The Pattern of Annual Growth in Basal Area of Sitka spruce, Norway spruce and Pinus contorta, in Ireland.

By NIALL O MUIRGHEASA

SINCE the forester does not reap his harvest of timber each autumn as the farmer reaps his corn or as the market gardener gathers his apple crop, the significance of the growing season *per se* may tend for him, to be less clearly identified than it might be.

The bursting of the bud and leaf-fall are obvious enough and accepted as an earnest of progress, but in the important matter of the volume increment which is yielded annually by each acre of forest, these are but indirect indicators of what is happening.

It is in the field of forest mensuration perhaps that the need for more precise data as to growth commencement and cessation as well as to the pattern of volume increment throughout the growing season, is most clearly recognised. This is particularly so where sampling survey estimates of standing volume derived from numerous plot measurements taken at different times during the growing season must be adjusted to provide estimates of volume at a particular date.

While it is recognised that basal area growth is not necessarily simultaneous with sectional area growth at other levels along the stem and that in consequence it may not be fully representative of the annual pattern of volume increment it is notwithstanding, conventionally a critical factor in volume estimation. By implication therefore it is accepted as a satisfactory guide to the current position during the transition of the growing season.

In the course of a volume sampling survey of some 71,500 acres of State forests carried out in 1960 by the Assessment Section of the Forestry Division, the need for data as to the annual cycle of basal area growth of our principal conifers became apparent.

In the Spring of 1961 a study of the matter was initiated. The species chosen for investigation were Sitka and Norway spruce and *Pinus contorta;* these being of predominating importance in managed plantations in Ireland. The 1960 survey had indicated that of the total current volume increment of State plantations of conifers having measurable volume, 69% was then being contributed by these three species—37% by the Sitka spruce, 24% by the Norway spruce and 8% by the *Pinus contorta.* Even though Scots pine contributed 12% of the total increment and rated third, to the fourth position held by the *Pinus contorta,* the marked decline in its use in the planting programmes of recent times served to tilt the balance favouring the inclusion of the *Pinus contorta.*

The prime object of the investigation was to obtain a graph of the accumulating percentage growth over the growing season for these

species, as representative of our conifer crops generally. In doing so it was also hoped to obtain some information as to whether such factors as region, species, age, quality class, or the position of the tree crown in the canopy, were of practical significance in the volume increment cycle.

The factor of elevation, though suspected of being of greater significance than most if not all of the above-mentioned ones was excluded because of difficulties related to the availability of the species concerned, in their respective sub-groupings over a worthwhile elevation range.

The five factors chosen were taken at three levels as follows:—

I. *SPECIES:* 1. Sitka spruce;
2. Norway spruce;
3. *Pinus contorta;*

II. *REGION:* 1. North-West;
2. Midlands;
3. South-West;

III. *AGE:* 1. Crops aged 13-17 years;
2. „ „ 22-25 „
3. „ „ 26-40 „

IV. *QUALITY CLASS:*—

Sitka spruce 1. Qual. Class II and over;
2. „ „ III;
3. „ „ IV and under;

Norway spruce 1. Qual. Class I and over;
2. „ „ II;
3. „ „ III and under;

Pinus contorta 1. Qual. Class I and over;
2. „ „ II;
3. „ „ III and under;

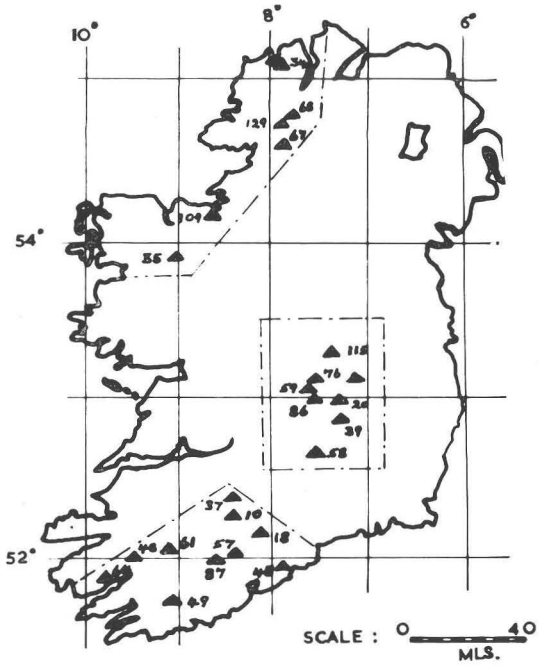
(*Pinus contorta* rated by Scots pine Tables;)

V. *POSITION IN THE CANOPY:*— 1. Dominants;
2. Co-dominants;
3. Sub-dominants.

Species: No attempt was made to segregate the spruces into their respective provenances, but in the case of the *Pinus contorta* the study was largely confined to the more important coastal strain.

Region: The regions chosen were as indicated on the map at Table I. Due to a shortage of suitable material it was found necessary to extend these—particularly region 3—over a wider territory than might have been wished. However, in the light of meteorological data supplemented by general experience of them, the regions so chosen were accepted as providing a satisfactory range of climatic conditions. The

TABLE I.
THE DISTRIBUTION OF THE FORESTS FROM WHICH READINGS WERE OBTAINED



No.	Forest	Map No.	No. Sites	No. Trees 1961	No. Trees 1962-63
1	Ards	34	5	7	28
2	Stranorlar	68	11	9	36
3	Ballybofey	129	6	6	24
4	Pettigo	67	1	1	4
5	Collooney	109	1	1	4
6	Foxford	35	3	3	12
7	Emo	33	9	9	36
8	Portlaoise	20	2	2	8
9	Durrow	39	3	2	8
10	Urlingford	58	1	1	4
11	Kinnitty	59	3	4	16
12	Clonaslee	76	2	2	8
13	Ossory	86	6	6	24
14	Tullamore	115	1	1	4
15	Kenmare	64	5	5	20
16	Killarney	48	2	2	8
17	Macroom	61	4	4	16
18	Dunmanway	49	1	1	4
19	Ballyhoura	10	5	6	24
20	Kilfinane	37	2	2	8
21	Banteer	87	1	1	4
22	Killavullen	57	3	2	8
23	Kilworth	18	4	2	8
24	Killeagh	45	2	2	8
	Totals		83	83	332

Midland region, it was expected, would provide more contrast with the North and South than they would with each other, and to accentuate this preference was given to trees growing at lower elevations in that region.

Age Classes: The range of age classes had perforce to be confined to what was generally available, and the limiting factor in this case was *Pinus contorta.*

Quality Classes: The scarcity of Sitka spruce quality class I and some categories of Norway spruce limited the range under this head.

Quality Class assessments were in all cases made in accordance with the British Forestry Commission Yield Tables.

The Selection Procedure.

The initial plan involved the selection of twenty-seven trees in each region. Those chosen were required generally to be normal in form, etc., and to have a minimum breast height diameter of three inches or more. They were selected so as to ensure that of the total in each region nine stems belonged to each of the three sub-categories, of the main categories, of Species, Age Class, etc. In 1961 a total of eighty-one trees were thus chosen.

Since Region was one of the five main factors concerned, three centres were chosen as focal points around which the trees were to be located, and with the minimum of scatter. The centres were Ballybofey (Region I), Emo (Region 2), and Kenmare (Region 3). Prior to the actual selection, tabulated lists of census data arranged by forest and in order of proximity to the centre or focal point of the region concerned in each case, were obtained. The lists indicated the stands where trees of the various categories might be found. Normally at each forest listed a number of possible stands occurred and the order in which they were visited was decided by random selection; likewise within the chosen stands the actual sites at which trees were to be selected were decided upon in advance by random means.

In cases where stands were found on inspection, not to include trees of the particular category sought, the next stand in random order was visited. This process was continued until all the necessary trees were located.

The Method of Recording Growth.

The method adopted was that described by Liming in 1957. It involved the use of aluminium dendrometers or girth-bands with part overlap and incorporating a vernier scale with the aid of which girth increases of 0.01 inch or more could be read. Prior to placing the band on a tree, the breast-height girth was measured accurately with a steel girthing tape, the stem bark having first been cleared of moss, ivy, loose bark or any abnormal protrusions of dead bark where such occurred. The girth-band (made to measure at the tree site) was then

placed on the stem at breast height; the necessary tension required to keep the band taut being provided by a stainless steel spring, having a modulus of elasticity of from 2 to 4 inches per lb. load.

When in position on the stem (which was duly numbered for identification purposes), the reading on the band scale was recorded. Each week during the growing season further readings were taken by

Girth-band in position on a *Pinus contorta* stem at Kenmare Forest, Co. Kerry.

local forest staff and forwarded to Assessment Section. There the weekly girth change for each tree was converted to a basal area change (true measure). These basal area changes were totalled in their respective groupings e.g. taking all 27 readings for each of the respective regions (irrespective of the species etc., concerned), for the three species (irrespective of the regions etc., concerned) and so on. The mean weekly values were then derived from these totals and plotted on squared paper. As the season progressed growth-trend curves were drawn.

Selection of Additional Trees in 1962 and 1963.

During the 961-63 seasons, readings were taken each week as described. In view of losses of data through damage to trees and/or to bands in 1961, and also for the purpose of increasing the sample

size, the number of banded trees was quadrupled at the beginning of the 1962 season. At each of the original sites three additional trees of the same category as the first, and within 10% of it in basal area were chosen. This measure did not upset the previous routine in any way except that the basal area increases of the single trees as used in 1961 were replaced in 1962 and after by values representing the means derived from the group of four trees at each site.

Winter Readings. Following the cessation of growth each year the bands were left in position on the trees and readings were taken at monthly intervals. These showed that while the majority of the stems did not vary in basal area during the winter, some increased slightly and some decreased. Between the end of October 1963 and the end of February 1964 for example, 84% of the 324 bands did not vary in their readings. Of those which did, 13% indicated an average girth increase of but 0.015 inches and 3% showed a mean contraction of 0.02 inches in girth. Such changes were not considered of practical significance in the context of the study.

The Basal Area Growth Trends.

At Table II the mean basal area growth per tree per week, for each of the sub-categories has been graphed; the three years being treated separately as well as on a combined basis.

In 1961 and 1962 band readings were not commenced until the beginning of May and in consequence some of the initial growth data were lost. While this is a matter for regret the general validity of the overall estimate of the growth-pattern now presented is not considered to have been significantly impaired. In 1963 and 1964 when readings were commenced at the beginning of April and March respectively, the growth which had taken place by the end of April was but 6% approximately, of the season's total in each case. In plotting the average growth-trend graphs for 1961 and 1962 extrapolations suggestive of similar growth levels have been made covering the month of April and part of March in each case. These extrapolations appear as broken lines.

The high initial readings shown on some of the 1961 graphs are as received, but since they were considered to have arisen through faulty band-adjustments or possibly through simple recording errors rather than through basal area growth, they have been rejected and in the calculations have been replaced by values more in keeping with the general trends.

Growth-Trends of the Sub-Categories.

The mean increment for all of the trees has been averaging 6% approximately. As between the individual categories e.g. the dominants, co-dominants etc., there has been wide variation in absolute growth, as might be expected, but their growth-trends on the other hand show a

TABLE II

WEEKLY AVERAGE GROWTH IN BASAL AREA (TRUE MEASURE) BY SPECIES, REGION ETC., FOR 1961 - 1963.

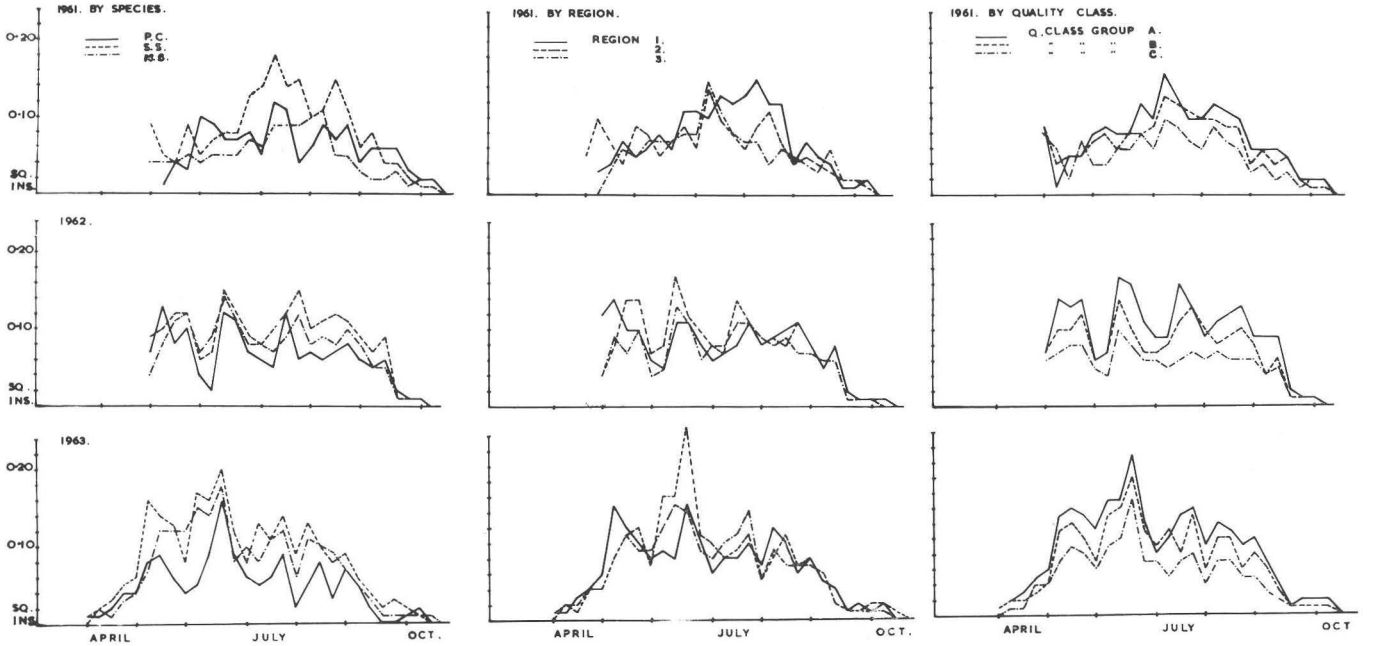
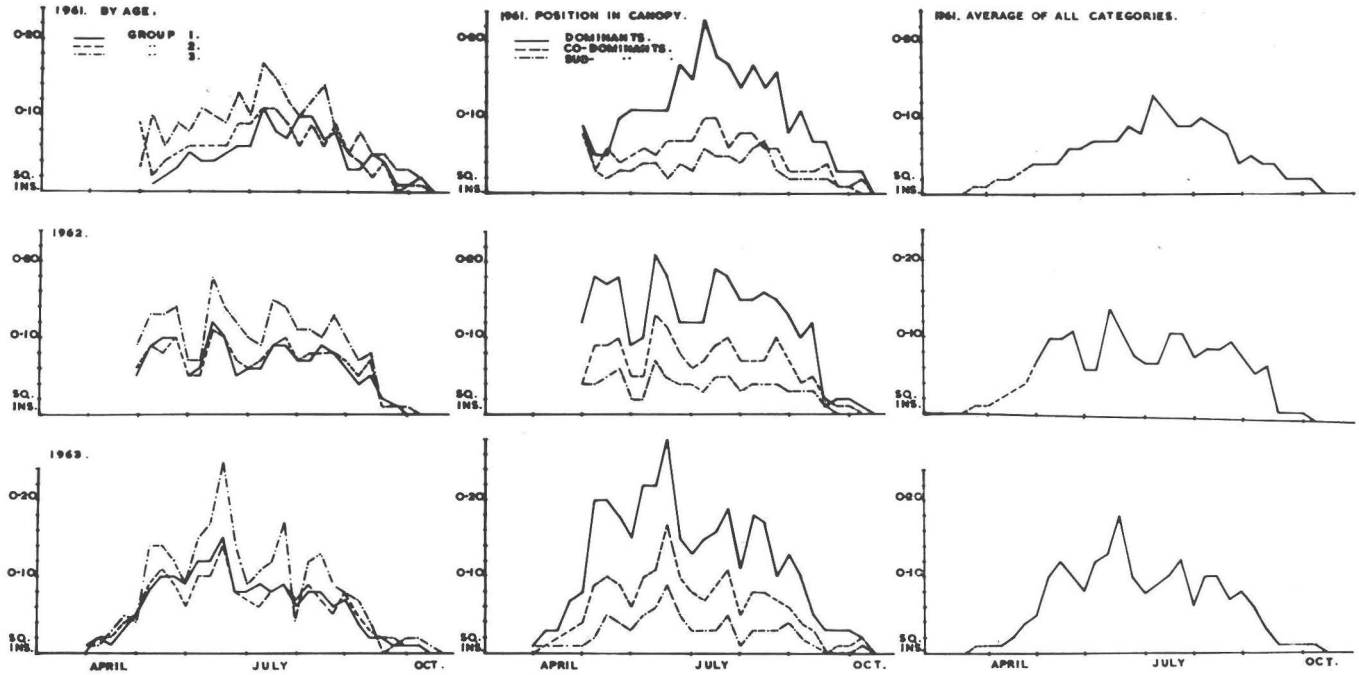


TABLE II CONTD.



generally good correspondence. The following are the correlation coefficients calculated for a selection of paired sub-categories for the years 1962 and 1963 :—

Sub-Category	*Correlation coefficient*	
	1962	*1963*
Quality Classes A & B	0.95	0.96
„ „ A & C	0.95	0.95
Regions 1 & 2	0.78	0.75
„ 1 & 3	0.83	0.77
Species P.C. & S.S.	0.84	0.80
„ P.C. & N.S.	0.77	0.79
Age Groups 1 & 2	0.95	0.94
„ „ 1 & 3	0.95	0.95
Position in the Canopy—		
Dominants & Co-dominants	0.94	0.97
„ Sub- „	0.90	0.90

Pending a more searching analysis of more extensive data, these results indicate that while the factors of locality and species may be of some material significance, quality class, age class and position in the canopy are not of practical importance in this context.

The Mean Percentage Growth Curve.

Despite the sometimes dramatic fluctuations in weekly growth rates which may be taken generally as reflecting prevailing weather conditions, the mean percentage growth curve for the season emerges as a much more regular trend. At Table III this curve may be seen. By means of it, it is possible to read the approximate percentage of the total annual growth which is likely to have taken place by a particular date. The range of variation from this average, by the individual yearly curves for the three years concerned, is also indicated. As further data become available changes in this curve in greater or lesser degree must be expected. It is noteworthy, however, that provisional calculations for the 1964 season indicate a curve which falls almost entirely within the confines of the already indicated range.

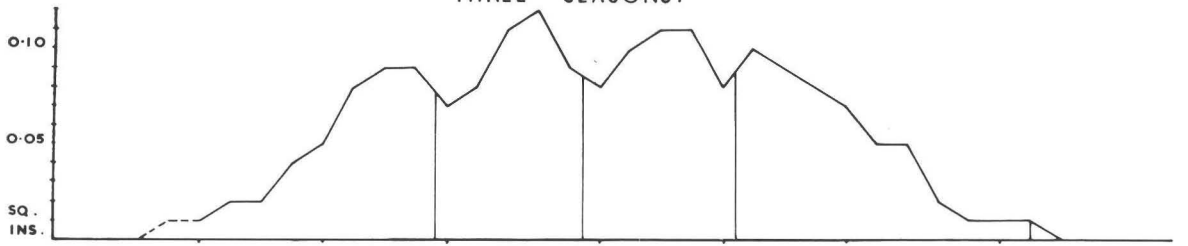
The dates at which the quarter, half etc., stages of total seasonal growth are reached have been indicated on Table III. The corresponding dates suggested by the 1964 curve agree with these, to within a week, in all cases.

Summary.

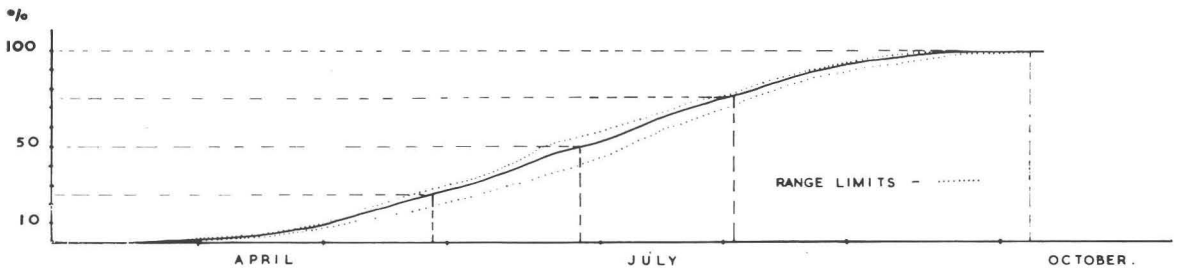
1. The pattern of the basal area growth of Sitka spruce, Norway spruce and *Pinus contorta* in Ireland during the 1961-1963 seasons is shown.
2. The implications or region, species, quality class, age class and the position of the tree crown in the forest canopy are also dealt with.

TABLE III.

MEAN BASAL AREA GROWTH-PATTERN FOR ALL CATEGORIES FOR THE THREE SEASONS.



PERCENTAGE GROWTH CURVE FOR THE 1961-1963 SEASONS.



Acknowledgments.

The co-operation of the Foresters-in-Charge at the forests concerned, and of the staff of the Assessment Section, who have, between them, being doing the routine work involved in this project is gratefully acknowledged.

References.

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