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IRISH FORESTRY

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IRISH FORESTRY

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Editorial

OUR "COMPETITORS"

It is difficult to say whether it is a good or a bad thing that forestry journals do not depend, as do newspapers and other commercial periodicals, on the quality or liveliness of their contents for the size of their readerships. The circulation of a forestry journal is usually controlled by the number of members in the organisation which publishes it. It is arguable, however, that quality, being often dependent on money and prestige, is directly related to income, and hence to the numbers of members.

I have been looking at a number of recent issues of forestry journals in the English language.

There are two from England. *Forestry,* journal of the Society of Foresters of Great Britain, concentrates on technical and research papers at a high scientific level, while the *Quarterly Journal of Forestry,* published by the Royal Forestry Society of England, Wales and Northern Ireland, is inclined to cater more for those interested in the practical aspects of forest management, and tends to carry articles of more general appeal. *Scottish Forestry,* issued by the Royal Scottish Forestry Society, is somewhat in between the first two, though tending more in the direction of the *Quarterly Journal.*

From the U.S.A. we have *Forest Science* "a quarterly journal of research and technological progress", and *Journal of Forestry,* both published by the Society of American Foresters. These Correspond approximately in scope with the two English journals, the former consisting entirely of scientific papers, and the latter containing a mixture of scientific, technical and general material. *The Forestry Chronicle,* from the Canadian Institute of Forestry has recently given itself a face-lift, and now compares favourably with the best in the world for both quality and liveliness. In content it is rather similar to *Journal of Forestry.* The New Zealand Institute of Foresters, Inc., publishes *The New Zealand Journal of Forestry,* of wide-ranging content, and perhaps of particular interest to readers here because of the existence in New Zealand of large areas of exotic conifer plantations.

All of these are of great interest in themselves, but for the forester who wishes to keep up to date on all technical advances, there is nothing to equal *Forestry Abstracts,* published quarterly by the Commonwealth Agriculture Bureaux at £8 per annum. This journal gives the gist of all articles relevant to all aspects of forestry published in all countries of the world. In 1969 it dealt with 6793 articles.

Spruce Growth Rates on Drumlin Soils

By L. P. O'Flanagan[1] and M. Bulfin[2]

INTRODUCTION

Of the many topographic features left to us by a departing Ice Age, one of the most outstanding is that characterised by the numerous small oval-shaped hills located mainly on the North-Central plains. These hills called drumlins (from the Irish *druim* meaning a mound or rounded hill) also occur in small areas in other parts of the country notably around Clew Bay and in Clare, but the great belt of drumlins stretching from southern Donegal and Sligo through Fermanagh, Leitrim, Cavan, Louth, Monaghan, Armagh and Down is one of the largest in the world. Drumlins were formed under moving ice and this is the reason claimed for their long low streamlined shape.

Gardiner and Ryan (1969) state that drumlin soils occupy 10.1% of the Republic, of which 7.8% are wet mineral or organic soils; only 2.3% are classed as mainly drier mineral soils. The discussion of spruce production on drumlin soils which follows, is confined to the wet mineral soils with particular reference to the Leitrim-West Cavan area.

GENERAL DESCRIPTION OF AREA

Definition

Embelton and King (1968) define a drumlin as: "a low hill having an oval outline and not exceeding 60m in height. It is formed mainly of till, but sometimes contains stratified material or a rock core."

Geology and Drift Origin

Most of the soils of the drumlin area have developed from sedimentary rocks. In the North Leitrim lowands, calcareous carbon-rich shale is the dominant parent material, while in South Leitrim siliceous limestone and shales are the predominant soil parent material. In the Cuilceagh mountains, sandstones and grits are the commonest parent materials. The drifts formed from these rocks are generally high in silt and clay and provide the material for the typical Leitrim "daub". Cruikshank (1961) implies that the movement of drift material from its parent rock has been negligible in most areas in Fermanagh and this holds for the Leitrim-Cavan area also.

Soils

The soils of the drumlins are typically heavy soils high in silt and clay, with poor subsoil structure and aeration. In the western

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areas of the drumlin belt, where the rainfall is higher, this leads to the formation of gley soils; sometimes locally called "daub" soils. East of County Cavan, where rainfall is less and soil parent material is somewhat more favourable, the soils have moderate to poor drainage. An increase in elevation, with its consequently increased rainfall, brings the development of peat, giving firstly peaty gleys and finally climatic peats on drumlin topography. This is typical of the Drumkeeran area where a drumlin landscape is covered with a thin skin of peat at elevations above 500 feet.

The typical gley has a surface layer rich in organic matter overlying a compacted plastic subsoil of blueish or greyish colour. Roots are normally limited to the organic layer. The dense plastic subsoil, low in pore space and impermeable to water, combined with all-the-year-round rainfall greatly in excess of evaporation (Mulqueen and Burke 1967) ensures that these soils are waterlogged for most of the year. Mapping of these soils is extremely difficult and very complex patterns emerge.

For the Leitrim-Cavan area a number of generalisations may be made about soils in a drumlin topography; the first is that the soils on the drumlin itself normally differ from those on the interdrumlin areas; secondly, drumlin soils can be segregated on the basis of slope, and finally, interdrumlin soils can be segregated on the nature of the soil material developed.

Drumlin Soils

In the wetter areas of the drumlin belt typified by County Leitrim, a 3-8 inch organic-layer overlies a plastic subsoil. Soils on the flat tops of drumlins and on the lower, more gentle slopes tend to be poorer, possibly with a skin of peat, than those on the sides (Lee and Ryan 1965, Jaritz and Lee 1968, Finch and Lee 1969). In the limestone areas of South Leitrim and West Cavan, a variation of the above soil, which has a hard-banded layer of chert gravel below the organic layer, occurs. The chert layer may be from a few inches to nine inches thick and is underlain by the heavy daub subsoil. Locally, this layer of chert is known as "channel". Rooting in either the daub or channel soils is limited to the thin organic-rich layer. Because these soils are normally waterlogged, and have a high silt and clay content and poor structure, they have a low bearing capacity, and are easily damaged by cattle treading or machinery movement.

Interdrumlin Soils

Soils occurring in the interdrumlin areas account for one fifth to almost half the total land surface in a drumlin topography; they generally average about one third of the area. Normally all are poorly drained to waterlogged for most of the year. They can be divided into three man types depending on local circumstances; where a stream of any size occurs, alluvium may be found; in depressions with no outlet peat may form, and finally a mixture of the two previous soils may form an organo-mineral soil.

Because infiltration of rainfall into heavy drumlin soils is slow, surface run-off of rainwater, particularly in heavy rain, is high. The run-off, carrying clay particles downslope, mixes with overflowing streams and deposits a colluvial-alluvial mixture on the interdrumlin flats. In flat areas, where water tends to stagnate, peat begins to form and a peat-alluvium mixture, of varying proportions of organic matter develops. Where continuous ponding of water takes place, peat formation becomes the dominant soil process; in the limestone areas a base rich *Phragmites* peat, that gives a rich free-draining soil when properly handled, develops, while on the more acidic shale or sandstone parent materials, a rawer more oligotrophic peat develops.

The first state afforestation of drumlin soils was in the middle thirties and figures shown in this paper are from plantations planted from then up to 1957.

METHODS

Conifer crops rated as high forest, and planted before 1958 were included in the 1968 Inventory of State Forestry. These crops were classified by yield class and these data are used here to show the production from drumlin soils. The forest areas in Leitrim, West Cavan and on the Roscommon-Leitrim border were checked against topographical maps, and the forest properties likely to be on drumlin were listed. These properties were checked in the field and the sub-compartments or compartments on drumlin soils noted. The yield classes used are those of the Forest Management Tables (Bradley, Christie and Johnson, 1966) for Sitka spruce and Norway spruce.

Production from State Forests

Most of the plantations in the areas which are covered by this inventory are on peats, peaty gleys, brown podzolics and alluvium leaving about 850 acres (344 ha.) of Norway and Sitka spruces on drumlin soils. The forests represented, and the areas involved, are shown in Table 1.

TABLE 1

Forest	Sitka spruce acres (hectares)	Norway spruce acres (hectares)
Drumsna	53 (21.5 ha.)	205 (83.0 ha.)
Dromahaire	6 (2.5 ha.)	— — —
Glenfarne	37 (15.0 ha.)	31 (12.5 ha.)
Killeshandra	218 (88.0 ha.)	297 (120.0 ha.)
TOTAL	314 (127.0 ha.)	533 (215.5 ha.)

Table 2 shows the area in each yield class of the two spruces. (The metric yield classes are cubic metres per hectare per annum).

TABLE 2

Yield Class	Sitka spruce		Norway spruce	
Hoppus measure (metric equivalents in brackets)	Acres	%	Acres	%
100 (8.9)	—	—	3 (1.0 ha.)	—
120 (10.7)	—	—	9 (3.5 ha.)	2
140 (12.5)	—	—	7 (3.0 ha.)	1
160 (14.0)	2 (1.0 ha.)	1	4 (1.5 ha.)	1
180 (16.0)	15 (6.0 ha.)	5	59 (24.0 ha.)	11
200 (17.8)	69 (28.0 ha.)	22	100 (40.5 ha.)	9
220 (19.6)	29 (12.0 ha.)	9	54 (22.0 ha.)	10
240 (21.4)	82 (33.0 ha.)	26	297 (120.0 ha.)	56
260 (23.2)	77 (31.0 ha.)	24		
280 (24.9)	40 (16.0 ha.)	13		
TOTALS	314 (127.0 ha.)	100	533 (215.5 ha.)	100

The mean yield class for Sitka spruce is 240 (21.4 metric) and for Norway spruce 220 (19.6 metric). These means are the weighted averages taken from the production and area figures in Table 2.

Production from Private Forestry

The authors were fortunate in having access to Mr. A. O'Rahilly's plantations near Leitrim village. These plantations show excellent growth on typical drumlin soils. The measurements taken were confined to Sitka spruce crops in the 15 - 20 age group at Drumhierny and Kilmaherna. While the area assessed is small, it does show the production potential of what is normally considered agricultural land in the region. The results obtained are in Table 3.

TABLE 3

Yield Class	Sitka spruce	
Hoppus measure, (metric equivalents in brackets)	Acres	%
260 (23.2)	4 (1.5 ha.)	10
280 (24.9)	29 (12.0 ha.)	75
280+ (24.9+)	6 (2.5 ha.)	15
TOTAL	39 (16.0 ha.)	100

The weighted mean yield class here is 280 (24.9 metric) which is the top yield class given in the management tables.

The yield classes of the Forestry Commission management tables are designed to incorporate three production classes, A, B and C. Production class B is the equivalent of the general yield class, produc-class A is a yield class above and production class C a yield class below the general yield class. Thus yield class 240, production class A, becomes the equivalent of yield class 260 though the age/height relationship is that of 240. Recent research work in the Forest Service indicates that Sitka spruce is normally production class A in this country.[1] This means that the mean production figures shown here for Sitka spruce could be assumed to be one class higher viz. 260 for state forestry and 300 for private forestry.

DISCUSSION

Agricultural production on drumlin areas is limited by both poor soils and uneconomically sized holdings. This fact is generally accepted but perhaps the inherent truth of it is best portrayed by the classic response of the people themselves. Emigration is high and population pattern projections indicate that there will be no successor for up to 60% of the farm holdings within the next thirty years (Duke, 1967). The forest potential must be considered against this background of high forestry production figures compared with the marginal agricultural returns. The spruce production figures shown here are certainly above average for the country as a whole and indicate that lage scale afforestation of low-lying drumlin soils would provide a high return (by forest standards) on the capital employed, and worthwhile employment.

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Dimensional Control in the Sawmill

By P. M. JOYCE[1]

SUMMARY

Following an outline of the theory of statistical control the construction of control charts for lumber dimension is explained with the aid of data.

INTRODUCTION

Just as variation is accepted in nature in general, so also does it exist in every manufacturing process, even the most precise. No two items are *exactly* alike. In the course of lumber production, variation in input factors (i.e. the material, the saw unit, the saw operator, the work method, etc.) will cause some variation in the dimensions of the output (the board, batten or plank). Thus a Mill sawing battens to a target 7 by 2 inches will produce material some of which will vary a few thousands of an inch from the target 2 inch thickness. This is fully acceptable to management and may be established as a standard for good sawing. Similar standards will be established for other dimensions. One would expect this small variation to remain relatively stable over time unless something happens to create a change in at least one of the input factors. The decision problem facing the sawmill manager is whether an observed difference between the actual measurement and the established standard is acceptable or is an exception to normal performance and necessitates corrective action. Shutting down the Mill unnecessarily can be costly, while the production of poorly sawn or over-dimensioned timber is wasteful and economically unattractive. How does management decide whether the production process is performing satisfactorily and what to do if it is not? The answer lies in statistical control whereby changes in the process, other than those due to chance causes, may be made known and action taken.

STATISTICAL CONTROL

The objective of control is to ensure that the manufactured product of future output conforms to some current or past standard of specification. This implies that variation in the product will remain

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stable and can be predicted. The underlying assumption is that stability in variation in the product will result from stability in the variation both within and between input factors but that a change in the variation contributed by the input factors will cause a change in the variation in the product. Thus the total variation in the product can be attributed to two possible causes (Bowman and Fetter, 1961)

(i) small random fluctuations inherent in the process;

(ii) identifiable causes, in particular something having gone wrong with the plant, the material or the method of control, causing either a shift in the average dimension of the product or a sudden increase in the variability.

The basis of control is to set limits to the amount of variation that can be ascribed to (i) above and to use this as a criterion for deciding at any given time whether a set of observed values indicate that an assignable cause of variation is present.

For the purpose of predicting the quality of future output it is necessary to select some method of describing the current output. The conventional statistics are the mean and standard deviation of the distribution which characterises the production process. These can be estimated as—

$$\bar{x} = \frac{\Sigma x}{n}$$

and
$$s = \sqrt{\frac{\Sigma (x-\bar{x})^2}{n-1}}$$

where x is the value of a variable, n is the number of values in the sample and $\bar{x}$ and s are estimates of the population mean, μ, and standard deviation, σ, respectively. If the variable is continuous and the frequency distribution of measurements follow the well known bell-shaped or normal distribution, then definite areas are included within known standard deviations on either side of the mean as follows:—

(i) $\mu \pm \sigma$ includes 68·26 per cent of the area under the curve.
(ii) $\mu \pm 2\sigma$ ” 95·45 ” ” ” ” ” ” ” ”
(iii) $\mu \pm 3\sigma$ ” 99·73 ” ” ” ” ” ” ” ”
(iv) $\mu \pm 4\sigma$ ” 99·99 ” ” ” ” ” ” ” ”

Given the mean and the standard deviation of a normal population of measurements it is possible to predict the proportion of observations which can be expected to occur within given limits. Provided the proportion of observations *outside* the limits does not exceed expectation one may infer that the production process is in control at the given limits. This is the basis of the control chart technique.

CONTROL CHARTS

A sawmill producing battens 2 inches in thickness provides the data shown in columns 2 to 5 in Table 1. The measurements are given in the order of sawing and the sequence is obtained by reading across the rows, i.e. the first measurement is 1·95 the second is 1·98, etc.

TABLE 1

Batten No.	Batten thickness in inches				$\bar{x}$	s	R
1	1·95	1·98	1·98	2·00	1·978	·0206	·05
2	1·99	1·99	1·98	1·98	1·985	·0057	·01
3	1·97	1·99	1·96	1·97	1·972	·0126	·03
4	1·98	1·99	2·00	1·96	1·982	·0171	·04
5	1·99	1·98	1·95	1·99	1·978	·0189	·04
6	1·90	1·92	1·92	1·95	1·922	·0206	·05
7	2·11	2·01	2·02	2·02	2·040	·0469	·10
8	1·98	1·99	1·98	1·95	1·975	·0173	·04
9	2·02	2·05	2·00	2·02	2·022	·0206	·05
10	2·00	2·00	2·00	2·02	2·005	·0100	·02
11	2·01	2·00	2·00	2·05	2·015	·0238	·04
12	2·00	2·00	2·02	2·04	2·015	·0191	·04
13	2·00	2·02	2·02	2·03	2·018	·0126	·03
14	2·09	2·04	2·06	2·08	2·068	·0222	·05
15	1·98	2·00	2·01	2·02	2·002	·0171	·04
16	2·00	2·00	2·00	2·04	2·010	·0200	·04
17	2·00	2·01	2·00	2·00	2·002	·0050	·01
18	2·00	2·00	2·00	2·02	2·005	·0100	·02
19	2·04	2·00	2·00	2·00	2·010	·0200	·04
20	2·03	2·02	2·00	1·98	2·008	·0222	·05
21	2·00	2·00	2·02	2·05	2·018	·0050	·05
22	2·02	2·00	2·00	1·99	2·002	·0126	·03
23	1·96	2·00	2·00	2·00	1·990	·0200	·04
24	2·00	2·00	2·05	2·02	2·018	·0236	·05
25	2·04	2·02	2·00	2·00	2·015	·0191	·04

Using the above equations, estimates of the population mean and standard deviation[1] are obtained as—

$\bar{x} = 2{\cdot}0022$ inches and $s = 0{\cdot}0318$ inches.

The data, when summarised in the form of a frequency distribution (Table 2) is approximately symmetrical about the mean and may be assumed normal.

TABLE 2

Class interval	Frequency
1·90—1·91	1
1·92—1·93	2
1·94—1·95	4
1·96—1·97	5
1·98—1·99	18
2·00—2·01	40
2·02—2·03	17
2·04—2·05	9
2·06—2·07	1
2·08—2·09	2
2·10—2·11	1

[1] It is more convenient to use the equation

$$s = \sqrt{\frac{\Sigma x^2 - (\Sigma x)^2/n}{n-1}}$$

when a calculator is available.

A knowledge of the form of the distribution, although useful, is not essential. If the measurements in Table 1 are divided into subgroups of, say 4, the distribution of the mean values of the subgroups will tend towards normality, with standard error (standard deviation of the distribution of means) $s\bar{x}$ equal to $s/\sqrt{n}$, where n is the size of each subgroup. Furthermore, the standard deviation of each subgroup may be calculated and the values arranged in a frequency distribution which will have a standard error (standard deviation of the distribution of sample standard deviations) ss approximately equal to $s/\sqrt{2n}$, where n is the subgroup size. This follows from the Central Limit Theorem (Mendenhall 1967), which states that, sample estimates of means or totals tend towards a normal distribution, regardless of the distribution of the parent population. The tendency towards normality is more pronounced as sample size increases. For control chart purposes, however, a subgroup or sample size of 4, 5 or 6 is most common for reasons which will be stated later.

If each row in Table 1 is treated as a subgroup of four, control may be established based on the statistics which result from computing the average and standard deviation of the distribution of means of samples of four. An estimate of the standard error is obtained from $s\bar{x} = s/\sqrt{n} = 0{\cdot}0318/\sqrt{4} = 0{\cdot}0159$ and $\bar{\bar{x}}$ is equal to the mean of the subgroup means. A chart may then be prepared with a central line corresponding to $\bar{\bar{x}}$ and limit lines above and below corresponding to given standard errors (Figure 1).

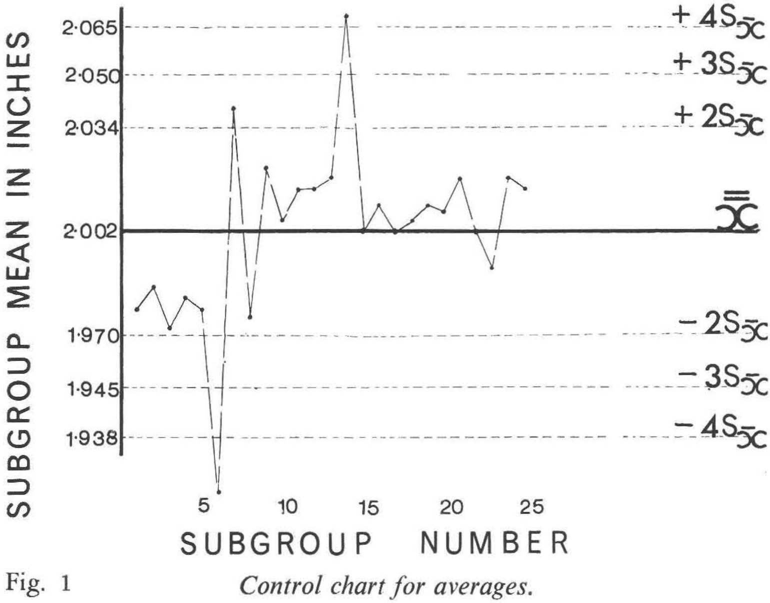

Fig. 1 *Control chart for averages.*

For a normal distribution expectation is 4·55 per cent outside $\bar{\bar{x}} \pm 2s\bar{x}$, 0·27 per cent outside $\bar{\bar{x}} \pm 3\,s\bar{x}$ and 0·1 per cent outside $\bar{\bar{x}} \pm 4s\bar{x}$. If the subgroup means in Table 1 (column 6) are plotted on a time basis it will be seen that observed values exceed expectation suggesting that some assignable causes of variation are present causing a shift in average thickness.

The purpose of the control chart for averages is to detect a shift in the average, the assumption being that variation remains constant. Yet, to take an extreme case, four thickness measurements might read 1·0″, 1·5″, 2·5″, 3·0″, giving an average thickness of 2·0″ which would fall on the centre line in Figure 1. Even though the average thickness is correct, such a product would of course be unacceptable. In order to exercise greater control over the production process, it is necessary to have a chart which will show changes in variation.

An estimate of the standard deviation of the sample standard deviations for subgroups may be approximated by $s_s = s/\sqrt{2n}$. In the above example

$$s_s = 0{\cdot}0318/\sqrt{8} = 0{\cdot}0112$$

Alternatively, the standard deviation of each subgroup may be calculated and an estimate of the standard deviation, $\bar{s}$, obtained by adding the subgroup standard deviations and dividing by the number of subgroups. In the above example

$$\bar{s} = 0{\cdot}4426/25 = 0{\cdot}0178$$

This new estimate of the population standard deviation is smaller than that obtained previously from all 100 measurements. The reduction may be attributed to the fact that the first estimate (0·0318) included variation due to the pooling of data from populations with different means.

Taking $\bar{s}$ as an estimate of the population standard deviation

$$s_s = 0{\cdot}0178/\sqrt{8} = 0{\cdot}0063$$

A control chart for standard deviation may be set up with $\bar{s}$ as the centre line and control limits set as $\bar{s} \pm 3s_s$ (Figure 2).
The standard deviation of each subgroup when plotted on a time basis will show where variation within subgroups is excessive. Usually, the setting of control limits does not involve the calculations of the standard deviation for each subgroup. When production is the effect of a single generating process the standard deviation of the single measurements will provide a good estimate of the population standard deviation and this can be used in the equation $s_s = s/\sqrt{2n}$ to obtain control limits. However, the standard deviation of each subgroup must be known if it is proposed to plot their respective values. In any event the approach demands a certain amount of tedious calculation and it is this difficulty which makes the use of a standard deviation chart somewhat impractical in the mill. For this reason the *range*, which is defined as the difference between the

highest and lowest measurement within the subgroup, is commonly used as a measure of variation in the construction of control charts. Range is an efficient estimator of standard deviation only when the subgroup size is small. This and the fact that there is generally less variability within subgroups than between subgroups when their size is small, are the reasons for selecting a relatively small subgroup size.

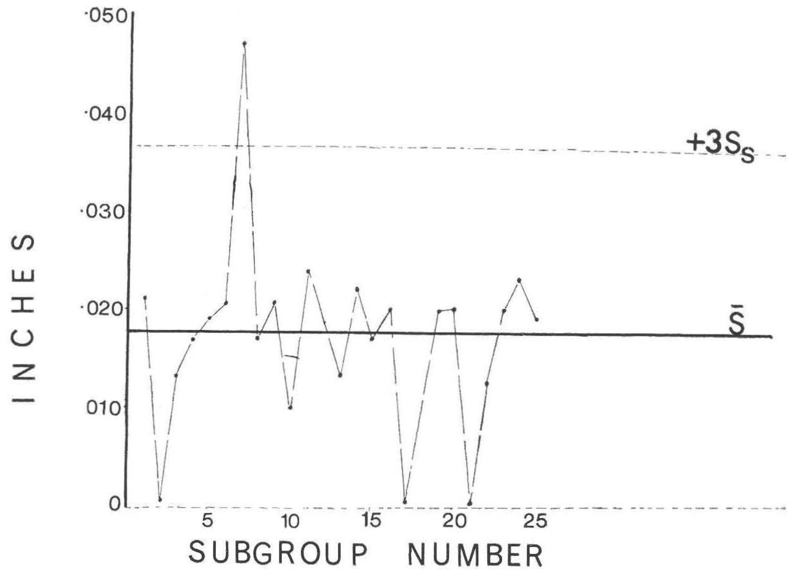

Fig. 2 *Control chart for standard deviation.*

CONTROL CHARTS USING RANGE:

To provide a practical example of the use of Range in setting up control charts, it is assumed that four thickness measurements are taken on each of 25 battens sawn to a target thickness of 2 inches. The average thickness, $\bar{x}$ and range, R are recorded for each subgroup of four measurements (Table 1).

The mean of the subgroup averages

$$\bar{\bar{x}} = \Sigma \bar{x}/n = 50{\cdot}055/25 = 2{\cdot}0022$$

and average range

$$\bar{R} = \Sigma R/n = 1{\cdot}00/25 = 0{\cdot}04$$

are calculated.

CONTROL CHART FOR AVERAGES

In order to use the range for control chart purposes it is necessary that the relationship between range and standard deviation should be determined. This has been done by Pearson (1932, 1941–42) who has tabulated the ratio of range to the population standard deviation, $w = R/\sigma$. An estimate of the population standard deviation may be obtained by multiplying the range in a single sample or the mean range in a number of samples by a factor. In practice the best available estimate of the expected range is $\bar{R}$, the average of range values for all subgroups, so an estimate of σ is obtained as

$$s = \bar{R}/d$$

where $1/d$ is the multiplication factor.
Since $s\bar{x} = s/\sqrt{n}$ a control chart for averages may be set up with upper confidence limits, $\bar{\bar{x}} + 3\bar{R}/d\sqrt{n}$ and lower confidence limits, $\bar{\bar{x}} - 3\bar{R}/d\sqrt{n}$.
To simplify calculation let

$$\mathrm{A} = 3/d\sqrt{n}$$

then the control chart limits become

$$\bar{\bar{x}} \pm \mathrm{A}\bar{R}$$

Values of A, abstracted from Brown and Bethel (1958), are tabulated for different subgroup sizes, n in Table 3.

In the above example the value of A is 0·73 for subgroup size 4, $\bar{\bar{x}} = 2{\cdot}0022$ and $\bar{R} = 0{\cdot}04$. Therefore, the control limits are $2{\cdot}0022 \pm 0{\cdot}73\ (0{\cdot}04) = 2{\cdot}0022 \pm 0{\cdot}0292$, giving

$$\mathrm{UCL}\bar{x} = 2{\cdot}0314$$

and

$$\mathrm{LCL}\bar{x} = 1{\cdot}9730$$

A control chart for averages is constructed (Figure 3). The chart is the same as that in Figure 2 except that the confidence interval is smaller. However, if the mean of the subgroup standard deviations had been used to construct control limits in Figure 2, both figures would be almost identical. Range is therefore considered to be an efficient estimator of the population standard deviation in this instance.

The means of successive subgroups are now plotted on the chart. According to probability theory the expectation of a mean falling outside the control limits is 0·27 per cent. In the data, the means of battens number 6, 7 and 14 fall outside the control limits suggesting that some attributable causes of variation are present.

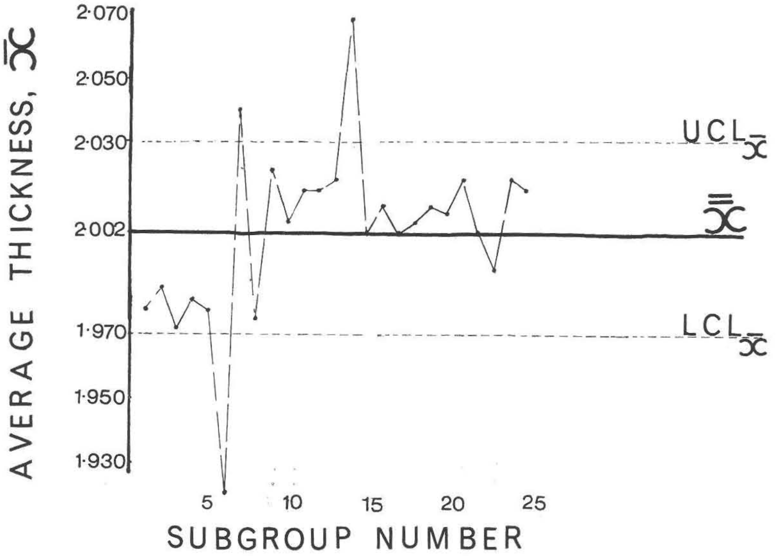

Fig. 3 *Control chart for averages.*

Possibly the saw operator made an incorrect setting or the variation may be due to a looseness in the setworks coming into play occasionally. The manager must use his judgement whether to take action at this stage. His reasoning will be conditioned by the attitude of the buyer towards the material. Will it be acceptable? At the same time he will be concerned that he is getting the maximum lumber yield from his logs. If the specified average thickness is 2 inches and the material being sawn has an average thickness of 2·1 inches there is an unnecessary wastage of 5 per cent. It may be argued that the dimensions of battens number 6, 7 and 14 in the above data are quite acceptable. This may well be true but the fact remains that the mill is not performing as well as it is capable of doing and it is wasteful to run any machine at a standard below its potential.

TABLE 3:

n	Factors for $\bar{x}$ chart	Factors for R chart	
	A	D_3	D_4
2	1·88	0	3·27
3	1·02	0	2·57
4	0·73	0	2·28
5	0·58	0	2·11
6	0·48	0	2·00
7	0·42	0·08	1·92
8	0·37	0·14	1·86
9	0·34	0·18	1·82
10	0·31	0·22	1·78

CONTROL CHART FOR RANGE

The control chart for averages will show if a shift occurs in the average thickness, the assumption being that variation remains more or less constant. The same value for average thickness could conceal a shift in the variability of the individual measurements but if the variability increases it is probable that, with continued sampling, an average outside the control limits will be obtained. Reliance on the control chart for averages to detect an increase in variation is, however, an inefficient method of control. It is preferable to have a chart which will show changes in variation. Range, as a measure of variation, is used again.

To prepare a control chart for range it is necessary to have available an estimate of the standard deviation of the population of ranges. This can be developed in the following way (Bowman and Fetter 1961)

$$w = R/\sigma \text{ and } R = w\sigma$$

Since the standard deviation of a distribution of values of w is $\sigma_w\sigma$, the standard deviation of values of R is $\sigma R = \sigma_w\sigma$. σR may be estimated from a sample as sR and, similarly, σ as s. Then $sR = \sigma_w s = \sigma_w \bar{R}/d$. Since $s = \bar{R}/d$. Control limits for range can be set at

$$\bar{R} \pm 3\ \sigma_w \bar{R}/\mathrm{d}.$$

To simplify the procedure let

$$D_4 = 1 + 3\ \sigma_w / d$$

and

$$D_3 = 1 - 3\ \sigma_w / d$$

Then the control limits for the range chart are

$$UCL_R = D_4 \bar{R}$$
$$LCL_R = D_3 \bar{R}$$

For different sample sizes, σ_w, the standard deviation of the values of R/σ, has been tabulated (Pearson, 1932) and values of D_4 and D_3 abstracted from Brown and Bethel (1958) are given in Table 3.

In the example given the values of D_4 and D_3 for $n=4$ are 2·28 and 0 respectively. The control limits are

$$UCL_R = 2{\cdot}28\ ({\cdot}04) = 0{\cdot}0912$$
$$LCL_R = \quad 0\ ({\cdot}04) = 0$$

A control chart for range showing the mean range and the upper and lower control limits is then constructed (Figure 4) and the range for each subgroup (R column in Table 1) plotted on the chart.

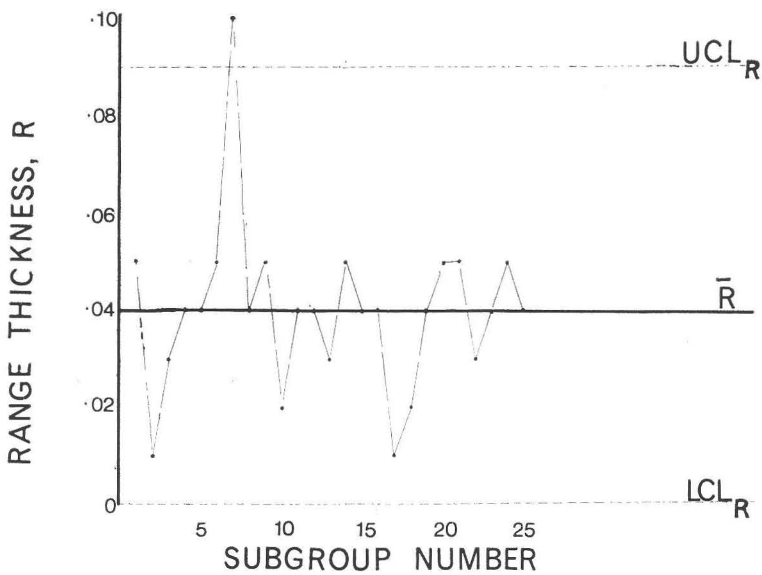

Fig. 4 *Control chart for range.*

It is apparent from the chart that variation in thickness within each batten is in a fairly good state of control. The one exception is batten number 7 whose high range value may be due to a slight movement in the log as the saw entered, possibly as a result of inadequate dogging.

The use of control charts as an effective means of control depend on their ability to show up attributable causes of variation in the production process. When a reading falls outside the control limits it may be due to some attributable cause of variation or it may be due to random causes. However, the probability of readings falling outside the control limits, due to random causes, can be determined in advance and used as a basis for deciding whether or not to take action. If control limits are set at $\pm$ 3 standard errors and action is taken whenever a reading falls outside the limits, there are about 3 chances in 1,000 that a wrong decision will be made. This is the probability of mistakenly inferring that the process is out of control when it is really in control. If $\pm$ 2 standard errors are used as control limits on the same basis there are about 45 chances in 1,000 of mistakenly inferring that the process is out of control when nothing is wrong. Obviously, wider limits decrease the probability of looking for trouble in the process when there is none. On the other hand, wider limits decrease the probability of detecting trouble in the process when it exists, but the probability of mistakenly inferring that the process is in control when it really is not depends on the magnitude of the shift that has occurred.

The selection of control limits should, if possible, depend on some consideration of the costs involved. These include the cost of investigating trouble in the process when it does not exist, and the cost, in the form of defective output, of not investigating trouble when it does exist. When ± 3 standard errors are used (as in the above example) a certain amount of judgement must be used in making decisions based on observations falling outside the control limits.

The procedure for setting up a control plan for dimensional control in the sawmill, described above, has wide application and can be applied to the control of any quality which can be measured on a continuous scale. The thickness of fibreboard and chipboard are two wood using processes which also lend themselves to this type of control.

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The Soils beneath the Midland Peats

M. L. Carey[1] and R. F. Hammond[2]

SUMMARY

Large areas of raised bog are being cutover for fuel and other purposes in Central Ireland. As a guide to reclamation and development programmes for future land-use systems, surveys have been carried out to determine the type of mineral soils[3] buried beneath approximately 36,000 acres of such bogs. Most of these soils are derived from limestone boulder till and show a variable degree of profile development. Others in the form of marls and glacial clays also occur. All of the soils would present difficulties in reclamation, but to a varying degree.

Amelioration of the soils through incorporation of the overlying peat residues is discussed with reference to experimental work in progress.

INTRODUCTION

The mechanical winning of peat for fuel and other purposes is being carried out by Bord na Mona in a number of localities in this country. The areas are predominantly of the raised bog type and vary from 600 to 20,000 acres in extent with a total area of approximately 130,000 acres involved.

The reclamation of these areas, after peat harvesting is completed, for agricultural, horticultural and silvicultural enterprises, will present several problems. Experiments designed to solve these are in progress at the Peatland Experimental Station, An Foras Taluntais, Lullymore, Co. Kildare and Trench 14, Clonsast Bog, Co. Offaly (Forestry Division, Department of Lands).

In 1963, The National Soil Survey of An Foras Taluntais in conjunction with Bord na Mona, drew up a programme designed to characterise the nature, extent and distribution pattern of the soils underlying certain bogs. Approximately 36,000 acres have been surveyed in detail. Figure 1 shows the location of these bog units.

In recent years afforestation of hand-cutover bog has been quite common. Tree growth on some of these sites has been retarded, probably due to nutritional disorders caused by low nutrient levels and/or, low nutrient availability resulting from root contact with underlying calcareous materials. In such instances, it is desirable that

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[3] In this paper the word "soil" refers to the mineral materials beneath the peat whether or not they show evidence of soil profile development.

foresters have a proper understanding of the resource they are dealing with, to ensure that the proper species and cultural treatment is used.

This paper describes the factors contributing to the development and extent of the various mineral soils delineated in these surveys. Problems associated with the future utilisation of cutover peat are considered with reference to experimental work in progress.

FACTORS OF SOIL FORMATION

Soil properties depend on: (a) the physical and mineralogical constitution of the parent material; (b) the past and present environment, including climate, vegetation and hydrologic conditions, which together regulate the nature and intensity of the soil forming process and (c) the length of time these environmental processes have been in operation, which is conditioned by the geomorphic history of the ground surface concerned. The Central Plain of Ireland has relatively uniform climatic conditions (9) and variations in the nature of the

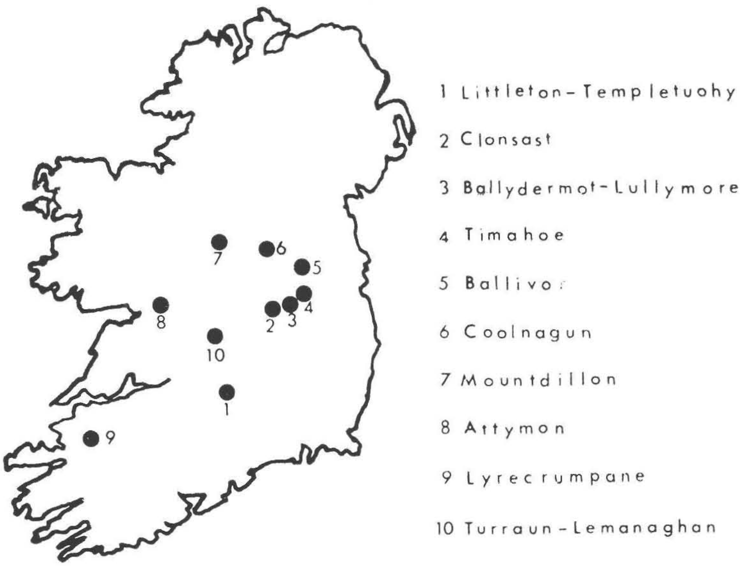

Fig. 1 *Location of bogs surveyed*

soils beneath the Raised Bogs arise chiefly from the integrated effects of parent material and geomorphic factors.

The retreat of the glaciers from the region about 12,000-15,000 years ago, left a gently undulating topography, with many enclosed basins in which Late Glacial inorganic and later organic, lacustrine deposits began to accumulate. Contemporaneously with the filling in of these lakes and ponds and their evolution to fen and woody-fen communities as described by Barry (6) much of the calcareous drift on the surrounding slopes gradually began to support a more arboreal type of vegetation with such species as oak, pine, hazel, alder and occasionally yew. With a deterioration of the climate in the post-glacial *Atlantic* period, tree growth in both community types was retarded, due to a rising watertable, and widespread waterlogging resulted in an increase in paludification and eventually the development of the oligotrophic dominantly *Sphagna* bog.

Hammond, (19), using radiocarbon dating and pollen analyses, has shown that the more depressed areas were covered by peat first and that paludification spread gradually outside the surrounding lagg. Consequently, the more elevated areas were subjected to the forces of weathering for a longer period of time. This factor in combination with the ability of their more highly developed arboreal communities to accentuate the weathering process has resulted in their soil profiles showing more advanced stages of development.

Owing to the relatively uniform nature of the glacial drift beneath the midland peats, it is now apparent that the major variations in the nature and degree of horizon development within the mineral soils are associated with differences in relief. Besides being the major cause of variations in profile development relief has also affected the extent and occurrence of superficial materials, such as marls, clays and silts. Such materials usually occur in the more low-lying areas beneath the peat.

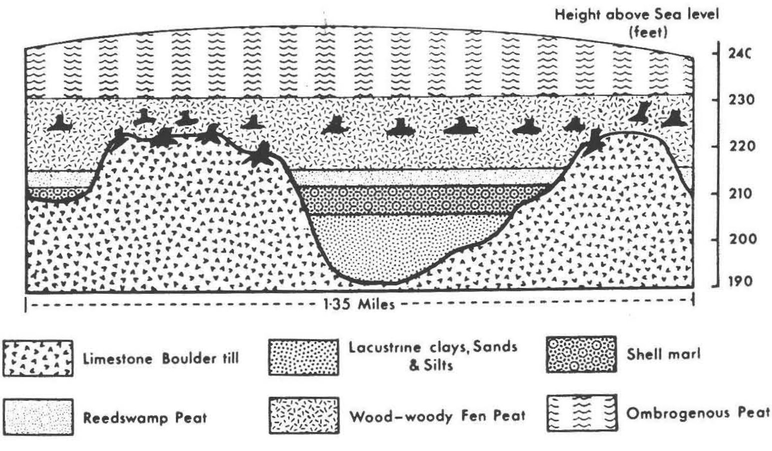

Fig. 2. *Schematic section across a Raised Bog in County Westmeath before peat harvesting. The ombrogenous and some of the more eutrophic peat is usually removed.*

The more important characteristics of the various categories delineated will now be described.

NATURE OF THE MINERAL SOILS

The nine different soils delineated in the surveys may be divided into two broad groups: —

(1) Those derived from glacial drift

(2) Those derived from superficial sands, silts, clays and marls, deposited over the glacial drift.

Different criteria have been used for further classification within these two broad groups. The degree of profile development is used to classify group (1) into more homogeneous units. Three degrees of development are recognised; (a) Well Developed, (b) Moderately developed and (c) Undeveloped. In Group (2) the texture and depth of the superficial deposits of sands, silts and clays are used as classification criteria. Marls are treated separately.

Group 1

Well Developed Relict Soils

These occur on the higher elevations of the bog floor and exhibit the maximum expression of profile development. Although found beneath all the bog areas surveyed, they vary considerably in their extent of occurrence. The most extensive areas are at Ballivor, Co. Meath (9), Clonsast, Co. Offaly (15) and Timahoe, Co. Kildare (18). Derived from calcareous limestone glacial drift, they are characterised by their upper horizons being leached and decalcified to an average depth of approximately 10 to 12 inches. They are usually greyish in colour, although the upper leached horizons generally display lighter colours than the underlying illuvial B horizons, which exhibit brownish colours, due to accumulation of sesquioxides. Yellowish red to yellowish brown mottles frequently occur particularly in the B horizon in the vicinity of old root channels. These soils have sandy loam textures in their surface horizons. The underlying B horizons, show heavier, clay loam textures. They have poor structural properties and tend to be rather compact. The upper leached horizons are moderately acid, but a sharp rise in pH and total neutralising value occurs once the lower calcareous C horizons are encountered. Fossil roots of grasses, sedges and trees frequently penetrate the B horizons and occasionally the calcareous C horizons. For example, fossil roots of Scots pine *(Pinus sylvestris L.)* have been observed *in situ* in the calcareous C horizon of these soils beneath both Littleton and Templetuohy bog. Fossil roots of oak, *(Quercus sp)*, alder, *(Alnus sp)*, hazel *(Corylus avellana L.)* and yew *(Taxus baccata L.)* also occur.

The level of plant nutrients, including trace elements, are low throughout with the exception of calcium and magnesium.

The well developed relict soils show many affinities with the Grey Brown Podzolic soils described by Ryan (29), which occur extensively in the midlands. Differences between the two are due mainly to the longer period of time that the latter have been exposed to weathering and anthropogenic influences.

Moderately Developed Relict Soils

These soils show a moderate degree of development intermediate between the well developed category described above and the undeveloped category described below. They are leached and decalcified to a depth of about six to eight inches. Their colour and structural properties are similar to the well developed category. Texture varies from sandy loam at the surface, to slightly heavier loam in the underlying B horizons. The surface horizon is usually slightly acid bu pH increases with depth and they become moderately alkaline in the lower calcareous C horizons. Nutrient status shows similar trends to the well developed category.

Although these moderately developed soils occur at all the areas surveyed, they are most common at Clonsast, Lullymore, Timahoe and Ballivor bogs, (15, 17, 18, 9). Sharp changes in topography such as occur at Coolnagun, Littleton and Mountdillon are not conducive to this type of profile development.

Undeveloped Relict Soils

This category includes soils derived from limestone boulder till, showing little evidence of profile development due to their occurrence on the relatively low elevations of the bog floor. They are characterised by the presence of free calcium and magnesium carbonates, at or within three inches of the surface, (peat/mineral junction) and have high pH and total neutralising values. Levels of essential plant nutrients are low throughout with the exception of calcium and magnesium. They differ from the more developed categories in having fewer fossil roots.

Undeveloped soils occur beneath all the bogs surveyed, but are particularly common at Littleton-Templetuohy, Attymon and Ballivor (9). They are also commonly found beneath parts of Timahoe bog (18), but their close association with other types precluded their delineation into separate areas.

The three soils derived from glacial drift and described above are seldom encountered in the field as discrete entities with clearly defined boundaries. Rather the boundaries between them tend to be gradual extending over variable distances depending on the rate with which topography changes. Their separation is made all the more difficult by the presence of the overlying peat. Together, they represent 60 per cent of the total area included in these surveys. The undeveloped category account for half of this.

Some analytical data for the three are presented in Table 1. Data from an upland Grey Brown Podzolic soil also derived from calcareous limestone boulder till is included for comparison. The main difference is the average depth to the calcareous C horizon. This decreases as one goes from the Grey Brown Podzolic soil to the Undeveloped Relict soils. Corresponding increases in pH values and levels for free calcium and magnesium carbonates also occur.

Table 1

Average Data for Relict soils derived from Glacial drift with corresponding data for an upland Grey Brown Podzolic soil.

Soil	Average depth to C horizon (inches)	Horizon	Texture	pH	T.N.V.**
Grey Brown Podzolic (Upland soil) Co. Longford	20-23	A	Sandy loam	7.5***	0
		B2t*	Clay loam	6.8	0
		C	Sandy clay loam	8.1	29.0
Relict soil (a) Well developed	10-14	A	Sandy loam	6.1	0
		B2t	Clay loam	6.9	0
		C	Sandy loam	7.8	38.0
Relict soil (b) Moderately developed	5-7	A	Sandy loam	6.1	0
		B	Loam	6.7	0
		C	Sandy loam	7.9	31.0
Relict soil (c) Undeveloped	0-2	A	sandy loam/loam	7.4	3
		C	Sandy loam/loam	8.1	31.0

*B2t = horizon showing increase in the finer textural components, clay (and silt).

**T.N.V. = Total Neutralising Value

***High surface pH due to liming.

Group 2

This group comprises three main categories which generally occur in the more lowlying basin situations of the bog floor. These include superficial deposits of (a) silty clays or silty clay loams; (b) marls, shell marls and chalk muds; (c) sands and sandy loams. Categories (a) and (b) are more common than category (c).

Category (a) — Silty clays, silty clay loams

These soils known locally as "glacial clays" and "blue clays" are characterised by their heavy texture, massive structure, sticky consistence, absence of gravels or stones and dark grey to grey colours. Their content of silt plus clay frequently represents over 90 per cent of their less than 2 mm fraction. This factor, together with their low permeability and poor structural properties engenders poor drainage conditions. They are generally, but not always, calcareous to the surface with pH values ranging from 7.0 to over 8.5. Their nutrient status is low, although high levels for certain trace elements e.g. molybdenum, have been recorded. This latter feature is probably related to their sedimentary origin.

Both shallow and deep phases of these soils have been delineated in the field. They frequently show evidence of varving with layers of fine sand, silt and clay occurring down the profile at varying intervals. The most extensive deposits occur beneath the Mountdillon group of bogs near Lanesborough, Co. Roscommon (7, 8). This region was greatly influenced by the River Shannon before peat accumulation began, this had resulted in approximately 2000 acres of peat being underlain by deep deposits of silty clays. They also occur commonly beneath the peat at Turraun and Lemanaghan, Co. Offaly. In some instances, they are overlain by deposits of marl — see below. Such is the case at Coolnagun bog, Co. Westmeath (9). At other areas, they are overlain by reedswamp peat. At the Mountdillon Group of bogs they are overlain by deposits of organic mud known as sapropel and gyttja, (5, 7, 8).

Category (b) — Marls and chalk muds

Included in this category are deposits of marl, which usually contain shells, and chalk muds. These materials may occur either immediately above category (a) or above undeveloped boulder till-relict soil 3 above. They vary from less than 1 inch to about 4 feet in depth. They also occur occasionally as layers of variable thickness, within deposits of peat.

These marls and calcareous muds were formed in lime-rich post glacial freshwater lakes through the precipitation of calcium carbonate by *Potamogeton* and species of *Characeae*. Such plants became coated with calcium carbonate and on their death and decay, the calcareous material accumulated on the lake bottom. Freshwater shells, the remains of species such as *Bythinia, Planorbis* and *Limnae* (10) may or may not be present. The chalk muds contain variable amounts of organic matter and because of this are usually darker in colour than the whitish coloured marls. Marl normally contains over 90 per cent calcium carbonate and is generally of moderate alkalinity. Levels of plant nutrients are always low.

Although deposits of marl occur beneath all of the bogs surveyed, their extent of occurrence varies greatly. The two largest areas so far encountered are beneath Ballydermot bog, Co. Kildare and Coolnagun bog, Co. Westmeath. At Ballydermot, deposits of shell marl extend over an area of more than 1,000 acres (17). More than eighty per cent of Coolnagun and Milkernagh bogs are underlain by deposits of this nature (9). It is apparent from observation in the field that deposits of marl occur beneath many areas of peatland not being worked by Bord na Mona. One example of this is to be found just north of Littleton bog, Co. Tipperary, where a large deposit of shell marl lies beneath shallow handcutover bog. This area has been afforested in recent years.

Category (c)—Sands, sandy loams.

These also form under alluvial or lacustrine conditions. Their light sandy texture, high permeability and low water-holding capacity favour excessive drainage, should the watertable be lowered sufficiently. They seldom show any worthwhile degree of development and are usually calcareous to the surface (with high pH values). However, in some areas, the surface horizons have undergone a moderate degree of leaching. Levels of plant nutrients are usually low. Both fine and coarse sandy deposits of varying thickness have been delineated. They seldom occur to any worthwhile extent.

APPLICATION OF SURVEY RESULTS

These surveys have shown that considerable variation exists in the mineral soils beneath the midland peats. In addition, the cutover peat surveys being carried out by Barry (2, 3, 4, 5), show that similar variation exists in the overlying peats. More recently, Barry *et al* (7) and Hammond (19) have demonstrated the strong correlation between peat type and underlying mineral soils. In designing future land-use policy cognisance must be taken of some problems associated with both the peat itself and the underlying soils. For the latter these include low biological activity, poorly developed and compact soil structure and low levels of essential plant nutrients. In some cases the highly alkaline nature of the upper layers also presents difficulties; free calcium and magnesium carbonates, very high pH, interference with plant nutrient uptake (including trace elements) and the restriction of the plant rooting system. The peat over-burden will present problems with regard to low levels of plant nutrients, high acidity, low permeability and shrinkage.

Before embarking on any reclamation programme involving forestry it would first be necessary to establish the effect of mixing the peat with the underlying mineral soil. Tree roots are unlikely to penetrate unless (a) soil is ameliorated through mixing with the peat by cultivation, (b) nutritional disorders are corrected (c) fertilizers are incorporated more deeply than at present. Excavation by the senior author of 10 years old roots of *Larix leptolepis* and *Pinus contorta* growing on shallow (6-9 inches deep) well drained cutover peat at Lullymore Experimental Station, underlain by a moderately developed soil showed that only about 2 per cent of the roots had penetrated below the peat. These trees are likely to be subject to windblow in future years.

Incorporation of the peat with the underlying mineral soil would alter the physical, chemical and biological properties of the medium resulting in many complex physico-chemical and biological interactions the nature and intensity of which would be greatly influenced by the type of peat and mineral soil concerned. The process involved in such organic — inorganic reactions are as yet little understood as evidenced by the reviews of Greenland (13) and Whitehead (34). The former, however, points out that the interactions of mineral soil and organic matter in addition to influencing the biological and physico-chemical properties of the soil results in decreased decomposition of the organic matter due to adsorption of organic molecules by clay minerals. The degree of adsorption depends to a large extent on the type of clay mineral concerned and also on the nature of the organic matter. Greenland, quoting others, states that such adsorption may in certain cases increase bacterial activity and decomposition of the organic fraction.

The improved aeration, permeability and aggregate stability resulting from the addition of organic matter to mineral soil, all accentuate the development of a more active biological flora in the latter. Dickenson and Dooley (11) have shown that cutover peat is not rapidly colonised by micro-organisms. These workers were concerned however, with acid anaerobic peat. As shown by Zverkov (36) and Nepomilev *et al* (23), suggested by Dickenson and Dooley *(loc. cit.)*, and concluded by Pessi (26), reclamation of peat (cultivation and fertilisation) results in a much improved micro-flora. Van Heuveln *et al.* (31) and Pons (27) in discussing soil formation and classification of reclaimed peat soils respectively referred to physical, chemical and biological "ripening" as the initial processes involved when drainage and nutrient status are satisfactory. More recently, Wieringa (35) has shown that treatment of acid "garden peat" with lime and fertilisers results in a marked improvement in its properties as a microbial medium. The addition, therefore, of material such as peat with this potential for improvement to the sterile mineral soils beneath should result in increased biological activity in the latter with all its associated improvements in fertility. Van Dijk *et al.* (32) have shown that the addition of horticultural peat to mineral soils results in increased availability of phosphate due to a reduction in fixation. This is especially important on calcareous soils. The beneficial effect of organic acids on the availability of insoluble sources of phosphorus and certain trace elements (34) also encourages the incorporation theory. Therefore, present evidence indicates that forest trees, when planted on shallow peat should grow and survive better if the peat is mixed with the underlying mineral soil before establishment. Further, Handley and Ridgman (14) showed that claying a light fen peat soil increased the yields of argricultural crops and although the presence of the clay might have an initial effect on nutrient supply they pointed out that in the long term it was desirable due to plant-soil moisture relationships. Results reported by O Carroll (25) also supports this hypothesis — see below. The presence of large fossil tree stumps *in situ* in some of the soils indicates that forest trees grew satisfactorily on such areas in the past. The presence of large Scots pine roots embedded in calcareous horizons is particularly interesting in view of the fact that this species is usually looked on as being a calcifuge. Perhaps a colder climate in early post glacial times favoured the growth of the species on such a medium. In this respect the findings of Tkachenko in the sub-arctic Archangelsk province of Russia as quoted by Iyer and Wilde (21) are particularly interesting. Under arctic conditions Tkachenko found that Scots pine grew much faster on calcareous than on acid soils. Wilde has also shown that the cooler the climate the more beneficial is soil alkalinity (36).

SUMMARY OF RELEVANT EXPERIMENTAL WORK TO DATE

The first experimental work concerned with the production of forest crops on cutover peat commenced at Trench 14, Clonsast Bog, Co. Offaly, in 1955 when Bord na Mona leased an area of 15 acres to the Forestry Service, Department of Lands. Peat types at Trench 14, as described by Barry (2) vary considerably in woodiness and depth. The peat is underlain by well developed and moderately developed relict soils (15). A pocket of deep silty clay occurs at the north end of the Trench, more or less coincident with Barry's reedswamp peat. Although not replicated the experiment is in many ways a classic and it shows that a wide range of conifers can be established successfully on Sod Peat cutover bog. Production figures of 220 cubic feet per acre per annum have been recorded. The presence of moderate amounts of calcareous mineral matter in the vicinity of the roots of *Larix leptolepis* improved growth (25). It was found that phosphate application was necessary where the remaining peat cover was greater than about two feet in depth. Where the peat is shallower or absent, other factors such as the nature of the mineral soil become dominant (25). In experiments at the Lullymore Peatland Experimental Station, potassium was found to be a limiting factor for coniferous tree growth on cutover peat (1). O Carroll (24) has also diagnosed pottassium deficiency on two species of conifer on a peat soil in the midlands. These findings are not surprising in view of the exceedingly low levels of potassium present in such situations. (7, 33). This factor in addition to the capacity of the mineral soils to fix potassium in relatively unavailable forms suggests that a shortage of potassium is likely at Clonsast or other areas where similar conditions prevail. In view of possible low nitrification in Irish peats as shown by Kuster and Gardiner (22) nitrogen may be a limiting factor as the trees get older.

The work at Trench 14 was extended in 1966 to study how the addition of mineral soil* to cutover peat might effect the growth of Sitka spruce. This involved four levels of application: 0, 60, 100 and 120 tons per acre of mineral soil. Each level was applied to four plots, two of which were cultivated, thereby mixing in the mineral soil with the peat and two which were not cultivated thereby leaving it spread on top of the peat. The control plots although receiving no mineral matter had two plots cultivated and two undisturbed. Results after the first season's growth showed that plant mortality increased with increasing

* The soil used was of the moderately developed type. In some cases it appears that the lower calcereous C horizons were used despite attempts to use only the leached horizons.

level of mineral soil applied. In the second year, cultivation significantly increased leader growth whether mineral soil was applied or not and irrespective of the amount applied.**

Another experiment on the N, P and K requirements of Sitka spruce and Contorta pine on cutover Sod Peat bog was laid down at Timahoe Bog, Co. Kildare by An Foras Taluntais in 1965. This has shown that potassium application increased the height growth of both species, phosphate application in excess of 2 oz. per plant had no effect while nitrogen adversely affected establishment (1). Similar trends but better growth rates were obtained with the same species in another trial on shallow cutover milled peat at Lullymore (1).

Further research is needed to investigate the rate, type and time of application of fertilisers. In addition to the major plant nutrients, micro-nutrients also deserve attention. Low levels of copper, boron, manganese and in some cases, molybdenum, zinc, cobalt and iron are a feature on both the cutover peats and their underlying mineral soils (7, 8). Hewit (20), has described deficiency symptoms in trees, due to abnormally low levels of most of these elements. The calcareous nature and high pH levels of some of the mineral soils beneath the peat will also merit attention in tree nutrition. In this respect, the demonstration by Richards (28) that *Pinus taeda* showed iron deficiency chlorosis in soils when the pH was raised above 7.5 is relevant as is the control of lime-induced chlorosis in Scots pine growing on a calcareous site by Schonhar (30) by injection of ferric sulphate into the trees. Further research is also needed to show whether it is best to plant trees on shollow peat *in situ* or on shallow peat mixed in with the underlying mineral soil and if so particular attention might be given to the mechanics of such an operation. The research being carried out at the Arthur Rickwood Experimental farm in the Fenlands in England (38) is particularly interesting in this respect. The performance of forest trees on all other peat types including the deep virgin raised bog types also needs further investigation from a biological, hydrological and nutritional point of view.

CONCLUSIONS

To plan a land use policy that will make the best use of cutover areas a thorough knowledge of the soil resources is most important. This information is being compiled as a result of these surveys. Then the best amelioration processes, the ideal cropping systems, the most desirable manurial and management practices to give optimum returns must be worked out. Research already in hand is providing some of the answers but many aspects have still to be investigated. The factors such as water, oxygen and nutrients limiting the achieve-

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** Grateful acknowledgement is extended to the Research Branch, Forest Service, Dept of Lands for the information on its experiment.

ment of potential timber production are within man's control but the level to which each should be adjusted under the environmental conditions concerned in order to reduce the potential/actual production ratio to a minimum is not yet known. Therefore, from a forestry viewpoint the potential timber production in these areas might first be investigated and then a research programme implemented, designed to assess what combination of adaphic and other limiting factors within the control of management, such as tree species or provenance, would take one nearest to that potential. The costs involved in such operations would also need consideration to ensure optimum economic returns on capital invested.

Finally, when the time comes for making land-use decisions for these cutover areas, in addition to considering the economic role played by silvicultural, agricultural and horticultural crops, the high recreational value associated with forests and the scarcity of visually attractive features in these midland areas might be given consideration. Similarly other alternative uses of land resources such as the provision of artificial lakes for wildfowl and other recreational needs might also be considered. Only in this way can the various forms of land-use be brought together in such a way as to serve best the economic and social interests both at a local and at a national level.

ACKNOWLEDGEMENTS

Grateful acknowledgement is extended to Bord na Mona for full financial assistance during the course of this project. The assistance of colleagues in An Foras Taluntais is also acknowledged.

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Trees, Woods and Literature

—As treeless as Portugal we'll be soon, says John Wyse, or Heligoland with its one tree if something is not done to reafforest the land. Larches, firs, all the trees of the conifer family are going fast. I was reading a report of Lord Castletown's . . .
—Save them, says the citizen, the giant ash of Galway and the chieftain elm of Kildare with a forty foot bole and an acre of foliage. Save the trees of Ireland for the future men of Ireland on the fair hills of Eire, O.
—Europe has its eyes on you, says Lenehan.

The fashionable international world attended en masse *this afternoon at the wedding of the chevalier Jean Wyse de Neaulan, grand high chief ranger of the Irish National Foresters with Miss Fir Conifer of Pine Valley. Lady Sylvester Elmshade, Mrs. Barbara Lovebirch, Mrs. Poll Ash, Mrs. Holly Hazeleyes, Miss Daphne Bays, Miss Dorothy Canebrake, Mrs. Clyde Twelvetrees, Mrs. Rowan Green, Mrs. Helen Vinegadding, Miss Virginia Creeper, Miss Gladys Beech, Miss Olive Garth, Miss Blanche Maple, Miss Priscilla Elderflower, Miss Bee Honeysuckle, Miss Grace Poplar, Miss O Mimosa San, Miss Rachel Cedarfrond, the Misses Lilian and Viola Lilac, Miss Timidity Aspenall, Mrs. Kitty Dewy-Mosse, Miss May Hawthorne, Mrs. Glariana Palme, Mrs. Liana Forrest, Mrs. Arabella Blackwood and Mrs. Norma Holyoake of Oakholme Regis graced the ceremony by their presence. The bride, who was given away by her father, The M'Conifer of the Glands, looked exquisitely charming in a creation carried out in green mercerised silk, moulded on an underslip of gloaming grey, sashed with a yoke of broad emerald and finished with a triple flounce of darker hued fringe, the scheme being relieved by bretelles and hip insertions of acorn bronze. The maids of honour, Miss Larch Conifer and Miss Spruce Conifer, sisters of the bride, wore very becoming costumes in the same tone, a dainty* motif *of plume rose being worked into the pleats in a pinstripe and repeated capriciously in the jade green toques in the form of heron feathers of pale tinted coral. Senhor Enrique Flor presided at the organ with his well-known ability and, in addition to the prescribed numbers of the nuptial mass, played a new and striking arrangement of* Woodman, spare that tree *at the conclusion of the service. On leaving the church of Saint Fiacre* in Horto *after the papal blessing the happy pair were subjected to a playful crossfire of hazelnuts, beechmast, bayleaves, catkins of willow, ivytod, hollyberries, mistletoe sprigs and quicken shoots. Mr. and Mrs. Wyse Conifer Neaulan will spend a quiet honeymoon in the Black Forest.*
—And our eyes are on Europe, says the citizen.

From *Ulysses* by James Joyce. Printed by permission of the Bodley Head Ltd.

James Joyce, the foremost writer in English in the twentieth century, was born in Dublin in 1882. He was educated at Belvedere, Clongowes Wood, and University College, Dublin. He left for the continent in 1904 where he remained, with rare visits to Ireland, until his death in Zurich in 1941.

Ulysses was in trouble with censors throughout the world for years after its publication in 1922, but was never banned in Ireland. The United States Court of Appeals in 1934 declared it fit to be admitted to the U.S. It appeared in paperback form in 1969.

Notes and News

Minister's Address at Avondale

Forward Planning in the Forest Service

In his address at the official opening of Avondale Forestry Extension School on 9 October. 1969, the Minister for Lands, Mr. Sean Flanagan, T.D., referred to the house's historical niche as the home of Charles Stewart Parnell, and also to its long association with forestry, going back to the tree enthusiast Samuel Hayes who built it in 1779. He reviewed the present state of forestry activity in the country and saw the potential for expansion of employment in ancillary industries as most heartening.

"As the young forests develop", he continued, " our people are becoming more aware of Irish forestry's contribution to the landscape and amenities of Ireland, but few indeed are yet aware of the very great contribution the forest can and will make to the future economy and prosperity of the country."

Referring to the increasing use of modern techniques of management within the Forest Service he said it was recognised as having been one of the first public services in Ireland to introduce modern concepts of forward forecasting and planned guidance of operational management to well defined ultimate objectives.

"We are at the moment at the point of taking another major step forward along this road. There are tentative plans under discussion with the Department of Finance to include Forestry in a pilot project for the application to public services of the most up-to-date methods of forward budgetary planning with a co-ordinated use of such techniques as Management by Objectives, Cost-benefit evaluation of multiple forest uses, etc."

He complimented the architects of the Commissioners of Public Works on the skill with which they blended old and new in the extension to Avondale, and in particular referred to their example of what can be done in timber to provide a building both decorative and functional.

Air Pollution and Vegetation

Writing in *Farm and Food Research,* Jan.-Feb., 1970, Dr. J. F. Eades deals with two of the most common poisons, sulphur dioxide and lead. Sulphur dioxide damages vegetation in and around most cities and smaller industrial areas, and results especially from the burning of coal and oil. Daily releases of 830 tons of sulphur dioxide in Philadelphia in 1959 were partially responsible for injury to 36 species of plants in adjacent southern New Jersey, while the same gas caused almost total destruction of vegetables in the Vicinity of smelters in Tennessee, Montana and Ontario.

Contamination of vegetation beside highways and streets with lead from motor vehicle exhausts has caused such concern as to necessitate a non-polluting means of powering vehicles.

Damage to agricultural and forest crops in the U.S. has been estimated as costing from 150 to 500 million dollars a year, and is believed to be rising.

Cumann Gaelach

Tá sé mar aidhm ag buion foraoiseóiri agus cigiri foraoiseachta cumann Gaelach a bhunú chun an Ghaeilge a spreagadh agus a fhorbairt i gcursai bitheólaíochta. Measann an buion seo dá mbeadh lucht talmhaiochta, gairneóireachta, éaneólaiochta leó go mbeadh an cumann seo níos éafachtaí agus nios forleithne ar ball. Einne ar mhian leó baint a bheith acu len a leithéid de Chumann ba chóir dóibh scriobh chuig:

Pádraig O Flaithbheartaigh, Bessmount, Inis Cóirthe,
Co. Loch Garman,

nó

Seán Ua Cearnaigh, 1 Príomh Sráid, Inis Cóirthe,
Co. Loch Garman.

Conifer Conference

A conference, organised by the Royal Horticultural Society, dealing with conifers in Britain and Ireland, will take place from October 5th to 16th 1970. For the first week the conference will be centred in London and for the second in Edinburgh.

The London session will include lectures and discussions on "Collections of conifers in the U.K. and Eire and possible methods of improving them", "Conifers in the human environment" and "Conifers in commerce". There will be an exhibition of living plant material, and measurements, photographs of specimen trees, and illustrations of pests and diseases will also be shown.

During the Scottish session there will be visits to gardens and estates with notable collections of conifers.

A detailed programme is available from the Society at Vincent Square, London, S.W.1.

Trees for Ireland

In his address to its twenty-first Annual General Meeting, Mr. Sean Feeney, President of *Trees for Ireland*, dealt with, as appropriate to European Conservation Year, aims and uses of forestry and afforestation other than timber production: the prevention of soil erosion, control of water, provision of wild life habitats and recreation areas. He pointed out the need for an educated public opinion — one of the aims of *Trees for Ireland* — and congratulated the State Forest Service on its diversified land use policy and on its efforts in the education of young people to know and understand the countryside.

In the Popular Press

In a witty, well informed, if slightly romantic article in the London *Observer* in February, Katherine Whitehorn advised us to "Watch Out for that Woodman". Having covered pysiology, history, sociology, technology and aesthetics of trees in about 400 words she goes on to the now familiar topic of trees that get polluted, "though not often as badly as the ones that all died in Millwall last summer. 'Drought', said the council feebly (well, they'd had a fortnight without rain in April) but the people with sore throats knew better." She also referred to municipal trees which are pruned so as to leave them looking "like a fire hydrant with whiskers" and concluded by urging everyone to do their bit in propagating trees, and not only those with gardens. Referring to wasteland she points out that "you can push 10 bits of poplar as long as a pencil into the ground and 10 trees will come up; you can stick a sycamore seed almost anywhere, even your enemy's nostrils, and it will grow if it's left alone. Who's going to notice if a passer-by casually stuffs a bit of stick or a handful of compost into somebody else's derelict ground?"

Forestry and Agriculture at Oxford

A new *Honour School of Agriculture and Forest Sciences* has been created in order to enable undergraduates, after a three terms preliminary course, to concentrate for a further six terms on the basic principles (physiological, ecological and economic) which underlie the subjects of Forestry and Agriculture. Those intending to follow Forestry as their vocation will be able to select from the optional papers those most suited to their interests. Nevertheless, the structure of the course and the contacts that undergraduates will have with those interested in other branches of biology, will give them a wider appreciation of the problems which concern effective land utilization and provide a broad general education.

For their First Public Examination undergraduates will normally take the Preliminary Examination in Biology at the end of their third term at the University. They will then enter a two year course of study in the Honour School. This will include field work in Britain during term and possibly a tour to Europe in vacation. The Final Examination will consist of compulsory papers on Biological Sciences, Soil Science and Economics, together with papers selected from four groups, which allow specialization either in Economics or in the study of Plant Sciences, Soil Science and even Animal Science, if desired. By selection of suitable subjects, undergraduates may follow (within broad limits) lines of study which suit their particular interests and future careers, including professional forestry and research leading to a higher degree.

For those wishing to follow Forestry as a career, the more specialized and technical aspects of the subject are taught in a one year postgraduate course leading to a Diploma on Firestry and its relation to Land Management which is available to suitably qualified graduates from Oxford or other universities. In this students may study in depth the economic, management and silvicultural aspects of Forestry, and the applications of soil science and biological sciences to Forestry.

The Diploma course will not only be suitable for the fourth year student to qualify for a post as a Forest Officer, but will also provide a high level refresher or extension course for serving forest officers. It will include advanced lectures and classes on Policy and Planning, Management and Utilisation, and also on applied biological sciences such as Genetics, Pathology and Ecology. Candidates will also be required to submit a written dissertation on a forestry subject of their choice.

Details of the new Honour School and of the Diploma, both of which are being introduced in October 1970, may be obtained from the Department of Forestry, South Parks Road or from the Oxford University Admissions Office, 58 Banbury Road.

Obituary

Wm. Y. CHISHOLM: 1898-1969

William Young Chisholm was born in Inverness, Scotland, and was educated at Inverness Academy and Edinburgh University where he took a degree of B.Sc. in Forestry. He served in the Army during the First World War and on demobilisation attended a course in forestry for ex-service men at Alness Castle, Ross-shire. His first job was in Dickson's Nurseries, Cheshire, and from there he went as Head Forester to Melchett Court in Hampshire.

When Mr. Chisholm came to Ireland in 1931 he was already an experienced forester. He spent the next 22 years at Birr Castle in Offaly where he was in charge of Lord Rosse's extensive woods and estate sawmill and it was when he was at Birr that he joined our society as a foundation member and later was elected to the council. In 1953 he took up the challenging position of Estate Agent for Captain Bruen and managed the woods, gardens, tillage and dairy farm at Oakpark, Carlow, up to the time of Captain Bruen's death in 1958.

When Oakpark was sold to *An Forus Taluntais* in the following year Mr. Chisholm went to Lismore Castle where he was Head Forester, Sawmill Manager and Fisheries Manager on the Duke of Devonshire's large estates in County Waterford and it was here that he died at Greenmount on the 8th September, 1969.

For a quarter of a century William Chisholm attended the meetings, study tours and outings of the Society. His advice on the running of our affairs was always most valuable and his contributions to technical discussions showed his wide knowledge of forestry. He will be remembered for his gay spirits and his readiness to enjoy himself at evening sessions and to join in the light-hearted fun after a long day's excursion through the forest.

We extend our sympathy to his wife and daughter who live in Dublin and to his son in Surrey, England.

H. M. FITZPATRICK.

Reviews

Readings in Forest Economics

Editor: A. SVENDSRUD,

Universitetsforlaget, Oslo — Bergen — Tromso 140 shillings

The aim of this publication is to give a picture, to as large a reading public as possible, of the kind of problems with which contemporary Nordic forest economists are occupied. The book is the brain child of the Nordic Forest Economic Seminar which is a rather informal group of forest economists from Denmark, Finland, Norway and Sweden. This group meets every second year and the idea to publish this book was brought up at a meeting of the Seminar. The different chapters have been written by members of the Seminar and the authors are very well known authorities in their special fields.

The contents are assembled under three headings — Forest Management, Marketing of Forest Products and Forest Economics at Large.

The first part, Forest Management, is devoted to the analysis of managerial economics. Short of giving a complete list of the papers and an abstract from each, it would be impossible to review adequately the range of topics covered. If one has to be selective, then it must be on the basis of personal preference or interest. It is of some interest to those concerned with the teaching of Forest Economics to find an article entitled Traditional Calculations for Economic Planning of Forest Management. This article by F. Jorgensen is aimed at demonstrating how the traditional type of calculations agree closely with general neo-classical economic theory. An attempt is made to illustrate how the problems of quantifying can be tackled to make the calculations of practical use. Indeed this question of quantifying runs through the whole section on management and many modern methods of economic analysis are introduced to the reader in this valuable section.

Under the heading Marketing of Forest Products, we are introduced to the different methods of marketing roundwood in the Scandinavian countries and Finland in a very interesting and readable article by V. Holopainen. Another article that must surely interest all those concerned with the outlook for the future of forest products is entitled "Plastics in Competition and Co-operation with Forest Products." In this most interesting paper Mr. L. Runeberg of the Finnish Forest Research Institute examines the extent to which (1) plastics have supplanted timber as a raw material and (2) plastics and timber form a stable symbiosis.

The vital question of the future is which seems to be growing faster — the proportion of competitive or co-operative plastic.

The most important changes forecasted are within the paper and paper board industry.

Production of wood plastic composite in particular can lead to the growth of a completely new branch of industry. According to a study carried out in Finland, the use of timber co-operative plastic is growing faster than the competitive plastic so that an integration between the plastics and forest industry appears expedient.

Under the Section heading Forest Economics at Large, there are papers dealing with Swedish Silvicultural Policy, Danish Forest Policy and Norwegian Forest Policy. There is a valuable article by P. Riihinen on Quantitative Aspects of Forest Policy Programs which includes a review on the Forest Policy of Britain. He states "the salient features of the economics followed in making decisions in British forestry stem from the current problems in the national economy and the fact that the main body in charge of afforestation is a Government agency."

The Impact of Social Change in Forestry is also dealt with in a number of valuable papers in this section which is by far the most interesting from the general readers point of view.

This whole exercise is one that foresters in these Islands might well emulate.

T. CLEAR

Safety and Health in Forestry Work

International Labour Office, Geneva, 1969. Pp. 159. Price 18 shillings.

This is a very useful publication and it should be a valuable addition to the library of every establishment involved in the training of Foresters, Forest Work Supervisors and Forest Workers.

It is a Code of Practice prepared by I.L.O. with the assistance of six experts— Mr. L. A. Aitken, Safety Adviser, Canada Department of Labour, Ottawa; Mr. R. Chandra, Chief Executive Officer, Government of India, Logging Training Project, Dehra Dun; Mr. R. Grabner, Lower Austria Agriculture and Forestry Inspectorate, Vienna; Mr. D. L. McNeil Director, African Timber and Plywood (Nigeria) Limited, Sapele; Mr. G. Skaaret, Forestry Section, Workers' Protection Board, Stockholm; Mr. K. Zaremba-Czereyski, Professor, Polish Forestry Research Institute, Warsaw.

The general provisions of the Code outline the principles which should be applied by employers when selecting forestry workers and placing them in employment, emphasising the importance of taking into consideration experience, aptitude, physical capacity and mental ability. It outlines the duties and responsibilities of workers and points out that it is their duty to refrain from careless or reckless practices which inevitably lead to disastrous consequences.

In a chapter on "Medical Care and Supervision" pre-employment medical examination and periodical re-examination of workers is recommended so that workers who are found to constitute a risk to the health or safety of others may be treated accordingly, an excellent recommendation which should benefit employers and workers alike. Other chapters provide information and advice on hand and power tools, engines, hydraulic machinery, flammable liquids, poisonous plants and insects, and dangerous substances as well as guidance on precautions necessary during felling, limbing, skidding, loading and associated operations.

The Code contains advice and guidance which if accepted and put into practice should do much to help to eliminate accidents and safeguard the health of workers in forestry.

It is presented in the form of a body of concise recommendations for the guidance of authorities, professional groups, employers and workers (including self employed forestry workers), forest equipment manufacturers and all those with responsibilities in occupational safety and health in forestry.

It covers the duties and responsibilities of employers and workers, the obligations of equipment manufacturers and suppliers of dangerous substances as well as occupational risks involved in operations which have to be undertaken to establish or maintain forests and to remove their produce.

It does not cover sawmills, pulpmills, chipboard plants or other factories which use timber.

The Code is designed to serve as a guide and is not intended to replace national laws or regulations, or accepted standards already provided to protect forest workers. The need to comply with relevant national laws is stressed in some of its provisions. This assumes that such laws exist. If they do not, it is high time the authorities responsible for the health and safety of their workers took action to remedy this neglect. The necessity for this Code of Practice to help to prevent accidents and to safeguard health is undeniable as standards of safety are virtually non-existent in this field in some developing countries. Economic pressures too are forcing the industry to introduce (prematurely perhaps) new equipment and new chemical substances of which little is known — thus adding to the hazards which the workers must face.

The book is divided into 35 short sections each of which deals with a separate subject. The lay-out is simple and the information available is well presented — an important consideration in a reference book. The language is simple enough to make it understood even by an uneducated worker. Most of the matters on which recommendations are made are adequately covered and excellent advice and guidance provided on what to do, and what not to do, as well as when, where and how to act under normal, and if needs be, under abnormal circumstances. Most of the recommendations are clear and concise. A few, however, are too vague, and do not convey the message clearly to the less intelligent. For example — on "Operation of Vehicles" one recommendation reads "Drivers of trucks should not drive for long periods without adequate rest." "Long" and "adequate" need to be defined. The drivers are entitled to more guidance from the experts! On "Selection and placement of workers" another recommendation reads "No person should be employed on work for which he is physically or mentally unsuitable". In theory this is ideal but the practical application is less simple.

Employers and employees should not fail to realise that in providing this Code of Practice I.L.O. is making a genuine attempt to establish a standard of safety and health in forest work to benefit all parties concerned and the effort is worthy of support. Laws and regulations alone are not sufficient. They must be enforced and the attitude of those involved is important. Education, proper training, and the provision of facilities to improve the skills and efficiency of workers throughout their years of service must not be neglected. Safety precautions should be built into every action of every operation until it becomes second nature to workers to guard their own and their workmates safety and health against possible dangers. This is emphasised throughout provisions of this Code..

The State is the largest employer of forestry workers in this country. During the last decade the Department responsible has achieved much in providing better working conditions for them. Many of the recommendations in the book have already been put into practice. Machinery is also in operation for investigating and for ascertaining the necessity for further improvements and precautionary measures which if considered desirable are likely to be put into practice. Employers and employees in the private sector of forestry in this country are likely to be influenced by the attitude of the State. If one is to judge by the progress to date full implementation of the relevant provisions of the Code should not be too long delayed in Ireland.

The book can be recommended to all for whom its use is intended. Employers, workers, advisors, supervisors and all others who have responsibilities in occupational safety and health in forestry cannot afford to be without it. It is a sound investment which if given reasonable time to mature should pay dividends.

Pocket size, well bound, and printed on good paper it should be an excellent companion for the practical man who has a sense of responsibility for the welfare of those working in his charge.

It can be obtained through major booksellers or direct from I.L.O. (Sales Section), 1211 Geneva, Switzerland).

D. McGLYNN

A Program for Outdoor Recreation Research

published by the National Academy of Sciences, Washington D.C., 1969. 60pp & Appendices.

The growing acceptance in the United States of the philosophy that holds outdoor recreation to be a primary public purpose promoted the Study Conference of which this booklet is the Report. Such new thinking supersedes the traditional viewpoint that such recreation is only a valuable byproduct of conservation policies which motivated the stewardship of potentially productive economic resources.

In the light of the heavy commitment of funds the Conference was called to formulate a course of action to increase the understanding of the economics, demand and motivation of outdoor recreation so as to refine the projection of needs and optima for investiment.

Of the six objectives recommended the greatest emphasis is laid on the desirability of Research programmes beyond the present primary emphasis on managing recreation resources. This would involve social and psychological studies as well as supply and demand economics. The question is posed whether already congested recreation sites can bear the cost of any additional visitors due to the depletion of the total resource for all visitors.

It is not the function of the Report to provide concise answers but in its discussion of current experience in resource management and study, it provides useful guide lines which are applicable in many circumstances. The chapter dealing with the operation of recreation service systems is particularly good in discussing the potential for expanding the supply of recreational opportunities and in the study of ecological and land use factors.

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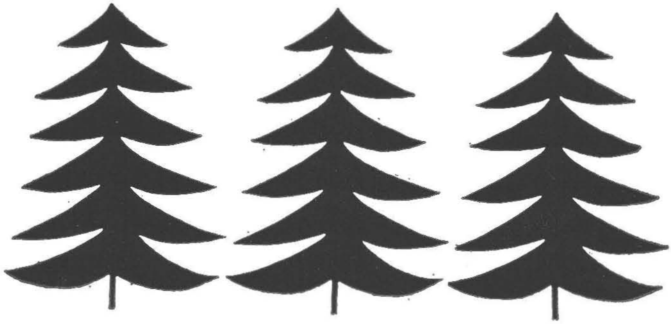

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