Issued December 16, 1907.

U. S. DEPARTMENT OF AGRICULTURE,
FOREST SERVICE—Circular 118.
GIFFORD PINCHOT, Forester.

MANAGEMENT OF SECOND GROWTH IN THE SOUTHERN APPALACHIANS.

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12894—Cir. 118—07——1

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1907

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MANAGEMENT OF SECOND GROWTH IN THE SOUTHERN APPALACHIANS.

INTRODUCTION.

Of the total wooded area of the Southern Appalachians from 80 to 85 per cent is second growth. Each year the supply of virgin timber grows less, and the many wood-using industries must depend upon this second growth for their future supplies. Its perpetuation is therefore one of the most vital problems of the region. Yet there is but little doubt that unless improvements are made in the present methods of handling these second-growth lands the future yield from them will be both small in quantity and poor in quality.

The changes most needed are, first, a closer economy in the use of the forest; second, better adaptation of the species and sizes to specific uses, more careful methods of logging, and longer intervals between cutting; and third, adequate protection of the forest. A large portion of this second growth consists of even-aged stands, the result of clear cutting either for charcoal, or, more recently, for ties and mine timbers. The suggestions for management contained in this circular are intended to apply specifically to such even-aged stands.

ECONOMY IN UTILIZATION.

The heavy drain now made upon the forest by the different industries of the region could be much reduced, without diminishing the supply, by adopting more economical methods in the utilization of the individual trees. The chief use of second growth is for cross-ties and mine timbers, and economy in management must be brought about chiefly with these products. Of the two, ties are the more important.

REDUCTION OF WASTE IN HEWING TIES.

Tables 1 and 2 give a clear idea of the wastefulness of the present methods of tie production. Out of every 100 trees cut for ties over 63 are taken to a top diameter of from 10 to 13 inches instead of 9 or 9½ inches, the smallest diameter from which a 6 by 8 inch tie can be

made. Out of 100 trees of 14 inches and over whose butt logs could be split two-thirds remain entirely unsplit, and of the remainder only a small number are split into the number of ties justified by the size of the logs.

Table 1 brings out strikingly the wastefulness of the present manner of tie cutting. Where ties were being cut 100 trees, embracing all diameters from 10 to 19 inches, were measured, the actual number of ties yielded by each ascertained, and the total cubic contents of each of the trees, as well as the contents of the portion used for ties, computed.

TABLE 1.—*Waste in producing slab cross-ties.*[a]

Diameter of trees breast-high.	Volume of usable length of tree.	Volume of used length of tree.	Ties produced.	Waste of used length of tree.		Waste of usable length of tree.		Wood used for one tie based on used length of tree.	Wood used for one tie based on usable length of tree.
Inches.	*Cubic feet.*	*Cubic feet.*	*Number.*	*Cubic feet.*	*Per cent.*	*Cu. feet.*	*Per ct.*	*Cubic feet.*	*Cubic feet.*
10	14.3	6.1	1.3	2.6	43	10.8	76	4.7	11.0
11	18.5	9.5	1.7	5.0	53	14.0	76	5.6	10.9
12	22.7	12.8	2.1	7.2	56	17.1	75	6.1	10.8
13	27.0	16.2	2.5	9.5	59	20.3	75	6.5	10.8
14	31.8	20.0	2.9	12.3	62	24.1	76	6.9	11.0
15	37.6	24.5	3.3	15.7	64	28.8	77	7.4	11.4
16	45.0	29.6	3.7	19.7	67	35.1	78	8.0	12.2
17	54.5	35.7	4.2	24.5	69	43.3	79	8.5	13.0
18	65.5	43.1	4.7	30.6	71	53.0	81	9.2	13.9
19	76.5	51.3	5.2	37.4	73	62.6	82	9.9	14.7

[a] Assuming each tie to contain 2.67 cubic feet.

Thus from 43 to 73 per cent of the logs used for ties and from 75 to 82 per cent of the whole tree are entirely wasted. This waste is enormous if we consider how much wood must be consumed to produce the 20,102,000 ties which are each year cut in the region. It amounts to about 221,122,000 cubic feet of wood, on the basis of the entire merchantable contents of the tree, or 140,714,000 cubic feet of logs, on the basis of the part actually cut. Of the total amount of timber cut for ties, nearly three-fourths is wasted. That this waste can be much reduced is proved by tie cutting in Germany. There also the majority of ties are hewed, while the common tie is larger than our standard tie. It is 8.17 feet (2.5 meters) long, has 10.2 inches (26 cm.) face, is 6.29 inches (16 cm.) thick, and contains 3.5 cubic feet instead of our 2.67 cubic feet. Yet in Germany it takes only from 4.4 to 5 cubic feet of log to produce one tie, while in this country it takes on an average from 7.5 to 8 cubic feet of log to produce a smaller tie. In spite of very strict specifications, the waste of timber in hewing does not there exceed 30 or 40 per cent of the log, while in this country it reaches 73 per cent, to say nothing of the top, which remains entirely unused. The waste in hewing oak ties is greater

than in hewing pine ties, since it takes about 11 cubic feet of hardwood timber to produce one tie, and only 9 cubic feet of pine wood. This is due not to any greater waste necessarily involved in hewing hardwood ties, but to the smaller taper and proportionately longer clear length of the pine as compared with oak.

With no inspection of the sizes and characters of the trees cut, the tie makers are guided in their choice of tie timber and the portion of each tree to be used for ties merely by their own convenience and by the ease with which the trees may be hewed into ties. By taking each tree to a top diameter of 9 inches outside the bark, cutting stumps not higher than 2 feet from the ground, and splitting into ties all logs large enough, an increase of from 67 to 185 per cent can be effected in the yield of individual trees above 15 inches in diameter. This is shown in Table 2, which compares the average number of black oak ties obtainable under the present practice and the number possible under more economical methods of tie cutting. The possible yield of ties per tree is based on the taper measurements of black oak.

TABLE 2.—*Comparison of the average number of black oak ties per tree obtained under present practice with the number possible under more economical methods of tie cutting.*

Diameter breast-high.	Ties cut.		Increase.
	Under present practice.	Under more economical methods.	
Inches.	*Number.*	*Number.*	*Per cent.*
[a] 12	2.7	3.0	11
13	3.0	3.6	20
14	3.3	4.3	30
15	3.6	5.9	64
16	3.9	6.5	67
17	4.2	8.0	90
18	4.5	11.1	147
19	4.9	13.5	176
20	5.4	15.4	185

[a] Trees under 12 inches can not be used economically for ties.

Under more rigid supervision the present yield in ties per acre could, in a great many cases, be doubled and even trebled, if all trees large enough were made into ties. At present many trees are left uncut, not out of consideration for the future of the forest, but because they are too large, tough, or crooked to be easily hewed into ties, while the straightest and youngest trees are taken because they yield the greatest number of ties with the least effort. Table 3 gives the actual yield of 15 sample acres and an estimate of what could be obtained from them if all the trees of tie size were made into ties under present methods and under more economical methods.

TABLE 3.—*Comparative yield of ties per acre under present system and under more economical methods.*

Age of stand.	Type.	Actual yield of ties.	Yield by taking all trees of tie size by the present methods.	Possible yield of ties by taking and fully utilizing all trees of tie size.
Years.		*Number.*	*Number.*	*Number.*
50	Slope	62	106	107
50–60	do	38	165	247
48–51	Cove	62	209	254
49–51	Ridge	100	191	211
60–80	Slope	123	140	218
50	do	90	152	154
50	do	48	113	340
53–60	do	46	66	94
55–65	do	21	52	113
55–70	Ridge	23	131	163
56–60	do	27	103	121
58–60	Slope	46	109	117
60–65	do	34	70	102
65–70	do	42	105	112
65–75	Ridge	54	162	187

By taking all trees that can be made into ties, even as cutting is now practiced, the yield per acre would be increased by from 60 to 125 ties, and with the closest utilization of each tree an increase of 170 ties might be secured from each acre. In this way, to supply the required number of ties, the forest area now annually cut over for ties could be reduced nearly two-thirds and the revenue per acre increased.

The greatest economy would be effected in the utilization of tie timber if all trees above 13 or 14 inches in diameter were sawed instead of hewed into ties. Where sawed ties are as readily accepted as hewed ones, and where logging is not difficult, sawing will usually prove cheaper and more profitable than hewing.

WASTE IN CUTTING MINE TIMBER.

In logging for mining timbers under present methods fully 40 per cent of the timber handled is wasted. The chief items of waste are high stumps, tops, partially used bolts, and even whole trees which are felled and rejected because slightly twisted in grain. Of the different timbers used by the mines the greatest demand upon the forest is for props, which are 3 or 4 inches square by from 4 to 9 feet in length, and for tram ties. Under such conditions clean logging and fullest utilization of the tops to a diameter of 4 inches should present no difficulty if proper supervision is given to logging operations. To secure close utilization of timber it would be best to saw into the required sizes the rougher material from the tops as well as the entire stems of those species which are difficult to split, instead of following the present practice of splitting the timber into props and rejecting all logs that will not split readily. If mining timber is cut into bolts of the required lengths in the woods, it can be sawed at the

mines to the required sizes at a great saving over the present wasteful methods of manufacture by splitting.

To secure the greatest economy in the utilization of mining timber and all other timber, the following rules should be strictly enforced:

(1) No sound trees should be cut higher than 15 inches from the ground.

(2) Felling should be done wholly with the saw. No butting should be done, except in the case of hollow trees, and then without waste.

(3) All marketable material should be utilized in the tops down to a diameter of 4 inches.

(4) All logged trees and sound windfalls should be utilized.

(5) No merchantable logs, bolts, or sections of bolts should be left in the woods.

BETTERMENT IN METHODS OF LOGGING AND LUMBERING.

There must be a radical change in the present system of logging if a permanent supply of timber is to be expected in the future. It has been a common practice to cull timberlands repeatedly, often at very short intervals, for the different species or for different diameters. Tracts were noted in the Southern Appalachians which have been logged over three times within ten years, first for the best poplar and white oak saw timber, next for oak stave timber, and finally for the smaller and rougher saw and tie timber of all species. The effect of these repeated cuttings was to prevent a dense and uniform regeneration, so that the second growth is limited to scattered, irregular bunches. Furthermore, as a result of such cutting, there is a deficiency of seed trees of the most valuable species, especially white oak and yellow poplar, which have been logged most heavily. The poorer species, on the other hand, since they were not logged at all, are left in very favorable condition for reproduction, and are excluding the valuable species from the second growth. There is an important example of this in the competition between white and black oak in the region. Since the relation was disturbed by heavy cutting of white oak, black oak has a marked advantage and is increasing in the younger age classes. Second growth of the more valuable species, therefore, is constantly becoming of rare occurrence under the prevailing strong tendency to cut the commercial trees closer and closer and to lower the diameter limit of sawlog trees. Moreover, by cutting small yellow poplar for pulp stock and chestnut for extract wood the diameter limits of these two species have recently been greatly reduced. The great seeding capacity of yellow poplar and white pine and the persistent sprouting power of chestnut and the oaks

prevent, in many instances, a sudden deterioration of the forest after logging. Such deterioration is, however, general, and while the indications of it, following any single cutting, may be slight, it is cumulative, and the seedlings of the less valuable species, which are not cut, such as beech, maple, black oak, sourwood, sassafras, and gum, tend, after each cutting, to form a larger proportion of the second growth.

Management of second-growth land in the region must primarily aim to secure a dense stand of the more valuable species. The first step is to lengthen the intervals between cuttings. Observations of the timberlands throughout the region show that forest areas that were heavily and thoroughly cut over once and have since been undisturbed are, as a rule, now covered with a uniformly dense and vigorous second growth, frequently 1,600 trees to the acre, while timberlands which were frequently cut over, even though slightly, have a poor stand of second growth, consisting of irregular groups of saplings, which frequently average not more than 275 trees to the acre. It is evident, then, that the interval between cuttings should be sufficiently lengthened to permit the development of young growth until it is too large to be injured.

Just what the interval should be to obtain satisfactory results must depend not only on the species which are being cut, but on the use for which they are cut as well. Second growth may include timberland that has been only slightly culled, timberland that has been frequently and heavily cut, and, finally, coaled-off land.

The timber in a considerable portion of the forest area in the region, on account of its remoteness from transportation (10 to 50 miles), could not be handled profitably for sawlogs of smaller size than 18 inches on the stump. Cutting to such a diameter limit leaves, as a rule, a good stand of polewood, which forms the basis of the second crop. Thus, on a tract of cove land in Perry County, Tenn., which was recently logged to a diameter of 18 inches on the stump, the remaining stand of young timber, from 3 to 17 inches in diameter, averaged 80 trees per acre, 34 per cent of which were white oak. It is evident that much of this remaining stand will be merchantable twenty-five years from now, and a second cut of white oak, poplar, and chestnut lumber can be made. Meanwhile, the seed-bearing trees left under this comparatively high diameter limit will keep the ground well stocked with young growth, so that at each cutting the next crop will already be well established. Following the same cutting limit in the future, the forest can be permanently utilized without depleting it in the least.

Timberland more severely or repeatedly cut may require from thirty-five to forty years from the time of the last cut before it will

sufficiently recuperate to be capable of furnishing permanently saw timber at 25-year intervals. The interval between two cuttings on timberland cut clear must necessarily be equal to the time which is needed by the hardwood species to attain merchantable sizes; that is, from thirty-five to fifty years for pulpwood and tanning extract stock, from fifty-five to sixty years for ties and other minor products, and seventy years and over for lumber.

Sizes at which different species may be most economically and profitably used depend upon the kind of wood and its common uses and the situation in which it grows. Since the kinds most valuable for lumber, such as white pine, yellow poplar, and white oak, occur almost exclusively in the coves and on the lower slopes, and the kinds most commonly demanded for cross-ties, mine props, and minor products occupy the upper slopes and ridges, the growing of timber for different purposes is closely connected with the management of the different types of forest. The Southern Appalachian forests fall naturally into three types—cove, slope, and ridge—each with peculiar characteristics. The slope, being by its position intermediate between cove and ridge, approaches in its upper part the ridge type, while the lower slope comes very close to the cove type.

COVE AND LOWER-SLOPE LAND.

Yellow poplar, white pine, and hemlock are strictly limited to the cove and lower-slope lands, and white oak grows here far more vigorously than on the other types. The coves and lower slopes are thus peculiarly adapted, by the species growing there and by the character of the soil, to the production of saw timber. Yellow poplar does not reproduce itself readily from the stump, and the only way to reproduce white pine and hemlock is by seed. For this reason clear cutting, with subsequent natural reproduction by sprouts, is out of place in the coves. Therefore it would be best to manage the coves and lower slopes for saw timber on a general selection system, with comparatively long cutting intervals. The species which should be favored in the management of these lands are white pine, yellow poplar, white oak, chestnut, cucumber, and basswood. All of these, and especially white pine and yellow poplar, demand a great deal of light for their existence. This adapts them preeminently to a system of heavy culling, combined with the leaving of seed trees to restock the ground. Heavy culling, admitting an abundance of light to the ground, is essential to dense and thrifty regeneration of the cove-land trees; at the same time their seeding capacity is so great that a single tree can reseed a very large area. In past logging of the region small or defective pine and yellow poplar

were often left standing. In many cases such trees have seeded up immense areas of cut-over land and greatly increased the proportion of white pine and yellow poplar in the second growth. Thus, cove lands in eastern Tennessee (Sullivan County, Holston Mountains), logged from eight to fifteen years ago, where a few seed-bearing pine and poplar unfit to cut were left, now contain in the second growth 25 per cent each of poplar and white pine, with a fair stand of white and red oaks and chestnut. Such results, secured by accident, indicate what may be accomplished by systematic management, the underlying principles of which may be summarized briefly as follows:

(1) White pine, yellow poplar, white oak, or any other valuable species of the cove and lower slope land should be cut to a diameter limit of about 18 or 20 inches on the stump. This cutting limit will take in all trees large enough for lumber and will leave a small sprinkling of seed-bearing trees. As far as possible, one seed tree of both white pine and yellow poplar to the acre, or four of white oak or chestnut, should be left on the logged-over area. Where seed trees of a diameter below the cutting limit are lacking, larger trees should be left; either those which are unsound and very defective, and which would furnish but little merchantable timber, or those which are still very thrifty and can wait over until the next logging without injury. In general, no sound, valuable trees over 24 inches in diameter at the stump, and no trees large enough to cut which are partly unsound but still largely merchantable, should be left by the loggers, since such trees would in all probability be a total loss by the time the second cut is made.

(2) To secure all the light and space needed by the young growth of the valuable species, the other merchantable species, such as hemlock, red and black oak, chestnut, hickory, gum, and basswood, should be logged just as closely and heavily as possible. Black and red oak can be used down to 10 inches breasthigh for cross-ties. Hickory and black gum are now being cut, the former for handle stock and the latter for rough construction lumber. These trees should be logged, together with black oak, as small as can be handled profitably. Only where the smaller trees of pine or poplar are lacking, or occur but sparsely, should red and black oaks, chestnut, or cucumber be left under the same cutting rules as those suggested for the two favored species. In case of special demand for oak and chestnut timber the smaller trees of those species may be left throughout the entire cove forest, under the method of cutting just outlined. After logging the growth of such small timber should be rapid and the increase in money value great. At the same time these small trees will seed up the ground and insure a better reproduction of valuable timber trees.

It must be borne in mind, however, that yellow poplar and white pine are much better adapted, by their abundant seed production and wide dissemination, to this system of logging than are any of the other species, and that much better results can be secured with them than with the heavy seeded oaks and chestnut. In any event, a good deal of oak and chestnut coppice will spring up after logging and enter into the second growth. A great many hemlock seedlings will also work their way into the new stand. With their slow growth, however, they will not interfere with the more rapidly growing pine and hardwoods. As the new stand matures, the tolerant, dense-crowned hemlock, coming up under the other species, will form a valuable element of the forest, forcing the height growth and stimulating the natural pruning of the more valuable timbers.

(3) Worthless trees, such as beech, magnolia, and red maple, which in some localities can not be logged at all, should be deadened by girdling at the time of, or soon after, logging, in order to further open up the ground and favor the reproduction of the desired species.

(4) The slash left in logging should be thrown together in piles well away from the remaining trees and burned as soon as the woods are in condition to favor control of the fire. By clearing the ground of débris this measure will help to protect the young growth from fires, and by destroying the leaf litter and exposing the mineral soil it will greatly assist the germination of poplar and white pine seeds.

(5) If the virgin stand before logging contained an advanced young growth, and the last cutting of the most valuable species has been made to a diameter of 18 or 20 inches on the stump, and if it is intended to cut to the same diameter limit in the future, the cove and lower slope land may be cut every twenty-five or thirty years without deterioration of the stand. If the forest has been repeatedly and severely culled, or the virgin stand consisted of only mature timber, it may be from forty to seventy years before a second cut can be made. During the intervening period little need be done for these lands except to protect them from fire. It would be advisable to go over the second-growth cove stands and girdle the beech, maple, magnolia, and worthless species which are interfering with the vigorous development of the new stand. The scraggy oak and chestnut which were left by the loggers should also be girdled.

(6) All the trees above the cutting limit which are to be left to furnish seed should be plainly marked in advance of logging. Strict care should be taken in felling to drop the timber away from the marked trees and from all promising young growth of valuable species and to throw the brush away from such trees in lopping and trimming.

UPPER SLOPES AND RIDGES.

The ridges and upper slopes have a dry, thin soil and are much exposed. Tree growth here is very slow, especially after the sapling and pole stages. The valuable commercial species of these types are chestnut, chestnut oak, black and red oaks, and occasionally white oak and white pine. The poor soil conditions, resulting in scrubby timber and comparatively slow growth, unfit these lands for permanent forest management designed to produce saw timber. With slow growth and poor development it will not pay to hold such lands for the long interval that must elapse before the second growth reaches merchantable sawlog size. In general there will be greater profit in managing these lands for chestnut extract wood, chestnut oak tanbark, oak cross-ties, and car stock on the sprout system, with a comparatively short rotation, utilizing in this way the period of most rapid growth.

Chestnut and all the oaks are merchantable for cross-ties. These species should therefore be logged to a diameter of 12 inches on the stump, and the lands left to reproduce by sprouts and by seed from the remaining trees of seed-bearing size. A large amount of sapling and polewood will be left on these lands also, to stock the ground and to make a second cut possible in twenty-five years, when the cove and lower slope lands are worked over for the second time. As in the coves, the blanks following each logging should be stocked with young growth by seed from the remaining trees of seed-bearing size. Thus, as in the true selection forest, the basis of the next cut should be left on the ground at each logging in the form of well-advanced sapling and polewood growth, which may be of coppice or of seedling origin.

Where the land has been coaled off, or cut clear for charcoal, or where no trees below 11 inches are left on the ground, the stand will consist almost exclusively of sprouts of the same age, and the interval between two successive cuttings must be from 55 to 60 years. No intermediate measures, other than protection against fire, are required between two cuttings.

If it is desired to raise some saw timber on these lands, the thriftier and more promising trees, preferably seedlings, should be left in logging. Such trees should be marked in advance of the cutting. These trees will serve the double purpose of developing valuable saw timber in themselves and at the same time will seed up the ground around them. It will be of great advantage to keep a small proportion of seedlings in the second growth to prevent the deterioration of the stand which is almost sure to result from repeated coppicing. In selecting trees to leave for the development of saw timber, chestnut and white oak should be the favored species; chest-

nut because of its rapid growth, and white oak because of its commercial value. In the absence of white oak, young thrifty trees of red or chestnut oak may be similarly marked and left until the second or third cutting, when they are to be taken out. The great windfirmness of the slope and ridge timber will make such trees, left for seed, comparatively safe from windthrow. As in the coves, no merchantable trees which are unsound and liable to deteriorate should be left in logging.

Girdling is not necessary on these types. There are very few of the low, dense-crowned, worthless species which would interfere with the establishment of thrifty second growth.

Slash burning is not recommended for these lands. It would be advisable simply as a means of better protecting the young growth after logging. It would not, as in the coves, have any beneficial effect upon the reproduction following lumbering. The comparative openness of the stand makes the slash much lighter and more scattered than in the coves. Moreover, the ground of the slopes and ridges, as a rule, is already well stocked with reproduction of the valuable species—chestnut and the oaks—which are wanted in the second growth. It will be a great gain to leave this young growth uninjured; it is often ten or twelve years old, and forms the basis of the second crop. The conditions here are entirely different from those found in the coves where the existing reproduction is, as a rule, not of the species wanted. In the slopes and ridges the aim should be to injure the reproduction as little as possible, and thus leave a fairly dense and uniform growth already established on the ground.

MANAGEMENT OF SPROUT FOREST.

In the Southern Appalachians reproduction from seed is greatly hampered by continuous fires. On the other hand, the capacity for sprout reproduction is possessed in a high degree by nearly all the southern hardwoods. Often 75 per cent of the hardwood second growth in the South is of sprout origin, and on thousands of acres, which were once cut for charcoal, it is exclusively coppice. Management of sprout forest must form, therefore, a large part of the management of second growth.

Of the most important southern hardwoods the oaks and chestnut are the species best suited to sprout management. Chestnut leads in the vigor and persistence of its sprouting power, with the oaks closely following it. Yellow poplar seldom produces sprouts of any consequence, either from stump or root. Chestnut and the oaks sprout almost exclusively from the "root swelling" at the bottom of the tree, although chestnut oak reproduces itself to some extent also by root suckers on shallow, rocky soil, where the trees are forced to

develop long lateral roots close to the surface. Of the oaks, red and black oak are the most vigorous and persistent sprouters; white and chestnut oak are fairly good, but rather inferior in this respect to the other two species. Tables 4, 5, and 6, based upon measurements of a great number of sprouts of the different species in stands of different ages, show the comparative vigor of sprouting of the different oaks on ridge and slope types.

TABLE 4.—*Growth in height of oak sprouts on ridge and slope types.*

Age.	White oak.		Black oak.		Scarlet oak.		Post oak.		Spanish oak.	
	Ridge.	Slope.	Ridge.	Slope.	Ridge.	Slope.	Ridge.	Slope.	Ridge.	Slope.
Years.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	2.7	2.2	3.1	3.7	3.1	3.1	.....	.....	.....	.....
2	4.0	4.5	6.0	6.8	6.0	6.0	5.5	4.5	5.75	6.85
3	7.0	7.8	8.7	9.7	8.7	8.7	7.45	6.6	8.2	9.7
4	9.5	10.2	11.5	12.4	11.5	11.6	9.4	8.6	10.4	12.2
5	11.5	12.3	14.0	15.0	14.5	14.7	11.3	10.2	12.2	14.4
10	20.5	20.5	25.0	25.8	26.2	26.8	19.2	18.0	20.0	22.8
15	27.4	26.7	32.8	35.5	34.0	36.0	.....	.....	.....	.....
20	33.2	31.8	38.3	48.0	40.0	43.7	.....	.....	.....	.....
25	37.6	36.3	42.9	52.1	44.7	50.2	.....	.....	.....	.....
30	40.8	37.8	47.4	59.0	48.4	55.7	.....	.....	.....	.....
35	44.0	43.4	51.5	66.0	53.6	60.2	.....	.....	.....	.....

TABLE 5.—*Growth in diameter of oak sprouts on ridge and slope types.*

Age.	White oak.		Black oak.		Scarlet oak.		Post oak.		Spanish oak.	
	Ridge.	Slope.	Ridge.	Slope.	Ridge.	Slope.	Ridge.	Slope.	Ridge.	Slope.
Years.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2	.....	0.45	0.75	0.75	0.75	0.75	0.28	.....	0.4	0.4
3	.....	.85	1.07	1.1	1.1	1.12	.57	.....	.65	.8
4	1.0	1.1	1.42	1.44	1.44	1.47	.85	.....	.95	1.27
5	1.23	1.37	1.73	1.77	1.78	1.83	1.1	.....	1.25	1.54
10	2.4	2.65	3.05	3.2	3.22	3.5	2.4	.....	2.63	3.2
15	3.25	3.58	4.1	4.37	4.36	5.05	.....	.....	.....	.....
20	3.86	4.18	4.94	5.37	5.28	6.24	.....	.....	.....	.....
25	4.22	4.65	5.55	6.25	6.14	7.26	.....	.....	.....	.....
30	4.44	5.1	6.05	7.05	6.94	8.1	.....	.....	.....	.....
35	4.56	5.5	6.55	7.8	7.67	8.75	.....	.....	.....	.....

Table 5 brings out also the effect of situation upon the vigor of growth of the sprouts. On slopes when the soil is fresh and fairly fertile the growth is more rapid in both height and diameter than on the dry thin-soiled ridges.

INFLUENCE OF AGE UPON SPROUTING

As trees grow older their sprouting capacity decreases, but not in the same degree in all species. Thus, while chestnut still produces numerous and vigorous sprouts from large stumps, the oaks often fail to produce sprouts from stumps above 15 inches in diameter. A number of old cuttings were cruised over in Tennessee and northern Alabama, two or three years after logging, and practically no cases

of sprouting from the larger oak stumps, over 12 inches in diameter, were noted. From the smaller stumps the sprouting was fairly vigorous and abundant, but much less than in the case of chestnut. Of the various oak species, black, scarlet, and red oak are able to sprout vigorously from larger stumps than either white or post oak. Therefore, after a cutting of virgin forest composed of large trees, many of the white oak stumps fail to send out sprouts, and for this reason are largely replaced in second growth by black oak, which, besides coppicing from larger stumps, does well on poor soils.

Table 6, based on measurements of 1,342 white oak and 1,306 black oak sprouts and of their mother stumps, proves black oak has greater sprouting capacity from large stumps than white oak has.

TABLE 6.—*Sprouting vigor of black oak and white oak from stumps of different diameters.*

Diameter of mother stumps.	Height of dominant shoot one year old.			
	Slope.		Ridge.	
	White oak.	Black oak.	White oak.	Black oak.
Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1-3	2.25	2.48	2.10	2.38
4-6	2.27	2.51	2.58	2.61
7-9	2.34	2.58	2.85	2.88
10-12	2.32	2.75	2.72	3.00
13-15	2.30	2.93	2.32	2.82
16-18	.....	2.75	.....	2.40

The most vigorous sprouts are produced in white oak from stumps from 7 to 9 inches in diameter, or at the age of from 35 to 45 years. In black oak the ability to put forth vigorous sprouts extends to larger stumps of greater age, reaching its maximum, on the slope, in stumps between 13 and 15 inches in diameter, or at the age of from 60 to 80 years. On the ridge it reaches its maximum in stumps between 10 and 12 inches, or at the age of from 45 to 55 years.

INFLUENCE OF TIME OF CUTTING UPON SPROUTS.

The time of the year at which trees are cut often exercises a marked effect upon the coppice growth. Late spring and summer cuttings are usually marked by less and feebler sprouting than spring and winter cuttings. The vigorous sprouts that may come up from stumps cut in June, July, or August are frequently killed by early fall frosts; in the short growing season then remaining they can not become entirely woody, and the winter finds them, therefore, green and tender. Extensive measurements on sprouts from stumps cut at different seasons of the year invariably show poorer results from cutting in summer than in winter, and that trees cut in summer failed, in many cases, to produce sprouts.

Table 7 compares the effect of summer and winter cutting.

TABLE 7.—*Comparison of the effect of summer and winter cutting upon the growth of two-year-old sprouts from stumps 32 years old.*

Species.	Summer cut.		Winter cut.	
	Diameter at the ground.	Height of dominant sprout.	Diameter at the ground.	Height of dominant sprout.
	Inches.	*Feet.*	*Inch.*	*Feet.*
White oak	0.82	4.35	0.71	4.85
Black oak	.88	4.94	.94	6.32
Scarlet oak	1.02	4.98	.88	7.2
Spanish oak	1.12	5.83	.84	6.62

The figures show that height growth is affected more by the time of cutting, and that diameter growth remains the same, or is a trifle greater in summer cuttings.

Among the other essential requirements for vigorous development of chestnut and oak sprouts are smooth, low stumps and abundant light. Deep, loose, well-watered soil favors the thrifty development of young sprouts, but in general, up to the sapling stage of oak sprouts, the soil and moisture conditions are much less important than the amount of light. Hence, on the slopes and ridges, where the mature stand is open and light abundant, oak sprouts develop most vigorously during the first ten years. In the coves, with dense forest and greater shade, the growth in height is considerably slower than on the upper, more exposed slopes, in spite of the better soil conditions. While abundant light is required for vigorous development, oak and chestnut sprouts are fairly tolerant for the first ten years. Coppice, during early life, is much less sensitive to shade than seedlings and grows fairly well, though slowly, under a moderately dense canopy. In their ability to endure shade, sprouts of the principal species suited for coppice management rank as follows: 1, black oak; 2, red oak; 3, chestnut; 4, white oak; 5, chestnut oak.

Both black and red oak sprouts are comparatively tolerant, growing abundantly under the broken cover of a lightly culled forest. Chestnut is somewhat inferior, and white and chestnut oak are decidedly inferior to black oak in this respect.

UNFAVORABLE FACTORS.

The greatest enemy of the sprout forest is fire. The fires that periodically run through the woods hold the coppice of chestnut and oaks in check, and burn the sprouts down to the ground, thus forcing the stumps to send up fresh sprouts until their vitality is partially or totally exhausted. A few small areas in the Tennessee River Valley were noted where after thirty or forty years of annual fires the

sprouting power of the oaks was largely exhausted and reproduction of any character was scarce. Oak sprouts are apparently hardier and more resistant to fire than chestnut sprouts, or poplar and white pine seedlings. Often, in spite of frequent fires, some oak sprouts survive and form an irregular second growth, whereas on poplar, chestnut, or pine lands, second growth would be permanently excluded.

Fire not only affects the density of sprout forests; it affects also the height of the individual sprouts. Since it was impossible to find coppice stands several years old that were not burned, the comparison given in Table 8 has been confined to badly burned and slightly burned stands.

TABLE 8.—*Effect of fire upon height growth, stand of sprouts 11 years old.*

Species.	Average height.	
	Badly burned.	Slightly burned.
	Feet.	*Feet.*
Black oak	24.3	25.9
Scarlet oak	25.8	27.7
White oak	19.7	21.3

An effect similar to that of fire is produced by grazing. This factor, however, is of only local importance. Occasionally areas are found which have been so heavily grazed that stock is forced, before the end of the season, to browse upon chestnut, poplar, and oak foliage. Here oaks again suffer much less than young poplars, and somewhat less than chestnut.

It is comparatively easy to gain all the knowledge needed for the intelligent handling of a sprout forest. Stands of sprout growth, since they were once cut clear, contain trees which are all practically of the same age. With several such uniform stands differing one from another by one or more years, it is not difficult to determine the amount of timber which will be yielded by each stand at certain intervals, since each older stand serves as an indication of the yield which may be expected from the younger stands. The future yield, which is the basis of forest management, can therefore be determined with greater accuracy for a sprout forest than for an irregular forest composed of trees of many diameters and ages.

In Tables 9 and 10 the yield is based on the results of a series of sample areas taken on the coaled-off lands around Bear Spring Furnace, Stewart County, and Brownsport Furnace, Decatur County, Tenn. Cutting for charcoal was begun seventy years ago, and at Bear Spring it is still continued, so that there are now uniform stands of coppice growth from 2 to 70 years old.

TABLE 9.—*Estimated yield for second-growth hardwoods, Stewart and Decatur counties, Tenn.*[a]

Age.	Average trees per acre.	Yield per acre.		Average annual production within each ten-year period.	
		Ridge.	Slope.	Ridge.	Slope.
Years.	*Number.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*
10	1,340	740	560	74.0	56.0
20	960	1,355	1,200	61.5	64.0
30	700	1,715	1,700	36.0	50.0
40	500	1,945	2,015	23.0	31.5
50	355	2,105	2,215	16.0	20.0
60	255	2,200	2,340	9.5	12.5
70	180	.....	2,440	.....	10.0
80	140	.....	.....	.....	.....

[a] The second growth in this region consists mainly of oak, with the white oaks and black oaks in almost equal quantities.

TABLE 10.—*Yield in lumber, in wood, and in ties per acre for ridge and slope land.*

Age.	Lumber (Doyle-Scribner).		Wood.		Ties.		Average annual increment within each decade.				Average annual production per acre.	
							Lumber (Doyle-Scribner).		Wood.		Ties.	
	Ridge.	Slope.	Ridge.	Slope.	Ridge.	Slope.	Ridge.	Slope.	Ridge.	Slope.	Ridge.	Slope.
Yrs.	*Bd. ft.*	*Bd. ft.*	*Cords.*	*Cords.*	*No.*	*No.*	*Bd. ft.*	*Bd. ft.*	*Cords.*	*Cords.*	*No.*	*No.*
10	.....	.....	8.6	6.6	.....	.....	.....	.....	0.86	0.66		
20	.....	.....	15.8	14.0	.....	.....	.....	.....	.72	.74		
30	220	330	20.0	19.8	.....	.....	.....	.....	.42	.58	3.3	3.5
40	660	885	22.7	23.5	.....	.....	44.0	55.5	.27	.37		
50	1,520	1,795	24.6	25.6	.....	.....	86.0	91.0	.19	.21		
60	2,780	3,200	25.7	27.3	200	213	126.0	140.5	.11	.17		
70	.....	.....	.....	28.5	.....	222	.....	.....	.....	.12	.....	.....

These figures apply to present forest conditions in the region and can be used to determine the amounts of timber, in the form of ties, cords, or board feet, which can be expected from the ridge and slope lands under sprout management.

The study of sprout forests, then, allows the following conclusions to be drawn with regard to their management:

(1) The species best suited to sprout management are chestnut and the oaks.

(2) Only the ridges and the upper slopes are suitable for sprout forest.

(3) The sprout forest should be managed with the aim of producing only timber for cross-ties, for mining purposes, extract, charcoal, and other minor products.

(4) The intervals at which the sprout forest should be cut must depend largely upon the product desired; for ties and mining props it will require from fifty to sixty years; for charcoal from thirty to forty years.

(5) No timber of large dimensions should be raised under sprout management, because stumps of large trees fail to sprout and the timber itself is likely to be defective. The black and red oaks, although more able to produce vigorous sprouts from large stumps than white oak, are subject to defect and should be cut, together with white oak, not later than at the age of from 55 to 60 years; the same age limit should be applied to the chestnut.

(6) Sprout timber should be cut either in winter or before the buds open in early spring, and the timber should be removed at once. If it is removed later the young sprouts that come up from the stump will be injured.

(7) Stumps should be cut low and smooth.

(8) Sprouts should be protected from fire and grazing.

PROTECTION.

Protection against fire is essential to conservative forest management in the Southern Appalachians. Yet at present but little effort is made to keep fire out of the forest. The result is, on virgin land, a large loss from decay and unsoundness of mature timber, and, on second-growth lands, an even more serious loss from the absolute failure of second growth, or, at best, marked delay in getting it established. Even when a start is finally made the growth is much less dense and contains a much larger proportion of worthless species than on land from which fire has been kept out.

Except when the virgin forest contains dense young stands of valuable species, the need of protection and the results gained from it are greater in the second growth. In time all timberlands should be protected from fire, but for the present, at least, the second growth should receive chief attention.

It is impossible to outline a system of fire protection which would apply to the region as a whole. To be practicable and efficient a scheme of protection must be perfectly adapted to local conditions, such as topography, character of ownership, nearness to settlements, and attitude of the people. The general policy in any plan, however, should be to enforce strictly the fire and stock laws of the region and at the same time to cultivate the friendship and good will of the resident population. The people should be educated to respect the rights of the timberland owner and should be brought to see that the prevention of forest fires and of unrestricted grazing is for the best interests of all. Many clearings, from 50 to 100 acres in extent, are scattered through the timbered area of the region. It would be a great advantage to the timberland owners to secure control of these little mountain farms and lease them to trustworthy tenants who

could be relied upon to assist in the protection of the tract. The terms of the lease should be so arranged that each tenant would be a local fire warden, keeping close watch over the area near his farm. The tenants, as a body, would form a reserve force of fire fighters whom the rangers could call upon in time of emergency. This system is in successful operation on a large estate in North Carolina.

Artificial fire lines in the Southern Appalachians are impracticable. The roughness of the country, the rapid growth of underbrush, and the heavy fall of leaves each year put an almost prohibitive cost upon building lines and keeping them open. Existing roads and trails serve as fire lines, and every deep, moist cove forms an effective barrier to the flames.

Protection should include a system of patrol during the danger season over definite ranges. The time of danger is from March 15 to June 15 and from October 15 to December 15, or five months in each year. Rangers should be selected from trustworthy men who are well acquainted with the country. Such men could probably be secured for from $50 to $60 a month, or from $250 to $300 for the entire season. By a system of trails along the ridges it is possible to patrol a large area with comparatively little traveling. Each ranger should patrol 12,000 acres, which would make the cost of protection about 2½ cents per acre.

Every ranger should be made a deputy sheriff of the county, with power to arrest without warrant and with full authority to enforce the State fire laws. They should also have authority to employ necessary aid in fire fighting.

Cut-over lands should be protected for not less than twenty-five or thirty years, since the young growth requires that length of time to reach a point where it can resist ground fires.

Approved:

JAMES WILSON,

Secretary of Agriculture.

WASHINGTON, D. C., *September 27, 1907.*

[Cir. 118.]

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