|------|------|------|------|------|--|--|
|           | NRO     | BO   | SO   | WO   | CO   | YP   | H    | BC   | RM   |  |  |
| 5         | 4565    | 3537 | 4233 | 3367 | 3278 | 2438 | 3694 | 2867 | 3582 |  |  |
| 6         | 3967    | 2960 | 3253 | 2293 | 2612 | 1305 | 2771 | 2511 | 3277 |  |  |
| 7         | 3706    | 2802 | 2932 | 1908 | 2417 | 860  | 2588 | 2307 | 3058 |  |  |
| 8         | 3601    | 2823 | 2898 | 1828 | 2423 | 725  | 2712 | 2182 | 2894 |  |  |
| 9         | 3573    | 2921 | 2995 | 1890 | 2519 | 739  | 2963 | 2102 | 2765 |  |  |
| 10        | 3585    | 3051 | 3150 | 2017 | 2653 | 825  | 3261 | 2048 | 2661 |  |  |
| 11        | 3617    | 3192 | 3329 | 2173 | 2800 | 944  | 3569 | 2010 | 2577 |  |  |
| 12        | 3659    | 3333 | 3512 | 2338 | 2949 | 1078 | 3870 | 1984 | 2506 |  |  |
| 13        | 3706    | 3469 | 3693 | 2504 | 3093 | 1214 | 4156 | 1965 | 2446 |  |  |
| 14        | 3754    | 3597 | 3865 | 2663 | 3230 | 1349 | 4425 | 1952 | 2395 |  |  |
| 15        | 3801    | 3718 | 4029 | 2816 | 3359 | 1479 | 4674 | 1941 | 2350 |  |  |
| 16        | 3847    | 3831 | 4182 | 2959 | 3480 | 1603 | 4906 | 1934 | 2311 |  |  |

Table 19  
 Dry weight of branches without bark per acre per in-tree (BAF=10).

| Dbh (in.) | Species |      |      |      |      |      |      |      |      |  |
|-----------|---------|------|------|------|------|------|------|------|------|--|
|           | NRO     | BO   | SO   | WO   | CO   | YP   | H    | BC   | RM   |  |
| 5         | 3601    | 2830 | 3441 | 2853 | 2540 | 2146 | 3002 | 2489 | 3117 |  |
| 6         | 3225    | 2346 | 2688 | 1898 | 2117 | 1099 | 2234 | 2189 | 2821 |  |
| 7         | 3053    | 2214 | 2445 | 1541 | 1995 | 683  | 2109 | 2016 | 2611 |  |
| 8         | 2979    | 2231 | 2424 | 1450 | 2002 | 552  | 2247 | 1909 | 2454 |  |
| 9         | 2952    | 2313 | 2504 | 1484 | 2066 | 557  | 2492 | 1839 | 2332 |  |
| 10        | 2951    | 2422 | 2627 | 1578 | 2154 | 629  | 2774 | 1791 | 2235 |  |
| 11        | 2963    | 2540 | 2769 | 1698 | 2250 | 733  | 3061 | 1758 | 2155 |  |
| 12        | 2983    | 2659 | 2913 | 1828 | 2347 | 850  | 3341 | 1734 | 2089 |  |
| 13        | 3006    | 2773 | 3055 | 1960 | 2441 | 971  | 3605 | 1716 | 2033 |  |
| 14        | 3030    | 2881 | 3191 | 2089 | 2530 | 1090 | 3852 | 1703 | 1986 |  |
| 15        | 3055    | 2982 | 3320 | 2212 | 2614 | 1206 | 4081 | 1693 | 1944 |  |
| 16        | 3079    | 3076 | 3440 | 2328 | 2692 | 1316 | 4293 | 1686 | 1908 |  |

Table 20  
 Dry weight of branch bark per acre per in-tree (BAF=10).

| Dbh (in.) | Species |     |     |     |     |     |     |     |     |  |  |
|-----------|---------|-----|-----|-----|-----|-----|-----|-----|-----|--|--|
|           | NRO     | BO  | SO  | WO  | CO  | YP  | H   | BC  | RM  |  |  |
| 5         | 964     | 707 | 793 | 513 | 740 | 225 | 686 | 378 | 465 |  |  |
| 6         | 743     | 614 | 565 | 394 | 495 | 222 | 625 | 322 | 456 |  |  |
| 7         | 653     | 588 | 486 | 367 | 420 | 219 | 578 | 291 | 447 |  |  |
| 8         | 622     | 592 | 474 | 378 | 420 | 216 | 540 | 273 | 439 |  |  |
| 9         | 621     | 608 | 492 | 406 | 451 | 214 | 509 | 263 | 433 |  |  |
| 10        | 634     | 629 | 523 | 440 | 498 | 212 | 482 | 257 | 427 |  |  |
| 11        | 654     | 651 | 560 | 475 | 549 | 211 | 459 | 253 | 421 |  |  |
| 12        | 676     | 674 | 599 | 510 | 601 | 209 | 440 | 250 | 417 |  |  |
| 13        | 700     | 696 | 637 | 543 | 651 | 208 | 422 | 249 | 413 |  |  |
| 14        | 724     | 717 | 674 | 575 | 700 | 207 | 406 | 248 | 409 |  |  |
| 15        | 747     | 736 | 709 | 604 | 745 | 205 | 392 | 248 | 406 |  |  |
| 16        | 769     | 754 | 742 | 631 | 788 | 204 | 380 | 248 | 403 |  |  |

Table 21  
Green weight to a 4-inch dbh per acre per in-tree (BAF=10).

| Dbh (in.) | Species |       |       |       |       |       |       |       |       |  |  |
|-----------|---------|-------|-------|-------|-------|-------|-------|-------|-------|--|--|
|           | NRO     | BO    | SO    | WO    | CO    | YP    | H     | BC    | RM    |  |  |
| 5         | 11911   | 16302 | 13513 | 8498  | 10551 | 8894  | 6775  | 12132 | 14921 |  |  |
| 6         | 13886   | 14249 | 14585 | 12004 | 13138 | 11237 | 8579  | 13463 | 12173 |  |  |
| 7         | 15517   | 14025 | 15620 | 14361 | 14977 | 13042 | 10475 | 14820 | 12190 |  |  |
| 8         | 16861   | 14536 | 16545 | 16049 | 16351 | 14468 | 12452 | 16060 | 13287 |  |  |
| 9         | 17978   | 15335 | 17351 | 17313 | 17417 | 15620 | 14503 | 17155 | 14781 |  |  |
| 10        | 18916   | 16229 | 18052 | 18295 | 18268 | 16568 | 16623 | 18115 | 16382 |  |  |
| 11        | 19713   | 17127 | 18661 | 19079 | 18964 | 17362 | 18806 | 18954 | 17958 |  |  |
| 12        | 20398   | 17991 | 19194 | 19718 | 19542 | 18035 | 21049 | 19692 | 19456 |  |  |
| 13        | 20992   | 18804 | 19663 | 20249 | 20031 | 18614 | 23348 | 20343 | 20854 |  |  |
| 14        | 21511   | 19561 | 20078 | 20697 | 20449 | 19116 | 25699 | 20920 | 22147 |  |  |
| 15        | 21970   | 20261 | 20447 | 21080 | 20812 | 19557 | 28101 | 21435 | 23339 |  |  |
| 16        | 22377   | 20907 | 20777 | 21412 | 21129 | 19945 | 30550 | 21897 | 24436 |  |  |

Table 22  
 Dry weight to a 4-inch dbh per acre per in-tree (BAF=10).

| Dbh (in.) | Species |       |       |       |       |       |       |       |       |  |  |
|-----------|---------|-------|-------|-------|-------|-------|-------|-------|-------|--|--|
|           | NRO     | BO    | SO    | WO    | CO    | YP    | H     | BC    | RM    |  |  |
| 5         | 6689    | 9106  | 6445  | 6264  | 7287  | 4722  | 4448  | 6848  | 7723  |  |  |
| 6         | 7930    | 7923  | 7211  | 7023  | 8015  | 5812  | 5619  | 8216  | 6564  |  |  |
| 7         | 8900    | 7810  | 7930  | 7737  | 8688  | 6723  | 6846  | 9185  | 6741  |  |  |
| 8         | 9673    | 8124  | 8609  | 8414  | 9316  | 7478  | 8124  | 9907  | 7422  |  |  |
| 9         | 10300   | 8606  | 9257  | 9060  | 9907  | 8109  | 9448  | 10466 | 8277  |  |  |
| 10        | 10819   | 9140  | 9878  | 9679  | 10468 | 8641  | 10814 | 10912 | 9166  |  |  |
| 11        | 11255   | 9676  | 10475 | 10276 | 11002 | 9094  | 12219 | 11275 | 10029 |  |  |
| 12        | 11625   | 10191 | 11052 | 10854 | 11514 | 9484  | 13660 | 11577 | 10842 |  |  |
| 13        | 11945   | 10674 | 11611 | 11413 | 12006 | 9823  | 15136 | 11832 | 11595 |  |  |
| 14        | 12222   | 11124 | 12153 | 11957 | 12480 | 10120 | 16644 | 12050 | 12289 |  |  |
| 15        | 12466   | 11540 | 12681 | 12486 | 12938 | 10382 | 18183 | 12238 | 12927 |  |  |
| 16        | 12681   | 11924 | 13195 | 13002 | 13382 | 10614 | 19751 | 12403 | 13512 |  |  |



Table 23  
 Dry weight without bark to a 4-inch dob per acre per in-tree (BAF=10).

| Dbh (in.) | Species |       |       |       |       |      |       |       |       |  |  |
|-----------|---------|-------|-------|-------|-------|------|-------|-------|-------|--|--|
|           | NRO     | BO    | SO    | WO    | CO    | YP   | H     | BC    | RM    |  |  |
| 5         | 5454    | 7426  | 5471  | 5753  | 6372  | 4059 | 3724  | 6089  | 6687  |  |  |
| 6         | 6748    | 6577  | 6157  | 6412  | 7052  | 4796 | 4784  | 7287  | 5823  |  |  |
| 7         | 7689    | 6549  | 6804  | 7029  | 7697  | 5523 | 5913  | 8170  | 6046  |  |  |
| 8         | 8404    | 6844  | 7418  | 7611  | 8269  | 6180 | 7105  | 8848  | 6672  |  |  |
| 9         | 8966    | 7261  | 8007  | 8164  | 8765  | 6755 | 8353  | 9384  | 7432  |  |  |
| 10        | 9418    | 7712  | 8572  | 8693  | 9195  | 7257 | 9654  | 9818  | 8211  |  |  |
| 11        | 9790    | 8160  | 9118  | 9201  | 9568  | 7695 | 11006 | 10177 | 8962  |  |  |
| 12        | 10102   | 8587  | 9647  | 9690  | 9894  | 8078 | 12404 | 10479 | 9665  |  |  |
| 13        | 10367   | 8986  | 10161 | 10163 | 10180 | 8416 | 13846 | 10737 | 10316 |  |  |
| 14        | 10595   | 9356  | 10660 | 10622 | 10433 | 8715 | 15330 | 10958 | 10915 |  |  |
| 15        | 10793   | 9697  | 11148 | 11068 | 10658 | 8982 | 16855 | 11152 | 11463 |  |  |
| 16        | 10967   | 10011 | 11624 | 11501 | 10859 | 9220 | 18418 | 11322 | 11966 |  |  |

Table 24  
 Dry weight of bark to a 4-inch dbh per acre per in-tree (BAF=10).

| Dbh (in.) | Species |      |      |      |      |      |      |      |      |  |  |
|-----------|---------|------|------|------|------|------|------|------|------|--|--|
|           | NRO     | BO   | SO   | WO   | CO   | YP   | H    | BC   | RM   |  |  |
| 5         | 1235    | 1680 | 971  | 509  | 1135 | 663  | 696  | 758  | 1027 |  |  |
| 6         | 1182    | 1346 | 1047 | 604  | 1226 | 1016 | 784  | 929  | 738  |  |  |
| 7         | 1211    | 1261 | 1115 | 698  | 1308 | 1199 | 868  | 1015 | 694  |  |  |
| 8         | 1268    | 1280 | 1179 | 791  | 1384 | 1299 | 947  | 1059 | 750  |  |  |
| 9         | 1334    | 1345 | 1237 | 884  | 1454 | 1354 | 1023 | 1082 | 847  |  |  |
| 10        | 1401    | 1428 | 1292 | 975  | 1520 | 1384 | 1097 | 1093 | 958  |  |  |
| 11        | 1464    | 1516 | 1344 | 1067 | 1582 | 1400 | 1167 | 1097 | 1070 |  |  |
| 12        | 1523    | 1604 | 1393 | 1157 | 1641 | 1406 | 1236 | 1097 | 1179 |  |  |
| 13        | 1577    | 1689 | 1440 | 1248 | 1697 | 1407 | 1303 | 1095 | 1282 |  |  |
| 14        | 1627    | 1769 | 1485 | 1337 | 1751 | 1405 | 1368 | 1091 | 1378 |  |  |
| 15        | 1672    | 1843 | 1528 | 1427 | 1802 | 1400 | 1431 | 1087 | 1467 |  |  |
| 16        | 1714    | 1913 | 1569 | 1516 | 1852 | 1394 | 1493 | 1082 | 1550 |  |  |

Table 25

## Weight equations for the red oak and white oak groups.

| Weight                               | Group      | Equation                                  | R <sup>2</sup> | Standard error |             |
|--------------------------------------|------------|---|----------------|----------------|-------------|
|                                      |            |   |                | Pounds         | % of W-mean |
| Total tree green wt.                 | Red oaks   | $W = 3.64938D^{2.54036}$                  | .990           | 109            | 9           |
|                                      | White oaks | $W = 2.68231D^{2.64500}$                  | .987           | 130            | 10          |
| Total tree dry wt.                   | Red oaks   | $W = 2.09014D^{2.54052}$                  | .989           | 69             | 10          |
|                                      | White oaks | $W = 1.68565D^{2.60982}$                  | .985           | 79             | 11          |
| Total tree dry wt. without bark      | Red oaks   | $W = 1.63495D^{2.57352}$                  | .989           | 61             | 10          |
|                                      | White oaks | $W = 1.37211D^{2.63256}$                  | .986           | 66             | 11          |
| Total tree dry wt. of bark           | Red oaks   | $W = 0.46923D^{2.37764}$                  | .985           | 12             | 11          |
|                                      | White oaks | $W = 0.29702D^{2.50850}$                  | .951           | 21             | 20          |
| Green wt. of branches                | Red oaks   | $W = 167.47727 + 5.57660D^{2.42.43430D}$  | .897           | 86             | 24          |
|                                      | White oaks | $W = 184.52253 + 5.32224D^{2.48.73647D}$  | .939           | 55             | 19          |
| Dry wt. of branches                  | Red oaks   | $W = 114.40758 + 3.55460D^{2.29.31907D}$  | .891           | 53             | 25          |
|                                      | White oaks | $W = 124.89440 + 3.31160D^{2.32.77917D}$  | .910           | 40             | 23          |
| Dry wt. of branches without bark     | Red oaks   | $W = 88.24854 + 2.83470D^{2.22.75065D}$   | .871           | 48             | 27          |
|                                      | White oaks | $W = 93.46358 + 2.51626D^{2.24.25798D}$   | .902           | 32             | 24          |
| Dry wt. of branch bark               | Red oaks   | $W = 26.15905 + 0.71990D^{2.6.56843D}$    | .902           | 10             | 24          |
|                                      | White oaks | $W = 31.55046 + 0.79647D^{2.8.54744D}$    | .893           | 10             | 27          |
| Green wt. to a 4-inch dob            | Red oaks   | $W = 208.76407 + 16.11594D^{2.85.39248D}$ | .978           | 127            | 11          |
|                                      | White oaks | $W = 21.03646 + 14.57852D^{2.48.52150D}$  | .984           | 111            | 9           |
| Dry wt. to a 4-inch dob              | Red oaks   | $W = 80.61690 + 8.82363D^{2.40.83982D}$   | .975           | 79             | 12          |
|                                      | White oaks | $W = 1.50659D^{2.56224}$                  | .983           | 66             | 10          |
| Dry wt. without bark to a 4-inch dob | Red oaks   | $W = 67.75124 + 7.65651D^{2.35.67783D}$   | .970           | 74             | 13          |
|                                      | White oaks | $W = 1.32023D^{2.56152}$                  | .985           | 54             | 9           |
| Dry wt. of bark to a 4-inch dob      | Red oaks   | $W = 0.23620D^{2.50780}$                  | .937           | 17             | 19          |
|                                      | White oaks | $W = 0.16386D^{2.61120}$                  | .908           | 21             | 24          |

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