NORTH CENTRAL FOREST EXPERIMENT STATION

Research Note NC-272

1992 FOLWELL AVE. ST. PAUL, MN 55108 FOREST SERVICE-U.S.D.A.

1981

# ESTIMATING TOTAL-TREE HEIGHT FOR UPLAND OAKS AND HICKORIES IN SOUTHERN ILLINOIS



**Charles Myers,**
*Research Forester,*
*and* **David M. Belcher,**
*Biometrician*



ABSTRACT.—An equation to predict total-tree height from merchantable length was developed for hardwoods: $\hat{Y} = 30.0 + 0.85\ X$, with $R^2 = 0.87$.

KEY WORDS: Regression, merchantable height, Lake States, hardwoods.

Total-tree height is often used for determining weight or volume of standing trees. It is difficult to measure in hardwoods due to the lack of visibility and a well defined terminal. In this paper we examine relations between total-tree height and more easily measured variables. We find that total height can be estimated from merchantable height.

Data for this study came from measurements on 155 felled trees in the Shawnee National Forest in southern Illinois. Trees were selected from three 25-acre blocks on upland oak-hickory sites. The aspect was predominantly southern and the trees were dispersed from top to bottom of the slope. Trees were selected to give a representative range of size classes for each species. Species included are red oak, white oak, black oak, and hickories. Measured variables were:

**D.B.H.**—tree diameter at 4.5 feet above ground, on the uphill side of the tree;

**Merchantable length**—distance above 1-foot stump to a point on the main stem where diameter outside bark is 5 inches;

**Total height**—height above ground to the tip of the tree. Averages and ranges for these variables are:

| Variable | Average | Range |
|---|---|---|
| D.b.h. (inches) | 13.5 | 5.0-23.6 |
| Merchantable length (feet) | 50.8 | 8.5-78.5 |
| Total height (feet) | 73.2 | 37.5-96.6 |

A more complete display of the data (table 1), shows trends between the variables and the little variation in total height within a given merchantable height class.

After examining various plots of the data and screening several equation forms, we decided that a simple linear regression relating total-tree height to merchantable height was the best relation ($Y = 30.0 + 0.85x$, with $R^2 = 0.87$). Gevorkiantz and Olson (1955) present total height as a function of merchantable height and d.b.h. for Lake States species. But we found that including d.b.h. did not appreciably improve our equation for southern Illinois trees (increased $R^2$ by .003).

Total-tree height can be estimated from merchantable length measurements for selected hardwoods in southern Illinois by using the equation, graph or table (fig. 1, table 1). When merchantable

length is estimated as number of 8-foot bolts, use this tabluation:

| Merchantable length (No. 8-ft. bolts) | Total height (Feet) |
|---|---|
| 1 | 37 |
| 2 | 44 |
| 3 | 50 |
| 4 | 57 |
| 5 | 64 |
| 6 | 71 |
| 7 | 78 |
| 8 | 84 |
| 9 | 91 |

These results essentially agree with those of Gevorkiantz and Olson (1955) but give a simplified procedure and equation for obtaining total-tree height. Our data points and resulting equation approximate the diagonal of the Gevorkiantz and Olson table of total height by d.b.h. and merchantable height.

Because our results are essentially the same as those of Gevorkiantz and Olson, their tables should apply in southern Illinois and our equation and tables should apply in the Lake States. But bottomland hardwoods, particularly eastern cottonwood, might require a different equation or table.

## REFERENCE

Gevorkiantz, S. R., and L. P. Olson. 1955. Composite volume tables for timber and their application in the Lake States. U.S. Department of Agriculture Forest Service, Technical Bulletin 1104, 51 p.

Table 1.—*Number of observations (n) and average total height ($\bar{y}$) by diameter at breast height (d.b.h.) and number of bolts*

| D.b.h. | Number of 8-foot bolts | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | 7 | | 8 | | 9 | |
| | *n* | $\bar{y}$ | *n* | $\bar{y}$ | *n* | $\bar{y}$ | *n* | $\bar{y}$ | *n* | $\bar{y}$ | *n* | $\bar{y}$ | *n* | $\bar{y}$ | *n* | $\bar{y}$ | *n* | $\bar{y}$ |
| 4 | | | | | | | | | | | | | | | | | | |
| 5 | 2 | 43 | 2 | 43 | | | | | | | | | | | | | | |
| 6 | | | 2 | 40 | | | | | | | | | | | | | | |
| 7 | | | 3 | 42 | 4 | 56 | 1 | 57 | | | | | | | | | | |
| 8 | | | | | 7 | 55 | 4 | 59 | 2 | 60 | | | | | | | | |
| 9 | | | | | | | 4 | 60 | 11 | 68 | 1 | 71 | | | | | | |
| 10 | | | | | | | 2 | 56 | 3 | 68 | 3 | 74 | | | | | | |
| 11 | | | | | | | | | 6 | 68 | 6 | 74 | 1 | 80 | | | | |
| 12 | | | | | | | | | 1 | 70 | 4 | 73 | 2 | 81 | | | | |
| 13 | | | | | | | | | 1 | 67 | 2 | 70 | 5 | 85 | | | | |
| 14 | | | | | | | | | 2 | 69 | 4 | 81 | 9 | 82 | | | | |
| 15 | | | | | | | | | 1 | 68 | 1 | 76 | 1 | 96 | 2 | 89 | | |
| 16 | | | | | | | | | | | 1 | 78 | 2 | 80 | 2 | 89 | | |
| 17 | | | | | | | | | | | 1 | 97 | 4 | 80 | 1 | 84 | 1 | 92 |
| 18 | | | | | | | | | | | | | 9 | 81 | 3 | 85 | | |
| 19 | | | | | | | | | 1 | 56 | | | 2 | 72 | 5 | 87 | 1 | 88 |
| 20 | | | | | | | | | | | 1 | 73 | 5 | 79 | 4 | 86 | | |
| 21 | | | | | | | | | | | 1 | 76 | 1 | 79 | 4 | 86 | 2 | 93 |
| 22 | | | | | | | | | | | | | | | 2 | 90 | | |
| 23 | | | | | | | | | | | | | | | 1 | 81 | 1 | 97 |
| 24 | | | | | | | | | | | | | | | 1 | 88 | | |
| 25 | | | | | | | | | | | | | | | | | | |
| 26 | | | | | | | | | | | | | | | | | | |

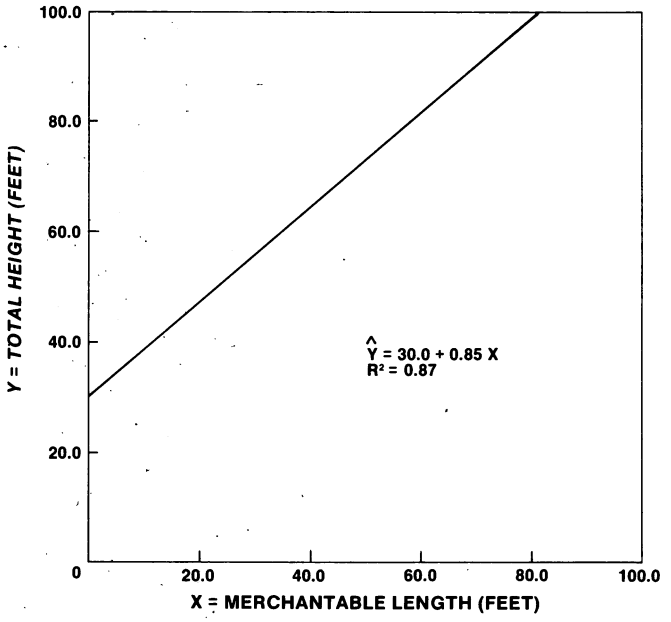


Figure 1.—*Relation between total-tree height and merchantable length for upland oaks and hickories in southern Illinois.*

☆ U.S. Government Printing Office: 1981—767-050/211 Region No. 6