1969 No. 30

BLACK ROCK FOREST PAPERS

DIAMETER GROWTH OF NORTHERN RED OAK FOLLOWING UNDERSTORY CONTROL

By

JACK J. KARNIG AND BENJAMIN B. STOUT

HARVARD BLACK ROCK FOREST
CORNWALL, NEW YORK 12518

DIAMETER GROWTH OF NORTHERN RED OAK FOLLOWING UNDERSTORY CONTROL

by

Jack J. Karnig[1/] and Benjamin B. Stout[2/]

ABSTRACT

Diameter growth of northern red oak trees was measured during the years 1962, 1963 and 1964. Three sample plots were compared: (1) Heavy thinning in 1956, elimination of underbrush in 1959 and 1961 by spraying 2,4,5-T. (2) Heavy thinning in 1956, no subsequent removal of underbrush. (3) Unthinned control area. The three-year (1962-64) accumulated basal area growth per tree in the three areas was (1) 0.0912 ± 0.0087 ft^2, (2) 0.0817 ± 0.0104 ft^2 and (3) 0.0512 ± 0.0093 ft^2. These are average results of all tree sizes, ranging from 5 to 18 inches in diameter at breast height. Growth increase due to brush removal was greater in trees of greater diameter.

1/ Forest Manager, Harvard Black Rock Forest, Cornwall, New York, 12518, and Harvard Forest, Petersham, Massachusetts, 01366.

2/ Professor, Department of Horticulture and Forestry, Rutgers The State University, New Brunswick, New Jersey, 08903.

REVIEW OF LITERATURE

Studies describing diameter growth patterns of forest trees are quite numerous in the literature. A newly kindled interest in this area might well be attributed to the vernier type dendrometer band developed by Liming (1957). Investigations of this type are continuing in this country as well as in other countries on a great variety of tree species.

Buchanan et al. (1962), Harkin (1962) and Winget and Kozlowski (1963) provide insights into the timing of growth during the active growing season with emphasis on initiation, peak growth and cessation of growth.

Another group of investigators attempted to isolate the one or more critical environmental factors influencing diameter behavior. The role of soil moisture is critical according to Friesner (1943), Boggess (1953) and Ermich (1959). McClurkin (1958) found the number of elapsed days of the growing season gave best correlation in daily increments of (*Pinus echinata* Mill.) Although he tested ten independent variables, there were some unexplained variations in growth rates.

Kozlowski et al. (1962) found radial growth of (*Quercus ellipsiodalis* E. J. Hill) closely related with daily maximum and minimum temperatures. In a five year study, Larsson et al. (1964) concluded that both temperature and rainfall are the principal influences on growth.

DESCRIPTION OF THE AREA

Located in the north central portion of the Forest the study area is situated on a gentle north facing slope at an elevation of 950 feet.

The soil is a clay loam containing a large quantity of weathered granite boulders, together with a smaller amount of rock of sedimentary origin. The latter was deposited by the glacier in the form of a thick till according to Denny (1938). Soil pits dug in conjunction with this study indicate that the soil mantle is about six to ten feet deep. Slopes vary betweeen nearly level to 15%. The forest floor is relatively free of surface boulders.

The ability of native hardwoods to sprout profusely after having been thinned is a well known phenomenon in this region. At the Harvard Black Rock Forest there exists a series of thinned areas where 50% of the basal area was removed during the decade 1950-1960. At the time of cutting, all underbrush was also felled and piled. For a year or two after logging an open park-like condition prevailed. The third year a count of sprouts and seedlings revealed a stocking of over 13 thousand stems per acre.

It would seem that control of such profuse sprouting by periodic cutting or by the use of herbicides, might stimulate diameter growth of the widely spaced residual trees. This hypothesis was tested over a four year period at this Forest using data collected on northern red oak (*Quercus rubra* L.) since it was the dominant species on the site selected for this study.

The 70 year-old stand had been heavily thinned during the winter 1956-57. In 1959 its basal area measured 43 square feet in the following proportions by species: northern red oak - 76%, chestnut oak (*Quercus prinus* L.) - 9%, tulip poplar (*Liriodendron tulipifera* L.) - 4%, white oak (*Quercus alba* L.) - 3%, and miscellaneous - 8%. The miscellaneous category includes red maple (*Acer rubrum* L.), sugar maple (*Acer saccharum* Marsh.)

black birch (_Betula lenta_ L.) black oak (_Quercus velutina_ Lam.), hickory (_Carya glabra_ Mill.) and white ash (_Fraxinus americana_ L.). The residual stand in 1959 averaged fifty widely spaced stems per acre ranging in size from 5 to 18 inches diameter at breast height. Mean diameter was 11.5 inches.

PROCEDURE

In 1959 a three acre rectangular plot within the cutting was foliage sprayed with a 1% aqueus solution of 2,4,5-T to eliminate all recently sprouted vegetation. As estimated 90% kill resulted from the herbicide spraying. Since complete elimination of underbrush was desired, the three acre plot was again treated in 1961 - using a back pack mist blower. This second spraying killed all but a few of the most resistant sprout clumps.

During the first few days of April, 1961, aluminum dendrometer bands similar to the type described by Liming (1957) were installed on twenty-three northern red oaks in the thinned, brushed out area. Fourteen northern red oaks outside the sprayed area in the same thinned stand were also banded. A random selection system was employed to designate sample trees. Comparison of the two populations revealed close similarity with respect to tree ages, diameter ranges, average diameter and vigor characteristics. At two week intervals during the active growing season, readings were taken on each of these trees. This procedure was repeated in 1962, 1963 and 1964 from April until growth ceased in October.

Prior to the initiation of growth during the 1962 season, twenty additional dominant northern red oaks growing in nearby natural undisturbed forest were banded to record growth patterns. These trees were randomly selected on the basis of similar age, size and condition to those in the "brushed-out" and "brush-in-place" sites described above. It was felt that a record of their growth patterns would add depth and greater scope to the study primarily from the standpoint of comparison with trees in their unthinned state. Basal area stocking averaged 100 square feet for these undisturbed or normally stocked trees.

The dendrometer bands used in this investigation were made from half inch wide aluminum straps. Vernier graduations were engraved with a sharp pointed instrument. When mounted, four-inch-long stainless steel springs provided tension from two to three pounds. Experience has proven that these bands are inexpensive, easy to install, very durable, simple to read and accurate to .005 inches (See Fig. 6).

RESULTS AND DISCUSSION

Cumulated average diameter for each growing season for all trees on each of the two treated areas and the uncut area are shown in Figures 1, 2 and 3. The increment on the trees growing in the brushed-out area and those growing where the understory was left undisturbed is very similar, in fact, differences probably reflect minor variations in site. Replication could have helped reduce measured variation in growth produced by differences in site, but limited space precluded using this technique.

Initiation and cessation of diameter growth shows some variation from year to year. Bole expansion began some time in April, accelerated in

May, June and July, slowed down by late August and generally ceased in September. Peak growth rates occurred in two years as early as late May. In 1963, two peak growth periods were recorded - one in May and a second in late July. Diameter increment usually declined sharply after July. Prolonged drought in August or September is reflected in some negative values (especially in 1964) indicating shrinkage at the point of measurement. As soon as ample rainfall recharged soil moisture deficiences, normal turgidity was restored and negative values were cancelled out.

Basal area growth over three growing seasons (1962 - 1964) was affected by the treatments. Trees within both treatment areas grew significantly more than those on the unthinned area. Trees in the treatment area which included removal of the undergrowth grew slightly more than those in the area in which the undergrowth was left intact. These results were obtained after adjustment for tree size was made. Figure 4 shows the mean increase in basal area per tree over a three year period. The values in the figure are:

Unthinned or normal stocking---------0.0512 ± 0.0093 ft^2

Thinned with brush------------------0.0817 ± 0.0104 ft^2

Thinned, brush removed---------------0.0912 ± 0.0087 ft^2

It becomes evident that under the conditions of this experiment that only a small response was measured in total basal area increment when brush was almost completely eliminated by two foliage sprayings. Either understory sprouts following cutting do not directly compete with the large residuals for soil moisture or possibly their elimination modifies the site through increased solar radiation which in turn depletes soil moisture supplies. The hormone spray itself may to some degree affect growth adversely. These inter-relationships are difficult to isolate since moisture gradients, though frequently critical, are not necessarily the only factors contributing to growth performance.

Plotting basal area increment per tree over diameter breast height for a three year period reveals an interesting relationship. In Figure 5, the curves resulting from the two treatments and the control (unthinned or normal stocking) are quite dissimilar.

Figure 5a superimposes these same three curves in order to relate them to each other. Apparently northern red oaks over eleven inches in diameter do respond, to a limited degree, to a drastic cutback of understory sprout competition. Trees under eleven inches seem to grow more rapidly when normal sprouting is left in place.

CONCLUSIONS

1. Virtual elimination of woody sprouts three growing seasons after a heavy thinning failed to produce an expected stimulation of basal area increment on northern red oak residuals. This would indicate that profuse sprouting either does not compete directly with large dominant trees for moisture and nutrients or that ecological changes in site due to sprout removal or the spray itself negated any gains accruing from the elimination of brush.

2. Comparison of dominant northern red oaks growing under natural or undisturbed conditions with those from the heavily thinned area indicates that the latter are growing at a more rapid rate. Expressed in basal area over a three year period the average tree values appear in Figure 4.

3. Plotting average annual basal area increment per tree over diameter for the three different growth conditions described above reveals an interesting pattern of response. There is an apparent more rapid growth on the part of trees over eleven inches in diameter where brush control was practiced. A reverse effect is noted for trees smaller than eleven inches.

This unusual response should be more thoroughly investigated. If verified by other studies, brush control programs may well be justified in stimulating growth of high value, large diameter trees capable of intensive management.

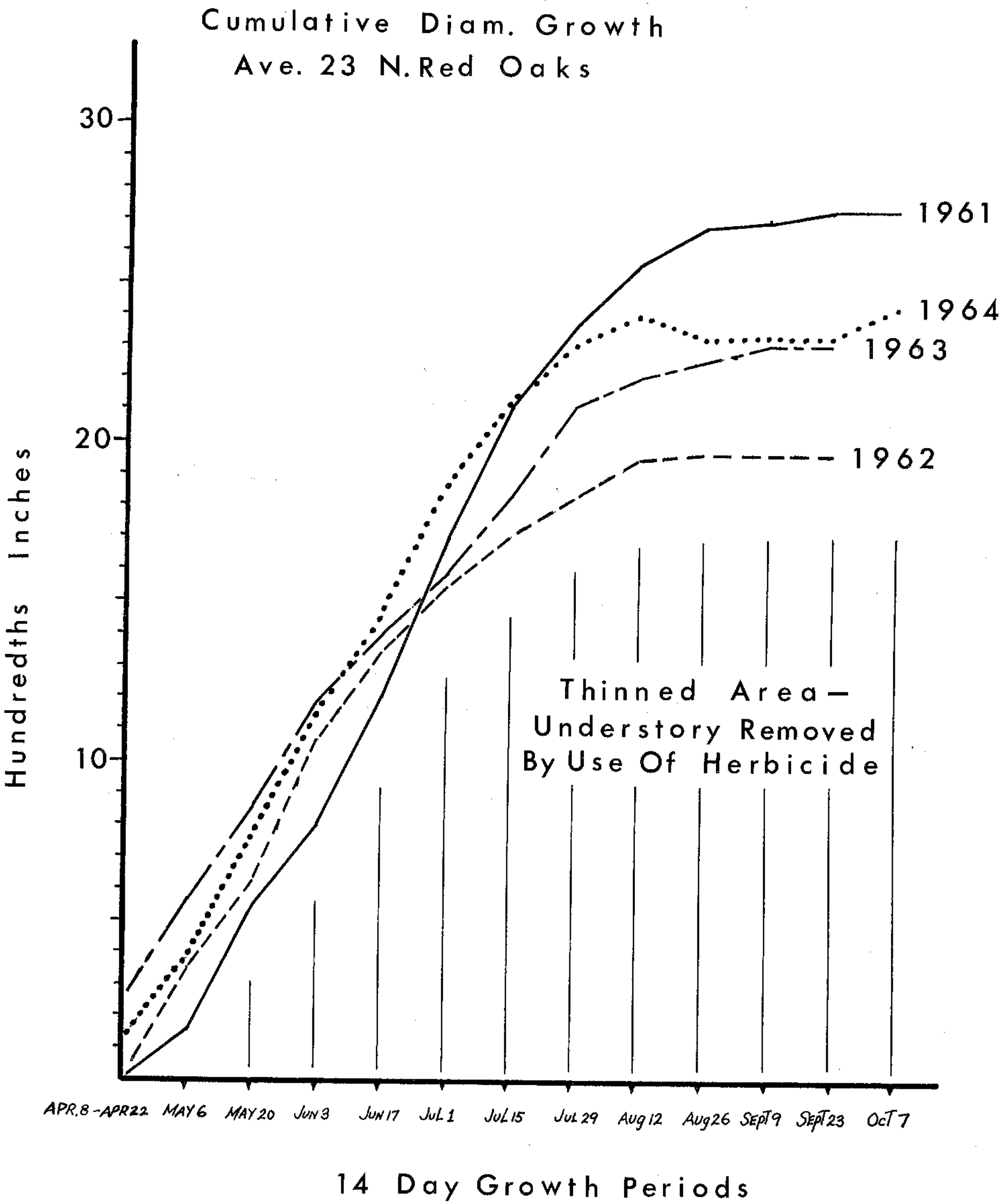

Cumulative Diam. Growth
Ave. 23 N. Red Oaks
30
20
10
Hundredths Inches
1961
1964
1963
1962
Thinned Area—
Understory Removed
By Use Of Herbicide
APR.8-APR22
MAY6
MAY20
JUN3
JUN17
JUL1
JUL15
JUL29
AUG12
AUG26
SEPT9
SEPT23
OCT7
14 Day Growth Periods

Figure 1.

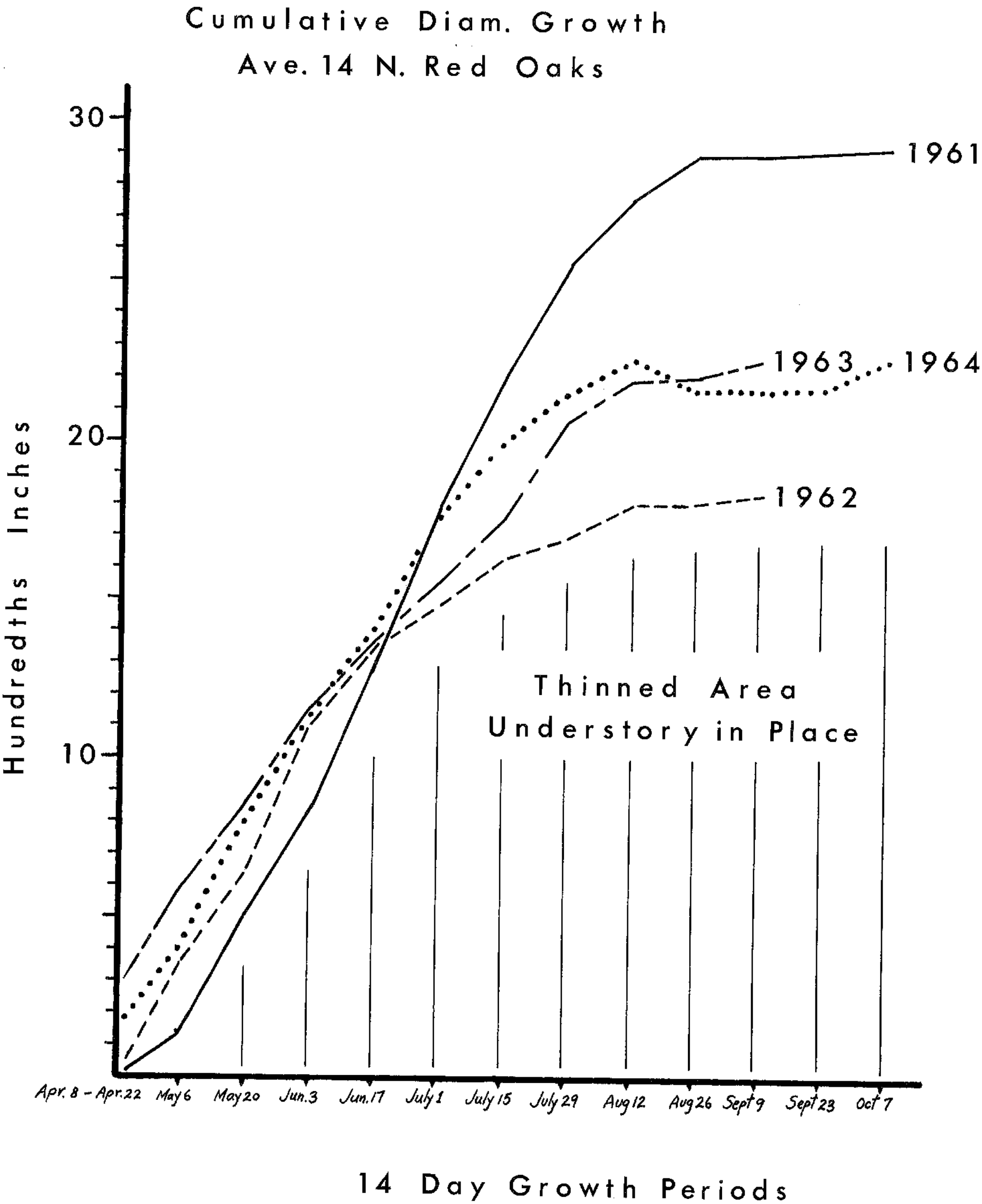

Cumulative Diam. Growth
Ave. 14 N. Red Oaks
30
20
10
Hundredths Inches
1961
1963
1964
1962
Thinned Area
Understory in Place
Apr. 8 - Apr. 22
May 6
May 20
Jun. 3
Jun. 17
July 1
July 15
July 29
Aug 12
Aug 26
Sept 9
Sept 23
Oct 7
14 Day Growth Periods

Figure 2.

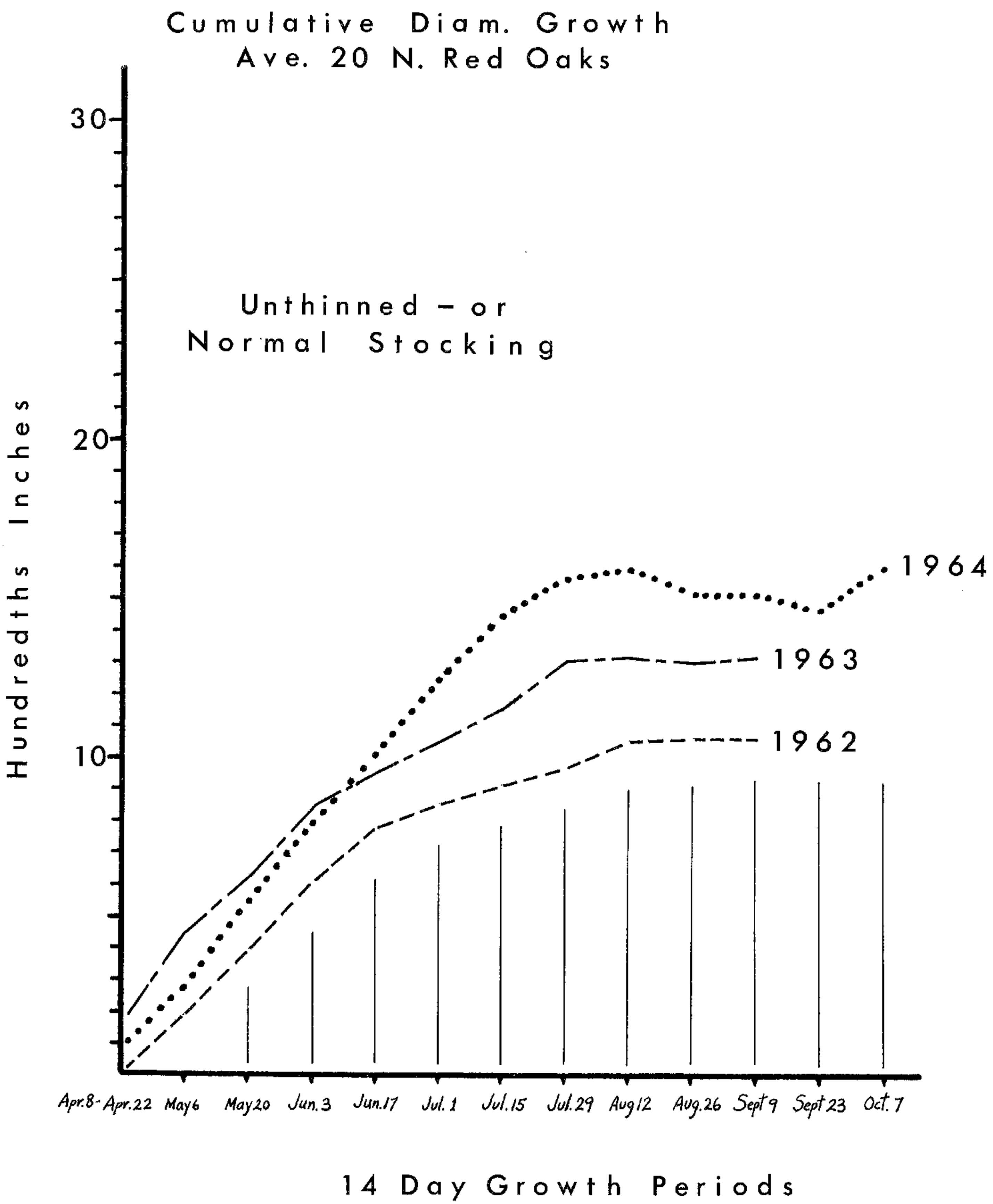

Cumulative Diam. Growth
Ave. 20 N. Red Oaks
Unthinned – or
Normal Stocking
Hundredths Inches
30
20
10
1964
1963
1962
Apr.8- Apr.22
May 6
May 20
Jun. 3
Jun. 17
Jul. 1
Jul. 15
Jul. 29
Aug 12
Aug. 26
Sept 9
Sept 23
Oct. 7
14 Day Growth Periods

Figure 3.

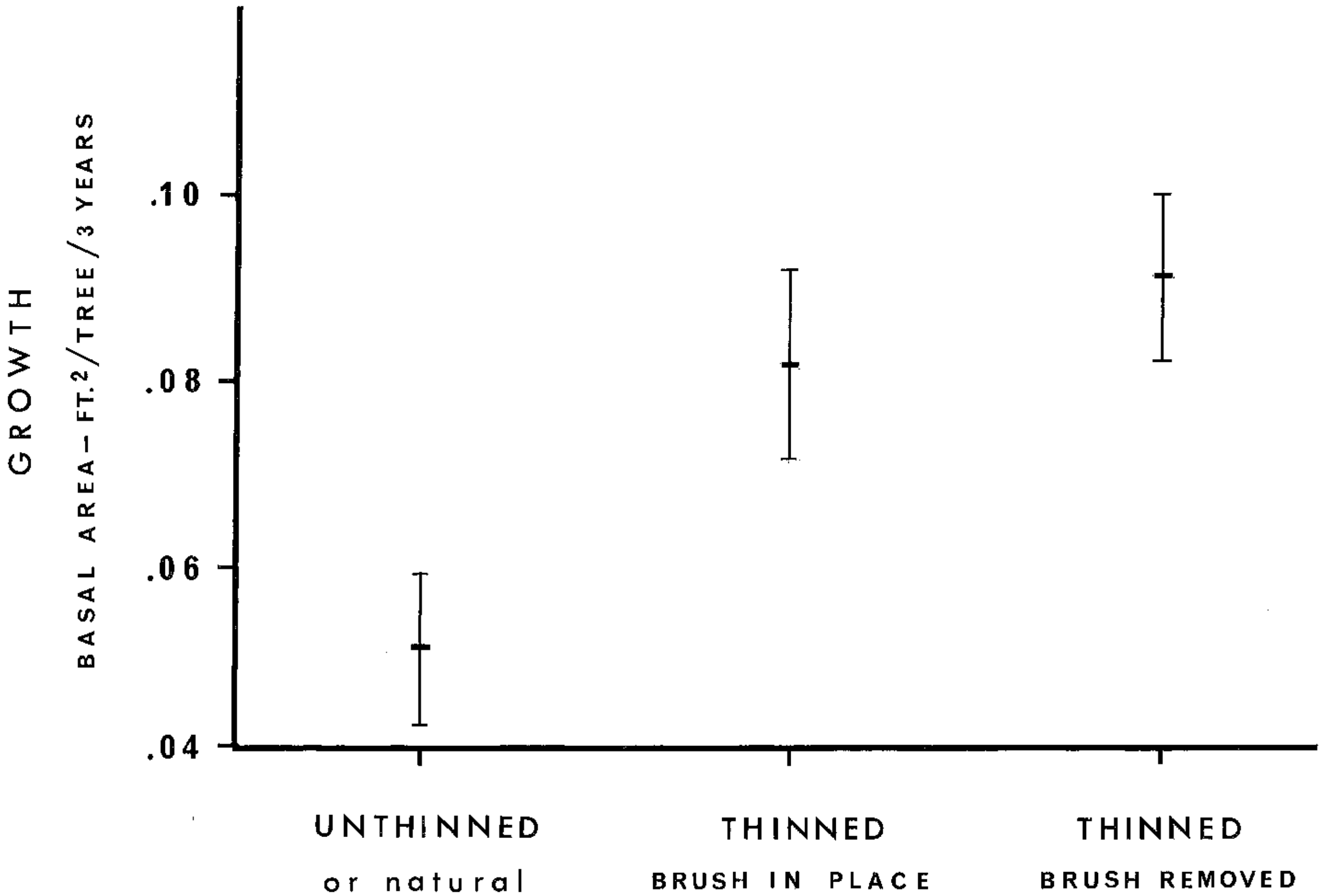


Figure 4. Average basal area increase in square feet by treatment, 1962 - 1964. Confidence limits are calculated thus: $CL = t(.05,55)\frac{s}{\sqrt{n}}$. In normal stocking, n= 20; thinned-brush in place, n=16; thinned-brush removed, n=23.

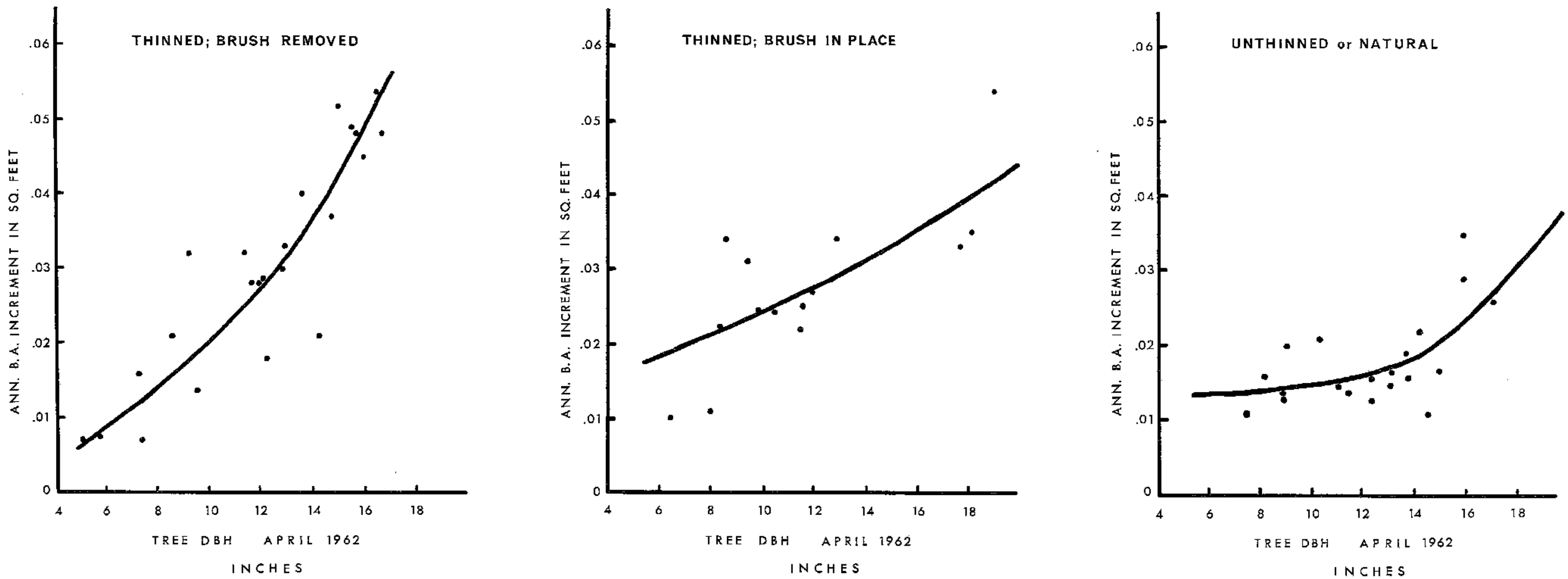


Figure 5. Average annual basal area growth for each tree in each of the two treatments and the control is plotted over diameter measured at breast height. Note the marked difference in the slope of each curve. Initial basal area of thinned plots was 43 square feet; in the unthinned plot it was 100 square feet.

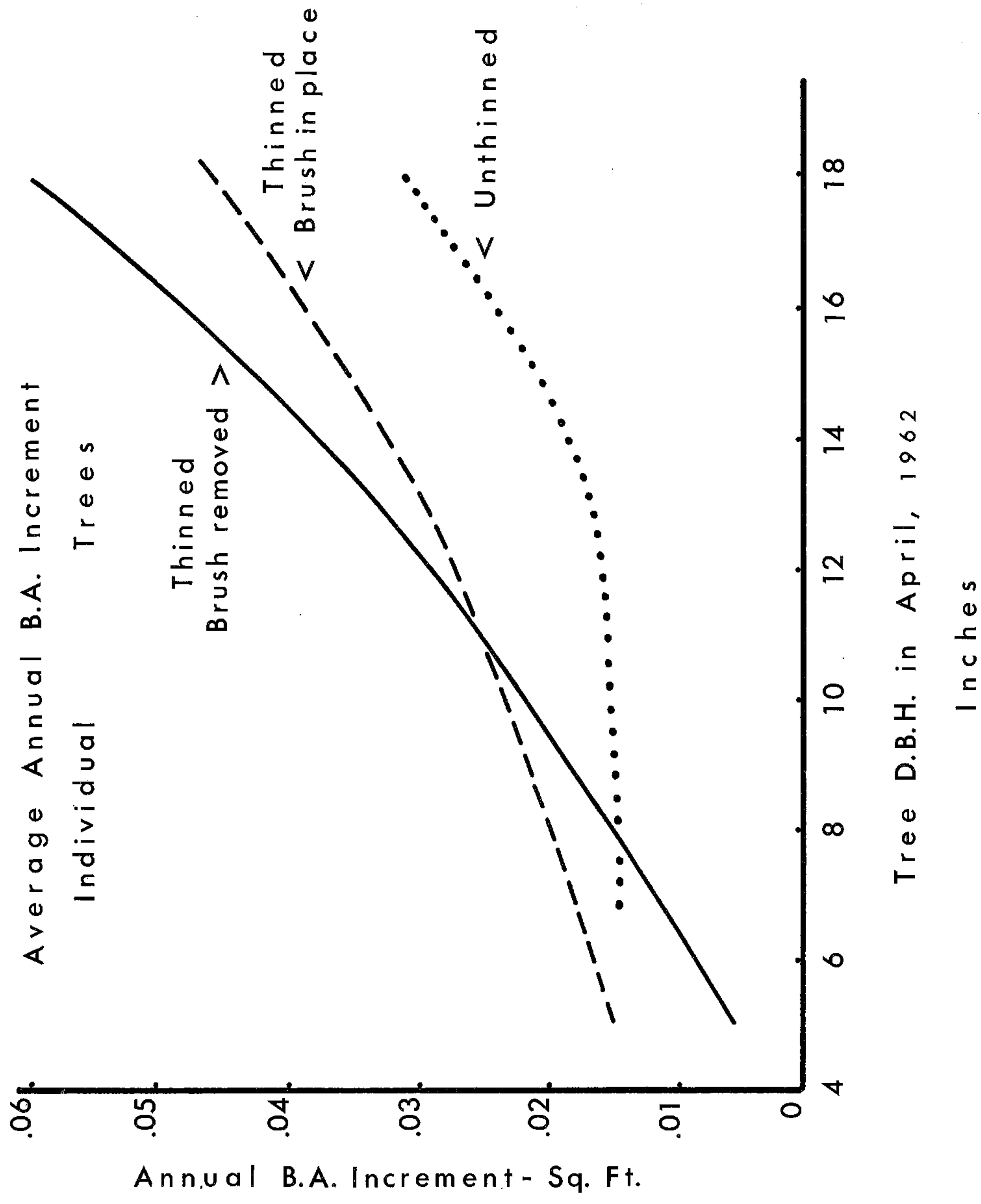
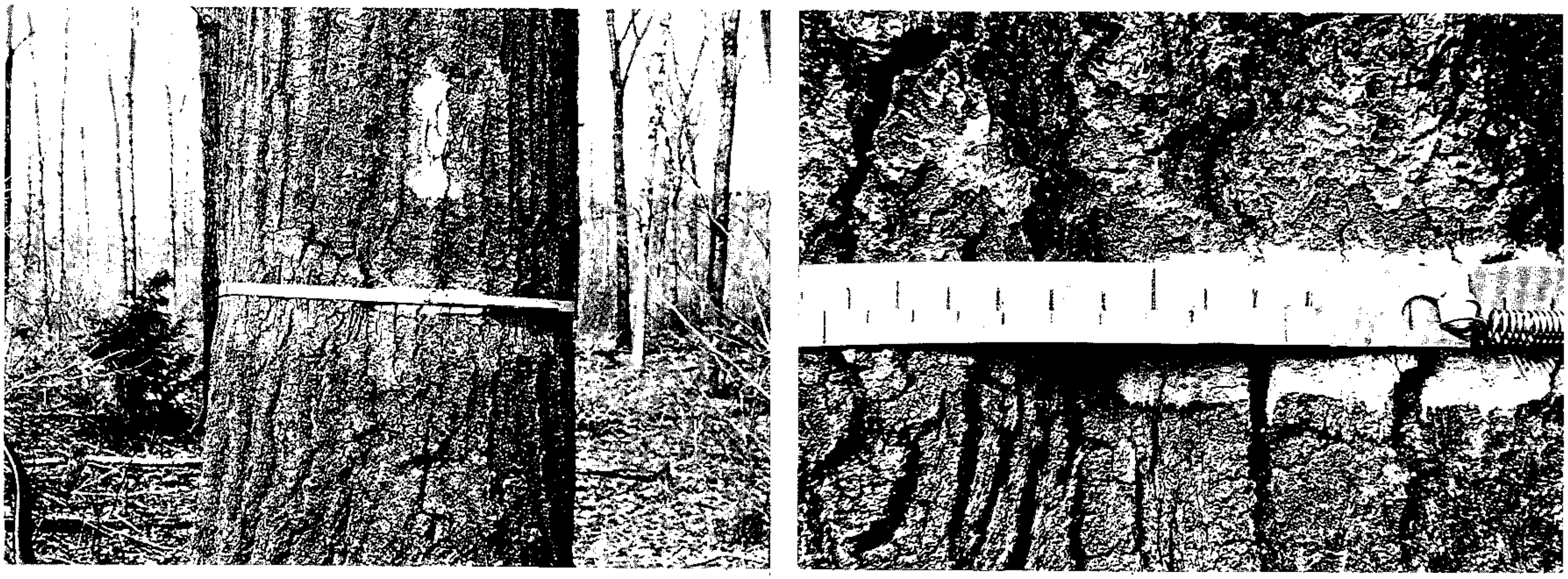

Average Annual B.A. Increment
Individual Trees
Thinned
Brush removed
Thinned
Brush in place
Unthinned
Tree D.B.H. in April, 1962
Inches
Annual B.A. Increment - Sq. Ft.
0
.01
.02
.03
.04
.05
.06
4
6
8
10
12
14
16
18

Figure 5A.



TOP - General view of study area. Right forground shows a portion of thinned forest with brush removed. Left background is thinned with brush in place.

BOTTOM - Dendrometer used in the study attached to a tree at breast height.

LITERATURE CITED

Boggess, W. R., 1953. Diameter growth of shortleaf pine and white oak during a dry season. For. Note Ill. Agric. Exper. Sta. No. 37.

Buchanan, W. D., F. G. Liming and W. Harrison, 1962. Diameter growth patterns of black oak trees. Jour. of For. 60: 352-353.

Denny, C. S., 1938. Glacial geology of the Black Rock Forest. Black Rock Forest Bulletin. No. 8.

Ermich, K., 1959. The seasonal course of diameter growth in P. sylvestris and Q. robur. Acta. Soc. Bot. Polon. 28(1): 15-63.

Friesner, R. C., 1943. Some aspects of tree growth. Proc. Ind. Acad. Sci. 52: 36-44.

Fritts, H. C., 1938. On analysis of radial growth of beech in a central Ohio forest during 1954-1955. Ecology 39(4): 705-720.

Harkin, D. A., 1962. Diameter growth periodicity of several tree species in the S. Carolina coastal plain. For. Sci. 8(4): 363-370.

Kozlowski, T. T., C. H. Winget and J. H. Torrie, 1962. Cambial growth and temperature extremes. For. Res. Note Wisc. Coll. Agric. No. 79.

Larsson, H. C., P. Jaciw, and O. Roos, 1964. The effects of some ecological and silvicultural conditions on seasonal diameter growth as measured with dendrometer tapes. Res. Rep. Ont. Dept. Lds. and For. No. 56.

Liming, F. G., 1957. Homemade dendrometers. Jour. For. Vol. 55(8): 575-577.

McClurkin, D. C., 1958. Soil moisture content and shortleaf pine radial growth in northern Mississippi. For. Sci. 4(3): 232-238.

Winget, C. H. and T. T. Kozlowski, 1963. Seasonal diameter growth patterns of trees in northern Wisconsin. Abstr. in Bull. Ecol. Soc. Amer. 44(3).