

FORESTRY COMMISSION.

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BULLETIN NO. 1.

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Collection of Data

AS TO THE

Rate of Growth of Timber.

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*Price 4d.*

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## COLLECTION OF DATA

### AS TO THE RATE OF GROWTH OF TIMBER.

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The need of accurate data as to the rate of growth of timber in the United Kingdom has always been felt. The Board of Agriculture and Fisheries have collected and published in their Journal the results of the measurements of a few interesting woods, while a good deal of information will be found scattered through the Journals of the Royal English and Royal Scottish Arboricultural Societies and in miscellaneous publications. There has, however, been no uniform method of approaching the subject, and it is almost impossible, therefore, to co-ordinate the information.

The very heavy fellings brought about by the war provided both an argument for action and a unique opportunity for securing accurate data. On the one hand it appeared that all the well-stocked woods would be swept away, and no record would be kept of the actual and potential production of the soil. On the other hand, so many woods were being felled that the difficulties in the way of securing sample trees were reduced to a minimum.

The problem of recording, for replanting and afforestation purposes, an account of the behaviour of each species as revealed by woods already growing in the United Kingdom presented two aspects, viz., the quantity of timber and the quality of the timber produced under given conditions.

With regard to quantity production, the Board of Agriculture and Fisheries made a beginning in the Autumn of 1917 to collect data on a systematic plan. Work on identical lines has since been started by the Timber Supply Department in Scotland and by the Department of Agriculture in Ireland. The work was assisted up to 31st March, 1919, by the Interim Forest Authority and will be continued until the end of the financial year 1919/20, by which time most of the interesting woods of the country should have been dealt with. The work will then be merged into the general scheme of experimental forestry which it is intended to undertake.

The methods by which this enquiry is proceeding are detailed in Appendix 1. It should be explained that owing to the demand for trained men in connection with timber supply operations practically the whole of the detailed work has been done by women, who have shown remarkable aptitude for the work.

The selection of areas for measurement, the marking of thinnings and similar work has, however, been entirely in the hands of trained forest officers, and great care has been taken to secure uniformity of procedure by joint outdoor work and by conferences.

As regards quality production, arrangements have meantime been made with the Department of Scientific and Industrial Research for Professors Dalby and Percy Groom to carry out mechanical tests and anatomical investigations of selected test pieces at the Imperial College of Science and Technology. Information relating to the collecting of test pieces is given in Appendix 2.

It is proposed to publish as soon as possible other bulletins summarising the preliminary results of the investigations as to the rate of growth of the more important species, and, subsequently, to prepare more detailed monographs.

It is also desired to thank landowners and their agents for help in securing data, and to ask them to continue their assistance. The results of the measurement of individual plots will be provided on request, and the maps on which the positions of the plots are recorded will be available for inspection.

FORESTRY COMMISSION,

November, 1919.

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## APPENDIX 1.

### COLLECTION OF DATA AS TO THE RATE OF GROWTH OF TIMBER.

#### Instructions to Field Parties.

1. The object of the work is to assess from existing woods the silvicultural possibilities of the woodlands and uncultivated lands of the country. To begin with, coniferous species only will be dealt with.

Two factors involved in any such assessment are :—

- (a) The quantity of timber, and
- (b) The quality of timber produced, under given conditions.

The present memorandum deals chiefly with the quantity of timber produced.

2. The volume production can be ascertained most easily by the measurements of completely stocked woods where they exist. Where they do not exist, the probable production must be worked out as far as is possible by methods of stem analysis. It is possible to obtain a fairly comprehensive idea as to the rate of growth of coniferous timber as expressed by height growth, but the interpretation of height growth in terms of volume involves the use of yield tables. Yield tables—accurate enough for general use—can be obtained for Scots pine and spruce, but tables will have to be constructed for larch. The latter point must be kept in view throughout.

#### Field Work.

3. To begin with, an attempt must be made to divide the country into regions in which the conditions, except in so far as they are affected by elevation and exposure, are approximately uniform. Districts should therefore be selected, in the first instance, with reference to climate, soil and geological conditions. The limits of each district are to be more closely defined as the experience gained in the field permits. Unless there is good first-hand evidence to the contrary it is to be assumed that every wood will furnish some useful information.

The collection of data will proceed by one of the three following methods :—

- (a) By sample plots.
- (b) By sample sub-plots.
- (c) By groups of trees.

#### Sample Plots.

4. *Selection of Plots.*—Plots should be chosen with the following considerations in view :—

- (1) They should provide average samples of the rate of growth under the conditions being investigated.
- (2) They should be uniformly stocked. Small plots uniformly stocked should be taken in preference to large ones irregular in character.

If the sample plot is not a fair sample of the rate of growth of the wood under investigation this is to be stated definitely in the description of the plot, and the differences and causes thereof noted.

5. *Size of Plots.*—As a rule the area should not be less than 0·2 nor greater than 0·5 acre. Plots need not necessarily be rectangular in shape.

6. *Preparation of Plots.*—The plot is first to be staked out roughly and the boundary lines cleared. When this is done the crop is to be inspected

carefully to ascertain that the stocking is uniform or at least satisfies, as completely as circumstances permit, the objects of the particular investigation. If not, it should be abandoned and a fresh plot selected. The boundary lines should next be marked out clearly and a string run along the lines so that the trees on the plot are entirely enclosed. The plot should then be accurately surveyed (lengths of sides to the nearest 6 in., angles to the nearest half degree) and the measurements recorded. The trees should next be marked for thinning, the following trees being removed :—

- (1) Dead.
- (2) Dying.
- (3) Whips.
- (4) Badly suppressed.

In overcrowded woods two thinnings may be made—an "A" thinning as above and a "B" or silvicultural thinning, by which some of the competing sub-dominant and co-dominant trees are also removed. The "B" thinning would consequently be such as would be required for the healthy development of the crop. The two thinnings are to be shown separately in such a way that the main crop, the "A" and the "B" thinnings when all added together give the total crop on the ground. Where only one thinning is made it is to be an "A" thinning unless otherwise stated.

To each stem (excluding dead trees) there should be attached a tough paper label bearing a distinctive number, the numbers running consecutively for the thinnings and for the main crop. Labels of different colours should be used for thinnings and for main crop trees.

7. *A general description of the plot* is to be made before any felling is done in it. The description is to proceed in the following order :— Situation, ordnance sheet, elevation, aspect, exposure and slope, soil and soil covering, species, past history as far as available, wind damage or disease, stocking and condition of the canopy. Where gaps occur, the number of average trees required to fill the gaps is to be recorded. In the case of Scots pine the percentages of broken crowns and forked stems should be determined by a count. The position of the plot is also to be accurately recorded for future reference on a map reserved for the purpose, and a tracing on the 6-in. scale placed with the plot records.

8. *Measurement of the Crop*.—The girths of the individual trees at breast height (4 ft. 3 in.) should first be recorded to the nearest  $\frac{1}{4}$  in. quarter girth, the thinnings being booked separately from the main crop (Form F.78).

The procedure from this point will vary according as the crop is to be measured felled or standing.

#### (A) FOR FELLED CROPS.

The following dimensions are to be taken for every tree :—

- (1) The total height.
- (2) The Timber height, *i.e.*, the length up to  $9\frac{1}{2}$  in. true girth over bark (3 in. diameter).
- (3) The quarter girth over bark at mid-timber height to the nearest  $\frac{1}{4}$  in. (Form F.81).

A number of sample trees, *viz.*, those which would have been chosen had the plot been measured standing, are to be measured as detailed below for standing crops.

#### (B) FOR STANDING CROPS.

A sufficient number of sample trees must be felled to permit a reasonably accurate determination of the volume. Less than ten trees will probably be too few to give accurate volume determinations, but especially interesting areas should not be rejected because a smaller number of trees only may be felled.

The sample trees are to be selected by Hartig's method, viz. :— The trees in the plot are first arranged in their appropriate quarter-girth classes (by quarter inches) and the number in each class totalled (Form F.75). The results are transferred from Form F.75 to Form F.76, and the basal area of each class and the total basal area for the plot are ascertained from a table of quarter-girth squares. The total basal area is divided by 5 and the stems arranged in five groups containing approximately equal basal areas (Form F.79). The basal area of each group, divided by the number of trees in the group, gives the mean basal area of the group, from which the mean quarter girth can be obtained from the table of quarter-girth squares.

If fewer than ten sample trees are taken the number of groups is to be reduced on the basis of two trees per group.

Having ascertained the mean quarter girth of each group, two or more sample trees are to be selected with (as nearly as possible) the calculated mean quarter girth, great care being taken that the trees selected are in other respects also typical of their class. Where suitable sample trees cannot be found in the plot they may be selected from the adjoining stand, provided that the conditions are similar. The sample trees are to be measured as on Form F.81 to the nearest 6 in. in length, and to the nearest  $\frac{1}{8}$  in. true girth or the nearest  $\frac{1}{4}$  in. quarter girth, as the case may be. The height of the Lower Crown (LC) is to be measured from the butt to the lowest living branch, and that of the Upper Crown (UC) from the butt to the lowest living whorl of branches.

*Analysis of Stems.*—In each sample plot three stems are to be analysed by cutting into sections and counting the rings on each section. The length of the sections will depend on various factors, such as the utilisation of the timber, but the shorter the sections can be made the better (Form F.77).

The trees for analysis are to be selected from the sample trees. The mean height of the latter is to be determined, and three trees with this mean are to be analysed. Sample trees for analysis should not be taken from the first or last of the groups.

### Working up the Results.

9. The results are to be expressed on Form F.80 (Final Summary).

The Age ( $a$ ) is to be determined by ring counting. In the case of larch care should be taken to exclude false rings.

The Quarter Girth (Q.G.) at breast height is to be determined to the nearest  $\frac{1}{4}$  in. as the geometric mean quarter girth, *i.e.*, it is the quarter girth of the tree which has the average basal area.

*The Height ( $h$ )* is to be determined as follows :—

The heights of the sample trees are to be plotted against their respective quarter girths, and a smooth curve drawn to show the relationship. From this curve the height corresponding with the mean quarter girth is to be read off, and the result taken as the mean height of the plot.

The Number of Stems ( $N$ ) for main crop and for thinnings is to be worked out per acre to the nearest multiple of 5 proportionately to the actual area of the plot.

*The Basal Area ( $A$ )* is to be determined to the nearest square foot by adding up the squared quarter girths of the main crop trees on the plot and calculating the proportionate area per acre, the result to be expressed to the nearest square foot quarter girth.

*The Form Factor ( $f$ )* is to be determined to three places of decimals by dividing the total volume (quarter girth under bark) by the basal area multiplied by the height, *i.e.*,  $f = \frac{V}{h \times A}$

*The Volume* is to be determined to the nearest "0" or "5": in the case of felled crops by summing up the contents of the individual stems and increasing the result proportionately to obtain the figure per acre.

In the case of standing crops the determination of the volume is to proceed from the sample trees, using Form F.79, as follows :—

For each group, details of the numbers of trees falling into each  $\frac{1}{4}$  in. quarter-girth class and the corresponding basal areas are to be brought forward from Form F.76. The total number of trees and the total basal area of each group is to be obtained, and the basal area and quarter girth of the mean tree (ideal sample tree) entered on the form. Details as to quarter girth, basal area and volume of the actual sample trees are to be brought forward from Form F.81. The basal areas and volumes of the sample trees of each group are to be summed, and the volume of the group calculated according to the following formula :—

$$\text{Volume of group} = \frac{\text{Volume of sample trees} \times \text{basal area of group.}}{\text{Basal area of sample trees.}}$$

The volume of the plot is to be obtained as the sum of the volumes of the groups. The volume per acre is then to be worked out proportionately to the volume of the plot.

The volumes over bark ( $V_{ob}$ ) and under bark ( $V_{ub}$ ) are to be calculated separately by the above method.

*The crown length* per cent. is the proportion of the whole length of stem which is covered by living crown.

For the individual tree the mean of the upper crown (UC) and the lower crown (LC) is to be subtracted from the total length of the tree, and the result divided by the total length, *i.e.*,

$$\text{Crown length per cent.} = \frac{L - \frac{UC + LC}{2}}{L} \times 100$$

For the whole crop the crown length is to be determined as follows :— The crown length per cent. is plotted against the quarter girth for each sample tree, and the crown length corresponding with the mean quarter girth of the plot read off.

*Thinnings.*—The determination of the number of stems, basal area and volume, over and under bark, proceed as for the main crop.

### Sample Sub-Plots.

10. Where crops are too irregular to yield plots of 0.2 to 0.5 acre it may be possible to secure smaller areas of value for comparative purposes. In such cases, sub-plots 1 ch.  $\times$  1 ch. (= 0.1 acre) in extent are to be taken. Sub-plots are to be treated exactly as plots, with the exception that all the trees are to be regarded as forming one group. The data are to be worked up on the basis of three arithmetical mean sample trees which must, consequently, be selected with great care as regards height.

### Groups of Trees.

11.—Measurements of groups of trees are to be recorded on Form F.82. The Form is to be used for woods in which areas large enough for plots or sub-plots cannot be found. It is intended for recording the rates of growths in different parts of the same wood, whether felled or about to be felled.

*Description—Slope.*—To be described in one of the following terms :— Flat, gentle, moderate, steep, precipitous.

*Soil.*—To be described in terms of gravel, sand, sandy loam, loam, loamy clay, clay; with approximate depth. Presence and depth of peat to be noted, also degree of wetness where this is noticeable.

*Soil Covering.*—Names of dominant plants and relative abundance.

*Type.*—Whether pure (broadleaved or coniferous) or mixed. In latter case, approximate percentage of different species occurring in the crop to be stated.

*Stocking and Past Management.*—Whether canopy complete; whether wood over- or under-thinned.

*General Remarks.*—Comments (where necessary) on health, &c., of wood.

*Total area felled or to be felled.*—Approximate area will suffice.



*Number and position of separate groups.*—Groups of trees to be selected on the basis that they have been grown under forest conditions, *i.e.*, the crowns of all the trees to be measured are to be in active competition with the crowns of neighbouring trees. The groups should be numbered A, B, C, &c., and the position of each shown on a tracing to scale of 6 in. = 1 mile.

*General Description of Timber.*—Indications in general terms as to straightness, soundness, uses to which timber is being put.

*Analysis of Stems* to be carried out where possible for trees (dominant) which have been grown under forest conditions. Procedure in analysis as for sample trees in plots. Height growth curves to be plotted, and graphs attached to form.

*Details of Trees in Groups—Tree Number.*—Each tree to be given a number for identification purposes.

*Q.G. 4 ft. 3 in.*—In case of felled trees take Q.G. at 4 ft. from butt end to correspond with 4 ft. 3 in. standing.

*Timber Height.*—Length of log to point where cut off by timber fellers, or to 9½ in. girth o.b. if not cut off.

*Girth at Timber Height* to be recorded when top has been cut off.

*Leading Shoots.*—To be recorded (in inches) beginning with the top-most shoot and continuing back towards the butt so far as the annual shoots can be recognised with certainty.

*Conditions of Butts.*—Incipient and actual heart-rot to be noted.

*Special Description of Groups.*—Variations in soil and other conditions affecting growth to be recorded in so far as they have been the cause of variations in the rate of growth of the group from the average of the whole wood.

*Comments on Replanting.*—The following information should be recorded when available:—

- (a) Whether owner intends to replant ;
- (b) Species he intends using ;
- (c) Statistical officers' recommendations ;
- (d) Prevalence of ground game, and protection required.

### **Checking and Filing of Results.**

12. The results for each plot, sub-plot and group of trees are to be worked up by the women taking the measurements, and checked by two other members of the field party. The results will subsequently be rechecked at Headquarters.

The papers (fair copies) relating to each plot, sub-plot or group are to be filed separately and in regular order in covers supplied for the purpose. Each file is to be forwarded to Headquarters under registered cover as soon as completed.

### **Checking Measuring Instruments.**

13. Measuring instruments are to be checked from time to time. Tapes in particular are to be checked after a wetting or after they have been in use for some time.

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**Forms used for Plots and Sub-plots.**

The data collected in accordance with the foregoing instructions to field parties are recorded on the following forms:—

**Girth Measurements.** FORM F.78

Plot No.....

Tree No.	Q.G. 4' 3"	Tree No.	Q.G. 4' 3"	Tree No.	Q.G. 4' 3"	Tree No.	Q.G. 4' 3"	Tree No.	Q.G. 4' 3"	Tree No.	Q.G. 4' 3"

**Measurements of Felled Trees.** FORM F.81

Plot No.....

Tree No.	Q.G. 4' 3"	True G. 4' 3"	Total Ht.	Timber Ht.	L. C.	U. C.	% C.	$\frac{1}{2}$ T.H. Q.G. o.b.	$\frac{1}{2}$ T.H. Q.G. u.b.	Vol o.b.	Vol u.b.	Remarks.

**Classification of Stems.** FORM F.75

Plot No.....

**MAIN CROP.**

Q.G.	TREE NUMBERS.	TOTAL.

**Girth Classification.** FORM F.76

Plot No.....

Quarter Girth.	MAIN CROP.			THINNINGS.		
	No. of Trees.	Basal Area of one tree.	Total Basal Area.	No. of Trees.	Basal Area of one tree.	Total Basal Area.

**Summary and Volume Calculation. FORM F.79:**

Plot No. ....

**MAIN CROP OR THINNINGS.**

Group.	Quarter Girth 4' 3"	Number of Trees.	Basal Area (sq. ft.).	Ideal Sample Tree.		Real Sample Tree.				Volume of Group (cubic feet).			
				Basal Area.	Quarter Girth 4' 3"	Tren No.	Quarter Girth 4' 3"	Basal Area (sq. ft.).		Volume (c.f.).		o.b.	u.b.
								Detailed.	Total.	o.b.	u.b.		

**Final Summary. FORM F.80.**

Plot No. ....

Species .....

**MAIN CROP (Per Acre).**

**THINNINGS (Per Acre).**

Age.	Height.	Q.G. 4' 3"	No. Stems.	Basal Area.	Form Factor.	Volume Q.G.		Crown Length %	Bark %	No. Stems.	Basal Area.	Volume Q.G.		
						o.b.	u.b.					o.b.	u.b.	

**Stem Analysis.** FORM F.77

Plot No.....

SAMPLE TREE No.....

$h =$  ;  $lc =$  and  $=$  per cent. ;  $L3 =$

Q.G.'s— $bh =$  ;  $\frac{1}{2}$  T.H.  $\left\{ \begin{array}{l} \text{o.b.} = \\ \text{u.b.} = \end{array} \right.$  ; V.'s  $\left\{ \begin{array}{l} \text{o.b.} = \\ \text{u.b.} = \end{array} \right.$

Height.....

Rings.....

Age.....

Leading Shoots.....

.....

**Groups of Trees.** FORM F.82

Area No.....

Name of Wood.....

Timber Supplies Dept. Refs.

Purchase File.....

Name of Estate.....

Conversion File.....

Owner.....

Pitwood File.....

Agent's Name and Address.....

6-in. Ordnance Sheet No.....

1. DESCRIPTION :—

Species.....

Range of Elevation..... Aspect.....

Exposure .....

Slope.....

Soil.....

Soil covering.....

Type.....

Stocking and Past Management.....

General Remarks.....



7. CONDITION OF BUTTS.

Group.	Species.	Sound.		Stained.		Moderately Bad.		Bad.	
		Number	%	Number	%	Number	%	Number	%

8. SPECIAL DESCRIPTION OF GROUPS.

9. COMMENTS ON REPLANTING.

Signed.....

Date.....

Checked.....

\_\_\_\_\_

TIMBER SAMPLES FOR BENDING TESTS.

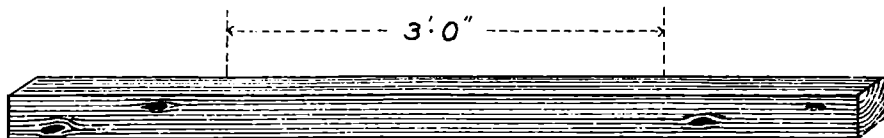


FIG. 1.



KNOTS. FIG. 2.



WAVY GRAIN AT CENTRE FIG. 3.



EDGE KNOTS & WAVY GRAIN FIG. 4.



RESIN POCKETS FIG. 5.





## APPENDIX 2.

## COLLECTION OF TIMBER SAMPLES FOR TESTING PURPOSES.

## Instructions to Collectors.

*Selection of Samples.*—The pieces should be as free as possible from knots. It is desirable at least that each piece should have a central length of 3 ft., in which the grain is straight and the wood is also free from knots (Fig. 1). A piece with 18 in. clear at the centre can be used if it is not possible to get anything better.

Pieces of the kind illustrated in Figs. 2, 3, 4 and 5 are useless for testing purposes. The term "wavy grain" used in figures 3 and 4 is meant to indicate irregular grain such as is found in the vicinity of large knots.

*Storage of Samples.*—The pieces should be kept dry (if possible, under a shed open on two sides) and stacked so that they will season as in ordinary air-drying.

*Description and Labelling of Samples.*—Each sample piece should be described on a separate form (F.83), and have attached to it a separate cardboard label (F.84). The use of these two forms is explained below.

*Dimensions.*—6 ft.  $\times$  3 $\frac{1}{4}$  in.  $\times$  2 $\frac{1}{4}$  in. The intention is that when the piece is planed the section shall be 3 in.  $\times$  2 in.

*Mr.*                      *'s. No.*                      *and O.W. No.*                      .—The latter will be filled in on receipt of the piece. Each collector may therefore number his own pieces serially from 1 onwards.

*Name of Wood and District* is required for general identification purposes.

*Geological Formation, e.g.,* Carboniferous limestone; Wenlock shales.

*Soil, e.g.,* 12-in. sandy loam on disintegrated shale; 6-in. peat on 9-in. clay.

*Elevation.*—Approximate height above sea level required.

*Aspect and Exposure, e.g.,* E. sheltered; S.W. fully exposed.

*Type of Wood, e.g.,* pure Scots pine, .8 stocked; mixed broadleaved and conifers, .75 stocked; standard over coppice. Information with regard to date of felling and sawing out samples, and weight on given dates, will be of value.

**Form used for Description of Timber Samples.**

Mr... ..'s No.....

6 ft. x 3 1/4 in. x 2 1/4 in. O.W. No.....

Species..... Part of Tree.....

Approximate Age.....

Name of Wood and District.....

Geological Formation.....

Soil..... Elevation.....

Aspect and Exposure.....

Type of Wood from which taken.....

(Date of felling tree.....; of sawing out samples

..... Actual weight of sample on (date).....lbs.

.....ozs.)

**Cardboard Label for attaching to Sample.**

**Timber Samples.**

Mr.....'s No.....

O.W. No.....

Please tack firmly to sample.

F.84