# INCREASE IN GROWTH OF LOBLOLLY PINES LEFT AFTER PARTIAL CUTTING [1]

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## INTRODUCTION

Information on the growth of trees left after partial cutting, and on the factors affecting it, is of value in planning the management of forest stands. Such information makes it possible not only to predict the growth of trees that have been left by partial cutting but also to select as trees to be left in partial cutting those more capable of benefiting by release. Together with information on other silvicultural characteristics of a species and on economic factors, it forms the basis for applied silviculture. This paper deals with the results of a study of increase in growth at breast height [3] of loblolly pine (*Pinus taeda*) trees left after partial cutting.

## REVIEW OF LITERATURE

Many workers have presented data on the increase in growth rate of forest trees after release. Marshall (*11*),[4] studying the growth of hemlock (*Tsuga canadensis*), found that on an average the trees grew five and one half times as fast in diameter at stump height after release as before. Lutz (*9*) and Merrill and Hawley (*12*) found that released hemlock trees showed an increase of from 250 to 350 percent in rate of diameter growth at breast height.

Ponderosa pines (*Pinus ponderosa*) studied by Krauch (*8*) showed marked increase in diameter growth after they were released by removal of part of the stand. In this instance the percentage increase in diameter growth was found to be inversely proportional to diameter at time of release. Dunning (*5*), also working with ponderosa pine, found trees with large crowns more responsive to release than small-crowned trees.

Bentley and Recknagel (*3*) pointed out that red spruce (*Picea rubra*) increased in rate of growth following release. The same tendency was noted for balsam fir (*Abies balsamea*) by McCarthy (*10*), who found that the small trees showed greater increase in diameter growth than the large ones.

Longleaf pines (*Pinus palustris*) studied by Barrett (*1*) showed a marked increase in growth after release. Trees that were small at the time of release showed greater increase in rate of volume growth than the larger trees.

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[2] The field work of this investigation was initiated by C. F. Korstian, formerly of the Forest Service, to whom the writer is indebted for later assistance. Acknowledgment is also due F. X. Schumacher and D. Bruce, of the Forest Service, for valuable suggestions in the statistical analysis, and Mary L. Denoyer, of the Forest Service, for assistance in the computational work.

[3] All diameter and basal-area data mentioned in this paper represent measurements taken at breast height (4.5 feet above ground) outside bark, unless otherwise specified.

[4] Reference is made by number (italic) to Literature Cited, p. 821.

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Chapman (*4*), investigating the growth of several loblolly pines after partial cutting, found a marked increase in rate of diameter growth. He concluded that the rate of increase depended upon the relative length of the crown at the time of release.

## CHARACTER OF DATA

The data used in this study were taken during 1927 and 1928 in nine loblolly pine stands on the Atlantic coastal plain of Virginia and

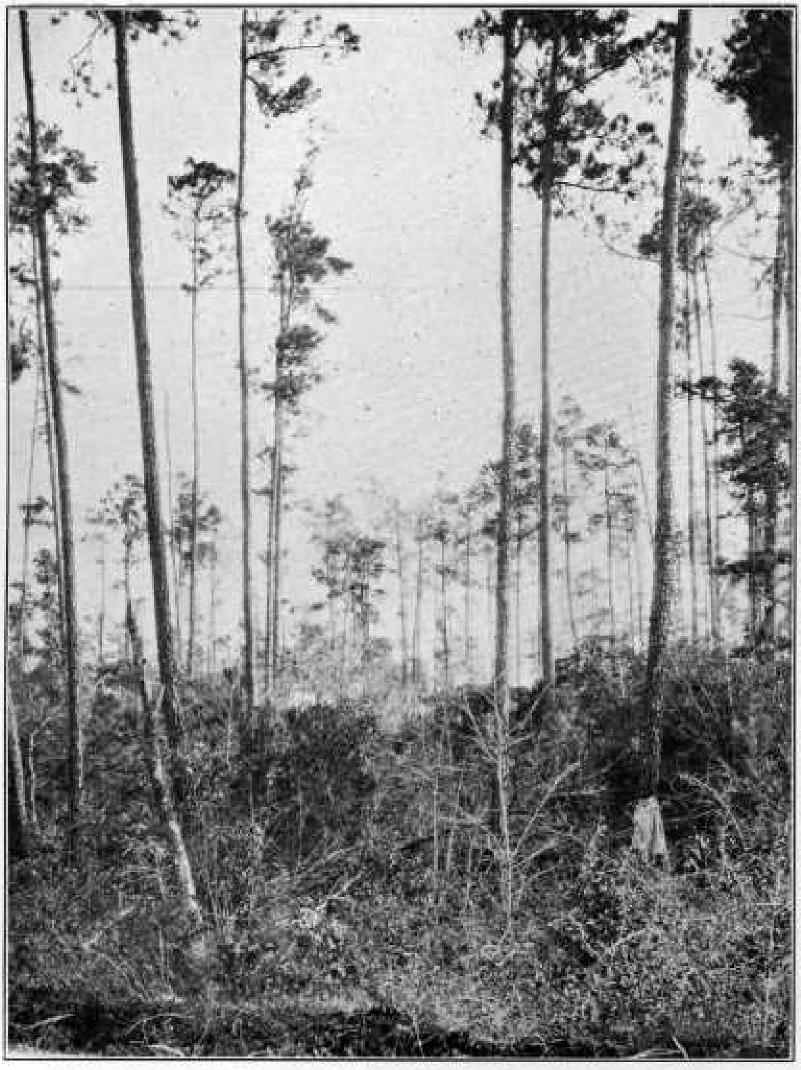

FIGURE 1.—Loblolly pine stand 11 years after it was cut to an elastic 10-inch diameter limit.

North Carolina. The stands had all been partially cut at least 10 years before and had since remained unburned. Figure 1 shows a typical stand. In general they were of the same age (45 to 60 years at the time of cutting), had the same site index [5] (85 feet) according to determinations in near-by stands, had alike been cut to an elastic 10-inch diameter limit, and were approximately the same in density of stocking by basal area (50 to 70 percent of normal values (*13*) at time of cutting).

The diameter distributions in the several stands at the time of cutting were estimated from tree and stump tallies, on the basis of increment borings. The stand tables so reconstructed undoubtedly include errors due to the rough method of taking stand and stump tallies and to the lack of data on mortality of trees since the time of cutting. In general, however, they indicate a high degree of similarity

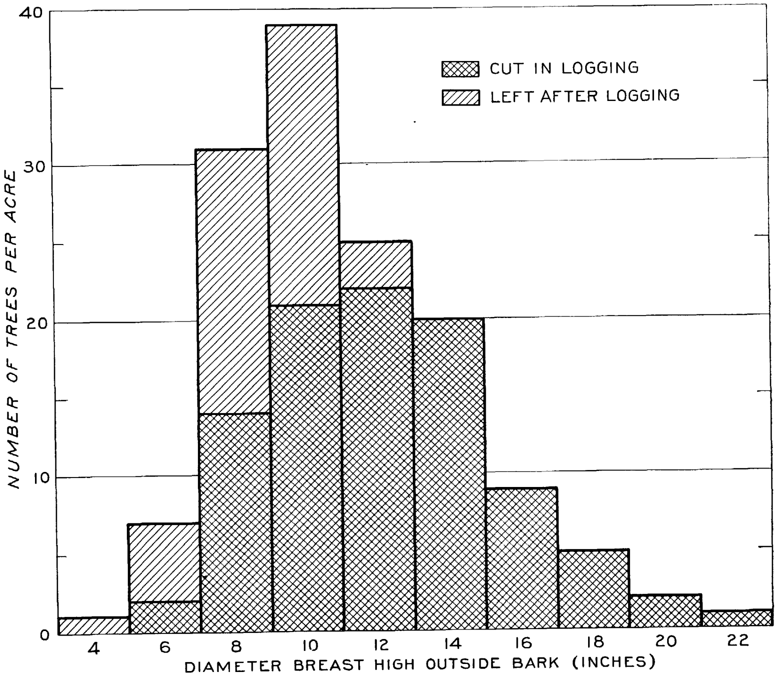


FIGURE 2.—Average distribution of trees cut and trees left in logging on study areas, by 2-inch diamete classes, according to reconstructed stand tallies.

among the nine stands as to density of stocking and as to representation of various diameter classes. Average stand conditions on the nine areas are presented graphically in figure 2.

A selected portion of each of the nine stands was examined in detail, the following data being taken for each of 1,464 trees:

| Measurement | Method |
|---|---|
| Diameter at breast height | Diameter tape. |
| Total height | Abney level. |
| Height to base of crown | Do. |
| Crown width | Estimated to nearest foot. |
| Growth in stem radius at breast height for 5 years before and 10 years after release. | Measured from increment cores taken on south side of trees. |
| Total age | Increment cores. |
| Number and size of trees cut and trees left within 30 feet of the tree studied, and their position in relation to it. | Positions sketched on field sheet and diameters estimated in 2-inch classes. |

[5] Average height attained by dominant and codominant trees at the age of 50 years.

## ANALYSIS OF DATA

In order to analyze factors affecting increase in growth it was necessary to project many values back to the time of release. This operation involved material difficulties. In some cases it was facilitated by the use of detailed stem analyses of 84 sample trees selected at random. A curve showing diameters inside bark corresponding to given diameters outside bark was set up from the values determined for these sample trees. The diameters inside bark of the 1,464 trees at the time of study were then read from this curve. When the diameters inside bark at different periods had been obtained for the individual sample trees by subtracting twice the radius increment as measured on the increment cores they were translated to diameters outside bark by reference to the same curve.

A curve relating height at time of release to height at time of study was likewise constructed on the basis of these stem analyses, and was used in estimating the heights of the study trees at the time of release.

A curve showing crown ratios [6] at the time of release corresponding to given crown ratios at the time of study was constructed from the stem-analysis data on the assumption that the height to base of crown of the individual trees had not changed since the time of release, and was used for projecting crown ratios of the study trees back to the time of release.

Estimation of crown width at the time of release was impracticable. Analysis of the growth of the branches on a few selected trees indicated that the horizontal expansion of the crowns was in most cases so small as to be negligible in comparison with the errors inherent in the methods of estimating crown width. Crown width estimated at the time of study was therefore used in the computations as crown width at the time of release.

The next step in the analysis of the data was to find a method of distinguishing, for individual trees, between (1) the growth that would have been made without release, and (2) the additional growth made, i.e., the growth attributable to release. The mean annual basal-area [7] growth at breast height for the 5-year period before release was taken as the equivalent of the growth that would have been made if the trees had not been released. This basis of comparison insured conservatism in estimates of growth increase due to release, since experience has shown that the rate of basal-area growth for individual trees in the lower crown classes, such as composed the residual stands included in this study, usually decreases and seldom or never increases unless the trees are influenced by changes in stand conditions. Accordingly, the portion of the growth attributable to release was computed for each tree as follows: (Basal area 10 years after release − basal area at time of release) − 2 (basal area at time of release − basal area 5 years before release). The values so obtained are herein referred to as increase in basal-area growth.

The increase in growth is graphically illustrated by the distance between the numerals 3 and 4 on the radius marked in figure 3.

The mean increase in basal-area growth shown by the study trees for the 10-year period following cutting was 0.093 ± 0.00185 [8] square

[6] Crown length in percentage of total height. All values considered in this paper are expressed in decimals.

[7] Cross-section area in square feet.

[8] $\text{Standard error} = \frac{\text{Standard deviation}}{\sqrt{\text{Number}}}$.

feet per tree, or 130 percent of the total mean basal-area growth which, according to estimates, the trees would have put on in that period if they had not been released. The smallness of the standard error of this mean in relation to the mean shows definitely that most loblolly pine trees left by cutting to an elastic 10-inch diameter limit in stands such as those studied increase in rate of basal-area growth during the 10 years following release. The chances are less than 1 in 1,000,000,000 that the mean basal-area growth of another sample of

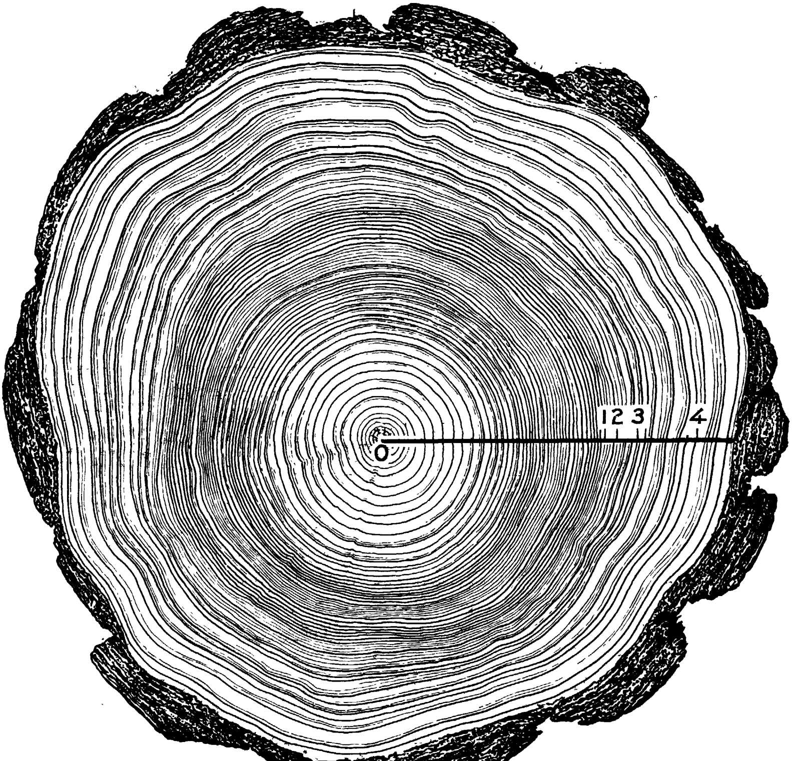


FIGURE 3.—Section of loblolly pine tree cut 12 years after release: 0–1, radius 5 years before release; 0–2 radius at time of release; 0–3, radius 10 years after release if basal-area growth had continued at the same rate prevailing in the 5-year period before release; 0–4, actual radius 10 years after release.

1,464 loblolly pine trees growing under like conditions (before and after release) would show no increase after release.

The change in rate of basal-area growth per tree in the 10 years following release varied widely, ranging from −0.10 to +0.45 square feet. A cursory examination of the data indicated that this wide variation was correlated in part with variations (1) in characteristics of the trees studied, hereafter referred to as tree factors, and (2) in degree of competition prior to release and degree of release from competition, which for the sake of brevity will be called the competition and release factors.

TREE FACTORS

The tree factors selected for consideration in the analysis were diameter, crown ratio, crown width, total height, and basal-area growth prior to cutting. In the sample studied the trees that had large diameters at the time of release showed less increase in basal-area growth than the smaller trees. The relationship between increase in basal-area growth and diameter was found to be distinctly curvilinear. Translation of diameter into basal area made the relationship linear (fig. 4, *A*).

Long-crowned trees plainly showed greater response to release than those with short crowns (fig. 4, *B*). Likewise, wide-crowned trees showed greater increase than those with narrow crowns (fig. 4, *C*). Trees about 60 feet tall showed greater increase in growth than either taller or shorter trees (fig. 4, *D*); this relationship, however, was not very distinct. No definite correlation was shown between basal-area growth during the 5 years before release and increase in basal-area growth after release (fig. 4, *E*).

It appeared that the factors just listed were intercorrelated and that the correlation of variations in any one of them with variations in increase in basal-area growth, the others being held constant, might be entirely different from the relationships shown in figure 4. Because the sample of trees was so small, it was impossible to subsort the data in such a way as to hold several factors constant. Mathematical correlation was chosen as the next best method of analysis, because it provides a measure of the relationship between two factors, others being held constant mathematically at their means.

Accordingly, increase in basal-area growth was correlated with the five tree factors considered in the foregoing, that is, basal area, crown ratio, crown width, and total height at time of release, and basal-area growth during the 5 years before release. The resulting equation was:

Increase in basal-area growth in the 10 years following release equals $-0.1397$ basal area $+0.2837$ crown ratio $+0.00163$ total height $+0.00633$ crown width $-0.3196$ basal-area growth during the 5 years prior to release $-0.1116$.

When the regression equation is interpreted in the usual way, that is, on the basis that the regression coefficient of any independent variable measures the change in the dependent variable associated with a unit change of that independent variable, the other independent variables being held constant at their means, it appears that the small, tall trees with long, wide crowns, which were growing the slowest before release, usually showed the greatest increase in basal-area growth after release. This conclusion was substantiated by the fact that all the regression coefficients were at least 4.5 times as large as their standard errors, proof that each factor was significantly correlated with increase in basal-area growth when the others were held constant.

When the regression coefficients were translated into $\beta$ coefficients [9] and so made directly comparable, it was found that

$\beta$ basal area $= -0.2906$
$\beta$ crown ratio $=0.3777$
$\beta$ crown width $=0.3736$
$\beta$ total height $=0.2408$
$\beta$ basal-area growth during the 5 years before release $= -0.1151$

[9] $\beta = \text{Regression coefficient}\ \frac{\text{Standard deviation of independent variable}}{\text{Standard deviation of dependent variable}}$.

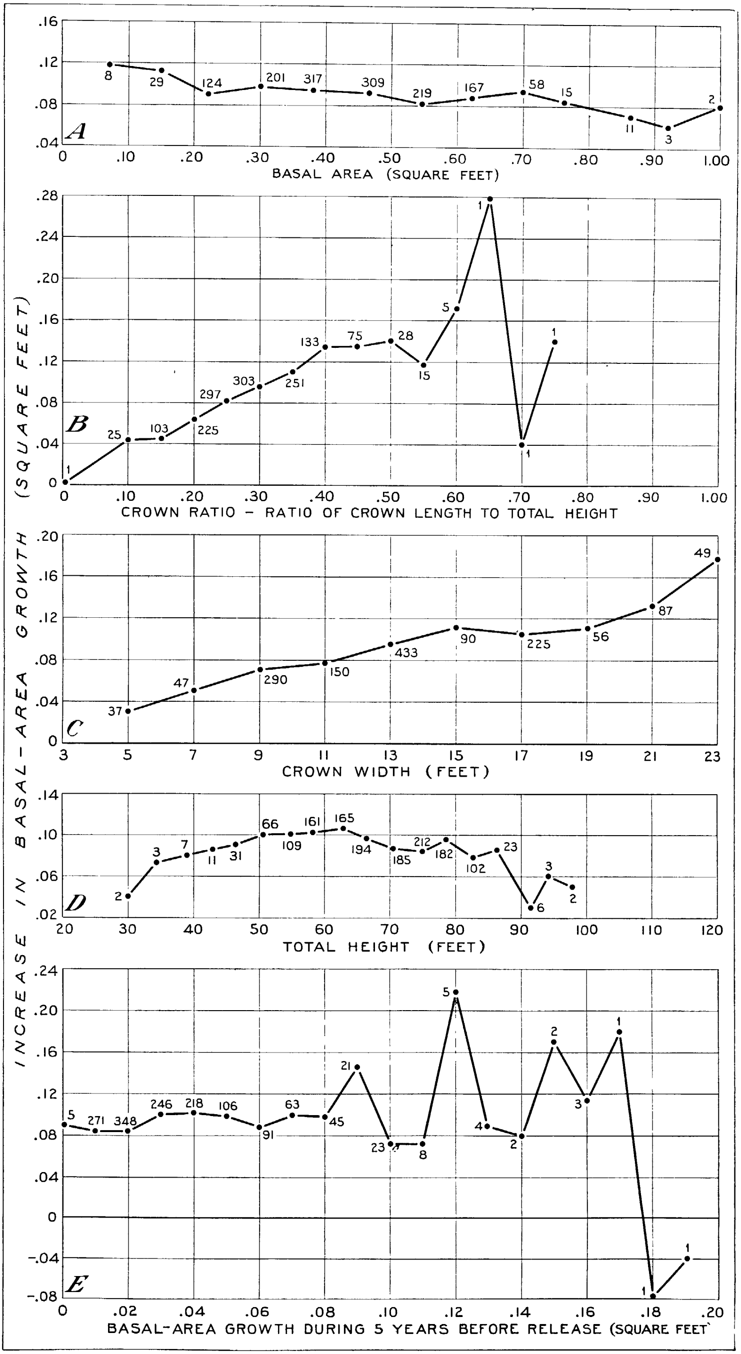


FIGURE 4.— Gross correlations between tree factors at time of release and change in rate of basal-area growth in the 10-year period following release. Numerals indicate number of trees in each class: *A*, Basal area (square feet); *B*, crown ratio (percentage of total height); *C*, crown width (feet); *D*, total height (feet); *E*, basal-area growth during the 5 years before release (square feet).

It is plain that, of the five factors considered, crown ratio and crown width had the greatest influence on increase in basal-area growth after release, and that basal-area growth before release had the least influence.

Although no significant gross correlation between total height and increase in basal-area growth was shown (fig. 4, *D*), a marked correlation between these factors appeared when basal area, crown ratio, crown width, and basal-area growth before release were held constant. Basal-area growth before release also showed much more definite correlation with increase in basal-area growth after release when the other tree factors included in the analysis were held constant.

## COMPETITION AND RELEASE FACTORS

A consideration of increase in growth following release would not be complete without an attempt to measure the effects of various degrees of release on trees differing in characteristics and previously subjected to various conditions of competition. The first problem encountered in this phase of the work was the selection of measures of competition and release. Any measure or measures of competition should include number and size of competing trees; quantity of tree reproduction, of shrubs, and of herbs; the distance of trees and other competing vegetation from the tree studied; their position in regard to the tree studied and to each other; and their characteristics. No specific data were available on competing tree reproduction, shrubs, and herbs. Data on competing trees were available for all these items except the last from sketches taken for each study tree and its surroundings. It was impracticable, however, to consider in full detail even all of the factors for which data were available. Accordingly, the number and size of competing trees located between 0 and 10 feet, between 10 and 20 feet, and between 20 and 30 feet [10] of the tree studied were chosen as the factors best lending themselves to analysis of the small quantity of data at hand.

Several methods of evaluating these measures were tried and rejected because they were logically inadequate or plainly would not allow the use of the correlation method in the analysis. For example, total basal area of all the trees in each of the 10-foot zones at the time of partial cutting, and percentage of the basal area removed from each of the three zones, were rejected because when analyzed on this basis the data exhibited a definite tendency toward joint correlation.[11] Finally it was decided that analysis of competition and release should be based on the number of trees cut, the number of trees left, the average basal area of the trees cut, and the average basal area of the trees left, in each of the three zones.

A multiple correlation of increase in basal-area growth with these factors and the five tree factors previously considered, computed in an attempt to determine in what degree any one of the several factors was correlated with increase in basal-area growth, the others being held constant at their means, gave some results difficult to reconcile with past findings.

As is shown in table 1, the regression equation indicates that a variation of 1 in the number of trees left in the 10-foot zone was not

[10] These ranges of distance are hereafter termed the 10-, 20-, and 30-foot zones.

[11] Joint correlation is that type in which the degree of correlation between an independent variable and the dependent variable is governed by values of another independent variable.

associated with so much variation in increase in basal-area growth as a variation of 1 in the number of trees (of the same size) left in either the 20- or the 30-foot zone. This indication, which might be interpreted to mean that trees left in cutting suffer less competition from trees left within 10 feet of them than from the same number of trees separated from them by a distance of from 10 to 30 feet, is inconsistent with the general experience of woodsmen.

TABLE 1.—*Regression coefficients, and their errors, obtained in multiple correlation of certain variables with increase in basal-area growth of loblolly pine in the 10 years following release*

| Variable [a] | $b$ [b] | $\sigma_b$ [c] | $t$ [d] |
|---|---|---|---|
| Basal area of study tree at time of release | −0.1487 | 0.01530 | 9.72 |
| Crown ratio of study tree at time of release | +.2729 | .01877 | 14.54 |
| Total height of study tree at time of release | +.0016 | .00022 | 7.27 |
| Crown width of study tree at time of release | +.0075 | .00048 | 15.62 |
| Number of trees left within 10 feet of study tree | −.0006 | .00050 | 1.20 |
| Number of trees cut within 10 feet of study tree | +.0159 | .00252 | 6.31 |
| Number of trees left 10 to 20 feet from study tree | −.0060 | .01380 | .43 |
| Number of trees cut 10 to 20 feet from study tree | +.0032 | .00102 | 3.14 |
| Number of trees left 20 to 30 feet from study tree | −.0018 | .00154 | 1.17 |
| Number of trees cut 20 to 30 feet from study tree | +.0013 | .00080 | 1.62 |
| Average basal area of trees left within 10 feet of study tree | +.0067 | .01015 | .66 |
| Average basal area of trees cut within 10 feet of study tree | −.0031 | .00392 | .79 |
| Average basal area of trees left 10 to 20 feet from study tree | +.0108 | .00593 | 1.82 |
| Average basal area of trees cut 10 to 20 feet from study tree | +.0025 | .00329 | .76 |
| Average basal area of trees left 20 to 30 feet from study tree | +.0108 | .00587 | 1.84 |
| Average basal area of trees cut 20 to 30 feet from study tree | −.0075 | .00391 | 1.92 |
| Basal-area growth of study tree in the 5 years before release | −.2238 | 07338 | 3.05 |

[a] Constant term is −0.1372.
[b] Regression coefficient denoting regression of variable on increase in basal-area growth, other variables being held constant at their means.
[c] Standard error of regression coefficient.
[d] Regression coefficient in terms of its standard error. Figures given in this column show by how many standard errors the regression coefficients are removed from 0. The limit of significance usually accepted is 2 standard errors.

Another relationship inconsistent with general observations is indicated by the coefficients of average basal area of trees cut and of trees left at different distances from the study trees. The coefficients as determined in the equation indicate that the removal of large trees from the 10- or 30-foot zones was associated with less increase in basal-area growth than the removal of large trees from the 20-foot zone.

These inconsistencies suggested that (1) important variables were not considered in the equation, (2) the relationships were curvilinear, (3) the relationships were joint, or (4) the relationships were joint and curvilinear.

Of these possibilities the first was not investigated, because data on other variables were not available. This lack of data was unfortunate, because it cannot be doubted that variations in several other tree factors, and in degree of competition from tree reproduction, shrubs, and herbs, had an important bearing on increase in growth.

The relationships were found to be linear, by the use of the Bruce and Reineke technic (*2*).

In investigating the third and fourth alternatives it was necessary to subsort the data according to different degrees of competition and of release from competition. The fineness of this subsorting was limited by the fact that so few data were available. Accordingly, the only competition and release factors recognized were number of trees cut and number of trees left in the 10- and 20-foot zones. Even in these classes, the data in each group created by subsorting were very scanty. The largest general group, that with 0 trees cut and 0 trees

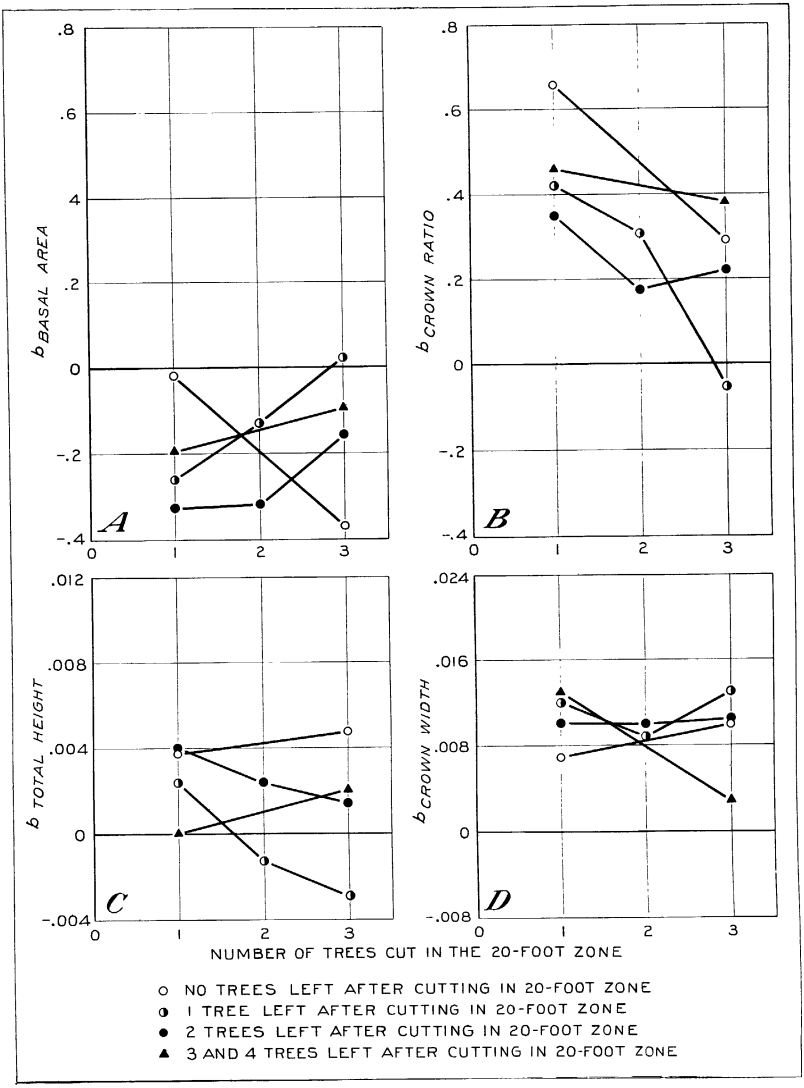


FIGURE 5.—Relations between multiple regression coefficients of basal area *A*, Crown ratio *B*, total height *C*, and crown width *D* as correlated with increase in basal-area growth in the 10 years following release, and degree of release as measured by number of trees cut in the 20-foot zone when different numbers of trees were left following cutting. In all cases no trees were present in the 10-foot zone before or after cutting.

left in the 10-foot zone and with varying numbers of trees cut and left in the 20-foot zone, was chosen for the more detailed analysis. This group was subdivided into groups having constant numbers of trees cut and left in the 20-foot zone.

Table 2 shows the regression equations obtained by correlating increase in basal-area growth with four tree factors for each group.

Figure 5 indicates a possible correlation of the regression coefficients with degree of release as measured by number of trees cut in the 20-foot zone. For the study trees this possible correlation is most pronounced in the case of basal area and crown ratio; even in these cases it is questionable, because of the comparatively large errors of the regression coefficients, shown in table 2.

TABLE 2.—*Regression coefficients obtained by correlating increase in basal-area growth in the 10 years following release with basal area, crown ratio, total height, and crown width at time of release of study trees within 20 feet of which varying numbers of trees were cut and left, respectively, no trees being cut or left within the 10-foot zone*

| Number of trees in 20-foot zone | | Characteristics of study trees at time of release [a] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Basal area | | Crown ratio | | Total height | | Crown width | | Number of instances |
| Cut | Left | b [b] | $\sigma_b$ [c] | b [b] | $\sigma_b$ [c] | b [b] | $\sigma_b$ [c] | b [b] | $\sigma_b$ [c] | |
| 1 | 0 | −0.0153 | 0.1391 | +0.6508 | 0.1914 | +0.0038 | 0.0024 | +0.0071 | 0.0046 | 22 |
| 2 | 0 | | | | | | | | | |
| 3 | 0 | −.3747 | .1388 | +.2916 | .1695 | +.0046 | .0022 | +.0097 | .0044 | 34 |
| 1 | 1 | −.2584 | .0954 | +.4145 | .1486 | +.0024 | .0014 | +.0118 | .0035 | 29 |
| 2 | 1 | −.1322 | .1160 | +.3106 | .1218 | −.0012 | .0015 | +.0081 | .0029 | 32 |
| 3 | 1 | +.0159 | .1223 | −.0531 | .1235 | −.0025 | .0019 | +.0131 | .0032 | 40 |
| 1 | 2 | −.3283 | .0952 | +.3534 | .1683 | +.0039 | .0025 | +.0104 | .0036 | 25 |
| 2 | 2 | −.3243 | .1238 | +.1784 | .1607 | +.0024 | .0022 | +.0097 | .0048 | 25 |
| 3 | 2 | −.1606 | .2397 | +.2161 | .2484 | +.0014 | .0033 | +.0106 | .0046 | 24 |
| 1 | 3 or 4 | −.1978 | .0916 | +.4760 | .1608 | +.0004 | .0016 | +.0131 | .0038 | 31 |
| 2 | 3 or 4 | | | | | | | | | |
| 3 | 3 or 4 | −.0935 | .0663 | +.3887 | .0908 | +.0019 | .0011 | +.0029 | .0022 | 30 |

[a] Independent variables.
[b] Regression coefficient denoting regression of independent variable on increase in basal-area growth, other independent variables being held constant at their means.
[c] Standard error of regression coefficient.

If these relationships are true, the degree of correlation between basal area at time of release and increase in basal-area growth after release tends to approach 0 as the degree of release is increased, competition before release and tree characteristics being constant. Likewise, such relationships might indicate that the degree of correlation between crown ratio and increase in basal-area growth approaches 0 as the degree of release is increased. No evidences of curvilinear relationships were found in these several equations.

## PREDICTION MECHANISMS DEVELOPED, AND THEIR APPLICABILITY

Analysis of the data available in this study has resulted in development of the following equations for predicting the sizes of individual loblolly pine trees 10 years after release:

(1) 0.8681 basal area (including bark) at time of release + 0.2914 crown ratio + 0.0065 crown width + 1.6332 basal-area growth during the 5 years before release + 0.0017 total height − 0.1212 = basal area (including bark) 10 years after release. Standard error of estimate = 0.0613 square foot.

(2) 1.0332 basal area (including bark) at time of release + 0.3116 crown ratio + 0.0088 crown width − 0.0602 = basal area (including

bark) 10 years after release. Standard error of estimate = 0.0726 square foot.

(3) 0.9564 basal area (including bark) at time of release + 2.2872 basal-area growth during the 5 years before release + 0.1015 = basal

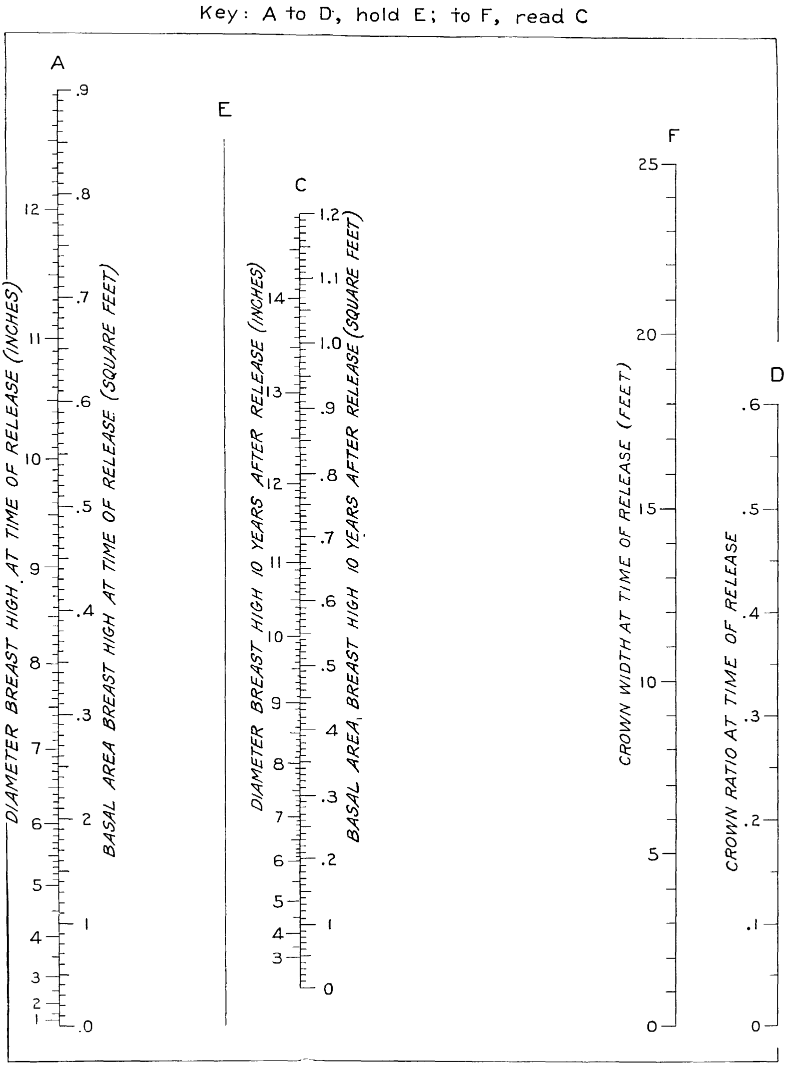


FIGURE 6.—Alinement chart for predicting sizes of individual trees 10 years after release by partial cutting. The chart is based on the equation 1.0332 basal area (including bark) at time of release +0.3116 crown ratio +0.0088 crown width −0.0602 = basal area (including bark) 10 years after release.

area (including bark) 10 years after release. Standard error of estimate = 0.0708 square foot.

A consideration of the standard errors of estimate for these three equations shows that (1) is the most accurate as a predicting mechanism and that (3) is second in accuracy. For practical purposes equations (2) and (3) are more usable than equation (1), and they are therefore presented in alinement-chart form in figures 6 and 7.

The use of either of these predicting mechanisms requires caution. It must be remembered that they will give results within the standard errors presented only if they are applied to trees growing in stands

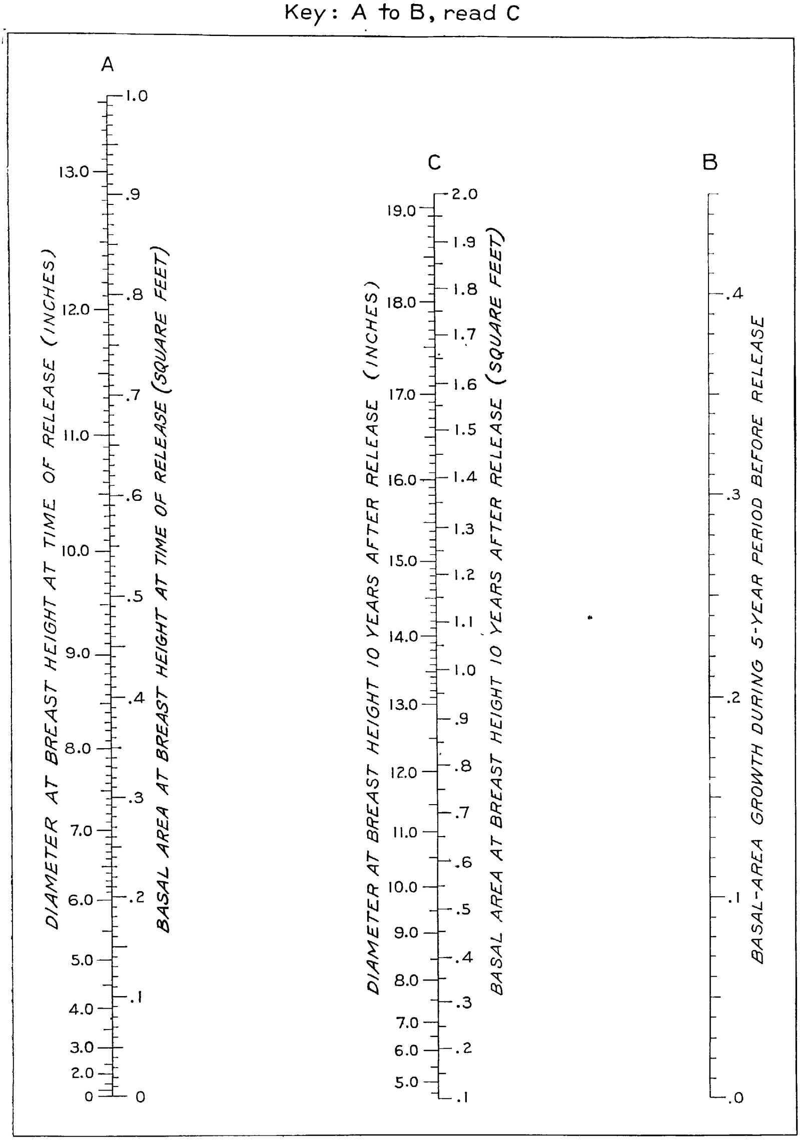


FIGURE 7.—Alinement chart for predicting sizes of individual trees 10 years after release by partial cutting. The chart is based on the equation 0.9564 basal area (including bark) at time of release + 2.2872 basal-area growth during the 5 years before release + 0.1015 = basal area (including bark) 10 years after release.

similar to those included in this study and only if the stands have been or are to be cut to an elastic 10-inch diameter limit and the distribution by size classes of trees cut and trees left approximates that presented in figure 2.

It does not appear that these limitations will greatly restrict the use of the equations on stands cut over under present cutting practices. Most of the loblolly pine stands that are now being cut are between 40 and 65 years old. Likewise, most of them are between 50 and 70 percent stocked by basal area and are growing on areas with site indices between 80 and 90 feet. In present cutting practice the elastic 10-inch diameter limit is the prevailing standard. If the equations are to be applied under future conditions, however, it will probably be necessary to extend the study to include areas cut over to other diameter limits. The probability that revision will be needed to meet future conditions is particularly great as regards application of the equations to areas cut over for lumber, since recent studies (*6*, *7*) have shown that in lumber operations the removal of trees less than 12 inches in diameter breast high is in many cases unprofitable.

The apparent variations in the correlation of tree factors and growth increase on the one hand with different degrees of release on the other led to the conclusion that with the small quantity of data at hand the effects of different degrees of release on growth increase could not be satisfactorily analyzed.

From the regression equation including the five tree factors as independent variables the tentative conclusion may be drawn that in order to get the greatest basal-area increase per tree after release the small, tall trees with long, wide crowns should be left in cutting.

## SUMMARY

The basal-area growth at breast height of loblolly pine trees released by cutting to an elastic 10-inch diameter limit was found to be 130 percent greater, on an average, in the 10 years following release than the growth which, according to estimates, the trees would have put on in that period had they not been released.

Variations in the growth increase of the individual trees in the stands studied were shown to be correlated in part with variations in individual tree characteristics. Crown ratio, crown width, basal area, and total height at the time of release, and basal-area growth during the 5-year period prior to release, were shown to be correlated with increase in basal-area growth after release, in degrees diminishing in the order named.

Measurement of the correlation between degree of competition prior to release and degree of release from competition on the one hand and increase in growth following release on the other was difficult because of the complexity of the relationships involved, including tree-factor relationships. No satisfactory method was found, in fact, for measuring the effects of different degrees of release on the growth of trees having the same characteristics.

Mechanisms were developed for predicting the sizes of individual trees 10 years after release. These are theoretically applicable only to trees growing under the same general conditions as the trees included in the sample, and to stands cut in approximately the same way as those sampled. Most of the loblolly pine stands now being cut in the Atlantic coastal plain are, in fact, highly similar in age, density of stocking, and size to the stands in which the study trees were growing prior to release.

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