A Comparison of Methods used in obtaining Current Annual Increment

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Norway spruce, Compartment 17, Rockingham Property, Ballyfarnon Forest.

In the course of a limited investigation carried out in this Norway spruce stand, current annual increment was evaluated by four different methods. As there was no significant difference in the results, a description of the methods may be of some interest. It should be emphasised that the investigation was anything but exhaustive, but the findings indicate that reliable increments can be cheaply obtained.

Description of Crop.

This Norway spruce stand is situated on a small knoll on the eastern shore of Lough Key, Co. Roscommon. Elevation is approximately 100 feet above sea level, exposure reasonably moderate though the presence of the lake limits wind protection. Slope varies up to 8 degrees, drainage is good and soil is a brown earth. The geological formation of the site is a post pliocene drift over lower carboniferous sandstone.[1] Forest floor vegetation consists entirely of mosses—cover being almost 100%. Butt rot appeared on the stump of one felled tree. The stand is Quality Class I according to British Forestry Commission revised Yield Tables.[2]

Methods of Assessment.

The area under Norway spruce was mapped on to 6 in. O.S. sheet (Roscommon 6) from ground detail. A ride 15 yards wide through the middle of the stand was excluded—this gave us two stands of approximately the same size totalling 4.9 acres.

To determine volume and increment values a 12% random sampling of this area was undertaken, the basis of which was six 1/10 acre circular plots, three being in each stand to obtain better distribution. A 6 in. to the mile acre grid, bored at random points with an order of choice, was used to get plot centres. The first three points obtained in each stand by throwing the grid onto the map were accepted and marked. One plot (No. 6) occurred on the stand boundary: in order to take edge effect into account two half plots, their centres on the boundary and circumference touching at the mapped point, were taken. A radius of 37 ft. 3 ins. gives 1/10th acre on level ground. Where slope was more than 5 degrees, adjustment to the plot radius was made according to a table by Bryan.[3]

Stems were entered in Quarter-girth classes and a mean basal tree ($7\frac{1}{4}$ ins. b.h.q.g.) calculatd for the whole sampled area, the plots being treated collectively. Two trees, 16% from either end of the quarter girth distribution[4] of all the plots were also picked, these turned out to be $5\frac{3}{4}$ ins. and $8\frac{1}{4}$ ins. b.h.q.g.

In each plot two mean basal area and the two 16% trees were marked. A further three mean basal area trees were selected by taking a diagonal line with a compass bearing in an east-south-easterly direction, and at pre-determined intervals the nearest mean basal area tree was marked. These three trees were felled as well as the first mean basal area tree marked in each plot. Form factor and leader growth measurements were taken from these nine trees and a stem analysis was carried out on five trees. The stems selected for stem analysis were the first five mean basal area trees felled, one from each plot except plot No. 3. In marking mean basal area and 16% trees within the plots, the first trees which fell into the appropriate quarter girth category were accepted, irrespecive of their form or vigour. Heights of unfelled mean basal area trees were taken with a Blume-Leiss hypsometer and increment borings taken at four points (north-east, south-east, south-west, north-west) on mean basal area and 16% trees with a Pressler borer.

These operations gave us sufficient information to calculate crop volume, age and bark percentage. Increment was calculated by four different methods—

(a) Stem analysis.
(b) Schneider's Formula modified * applied to 16% trees.
(c) Schneider's Formula modified applied to mean basal area trees.
(d) Leader growth tables.[5]

Crop Data.

Age of crop from nine stump counts	= 37 years.
Area of both stands	= 4.9 acres.
Number of stems per acre ...	= 454.
Form factor of mean basal area tree	= 0.52.
Height of mean basal area tree ...	= 60 feet.
Mean basal area tree	$=7\frac{1}{4}''$ b.h.q.g.
Volume of mean basal area tree	= 11.4 cubic feet Hoppus measure.
Volume per acre	= 5.176 cubic feet Hoppus measure.
Total volume of both stands ...	= 25,360 cubic feet Hoppus measure.

(a) Stem analysis.

The normal methods of stem analysis were used on five trees, A, B, C, D. E from plot No. 4, 5, 1, 2, 6, respectively. Bark percentage

* Volume increment modification for young conifers V = .9D + 1.8 where V = current annual volume increment % and D = % obtained from Schneider's formula (Unpublished work of Assessment Section, Forestry Division, 22 Upper Merrion Street, Dublin).

was calculated from stem analysis. Current annual increments for each tree (mean of 3 year period) in true measure—

A	B	C	D	E	Total	Mean increment
.700	.723	.797	.697	.543	3.460	0.692

$$\text{Current Annual Increment per cent.} = \frac{\text{C.A.I.} \times 100}{\text{Mean under bark vol. (true measure)}} = \frac{0.692 \times 100}{12.328} = 5.61\%.$$

Volume over bark per acre = 5,176 Hoppus feet.

Bark % = 7.8; bark volume = 404 ,, ,,

Volume under bark per acre = 4,772 ,, ,,

Current annual increment per acre = 4,772 × 5.61% = 268 Hoppus ft.

(b) Schneider's formula applied to 16% trees and modified.

Plot	$5\frac{1}{4}''$ tree	$8\frac{1}{4}''$ tree	Mean Schneider of 16% tree
1	3.9%	3.3%	3.60%
2	3.2%	3.7%	3.45%
3	4.5%	4.5%	4.50%
4	4.6%	3.4%	4.00%
5	4.0%	6.0%	5.00%
6	3.5%	4.1%	3.80%

Mean = 4.05%.

With assessment modification = 5.40%.

Volume per acre under bark = 4,772 Hoppus feet.

Current annual increment = 258 Hoppus feet.

(c) Schneider's Formula on mean basal area trees and modified.

Plot No.	Schneider's	Formula
1	4.80%	3.52%
2	3.77%	4.10%
3	4.30%	5.86%
4	6.27%	4.04%
5	4.64%	4.68%
6	4.97%	4.13%

Mean = 4.59%.

With assessment modification = 5.93%.

Under bark volume per acre = 4,772 Hoppus feet.

Current annual increment = 4,772 × 5.93%.

= 283 Hoppus feet.

(d) Leader growth tables:

LEADER GROWTH PER TREE PER YEAR IN INCHES

Tree	1960	1959	1958	1957	1956	
A	14	14	18	13	23	
B	12	25	19	17	19	
C	22	21	24	16	29	
D	10*	14	16	10	24	
E	9	3	8	8	18	
F	13	11	10	12	21	
G	6	5	5	10	17	
H	24	20	20	10	14	
I	29	13	30	9	32	
Totals	139	126	150	105	197	ins.
Average growth	15.4	14.0	16.6	11.6	21.9	ins.
Vol. increment per 12″ growth	218	218	210	210	210	Hoppus ft.
Increment	280	250	290	203	383	Hoppus ft.

Total increment for 5 years = 1,411 Hoppus feet.
Current increment based on 5 year period = 282 Hoppus feet.

An analysis of variance was undertaken to find if there was any significant difference between the methods used for increment estimation. For this purpose the plots were treated as blocks and for each method increment was worked out from single plot data and applied to volume under bark per acre. Due to the fact that stem analysis was only carried out on five trees we have a missing cell in our table for plot 3. The missing figure was estimated by formula.

Table showing increments for plots and methods ("X" calculated).

	PLOTS					
Methods	1	2	3	4	5	6
Stem analysis	304	258	X=255	267	337	192
Schneider on Mean trees (Mod.)	264	255	304	307	286	281
Schneider on 16% trees (Mod.)	234	300	240	279	249	257
Leader Growth	410	269	243	298	334	167

Analysis of Variance.

Source	Degrees of freedom	Sum of Squares	Mean Squares	F
Methods	3	2,732	910.7	Not
Plots	5	17,815	3,563	significant
Error	14	33,805	2,415	
Total	22	54,352		

* Leader broken at 7 ins. 3 ins. allowed as an estimate of amount lost.

References.

1. Geological Survey of Ireland 1″ map. Sheet 66.
2. Hummel, F. C. and Christie J. *Revised Yield Tables for Conifers in Great Britain.* Forest Record No. 24, H.M. S.O.
3. Bryan, Mackay A. (1956) A simplified method of correcting for slope on circular sample plots. *Journal of Forestry.* Vol. 54. No. 7.
4. Krenn, K. (1940) Uber Naherungsverfahren zur Berechnung der Durchmesser der Hohenadlschen Mittelstamme, dargestellt an einem extremen Bestandesbeispiel. *Allg. Forst.—u. Jagdztg* 116 (in Forestry Abstracts 3. P. 172).
5. Hummel, F. C. and Brett J. (1950) A Simple method of Estimating Volume increment in stands of young conifers. *Empire Forestry Review* Vol. 29, 1.