# CENTRAL HARDWOOD NOTES

## Estimating Pine Growth And Yield

Although hardwoods comprise the bulk of the volume in the central hardwood forest, pines are locally important in the oak-pine association, pine types, and plantations. The two principal pine species are shortleaf pine and eastern white pine. Shortleaf occurs primarily in the southern parts of the central hardwood forest: white pine is found in the northern and eastern parts of the region.

Users of growth and yield models should understand how they were developed and what kind of data were used. This knowledge will help you make better investment decisions, but remember that yield is only one of the many criteria. Here are some points to consider:

- Reliable yield estimates for thinned stands must come from permanent plots that have been thinned to different densities and periodically remeasured. This information is the most useful but it is scarce.
- Because growth and yield studies are expensive, models are sometimes derived from inventory data. These models may underestimate what can be produced in managed stands.
- Some growth and yield models are developed from temporary plots.
- For natural even-aged stands, yields are presented by age and site index classes; plantation yields are given by age, site index, and planting density.
- Yields are usually for unthinned stands; if so, do not apply them to thinned stands.
- Past history and origin of the stand can influence yields. For example, most plantation information is for old-field stands; but many plantations are now being established on cutover sites. Yields from cutover sites may be less than that from old-fields because of greater vegetation competition. Or, plantation yields may be higher than comparable natural stands because of earlier stocking and spacing control.
- Growth and yield information is most reliable when used to choose a management regime. Models predict average growth and yield, what is produced in a specific stand may be higher or lower.
- Yield estimates outside the data range are less reliable than those within.

With these cautions in mind, let us look at some yields.

Shortleaf Pine

*Plantations*

The only available example of yields from unthinned plantations on old-fields shows that site index has a profound effect on yield (table 1). The yield at age 30 with an initial planting density of 750 trees per acre is more than two times greater for a good site versus a poor site. Mean annual increment peaks between 25 and 30 years for average and good sites but has not yet culminated by age 30 for poor sites. Planting more trees results in more merchantable cubic-foot yield. At age 30, doubling the trees planted from 750 to 1,500 per acre increases yield from 11 percent on poor sites to 19 percent on good sites.

**Table** *1 .-Merchantable cubic-foot and green weight yields' for old-field shortleaf pine plantations in Tennessee, Alabama, and Georgia Highlands*

| Age (from seed) | Trees planted (per acre) | | | |
|---|---|---|---|---|
| | 750 | 1,000 | 1,250 | 1,500 |
| | *Cubic feet (green tons) per acre* | | | |
| | **POOR SITE'** | | | |
| 15 | 383 (12) | 343 (11) | 290 ( 9) | 247 ( 8) |
| 20 | 865 (27) | 855 (26) | 819 (25) | 806 (25) |
| 25 | 1,334 (41) | 1,368 ( 42) | 1,405 43) | 1,409 ( 43) |
| 30 | 1,771 ( 55) | 1,847 ( 57) | 1,881 58) | 1,974 ( 61) |
| | **AVERAGE** SITE[3] | | | |
| 15 | 850 (26) | 835 (26) | 792 ( 24) | 752 (23) |
| 20 | 1,573 ( 48) | 1,671 (51) | 1,712 ( 53) | 1,725 ( 53) |
| 25 | 2,245 ( 69) | 2,386 ( 74) | 2,490 ( 77) | 2,610 ( 80) |
| 30 | 2,745 ( 85) | 2,955 (91) | 3,077 ( 95) | 3,277 (101) |
| | **GOOD** SITE[4] | | | |
| 15 | 1,401 ( 43) | 1,463 ( 45) | 1,466 ( 45) | 1,522 ( 47) |
| 20 | 2,377 ( 73) | 2,571 ( 79) | 2,711 ( 84) | 2,830 ( 87) |
| 25 | 3,152 ( 97) | 3,422 (105) | 3,637 (112) | 3,826 (118) |
| 30 | 3,686 (114) | 3,915 (121) | 4,171 (129) | 4,402 (136) |

[1] Solid wood volume from a 6-inch stump to a 4-inch top, d.o.b. Green weights are to same merchantability standards and were derived by using ratio of 61.618 pounds per cubic foot of solid wood.

[2] Poor site-site index 40 feet (base age 25).

[3] Average site-site index 50 feet (base age 25).

[4] Good site-site index 60 feet (base age 25).

The higher the planting density the smaller the stem diameter and the longer it takes for trees to reach sawtimber size. Notice that board-foot yields at a given age decrease with increased planting density (table 2). To accelerate sawtimber production, you should sacrifice some total cubic yield and plant fewer trees, so planting costs should also be less. You should probably choose a rotation longer than 30 years for sawtimber. Notice that site quality affects sawtimber yields (table 2) more than cubic-volume production (table 1).

Table 2.-Board-foot yields' (International 1/4-inch rule) for old-field unthinned shortleaf pine plantations at age 30 in Goergia, Tennessee, and Alabama Highlands

| Trees planted (per acre) | Site quality[2] | | |
|---|---|---|---|
| | Poor | Average | Good |
| | Board feet per acre | | |
| 750 | 247 | 2,398 | 7,738 |
| 1,000 | 99 | 1,227 | 5,385 |
| 1,250 | 49 | 686 | 3,939 |
| 1,500 | — | 356 | 2,933 |

[1] Trees 9.6 inches d.b.h. and larger from a 0.5foot stump to an 8-inch top, d.o.b. Using stand tables from Smalley and Bailey (1974), tree volumes were calculated from equations found in the following: Rockwood, D.L.; Arvanitis, L.G.; Hodgins P.E. 1980. Southern pine volume equations and associated conversion factors for southwest Georgia. FL Agric. Exp. Stn. Bull. 813. Gainesville, FL: Florida Agricultural Experiment Station. 49 p.

[2] Poor site is site index 40 feet; average site, 50 feet; and good site, 60 feet (all base age 25).

*Natural Stands*

Extensive natural stands of shortleaf are found in the central hardwood forest, particularly in Arkansas. The yields for even-aged stands (table 3) were from permanent plot inventory data and show that the stands were not managed intensively. More intensively managed stands with aggressive hardwood control will produce larger yields.

Table 3.-Board-foot (International 1/4-inch rule) and green weight yields' for extensively managed natural even-aged shortleaf pine stands in the Interior Highlands of Arkansas

| Age (years) | Site quality[2] | | |
|---|---|---|---|
| | Poor | Average | Good |
| | Board feet (green tons) per acre | | |
| 30 | 1,048 (6) | 2,711 (16) | 6,042 (35) |
| 40 | 4,473 (26) | 6,495 (37) | 10,092 (56) |
| 50 | 7,207 (41) | 9,443 (53) | 13,220 (72) |
| 60 | 8,609 (49) | 10,966 (61) | 14,940 (81) |

[1] Yields are solid wood in trees 8.6 inches d.b.h. and larger from a l-foot stump to a 7-inch top, d.o.b. Green weights were derived by using the ratio of 61.618 pounds per cubic foot of solid wood.

[2] Poor site is 50 feet site index (base age 50), the medium site is 60 feet, and the good site is 70 feet.

Table 3 does not contain yields at different density levels because the same thinning strategy was employed. Assuming that the poor, average, and good sites have 120, 130, and 140 square feet of basal area, respectively, at age 30, the stands are thinned back to 80 square feet at ages 30, 40, and 50; cut back to a seed tree at age 55; and harvest cut at age 60. The yields at each age and site represent thinnings plus the standing volume. Yields become larger with increasing site quality and advancing age. The mean annual increments at age 60 are 143, 183, and 249 board feet for the poor, average, and good sites, respectively.

Another alternative is uneven-aged management. Uneven-aged stands on average sites usually grow about 2 square feet of basal area per acre per year. You must choose both the number of trees by diameter class to leave and a cutting cycle. These two factors are interdependent. (For further details on growth and yield for uneven-aged shortleaf pine stands, consult the appropriate publication in the References.)

*White Pine*

In the southern part of its range, white pine is not subject to severe insect and disease attack as farther north. It also grows faster than most of its associates there. However, growth and yield models for this part of the range are scarce, and the best data are for unthinned old-field plantations.

The yields from Ohio are impressive (table 4). Wide spacings result in higher sawtimber yields for young stands. But by age 50, board-foot volume is slightly more with close spacing; the trees are smaller, but there are more of them. Mean annual increment peaks on good sites between 40 and 50 years, but it is still increasing at age 50 for average sites.

Yields for the southern Appalachians are in table 5.

Table *4.-Yields of unthinned old-field white pine plantations in Ohio*

| Age | Initial spacing (trees per acre) | | | |
|---|---|---|---|---|
| | 6X6 ft (1,210) | 7X7 ft (889) | 8X8 ft (681) | 9x9 ft (538) |
| | ***Board feet per acre[1] (green tons)[2] per acre*** | | | |
| | AVERAGE SITE[3] | | | |
| 20 | — (59) | 134 (58) | 1,215 (56) | **1,774 (54)** |
| 30 | 12,744 (95) | 13,128 (93) | 13,277 **(91)** | **13,142 (90)** |
| 40 | 22,192 (118) | 22,090 (117) | 21,818 (115) | 21,355 (113) |
| 50 | 29,609 (135) | 29,264 (133) | 28,778 (131) | 28,136 (130) |
| | GOOD SITE[4] | | | |
| 20 | 4,145 (79) | 6,130 (77) | 7,454 (74) | 8,165 (71) |
| 30 | 20,908 (132) | 21,391 (130) | 21,586 (127) | 21,474 (125) |
| 40 | 31,598 (169) | 31,512 (166) | 31,240 (164) | 30,762 (162) |
| 50 | **39,741 (194)** | **39,387 (192)** | 38,882 **(189)** | **38,212 (188)** |

[1] international 1/4-inch rule from a 1-foot stump to an E-inch top, d.i.b.
[2] Tons of wood (excluding bark and branches) from a 1-foot stump to a 2-inch top, d.i.b.
[3] Average site is site index 70 feet (base age 35).
[4] Good site is site index 90 (base age 35).

Table *5.-Merchantable cubic-foot yields' for unthinned old-field white pine plantations in the southern Appalachians*

| Age | Initial spacing (trees per acre) | | | |
|---|---|---|---|---|
| | 6X6 ft (1,210) | 8X8 ft (681) | 10x10 ft (435) | 12X12 ft (302) |
| | ***Cubic feet per acre*** | | | |
| | AVERAGE SITE[2] | | | |
| 10 | 360 | 327 | 313 | 305 |
| 20 | 2,985 | 2,844 | 2,782 | 2,749 |
| 30 | 5,157 | 4,995 | 4,920 | 4,882 |
| | GOOD SITE[3] | | | |
| 10 | 630 | 572 | 547 | 534 |
| 20 | 5,222 | 4,975 | 4,866 | 4,807 |
| 30 | 9,018 | 8,734 | 8,604 | 8,537 |

[1] Volume, outside bark, for trees 3 inches d.b.h. and larger from a 6-inch stump to a 3-inch top, d.o.b.
[2] Average site is site index 55 feet (base age 25).
[3] Good site is site index 70 (base age 25).

*Oak-pine*

There have been no growth and yield studies aimed specifically at the oak-pine type, in which shortleaf is a component. Should you want to simulate yields from this type, a software package called TWIGS is available (see References).

References


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