An Assessment of the Extent of Basal Sweep in South Coastal Lodgepole Pine

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Introduction

Lodgepole pine is a species which causes great difficulties for the forest manager. The most extensively planted provenances, the coastal varieties (LPC), are affected by problems of stability and poor stem form, though impressive growth rates can be achieved even on very poor sites. Originally LPC was planted on infertile sites as a pioneer crop, the idea being to pay for itself and to improve the site for the second rotation which would be spruce. However the quality of log produced in crops of LPC from older plantations led to an expectation of similar material being produced on the peat sites where most LPC has been planted. Recently, managers have become less optimistic about the prospects of sawlog from such stands of LPC and there has been a movement in favour of planting spruce, despite the nutritional problems. The economics of a 'pioneer' rotation are not yet known, so the move to spruce (or mixtures) would be reasonable if no sawlog of at least structural quality can be produced from crops of LPC.

It has been shown, however, that given the right environment, LPC can produce logs of good joinery quality. Given this, the economic justification for growing the relatively low-input pine would be strong if joinery quality logs could be produced from high yield class LPC on peat. These crops would no longer need to be considered as pioneer crops. The main factor militating against this is poor stem form and the compression wood produced in trees with crooked stems.

A joint study by EOLAS (formerly the Institute of Industrial Research and Standards) and the Forest Service* was undertaken to determine whether or not trees of the degree of straightness which can reasonably be expected on peat sites can, in fact provide joinery quality logs.

*Formerly Forest & Wildlife Service.

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Methods and Materials

The project was divided into two parts:

1. A basal sweep survey of LPC crops on ploughed ground to estimate the amount of sweep present in such crops.
2. An examination of LPC logs from trees with the degree of sweep indicated by the above survey to determine
   (a) The results of drying such material
   (b) The results from manufacturing the timber into finished joinery products.

This paper describes part 1 of the project.

Basal Sweep Survey

A random sample of LPC stands planted in 1963 was chosen and they were assessed for degree of lean or sweep at breast height. These crops were the oldest which could definitely be identified as pure south coastal in origin and thus similar to the LPC planted since that time. A total of 85 plots in 25 stands in 10 different forests were laid out and assessed; all of them in the western half of the country.

Two situations were examined:

(a) A systematic sample of the trees in the stands; no selection for stem form. This was to give an estimate of the degree of sweep to be expected if the crops are left unthinned.

(b) A selection of final crop trees was made and these were then assessed. This was to give a picture of the amount of sweep which might occur if the stands were re-spaced or selectively thinned.

The sampling procedures were as follows:

1. A list of all stands (sub-compartments) of LPC (pure) planted in 1963 was compiled. A weighting procedure was adopted to allow for the area of the stand, so that larger stands had a greater chance of selection. Twenty-five (25) stands were then selected from the list at random. It was first established that the stand still existed and it was confirmed that the lodgepole pine was of coastal origin. *Unploughed sites were not included.*

2. Plots of ·02 ha were marked out in each stand. The number of plots taken depended on the area of the stand:

Sub-Compt Area (ha)	*No. of Plots*
less than 1·5	2
1·5-2·4	3
2·5-3·4	4
greater than 3·5	5

3. The plots were scattered throughout the area, avoiding patches which were severely understocked. The plots were located randomly and great care was taken to ensure that the form of the trees did not influence the location of a plot.

4. Twelve (12) final crop trees were selected within each plot. This was a subjective selection and was a compromise between straightness and vigour. They were selected as if choosing a final crop with a view to thinning subsequently to favour those trees.
This was to give an estimate of the degree of sweep which might be expected in the final crop if the stand is thinned.
These trees were marked with white paint.

5. A further 12 trees were selected systematically throughout the crop, regardless of form, but omitting trees less than:
10cm if plot is YC 12
11cm if plot is YC 14
12cm if plot is YC 16
13cm if plot is YC 18 or greater.
This was to give an estimate of the degree of sweep which might be expected at clearfelling if the stand is left unthinned.
These trees were marked with coloured paint.
Note: It happened that some of the same trees were picked in both selections. This was acceptable provided the second sampling was systematic and trees picked by the first method were never deliberately re-selected.

6. For each *plot* the following was recorded:

(a) Soil type
(b) Type of ground preparation and direction of ploughing.
(c) Comments on degree of exposure.
(d) No. of stems in the plot (and whether it has been thinned).

For each overall sub-compartment the following were recorded (if available).
(a) Record of Fertilisation.
(b) Brashing/pruning.
(c) Elevation and aspect.

7. For each tree measured the following were recorded:

(i) The degree of sweep
(ii) The direction of sweep
(iii) The DBH.

8. The location of the plots was roughly indicated on a 6 inch (1:10,560) map. They were not marked out on the ground but the paint marks on trees should be sufficiently clear to remain visible. The plots may be required for future reference.

Measurement of Degree of Sweep

The degree of sweep is the angle the stem forms with a vertical pole rising from the base of the tree. It is measured in the direction of greatest sweep or lean.

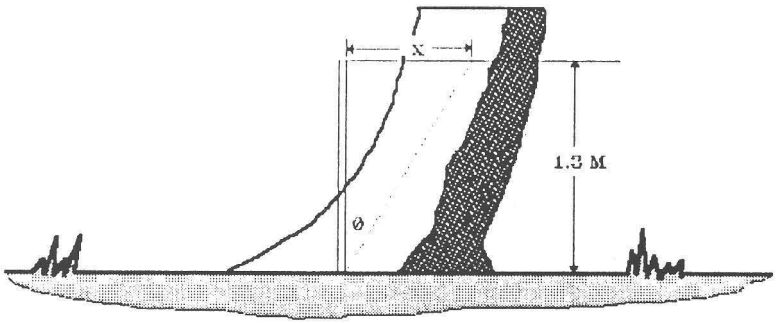

Figure 1.

The pole is held vertically and stuck into the ground beside the centre of the base of the tree. At 1·3m (breast height) the distance from the pole to the centre of the stem ('X' in Fig. 1) is recorded. From this the angle of sweep can be calculated. On a specially constructed "sweepometer" the angle can be read directly. Care was taken that the distance measured was in the horizontal plane. On the sweepometer there is a spirit-level to ensure this.

Systematic Selection of Trees

Under item (5) of the procedures above a systematic sampling is required. To illustrate the steps involved here is an example:

a. The number of stems in the plot were counted. At 2m spacing this was about 50.

b. Approx. 30% may be below the diameter limits for the yield class so there may be 35 or 40 trees to choose from.

c. Twelve are required thus every 3rd tree of sufficient girth was measured.

d. Assessment started in one corner of the plot and followed a line of trees, taking every third tree. If it was large enough it was measured, if not the next one was taken, and so on.

e. When 12 trees were measured assessment was complete. If the assessor had gone through the entire plot and still needed some trees, they were taken at random through the plot.

Results

The average degree of sweep or lean in all the plots surveyed was 12·9°. After selection of final crop trees (the 600 best stems/ha), the average sweep was reduced to 9.2°.

There was, however, great variability between plots. Fig. 2 below shows the distribution of plots by mean degree of sweep for both systematic and selective systems of measurement.

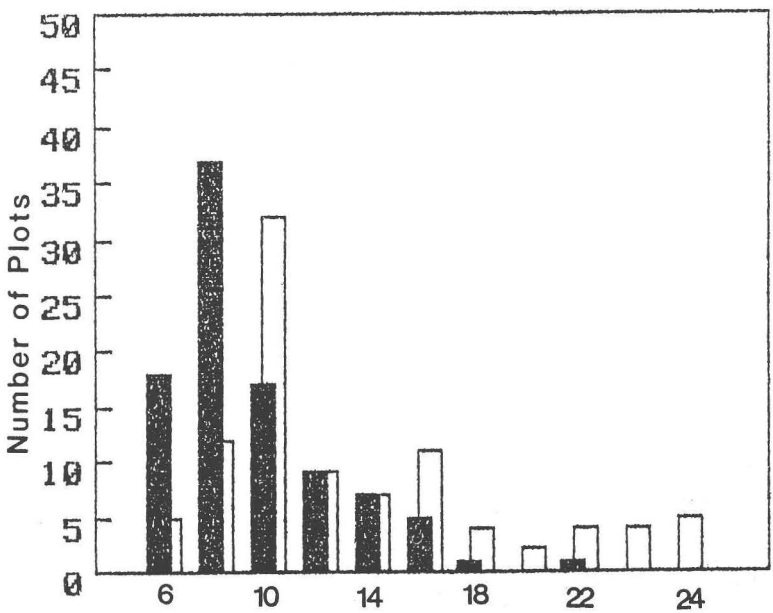

Figure 2 Mean Angle of Plot.

(White bars show distribution when all trees in the plot are included, the dark bars show the situation after selection).

The systematic system above measured the mean degree of sweep in the stands as they were at time of assessment. All but 11 of the 85 plots were unthinned. Where thinning was carried out it was systematic, removing one line in three, so it did not effect the results of the no-selection survey. Where a final crop was selected it is to be expected that the removal of lines will reduce the straightness of the final crop by removing a third of the potential final crop stems. Nearly all of the plots which were thinned occurred in two of the best forests in terms of tree straightness, so this anticipated effect of thinning is not clearly evident from the figures. Assuming such an effect exists, the effect of the thinning on the survey results will be to cause it to give a slightly low estimate of the improvement in stem form to be gained by selection.

From the comparison of the two plot distributions (Fig. 2) above, the importance of selective thinning (or re-spacing) can be seen. The large 'tail' of very poor plots is virtually eliminated by selection.

A summary of the results of the survey is given in Appendix 1.

Discussion

The survey described in this paper was the initial phase in the work of a Task Force on coastal lodgepole pine (Evertsen, 1987). The personnel involved were from the Institute of Industrial Research and Standards (now known as Eolas) and the Forest Service. The objective was to examine the end-use potential of crops of LPC planted since 1963. Following the results of this survey, extensive work was carried out on comparable older material to determine its suitability for joinery purposes. Specifically, it was compared directly with imported 'red deal'. The results will be described in detail elsewhere.

The timber selected for the tests came from trees with an average basal sweep of approximately 10°. The range was 7·5°-12·5°. Over the wide range of features tested, the LPC was found to be equal or superior to the red deal used in the comparisons. If it is assumed that stands with an average sweep of 15° or greater have no sawlog potential, the results from the survey are promising.

Accepting that stands with a mean basal sweep of 12° or less can substitute for imported red deal, the implications are illustrated in Figure 3. This shows the cumulative percentage of stands surveyed which have a degree of sweep equal to or less than the figure given on the horizontal axis. The two sets of silvicultural options discussed are shown: (i) selective thinning or re-spacing and (ii)

systematic thinning or no-thinning. Looking at the histograms for 12° it is seen that over 80% of the stands, if selectively treated, can achieve this degree of straightness or better. Even without selection 60% of the stands appear to have joinery potential.

If the average sweep of the trees used in the tests (10°) is used as the cut-off point the equivalent figures are 75% of stands suitable (selective systems) and 50% (no selection).

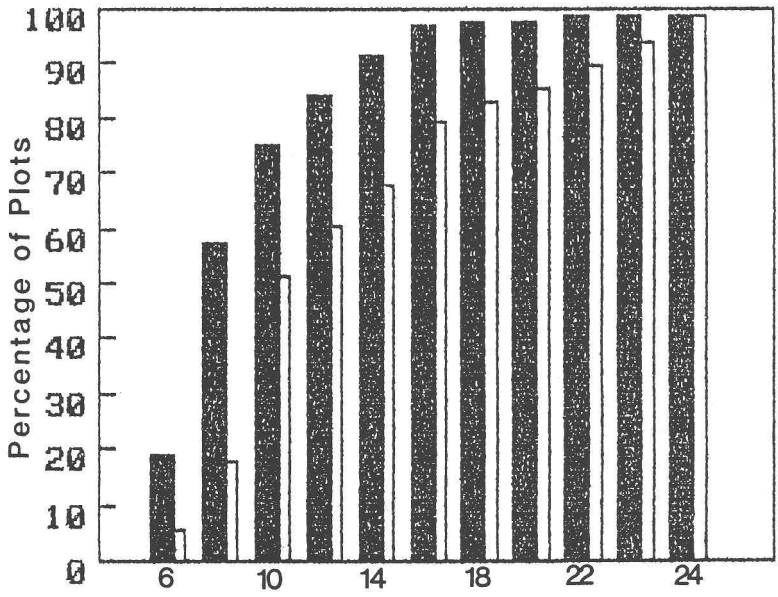

Figure 3 Mean Angle of Plot.

(Cumulative % of plots with mean sweep equal to or less than the angle given on the horizontal axis).

Stands which are not suitable for joinery are very unlikely to be suitable for sawlog. Firstly, because many of the intrinsic properties which exclude them from joinery uses would do likewise for other sawlog end-uses, secondly, long lengths are difficult to extract from the type of stands in question due to sweep and taper and the consequent reduction in recovery with longer lengths. The

choice is between joinery timber and lower value palletwood, firewood or pulpwood.

Limitations of the Study

The most important unknown factor in the study is how trees will develop in terms of stem form between now and clearfelling age. It is unclear whether sweep continues to develop near the butt of the tree after first-thinning stage, or whether trees with reasonably straight stems remain straight until the end of the rotation. Re-assessment of the plots in the survey in future years should help clarify this.

The second important unknown factor is the relationship between deviation from the vertical at 1·3m and timber quality. Because of the great variability in stem form between stands and forests, an extensive survey was required to give an overall picture. The measurements taken, had, of necessity, to be simple. Thus the angle of 'sweep' at 1·3m is an objective ranking of the trees by an external characteristic which is assumed to be related to wood quality. It is hoped in the testing programme to quantify the relationship. However, it is not known whether or not trees with the same measurement of angle at 1·3m will exhibit the same wood quality effects. For example, it seems probable that the effects caused by lean will be different to those caused by sweep. There are numerous types of stem distortion which give the same angle of deviation at 1·3m, though the common basal sweep accounts for most of it.

Explanation of Variability

Examining the data available it is very difficult to come to firm conclusions as to why some stands are poor and others good, other than a general confirmation of what has previously been observed. Thus soil type, exposure and ploughing direction all seem to play a part.

Acknowledgements

Special thanks are due to Mr. T. Horgan, Research Forester, Mallow, who designed the 'sweepometer' thus greatly facilitating the work of the survey; Mr. W. F. Collins and Mr. P. O'Halloran, Research Foresters, Oranmore, who surveyed the bulk of the plots.

Mr. S. Heaney, Dundrum Sawmill, who carried out, or was involved in all aspects of the project.

REFERENCE

EVERTSEN, J. A. (Task Force Co-ordinator). Lodgepole Pine Task Force, Report No. 2 (Volume 1), IIRS 1987. Unpublished.

APPENDIX 1

LPC BASAL SWEEP SURVEY — SUMMARY

Forest	Compt	Sub	Plot No.	YC	Systematic		Selective		Site Details				
					Mean DBH	Angle	Mean DBH	Angle	Plough Dir.	Exp.	El.	Asp.	Soil
Cloosh Valley	51604W	3	1	16	15.3	21.2	16.5	13.3	E/W	Mod.	90	Flat	BB
„	„	„	2	12	13.8	19.6	16.1	15.0	„	„	90	„	„
„	„	„	3	12	13.6	15.4	14.6	9.6	„	„	85	„	„
„	„	„	4	12	14.4	16.7	15.0	9.6	„	„	„	„	„
„	„	„	5	14	17.0	25.4	16.4	16.2	N/S	„	80	„	„
Derrybrien	51869Q	2	1T	16	20.4	8.3	20.4	6.7	NE/SW	Ex	115	W	Peat (15-20)
„	„	„	2T	14	15.0	6.7	18.0	8.3	SE/NW	„	106	SE	Peat (30)
„	„	„	3T	14	16.9	9.2	17.8	8.3	„	„	110	S	Shallow peat
„	„	„	4	14	18.6	7.5	19.7	6.7	„	Mod.	100	„	Peat (20-30)
„	„	„	5	14	18.4	7.1	19.1	5.4	„	Ex	122	„	„
„	51870S	„	1T	16	15.8	11.7	18.1	7.9	NE/SW	Ex	95	SW	Peat (35-40)
„	„	„	2	12	14.1	7.9	14.6	6.2	„	„	106	„	Peat (25)
„	„	„	3T	14	16.2	10.0	17.8	8.8	„	„	91	„	Peat (35)
„	„	„	4T	14	18.7	10.0	17.7	6.2					
„	„	„	5T	16	17.8	9.2	16.8	6.7	NE/SW	Mod.	98	E	Peat (20-25)
„	51870J	4	1T	16	19.5	11.2	21.1	8.3	SE/NW	Ex	99	S	Peat (15-20)
„	„	„	2	14	16.8	9.2	18.3	7.5	N/S	Mod.	100	„	Peat (20-30)

„	„	„	3	18	17.9	12.9	19.5	8.3	„	„	106	„	Peat (15-25)
„	„	„	4T	14	17.2	12.9	18.6	8.8	NE/SW	„	91	SW	Peat (30)
„	„	„	5	14	16.1	10.0	16.5	6.7	„	Ex	84	„	Peat (15-25)
„	51880D	2	1	14	16.0	9.6	18.2	7.9	NE/SW	Ex	160	W	Peat (25)
„	„	„	2	14	18.7	10.4	19.2	8.3	N/S	„	160	„	Peat (ORS)
„	„	„	3	10	13.8	10.4	15.8	7.1	E/W	„	161	„	Peat (15-20)
„	„	„	4	10	14.1	9.2	15.6	6.7	„	„	167	NW	Peat
Duhallow	35490L	3	1	12	19.5	7.1	21.9	8.3	SE/NW	Mod.	305	SW	Peatylayer
„	„	„	2	10	19.9	6.2	20.7	5.8	„	Exp.	335	„	of ORS
„	„	„	3	10	19.3	10.4	21.2	5.0	„	„	„	„	„
„	„	„	4	10	18.1	10.0	18.9	7.5	„	„	„	„	„
„	„	„	5	10	18.7	9.6	19.5	6.2	„	Mod.	„	„	„
„	35504P	6	1	12	19.6	13.8	22.1	9.6	SE/NW	Ex	260	W/SW	Peat ORS
„	„	„	2	12	16.2	10.8	21.0	9.6	„	„	„	„	„
„	„	„	3	12	17.3	10.4	20.3	10.4	„	„	„	„	„
„	„	„	4	10	19.2	12.9	20.6	11.7	„	„	„	„	„
„	„	„	5	10	17.4	10.0	20.7	9.2	„	„	„	„	„
„	35490L	1	1	12	18.8	9.2	19.7	5.8	SE/NW	Ex	300 340	SW	Peat ORS
„	„	„	2	12	19.9	14.6	21.1	5.8	„	„	„	„	„
„	„	„	3	12	19.2	9.6	19.9	4.6	„	„	„	„	„
„	35531F	1	1	12	17.4	10.4	19.2	7.9	SE/NW	Not	260	SW	Brown Earth ORS
„	„	„	2	12	16.4	7.5	19.2	7.1	„	„	„	„	„
„	„	„	3	12	18.0	11.2	20.8	7.1	„	„	„	„	„
„	„	„	4	12	16.1	10.8	18.9	8.3	„	„	„	„	„
„	„	„	5	12	15.3	8.8	19.1	6.7	„	„	„	„	„

APPENDIX 1 (continued)

LPC BASAL SWEEP SURVEY — SUMMARY

Forest	Compt	Sub	Plot No.	YC	Systematic		Selective		Site Details				
					Mean DBH	Angle	Mean DBH	Angle	Plough Dir.	Exp.	El.	Asp.	Soil
Killary	51341D	1	1	12	14.4	9.6	17.4	10.0		Exp	70m	SE	BB
„	„	„	2	14	14.7	14.6	15.8	10.0		„	„	„	„
„	„	„	3	14	16.0	14.6	18.4	11.7		Mod.	„	„	„
„	„	„	4	12	13.0	12.5	17.3	9.6		Exp	„	„	„
Lough Atorick	41861T	3	1	12	14.2	10.0	14.8	7.9	N/S	Exp	106	W	Peat over ORS
„	„	„	2	10	14.2	12.5	14.5	8.3	„	„	109	„	„
„	„	„	3	10	15.9	10.8	16.8	9.2	„	„	97.5	NW	„
Mount Bellew	55761B	5	1	14	15.3	12.5	16.4	7.5	NW/SE	Mod.	34	Flat	Raised Bog
„	„	„	2	12	13.5	10.0	15.2	5.4	„	„	33	„	„
„	„	„	3	12	13.8	9.6	14.9	7.1	N/S	„	30	„	„
„	„	„	4	12	12.4	8.3	14.4	6.2	NW/SE	„	33	„	„
„	„	„	5	14	13.6	6.2	15.1	5.4	„	„	„	„	„
„	55766G	2	1	12	13.7	7.9	15.2	7.1	N/S	Not	33	„	„
„	„	„	2	16	15.0	16.2	18.0	11.7	NE/SE	„	„	„	„
„	„	„	3	14	14.7	15.8	18.0	9.6	„	„	„	„	„
„	55766G	3	1	14	16.3	10.4	18.2	9.6	N/S	Mod.	„	„	„
„	„	„	2	12	14.7	15.0	15.1	7.9	NW/SE	Not	„	„	„

„	55767B	5	1	14	15.3	12.5	16.4	7.5	NW/SE	Mod.	34	Flat	Raised Bog
„	„	„	2	12	13.5	10.0	15.2	5.4	„	„	33	„	„
„	„	„	3	12	13.8	9.6	14.9	7.1	„	„	30	„	„
„	„	„	4	12	12.4	8.3	14.4	6.2	NW/SE	„	33	„	„
„	„	„	5	14	13.6	6.2	15.1	5.4	„	„	„	„	„
„	55766G	2	1	12	13.7	7.9	15.2	7.1	N/S	Not	33	„	„
„	„	„	2	16	15.0	16.2	18.0	11.7	NW/SE	„	„	„	„
„	„	„	3	14	14.7	15.8	18.0	9.6	„	„	„	„	„
„	55766G	3	1	14	16.3	10.4	18.2	9.6	N/S	Mod.	„	„	„
„	„	„	2	12	14.7	15.0	15.1	7.9	NW/SE	Not	„	„	„
Rathluirc	36542Q	1	1	12	12.8	10.0	17.0	5.4	NE/SW	Not	180 210	NW	ORS Light Peat
„	„	„	2	12	14.4	8.8	15.1	7.1	„	„	„	„	„
„	„	„	3	10	13.8	9.6	16.2	7.1	„	„	„	„	„
„	„	„	4	10	13.9	8.8	14.8	5.8	„	„	„	„	„
„	„	„	5	12	13.8	6.2	16.2	7.5	„	„	„	„	„
Nephin Beg	510	4	1	10	14.0	4.6	16.4	7.5	NE/SW	Ex	150	S	BB
„	„		2	14	16.3	10.8	18.1	6.7	„	„	„	„	„
„	„		3	14	16.3	11.7	19.8	11.2	„	„	„	„	„
„	„		4	10	17.7	10.4	18.5	6.2	„	„	„	„	„
„	„		5	12	15.8	8.3	17.6	8.3	„	„	„	„	„
Oughterard	52447M	1	1	12	—	35+	—	35+	E/W	Ex	122	E	Peat (40m)
„	„	1	2	10	16.9	22.9	20.6	17.9	„	Mod.	135	„	„
„		3	1	12	16.6	25.8	18.4	21.7	E/W	Ex	140	E	„
„	„	„	2	12	16.7	23.8	18.4	14.2	„	Mod.	„	NE	„
„	„	„	3	12	16.8	26.2	19.6	15.0	„	Ex	135	E	Peat (1m)

APPENDIX 1 (continued)

LPC BASAL SWEEP SURVEY — SUMMARY

Forest	Compt	Sub	Plot No.	YC	Systematic		Selective		Site Details				
					Mean DBH	Angle	Mean DBH	Angle	Plough Dir.	Exp.	El.	Asp.	Soil
Oughterard	52447M	3	4	14	15.7	20.8	17.5	12.5	E/W	Mod.	120	NE	Peat (1m)
„	52449C	6	1	12	16.6	25.8	17.7	12.5	N/S	Ex	137	W	Peat (1m)
„	„	„	2	10	16.2	22.5	17.0	12.1	„	„	„	NW	BB
„	„	3	1	12	15.8	20.4	16.5	11.2	„	„	135	S	„
„	„	„	2	12	14.5	17.5	15.0	10.8	„	„	„	NW	BB Stiff.
„	„	„	3	12	15.5	22.1	18.5	15.0	„	„	„	SW	BB
„	52448H	7	1	12	14.3	25.8	15.4	13.3	E/W	Ex	135	NE	„
„	„	„	2	12	14.5	22.9	15.3	13.3	„	„	137	S	„
„	„	„	3	12	14.6	20.8	15.4	15.4	„	„	140	„	„
„	„	„	4	12	13.9	17.5	15.8	13.3	„	„	„	„	„
„	41447M	2	1	16	19.7	15.0	19.3	10.4	NE/SW	Not Ex	90	NE/SW	Peat (15cm)
„	„	„	2	16	17.9	18.3	19.0	12.1	„	„	„	„	„

Explanation of abbreviations in Appendix 1.

EXP=exposure
EL=elevation in metres
ASP=aspect
BB=Blanket bog
T (beside plot number)=plot has been thinned
ORS=Old Red Sanstone (parent material)
YC=Yield Class (estimated productivity in m^3/ha/year)
DBH=Diameter at 1.3m given in cms
Angle=Given in degrees