

36500

Elliott, K. R.

1954

PDF

A SURVEY OF A CONTINUING SPRUCE BUDWORM
INFESTATION SOUTH OF BLACK STURGEON LAKE. 1954

by

K. R. ELLIOTT

INTERIM REPORT 1954-11
FOREST INSECT LABORATORY
SAULT STE. MARIE, ONTARIO

CANADA
DEPARTMENT OF AGRICULTURE
SCIENCE SERVICE
FOREST BIOLOGY DIVISION

February, 1955

(This report may not be published in whole or in part without the
written consent of the Chief, Forest Biology Division, Science
Service, Department of Agriculture, Ottawa, Canada.)

1. INTRODUCTION

A spruce budworm infestation will usually build up to a peak and then decline steadily until it disappears, leaving dead, dying and weakened host trees in its wake. The Lake Nipigon infestation followed this pattern until its end appeared certain but a remnant south of Black Sturgeon Lake, in the Little Sturge-Disraeli-Sturge lakes area, increased in severity and now appears to be building-up to a secondary peak.

This unusual situation warranted an investigation to determine, if possible, why the remnant infestation had increased in severity when the general infestation had ceased. As the initial step, a growth survey was carried out in 1954. Records were obtained of the effect of the feeding on radial and terminal branch growth from trees that had survived the prolonged defoliation and these were compared with available records of the infestation.

2. HISTORY

The Lake Nipigon infestation was firmly established when it was first reported in detail in 1943 (14), by which time host trees were defoliated to various degrees within an area of some 2500 square miles, west, east and south of Lake Nipigon. The heaviest defoliation was in the Chief Bay area on the western shore of Lake Nipigon, while moderate to heavy defoliation extended southward from Chief Bay to Little Sturge Lake and eastward towards Frazer Lake. Light to moderate defoliation extended westward to Garden Lake and eastward to Geraldton.

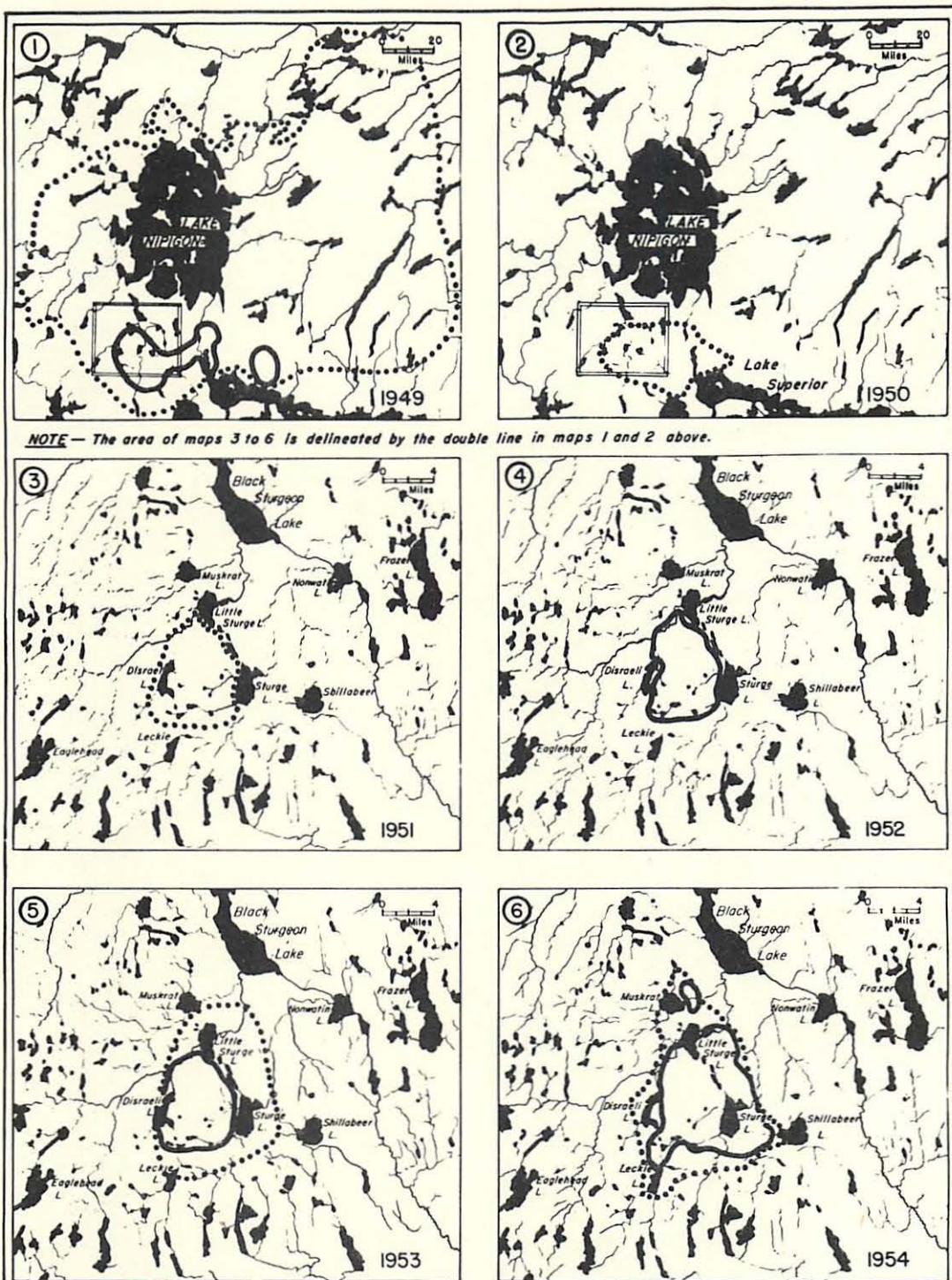
The infestation continued to spread until 1948 when the host trees within an area of some 15,000 square miles, completely surrounding Lake Nipigon and extending southward to Lake Superior, were heavily defoliated and mortality of balsam fir and white spruce was widespread

within areas affected early in the infestation (2). However, less severe defoliation throughout most of the area in 1948 marked the decline of the infestation (10).

By 1951 the infestation appeared to have generally subsided. Only 50 square miles of lightly-infested forest remained south of Black Sturgeon Lake in the Little Sturge-Disraeli-Sturge Lakes area (8) and an area of similar size, east of Pays Plat on the northern shore of Lake Superior, was also lightly infested (5). However, in 1952 these areas were more heavily infested and the budworm populations continued to increase during 1953 and 1954. In 1953, the Pays Plat infestation joined with an apparently separate infestation that had started on Sibley and Black Bay peninsulas about 1944. It should be noted that by 1951 the infestation had been active in the Pays Plat area for only a few years, whereas the area south of Black Sturgeon Lake had been affected for 8 years or more.

Map 1 portrays the decline of the main infestation and the rise of its remnant south of Black Sturgeon Lake (1). Attention is drawn to sub-map 1. The area of light to medium infestation shown for 1949 was heavily infested in 1948 and it was the maximum area affected by the infestation.

The forest cover in the area of infestation south of Black Sturgeon Lake is partly coniferous and partly hardwood (13). The stands east of a line drawn from the southwest corner of Muskrat Lake to the southwest corner of Sturge Lake (map 2) contain mature or over-mature white spruce and balsam fir with scattered poplar and birch. Second growth black spruce and jack pine stands also occur in the vicinity of Muskrat Lake in the north, and in the vicinity of Shilabeer Lake in the souther. In the stands west of the line, poplar and birch predominate over white spruce and balsam fir but there are scattered stands



Map 1. SERIES OF MAPS SHOWING THE DECLINE OF THE LAKE NIPIGON SPRUCE BUDWORM INFESTATION AND THE RISE OF ITS REMNANT SOUTH OF BLACK STURGEON LAKE.

LEGEND

- Boundary of Light to Medium infestation.
- Boundary of Heavy infestation.

where the reverse is true. There are also a few small mature black spruce stands and in the vicinity of Muskrat Lake, second growth black spruce and jack pine predominate. White pine is found scattered throughout the whole area, usually in association with white spruce and balsam fir.

Most of the balsam fir and white spruce in the area suffered heavy defoliation from as early as 1943 to 1948. Defoliation was not as severe from 1949 to 1951 but it was again heavy from 1952 to 1954. Observations made in 1954 revealed host tree mortality of 0 to 90 per cent for balsam fir and 0 to 50 per cent for white spruce in various parts of the area (Table I, Map 2). However, the mortality listed in Table 1 is for areas where some living trees at least remain. In some cases these areas were surrounded by stands where the mortality of balsam fir is 100 per cent and only a few living white spruce remain. Thus, damage to the area as a whole has been heavy.

The Great Lakes Paper Company began cutting operations to the east and north of the area about 10 years ago. By 1954, all the merchantable stands of white spruce, balsam fir, black spruce and jack pine were clear-cut up to the northern, eastern and southern boundaries of the area of infestation shown in Map 1, sub-map 6. In addition, extensive patches were clear-cut around Little Sturge, Disraeli, Sturge and Leckie Lakes. The only undisturbed spruce and balsam stands in the vicinity are to the southwest of the present area of infestation.

Three areas within the southwest border area of the main infestation have been sprayed with DDT (12). One of these, a 62 square mile area around Little Sturge Lake was sprayed in 1945 and it coincides with the present area of infestation (Map 2). In the same year, an area of 38 square miles was sprayed around Circle Lake which is

located about 15 miles north of Little Sturge Lake and immediately west of Black Sturgeon Lake. In both of the areas, DDT was applied at the rate of 1 pound per acre. In 1946 an area of 48 square miles around Eaglehead Lake, which is located about 20 miles southwest of Little Sturge Lake, was sprayed with DDT at the rate of 2 pounds per acre. Defoliation of spruce and balsam was heavy when the Little Sturge and Circle Lake areas were sprayed but aerial and ground checks made in 1947 showed that trees in the area were as heavily defoliated as trees in the surrounding unsprayed areas (7). The Eaglehead area is in the extreme southern border area of the main infestation and at no time was defoliation as heavy nor as prolonged as it was in the other two spray areas (7).

3. METHODS

3.1 Field Methods

Sampling areas where white spruce and balsam fir were the predominate species were selected with the aid of 1952 aerial photographs and a 1940 forest-type map (13). Areas were selected both within and without the 1954 area of infestation to ensure representative sampling (Map 2.).

The following samples were taken in each area. A 12-inch increment borer was used to obtain single cores from living white spruce and balsam fir trees. In some areas, dead and unsound trees limited the number of cores obtained, but usually all the trees within a reasonable radius of the centre of the stand were sampled. Two co-dominant balsam fir trees were felled and six branches were cut, two each from the top, mid and bottom sections of the crown. The branches were selected at random except that they had to be at least 13 years old. The latter was ascertained by counting the inter-nodes. Finally, six

young trees in the advanced growth stage were cut and a disc was taken from each at the one-foot level. For sampling purposes, advanced growth was any young tree larger than a seedling that was 15 to 25 years of age at the one-foot level.

Notes were kept of the forest composition, the per cent mortality due to budworm feeding, and of the per cent defoliation of the current year's growth. The forest composition and the tree mortality were estimated by a stem-count made in a central portion of the stand within a circle having a 2-chain radius. The degree of defoliation was estimated with the aid of binoculars and supplemented by a close inspection of the trees felled for branch samples. A summary of the above is included in Table 1.

The above field work was carried out after feeding by the spruce budworm had ceased for the 1954 season. The area of infestation was observed from the air and the degree of defoliation mapped when the so-called "red condition" caused by the colouration of dead needles was most apparent.

3.2 Laboratory Methods

Annual ring width in increment cores and discs was measured in arbitrary units by means of a scale mounted in a stereoscopic binocular microscope. The length of the terminal growth of the branches was measured from node to node to the nearest one-quarter inch. To ensure that the length of the inter-node was attributed to the corresponding year, the annual rings in each inter-node were counted. In both cases the measurements were recorded for the years 1942 to 1954. Averages were computed and are listed in Tables 2 and 5.

Graphs were prepared to show the average annual ring width of balsam fir and white spruce trees and of balsam fir advanced growth for each sampling area for the years 1942 to 1954 (Figs. 1 to 4), and of the annual ring width of individual balsam fir trees compared with

the length of the branch terminal growth (Figs. 5 and 6). To serve as illustration, only twenty comparisons were prepared from a total number of 60.

From the suppression patterns shown in the graphs and in the corresponding data, the annual rings indicating the first year of suppression, the most suppressed year and the peak after suppression, were determined for each area and are listed in Table 3. The "first year of suppression" was chosen as that year which showed a decline in ring width followed by rings of proportionately declining width. The "most suppressed ring" and the "peak after suppression" were the smallest and largest rings of the suppression pattern respectively. In either case, if there was more than one ring of the same width, the one formed earliest was chosen.

4. RESULTS

Sampling was carried out in 35 areas as shown on Map 2. These areas were in typical spruce-balsam stands as indicated in the "per cent composition" column in Table 1. The recent mortality and current defoliation of balsam fir and white spruce are also shown in Table 1, and for convenience the mortality and defoliation of balsam fir is indicated beside each sampling area on Map 2.

Table 1 and Map 2 show that the current defoliation of balsam and spruce followed a regular pattern with the heaviest in the centre and the lightest in the periphery of the area of infestation. The original infestation advanced from north to south so that an increase in mortality from south to north would be a normal assumption. The assumption is valid and in the southwest where the mortality increased from 0 to 90 per cent for balsam fir and 0 to 20 per cent for white spruce between Eaglehead Lake and the Spruce River. However, the

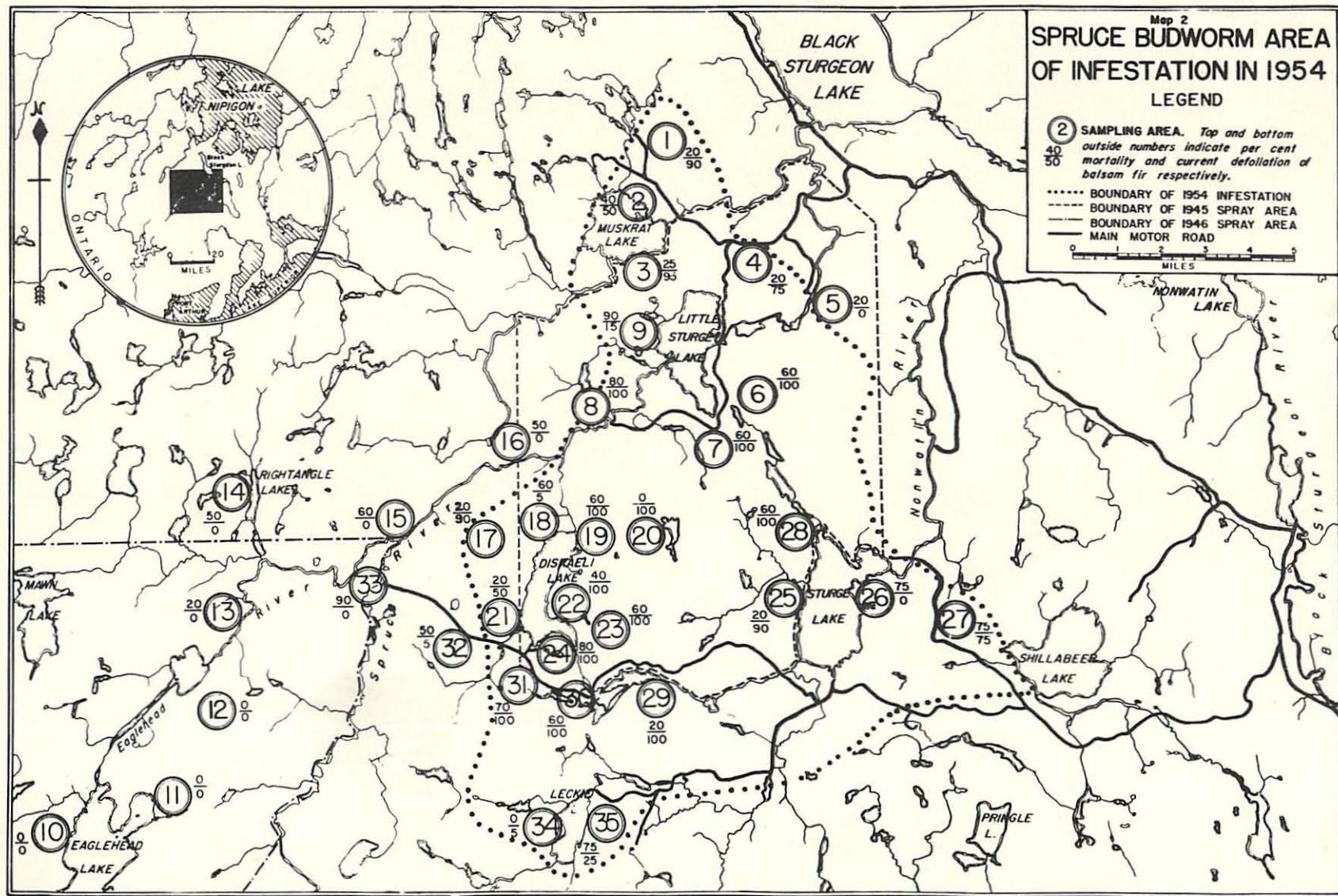


TABLE 4

ESTIMATES OF THE FOREST COMPOSITION AND DAMAGE IN THE SPRUCE
BUDWORM INFESTATION AREA SOUTH OF BLACK STURGEON LAKE - 1954

Sample Area No.	Per Cent Composition (Advanced Growth Included)								% Recent Mortality		% Current Defoliation	
	bF	wS	bS	jP	wP	eC	Po	wB	bF	wS	bF	wS
1	40	5	30	0	0	0	0	25	20	0	90	75
2	60	10	20	0	0	0	5	5	40	0	50	50
3	50	5	30	0	0	0	10	5	25	0	95	75
4	60	10	10	5	0	0	10	5	20	0	75	75
5	60	5	20	5	0	0	5	5	20	0	0	0
6	50	10	5	0	0	5	10	20	60	20	100	100
7	60	15	5	0	0	0	5	10	60	0	100	100
8	60	25	0	0	0	5	0	10	80	10	100	100
9	40	20	10	5	0	5	10	10	90	10	15	25
10	75	5	5	0	0	5	0	10	0	0	0	0
11	80	10	0	0	0	5	0	5	0	0	0	0
12	80	10	5	0	0	0	0	5	0	0	0	0
13	80	10	0	0	0	5	0	5	20	0	0	0
14	60	20	-	10	0	0	0	0	50	5	0	0
15	60	5	5	10	0	0	10	10	60	10	0	0
16	70	15	5	0	0	0	5	5	50	20	0	0
17	60	10	0	0	0	0	20	10	20	0	90	100
18	60	25	0	0	0	0	10	5	60	5	5	5
19	60	15	5	5	0	0	10	5	60	0	100	100
20	70	20	0	0	0	0	5	5	0	0	100	100
21	60	10	5	0	0	0	20	5	20	0	50	75
22	70	10	5	0	0	0	10	5	40	0	100	100
23	60	20	0	0	5	0	5	10	60	0	100	100
24	60	10	5	0	5	5	0	10	80	0	100	100
25	60	20	0	0	0	0	5	15	20	0	90	90
26	60	20	5	0	0	0	5	10	75	10	0	0
27	60	20	5	0	0	0	5	10	75	10	75	75
28	60	20	10	0	0	0	5	5	60	50	100	100
29	60	15	5	0	0	10	5	5	20	0	100	100
30	65	20	0	0	0	0	5	10	60	5	100	100
31	60	25	0	0	0	0	5	10	70	20	100	100
32	65	20	0	0	0	0	5	10	50	30	5	5
33	65	15	0	0	0	0	0	10	90	20	0	0
34	60	20	0	0	0	0	5	10	0	0	5	5
35	60	10	5	9	9	10	5	10	75	20	25	25

Key To Abbreviations:-

bF - Balsam Fir
wS - White Spruce

bS - Black Spruce
jP - Jack Pine

wP - White Pine
eC - Cedar

Po - Poplar
wB - White Birch

assumption is not valid within the present area of infestation because the mortality is highly variable from south to north.

Table 2 lists the average annual ring width of balsam fir and white spruce trees and of balsam fir advanced growth in each sampling area for the years 1942 to 1954 and Figs. 1 to 4 are a graphic presentation of Table 2. The averages were computed from the data listed in Appendix I.

Figs. 1 to 4 show clearly that the radial growth of balsam fir and of white spruce was progressively suppressed to a low point and then progressively recovered to a peak after the suppression. This corresponds to the period of heavy budworm feeding, followed by the period of light feeding described in the history of the infestation (Sec. 2). The recurrence of heavy feeding in recent years is not wholly reflected in the radial growth patterns.

The degree of suppression as shown in Figs. 1 to 4 varies from area to area and in most cases is related to the degree of mortality for the areas as listed in Table I. For example, the patterns for areas 10 to 13 show a mild suppression and the per cent mortality for balsam and spruce is 0; the patterns for area 8 show greater suppression than those for area 7 and the per cent mortality of balsam and spruce is 80 and 60, and 10 and 0, respectively.

An inspection of Figs. 1 to 4 reveals that in most cases the patterns for advanced growth did not indicate the suppression as clearly as did the patterns for the trees. For this reason they are not referred to in the following.

Table 3 lists the years in which the first suppressed ring, the most suppressed ring and the peak after suppression appeared for the average pattern and for the individual patterns. Examination of the table shows that each of these rings appeared within the space of a few years throughout the study area. For example, the first year

TABLE 21

AVERAGE ANNUAL RING WIDTH OF BALSAM FIR (bF) AND WHITE SPRUCE (sW)
TREES AND OF BALSAM FIR ADVANCED GROWTH (A.G.) IN THE SPRUCE BUDWORM
INFESTATION AREA SOUTH OF BLACK STURGEON LAKE

(ARBITRARY UNIT = 0.064 mm.)

Area No.	Species	No	Average Annual Ring Width In Arbitrary Units For:-												
			1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
1	bF	6	33.0	29.5	22.5	19.2	16.8	7.3	3.2	4.5	9.0	12.2	17.3	19.2	13.5
	wS	4	13.0	11.3	19.3	10.5	9.5	5.5	2.3	5.0	5.8	8.0	11.0	10.0	6.3
2	bF	5	47.4	46.4	38.8	37.0	30.2	20.4	12.6	8.4	7.4	8.4	12.2	15.0	11.4
	wS	3	14.7	13.7	14.7	15.0	13.7	9.0	4.7	4.3	6.3	9.3	11.0	12.7	9.0
	A.G.	3	18.7	18.0	19.3	19.3	14.7	8.0	8.7	8.3	12.0	9.7	20.0	16.0	15.7
3	bF	16	33.2	34.7	32.9	28.9	25.0	17.8	13.1	9.5	8.1	8.8	12.8	14.4	17.4
	sW	17	42.6	37.7	46.5	42.2	36.9	20.9	16.6	16.9	25.2	36.9	48.1	46.8	40.2
	A.G.	6	8.7	9.3	9.0	11.7	9.5	5.5	7.3	9.5	10.0	11.5	17.8	15.3	21.8
4	bF	20	56.0	52.0	46.6	48.7	42.3	31.5	22.6	20.8	26.0	24.9	32.6	37.7	37.5
	wS	7	44.6	34.3	44.3	51.7	39.4	27.7	17.7	18.0	22.6	30.0	32.0	34.3	28.9
	A.G.	6	10.0	11.3	12.0	15.7	17.2	14.8	15.3	21.5	24.3	22.0	28.3	25.8	26.7
5	bF	21	53.3	47.6	40.5	39.7	30.2	23.1	15.0	9.4	10.5	13.7	19.4	23.8	24.2
	wS	4	43.0	37.0	34.0	32.5	30.0	22.0	15.5	12.5	16.0	24.5	29.0	28.5	28.0
	A.G.	6	11.7	15.0	11.0	9.8	7.8	7.0	5.0	5.2	5.8	10.5	14.0	10.0	4.8
6	bF	19	29.1	28.1	25.8	24.1	18.7	10.2	7.4	5.8	6.3	7.4	10.1	10.1	8.0
	wS	10	37.0	31.3	31.2	38.4	30.5	17.1	10.5	9.6	10.9	19.0	20.4	15.7	14.2
	A.G.	6	11.7	15.0	11.0	9.8	7.8	7.0	5.0	5.2	5.8	10.5	14.0	10.0	4.8
7	bF	20	57.8	51.5	45.5	45.5	39.5	25.5	15.7	13.1	13.8	20.0	31.4	34.9	25.7
	wS	13	50.6	40.0	40.2	38.6	39.1	22.9	15.5	18.8	23.5	32.8	41.8	42.8	33.2
	A.G.	6	14.2	18.0	13.2	16.3	16.0	14.8	11.5	7.0	7.8	8.0	12.8	12.5	13.0
8	bF	22	34.5	32.5	28.2	22.4	20.2	13.6	8.3	5.5	5.1	6.6	9.5	13.1	14.1
	wS	9	40.0	30.9	27.1	19.6	17.6	11.6	7.6	6.0	7.3	16.9	23.8	26.4	23.1
	A.G.	6	8.2	9.5	8.8	7.2	6.5	6.3	3.2	1.7	3.0	6.8	9.2	9.0	11.5
9	bF	11	22.6	22.2	22.2	19.7	16.8	11.1	6.4	3.8	6.4	8.2	13.5	16.0	19.5
	wS	19	21.4	18.1	17.2	14.9	14.5	9.7	4.8	2.9	3.4	6.9	10.7	11.6	12.0
	A.G.	6	12.2	11.8	12.5	13.8	12.8	6.0	4.5	5.5	8.7	11.8	16.5	15.8	15.7
10	bF	7	25.7	26.3	22.9	27.9	31.3	28.1	24.3	20.6	18.3	18.3	21.6	23.0	17.7
	wS	3	17.7	15.7	15.7	18.0	22.3	16.3	13.3	9.0	11.0	14.3	15.7	15.0	11.7
11	bF	8	25.5	25.5	23.1	27.5	33.4	28.3	23.8	17.6	16.9	19.5	21.4	21.6	18.6
	wS	7	15.1	14.3	23.4	15.7	17.6	16.4	13.4	9.6	11.4	12.4	17.1	16.9	12.3
12	bF	7	19.9	18.0	12.9	15.9	17.3	14.9	11.9	9.7	9.4	15.1	16.3	18.3	13.6
	wS	8	26.6	21.8	20.1	25.9	20.5	15.8	16.4	12.0	16.8	27.1	30.3	28.9	18.6
13	bF	6	14.8	15.3	13.3	12.2	11.8	9.3	9.2	6.3	4.8	8.2	10.7	11.7	10.5
	wS	9	18.8	14.4	15.3	18.4	17.0	8.3	9.9	7.4	9.8	15.3	19.2	18.4	13.6

TABLE II (Continued)

Area No.	Species	No	Average Annual Ring Width in Arbitrary Units For:-												
			1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
14	bF wS	7 4	27.7 36.5	28.4 36.3	24.9 34.5	25.9 30.8	25.3 27.0	18.7 17.0	10.6 9.5	4.3 4.5	4.4 6.5	9.4 14.8	18.9 20.5	25.0 24.3	21.9 16.3
15	bF wS	8 5	37.4 38.8	34.4 36.8	29.1 42.6	30.1 43.4	26.0 36.6	18.4 22.6	11.8 13.2	8.5 11.6	12.3 16.8	18.3 28.0	26.8 35.8	28.6 40.2	21.8 26.6
16	bF wS	3 3	59.7 21.0	57.3 18.0	48.0 20.7	42.7 14.3	36.0 13.7	26.0 8.3	16.7 2.7	13.0 1.0	23.0 5.3	36.0 8.7	52.7 15.3	48.7 18.3	44.3 17.0
17	bF wS A.G.	17 5 6	27.5 25.0 13.5	28.2 25.4 13.3	27.9 23.8 16.5	29.6 22.0 19.0	26.5 21.2 14.8	19.4 19.4 7.2	10.6 10.8 6.5	5.8 5.0 6.8	4.7 2.8 11.7	8.7 10.8 14.8	14.5 17.2 27.2	18.2 20.8 31.8	17.1 16.6 27.2
18	bF wS A.G.	16 8 6	28.5 20.4 20.8	31.5 18.6 18.0	32.4 21.9 20.2	33.7 20.5 20.8	18.4 19.1 16.8	17.9 11.6 12.7	9.5 6.1 12.0	5.1 4.8 12.7	3.4 5.3 14.3	8.3 11.5 13.3	18.2 16.5 30.2	21.6 17.3 30.3	22.0 17.6 32.7
19	bF wS A.G.	20 4 6	38.3 50.3 10.8	39.2 46.3 11.3	35.0 43.5 13.8	34.2 42.8 17.5	30.3 39.8 10.8	20.8 22.5 4.0	13.0 16.8 3.7	7.7 12.0 5.7	5.0 11.8 9.5	7.9 23.3 14.3	14.1 30.3 19.2	15.6 32.5 18.0	16.4 24.0 20.5
20	bF wS A.G.	21 9 6	41.8 46.6 15.2	38.9 33.7 10.3	33.2 35.3 12.2	35.2 32.6 14.7	28.6 28.4 14.8	21.9 15.2 10.3	14.9 9.0 14.2	11.5 6.7 15.2	9.8 9.7 17.2	12.5 18.6 16.5	17.0 26.9 26.8	18.0 25.4 27.2	13.1 15.0 16.8
21	bF wS	12 1	30.3 32.0	34.9 35.0	36.9 27.0	38.9 33.0	33.8 15.0	23.3 9.0	13.4 2.0	8.3 6.0	6.5 10.0	11.2 35.0	21.8 45.0	24.0 50.0	21.7 30.0
22	bF wS	10 2	32.0 29.5	30.1 25.5	26.4 24.5	29.3 32.5	29.2 28.0	19.6 16.0	12.3 9.0	8.7 9.0	9.6 12.5	10.1 17.0	14.2 24.0	14.5 22.5	15.6 21.5
23	bF wS	14 8	39.5 29.1	35.8 25.3	34.4 28.3	36.0 27.5	29.2 20.0	18.6 10.4	10.6 5.8	6.9 3.8	4.9 7.1	7.4 14.0	12.1 20.5	11.0 16.0	7.4 10.3
24	bF wS	13 10	21.0 20.3	18.4 20.7	15.9 24.4	16.7 23.2	15.9 21.8	11.5 12.5	7.6 9.6	6.6 8.1	6.0 8.4	7.7 12.7	10.2 19.4	19.5 19.8	9.8 12.9
25	bF wS A.G.	16 10 6	48.4 42.1 20.3	43.4 37.9 20.2	42.8 32.6 19.7	44.3 39.8 23.3	36.4 37.4 19.7	28.6 21.8 13.7	19.3 15.8 11.2	14.7 17.0 14.7	12.3 22.8 15.0	11.1 32.3 13.0	18.6 37.6 18.7	19.1 39.2 14.3	16.8 25.2 13.0
26	bF wS A.G.	23 12 6	39.9 27.3 11.0	33.5 22.2 11.3	31.2 21.5 13.0	33.8 25.2 16.8	33.7 21.0 15.8	24.8 16.3 10.0	17.1 10.9 11.8	12.5 10.3 13.2	9.3 9.3 18.5	9.2 14.3 17.7	16.3 20.4 23.2	20.0 21.3 26.8	19.9 17.3 29.5
27	bF wS A.G.	24 10 6	44.5 29.5 11.2	42.2 26.2 10.2	28.2 26.9 11.5	38.8 32.7 13.0	32.6 26.4 11.3	19.3 17.1 11.2	10.8 14.5 11.2	7.3 14.3 10.2	6.0 14.3 16.5	9.1 23.0 18.0	16.4 24.5 21.0	18.1 22.2 20.7	17.0 17.2 21.0
28	bF wS A.G.	17 13 6	24.5 25.7 14.5	23.9 21.8 17.3	21.4 21.5 14.5	19.8 16.8 15.0	15.6 9.3 13.5	10.1 6.0 6.0	6.7 5.4 5.8	4.5 4.0 8.2	4.4 4.3 10.8	5.9 8.1 12.7	8.6 8.1 21.0	9.9 13.2 20.8	10.1 13.8 19.3

TABLE II (Concluded)

Area No.	Spe-cies	No	Average Annual Ring Width in Artibrary Units For:-												
			1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
29	bF	17	30.2	28.3	23.1	26.1	21.9	16.3	10.8	8.6	7.1	8.8	13.2	14.1	9.6
	wS	11	28.5	22.5	22.6	23.2	19.2	12.7	7.8	5.8	5.8	11.4	15.4	15.3	9.6
	A.G.	6	7.3	8.5	11.5	16.7	13.5	8.2	3.5	4.3	7.3	5.0	11.3	11.3	10.7
30	bF	17	34.9	33.4	30.8	34.1	30.0	20.4	12.4	9.6	7.6	9.5	12.5	10.8	6.2
	wS	8	45.9	36.5	46.1	43.6	39.3	17.3	15.0	10.1	13.4	21.8	28.1	25.4	18.4
	A.G.	6	16.2	12.3	12.3	15.8	12.0	7.7	7.0	4.2	2.5	7.2	12.2	15.5	10.5
31	bF	18	31.6	32.4	50.9	28.8	22.3	15.5	9.4	4.6	3.8	6.7	10.7	11.3	8.9
	wS	12	32.6	28.9	30.2	23.7	21.1	13.8	8.7	4.0	4.2	9.5	17.5	16.6	12.6
	A.G.	6	16.0	20.2	17.2	20.5	16.0	11.0	8.3	5.7	10.0	14.5	13.0	15.8	8.7
32	bF	17	31.3	31.5	25.6	27.9	23.6	17.1	9.6	5.3	2.8	6.4	11.1	18.2	18.2
	wS	8	21.9	19.6	18.6	16.5	14.3	7.1	3.1	1.5	2.6	8.4	12.9	14.5	11.8
	A.G.	6	9.7	14.7	10.7	13.0	10.7	6.5	7.8	4.3	3.0	6.8	13.3	12.3	10.3
33	bF	12	25.6	26.1	23.2	21.9	19.3	11.6	9.9	5.8	4.5	7.8	11.5	11.7	12.5
	wS	14	35.4	27.7	29.0	26.4	23.3	13.6	11.2	5.7	8.4	21.2	28.5	31.5	26.9
	A.G.	6	8.2	8.8	8.2	12.2	7.5	5.7	6.3	4.0	6.8	12.7	16.5	20.8	23.2
34	bF	18	20.6	19.8	17.7	18.3	16.8	12.3	6.9	3.3	3.2	5.9	9.1	9.7	9.7
	wS	11	21.2	18.1	15.8	16.8	14.9	9.5	5.6	4.3	6.9	10.5	14.9	16.8	14.6
	A.G.	6	9.5	10.5	10.2	12.8	11.3	5.7	2.3	2.7	2.3	5.7	7.2	7.2	6.0
35	bF	12	23.3	23.6	19.3	20.7	20.2	13.4	9.0	7.3	7.7	8.6	13.0	13.8	12.8
	wS	9	22.0	20.2	19.1	23.0	20.6	12.7	7.1	4.8	7.6	13.3	17.8	19.8	16.2
	A.G.	6	17.5	21.0	19.5	19.8	15.0	7.0	8.2	10.7	15.3	15.3	21.5	16.8	16.3

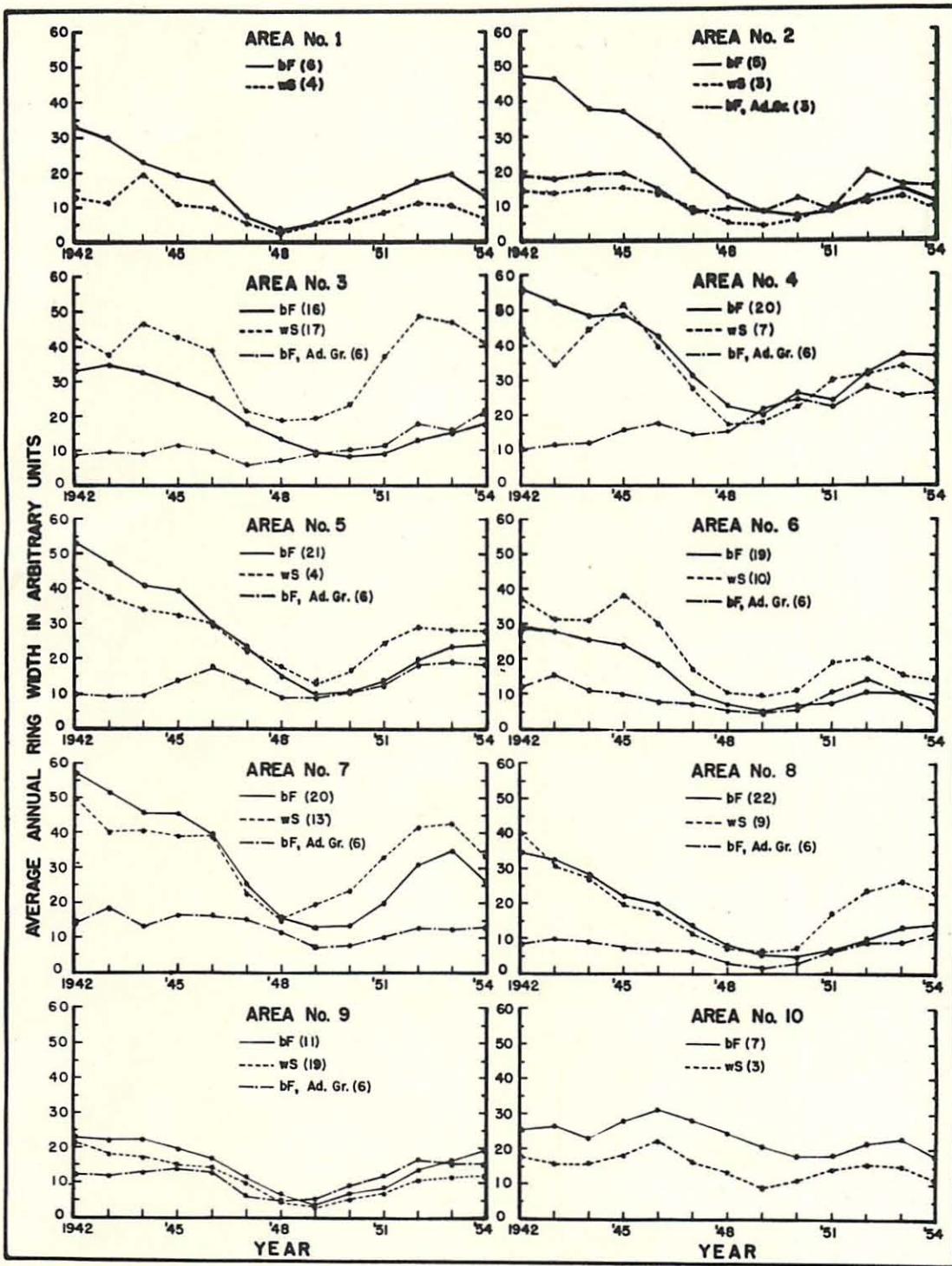


Figure 1. AVERAGE ANNUAL RING GROWTH OF BALSAM FIR AND WHITE SPRUCE TREES AND OF BALSAM FIR ADVANCED GROWTH IN THE SPRUCE BUDWORM INFESTATION AREA SOUTH OF BLACK STURGEON LAKE.

NOTE: The averages were calculated from the number of samples shown in brackets for each sampling area. 1 ARBITRARY UNIT = 0.064 mm.

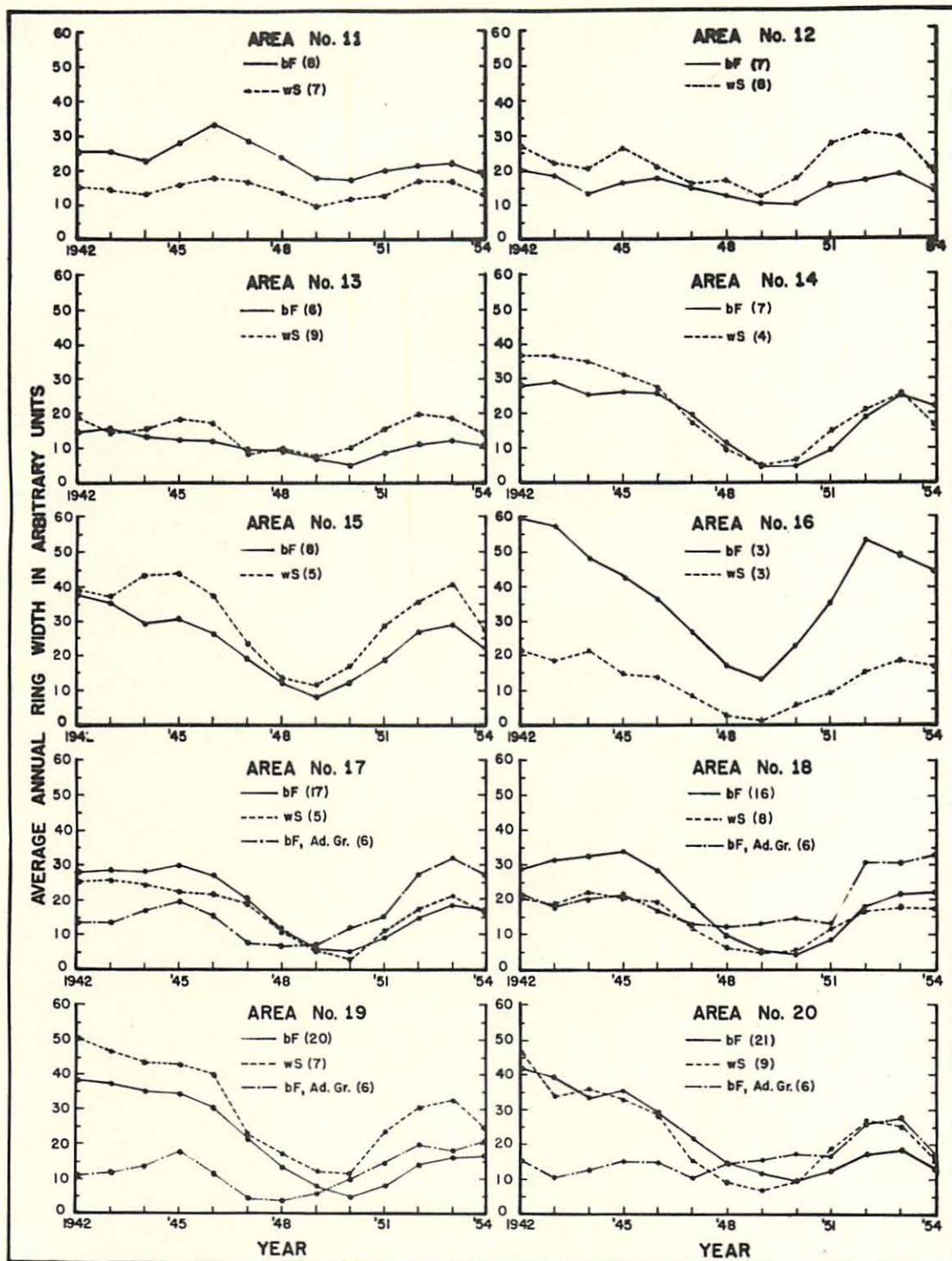


FIGURE 2. AVERAGE ANNUAL RING GROWTH OF BALSAM FIR AND WHITE SPRUCE TREES AND OF BALSAM FIR ADVANCED GROWTH IN THE SPRUCE BUDWORM INFESTATION AREA SOUTH OF BLACK STURGEON LAKE.

NOTE: The averages were calculated from the number of samples shown in brackets for each sampling area. 1 ARBITRARY UNIT = 0.064 mm.

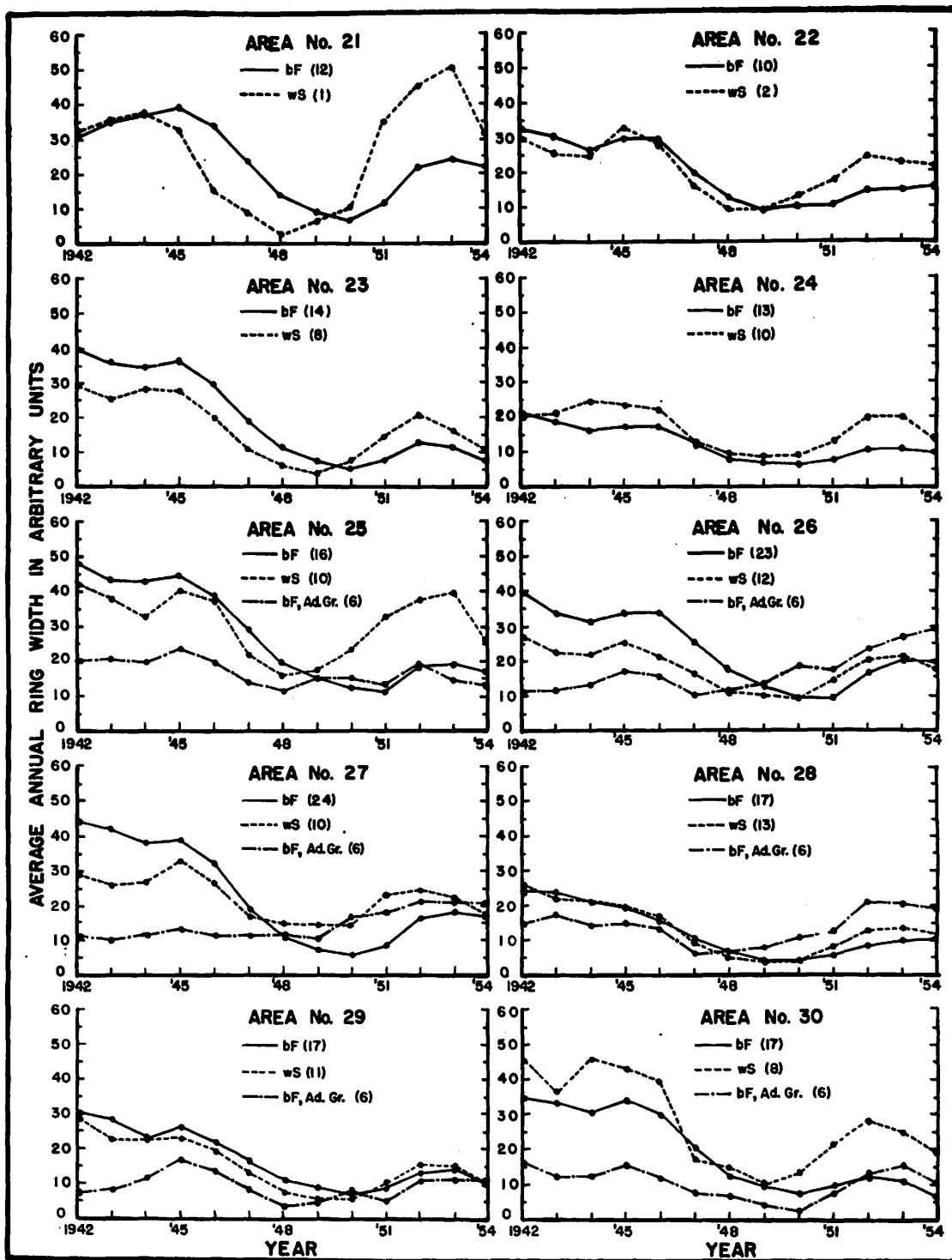


FIGURE 3. AVERAGE ANNUAL RING GROWTH OF BALSAM FIR AND WHITE SPRUCE TREES AND OF BALSAM FIR ADVANCED GROWTH IN THE SPRUCE BUDWORM INFESTATION AREA SOUTH OF BLACK STURGEON LAKE.

NOTE: *The averages were calculated from the number of samples shown in brackets for each sampling area.* / ARBITRARY UNIT = 0.064 mm.

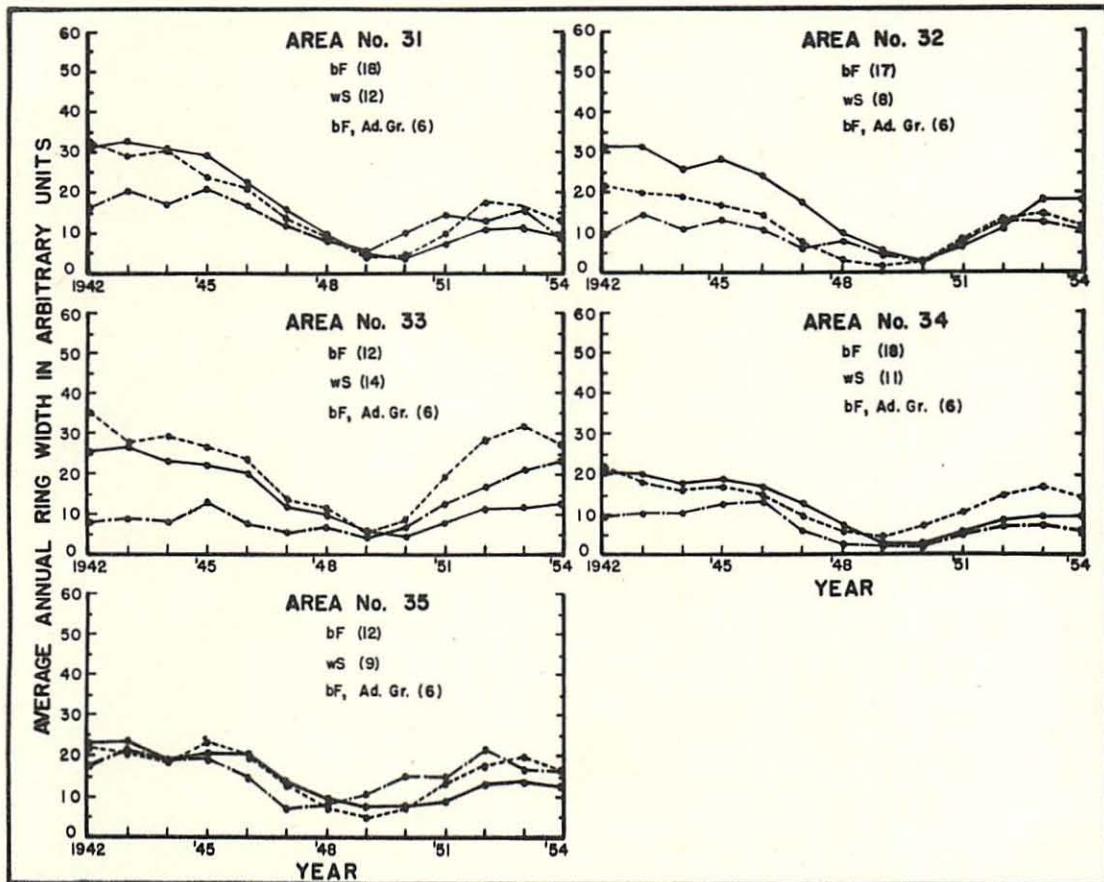


FIGURE 4. AVERAGE ANNUAL RING GROWTH OF BALSAM FIR AND WHITE SPRUCE TREES AND OF BALSAM FIR ADVANCED GROWTH IN THE SPRUCE BUDWORM INFESTATION AREA SOUTH OF BLACK STURGEON LAKE.

NOTE: *The averages were calculated from the number of samples shown in brackets for each sampling area.* 1 ARBITRARY UNIT = 0.064 mm.

TABLE III

SUMMARY OF ANNUAL RING SUPPRESSION PATTERNS RESULTING FROM SPRUCE BUDWORM FEEDING ON BALSAM FIR (bF) AND WHITE SPRUCE (wS) TREES AND ON BALSAM FIR ADVANCED GROWTH (A.G.) IN THE SPRUCE BUDWORM INFESTATION AREA SOUTH OF BLACK STURGEON LAKE.

Area No.	Species	Average Pattern						Individual Patterns										Number with Peak After Supp.							
		To-tal No.	First Supp. Ring	Most Supp. Ring	Peak After Supp.	Number with First Suppressed Ring in 19--					Number with Most Suppressed Ring in 19--														
						44	45	46	47	48	49	46	47	48	49	50	51								
1	bF	6	1945	1948	1953	1	3	1	1	0	0	0	0	5	1	0	0	0	2	4	0				
	wS	4	1945	1948	1952	0	2	1	1	0	0	0	1	3	0	0	0	0	3	1	0				
2	bF	5	1946	1950	1953	0	0	3	1	1	0	0	0	0	1	4	0	0	0	0	5	0			
	wS	3	1947	1949	1953	0	0	1	2	0	0	0	0	0	1	2	0	0	0	1	2	0			
	A.G.	3	1946	1947	1952	0	0	2	1	0	0	0	1	2	0	0	0	0	0	2	1	0			
3	bF	16	1947	1950	1954	0	0	4	9	3	0	0	0	0	1	5	6	3	1	0	0	1	3	12	
	wS	17	1947	1948	1952	0	0	3	14	0	0	0	2	7	6	2	0	0	1	2	5	6	3		
	A.G.	6	1947	1947	1954	0	0	3	3	0	0	0	5	1	0	0	0	0	0	0	2	0	4		
4	bF	20	1947	1949	1954	0	0	4	14	2	0	0	0	0	5	12	1	2	0	1	1	2	4	10	
	wS	7	1947	1948	1953	0	0	2	5	0	0	0	0	0	5	2	2	0	0	0	0	2	4	1	
	A.G.	6	1947	1947	1952	0	1	1	3	1	0	0	3	2	1	0	0	0	0	0	0	0	4	1	
5	bF	21	1946	1949	1954	0	0	13	6	2	0	0	0	0	1	14	6	0	0	0	1	2	6	12	
	wS	4	1947	1949	1952	0	0	1	3	0	0	0	0	0	0	4	0	0	0	0	0	0	2	2	
	A.G.	6	1947	1948	1953	0	0	0	6	0	0	0	0	0	3	3	0	0	0	0	0	0	2	3	
6	bF	19	1946	1949	1952	0	3	12	3	1	0	0	0	0	6	5	7	1	0	0	0	1	13	5	
	wS	10	1947	1949	1952	0	0	2	8	0	0	0	0	0	6	3	1	0	0	0	0	0	3	7	
	A.G.	6	1947	1949	1952	0	1	1	3	1	0	0	0	2	2	2	1	1	0	0	0	0	3	3	
7	bF	20	1947	1949	1953	2	1	7	10	0	0	0	0	0	3	10	7	0	0	0	0	0	8	12	
	wS	13	1947	1948	1953	0	0	0	13	0	0	0	0	2	8	2	1	0	0	0	0	0	2	7	
	A.G.	6	1948	1949	1952	0	0	0	2	4	0	0	0	0	2	2	2	0	0	0	0	0	2	2	
8	bF	22	1947	1949	1954	0	4	4	12	2	0	0	0	1	2	12	5	2	0	0	0	0	1	7	14
	wS	9	1947	1949	1953	0	3	2	4	0	0	0	0	0	3	4	2	0	0	0	0	0	1	4	
	A.G.	6	1948	1949	1954	0	0	0	3	3	0	0	0	2	2	2	0	0	0	0	0	0	1	4	
9	bF	11	1947	1949	1954	0	1	3	7	0	0	0	0	0	3	8	0	0	0	0	0	0	3	8	
	wS	19	1947	1949	1954	0	2	2	11	4	0	0	0	0	3	12	4	0	0	0	0	1	8	4	
	A.G.	6	1947	1948	1952	0	0	2	3	1	0	0	2	4	0	0	0	0	0	0	0	0	3	1	
10	bF	7	1947	1950	1953	0	0	0	4	3	0	0	0	0	2	3	1	1	0	2	1	4	0		
	wS	3	1947	1949	1952	0	0	0	2	1	0	0	0	0	3	0	0	0	0	0	1	2	0		
11	bF	8	1947	1950	1953	0	0	0	6	2	0	0	0	0	4	4	0	0	0	0	0	0	4		
	wS	7	1947	1949	1953	0	0	1	3	2	1	0	0	1	6	0	0	0	0	0	0	0	1		
12	bF	7	1947	1949	1953	0	0	0	6	1	0	0	1	2	2	2	0	0	0	0	0	0	2		
	wS	8	1947	1949	1952	0	0	3	5	0	0	0	0	0	8	0	0	0	0	0	0	0	3		
13	bF	6	1947	1950	1953	0	0	0	4	1	1	0	0	0	1	3	1	0	0	0	1	2	3		
	wS	9	1947	1949	1952	0	0	1	8	0	0	0	3	0	6	0	0	0	0	0	2	5	2		

TABLE III (Continued)

Area No.	Species	Total No.	Average Pattern			Individual Patterns															Number with Peak After Supp. in 19--		
			First Supp. Ring	Most Supp. Ring	Peak After Supp.	Number with First Suppressed Ring in 19--					Number with Most Suppressed Ring in 19--												
						44	45	46	47	48	49	46	47	48	49	50	51	52	50	51	52		
14	bF	7	1947	1949	1953	0	0	0	5	2	0	0	0	0	3	3	1	0	0	0	1	6	0
	wS	4	1947	1949	1953	0	0	0	3	1	0	0	0	0	2	2	0	0	0	1	2	1	0
15	bF	8	1946	1949	1953	0	0	4	3	1	0	0	0	0	1	5	2	0	0	0	0	5	0
	wS	5	1946	1949	1953	0	0	1	3	1	0	0	0	0	2	2	1	0	0	0	1	4	0
16	bF	3	1946	1949	1952	0	1	2	0	0	0	0	0	0	3	0	0	0	0	0	0	3	0
	wS	3	1947	1949	1953	0	3	0	0	0	0	0	0	0	3	0	0	0	0	0	1	2	0
17	bF	17	1947	1950	1953	0	0	3	11	3	0	0	0	0	0	7	10	0	0	0	0	4	7
	wS	5	1947	1950	1953	0	0	1	1	3	0	0	0	0	0	1	4	0	0	0	0	1	2
	A.G.	6	1946	1948	1953	0	0	3	3	0	0	0	0	3	1	2	0	0	0	0	0	1	4
18	bF	16	1947	1950	1954	0	0	1	14	1	0	0	0	0	0	6	10	0	0	0	0	4	6
	wS	8	1947	1949	1954	0	0	1	7	0	0	0	0	0	2	4	1	0	0	0	0	2	3
	A.G.	6	1946	1948	1954	0	1	3	1	1	0	1	1	1	2	1	0	0	0	0	0	1	3
19	bF	20	1947	1950	1954	0	1	3	14	1	1	0	0	0	0	3	15	2	0	0	0	6	9
	wS	4	1947	1950	1953	0	0	0	0	4	0	0	0	0	1	1	2	0	0	0	0	1	3
	A.G.	6	1946	1948	1954	0	0	4	2	0	0	0	0	3	3	0	0	0	0	0	0	2	4
20	bF	21	1946	1950	1953	0	1	15	5	0	0	0	0	0	1	8	12	0	0	0	0	1	10
	wS	9	1947	1949	1952	0	0	0	0	9	0	0	0	0	2	7	0	0	0	0	0	0	1
	A.G.	6	1947	1947	1953	0	0	2	4	0	0	0	0	4	2	0	0	0	0	0	0	3	0
21	bF	12	1946	1950	1953	0	0	0	8	4	0	0	0	0	1	2	9	0	0	0	0	3	4
	wS	1	1946	1948	1953	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
22	bF	10	1947	1949	1954	0	0	1	8	1	0	0	0	0	0	0	7	3	0	0	0	0	4
	wS	2	1947	1948	1952	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	2	0
23	bF	14	1946	1950	1952	0	1	7	6	0	0	0	0	0	1	4	9	0	0	0	0	1	4
	wS	8	1946	1949	1952	0	0	5	3	0	0	0	0	0	2	5	1	0	0	0	0	5	0
24	bF	13	1947	1949	1953	0	0	3	9	1	0	0	0	0	4	5	2	2	0	0	0	2	2
	wS	10	1947	1949	1953	0	0	1	9	0	0	0	0	0	2	5	3	0	0	0	0	6	4
25	bF	16	1947	1951	1953	0	1	5	10	0	0	0	0	0	2	1	7	6	0	0	0	8	1
	wS	10	1947	1948	1953	0	0	0	9	1	0	0	0	0	5	4	1	0	0	0	0	4	1
	A.G.	6	1947	1948	1952	0	0	2	4	0	0	0	0	0	2	3	1	0	0	0	0	0	1
26	bF	23	1947	1951	1953	0	0	0	19	4	0	0	0	0	0	4	9	10	0	0	0	1	8
	wS	12	1947	1950	1953	0	0	3	8	1	0	0	0	0	6	2	3	1	0	0	0	1	5
	A.G.	6	1947	1947	1954	0	0	2	4	0	0	0	0	0	4	0	2	0	0	0	0	2	4
27	bF	24	1947	1950	1953	0	0	3	20	1	0	0	0	0	4	6	14	0	0	0	0	6	5
	wS	10	1947	1949	1952	0	0	4	6	0	0	0	0	0	3	2	5	0	0	0	0	3	2
	A.G.	6	1946	1949	1954	0	0	4	0	2	0	0	0	0	3	0	3	0	0	0	0	1	1

TABLE III (Continued)

Area No.	Species	To-tal No.	Average Pattern			Individual Patterns												Number with Peak After Supp.						
			First Supp. Ring	Most Supp. Ring	Peak After Supp.	Number with First Suppressed Ring				Number with Most Suppressed Ring in				in 19--										
						44	45	46	47	48	49	46	47	48	49	50	51	52	50	51	52	53	54	
28	bF	17	1946	1950	1954	2	3	7	5	0	0	0	0	3	9	4	1	0	0	3	5	6	3	
	wS	13	1947	1949	1953	0	3	6	4	0	0	0	0	5	3	4	1	0	0	0	0	6	4	
	A.G.	6	1947	1948	1952	0	0	1	5	0	0	1	0	5	0	0	0	0	0	0	4	2	0	
29	bF	17	1947	1950	1953	0	1	7	9	0	0	0	0	2	6	9	0	0	0	0	1	6	10	0
	wS	11	1947	1949	1952	0	0	4	7	0	0	0	0	1	5	7	3	0	0	0	0	6	5	0
	A.G.	6	1947	1948	1952	0	0	1	5	0	0	0	0	1	5	0	0	0	0	0	0	4	2	0
30	bF	17	1947	1950	1952	0	0	4	13	0	0	0	0	1	4	10	1	1	0	0	0	14	2	1
	wS	8	1947	1949	1952	0	0	1	7	0	0	0	0	0	1	5	3	0	0	0	0	5	3	0
	A.G.	6	1947	1950	1953	0	0	1	5	0	0	0	0	0	1	3	2	0	0	0	0	3	3	0
31	bF	18	1946	1950	1953	0	2	10	4	2	0	0	0	0	2	7	9	0	0	0	0	10	8	0
	wS	12	1947	1949	1952	0	2	3	6	1	0	0	0	0	0	2	8	3	1	0	0	0	8	1
	A.G.	6	1947	1949	1953	0	0	4	2	0	0	0	0	0	0	2	4	0	0	0	0	4	2	0
32	bF	17	1947	1950	1954	0	0	4	11	2	0	0	0	0	0	4	12	1	0	0	0	3	7	7
	wS	8	1947	1949	1953	0	0	2	5	1	0	0	0	0	0	6	2	0	0	0	0	3	5	0
	A.G.	6	1949	1950	1952	0	0	0	1	1	4	0	0	1	0	1	4	0	0	0	0	4	2	0
33	bF	12	1947	1950	1954	0	0	4	8	0	0	0	0	0	0	3	8	1	0	0	0	6	1	5
	wS	14	1947	1949	1953	0	1	5	8	0	0	0	0	0	0	11	2	1	0	0	0	4	10	0
	A.G.	6	1946	1949	1954	0	0	6	0	0	0	0	0	2	1	3	0	0	0	0	0	1	5	0
34	bF	18	1947	1949	1954	0	2	4	10	2	0	0	0	0	0	10	7	1	0	0	0	5	8	5
	wS	11	1947	1949	1953	0	1	3	7	0	0	0	0	0	1	9	1	0	0	0	0	5	3	3
	A.G.	6	1947	1950	1953	0	0	1	5	0	0	0	0	0	0	3	0	3	0	0	0	3	2	1
35	bF	12	1947	1949	1953	0	1	1	10	0	0	0	0	0	1	8	2	1	0	0	0	1	5	3
	wS	9	1947	1949	1953	0	0	3	6	0	0	0	0	0	3	6	0	0	0	0	0	7	2	0
	A.G.	6	1946	1947	1952	0	2	4	0	0	0	0	0	4	2	0	0	0	0	0	0	6	0	0

of suppression appeared in only one sampling area in 1945 for both balsam and spruce trees. It appeared in 10 areas for balsam and in 3 areas for spruce in 1946 and the most common year was 1947 when it appeared in 24 areas for balsam and 35 areas for spruce.

In most of the sampling areas the average pattern indicates that the above events occurred in the same year for both balsam and spruce. Where the events occurred in different years for the two species in any one sampling area, the first year of suppression always occurred one year earlier in balsam than in spruce, but the most suppressed ring and the peak after suppression always occurred one or two years earlier in spruce. Thus the period of suppression from the first suppressed ring to the peak after suppression usually lasted longer in balsam fir than it did in white spruce. For example, the period of suppression in 3 of the sampling areas was 9 years for balsam but in no area was the period this long for spruce. Also, an 8-year period showed in 15 sampling areas for balsam but in only 5 areas for spruce. The most common period was 7 years, appearing in 16 areas for balsam and 17 areas for spruce. The shortest period, 6 years, appeared in only 1 area for balsam but in 15 years for spruce.

In general, the first year of suppression appeared earliest in the northern part of the present area of infestation. It appeared in sampling area 1 (the most northern area) in 1945 and in all the other areas in either 1946 or 1947. The latter year predominated in the most southern sampling areas but in the central areas either year appeared in no definite pattern.

Individual patterns reveal more variation than the average patterns, as would be expected. In most of the sampling areas, the first year of suppression occurred in the various individuals over a 3-year period but in some areas the period was 1, 2 or 4 years. The same

variation held for the occurrence of the most suppressed ring and the peak after suppression except that in a few areas the period was 5 years. Whereas the average patterns showed that the first year of suppression occurred from 1945 to 1947, individual patterns in three areas (Nos. 1, 7 and 28) showed the first year of suppression as early as 1944 and three areas (Nos. 11, 13 and 19) showed it as late as 1949. Similar variations occurred in the most suppressed ring and the peak after suppression in different sampling areas.

A comparison of Table 3 with Map 1 reveals that the suppression patterns are out of phase with the defoliation history, because the effect of the feeding on the radial growth appeared several years after the feeding. This is shown more clearly by a comparison of the defoliation records for balsam fir in Areas 7, 24 and 29 in Table 4 with the years of suppression for the respective areas in Table 3. In area 24, the first recorded year of heavy defoliation was 1945 (9) but the first suppressed ring appeared in 1947. Defoliation was much reduced in 1949 but reductions of the radial growth continued until the most suppressed ring appeared in 1950. Heavy defoliation again occurred in 1951 and continued to 1954 but the radial growth continued to increase until the peak was reached in 1953. Similar comparisons can be made with areas 7 and 29 (15) which show that the effect of the feeding was not reflected in the radial growth for two or more years.

Table V presents a comparison of the branch terminal growth with the annual ring growth in individual balsam fir trees and the comparison is presented graphically in Figs. 5 and 6 for twenty trees to illustrate the inverse relationship that existed between the two forms of growth during the budworm feeding period.

TABLE IV

MORTALITY AND DEFOLIATION DATA FROM BALSAM FIR TREES IN
PERMANENT SAMPLE PLOTS IN THE SPRUCE BUDWORM AREA OF INFESTATION
SOUTH OF BLACK STURGEON LAKE

Year	Plot 401 (Area 24)		Plot 402 (Area 24)		Plot 8 (Area 29)	Plot 9 (Area 7)
	Cumulative Per Cent Mortality	Estimated Per Cent Defoliation	Cumulative Per Cent Mortality	Estimated Per Cent Defoliation	Estimated Per Cent Defoliation	Estimated Per Cent Defoliation
1943	1.5	10	0.4	10	--	--
1944	1.5	--	5.5	--	--	--
1945	8.2	75 - 100	6.0	90 - 100	--	--
1946	21.7	100	8.2	100	98	85
1947	22.5	75 - 90	12.7	75 - 90	97	80
1948	39.2	50 - 90	17.5	50 - 90	95	75
1949	52.4	10 - 25	23.1	10 - 25	72	58
1950	75.0	0 - 10	40.2	0 - 10	63	37
1951	87.0	83*	59.9	--	70	47
1952	87.0	87*	68.6	--	76	70
1953	92.3	81*	--	--	77	57
1954	--	--	--	--	93	99

* Estimates based on two trees only, sampled in the vicinity of Plot 401.

TABLE V

COMPARISON OF THE BRANCH TERMINAL GROWTH (B) WITH THE ANNUAL RING GROWTH (R) OF BALSAM FIR TREES IN THE SPRUCE BUDWORM INFESTATION AREA SOUTH OF BLACK STURGEON LAKE

Based on six branch samples and one increment core per tree.

1 ARBITRARY UNIT = 0.064 in.

Area No.	Tree D.B.H. (Ins.)	B or R	Average Length of the Branch Terminal Growth in Inches and the Annual Ring Width in Arbitrary Units for:-												
			1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
1	7	B	-	1.75	1.04	0.46	0.29	1.21	1.96	1.88	1.63	1.29	1.29	1.66	1.21
		R	30	24	21	15	15	6	4	3	9	14	20	20	16
2	10 ¹	B	-	2.54	3.46	3.08	1.54	1.33	1.42	2.00	2.42	2.17	1.50	2.00	1.25
		R	56	42	41	33	27	17	9	5	4	6	12	14	11
3	6	B	-	2.46	2.58	0.92	1.32	1.58	2.13	2.25	2.25	1.71	1.29	2.08	1.08
		R	42	40	33	37	35	23	15	10	11	11	12	15	14
4	12	B	3.42	3.67	2.63	2.13	1.13	0.89	1.71	2.00	1.42	1.46	1.42	1.46	0.29
		R	34	27	26	21	24	21	18	16	20	16	18	18	23
5	14	B	2.52	3.38	3.29	2.08	3.04	2.31	2.17	2.67	2.00	1.83	0.92	1.50	1.42
		R	31	23	25	25	26	21	17	22	22	17	23	27	30
7	10	B	1.96	2.17	1.23	1.88	1.83	1.83	1.42	1.83	1.33	1.13	0.88	1.08	0.67
		R	20	18	17	13	10	5	2	1	5	5	7	9	11
7	10 ^{1,2}	B	2.50	2.50	2.29	2.29	1.96	1.04	1.50	2.63	2.04	1.21	0.75	1.08	0.46
		R	24	21	16	14	10 ^{1,2}	9 ²	2	1	3	4	8	10	11
11	11	B	3.55	4.10	3.50	2.90	1.35	1.65	1.90	1.65	2.60	1.85	1.95	0.35	0.05
		R	37	31	23	23	20	11	6	5	9	16	22	22	17
8	8 ¹	B	2.50	2.08	1.21	0.89	0.89	0.92	1.66	1.88	1.92	1.38	1.04	1.38	0.13
		R	8	9	9	7	5	5	2	1	1	2	4	4	4
8	9 ²	B	1.60	1.05	1.40	0.92	0.42	1.30	1.00	1.20	1.00	1.25	0.90	1.20	0.45
		R	12	10	6	2	4	3	1	1	2	3	6	7	4
10	7	B	1.88	1.81	2.21	2.54	1.35	1.33	1.21	1.46	1.71	1.38	1.38	2.04	1.54
		R	12	16	18	13	15	20	17	17	12	14	12	7	5
10	13	B	1.63	1.75	1.58	1.83	1.64	1.17	1.04	1.33	1.17	1.04	0.76	0.79	0.75
		R	15	16	12	12	17	16	13	11	11	10	8	8	8

1 - Illustrated in Figure 5.

2 - 5 branch samples only.

TABLE V (Continued)

Area No.	Tree D.B.H. (Ins.)	B or R	Average Length of the Branch Terminal Growth in Inches and the Annual Ring Width in Arbitrary Units for:-												
			1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
11	6	B	1.50	2.71	3.50	4.08	3.43	2.08	0.73	2.25	2.50	2.38	1.54	2.50	1.54
	11 ¹	R	25	25	16	23	27	22	20	17	16	20	23	22	18
		B	3.00	3.00	2.60	2.60	3.80	2.30	0.64	1.22	2.00	2.05	1.55	0.30	1.20
12	12	R	37	41	40	45	52	39	35	26	31	35	41	35	30
		B	2.00	2.17	2.42	1.71	1.33	0.77	1.20	2.08	2.25	2.04	1.83	1.75	1.25
14	8 ^{1,3}	R	13	15	10	12	15	13	10	8	8	10	13	19	15
		B	3.20	3.10	2.80	2.35	1.35	0.42	0.80	2.30	3.50	2.80	1.75	2.50	1.70
15	8 ⁴	R	13	20	20	15	22	21	10	5	3	8	15	19	18
		B	2.83	3.83	1.50	1.63	1.33	1.58	1.67	1.88	2.17	1.88	1.29	2.67	2.42
15	10 ¹	R	16	14	13	16	16	14	8	3	6	11	17	19	15
		B	2.50	2.02	1.75	0.96	1.20	2.02	2.67	2.17	1.71	1.54	0.92	1.25	0.92
17	13 ¹	R	21	20	18	22	15	9	5	5	7	8	14	11	10
		B	2.21	2.46	1.96	2.04	1.71	1.54	0.75	1.42	1.75	1.58	0.50	1.29	0
17	11	R	27	23	26	25	19	11	4	2	2	6	12	17	14
		B	3.58	4.25	3.42	2.83	1.96	0.71	1.21	1.38	2.17	1.42	1.58	1.83	1.13
18	6 ¹	R	17	28	25	20	18	14	7	3	5	20	26	22	14
		B	3.33	3.17	1.89	1.42	1.31	0.43	0.83	1.76	1.58	0.88	0.89	1.33	1.25
18	7	R	26	31	33	40	40	30	18	10	3	11	32	36	36
		B	3.17	3.08	2.83	1.53	2.58	1.77	0.38	1.29	1.75	1.13	1.13	1.79	2.21
19	12 ¹	R	43	45	43	41	27	15	9	2	2	4	6	10	10
		B	1.96	2.00	1.56	1.23	0.81	1.43	1.39	2.58	1.83	1.08	0.75	0.54	0.08
19	13	R	30	23	20	15	13	11	9	6	3	4	5	7	9
		B	3.38	2.67	2.17	0.93	1.17	1.13	1.92	1.46	2.00	1.38	0.71	1.50	0.21
20	12	R	32	28	24	24	21	16	14	8	10	10	15	18	10
		B	2.08	1.28	1.33	1.46	1.83	1.29	1.04	1.25	1.33	1.33	0.96	0.52	0.02
20	13	R	36	52	23	33	40	30	24	28	15	23	24	30	27
		B	3.33	1.21	0.17	2.50	2.63	1.67	1.96	2.29	1.71	1.15	1.46	0.75	0.08
21	8 ²	R	34	36	40	43	33	17	10	5	4	12	30	37	35
		B	1.75	3.25	4.25	3.13	0.51	1.50	1.75	1.25	1.63	0.56	1.00	2.00	1.63
21	9 ⁴	R	41	50	60	60	52	28	17	11	9	13	20	32	30
		B	1.80	1.80	2.30	2.40	2.50	2.50	2.40	2.00	1.80	1.15	1.40	1.20	0.30
22	11 ³	R	55	50	38	50	42	22	13	8	6	9	13	13	16
		B	2.33	1.92	1.83	0.98	1.42	1.50	0.88	1.29	1.21	1.04	0.96	0.54	0.42

1 - Illustrated in Figure 5.

2 - Illustrated in Figure 6.

3 - 5 branch samples only.

4 - 4 branch samples only.

TABLE V (Continued)

Area No.	Tree D.B.H. or (Ins.)	B R	Average Length of the Branch Terminal Growth in Inches and the Annual Ring Width in Arbitrary Units for:-												
			1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
23	7	B R	3.33 36	3.08 28	2.46 26	2.33 40	1.71 33	1.63 21	1.10 10	1.33 6	0.93 5	1.33 13	1.04 20	0.50 20	0 10
24	9 ¹	B R	2.25 64	2.33 58	1.42 56	1.35 58	1.13 38	0.52 26	0.74 17	1.60 12	2.25 5	0.96 7	0.71 9	0.92 7	0.29 5
	7	B R	2.67 18	3.46 15	1.63 13	2.29 13	1.83 15	1.88 9	1.42 5	2.00 4	2.17 5	1.92 8	1.08 12	1.71 11	0.50 10
25	9 ¹	B R	2.83 14	1.88 14	2.33 17	1.25 16	1.00 15	0.67 17	1.04 15	1.29 15	1.33 11	1.58 6	1.42 7	0.88 10	0.21 10
	8 ¹	B R	2.50 62	2.42 52	3.83 50	2.96 58	1.88 49	1.46 33	1.88 22	2.58 21	2.29 12	1.92 13	1.04 24	1.46 27	0.08 18
26	9	B R	3.17 53	2.63 54	2.67 46	2.67 47	2.83 47	2.33 40	1.79 26	1.58 19	1.75 13	1.21 15	0.71 17	1.38 15	1.08 12
	9	B R	4.63 36	5.42 50	3.33 39	3.83 38	3.54 37	2.88 19	2.13 14	2.00 10	2.13 9	1.96 9	1.92 10	2.21 13	1.67 18
27	10	B R	0.08 20	1.58 16	1.04 23	1.79 26	0.92 30	1.38 19	1.79 11	1.88 8	1.54 9	1.33 7	1.46 11	1.75 16	1.17 18
	10	B R	1.23 49	0.83 43	1.29 46	0.33 48	0.39 42	1.13 26	1.42 15	2.21 6	1.96 4	1.75 5	1.25 15	1.25 20	0.33 18
28	12 ¹	B R	2.21 58	1.75 50	1.88 42	1.50 38	0.29 32	0.85 19	1.64 11	1.38 5	1.21 3	1.13 7	0.92 13	1.46 20	1.08 18
	8 ¹	B R	3.42 23	2.54 18	2.63 17	1.92 17	1.08 9	0.76 6	0.96 4	1.63 4	1.50 5	1.46 7	1.42 5	1.75 4	0.75 10
29	9	B R	4.25 38	4.17 38	4.00 32	3.29 27	2.83 20	1.29 11	1.29 6	1.75 2	1.71 5	1.21 7	0.71 15	1.25 11	0 14
	9	B R	1.92 52	2.04 47	3.04 35	2.25 44	1.18 41	1.83 33	1.42 23	1.38 20	1.50 17	1.17 18	1.04 28	1.04 30	0.29 21
30	10	B R	3.33 25	2.38 18	2.33 17	2.93 25	1.46 20	1.38 12	1.17 5	1.04 3	1.92 2	1.63 7	1.25 8	1.04 10	0.46 8
	8	B R	0 60	0 52	1.79 43	1.29 50	1.04 46	1.21 31	0.88 19	0.96 14	1.33 12	1.13 27	0.92 30	0.75 25	0.31 8
31	9 ¹	B R	1.25 43	2.25 46	2.67 41	1.92 40	1.50 42	1.23 25	1.92 18	2.04 11	1.92 10	1.46 13	1.29 19	1.38 20	0.25 12
	7 ¹	B R	3.63 28	3.13 28	2.29 23	1.71 23	1.50 18	1.02 12	1.25 7	2.29 3	2.50 4	1.58 5	1.38 10	0.88 9	0.25 7
	13	B R	3.04 36	1.83 27	1.50 45	1.71 37	1.08 31	1.63 27	1.42 20	2.00 7	2.54 2	1.71 4	1.25 8	0.33 11	0.08 7

1 - Illustrated in Figure 6.

TABLE V (Concluded)

Area No.	Tree D.B.H. (Ins.)	B or R	Average Length of the Branch Terminal Growth in Inches and the Annual Ring Width in Arbitrary Units for:-												
			1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
32	10	B	1.96	1.79	1.83	1.13	1.79	2.25	1.79	2.63	2.04	1.79	2.08	2.25	2.54
		R	20	13	14	15	18	11	5	4	4	6	10	9	10
33	9	B	4.33	4.29	3.79	1.96	1.75	1.42	1.08	1.17	2.13	1.33	1.33	1.67	1.67
		R	32	36	32	30	22	12	10	6	3	6	12	8	11
34	11 ¹	B	2.54	1.83	1.38	1.75	1.88	2.38	1.29	1.43	2.25	1.71	1.00	1.79	1.08
		R	12	9	7	9	9	8	7	4	6	8	10	11	13
35	7 ¹	B	3.75	4.08	2.88	2.25	1.29	1.29	0.43	0.96	2.08	1.63	1.25	2.21	1.83
		R	36	33	28	31	25	13	5	2	4	6	15	14	17
	9	B	1.67	1.67	1.79	1.50	1.13	1.17	1.38	1.50	1.17	1.00	0.71	1.00	0.67
		R	31	26	23	26	21	13	7	5	6	9	15	18	5

1 - Illustrated in Figure 6.

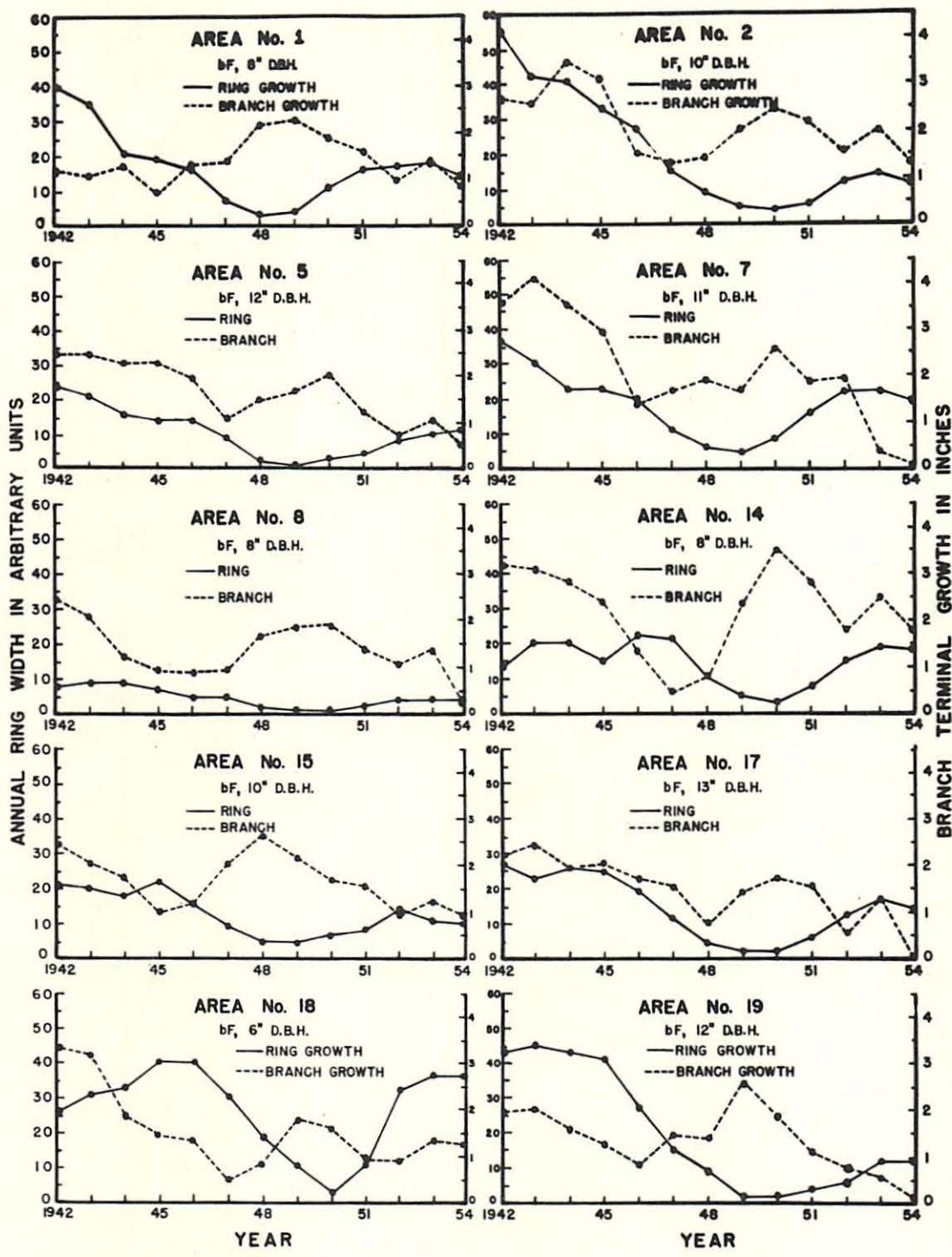


FIGURE 5. COMPARISON OF THE ANNUAL RING GROWTH WITH THE
BRANCH TERMINAL GROWTH OF BALSAM FIR IN THE SPRUCE BUD-
WORM INFESTATION AREA SOUTH OF BLACK STURGEON LAKE, BASED
ON ONE INCREMENT CORE AND SIX BRANCH SAMPLES PER TREE.

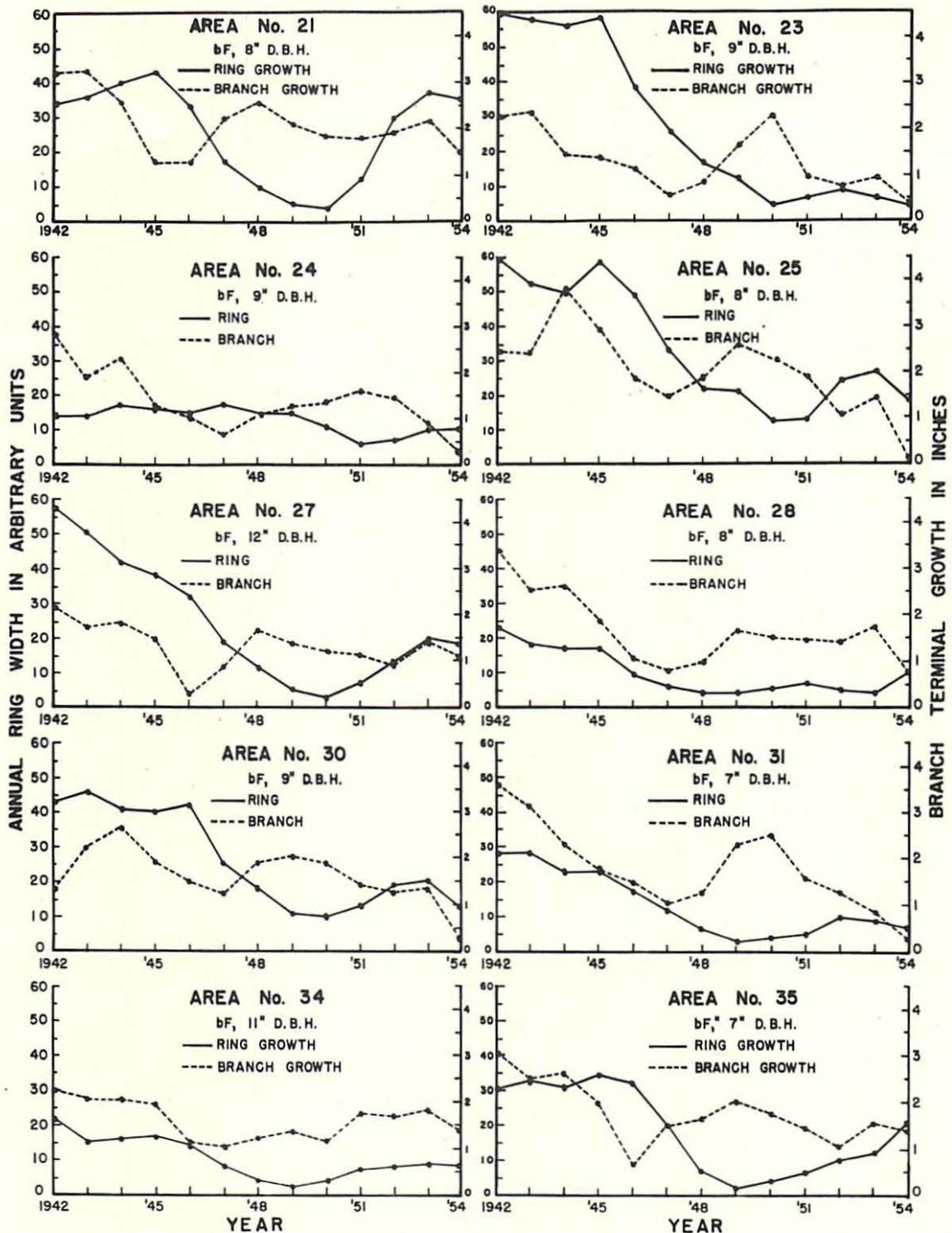


FIGURE 6. COMPARISON OF THE ANNUAL RING GROWTH WITH THE BRANCH TERMINAL GROWTH OF BALSAM FIR IN THE SPRUCE BUD-WORM INFESTATION AREA SOUTH OF BLACK STURGEON LAKE, BASED ON ONE INCREMENT CORE AND SIX BRANCH SAMPLES PER TREE.

5. DISCUSSION

The radial growth suppression patterns in balsam fir and white spruce trees indicate that the area of infestation south of Black Sturgeon Lake was affected quite uniformly by the original infestation and that the northern section suffered defoliation earlier than the southern section. This is in agreement with the history of the infestation as recorded in the annual reports of the Forest Insect Survey and in Forest Biology Ranger reports.

In discussing the Lake Nipigon spruce budworm infestation, Fettes (6) stated, - "The entire population behaved as a unit, rising to epidemic proportions at the epicenter, expanding in waves to reach a maximum after ten years and subsiding as a unit throughout the entire infested area. Each succeeding wave persisted for a shorter period than the preceding one by approximately one year, even in the presence of abundant food in the peripheral areas." A theory for the decline of the infestation was proposed by McGugan (11), - "Following in the wake of the epidemic population and separated in time by several generations, is a second wave of density-dependent factors such as insect parasites, predators and diseases. Once the combined effect of all factors exceeds the reproductive potential, the infestation begins to decline. This trend progresses at an accelerated rate owing to the increased influence of control factors on the decreased population. Thus, the final stages of decline of the outbreak are rapid and take place throughout the entire population almost simultaneously."

With the general course of the infestation thus established, it would be well to note that the records show that the remnant of the infestation south of Black Sturgeon Lake had increased in severity and in area after the activity of the main infestation had ceased. Thus it would appear that the control factors which caused the rapid decline of the

infestation were not wholly effective in the remnant. This is an unusual situation, made more unusual because the budworm populations increased in an area which was far from ideal in respect to ecological conditions. Severe defoliation for at least five years had caused heavy host-tree mortality and extensive clear-cutting had further reduced the food supply. Despite the unfavourable conditions, the remnant acted as the center of a new infestation in that it has spread radially in much the same manner as the original infestation, but to a lesser degree.

The factors that allowed the budworm populations to increase in the remnant area are obscure. Ecological conditions in the area did not differ greatly from some parts of the main area where the infestation ceased, nor did the over-all weather conditions. Unfortunately, data on biotic control factors were not obtained. The only known factor that differentiated the remnant area from other areas affected by the main infestation was the DDT spraying project in 1945. It seems significant that the remnant area is entirely within the spray area although it later expanded beyond it.

Brown (3) reported that the spray application was very uneven and that it was applied during all stages of budworm development from the needle-mining stage through to the pupal stage. Thus the effect of the spraying on the budworm population was highly varied throughout the area. Despite the variation, average defoliation was 60 per cent compared to 96 per cent in a near-by unsprayed check-area. However, Fettes and Prebble (7) reported that any beneficial effect from the reduced defoliation was not apparent two years later when the defoliation was as heavy inside the spray area as outside.

The suppression patterns in balsam fir and white spruce trees show that very heavy defoliation from 1943 to 1948 caused a progressive

decline in radial growth and that lighter defoliation from 1949 to 1951 allowed a progressive and almost complete recovery. It is emphasized that defoliation did not cease during the 1949-51 period; available records show that it ranged from 10 to 80 per cent in various parts of the remnant area. The reduction in defoliation allowed branch terminal and tree radial growth to increase which indicates that tree vigour was markedly increased. Tree vigour must also have been increased by the reduced defoliation resulting from the 1945 spraying which would allow the trees to withstand the years of heavy defoliation that followed, better than if no reduction had occurred. Also, the variable effect of the spray on the budworm population may have caused the variable host-mortality that was encountered throughout the remnant area despite the fact that the area was affected uniformly by the original infestation.

Increased tree vigour alone will not explain why the budworm populations increased because the populations did not increase outside the remnant area where host-trees were in a healthier condition. However, increased tree vigour resulting from reduced defoliation during the year of spraying, together with the effects of DDT on the budworm population and other forest fauna, may have presented conditions differing from those in the remainder of the infestation area which allowed the populations to survive.

The decrease and increase in radial growth resulting from periods of heavy and light defoliation respectively, did not appear for several years after the causal defoliation. This delayed reflection of the effects of the defoliation on the radial growth also applied to the recurring heavy defoliation from 1952 to 1954 because the growth patterns show little or no reduction during these years. Therefore, radial growth suppression patterns in balsam fir and white spruce trees can not be used for the direct dating of spruce budworm infestations as suggested

by Swaine et al., (16). The data on branch terminal growth indicate that branch growth reacted more directly to defoliation than did radial growth. In general, branch growth showed a progressive reduction during the period of heavy defoliation, a rapid increase during the period of light defoliation and reduction during the period of recurring heavy defoliation. Such a pattern would be expected because larval feeding would immediately affect the branch growth, especially in years when feeding was heavy enough to kill the buds or to defoliate the shoots before growth was completed. Terminal stem growth would be affected in the same manner, but in this study branches were used because of the prevalence of dead stem terminals.

6. SUMMARY

1. A remnant of the Lake Nipigon spruce budworm infestation south of Black Sturgeon Lake increased in severity and in area after the activity of the main infestation had ceased, in spite of unfavourable ecological conditions caused by heavy host-tree mortality.
2. Radial growth patterns in balsam fir and white spruce trees indicated that the infestation had affected the most northern part of the remnant area first and then spread evenly southward. The degree of host-mortality did not follow this regular pattern except in an area southwest of the remnant area but in most cases the degree of radial growth suppression was comparable to the degree of host-mortality.
3. Although the factors which allowed the budworm populations to increase after the decline of the main infestation are not known, it would appear to be more than coincidental that the remnant area was entirely within the area sprayed with DDT in 1945.
4. The decrease and increase in radial growth caused by periods of heavy and lighter defoliation respectively, did not appear for several

years after the causal defoliation but the decrease and increase in branch terminal growth appeared close to the time of the causal defoliation.

ACKNOWLEDGEMENTS

The aerial photographs and the forest type-map used to locate the sampling areas were kindly loaned by K. B. Turner of the Ontario Department of Lands and Forests, and B. Dunn, Chief Ranger, Black Sturgeon Division, arranged the aerial flights required during the course of the work. Thanks are also extended to the personnel of the Woodlands Office, Camp 1, Great Lakes Pulp and Paper Co., for information supplied and for accommodation arranged during field trips.

Helpful suggestions were made by J. B. Thomas, Officer-in-Charge of the Black Sturgeon Lake Field Station and by R. M. Belyea, Officer-in-Charge of the Forest Insect Laboratory, Sault Ste. Marie. Photographic work was done by D. C. Anderson and J. Carter assisted with the field work.

REFERENCES

1. Annual Technical Reports. Forest Insect Laboratory, Sault Ste. Marie, Ontario. 1947 to 1953.
2. Belyea, R. M. 1952. Death and deterioration of balsam fir weakened by spruce budworm defoliation in Ontario. Jour. For. 50, 729-738.
3. Brown, N. R. 1946. Report on DDT spraying operation in 1945. Unpublished report, Forest Insect Laboratory, Sault Ste. Marie, Ont. 1946.
4. Brown, N. R. 1949. Lake Nipigon spray operations, in forest spraying and some effects of DDT. Ontario Department of Lands and Forests, Div. of Research, Biol. Bull. No. 2. 1949.
5. Clinton, E. 1951. Report of forest insect ranger, Geraldton district, Unpublished report, Forest Insect Laboratory, Sault Ste. Marie. 1951.

6. Fettes, J. J. 1950. Investigations of sampling techniques for population studies of the spruce budworm on balsam fir in Ontario. Unpublished report, Forest Insect Laboratory, Sault Ste. Marie, Ont.. 1950.
7. Fettes, J. J. and M. L. Prebble. 1947. Statement on defoliation injury in 1947 in forested area, Thunder Bay District, sprayed with DDT in 1945 and 1946. Unpublished Report, Forest Insect Laboratory, Sault Ste. Marie, Ont.. 1947.
8. Foster, H. R. 1951. Report of the Forest Insect Ranger, Port Arthur District. Unpublished report, Forest Insect Laboratory, Sault Ste. Marie. 1951.
9. Foster, H. R. 1954. Summary of permanent mortality plot data. Unpublished. Forest Insect Laboratory, Sault Ste. Marie, Ont.
10. Harnden, A. and D. Lynn. 1948. Report of the Forest Insect Ranger, Port Arthur district. Unpublished report, Forest Insect Laboratory, Sault Ste. Marie, Ont. 1948.
11. McGugan, B. M. 1950. Investigations of parasites in the natural control of the spruce budworm. Unpublished report, Forest Insect Laboratory, Sault Ste. Marie, Ont.. 1950.
12. Ontario Department of Lands and Forests. 1949. Forest spraying and some effects of DDT. Div. of Research, Biol. Bull. No. 2, 1949.
13. Parsons, A. 1940. Forest type map for the Black Sturgeon Lake concession of the Great Lakes Paper Co., Ont. Dept. Lands and Forests, Div. of Timber Management.
14. Richmond, H. A. and D. N. Smith. 1943. Spruce budworm infestation in the Lake Nipigon-Geraldton region, in Annual Report of the Forest Insect Survey. 1943. 46-47.
15. Stairs, G. 1954. Summary of defoliation in Plots 8 and 9, Black Sturgeon Lake Field Station, in unpublished report, Forest Insect Laboratory, Sault Ste. Marie, Ont. 1954.
16. Swaine, J. M., F. C. Craighead and J. W. Bailey. 1924. Studies on the spruce budworm (*Cacoecia fumiferana* Clem.) Can. Dept. Agr. Tech. Bull. 37 (N. S.)

APPENDIX I

ANNUAL RING DATA FROM BALSAM FIR (bF) AND WHITE SPRUCE (wS) TREES
AND FROM BALSAM FIR ADVANCED GROWTH (Ad.Gr.) IN THE SPRUCE BUD-
WORM INFESTATION AREA SOUTH OF BLACK STURGEON LAKE (1954).

1 ARBITRARY UNIT = 0.061 mm.

Area No.	Species	Annual Ring Width in Arbitrary Units for:-												
		1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	
1	bF(7)	30	24	21	15	15	6	4	3	9	14	20	20	16
	bF(8)	40	35	21	19	16	7	3	4	11	16	17	18	13
	bF	26	32	29	21	18	13	3	4	6	10	15	20	13
	"	32	28	24	20	15	5	2	3	6	8	14	10	10
	"	37	32	19	26	23	8	5	11	16	24	27	32	19
	"	33	26	21	14	14	5	2	2	6	7	11	15	10
	wS	18	13	17	10	10	6	3	6	6	8	10	8	7
	"	22	21	19	21	20	12	4	9	9	12	18	19	10
	"	6	6	6	7	5	3	1	3	5	7	10	8	4
	"	6	5	5	4	3	1	1	2	3	5	6	5	4
2	bF(10)	45	43	37	31	20	12	9	5	4	6	8	9	6
	bF(11)	42	40	33	37	35	23	15	10	11	11	12	15	14
	bF	80	60	55	47	38	24	13	7	6	8	17	20	16
	"	54	64	52	52	42	26	20	16	13	14	19	23	13
	"	18	25	17	18	16	17	6	4	3	3	5	8	8
	wS	8	13	12	14	11	7	4	3	6	10	10	12	8
	wS	18	16	17	15	13	9	4	3	5	8	12	10	9
	"	18	12	15	16	17	11	6	7	8	10	11	16	10
	Ad.Gr.	20	21	17	18	10	5	3	3	7	6	10	12	10
	" "	22	18	24	25	24	13	18	16	21	16	34	21	22
	" "	14	15	17	15	10	6	5	6	8	7	16	15	15
3	bF(6)	52	61	55	50	28	16	13	15	15	19	7	5	10
	bF(13)	83	70	62	40	31	16	16	7	10	15	19	19	14
	bF	27	37	31	35	30	25	16	11	7	5	7	14	10
	"	23	25	24	21	20	20	11	6	4	6	8	17	18
	"	20	21	23	21	25	23	11	6	4	4	5	8	20
	"	13	19	19	17	17	10	5	4	3	4	3	4	4
	"	21	26	27	24	22	21	14	12	9	10	8	11	12
	"	23	23	22	18	17	9	4	1	3	4	10	12	15
	"	36	37	40	44	34	21	17	10	11	21	22	27	
	"	22	25	26	26	21	13	9	9	10	8	16	4	17
	"	39	41	32	24	18	13	13	12	14	19	22	26	
	"	23	28	27	22	16	12	22	9	5	6	15	18	18
	"	28	26	27	25	20	12	9	7	7	7	16	25	32
	"	42	43	40	35	33	23	17	11	13	16	23	22	25
	"	27	30	32	33	31	17	12	8	10	10	10	10	15
	"	52	43	40	31	21	16	16	12	2	18	17	19	
	wS	50	46	45	33	33	21	10	18	20	30	47	48	29
	"	53	49	46	50	46	29	25	16	17	28	40	40	33
	"	63	58	66	51	46	22	17	20	50	63	84	92	72
	"	29	36	47	55	51	29	22	25	31	70	92	74	58
	"	39	38	47	42	27	13	11	4	3	11	20	20	20
	"	68	57	72	56	48	31	24	16	17	40	54	63	71

(Area 3 continued next page)

Note:-D.B.H. of trees cut for branch samples shown in brackets
in the "Species" column.

APPENDIX 1 (Continued)

Area No.	Species	Annual Ring Width in Arbitrary Units for:-												
		1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
3	wS.	39	33	29	35	25	14	11	6	7	20	52	64	63
	"	43	40	47	43	44	22	22	15	20	48	44	35	49
	"	46	34	54	41	40	19	13	16	42	44	48	56	30
	"	30	33	39	35	30	15	8	3	6	24	54	58	56
	"	31	26	30	29	21	14	10	8	10	13	21	16	18
	"	40	33	45	48	43	24	19	27	51	53	46	32	18
	"	42	38	31	35	35	23	26	37	31	37	50	48	45
	"	38	35	45	47	48	31	29	26	25	38	52	54	43
	"	38	33	39	34	31	19	9	10	16	29	31	30	30
	"	12	10	12	11	9	5	1	2	4	5	9	11	12
	"	64	42	97	72	50	25	26	38	73	74	73	64	36
	Ad.Gr.	5	5	6	12	14	6	7	10	12	13	25	21	35
	" "	13	16	15	17	12	7	9	12	10	11	14	11	10
	" "	13	4	5	10	7	7	12	18	21	25	31	23	25
	" "	10	10	10	11	7	4	7	7	5	8	16	16	26
	" "	14	15	14	13	12	7	6	6	8	8	9	10	20
	" "	5	6	4	7	5	2	3	4	4	4	12	11	15
4	bF(12)	34	27	26	21	24	21	18	16	20	16	18	18	23
	bF(14)	31	23	25	25	26	21	17	22	22	17	23	27	30
	bF	72	64	60	68	60	56	42	32	42	50	68	88	64
	"	50	42	44	46	30	18	10	10	16	16	24	44	48
	"	46	48	42	44	36	22	14	12	22	22	20	20	22
	"	68	66	58	64	52	36	32	24	30	28	40	52	52
	"	44	36	34	34	26	16	10	8	8	10	8	6	6
	"	56	34	58	70	60	46	36	52	59	54	64	70	52
	"	52	58	25	46	34	20	12	24	30	30	56	70	62
	"	86	70	60	51	54	46	28	20	24	20	16	14	20
	"	46	44	38	40	32	28	18	12	28	32	32	36	60
	"	36	34	34	32	26	16	14	20	18	20	24	28	34
	"	40	40	30	28	18	8	6	4	4	2	4	16	8
	"	60	64	64	78	66	54	24	36	46	42	56	54	50
	"	78	68	50	52	50	40	28	20	20	18	14	14	12
	"	40	32	32	26	26	18	12	10	18	16	24	22	14
	"	76	66	40	60	50	30	28	18	22	18	32	36	42
	"	46	40	38	42	30	14	6	8	12	10	8	8	10
	"	22	16	24	24	24	18	14	12	15	16	28	40	22
	"	72	80	74	68	60	46	40	30	28	28	40	46	44
	wS	22	20	18	18	19	16	10	10	12	12	12	14	10
	"	50	34	38	42	30	20	16	20	20	24	30	36	28
	"	66	40	72	96	68	38	26	28	30	40	52	48	34
	"	50	52	74	86	70	50	28	16	30	54	46	48	48
	"	32	42	44	30	22	28	22	30	34	34	34	40	36
	"	30	18	22	26	20	10	4	2	6	10	12	24	22
	"	62	34	42	64	48	32	18	20	26	36	38	30	12

(Area 4 continued next page)

Note:- D.B.H. of trees cut for branch samples shown in brackets in the "Species" column.

APPENDIX I (Continued)

Area No.	Species	Annual Ring Width in Arbitrary Units for:-												
		1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
4	Ad.Gr.	10	10	17	28	29	25	34	38	22	35	33	35	
	" "	10	12	14	18	18	12	10	15	19	23	25	17	15
	" "	4	9	13	8	6	6	7	15	20	15	24	18	17
	" "	18	16	12	22	30	23	28	23	26	29	27	33	35
	" "	11	14	10	10	11	9	12	25	25	22	32	35	35
	" "	7	7	6	8	9	10	10	17	18	21	27	19	23
5	bF(10)	40	36	34	26	20	10	4	2	10	10	14	18	22
	bF(12)	48	42	32	28	28	18	4	2	3	8	16	20	22
	bF	36	34	28	24	22	14	6	2	4	8	8	12	20
	"	54	52	34	30	24	14	6	6	10	12	16	14	8
	"	60	56	52	60	30	22	24	18	12	16	18	30	38
	"	76	38	52	50	36	28	22	16	18	20	24	30	26
	"	46	38	38	34	32	28	22	14	18	28	39	46	36
	"	78	66	56	56	42	38	26	16	18	30	52	62	60
	"	28	28	48	40	28	30	22	10	4	6	4	4	2
	"	22	24	18	18	14	12	6	2	6	8	12	10	16
	"	46	34	26	26	20	12	8	2	4	6	10	20	24
	"	58	56	52	54	22	28	16	8	14	18	22	26	26
	"	52	58	46	52	40	22	12	6	8	10	10	6	4
	"	36	36	42	44	36	22	24	20	22	20	36	40	48
	"	54	42	38	38	26	22	12	6	8	8	6	10	10
	"	32	32	26	22	18	12	10	6	4	6	8	20	22
	"	96	72	52	76	40	26	24	20	14	20	32	38	36
	"	86	82	62	60	50	44	32	26	22	24	38	32	24
	"	42	30	34	32	22	20	12	8	2	4	4	4	8
	"	60	56	40	48	34	28	18	6	8	16	32	48	46
	"	70	58	40	36	28	16	6	2	8	10	8	10	10
wS	wS	32	28	32	30	26	22	14	12	16	26	42	36	36
	"	50	38	36	32	32	24	16	14	16	26	26	26	22
	"	52	46	38	42	34	24	24	18	22	26	34	36	34
	"	38	36	30	26	28	18	8	6	10	20	14	16	20
7	Ad.Gr.	19	6	9	13	17	11	7	2	5	9	7	16	13
	" "	12	40	22	23	29	17	12	15	13	10	22	26	26
	" "	8	2	6	13	13	10	3	3	6	13	22	14	15
	" "	1	1	5	10	16	13	8	14	18	12	21	23	20
	" "	3	1	4	9	8	8	5	3	7	12	20	16	11
	" "	16	3	9	15	18	21	17	12	13	17	19	19	24
6	bF	13	12	12	12	7	5	3	3	3	3	5	4	3
	"	30	26	20	19	13	10	6	3	3	3	6	5	4
	"	15	14	17	12	11	6	5	5	6	5	6	4	3
	"	14	18	19	22	15	10	7	4	3	4	5	3	1
	"	40	36	30	28	21	13	8	7	9	12	14	12	8
	"	39	38	32	27	21	14	6	4	3	4	5	4	4

(Area 6 continued next page)

Note:- D.B.H. of trees cut for branch samples shown in brackets in the "Species" column.

APPENDIX I (Continued)

Area No.	Species	Annual Ring Width in Arbitrary Units for:-												
		1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
6	bF	36	40	40	33	30	16	12	12	15	12	18	16	17
	"	28	30	30	32	20	12	7	8	9	12	15	12	10
	"	34	37	35	31	24	18	12	9	11	10	16	13	10
	"	39	26	18	24	19	13	7	6	5	6	8	7	8
	"	49	37	37	43	33	23	13	14	15	19	17	16	13
	"	34	37	24	17	11	6	2	1	3	5	7	11	7
	"	45	38	55	28	17	8	5	5	7	14	23	35	30
	"	22	24	20	27	26	15	8	5	3	5	8	13	6
	"	26	27	25	25	19	12	7	7	7	6	9	10	6
	"	23	19	18	18	15	13	6	3	2	2	3	2	1
	"	29	35	33	27	23	15	9	3	1	3	5	6	5
	"	16	16	17	16	15	14	8	3	2	3	5	5	3
	"	21	24	26	20	16	13	10	8	12	12	16	14	13
	wS	12	10	10	11	10	6	3	5	6	9	11	9	6
	"	53	37	26	26	22	18	15	9	4	14	14	13	13
	"	26	25	20	20	18	11	4	7	7	12	12	10	7
	"	32	25	34	32	34	20	9	10	10	20	19	14	13
	"	52	38	43	37	31	25	17	12	18	22	28	25	25
	"	14	13	15	12	12	8	6	10	9	10	9	10	11
	"	38	55	64	57	62	36	16	6	10	14	18	16	14
	"	34	37	25	30	57	16	10	14	15	30	25	18	15
	"	40	25	30	16	26	12	14	8	10	18	23	18	16
	"	69	48	45	43	33	19	11	15	20	41	45	24	22
	Ad.Gr.	5	5	6	12	14	6	7	10	12	13	25	21	35
	" "	33	16	15	17	12	7	9	12	10	11	14	11	10
	" "	13	4	5	10	7	7	12	18	21	25	31	23	25
	" "	10	10	10	11	7	4	7	7	5	8	16	16	26
	" "	14	15	14	13	12	7	6	6	8	8	9	10	20
	" "	5	6	4	7	5	2	3	4	4	4	12	11	15
7	bF(10)	36	29	25	19	17	11	7	5	6	8	10	10	6
	bF(11)	37	31	23	23	20	11	6	5	9	16	22	22	17
	bF	56	44	44	42	34	20	10	6	4	6	12	16	12
	"	68	58	50	46	34	22	20	16	8	10	24	36	40
	"	50	50	38	38	34	22	10	6	14	8	22	28	22
	"	48	48	36	34	30	14	8	4	6	8	6	14	10
	"	62	28	62	66	52	36	22	14	12	14	22	28	24
	"	28	26	20	20	22	14	8	8	10	8	8	10	6
	"	58	62	54	54	54	38	22	22	16	24	28	24	18
	"	70	66	80	76	52	36	28	26	30	42	68	62	40
	"	52	56	62	56	48	38	22	20	32	50	92	116	96

(Area 7 continued next page)

Note:- D.B.H. of trees cut for branch samples shown in brackets in the "Species" column.

APPENDIX I (Continued)

Area No.	Species	Annual Ring Width in Arbitrary Units for:-												
		1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
7	bF	74	76	36	34	34	22	10	6	6	10	28	26	12
	"	76	44	26	24	22	10	6	6	9	12	19	18	15
	"	34	37	31	32	30	20	9	5	9	8	13	15	11
	"	44	55	49	44	42	30	21	9	3	6	7	11	9
	"	60	56	70	90	70	50	34	28	26	32	38	44	28
	"	48	46	46	50	22	26	19	17	19	31	55	72	46
	"	68	46	40	48	56	32	21	37	31	45	53	54	46
	"	51	41	25	27	24	19	13	9	7	13	35	29	23
	"	63	43	45	45	33	17	5	3	3	9	15	19	11
	wS	52	46	44	38	40	28	22	22	24	36	48	44	32
	"	44	26	34	56	46	24	24	28	38	20	26	30	20
	"	86	88	88	74	70	42	28	38	46	78	92	98	70
	"	46	42	52	56	56	36	30	30	28	36	38	32	30
	"	44	30	36	30	34	16	10	8	14	22	42	44	34
	"	46	42	34	38	40	28	24	34	34	50	60	56	30
	"	64	38	34	34	34	18	6	10	34	30	40	54	48
	"	44	28	28	24	34	18	10	16	14	28	26	32	32
	"	62	52	48	38	50	28	12	16	24	38	62	60	44
	"	26	24	28	24	22	10	4	4	8	10	10	10	8
	"	40	26	30	28	32	20	12	18	22	38	36	28	16
	"	18	16	20	24	18	10	8	6	8	22	32	36	28
	"	86	60	46	38	32	10	12	14	12	18	32	32	40
	Ad.Gr.	12	24	18	20	20	17	5	3	2	7	8	6	10
	" "	7	17	20	11	16	17	3	2	3	3	5	6	9
	" "	23	25	8	22	17	9	8	9	17	11	17	15	16
	" "	16	16	14	17	14	4	2	3	8	6	12	15	15
	" "	10	9	12	16	12	15	22	1	1	2	5	8	7
	" "	17	17	7	12	17	27	29	24	19	19	30	25	21
8	bF(8)	8	9	9	7	5	5	2	1	1	2	4	4	4
	bF(9)	12	10	6	2	4	1	1	1	2	3	6	7	4
	bF	54	60	52	40	22	20	12	4	6	10	18	22	22
	"	16	12	12	14	14	12	10	8	2	4	4	4	6
	"	66	62	48	30	24	8	6	2	4	8	12	14	12
	"	26	22	24	18	16	12	6	4	4	6	8	12	18
	"	14	16	16	10	10	6	4	2	4	4	6	8	10
	"	26	14	20	14	10	6	6	4	2	4	4	6	8
	"	46	48	32	36	28	22	4	2	2	4	4	10	6
	"	40	38	32	24	20	8	6	6	4	8	16	24	22
	"	28	18	14	10	10	8	6	6	4	6	10	16	14
	"	28	24	22	20	16	6	6	6	2	2	4	4	6
	"	34	32	32	24	20	12	6	2	4	6	8	14	18
	"	28	28	16	10	8	4	4	2	2	4	6	8	10
	"	32	26	20	12	14	6	2	2	2	4	6	10	14
	"	46	58	44	34	26	16	6	6	4	4	10	24	28
	"	28	30	36	26	22	18	14	6	6	6	8	16	22

(Area 8 continued next page)

Note:- D.B.H. of trees cut for branch samples shown in brackets
in the "Species" column.

APPENDIX I (Continued)

Area No.	Species	Annual Ring Width in Arbitrary Units for:-												
		1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
8	bF	20	20	22	16	14	6	6	4	2	2	2	4	6
	"	42	34	32	26	20	10	8	6	12	20	26	26	30
	"	76	66	56	60	84	80	46	40	25	20	18	24	26
	"	50	48	40	30	26	14	8	8	8	8	12	16	14
	"	20	20	20	20	22	14	10	4	4	2	2	2	2
	wS	30	22	16	12	14	8	4	6	4	6	14	30	26
	"	26	20	18	10	10	8	6	4	8	18	24	30	20
	"	54	38	36	26	24	19	14	18	20	36	50	60	46
	"	40	40	28	24	14	18	8	6	4	8	12	10	10
	"	48	32	28	16	16	10	8	6	12	34	46	44	36
	"	40	22	20	14	16	8	2	4	6	16	26	30	34
	"	34	30	34	28	30	16	10	6	4	12	19	16	18
	"	66	56	52	36	32	16	8	2	4	18	22	14	14
	"	22	18	12	10	2	2	8	2	4	4	2	4	4
	Ad.Gr.	5	5	3	2	4	1	3	2	2	11	12	13	13
	" "	5	3	3	2	2	1	3	1	3	7	16	15	21
	" "	2	2	2	2	2	5	1	1	6	7	12	9	14
	" "	3	7	5	8	6	8	3	1	1	2	5	10	14
	" "	18	22	22	16	10	13	1	1	1	12	8	5	4
	" "	16	18	18	15	15	10	8	4	5	2	2	2	3
9	bF	8	13	17	13	10	8	5	2	3	3	7	14	13
	"	34	30	26	18	15	12	7	6	11	15	19	22	27
	"	18	21	20	20	15	8	5	4	6	6	14	15	18
	"	16	11	13	15	13	10	3	3	7	8	7	9	17
	"	10	14	12	10	10	7	3	3	4	4	9	18	15
	"	35	35	33	26	25	18	10	2	3	3	7	6	8
	"	27	30	23	20	20	11	7	7	10	14	18	17	28
	"	27	17	20	19	13	10	6	2	6	6	8	15	10
	"	25	30	28	26	24	15	8	6	8	12	24	30	34
	"	29	30	30	29	23	14	7	5	9	15	26	32	42
	"	20	13	22	21	17	9	9	2	3	2	2	3	6
	wS	32	28	31	29	34	28	12	9	14	26	38	37	33
	"	12	9	7	6	6	2	1	2	2	4	7	7	7
	"	22	19	20	21	17	12	7	3	3	3	13	12	18
	"	12	12	11	4	8	4	2	1	2	2	5	4	5
	"	12	11	9	6	5	4	3	1	1	1	3	3	3
	"	33	27	23	19	16	10	5	1	2	7	11	14	14
	"	23	15	14	13	15	9	3	5	6	11	13	14	13
	"	45	37	33	34	24	13	6	3	2	8	12	20	22
	"	17	16	10	14	10	10	4	1	1	4	6	7	6
	"	22	14	15	13	10	5	2	1	3	6	13	12	10
	"	28	21	24	17	18	12	9	4	4	8	12	22	19
	"	40	33	28	22	35	14	8	4	5	10	14	13	18
	"	7	7	6	8	9	7	3	1	1	3	4	3	4
	"	19	15	15	12	11	7	3	3	2	4	6	4	4
	"	14	16	14	14	12	13	9	6	3	3	3	4	5

(Area 9 continued next page)

Note:- D.B.H. of trees cut for branch samples shown in brackets
in the "Species" column.

APPENDIX I (Continued)

Area No.	Species	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
9	bF	9	14	10	10	12	11	4	5	1	4	5	3	3
	"	11	12	9	8	7	2	1	2	5	6	12	12	11
	"	23	20	26	20	21	12	6	3	4	8	16	20	22
	"	25	18	21	13	16	9	4	2	3	7	10	8	11
	Ad.Gr.	14	6	12	13	10	6	7	9	13	14	24	24	23
	" "	11	18	14	12	10	1	2	2	2	8	8	10	11
	" "	17	14	18	25	23	15	13	13	23	21	28	30	27
	" "	8	11	10	10	14	5	3	5	4	11	16	13	15
	" "	17	15	17	18	14	3	1	2	4	13	17	11	8
	" "	6	7	4	5	6	6	1	2	3	4	6	7	10
	wS	14	14	12	14	18	16	8	5	8	14	20	19	15
	"	15	14	18	16	15	14	12	12	12	12	12	11	10
	"	23	19	17	24	24	19	20	10	13	17	15	15	10
10	bF(7)	12	16	18	13	15	20	17	17	12	14	12	7	5
	bF(13)	15	16	12	12	17	16	13	11	11	10	8	8	8
	bF	18	20	18	16	21	21	20	11	12	15	22	25	16
	"	33	30	26	40	40	36	35	27	22	25	33	43	35
	"	25	31	34	36	38	30	31	28	29	26	32	35	23
	"	25	24	20	28	32	31	27	25	20	18	17	20	17
	"	52	47	32	50	56	43	27	25	22	20	27	23	20
	wS	14	14	12	14	18	16	8	5	8	14	20	19	15
	"	15	14	18	16	15	14	12	12	12	12	12	11	10
	"	23	19	17	24	24	19	20	10	13	17	15	15	10
	bF(6)	25	25	16	23	27	22	20	17	16	20	23	22	18
	bF(11)	37	41	40	45	52	39	35	26	31	35	41	35	30
	bF	22	16	18	17	29	25	23	15	5	11	8	13	10
11	"	37	35	33	36	44	38	33	20	27	28	33	30	30
	"	19	17	18	24	28	22	14	10	8	12	11	17	15
	"	26	27	23	32	36	32	28	25	25	24	28	26	21
	"	13	14	9	12	15	15	10	5	8	8	7	8	7
	"	25	29	28	31	36	33	27	23	15	18	20	22	19
	wS	10	10	10	12	15	12	10	9	11	13	21	23	15
	"	11	11	7	5	7	8	10	6	7	4	9	4	5
	"	20	16	13	14	18	14	12	7	7	11	10	13	10
	"	22	21	23	29	35	32	22	17	24	24	31	32	22
	"	22	21	20	22	23	23	18	11	13	14	16	13	10
	"	14	13	12	17	17	20	18	13	13	14	23	22	15
	"	7	8	9	11	8	6	4	4	5	7	10	11	9
12	bF(9)	30	25	20	24	27	30	24	22	17	28	32	33	22
	bF(12)	13	15	10	12	15	13	10	8	8	10	13	19	15
	bF	13	10	9	10	10	6	7	7	7	16	17	20	10
	bF	13	12	10	11	12	10	9	9	6	9	10	13	13
	"	15	15	11	9	10	5	4	3	3	8	4	5	5
	"	37	36	20	27	29	25	19	14	18	27	28	28	20
	"	18	13	10	18	18	15	10	5	7	8	10	10	10

(Area 12 continued next page)

Note:- D.B.H. of trees cut for branch samples shown in brackets in the "Species" column.

APPENDIX I (Continued)

Area No.	Species	Annual Ring Width in Arbitrary Units for:-												
		1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
12	wS	41	30	24	38	25	20	24	16	27	55	60	52	30
	"	20	13	10	15	15	10	10	5	14	17	20	17	15
	"	28	24	22	33	35	24	24	22	23	35	47	50	30
	"	22	20	26	29	26	17	22	17	18	25	22	25	10
	"	10	10	11	15	10	7	9	8	10	11	10	10	7
	"	34	30	22	30	20	22	22	20	24	42	40	32	25
	"	37	32	34	32	20	12	10	3	10	19	27	30	22
	"	21	15	12	15	13	8	10	5	8	13	16	15	10
13	bF	15	8	9	10	11	9	9	7	5	8	16	16	12
	"	15	19	16	10	14	15	7	9	3	17	12	13	12
	"	11	17	15	14	11	7	8	4	3	6	8	11	10
	"	13	15	8	8	7	6	12	6	6	5	7	8	8
	"	27	25	25	26	23	16	14	9	7	8	13	14	13
	"	8	8	7	5	5	3	5	3	5	5	8	8	8
	wS	11	10	12	12	12	7	8	6	8	8	10	8	10
	"	14	10	14	14	13	6	10	6	11	15	14	20	10
14	"	10	6	5	7	5	4	6	5	5	12	14	10	10
	"	45	29	24	31	30	15	16	13	20	27	30	31	15
	"	14	11	17	20	20	10	12	11	11	20	20	20	15
	"	20	16	20	26	23	10	13	7	10	15	20	17	15
	"	14	12	10	11	10	4	6	6	8	10	9	9	7
	"	25	23	20	27	25	10	12	10	11	23	35	30	20
	"	16	13	16	18	15	9	6	3	4	8	11	21	20
	wS	13	20	20	15	22	21	10	5	3	8	15	19	18
15	bF(8)	16	14	13	16	16	14	6	3	6	11	17	19	15
	bF(9)	41	40	32	40	40	26	13	5	7	17	20	27	22
	bF	"	38	34	22	30	28	15	10	5	4	13	32	40
	"	"	18	31	30	25	25	21	11	3	1	5	23	32
	"	"	40	35	32	35	34	17	10	3	6	9	20	33
	"	"	28	25	25	20	12	17	14	6	4	3	5	5
	wS	4	3	5	5	3	4	3	2	1	3	3	3	3
	"	65	60	52	54	50	32	16	11	15	20	26	26	18
15	"	43	51	45	26	16	9	5	2	8	24	32	30	20
	"	34	31	36	38	39	23	14	3	2	12	21	38	24
	bF(8)	47	48	36	42	31	18	10	8	16	30	48	52	35
	bF(10)	21	20	18	22	15	9	5	5	7	8	14	11	10
	bF	"	60	52	38	17	22	25	22	10	18	28	50	43
	"	"	46	43	42	50	38	26	14	9	16	19	30	30
	"	"	44	39	32	39	35	25	14	11	16	26	28	22
	"	"	24	22	20	23	24	16	13	9	7	10	14	12
	"	"	29	29	25	27	22	12	6	5	9	13	13	9
	"	"	28	22	22	21	21	16	10	11	9	12	17	15
	wS	32	27	37	22	23	12	10	5	10	19	18	22	18
	"	"	17	15	26	30	28	19	11	7	5	18	20	30
	"	"	58	60	56	62	45	35	20	21	28	33	58	55
	"	"	35	32	42	41	32	17	7	5	9	25	33	47
	"	"	52	50	52	62	55	30	18	20	32	45	50	30

Note:- D.B.H. of trees cut for branch samples shown in brackets in the "Species" column.

APPENDIX I (Continued)

Area No.	Species	Annual Ring Width in Arbitrary Units for:												
		1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
16	bF	75	70	55	52	45	45	32	25	40	42	60	56	45
	"	48	48	39	32	28	13	6	4	11	23	33	30	28
	"	56	55	50	44	35	20	12	10	18	43	65	60	40
	wS	33	27	35	25	20	10	4	1	10	14	30	37	25
	"	18	13	13	10	11	7	2	1	3	8	10	9	8
	"	12	14	14	8	10	8	2	1	3	4	6	9	8
17	bF(13)	27	23	26	25	19	11	4	2	2	6	12	17	14
	bF(11)	17	28	25	20	18	14	7	3	5	20	26	22	14
	bF	24	14	12	11	12	6	3	1	1	2	3	5	5
	"	24	30	24	20	16	18	10	6	3	7	10	1	10
	"	22	28	27	25	29	21	12	4	2	6	7	15	16
	"	25	26	24	24	22	19	11	9	6	6	7	15	16
	"	22	20	22	21	20	15	8	8	5	5	8	10	11
	"	27	28	33	39	29	20	8	3	2	5	10	10	32
	"	21	16	13	20	21	17	9	7	6	8	16	18	15
	"	38	35	35	42	36	33	22	13	15	18	25	28	30
	"	20	15	28	32	20	27	18	13	5	10	11	17	21
	"	27	23	26	39	37	25	10	3	4	7	9	11	11
	"	38	50	50	55	50	30	16	6	10	18	27	19	11
	"	40	43	40	40	32	22	13	6	4	7	28	30	23
	"	41	40	37	40	32	22	15	10	5	6	14	13	11
	"	40	45	37	36	32	17	6	2	3	6	20	34	30
	"	15	15	16	14	15	12	9	3	2	3	7	16	18
	wS	35	24	25	19	18	9	7	4	4	13	17	18	17
	"	13	11	12	10	8	8	6	2	1	1	2	1	3
	"	48	65	52	50	48	43	16	6	3	12	42	60	40
	"	9	13	13	17	14	15	8	4	1	8	7	9	10
	"	20	14	17	14	18	22	17	9	5	20	18	16	13
Ad.Gr.	Ad.Gr.	12	15	25	26	19	6	11	11	21	11	20	26	30
	" "	13	15	20	20	12	5	3	1	4	11	23	21	17
	" "	13	14	15	17	15	9	5	7	18	26	36	35	36
	" "	19	8	5	8	8	3	5	6	10	17	39	40	28
	" "	10	10	14	17	14	6	8	12	11	13	20	25	22
	" "	15	18	20	26	21	14	7	4	6	11	25	41	30
18	bF(6)	10	10	14	14	14	7	4	3	2	4	15	11	11
	bF(7)	26	31	33	40	40	30	18	10	3	11	32	36	36
	bF	38	47	43	42	28	15	6	4	3	4	8	10	11
	"	28	27	29	38	30	16	8	7	5	10	16	19	23
	"	37	38	37	43	35	28	17	8	7	11	29	29	28
	"	35	36	37	36	28	20	11	6	6	13	28	36	37
	"	21	20	12	14	14	8	5	4	2	4	5	9	10
	"	26	23	22	30	26	15	10	4	3	10	22	21	20
	"	24	32	35	30	24	16	8	9	4	6	17	20	15
	"	28	30	32	33	28	17	12	7	8	14	30	37	30
	"	25	23	29	30	28	20	8	5	4	7	13	20	28

(Area 18 continued next page)

Note:- D.B.H. of trees cut for branch samples shown in brackets in the "Species" column.

APPENDIX I (Continued)

Area No.	Species	Annual Ring Width in Arbitrary Units for:-												
		1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
18	bF	35	46	50	48	35	23	12	6	8	12	17	25	23
	"	26	30	35	37	28	21	12	4	2	4	12	24	23
	"	48	50	50	50	40	20	9	1	5	12	20	18	20
	"	22	31	33	32	32	21	8	2	2	3	10	12	18
	"	27	30	28	32	25	10	4	2	5	8	17	19	19
	wS	11	9	10	10	10	7	2	3	4	10	12	13	10
	"	2	2	2	2	2	2	1	4	2	3	6	5	3
	"	27	25	30	20	25	15	10	10	10	9	15	15	15
	"	19	17	25	26	25	15	9	6	9	24	32	23	22
	"	11	11	15	17	12	7	3	1	2	6	7	10	10
	"	50	45	48	40	32	20	10	6	7	15	21	30	40
	"	21	18	15	17	19	10	6	6	5	10	13	14	13
	"	22	22	30	32	28	17	8	2	3	15	26	28	28
	Ad.Gr.	18	20	17	10	3	4	10	15	15	11	42	36	37
	" "	17	18	20	21	24	15	3	2	1	6	15	21	16
	" "	42	20	32	34	18	8	2	1	4	12	30	32	42
	" "	24	20	16	20	25	30	35	29	34	18	33	33	34
	" "	10	12	16	19	12	5	13	18	22	23	43	38	35
	" "	18	18	20	21	19	11	9	11	10	11	18	22	32
19	bF(12)	43	45	43	41	27	15	9	2	2	4	6	10	10
	bF(13)	30	23	20	15	13	11	9	6	3	4	5	7	9
	bF	36	36	43	30	28	25	26	13	6	4	8	7	9
	"	19	25	26	24	27	27	19	8	7	5	5	8	7
	"	23	17	15	14	16	13	11	7	4	5	12	13	13
	"	22	15	15	20	18	10	6	4	3	6	8	8	10
	"	38	35	30	31	29	16	12	10	6	5	10	12	12
	"	52	41	40	42	40	24	14	7	7	5	12	8	7
	"	32	35	27	36	28	20	15	7	7	4	20	16	25
	"	31	32	32	26	22	20	16	8	9	4	6	6	6
	"	33	34	37	37	33	16	8	9	8	7	15	18	20
	"	47	44	43	42	50	38	25	22	8	7	28	27	27
	"	52	42	23	25	24	19	11	5	4	9	19	18	16
	"	36	47	40	18	16	14	7	6	1	4	6	10	10
	"	42	38	35	32	27	20	12	8	4	6	15	22	32
	"	52	42	29	30	27	18	13	5	3	8	15	20	23
	"	43	43	34	41	38	27	12	7	4	7	19	28	33
	"	64	76	100	100	87	40	16	11	20	30	48	46	33
	"	30	33	30	36	31	18	6	2	2	6	15	19	15
	"	41	40	37	43	34	25	12	7	4	8	9	8	11
	wS	43	39	31	30	26	15	5	7	9	13	15	19	18
	"	42	31	32	33	26	15	5	3	6	14	24	26	23
	"	26	27	33	33	27	15	10	6	3	13	18	18	13
	"	90	88	78	75	80	45	47	32	29	53	64	67	42
	Ad.Gr.	3	3	6	10	10	3	3	3	8	23	26	22	25
	" "	10	13	21	27	14	4	8	13	18	21	23	20	25
	" "	17	19	21	17	11	4	3	3	2	1	5	11	15
	" "	11	14	10	14	12	6	3	4	8	12	18	18	20
	" "	10	10	13	14	11	5	2	4	10	9	18	17	21
	" "	14	9	12	23	7	2	3	7	11	20	25	20	20

APPENDIX I (Continued)

Area No.	Species	Annual Ring Width in Arbitrary Units for:-												
		1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
20	bF(12)	32	28	24	24	21	16	14	8	10	10	15	18	10
	bF(13)	36	52	23	33	40	30	24	28	15	23	24	30	27
	bF	48	41	38	41	30	21	14	10	7	7	10	10	7
	"	36	29	28	28	23	17	9	7	8	13	13	10	5
	"	52	44	38	50	41	26	15	10	10	15	22	22	20
	"	41	33	30	26	18	12	8	7	8	12	18	20	13
	"	26	33	35	30	23	24	14	7	3	4	6	9	10
	"	38	33	31	33	26	20	12	8	5	7	10	12	8
	"	30	30	20	21	20	16	9	3	2	5	5	5	2
	"	30	33	27	24	19	13	10	7	6	8	14	13	7
	"	60	54	33	32	27	21	15	10	12	16	24	28	20
	"	43	41	37	34	34	23	15	12	12	11	20	21	16
	"	34	32	30	30	27	21	17	14	18	22	23	23	15
	"	52	41	32	39	24	22	15	11	10	13	17	15	12
	"	62	51	47	55	52	37	25	28	28	35	40	39	29
	"	72	79	68	62	49	37	27	21	16	17	24	26	19
	"	15	12	14	13	11	9	5	3	5	7	16	20	19
	"	51	41	36	43	30	26	12	11	7	9	15	13	8
	"	33	40	29	32	28	20	16	11	6	7	14	17	10
	"	56	46	38	40	33	25	16	15	14	15	22	21	15
	"	30	24	30	31	30	24	18	10	3	6	5	6	3
	wS	55	43	32	26	25	18	10	7	11	20	20	30	25
	"	26	25	25	23	21	13	10	8	11	17	26	24	12
	"	53	28	31	26	26	12	6	5	11	34	48	30	17
	"	68	42	46	62	44	18	13	15	15	18	28	26	11
	"	82	55	58	48	44	25	17	8	10	25	34	34	20
	"	38	38	54	47	32	19	8	5	9	15	25	25	13
	"	28	26	21	20	23	12	7	4	5	9	17	16	11
	"	24	14	17	13	18	9	7	7	9	14	19	19	13
	"	45	32	34	28	23	11	3	1	6	15	25	25	13
	Ad.Gr.	5	2	4	4	6	7	11	13	25	21	26	29	15
	" "	35	22	17	17	16	16	15	19	12	11	20	21	10
	" "	18	10	10	18	16	10	15	13	16	18	30	27	16
	" "	15	13	12	18	20	15	19	18	20	25	37	37	22
	" "	8	12	20	15	17	7	22	25	24	17	35	30	25
	" "	10	3	10	16	14	7	3	3	6	7	13	19	13
21	bF(8)	34	36	40	43	33	17	10	5	4	12	30	37	35
	bF(9)	41	50	60	60	52	28	17	11	9	13	20	32	30
	bF	38	45	50	54	52	45	30	12	5	7	11	14	14
	"	32	31	32	38	29	15	5	4	3	6	20	18	15
	"	30	35	36	39	31	18	10	7	6	12	28	24	20
	"	10	8	7	7	11	12	5	3	1	2	4	4	6
	"	52	55	52	55	52	33	20	15	10	17	28	32	35
	"	36	44	50	55	45	23	11	6	8	14	36	33	23
	"	37	38	33	34	34	24	14	14	15	22	28	26	20
	"	13	22	15	24	20	17	10	4	3	6	12	15	17
	"	13	16	21	23	20	13	7	3	5	6	8	12	10
	"	28	39	47	35	27	34	22	16	9	17	36	48	35

Note:- D.B.H. of trees cut for branch samples shown in brackets in the "Species" column.

APPENDIX I (Continued)

Area No.	Species	Annual Ring Width in Arbitrary Units for:-												
		1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
wS	wS	32	35	37	33	15	9	2	6	10	35	45	50	30
22	bF(11)	55	50	38	50	42	22	13	8	6	9	13	13	16
	bF(12)	37	35	38	46	45	29	13	10	10	12	13	19	20
	bF	30	33	29	32	32	25	17	14	18	15	20	20	25
	"	18	18	20	22	21	13	7	5	7	8	12	12	12
	"	21	21	21	21	16	8	6	8	7	11	9	10	10
	"	13	13	12	17	23	15	10	4	9	8	14	16	15
	"	14	12	13	12	10	11	10	10	5	3	5	6	6
	"	33	34	26	27	27	17	10	7	8	8	10	11	12
	"	54	45	33	34	41	26	20	16	15	18	20	17	18
	"	45	40	34	32	30	22	15	7	10	13	24	22	22
	wS	24	20	17	27	28	12	6	5	7	9	16	14	15
	"	35	31	32	38	28	20	12	13	18	25	32	31	28
23	bF(7)	36	28	26	40	33	21	10	6	5	13	20	20	10
	bF(9)	64	58	56	58	38	26	17	12	5	7	9	7	5
	bF	31	27	30	31	30	15	8	4	3	5	9	9	7
	"	56	43	30	33	21	10	5	3	3	4	12	6	6
	"	36	37	40	37	28	20	14	9	8	8	10	9	7
	"	36	35	38	42	37	24	13	8	8	8	10	15	14
	"	55	52	42	41	34	26	16	14	9	9	10	18	15
	"	42	29	36	48	45	25	12	3	3	3	6	16	15
	"	43	31	27	31	30	17	10	5	4	9	21	10	5
	"	26	25	23	23	22	17	11	10	3	5	8	5	5
	"	38	42	40	32	24	17	9	4	4	4	8	10	7
	"	28	35	40	39	33	22	13	12	8	7	12	14	10
	"	42	37	29	27	21	14	9	5	5	2	3	4	2
	"	20	22	25	22	13	6	2	2	4	4	10	7	3
	wS	37	26	36	42	27	15	5	1	6	17	26	30	20
	"	52	43	32	37	28	20	15	10	14	35	45	28	20
	"	29	26	26	27	21	8	2	4	20	28	46	25	12
	"	16	17	22	28	22	9	4	2	1	3	7	6	3
	"	29	27	37	25	15	13	10	6	7	8	13	10	7
	"	37	27	30	26	16	7	3	3	4	8	12	12	10
	"	13	12	13	9	11	5	3	2	2	4	4	5	5
	"	20	24	30	26	20	6	4	2	3	9	11	12	5
24	bF(7)	18	15	13	13	15	9	5	4	5	8	12	11	10
	bF(9)	14	14	17	16	15	17	15	15	11	6	6	7	10
	bF	23	20	18	18	18	11	6	3	2	3	5	5	5
	"	31	29	23	30	31	26	16	16	12	20	30	30	23
	"	16	15	15	13	9	5	4	5	4	10	6	8	5
	"	26	25	19	15	13	7	4	2	3	5	4	2	5
	"	18	14	16	15	15	11	8	3	3	3	4	5	1
	"	13	15	11	12	13	10	5	5	5	5	10	15	14
	"	5	3	3	2	4	3	2	2	2	2	2	3	6
	"	34	27	24	21	19	15	11	11	8	6	6	6	11
	"	27	25	13	22	22	13	9	5	6	6	8	11	13
	"	20	18	15	18	15	12	6	8	10	10	15	13	13

Note:- D.B.H. of trees cut for branch samples shown in brackets
(Area 24 continued next page)

APPENDIX I (Continued)

Area No.	Species	Annual Ring Width in Arbitrary Units for:-												
		1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
24	bF	28	19	20	22	18	11	8	7	7	8	13	13	13
	wS	22	18	19	17	15	8	3	2	1	2	3	5	3
	"	12	13	14	17	23	17	12	12	12	22	33	32	19
	"	38	36	40	42	43	23	18	22	22	30	40	38	30
	"	30	20	29	29	23	10	6	2	3	10	15	12	10
	"	10	9	11	12	11	6	5	4	5	6	8	8	7
	"	6	7	8	6	7	6	8	7	5	6	9	8	5
	"	12	12	17	15	17	10	7	4	10	13	18	20	16
	"	21	23	32	29	25	9	8	7	8	13	31	31	12
	"	26	27	22	21	23	9	6	5	3	5	12	16	7
	"	26	42	52	44	31	27	23	16	15	20	25	28	20
25	bF(8)	62	52	50	58	49	33	22	21	12	13	24	27	18
	bF(9)	53	54	46	47	47	40	26	19	13	15	17	15	12
	bF	54	40	42	43	44	22	13	13	13	12	19	23	15
	"	50	42	48	52	50	33	21	13	11	10	19	16	17
	"	40	33	28	27	25	20	16	11	10	10	28	25	20
	"	62	54	64	57	49	35	33	25	19	18	24	20	17
	"	47	42	52	51	46	31	20	12	10	7	13	12	10
	"	28	31	30	30	25	22	14	18	20	15	19	30	23
	"	32	39	41	49	40	26	13	7	5	6	15	13	8
	"	52	47	52	50	39	39	31	20	17	12	27	30	30
	"	45	34	24	25	14	10	6	9	9	7	12	11	10
	"	58	50	45	55	48	37	22	14	12	12	20	22	26
	"	53	43	44	45	41	32	19	12	9	9	15	16	15
	"	41	38	43	48	40	37	27	24	21	16	21	18	20
	"	75	74	52	53	40	30	21	15	12	12	18	20	20
	"	23	22	23	19	16	10	4	2	3	3	6	8	7
	wS	37	27	16	29	36	22	21	26	33	45	56	39	22
	"	53	45	45	49	42	22	17	16	21	39	52	36	32
	"	20	43	22	23	25	17	11	5	10	10	31	98	25
	"	24	24	23	32	33	18	13	13	15	28	45	18	13
	"	27	23	23	33	28	11	6	8	8	12	12	10	6
	"	48	40	46	46	37	28	15	12	12	16	22	23	18
	"	80	66	61	74	71	47	35	38	58	77	46	57	48
	"	43	43	42	37	27	17	12	13	13	26	40	31	28
	"	72	53	28	53	53	20	15	30	50	61	60	64	42
	"	17	15	20	22	22	16	13	9	8	9	12	16	18
	Ad.Gr.	23	13	13	18	13	8	10	16	16	10	12	13	10
	" "	19	20	23	24	14	11	8	5	7	10	15	13	13
	" "	16	17	7	23	21	17	13	17	17	15	22	18	15
	" "	12	13	20	20	19	15	12	15	18	12	24	16	16
	" "	30	28	28	27	23	15	8	14	12	14	16	18	20
	" "	22	30	27	28	28	16	16	21	20	17	23	8	4
26	bF(9)	36	50	39	38	37	19	14	10	9	9	10	13	18
	bF(10)	20	16	23	26	30	19	11	8	9	7	11	16	18
	bF	33	37	35	44	39	28	17	13	14	11	19	18	18
	"	33	20	35	45	46	42	24	12	8	12	18	13	11

Note:- D.B.H. of trees cut for branch samples shown in brackets in the "Species" column.

APPENDIX I (Continued)

Area No.	Species	Annual Ring Width in Arbitrary Units for:-												
		1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
26	bF	33	37	35	44	39	28	17	13	14	11	19	18	18
	"	33	20	35	45	46	42	24	12	8	12	18	13	11
	"	50	42	32	37	37	28	17	15	7	7	10	15	10
	"	46	42	48	57	52	38	27	22	25	30	50	57	53
	"	41	32	29	27	27	19	15	11	5	6	13	14	20
	"	21	16	15	16	15	11	9	4	5	4	5	6	7
	"	27	18	14	20	22	15	12	9	5	3	8	7	7
	"	78	55	50	57	53	43	35	25	18	15	30	33	31
	"	16	10	12	15	17	13	8	6	7	5	11	11	9
	"	44	34	33	34	35	24	18	16	13	13	38	57	60
	"	10	8	16	17	10	9	8	10	1	9	11	14	15
	"	18	19	21	18	20	14	11	8	6	5	13	17	15
	"	88	67	53	61	53	41	28	22	9	8	17	24	18
	"	35	28	25	27	28	20	15	16	12	10	18	24	20
	"	33	28	36	45	47	33	25	13	16	18	26	25	30
	"	26	21	14	10	13	10	6	5	2	3	7	7	4
	"	52	53	47	50	46	26	16	10	6	7	14	23	26
	"	45	52	46	26	32	28	18	10	8	3	4	6	5
	"	78	61	50	52	54	42	26	21	15	13	27	37	37
	"	53	36	23	30	32	26	14	9	7	7	11	17	17
	"	34	26	22	26	31	23	20	13	8	6	5	6	8
	wS	27	22	20	25	20	17	12	17	16	28	28	26	23
	"	10	10	6	9	6	4	1	2	2	2	3	4	4
	"	67	51	43	32	37	31	25	9	11	13	9	10	7
	"	32	23	13	25	20	12	6	6	3	8	11	15	13
	"	11	9	9	10	10	6	5	7	5	4	5	7	7
	"	18	18	27	23	13	10	7	5	6	10	18	30	26
	"	28	21	21	29	27	20	14	12	9	13	20	20	14
	"	16	13	12	16	17	9	7	9	10	18	42	32	23
	"	26	24	30	35	27	21	11	14	13	18	23	22	20
	"	28	25	28	48	32	23	16	22	18	19	28	33	24
	"	22	22	21	22	28	22	17	10	7	13	26	26	23
	"	43	28	28	28	25	20	10	10	12	25	32	30	24
	Ad.Gr.	13	15	16	20	21	12	27	21	25	22	28	35	40
	" "	12	11	11	18	15	7	9	12	16	14	28	32	32
	" "	7	8	14	17	14	9	10	16	12	11	14	20	33
	" "	10	11	10	11	12	10	10	7	14	13	20	19	17
	" "	12	10	13	18	18	9	11	13	20	16	21	17	12
	" "	12	13	14	17	15	13	14	10	24	30	28	38	43
27	bF(10)	49	43	46	48	42	26	15	6	4	5	15	20	18
	bF(12)	58	50	42	38	32	19	11	5	3	7	13	20	18
	bF	46	46	45	45	40	23	13	9	5	7	17	16	12
	"	38	36	37	38	32	18	8	5	3	4	6	8	5
	"	9	16	18	22	29	21	11	6	2	4	7	6	5
	"	28	32	25	28	27	18	10	7	7	7	26	23	25
	"	33	24	20	24	14	7	4	3	2	5	7	15	21
	"	62	62	46	44	40	21	10	6	3	5	10	11	9
	"	48	53	41	40	35	20	14	14	15	23	30	23	22

(Area 27 continued next page)

Note:- D.B.H. of trees cut for branch samples shown in brackets
in the "Species" column.

APPENDIX I (Continued)

Area No.	Species	Annual Ring Width in Arbitrary Units for:-												
		1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
27	bF	43	38	44	34	11	12	11	8	7	13	20	23	18
	"	67	67	53	55	48	28	16	20	17	31	52	47	46
	"	32	35	35	38	32	17	9	5	5	6	10	5	10
	"	41	40	33	32	30	16	10	10	10	13	19	12	17
	"	64	57	48	48	38	20	10	5	5	7	14	19	19
	"	31	30	45	44	40	34	22	8	3	6	7	7	10
	"	44	41	33	38	33	19	9	7	7	12	23	25	20
	"	70	64	62	58	48	28	10	5	3	5	21	38	22
	"	42	36	34	39	34	21	14	9	6	8	14	18	13
	"	52	52	37	50	40	18	11	7	6	8	18	21	19
	"	30	20	18	21	17	10	6	4	4	4	9	12	8
	"	50	54	42	42	38	22	15	15	16	21	30	26	21
	"	42	40	44	39	31	16	8	5	7	10	16	19	24
	"	70	58	47	45	31	19	8	4	3	4	6	11	14
	"	20	19	21	21	20	9	5	3	2	3	7	10	12
	wS	33	26	27	40	20	12	6	7	13	32	41	34	19
	"	31	31	21	24	16	12	8	9	7	9	10	14	13
	"	24	19	21	24	23	18	16	15	16	16	20	27	16
	"	3	3	4	5	4	3	1	6	3	5	6	6	4
	"	33	43	59	66	50	32	40	36	33	40	36	25	21
	"	37	33	28	39	30	18	16	16	15	25	28	24	17
	"	10	7	5	6	3	2	2	3	2	4	5	5	4
	"	32	33	32	41	48	27	19	20	21	46	42	37	28
	"	38	32	41	52	42	30	26	24	28	42	40	40	34
	"	54	40	31	30	28	17	11	7	5	7	10	14	16
	Ad.Gr.	8	9	15	15	13	13	16	14	21	20	25	22	24
	" "	10	5	9	10	10	12	10	7	14	22	20	22	26
	" "	15	19	15	18	16	13	20	22	15	17	22	25	3
	" "	8	8	12	12	11	7	10	13	21	20	24	24	26
	" "	15	12	11	12	8	3	5	4	6	8	7	6	9
	" "	11	8	7	11	10	10	6	1	2	21	28	25	38
28	bF(8)	23	18	17	17	9	6	4	4	5	7	5	4	10
	bF(9)	38	38	32	27	20	11	6	2	5	7	15	11	14
	bF	26	32	32	26	20	13	12	7	7	6	10	18	15
	"	18	16	14	13	12	6	3	2	3	3	4	7	6
	"	10	12	11	5	5	4	3	2	2	3	6	7	6
	"	8	7	9	7	7	6	2	2	2	3	3	3	2
	"	16	14	12	8	5	3	2	2	3	3	4	2	2
	"	41	41	39	35	13	8	6	6	5	8	20	31	39
	"	15	16	11	9	8	4	2	1	1	2	2	1	1
	"	35	34	27	27	21	11	5	3	4	8	12	15	13
	"	28	26	23	24	16	7	4	3	3	2	5	8	9
	"	42	38	29	26	24	20	13	9	9	11	17	16	16
	"	16	16	15	15	17	9	7	8	5	5	6	8	5
	"	28	30	27	29	26	21	17	9	9	12	15	18	18
	"	26	26	26	28	27	19	13	11	4	5	3	4	4
	"	19	22	18	16	12	7	2	2	1	3	4	5	5
	"	27	20	21	24	23	16	10	6	4	8	12	9	6

(Area 28 continued next page)

Note:- D.B.H. of trees cut for branch samples shown in brackets in the "Species" column.

APPENDIX I (Continued)

Area No.	Species	Annual Ring Width in Arbitrary Units for:-												
		1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
28	wS	20	17	17	16	13	6	5	3	2	5	6	8	8
	"	28	21	22	20	16	8	4	3	4	8	9	7	6
	"	37	31	34	29	23	9	3	2	1	5	12	14	15
	"	11	11	12	14	14	9	6	5	7	13	18	18	12
	"	48	46	39	31	32	17	10	11	16	30	45	45	37
	"	26	19	22	17	12	6	3	3	4	4	8	11	9
	"	10	12	7	8	4	5	1	2	4	4	18	15	14
	"	14	16	13	13	15	12	6	2	1	2	5	4	3
	"	38	26	27	18	17	12	12	6	4	3	7	11	11
	"	35	27	26	25	17	7	3	2	2	3	6	9	10
	"	22	17	15	17	15	9	3	4	5	10	16	14	12
	"	15	13	15	15	12	5	2	3	3	4	8	10	8
	"	30	28	30	33	28	17	12	6	2	7	10	13	8
	Ad.Gr.	8	12	10	10	12	4	3	6	9	11	17	17	15
	" "	6	10	6	10	6	7	10	13	10	12	24	25	22
	" "	11	17	14	15	15	6	5	6	11	11	24	22	20
	" "	20	20	15	12	12	4	3	5	15	20	22	20	20
	" "	17	20	21	23	18	10	8	13	15	13	20	23	22
	" "	25	25	21	20	18	5	3	6	5	9	19	18	17
29	bF(9) bF(10)	52	47	35	44	41	33	23	20	17	18	28	30	21
	bF	25	18	17	25	20	12	5	3	2	7	8	10	8
	"	54	43	41	47	41	38	20	28	20	24	34	33	28
	"	27	18	20	24	19	10	5	4	3	4	9	11	8
	"	45	40	32	39	40	33	30	30	22	25	30	28	11
	"	15	15	12	12	11	7	3	2	3	4	6	10	6
	"	44	44	36	41	34	26	19	10	10	12	19	24	16
	"	8	10	10	12	8	6	3	2	3	4	4	5	4
	"	40	35	22	27	18	10	5	7	6	8	16	19	16
	"	23	25	15	24	23	15	7	5	5	6	6	6	4
	"	39	38	28	33	26	19	16	11	9	12	21	20	8
	"	32	27	17	20	14	7	5	3	2	2	3	4	4
	"	16	23	23	20	20	14	10	3	3	4	8	8	6
	"	35	43	35	26	20	20	13	10	8	8	13	14	10
	"	13	14	15	18	14	11	6	3	3	4	6	6	4
	"	5	6	7	6	5	7	7	2	1	4	6	5	4
	"	40	35	27	26	18	9	6	4	3	4	8	7	6
	wS	12	10	13	13	10	7	4	3	3	10	13	10	6
	"	45	37	40	35	24	14	8	5	9	17	24	20	11
	"	18	16	16	18	13	10	5	4	3	6	10	8	6
	"	28	12	15	25	28	20	18	10	6	11	16	17	11
	"	19	21	22	23	23	16	11	16	17	28	31	29	15
	"	41	23	24	25	25	11	6	5	5	8	12	13	10
	"	21	19	16	21	17	9	5	3	2	6	9	9	8
	"	52	41	41	40	32	23	16	11	12	22	22	24	13
	"	29	21	20	23	15	10	6	4	4	6	10	10	6
	"	35	24	31	24	14	13	5	2	2	9	17	21	17
	"	23	21	11	9	10	7	2	1	1	2	5	7	3

(Area 29 continued next page)

Note:- D.B.H. of trees cut for branch samples shown in brackets
in the "Species" column.

APPENDIX I (Continued)

Area No.	Species	Annual Ring Width in Arbitrary Units for:-												
		1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
29	Ad.Gr.	11	18	31	28	23	11	3	12	17	1	15	14	15
	" "	2	2	4	9	8	5	3	3	8	8	10	10	6
	" "	7	7	5	9	8	6	4	3	4	3	7	9	8
	" "	10	6	11	18	18	17	5	4	6	5	10	13	15
	" "	11	15	16	18	12	3	3	1	5	9	20	15	15
30	bF(8)	60	52	43	50	46	31	17	14	12	27	30	25	8
	bF(9)	43	46	41	40	42	25	18	11	10	13	19	20	12
	bF	33	31	33	33	33	21	12	12	10	13	17	17	15
	"	27	23	26	22	16	13	7	6	4	5	10	7	5
	"	48	43	37	46	42	30	17	14	13	16	21	17	12
	"	36	35	34	36	32	23	14	15	11	13	18	17	14
	"	18	23	22	28	25	14	8	2	3	4	7	5	1
	"	48	45	37	40	36	31	22	17	12	15	21	18	14
	"	46	45	37	40	30	22	11	8	3	6	8	7	3
	"	29	26	25	31	27	25	28	26	20	11	5	5	6
	"	23	32	23	23	27	14	13	7	4	3	3	4	3
	"	20	25	30	38	35	22	13	13	7	8	10	7	1
	"	23	20	17	18	16	6	2	3	4	5	8	6	4
	"	21	17	12	12	14	11	4	2	3	3	6	6	2
	"	39	34	43	40	24	15	7	4	5	7	9	8	2
	"	34	33	32	32	27	16	7	4	3	5	9	8	3
	"	46	37	32	50	38	24	11	5	5	7	12	7	1
31	wS	42	35	37	44	30	15	6	3	2	9	14	19	11
	"	62	46	59	55	50	29	23	14	13	35	40	37	25
	"	40	31	40	30	28	14	10	7	7	13	13	15	13
	"	37	36	44	45	41	19	12	11	21	16	27	22	13
	"	25	23	25	26	27	11	6	5	10	11	21	28	20
	"	48	41	63	50	48	31	22	12	14	25	32	23	22
	"	56	45	60	58	54	37	26	17	16	31	36	29	26
31	Ad.Gr.	24	10	9	13	10	4	1	1	1	3	12	17	7
	" "	23	19	19	16	13	6	2	1	2	5	20	18	10
	" "	17	10	10	16	16	6	3	2	6	25	28	20	14
	" "	10	10	9	16	12	17	16	7	1	2	8	7	3
	" "	6	10	8	12	7	7	17	12	2	3	4	10	10
	" "	17	15	19	22	14	6	3	2	3	5	11	21	19
(Area 31 continued next page)	bF(7)	28	28	23	23	18	12	7	3	4	5	10	9	7
	bF(13)	36	27	45	37	31	27	20	7	2	4	8	11	7
	bF	14	14	12	18	18	15	10	6	2	2	2	3	3
	"	22	28	26	24	16	7	3	2	3	6	6	5	6
	"	38	55	42	37	27	22	10	5	6	21	25	27	19
	"	13	12	16	15	15	15	11	5	4	4	5	5	2
	"	36	31	32	27	23	13	8	5	6	10	17	15	13
	"	20	48	42	41	29	18	10	3	4	8	12	13	7
	"	33	35	32	30	23	14	9	5	3	5	12	11	5

Note:-D.B.H. of trees cut for branch samples shown in brackets in the "Species" column.

APPENDIX I (Continued)

Area No.	Species	Annual Ring Width in Arbitrary Units for:-												
		1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
31	bF	35	30	47	42	31	29	24	12	4	5	4	6	5
	"	18	13	17	13	13	6	4	1	4	9	14	13	13
	"	28	24	26	17	9	5	2	2	4	8	14	14	13
	"	56	52	42	48	31	21	13	7	6	7	13	13	12
	"	37	38	29	37	28	18	12	5	3	5	9	10	10
	"	62	54	41	37	32	23	9	4	5	10	15	18	16
	"	39	45	41	36	26	16	8	5	3	5	11	16	13
	"	34	35	30	26	21	13	6	3	2	4	11	8	4
	"	19	14	13	10	11	5	2	3	3	4	5	7	5
	wS	28	28	30	26	21	10	6	2	4	12	21	17	13
	"	28	27	36	31	28	14	7	3	4	11	22	16	8
	"	7	8	8	9	8	8	4	2	1	3	6	6	5
	"	6	7	7	9	6	5	3	1	1	3	5	5	5
	"	29	24	29	16	17	9	6	3	5	7	15	14	11
	"	44	65	50	54	36	30	15	6	2	8	24	32	20
	"	62	54	43	23	19	11	7	5	6	10	20	22	17
	"	40	30	34	22	22	9	4	1	4	16	28	22	14
	"	47	35	37	25	25	12	9	2	8	17	26	21	20
	"	44	31	50	33	36	36	30	12	6	10	16	18	14
	"	41	22	22	18	18	10	7	6	7	16	24	23	19
	"	15	16	16	18	17	11	6	5	2	1	4	3	5
	Ad.Gr.	6	17	9	10	16	15	3	1	3	6	13	25	13
	" "	17	18	21	26	18	5	1	2	3	10	16	19	12
	" "	24	20	20	17	6	4	10	3	20	23	23	20	10
	" "	20	25	17	20	15	13	11	5	8	10	17	15	7
	" "	12	18	22	27	24	16	15	18	16	21	3	3	2
	" "	17	23	14	23	17	13	10	5	10	17	18	13	8
32	bF(10)	20	13	14	15	18	11	5	4	4	6	10	9	10
	bF(14)	32	26	16	21	19	16	14	5	5	5	5	5	6
	bF	43	36	32	35	25	17	9	5	3	10	19	17	17
	"	38	58	28	29	33	23	8	2	1	3	13	13	24
	"	6	10	10	12	9	10	5	1	3	2	3	2	5
	"	12	12	17	17	12	13	10	7	2	5	3	3	5
	"	14	12	10	10	8	4	3	1	3	2	3	3	3
	"	55	54	43	42	49	32	16	7	3	13	23	38	36
	"	50	40	25	35	24	17	11	8	4	8	17	29	26
	"	47	42	37	37	25	13	6	2	3	14	38	33	16
	"	22	22	20	26	20	16	12	16	1	12	11	12	18
	"	18	17	17	22	19	12	6	2	1	5	13	38	38
	"	17	27	21	26	25	18	11	4	2	3	9	20	20
	"	48	40	34	39	28	17	9	4	3	8	15	24	20
	"	18	20	20	22	20	12	4	1	3	7	10	19	22
	"	46	58	52	45	45	35	20	5	2	4	10	15	18
	"	46	48	40	41	33	25	14	6	3	7	16	26	25
	wS	52	44	34	26	20	12	5	3	2	16	26	31	21
	"	3	4	3	3	4	4	2	1	2	4	4	5	4
	"	13	15	16	16	18	8	3	1	3	8	10	11	10

(Area 32 continued next page)

Note:- D.B.H. of trees cut for branch samples shown in brackets in the "Species" column.

APPENDIX I (Continued)

Area No.	Species	Annual Ring Width in Arbitrary Units for:-												
		1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
32	wS	10	10	8	8	5	3	2	1	3	3	4	6	5
	"	16	23	29	23	19	11	4	2	1	13	20	27	22
	"	24	12	10	11	10	3	1	1	4	4	3	3	2
	"	14	15	17	15	16	8	3	1	3	7	13	11	10
	"	43	34	32	30	22	8	5	2	3	12	23	22	20
	Ad.Gr.	7	14	10	12	13	10	3	2	1	2	7	7	5
	" "	13	16	7	11	4	3	4	4	1	2	2	2	2
	" "	8	7	9	10	13	15	17	2	1	3	2	3	2
	" "	15	20	20	25	16	7	17	13	6	11	22	16	15
	" "	8	7	8	10	10	1	2	3	6	15	29	25	18
	" "	7	4	10	10	8	3	4	2	3	8	18	21	20
33	bF(9)	32	36	32	30	22	12	10	6	3	6	12	8	11
	bF(12)	12	9	7	9	9	8	7	4	6	8	10	11	13
	bF	18	15	20	17	17	9	8	2	6	10	16	12	13
	"	17	18	14	13	10	6	7	2	3	6	9	11	13
	"	26	27	22	18	17	10	11	8	9	11	10	10	10
	"	46	48	35	39	31	21	15	9	4	8	17	22	23
	"	20	17	21	14	13	7	6	2	1	6	7	7	6
	"	21	18	19	16	15	7	7	6	5	9	13	10	8
	"	34	42	33	28	25	12	10	4	3	10	18	25	23
	"	25	26	20	24	23	11	9	5	3	7	9	8	8
	"	31	37	34	32	29	18	15	8	6	9	12	11	16
	"	25	20	21	23	20	18	14	7	5	4	5	5	6
	wS	36	28	30	20	18	8	7	2	4	13	25	34	28
	"	28	21	19	18	16	9	7	3	6	14	20	26	22
	"	34	24	28	25	21	11	10	5	6	15	20	21	18
	"	46	30	30	23	28	17	12	8	5	17	24	22	16
	"	37	27	30	27	28	16	8	3	4	18	30	24	21
	"	23	20	20	18	14	10	6	3	6	17	18	24	21
	"	12	14	13	18	14	11	6	3	1	6	8	12	8
	"	24	21	21	17	13	10	10	8	16	42	31	32	
	"	31	25	26	24	24	14	10	6	8	18	24	30	27
	"	47	46	48	50	35	16	19	5	11	20	33	42	36
	"	49	28	21	23	26	15	13	8	16	26	38	32	28
	"	30	32	32	25	24	14	11	4	8	20	29	40	28
	"	70	51	64	62	48	30	30	17	20	50	63	66	64
	"	29	21	24	19	17	9	8	5	7	21	26	37	28
	Ad.Gr.	5	5	5	9	4	2	5	3	6	11	9	10	14
	" "	8	10	9	16	12	10	9	5	5	7	9	13	18
	" "	8	8	5	12	7	5	3	4	10	10	18	23	27
	" "	5	6	6	9	7	7	4	2	7	21	15	16	15
	" "	14	16	18	17	10	5	5	8	8	13	28	34	40
	" "	9	8	6	10	5	5	9	2	5	14	20	20	25
34	bF(11)	22	15	16	17	14	8	4	2	4	7	8	9	8
	bF(13)	36	33	28	31	25	13	5	2	4	6	15	14	17
	bF	28	25	18	20	23	16	10	4	6	10	18	13	8

(Area 34 continued next page)

Note:- D.B.H. of trees cut for branch samples shown in brackets in the "Species" column.

APPENDIX I (Continued)

Area No.	Species	Annual Ring Width in Arbitrary Units for:-												
		1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
34	bF	11	12	11	12	13	10	7	3	4	4	6	7	7
	"	16	14	20	13	13	15	13	7	2	5	5	5	4
	"	8	10	10	10	10	8	5	1	2	2	2	4	4
	"	18	16	13	19	16	12	3	2	1	3	4	6	5
	"	23	21	14	19	14	10	5	2	2	3	3	16	15
	"	15	13	9	12	12	8	3	1	6	3	14	15	18
	"	25	29	25	29	25	18	7	4	3	3	2	2	2
	"	11	10	12	8	7	6	5	3	3	3	9	10	
	"	23	24	20	22	20	15	9	2	4	2	6	10	12
	"	19	21	22	16	18	6	8	2	4	5	6	7	7
	"	17	20	16	22	20	14	7	4	5	6	9	11	8
	"	47	43	28	33	31	23	10	5	2	4	8	18	20
	"	18	20	15	14	14	11	5	3	1	8	6	8	12
	"	10	15	11	10	13	15	5	3	1	8	10	13	12
	"	23	16	30	23	14	14	14	7	3	4	4	5	4
	sW	18	11	10	10	12	7	4	2	4	7	7	7	8
	"	15	13	14	17	12	10	7	6	4	10	18	17	10
	"	13	11	13	13	12	6	5	4	5	8	10	11	11
	"	21	17	18	26	22	14	5	5	9	15	21	20	20
	"	30	29	20	24	18	11	5	2	7	13	17	28	11
	"	23	21	15	17	17	11	6	3	6	10	19	17	20
	"	16	15	13	14	10	7	5	4	8	10	15	14	12
	"	20	21	22	18	14	9	5	4	5	10	13	15	18
	"	17	14	12	11	11	5	2	1	4	7	10	9	8
	"	8	8	8	6	7	4	2	3	4	6	9	7	7
	"	52	39	26	29	29	21	14	13	13	20	19	25	40
	Ad.Gr.	14	12	8	13	16	7	3	2	1	3	5	8	5
	" "	10	8	14	18	12	6	1	3	3	8	7	6	5
	" "	10	10	8	14	10	3	3	3	2	5	5	8	10
	" "	10	18	17	10	11	6	1	2	2	3	3	5	5
	" "	5	5	5	10	8	3	3	3	2	10	14	7	6
	" "	8	10	9	12	11	8	3	3	4	5	7	9	6
35	bF(7)	30	33	31	34	32	20	7	2	4	6	10	12	21
	bF(9)	31	26	23	26	21	13	7	5	6	9	15	18	5
	bF	27	27	20	19	17	13	8	4	5	7	12	11	11
	"	34	33	24	30	25	19	11	5	6	16	33	33	34
	"	27	31	18	17	17	11	6	3	4	5	9	9	8
	"	14	13	10	12	13	11	10	8	3	4	3	2	3
	"	18	16	16	19	18	14	13	11	7	3	3	2	3
	"	19	13	14	11	13	6	5	18	22	24	39	44	44
	"	24	27	17	20	29	22	14	10	7	9	7	11	1
	"	15	14	14	17	17	8	6	5	7	5	7	4	3
	"	28	31	25	30	27	15	15	12	13	10	13	11	11
	"	13	19	19	13	13	9	6	5	8	5	8	8	9
	wS	40	33	21	26	17	13	9	8	12	15	21	22	18
	"	14	15	17	22	20	11	6	4	9	21	30	43	30
	"	16	13	15	18	17	10	5	3	5	13	16	22	16
	"	12	10	12	12	11	11	7	8	10	8	9	11	7
	"	3	5	5	7	10	6	3	4	4	5	6	6	4

Note:- D.B.H. of trees cut for branch samples shown in brackets in the "Species" column.

APPENDIX I (Continued)

Area No.	Species	Annual Ring Width in Arbitrary Units for:-												
		1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
35	wS	21	19	22	30	28	15	10	3	5	15	19	20	17
	"	38	41	33	44	40	19	12	7	12	18	30	25	25
	"	31	27	33	27	22	19	10	4	7	19	26	24	24
	"	23	19	14	21	20	10	2	2	4	6	3	5	5
	Ad.Gr.	10	10	15	15	12	6	7	12	17	13	25	25	21
	" "	30	33	22	14	14	5	9	12	14	12	15	12	12
	" "	26	33	30	28	20	13	12	14	22	27	30	20	20
	" "	15	15	16	19	15	10	9	9	10	9	20	14	15
	" "	8	10	10	15	11	5	7	9	13	18	21	15	15
	" "	18	19	24	28	18	3	5	8	16	13	18	15	15

Note:- D.B.H. of trees cut for branch samples shown in brackets
in the "Species" column.