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Estimating Cubic Foot Volume, Green Weight, or Dry Weight Per Acre of Planted Loblolly Pine Using Variable-Radius-Plot Cruising Techniques

by

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The variable-radius-plot (VRP) cruising concept, introduced to American forestry in the 1950's, has developed into a useful forest management tool for inventorying timber stands. Various VRP cruising procedures for estimating volume per acre have been developed (1, 2, 3, 4, 5, 6). Growing acceptance of weight scaling makes it desirable to estimate green or dry weight per acre in pounds. Information on timber stand weights should also facilitate planning for both the forest manager and the mill manager.

TREE MEASURE/BASAL AREA CONVERSION MODEL

Each tree tallied in VRP cruising represents a fixed number of square feet of basal area per acre determined by the "factor" of the prism or other sighting instrument used (7, 8, 9, 10, 11).

To facilitate the conversion of tree basal area per acre to a product measure per acre, a widely used tree measure prediction model can be modified. The model is

(1) Tree measure = $a + bD^2H$,

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where: D = diameter at breast height, in inches

H = total tree height, in feet, and

a and b = regression coefficients.

The first step in the modification process is to divide equation 1 by $0.00545415D^2$, which is the basal area (BA) in square feet for a diameter class, expressed in inches; as

$$(2)\ \frac{\text{Measure}}{0.00545415D^2} = \frac{a}{0.00545415D^2} + \frac{bD^2H}{0.00545415D^2}$$

Manipulation of equation 2 produces

$$(3)\ \frac{\text{Measure}}{BA} = \frac{aD^{-2}}{0.00545415} + \frac{bH}{0.00545415}$$

Equation 3 is a general model suitable for transforming individual tree measure prediction equations (of the type shown as equation 1) for use in variable-radius-plot cruising (12, 13).

CUBIC FOOT VOLUME, GREEN OR DRY WEIGHT ESTIMATION

Recent mensurational work in old-field loblolly pine (*Pinus taeda* L.) plantations in the Interior West Gulf Coastal Plain region of Texas, Oklahoma, Arkansas, and Louisiana has provided procedures for predicting several different tree measures. Comprehensive equations and tables have been developed for volume (cubic feet), (14); for green weight (pounds), (15); and for dry weight (pounds), (16).

Selected equations for three merchantability standards from these authors' work transformed according to equation 3. The modified equations are

Excluding bark - to a 2.0-inch d.o.b.

(4) VOLUME, CUBIC FEET/BA = $0.35907H - 26.62193D^{-2}$

(5) GREEN WEIGHT, POUNDS/BA = $23.49404H - 3664.03748D^{-2}$

(6) DRY WEIGHT, POUNDS/BA = $10.09507H - 897.36806D^{-2}$

Excluding bark - to a 3.0-inch top d.o.b.

(7) VOLUME, CUBIC FEET/BA = $0.36083H - 59.39514D^{-2}$

(8) GREEN WEIGHT, POUNDS/BA = $23.59121H - 5848.71520D^{-2}$

(9) DRY WEIGHT, POUNDS/BA = $10.15007H - 1730.83248D^{-2}$

Excluding bark - to a 4.0-inch top d.o.b.

(10) VOLUME, CUBIC FEET/BA = $0.36620H - 144.38913D^{-2}$

(11) GREEN WEIGHT, POUNDS/BA = $23.89190H - 11405.67641D^{-2}$

(12) DRY WEIGHT, POUNDS/BA = $10.29858H - 3946.41512D^{-2}$

APPLICATION

Two computational techniques for estimating volume, green weight, or dry weight per acre may be used with VRP cruising. If the cruiser has access to a programmable desk-top electronic calculator or a computer, the "formula" approach is efficient and precise. However, if sophisticated electronic calculating machines are not available, the less precise "table" approach may be acceptable.

"FORMULA"

1. Each loblolly pine tree tallied on a VRP is measured as precisely as feasible, which may be to the nearest tenth inch in tree diameter and to the nearest foot in total tree height.
2. The tree tally is separated by plots.
3. One (or more) of the 9 modified equations (4-12) above is used in programmable electronic calculating machines—desk-top or full scale.
4. Each diameter and height pair from a VRP is then used to calculate its appropriate tree measure ratio.
5. The ratios for all trees tallied on a VRP are summed.
6. This total is multiplied by the BAF of the prism used in the cruising.
7. The result is the estimated measure per acre based on one VRP.

"TABLE"

1. A VRP tally sheet can be developed showing two classifications—tree diameter by 1-inch classes and total tree height by 5-foot classes. (Fig. 1)

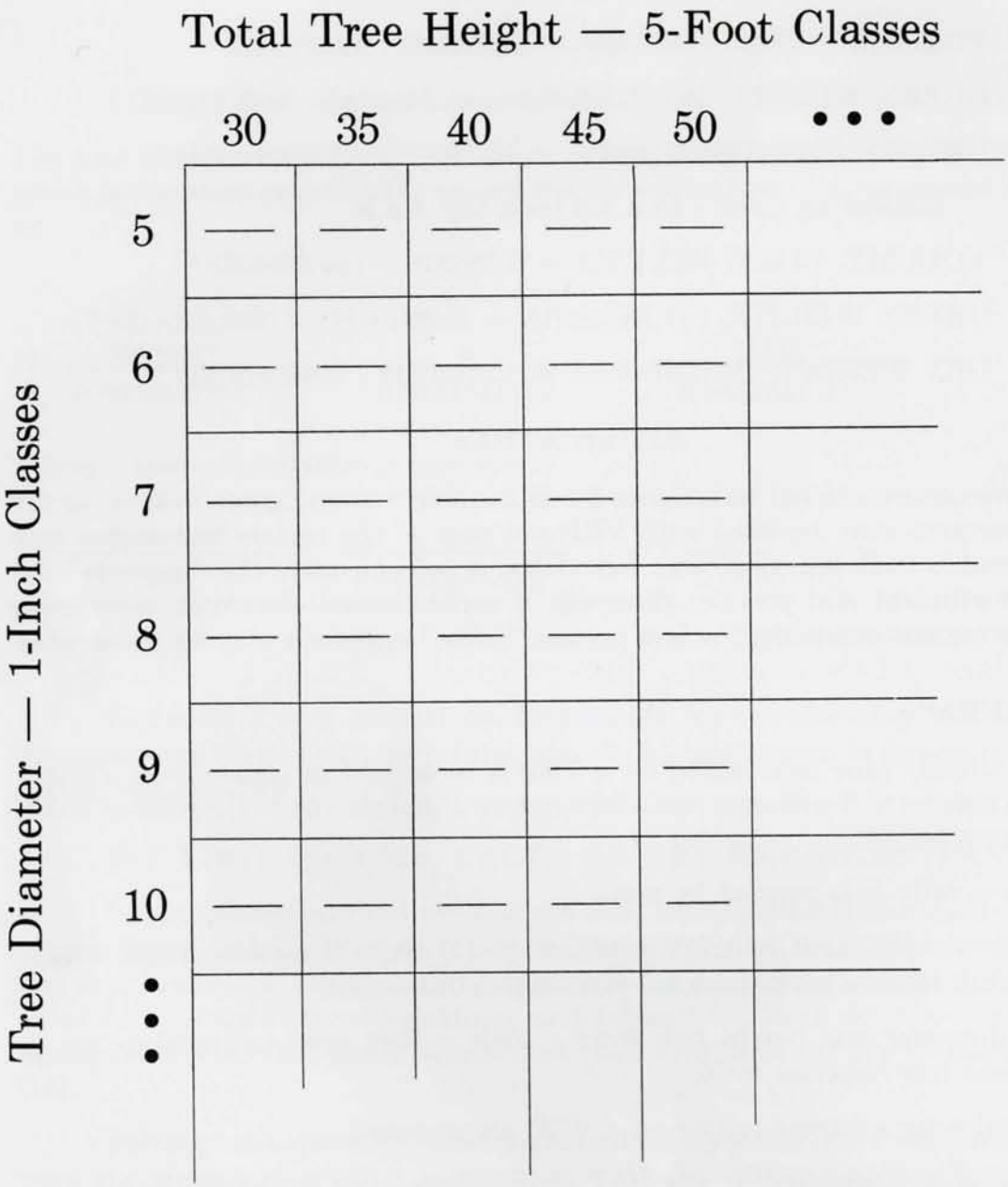

Figure 1. Portion of a suggested VRP cruising tally sheet showing the cells with space for precalculated ratios and the observed tree tally.

2. A ratio for the particular diameter/height combination is precalculated for each cell using one of the nine modified equations above. It is often convenient to have these values printed in their respective cells on the tally sheet.

3. Each tree tallied and measured is recorded by its appropriate diameter and height class.

4. After cruising is completed, the ratio in each cell is multiplied by the number of trees tallied in that cell.

5. All the products on each tally sheet are summed.

6. This total is multiplied by the BAF.

7. If a separate tally sheet is used for each VRP, the result is the estimated measure per acre based on one VRP. In this case, as in the "Formula" method, the information determined can be used to estimate the sampling variation.
   If, however, an estimate of the variation is not required, computations can be reduced by combining the tally from more than one VRP on a single tally sheet. When the total value for all cells (step 5) is found, it is multiplied by the BAF and then divided by the number of VRP's included in the total, to produce the estimated measure per acre, based on all included VRP's.
   A similar modification of the "Formula" method is possible, but has no important advantages.

LITERATURE CITED

1. Grosenbaugh, L.R. 1952. *Plotless Timber Estimates—New, Fast, Easy.* Jour. For. 50:32-37.

2. Hunt, E.V., Jr. and R.D. Baker. 1967. *Practical Point-Sampling.* SFA State College. Dept. For. Bulletin 14.

3. Hunt, Ellis V., Jr., R.D. Baker, and L.A. Biskamp. 1964. *Point-Sampling from Two Angles.* SFA College. Dept. For. Bulletin 6.

4. Palley, M. and W.G. O'Regan. 1961. *A Computer Technique for the Study of Forest Sampling Methods. Point Sampling Compared with Line Sampling.* For. Sci. 7:282-294.

5. Parker, R.C. 1969. *Tree Volume-Basal-Area Ratio Tables.* Cooperative Extension Service. Virginia Polytechnic Institute. Publication 277. 58 pp.

6. Wilson, D.A. and W.C. Robbins. 1970. *Formulas and Tables for Point-Sampling in Forest Inventory.* School of Forest Resources, University of Maine. Station Bulletin 671. 107 pp.

7. Beers, T.W. and C.I. Miller. 1964. *Point-Sampling: Reseach Results, Theory, and Applications.* Purdue Univ. Agr. Expt. Sta. Res. Bull. 786. 55 pp.

8. Dixon, R.M. 1958. *Point-Sampling, Wedge Prisms, and their Application in Forest Inventories.* Ontario Dept. of Lands and Forests. 13 pp.

9. Grosenbaugh, L.R. 1958. *Point-Sampling and Line-Sampling: Probability Theory, Geometric Implication, Synthesis.* Southern Forest Expt. Sta. Occ. Paper 160. 34 pp.

10. Grosenbaugh, L.R. 1955. *Better Diagnosis and Prescription in Southern Forest Management.* Southern Forest Expt. Sta. Occ. Paper 145. 27 pp.

11. Kulow, D.L. 1965. *Elementary Point-Sampling.* West Virginia Agr. Exp. Sta. Circular 116.

12. Smalley, G.W. and D.R. Bower. 1968. *Volume Tables and Point-Sampling Factors for Loblolly Pines in Plantations on Abandoned Fields in Tennessee, Alabama, and Georgia Highlands.* Southern Forest Expt. Sta. SO-32. 13 pp.

13. Smalley, G.W. and D.R. Bower. 1968. *Volume Tables and Point-Sampling Factors for Shortleaf Pines in Plantations on Abandoned Fields in Tennessee, Alabama, and Georgia Highlands.* Southern Forest Expt. Sta. SO-39. 13 pp.

14. Hasness, J.R. and J.D. Lenhart. 1972. *Cubic-foot Volumes for Loblolly Pine Trees in Old-Field Plantations in the Interior West Gulf Coastal Plain.* Texas Forestry Paper No. 12. 7 pp.

15. Hicks, D.R., J.D. Lenhart, and S.I. Somberg. 1972. *Merchantable Green Weights for Loblolly Pine Trees in Old-Field Plantations in the Interior West Gulf Coastal Plain.* Texas Forestry Paper No. 16. 4 pp.

16. Hyink, D.M., J.D. Lenhart, and S.I. Somberg, 1972. *Ovendry Weights for Loblolly Pine Trees in Old-Field Plantations in the Interior West Gulf Coastal Plain.* Texas Forestry Paper No. 17. 4 pp.