Forest Research Note

N

FOREST SERVICE, U.S. DEPT. OF AGRICULTURE, 102 MOTORS AVENUE, UPPER DARBY, PA.

E

No. 126
1961

PREDICTION OF YIELD IN OLD-FIELD SWEETGUM STANDS IN SOUTHERN NEW JERSEY

During a recent soil-site study of sweetgum in southern New Jersey, measurements of volume were also made on forty-six 0.1-acre plots. These plots were in pure, well-stocked, even-aged stands ranging in age from 30 to 65 years. Basal area ranged from 117 to 245 square feet per acre, with a mean of 180. Site index varied from 60 to 95 feet at 50 years. The trees were of seedling origin, with a maximum age range of about 8 years within a plot.

Merchantable cubic-foot volume (to a 4-inch top, outside bark) was computed for each plot from Schnur's (1) table 61. Only trees 5.6 inches d.b.h. and larger were used for yield computations. Site-index values were assigned according to Trenk's (2) table 21. Site index and age were determined from 10 dominant trees on each plot. Basal area was measured for all trees 1.6 inches d.b.h. and larger.

Analysis of these data resulted in several yield equations and in the construction of a cubic-foot volume table for old-field sweetgum stands.

The yield equations obtained are of two types: those for estimating present stand volume, and those for predicting future volumes. They differ in that the second type must include a measure of land capability (site index) and allow for the changes that occur in time.

Table 1 shows the simple and partial correlation coefficients among the variables studied. The small negative correlation between site index and age apparently reflects plot distribution in the sample: the older age classes were predominantly on the poorer sites. This may well reflect a pattern in field abandonment. The negative correlation may also be due to bias in the site-index curves themselves, although the curves were

1

checked against the data and no such error was detectable. In any case, the correlation is so small that it has no practical significance.

Current Yields

In estimating current yield, basal area alone (the most commonly and easily measured stand characteristic) gives only a rough approximation. The equation is:

$$\text{Yield} = 0.428 \text{ (basal area)} - 27.5$$

where yield is computed to the nearest 100 cubic feet. The error of estimate is $\pm$ 1,030 cubic feet—hardly a precise estimate.

Including the average height of dominant trees with basal area gives a more precise estimate. The equation for this is:

$$\text{Yield} = 0.452 \text{ (basal area) (height of average dominant)} - 1,250$$

where current yield is computed to the nearest cubic foot. The error of estimate is reduced to $\pm$ 460 cubic feet, and the correlation coefficient is 0.954, a much better relationship. Although this equation for current yield is not precise, it may be of value in rapid cruising where prisms are used to obtain basal area.

More exact values would have to be based on individual-tree measurements of height and diameter that are commonly used in computing stand volumes.

Future Volumes

For predicting future stand volumes, the expressions shown in table 2 were tried. Inclusion of basal area in the equation gave a much better fit than did site index and age alone, and product-moment interactions fitted the data better than the simple values for individual factors. The final equation derived is:

$$\text{Yield} = 580 + 0.813 \text{ (site index)}^2 \text{ (age) (basal area) } (10^{-4})$$

The error of estimate is $\pm$ 385 cubic feet, and the correlation coefficient

Table 1.--Simple (above) and partial (below) correlation
coefficients among the variables

Variable	Age	Basal area	Volume
Site index	*-0.306	*0.312	**0.593
	**- .424	** .429	** .876
Age	--	.267	** .446
	--	** .400	** .831
Basal area	--	--	** .742
	--	--	** .763

*Significant at the 5-percent level

**Significant at the 1-percent level

Table 2.--**Expressions tried for predicting future stand volumes**

Expression	Degrees of freedom	Correlation coefficient
Site index, age	2	0.768
(Site index) (age)	1	.803
(Site index)^2 (age)	1	.893
Site index, age, basal area	3	.954
(Site index)^2 (age), basal area	2	.965
(Site index)^2 (age) (basal area)	1	.968

Table 3.--Yield table for old-field sweetgum stands in New Jersey[1]

(Merchantable cubic-foot volume in trees larger than 5.5 inches
d.b.h. to a 4.0-inch top, outside bark)

Stand age (years)	60-foot sites		70-foot sites		80-foot sites		90-foot sites	
	Basal area	Yield	Basal area	Yield	Basal area	Yield	Basal area	Yield
	Sq.ft.	Cu.ft.	Sq.ft.	Cu.ft.	Sq.ft.	Cu.ft.	Sq.ft.	Cu.ft.
30	115	1590	130	2130	140	2770	155	3650
	155	1940	170	2610	180	3390	I95	4430
40	130	2100	140	2810	150	3700	165	4930
	170	2570	180	3450	190	4530	205	5980
50	140	2630	150	3570	160	4740	175	6340
	180	3220	190	4370	200	5780	215	7660
60	150	3220	160	4400	175	6040	190	8080
	190	3910	200	5360	215	7300	230	9670

[1]Dotted lines indicate limits of basic data.

is 0.968. The relationship between the 3-factor interaction and yield is shown in figure 1. There is no detectable curvilinearity in this relationship. However, understocked stands or those younger than 30 years or older than 65 years may not follow the same trend.

Solution of this equation for a range of values for each independent variable results in the normal yield table shown in table 3. In this table, two values of basal area and yield are given for each site index and age class. The normally expected basal area and yield are halfway between the two. The interval shown was used because, on the average, an increase of 20 square feet in basal area raised yield beyond the error of estimate. Also, the standard deviation of basal area within site index and age classes was ± 23 square feet,[1] so the two figures shown correspond fairly well with the variation that can be expected in well-stocked stands.
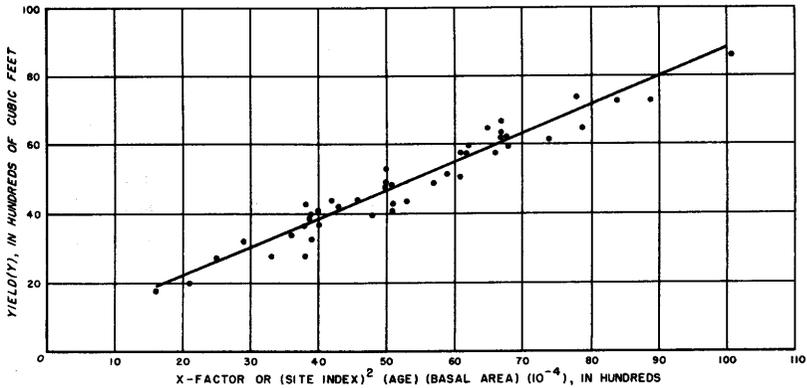
3

Figure 1. — Graphic form of the merchantable cubic-foot yield equation: Yield $= 580 + 0.813$ (site index)^2 (age) (basal area) (10^{-4}). Note the linearity of this expression of the data.

If less accurate information is acceptable, site index and age can be used to predict yield. This equation is:

$$\text{Yield} = 0.018 \ (\text{site index})^2 \ (\text{age}) - 464$$

The standard error of ± 690 cubic feet and the correlation coefficient of 0.893 indicate the loss in prediction efficiency. However, it may sometimes be more easily applied. Also, in using this yield equation, confidence limits can be computed easily for any value of the interaction.[2]

Use of these equations and tables outside of the population described on the first page of this report is risky, and should not be undertaken lightly. Neither should cause and effect be read into these relationships; the effects of the three individual factors on yield cannot be separated in data of this type.

Literature Cited

1. Schnur, G. L.
   1937. Yield, stand, and volume tables for even-aged upland oak forests. U. S. Dept. Agr. Tech. Bul. 560. 87 pp., illus.
2. Trenk, F. B.
   1929. Sweetgum in Maryland. Univ. Md., State Dept. of Forestry. 75 pp., illus.

—JOHN J. PHILLIPS
Soil Scientist, New Lisbon Research Center
Northeastern Forest Experiment Station
Forest Service, U. S. Dept. Agriculture
New Lisbon, N. J.

[1] Basal area $= 30.4 + 1.22$ site index $+ 1.10$ age. $r = 0.482$
[2] Confidence limits $=$
$$\text{predicted value} \pm 1{,}387 \ \sqrt{1.022 + \frac{[(\text{site index})^2 \ (\text{age}) \ (10^{-4}) - 29.2]^2}{2{,}453}}$$

4