Shortleaf Pine

The Lumber-Making Qualities of Second-Growth and of Virgin-Growth Timber

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THE reputation that Southern yellow pine lumber enjoys in the trade is based upon the properties of virgin timber, and yet the time is not far distant when practically all Southern pine will be sawed from second-growth logs. Thanks to hogs, improper turpentining, and fires, the coming Southern yellow pine timber promises to be even more largely shortleaf than at present. To what extent will second-growth stock be able to hold its own in the market when this time comes? Are the properties and the characteristics of lumber from second-growth Southern yellow pine such that it will not suffer too much by comparison with lumber from virgin timber? A complete answer involves a comparison of all the properties and the characteristics of both types of timber, and some of the necessary data are non-existent at this time. Recent• studies carried out by the Forest Products Laboratory, however, have developed data on such lumber-making characteristics as relative size, number, and quality of defects, heartwood content, and rate of growth in different grades and species. This article compares those characteristics as found in. virgin-growth and in second-growth shortleaf.

"Virgin growth" (Fig. 1) is used in this article in the same sense that it ordinarily has when employed by lumbermen; it designates timber that previously has not been logged over, although the timber is likely to vary somewhat it) age, size, and matturity according to the history of the stand. Similarly, "second growth" (Fig. 2) refers to timber that has grown up to sawlog size either from seed on old fields or from small trees that survived an earlier logging. "Shortleaf" as here used means commercial shortleaf, the mixture, composed largely of shortleaf and loblolly pine, that is marketed as shortleaf or as Arkansas soft pine or as North Carolina pine, depending on the region where it is produced.

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Fig. 1—Trees of this type, which are found only in virgin stands, yield the largest proportion of high-grade commercial shortleaf lumber.

For the investigation we are now discussing, five mills were picked, with the advice of lumber association officials, to represent commercial shortleaf pine lumber as it is manufactured at present. About 6,000 board feet each of B and better, No. 1 common, No. 2 common, and No. 3 common were studied at three mills in Arkansas, Louisiana and Mississippi, which were sawing practically nothing but virgin growth. The other two mills, in Georgia and South Carolina, sawed second growth exclusively, and at them a total of 11,000 feet divided among the three common grades were studied. The two mills were really concentration plants where lumber from numerous portable mills was machined for shipment. By reason of the small size of the logs from which the lumber was cut and of the prevalence of sap stain, too little B and better was obtained to give a fair average, and therefore statements about second growth in this article refer only to the common grades. In some localities large amounts of small and very fast-growing shortleaf are sawed, largely into two-inch dimension. Since the figures presented here are based only on 1 by 8-inch boards, this wide-ringed dimension is not represented, although there was no shortage of wide-ringed material among the boards examined. Although the timber varies in different localities, there is good reason to believe that the lumber being cut at each mill was typical of local conditions.

At each mill a representative lot of 1 by 8-inch dressed boards of each important grade was graded by the head inspector. Forest Products Laboratory representatives then made a board-by-board study of the defects, classifying them in accordance with the American Lumber Standards definitions (most of which are included in Southern Pine Association grading rules) and keeping a separate and detailed record for each piece on special forms. With knots, for instance, the number, the size, and twelve different qualities were noted. Decay, if present, was recorded as incipient or advanced, together with the percentage of the area of the board affected, and shake, if present, was listed as fine, slight, medium, open, or through, with the percentage of the length of the board affected.

Heart Content

The heartwood content of boards cut from virgin shortleaf averaged about 50 per cent and from second growth about 25 per cent. These figures apply to what may be thought of as the average log run board. A low heart content (33 per cent or less) was found in 65 per cent of the second-growth boards, and in only 41 per cent of the virgin growth. On the other hand, a high heart content (of 65 per cent or more) occurred in 46 per cent of the virgin growth and in only 15 per cent of the second growth. (Table 1.)

Table 1—Heartwood Content of Boards of Second-Growth and of Virgin-Growth Commercial Shortleaf Pine

All grades are combined on a long run basis.

Heartwood Content	Virgin Growth	Second Growth
Area of Face **of** Board in Per Cent	Percentage of ***Log*** Run Boards	
0— 33	40.7	65.4
34— 66	13.6	20.0
65-100	45.7	14.6

Average heartwood content Virgin growth, 49.3 per cent ; second growth, 26.5 per cent.

Except for such minor products as heart boards and heart timbers the proportion of hardwood in a piece has no direct bearing on its grade. However, heart content is important from the standpoint of decay resistance, facility of impregnation with preservatives or fire retardants, and the occurrence of stain and of red heart. The more heartwood the greater the durability of untreated timber under conditions favoring decay, although from a practical point of view lumber would need to be virtually 100 per cent heart for many uses in order to reduce the replacement of partly-decayed pieces. On the other hand, if the lumber is to be given preservative treatment in order to obtain maximum durability, a low heart content insures better penetration of the preservative. For the many uses where durability is not a prime consideration it goes without saying that heart content is immaterial. As far as stain is concerned, the lower the heart con-

Fig. 2—Second-growth stands of commercial shortleaf contain a much larger proportion of trees of this type than virgin-growth stands.

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tent the greater the liability to degrade from this source. Generally speaking, high heart content goes with large, mature timber, and the same is true of red heart. The relationship between heart content and red heart -is self-evident. From the standpoint of strength and of most other properties the difference between heartwood and sapwood are negligible when other conditions are equal.

Rate of Growth

The second-growth commercial shortleaf lumber studied in this investigation had 5.4 rings per inch, compared with 7.7 for virgin growth. Less than a quarter of the boards from virgin shortleaf were considered wide ringed (1 to 4 rings per inch), whereas half of the second-growth stock fell in that class. On the other hand, a little over a quarter of the virgin-growth boards had 9 or more rings to the inch, as compared with less than one-tenth of the second growth. (Table 2.)

Table 2-Width of Annual Ring in Boards of Second-Growth and of Virgin-Growth Commercial Shortleaf Pine

All grades are combined on a log run basis.

Ring Class Number Per Inch	Virgin Growth Percentage of Log Run Boards	Second Growth Percentage of Log Run Boards
1 to 4	20.2	50.0
5 to 8	52.5	41.3
9 and more	27.3	8.7

Rate of growth is probably the most variable of all the characteristics of Southern yellow pine. One sample may show two rings per inch, another fifty, and big variation is found between different localities.

Except for certain structural grades, rate of growth does not affect the grade, but as time goes on and more refinement of selection is practiced, probably it will come into greater use. At present the trade shows a decided preference for slow-growth lumber for most uses. Little of a definite nature is yet known as to the effect of rate of growth by itself upon the satisfaction that lumber gives in use.

Knots

Size and Number of Knots.-Knots comprised 70 per cent of all the defects found in the commercial shortleaf pine studied. The Southern yellow pines in general have fewer but larger knots than our other commercial pines,[2] and among Southern yellow pines second-growth shortleaf is the knottiest. Its knots averaged one-third larger than virgin shortleaf, and they were more numerous grade by grade. Columns 3 and 4, table 3, show this condition plainly, and columns 5 to 10 offer an interesting comparison between virgin and second-growth shortleaf as regards the proportion of knots falling in the different size classes. Virgin timber had a much larger proportion of knots of the smallest size. In the one-fourth and one-half-inch class there was little diffeernce. Knots from one-half-inch to three inches in diameter were more common in second growth, and it is the preponderance in these sizes that made that type the more coarsely knotted of the two. In brief, then, knots cover about the same range in size in both virgin and second-growth shortleaf but are more numerous and have a larger proportion approaching the maximum size allowable in the second growth.

No doubt differences in growth conditions explain the preceding facts. Virgin timber, being forest grown in dense stands, tends to form taller, more cleanly pruned boles, while second growth is more largely short-boled and limbed, has fewer logs to the tree, and consequently has a larger proportion of top logs. How far it is practical to control the size and the number of knots by regulating the density of the stand is an interesting question that remains to be solved.

Other things being equal, second-growth shortleaf pine lumber will be weaker than virgin growth on account of its larger and more numerous knots, but this alone will probably not interfere with the use of second growth in place of virgin, at least for uses that consume the great bulk of the cut.

Quality of Knots.-As regards quality of knots, second-growth shortleaf was superior to virgin. Twelve different qualities of knots were recorded in the field, but for the sake of simplicity and to facilitate the analysis they are grouped into three main classes in Table 4. "Good or intergrown knots" (Fig. 3a) are the largest class of all. Their "rings of annual growth are completely intergrown with those of the surrounding wood" and on both sides of the board. Such knots are fixed by growth and nothing short of forcible breaking will get them out of the board. Second growth shows a substantially larger proportion of good knots in all grades.

"Bad knots" include knot holes, loose knots, and decayed knots (Fig. 3-b). They form a relatively small class, but frequently determine the grade of the board in which they occur, because they affect its tightness and, from the grade's standpoint, tightness is of the greatest importance. With one slight exception, No. 3 common, virgin growth had the larger proportion of bad knots in all grades and practically twice as many in the log run.

"Doubtful knots" comprise a large class, consisting of encased, unsound, broken, checked, and pith knots. An encased knot is defined as "one whose rings of annual growth are not intergrown or homogeneous with those of the surrounding wood. The encasement may be partial or complete or pitch or bark." Most doubtful knots can be depended on to hold their places, depending somewhat on their size and position, but an occasional one will come out. In every grade virgin-growth shortleaf had a larger proportion of doubtful knots than second growth. In the log run lumber doubtful knots were 39 per cent of the total in virgin shortleaf, as compared with 34.5 per cent for second growth.

The tendency of knots to loosen is to some extent a species characteristic. Southern yellow pine is generally considered a comparatively tight-knotted wood. Other things being equal, however, large intergrown knots are more likely to check and large encased knots to loosen in drying than small ones, and, as has been said, the knots average larger in second growth. On the other hand, the drier the lumber becomes the more pronounced is the tendency toward checking and loosening, and at present a much larger proportion of lumber from virgin shortleaf is kiln-dried than from second growth.

Important Defects Other Than Knots

The more important natural defects other than knots (shake, decay, worm holes, and pitch defects) were more frequent in virgin growth than in second growth, but the opposite was true of defects that occur in seasoning, such as split, check and stain.

In. Table 5 several of the more common and more important defects are listed as well as knots. The figures in columns 4 to 11 represent the percentage of boards in which the different defects were found. Although knots have already been dealt with in some detail, they are included here for comparison because of their great importance.

It has already been shown that knots were more numerous in second growth, and column 3 of Table 5 shows that the same was true of other defects in their total number. Considering the log run lumber instead of individual grades, second growth had two defects for every one found in virgin shortleaf.

Among the defects that are chiefly characteristic of mature and overmature timber are shake, decay and worm holes. Naturally these defects were found more frequently in virgin shortleaf than in second growth, and this was true of all the grades in which the defects are permitted.

Virgin shortleaf (log run) had three and one-half times as many occurrences of shake, twenty-eight and one-half times as

[2]This statement applies to yard lumber only, shop grades not being included.

Table 4—Quality of Knots in a Run of Lumber From Virgin-Growth and Second-Growth Commercial Shortleaf Pine

Type of Growth	Grade	Good Knots (Intergrown only)	Bad Knots (decayed holes loose)	Doubtful Knots (all Other types)	Total
		Percentage of all knots			
Virgin	Log run*	55.3	5.7	39.0	100.0
Second	Log run	62.6	2.9	34.5	100.0
Virgin	B & Bet.	69.6	..	30.4	100.0
Virgin	No. 1 Com.	55.0	.7	44.3	100.0
Second	No. 1 Com.	90.2	..	9.8	100.0
Virgin	No. 2 Com.	57.3	4.6	38.1	100.0
Second	No. 2 Com.	61.7	1.9	36.4	100.0
Virgin	No. 3 Com.	43.8	15.3	40.9	100.0
Second	No. 3 Com.	54.4	15.7	29.9	100.0

*No. 3 Common and Better, a weighted average.

Table 3—Number and Size of Knots in Run of Lumber from Virgin-Growth and Second-Growth Commercial Shortleaf Pine

Type of Growth 1	Grade 2	Av. No. of Knots Per 8 ft. b.m. 3	Av. Size of Knots 4	Size Classes—Inches 0-¼ 5	¼-½ 6	½-1 7	1-1½ 8	1½-3 9	3+ 10	Total 11
				Percentage of All Knots						
Virgin	Log run*	3.80	0.81	30.2	19.4	22.6	13.7	12.8	1.3	100.0
Second	Log run	5.68	1.10	6.4	19.4	29.4	23.0	20.4	1.4	100.0
Virgin	B & Bet.	.03	.24	82.6	13.0	4.4	...	...	...	100.0
Virgin	No. 1 Com.	.73	.50	42.5	25.3	20.4	9.2	2.6	...	100.0
Second	No. 1 Com.	1.16	1.09	9.2	16.8	26.0	26.6	21.4	...	100.0
Virgin	No. 2 Com.	6.33	1.00	12.9	19.8	28.6	19.8	18.2	.7	100.0
Second	No. 2 Com.	7.16	1.07	6.7	20.6	29.8	22.6	19.2	1.1	100.0
Virgin	No. 3 Com.	5.49	1.36	7.5	14.8	26.7	17.2	27.1	6.7	100.0
Second	No. 3 Com.	5.50	1.53	1.2	8.4	26.4	24.9	33.1	6.0	100.0

*No. 3 Common and Better, a weighted average.

Table 5-Occurrence of the More Important Defects in a Run of Lumber from Virgin-Growth and Second-Growth Commercial Shortleaf Pine

Type of Growth 1	Grade 2	Av. No. of Defects Per 8 ft. b.m. 3	Knots 4	Shake 5	Decay 6	Worm Holes 7	Pitch and Pitch Streaks 8	Pitch Pockets 9	Split and Check 10	Stain 11
			Percentage of boards in which the defects occur							
Virgin	Log run*	4.74	66.7	7.7	5.7	4.2	16.5	43.7	26.8	11.2
Second	Log run	9.84	90.5	2.2	.2	.8	5.9	28.9	32.4	60.5
Virgin	B & Bet.	1.00	3.4	..	..	..	8.2	36.2	19.4	2.0
Virgin	No. 1 Com.	3.39	35.7	.3	4.6	3.4	19.5	55.5	42.7	6.3
Second	No. 1 Com.	5.70	31.5	..	..	..	4.6	56.2	57.7	63.0
Virgin	No. 2 Com.	8.85	96.4	10.0	4.8	4.5	15.9	44.3	25.8	15.4
Second	No. 2 Com.	11.53	94.0	2.2	.2	.5	5.7	26.7	30.1	60.2
Virgin	No. 3 Com.	8.13	89.3	4.1	..	4.1	9.9	35.5	41.3	62.0
Second	No. 3 Com.	10.40	96.8	18.2	14.5	7.5	18.8	34.0	21.0	9.2

*No. 3 Common and Better, a weighted average.

many of decay, and five times as many occurrences of worm holes as second growth. Although it is not apparent from Table 5, the occurrences in virgin shortleaf represent in most cases a more extreme condition and involve a larger portion of the board.

No reason is apparent why there should be more or fewer pitch defects in one type of shortleaf than in another. Nevertheless, in every grade pitch and pitch streaks were more frequent in virgin growth. The log run figures show more pitch packets also in virgin shortleaf, although a grade-by-grade comparison is inconclusive. Pitch defects, together with others, such as knots, shake and decay, which are found in the standing timber, may for convenience be termed natural defects.

Split and check that occur in seasoning are much more common in second growth. They are partly subject to control, and their frequency varies considerably with the care and the skill used in drying and with the species. How much virgin-growth and second-growth shortleaf differ in susceptibility to split and to check as a result of different rates of growth, percentages of summerwood, etc., is not definitely known, but the trade generally considers the second growth to be more susceptible. The figures in column 10, Table 5, appear to support this contention. Assuming that second-growth shortleaf is more subject to split and to check, it still seems probable that the difference in the amount of split and check in the two types must be attributed partly to the human element in the drying process. This appears practically certain when it is considered that the virgin growth was largely kiln-dried and the second growth was almost all air-dried.

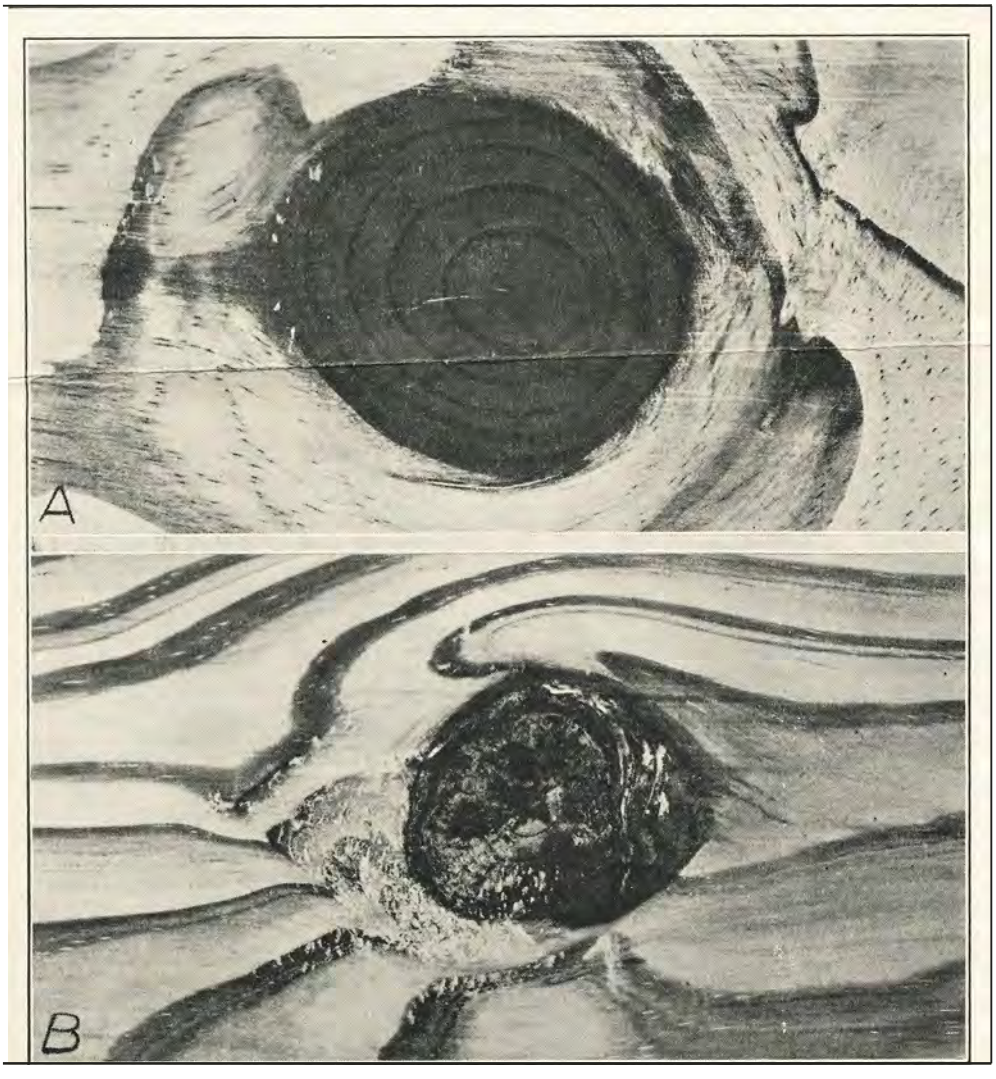

Fig. 3-A. An intergrown knot. A larger proportion of the knots in second-growth shortleaf are intergrown. B. A decayed knot. Decay in the knot *is one of the knot qualities grouped together* as *bad in this report. Virgin growth contains a larger proportion of 14.5 ots than second-growth.*

The proportion of sap-stained boards was immensely larger in second-growth than in virgin shortleaf. To be sure, the second growth had nearly twice as much sapwood and to that extent was more susceptible to sap stain. Nevertheless, although stain is largely subject to control, almost the only efforts to avoid it, either through kiln-drying or through the use of chemical dip, were made at mills sawing virgin timber. As a result second growth showed five times as many occurrences of stain. The entire sapwood was solidly stained in some boards and occasional pieces that would otherwise have graded B and better were necessarily put in the commons because of large areas of heavy stain.

Conclusions

Based upon averages and on present conditions the following conclusions are drawn in regard to the shortleaf pine studied:

1. Virgin shortleaf pine lumber had nearly twice as large a percentage of heartwood as second growth.
2. Lumber from second-growth shortleaf pine had only about two-thirds as many rings per inch as virgin growth.
3. Virgin shortleaf lumber had fewer and smaller knots.
4. Second-growth lumber had sounder and tighter knots.
5. Second-growth lumber had less shake, decay, and worm holes.
6. Virgin-growth lumber had more pitch defects.
7. Seasoning defects, split, check, and stain were more frequent in second-growth lumber.
8. In general, we may expect (as second growth forms more and more of the cut) smaller proportions of B and better and larger yields of sound, tight-knotted common lumber.
9. Both the forester and the lumberman can take steps to improve the present quality of second growth.