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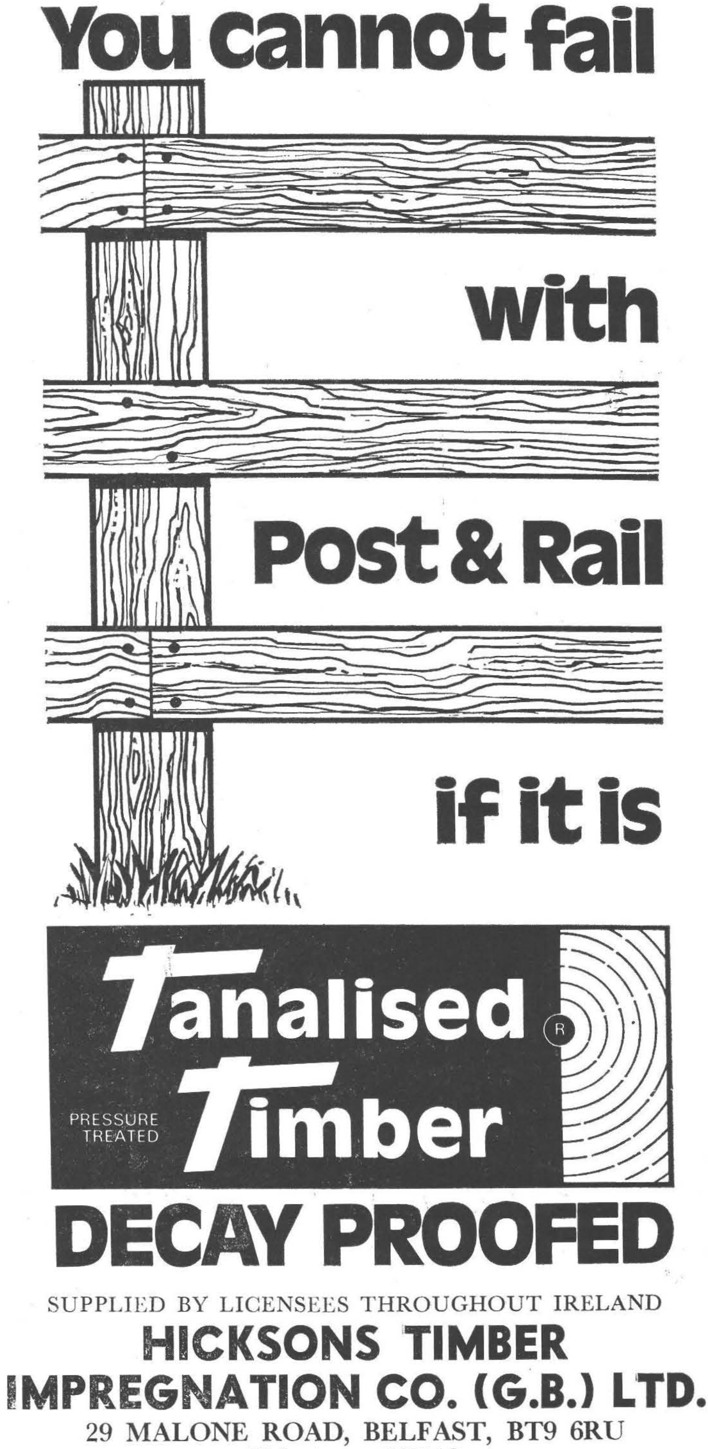
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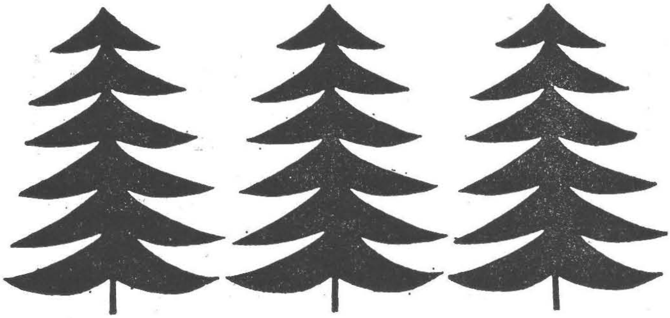

IRISH FORESTRY

CONTENTS

(Authors alone are responsible for views expressed)

COVER: Head of a red hybrid stag (See *Irish Forestry* Vol. 30, No. 2, 1973, pp. 64-78) (Photograph: Rory Harrington)

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IRISH FORESTRY

Vol. 31 1974 No. 1

An Aspect of Awareness

FORESTRY, at least in Europe, has traditionally been associated with hunting and shooting and the pursuit, for "sport", of various classes of "game".

At the present time resources are being devoted to the development of those pursuits, and the conduct of research aimed at increasing the number of the victims and the ease with which they can be located and destroyed. Much of this research can also be of value in conservation, and conservation can certainly be combined with a controlled amount of shooting for pleasure—that is not at issue.

But as foresters we must remain alert to the changing moods of the general public, lest we wake up some day to find ourselves behind the times.

The feeling against all blood sports is developing steadily. Hare coursing will disappear before long under pressure arising from this feeling, as will fox hunting if it has not already disappeared for other reasons. When this happens it will be difficult to defend any form of "sport" which involves the destruction of life solely for pleasure. Sooner or later, hopefully sooner but probably no later than the end of this century, shooting and hunting for pleasure will have become as generally unacceptable as are cockfighting and bull-baiting now.

Let us hope we never find ourselves in a position where we have to be told by outsiders that we are condoning or assisting in an activity which is condemned by the public at large.

Why Forests?[1]

T. McEvoy[2]

In attempting to answer the question "why forests?" I will forego the reams of figures, encouraging though they may be to a forester, in the various FAO reports on world and European timber trends and prospects. Nor will I go into a deep analysis of the economic studies which have become so much a feature of our times and which tend to show that no sane economic being would invest a penny in forests when, apparently, a comfortable 10 per cent compound interest or better can be obtained from activities quite unrelated to land use and when therefore a 10 per cent discount rate in real terms is prescribed for this long term investment. I will only comment that recent events, especially the fuel situation, have raised serious doubts about such prescriptions. Only yesterday I noted an investment consultant rated farms and forests before stocks and shares for 1974.

In any case one should not be over-awed by the predictions of economists. The economist, like any other expert, is dependent on the facts or figures which he uses as a basis for his calculations and his conclusions are no better than his initial assumptions. And in this field of exceptionally long term investment, still 50 to 100 years, there is no shortage of initial assumptions, especially in these kaleidoscopic times. In the colloquial expression "you pays your money and you takes your pick". Mention of the economist reminds me of the story of the botanist and the ornithologist who decided to go on a walk together. One never looked up, the other never looked down. Consequently they came home with two very different sets of impressions from the same walk. The lesson is "Beware of specialist experts". The forester must look up and down, look forwards and backwards in time, listen to the experts but draw his own conclusions in the light of the long term, secular trends.

May I remind you that this question "Why Forests?" is one concerning the function, the continuing function, of a vegetation type which covers nearly one-third of the land surface of this globe. As such it is too broad, too bound up with the future of the human race, to be assessed in purely economic terms. I need not remind you that considerations of climate, soil erosion and degradation, desert formation, water supply, indeed of the whole environment of human life are at stake. But I will confine myself in the main to the forest as a source of raw material, of wood—an aspect which in

1. Text of address to the International Forestry Student Symposium, University College, Dublin. 2nd–5th January 1974.

2. Chief Inspector, Forest and Wildlife Service, Dublin.

recent times has tended to be pushed rather into the background in the densely populated industrial countries where the emphasis has been on the environmental contribution of the forest.

It must be admitted that the last decade or so has been a time of questioning by economists and others and of self-questioning by foresters as regards the forest as a producer of wood. Continental European forests in particular had been going through an economic crisis as returns to the grower dwindled and the value of the forest output, set against the vastly increased output of industry, seemed to fade into insignificance. Foresters do not need to be reminded of the theory that the price of the cubic metre of standing timber is a residual price, what in fact the finished wood product will sell for, less all the intermediate costs of felling, extraction, transport, manufacture and retailing. In a period when all these intermediate costs were increasing rapidly and when there was still little evidence of wood shortage, despite increasing consumption, standing values were static or in real terms even falling in many countries.

When at last prices for standing timber and its products did begin to rise steeply in the last year or so something like panic hit the market and the frantic search for substitutes began. Now the price of oil and fuel is going to add substantially to the cost of these substitutes, aluminum, steel, cement, plastics—all require fuel in quantity. In my view wood prices are only now making up ground lost since World War II and we may now, perhaps, hope that the prices may settle down (or up!) at a realistic level in relation to potential substitutes, a level which will at the same time give a more equitable return to the grower and enable forests to be rationalised and expanded as a profitable business.

We must look at the recent history of wood prices in global terms. In my view we have reached the end of an era in which the terms of trade were very much against the primary producers and in favour of the manufacturers in sophisticated industrial economies. A new balance is now emerging which may be painful in its effects in the industrial regions but which may ultimately lead to a better world. A fairer price for its primary products means far more to a developing country or region than the various forms of aid or charity which the developed countries offered in the past. Even the recent sharp increase in the price of crude oil may eventually be justified if the income it generates is wisely used and appropriately dispersed among developing populations. The conclusion I draw is that the outlook for the grower of wood, whether he be in remote Africa or in Connemara, is favourable—as it is also for farmers and miners, not to mention oil sheiks. Incidentally, it is interesting to note the change of emphasis in the themes of recent World Forestry

Congresses. In Madrid in 1966 the theme was purely economic, but in Buenos Aires in 1972 it was "Forests and socio-economic development", with emphasis on the social factors and social justice towards the primary producers.

This is not to say that the forest owner can be complacent and expect good profits without every effort to make his enterprise more efficient within the biological and environmental constraints which are inherent in his business. It is, I think, fair to say that forestry, especially in those countries of Continental Europe where classical forms of silviculture were developed, has clung to its traditional methods involving intensive use of manual labour and silvicultural skills. And of course tropical forestry still relies on the lavish use of manual labour. The lesson must be learned from industry that mechanisation is essential to multiply the output per man and to justify high wages without pricing the commodity out of its market. The forester's skill in the future will be in developing silvicultural techniques which bring in the economies of mechanisation without upsetting the biological balances on which the health of the forest depends.

It may well be asked how one can be so confident of the utility and value of forests so far into the future when all around one sees the death of old trades and old industries and the desperate efforts of existing industrial corporations to diversify and thus to insulate themselves against market changes. The answer, to my mind, is that the forest has an inbuilt diversification potential. Wood is a primary, adaptable, flexible raw material. The industry which carries the highest risk of overnight obsolescence is that with a highly specialised product catering for an artificial market created by fashion and sustained by advertising. The forester depends on the ingenuity of the inventor and manufacturer to find increasingly diverse uses for his raw material. So despite economies in the use of wood, say, in house building, far more wood is now used than before World War II in the European and world economies. We must not fight against rational economies in the traditional uses of wood. Improvements such as stress grading, lamination, jointing, preservative treatments make wood more competitive and ultimately are of benefit to the grower. Aggressive development of new products and markets is more important than the defence of traditional uses. This is, perhaps, the chink in the forester's armour. The growers of wood are so dispersed and unorganised that there may not be the same incentives for product development and marketing as in the case of a manufacturer with a near-monopoly in raw material or patent-protected processes.

There is one other distinguishing feature of the forest which must be mentioned. Whereas coal, oil, natural gas, minerals are all wasting assets which are being very rapidly depleted since the Industrial Revolution led to the affluent and wasteful—effluent—society, the forest is the great renewable, non-polluting natural resource. It seems to be merely elementary good housekeeping on a world scale to conserve and manage such a resource and it seems inevitable that the economics of the forest will improve as competing raw materials become more scarce, more inaccessible and more expensive.

So far I have spoken in rather general terms. You may well ask how does one apply these generalities to these two islands. I think the broad arguments based on world trends are fully applicable. As the balance between primary and industrial products adjusts itself, a more intensive use of our land resources becomes justified in which the physical production of the forest, as well as its environmental contribution, will be more fully recognised. Admittedly since our accession to the EEC the pressure for land reclamation on marginal lands has increased and has affected the availability of land for afforestation. It will take several years before we can discern clearly how agricultural prices will fare in real terms in the EEC and how these will be affected by schemes for the rationalisation of farms and for regional subsidies to underdeveloped areas. In the long term I believe there can be a sensible allocation of land as between forestry and agriculture which will recognise Europe's need both for wood and food—an allocation which will allow a substantial increase in our present forest areas.

Our forests are capable of extremely high rates of production of the most versatile form of wood—conifers. We live in a world which faces a shortage of wood and we are part of a European community which can supply only half its current needs and with its wood deficit increasing steadily. There is every reason to be optimistic about the future of our forests.

May I conclude by quoting a remark made by Professor Clear[3] some years ago. Forestry, he said, was always seen to be justified when the crop matured but seldom for the precise reasons advocated by its planters. That statement seems to me to combine aptly the faith and the humility which are essential ingredients in the make-up of a good forester and it is also pertinent to the answer to your question "Why Forests?".

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3. Professor of Forestry, University College, Dublin.

Assessment of the Economic Limit of Plantability

P. S. Savill[1]

Introduction

About 40 per cent of the State forest land in Northern Ireland has been classed as climatic or blanket peat. Such peats are found only in inhospitable areas where precipitation is high, usually at least 1,400 mm a year, elevations generally exceed 300 m (Barry, 1969); the areas are very windy. (Mean hourly windspeed at Ballypatrick, Co. Antrim was 11.8 knots in 1972 with 677 hours during the year when the mean speed was in excess of 22 knots (Anon 1973).)

The demarkation line between economically successful and unsuccessful afforestation often lies within the altitudinal range of climatic peats. Much attention has been paid in recent years to try to demarcate this boundary more precisely than by the forester's subjective assessment. Limitations on economic timber production can be caused by two main factors. Firstly, growth may be so slow as to result in unacceptably low returns from the money invested and, secondly windthrow may cause extensive damage very early in the rotation.

Lines and Howell (1963) were among the first to give detailed consideration to the problems of "exposure" on tree growth. They analysed the combined effects of a number of variables, including elevation, rainfall, proximity to the sea and the rate of disintegration of cotton flags, which contribute to the generalised concept of "exposure". This was done on an extensive scale, covering much of Scotland and northern England.

The aim of the work carried out in Northern Ireland was to investigate the effects of "exposure" on the growth of Sitka spruce on a local rather than an extensive scale.

"Exposure" in Relation to Tree Growth

Gloyne (1966) has pointed out that a satisfactory definition of the term "exposure" has not yet been produced. It may well be impossible since the term almost always relates to the response of some physical or biological system to various elements of the atmosphere environment, both acting singly and in different combinations. There is evidence that on certain sites the rate of disintegration (or tatter) of cotton flags may well be governed by that combination of atmospheric influences which inhibits tree growth and in this

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1. Research Officer, Forestry Division, Department of Agriculture, Belfast.

context flags may be better indicators of exposure than would purely wind measuring devices.

Tatter Flags

"Exposure" or "tatter" flags are made of "Madapollam", a specially manufactured cotton cloth, and are 12 inches high and 15 inches long (about 30 cm × 38 cm). The important feature of the cloth is its uniformity. Flags are mounted on steel rods sited at about 1.5 m above the ground and are free to rotate. Over a period of time the free vertical edges of the flags fray and assessments of exposure are made by measuring the area of solid weave lost. Details are given by Lines and Howell (1963). Those elements of the weather with which flags loss is most closely correlated have been discussed by, among others, Gloyne (1966), Rutter (1966, 1968) and Jack and Savill (1973).

Collection of Data

With a few exceptions tatter flags were flown in the year following the planting of trees on an area (P+1) and in the following year (P+2). Precise periods are given in Table 2. They were located in the forest by using a stratified random sampling design in which two flags were placed at random within strata of approximately 4 ha. The strata were subjectively by chosen experienced staff as being areas where exposure would be roughly the same. Altogether exposure, as indicated by flag tatter, has been measured on 276 sampling points at Beaghs Forest, Co. Antrim (in the P59–71 areas) and on 392 points at Ballintempo Forest, Co. Fermanagh (P66–71 areas).

Individual flags were flown for periods of 7 weeks at Beaghs Forest and 6 weeks at Ballintempo and then all replaced by new ones on the same day. After each flag change the area of solid weave lost by tattering was estimated. This was originally done by tracing the area remaining on to squared paper.

Later, Jack (1965) found it could be calculated with a very high degree of precision by using the formula:

$$Y = 1179.4 — 28.2X$$

where Y is the area of flag lost in square cms and X is the length of flag remaining in cm, as measured horizontally from the pole to the centre of the frayed edge.

Jack also demonstrated that provided the period of exposure of a flag does not exceed 7 weeks, then correlations of flag losses remain high between pairs of flags. The rate of tatter of flags which have already been exposed for some weeks is likely to be higher than the rate of tatter of recently exposed flags. It is therefore probable that differences in exposure values for Beaghs and Ballintempo, where flags were exposed for 7 and 6 week periods respectively are small. The longer period used at Beaghs may however result in a slight over estimate of exposure relative to Ballintempo.

The growth of the Sitka spruce trees at some tatter flag points was measured periodically. In an attempt to eliminate the effects of soil differences and those of varying levels of fertiliser application a degree of selection was necessary in deciding at which flag positions growth measurements should be used for analysis since it is now well established that a very important factor influencing tree growth on peat is adequate nutrition (Dickson and Savill 1974). Plots were therefore discarded if the trees were clearly showing symptoms of a nutrient deficiency, which was usually caused by insufficient quantity or uneven spreading of fertilisers at the time of planting. Other plots were discarded if they were on soil types other than oligotrophic peat, except in the P69 area at Beaghs where over half of the plots were on mesotrophic peat. (These peat types are described by Dickson and Savill, 1974.) Thus, except in this one P- year, plots with low tatter values were not associated with depressions in the topography which resulted in more fertile soil conditions. For these reasons several whole P-years had to be rejected from the analyses at Beaghs Forest. At Beaghs, only the 5 tallest trees (out of a plot of 20), representing about the 1,000 tallest per hectare were measured. At Ballintempo all trees in the plot, representing about 2,500/ha were measured. It was found that much better results were obtained at Ballintempo by using all 20 trees in the analyses rather than the 5 tallest.

Analysis and Results

1 *Exposure*

It was soon found that only long-term averages of flag loss were satisfactory to obtain a reasonable estimate of the relative exposure of the site. Table 1 shows how "exposure", expressed as the mean daily flag loss in cm^2, in each 6 week period is correlated with all other periods among 95 flags flown from 1967 to 1969 at Ballintempo. While some correlations are good and all are significant at the 95 per cent probability level or more, none provides as consistently good an estimate of relative exposure as average daily flag loss over the approximate annual periods shown in Table 2, where coefficients of correlation were generally in the order of 0.95 on 11 different P-years. As a result it was decided to use only long-term averages when examining the relationships between exposure and growth. Further details about mean daily flag loss in different P-years are given in Table 2. Column 3 shows that average losses ranged

TABLE 1

CORRELATION MATRIX OF MEAN DAILY FLAG LOSS ON 95 SAMPLING POINTS DURING 1967-68 ON P66 AND P67 AREAS AT BALLINTEMPO

Period

	10.10.67 to 21.11.67	21.11.67 to 2.1.68	2.1.68 to 13.2.68	13.2.68 to 26.3.68	26.3.68 to 7.5.68	7.5.68 to 18.6.68	18.6.68 to 30.7.68	30.7.68 to 10.9.68	10.9.68 to 22.10.68
	1	2	3	4	5	6	7	8	9
1	1.000								
2	.864	1.000							
3	.961	.882	1.000						
4	.889	.849	.911	1.000					
5	.823	.738	.795	.799	1.000				
6	.743	.680	.769	.729	.683	1.000			
7	.379	.301	.353	.351	.300	.274	1.000		
8	.612	.595	.622	.610	.619	.612	.218	1.000	
9	.894	.826	.864	.849	.787	.735	.384	.640	1.000

TABLE 2

SUMMARY OF ANALYSES OF FLAG TATTER DATA AT BEAGHS AND BALLINTEMPO FORESTS

P Year	Period of measurement	Daily flag loss cm^2 Min	Daily flag loss cm^2 Mean	Daily flag loss cm^2 Max	Std error of mean $\pm cm^2$	Coeff. of var. %	Consistency of tatter from year to year R	Residual degrees of freedom
BEAGHS FOREST								
1959	13.10.64–27.10.65	2.8	8.3	12.1	0.83	14.2	—	21
1962								
1963	13.10.64–27.10.65	3.1	8.2	10.5	0.85	14.5	0.88***	32
1964	27.10.65–17.10.66	2.4	8.1	11.0	0.90	15.7		
1965	27.10.65–17.10.66	2.0	8.7	11.6	0.96	15.6	0.94***	13
	17.10.66–18. 9.67	2.4	9.4	12.6	1.01	15.2		
1966	17.10.66–18. 9.67	3.3	9.4	12.1	1.47	22.0	0.97***	10
	18. 9.67– 7.10.68	3.0	7.1	8.7	1.04	20.6		
1967	18. 9.67– 7.10.68	5.8	8.3	10.9	0.73	12.3	0.93***	1
	7.10.68– 7.11.69	6.7	9.6	12.3	0.83	12.2		
1968	7.10.68– 7.11.69	2.5	6.0	13.6	0.85	20.0	0.93***	9
	7.11.69– 4.12.70	2.5	6.1	12.6	0.93	21.6		
1969	7.11.69– 4.12.70	3.4	8.9	12.3	1.50	23.7	0.95***	7
	4.12.70– 5.11.71	3.0	7.4	11.2	1.27	24.2		
1970	4.12.70– 5.11.71	4.6	6.8	11.0	0.84	17.4	0.96***	10
	5.11.71– 1.12.72	4.6	7.1	11.1	0.79	15.7		
1971	5.11.71– 1.12.72	2.9	6.2	12.0	1.01	22.9	—	25

Table 2 Continued

BALLINTEMPO FOREST								
1966	10.10.67–22.10.68	3.6	6.2	9.7	0.79	18.1	—	41
1967	10.10.67–22.10.68	3.6	7.6	13.2	0.84	15.6	0.96***	36
	22.10.68– 4.11.69	3.6	6.7	13.4	0.80	16.8		
1968	22.10.68– 4.11.69	3.6	7.0	12.3	0.79	15.8	0.88***	34
	4.11.69–17.11.70	3.9	7.8	12.7	0.66	11.9		
1969	4.11.69–17.11.70	5.0	9.7	15.2	0.78	11.4	0.96***	26
	17.11.70–30.11.71	3.6	6.8	12.7	0.49	10.2		
1970	17.11.70–30.11.71	3.4	4.6	7.2	0.31	9.6	0.94***	29
	30.11.71–12.12.72	3.5	5.5	8.7	0.49	12.7		
1971	30.11.71–12.12.72	3.5	6.4	11.4	0.79	17.3	—	30

Significance at probability levels: NS = not significant, * = 0.05, ** = 0.01, *** = 0.001.

between 4.6 and 9.7 cm^2/day. The minimum loss found in any year was 2.0 cm^2 and the maximum 15.2 cm^2/day. These values compare well with the range found by Lines and Howell (1963). Tatter values in mid-summer are very low, which may partly explain the weak correlations of tatter in period 7 (mid-June to July) with all other periods shown in Table 1.

Tatter flags give only an indication of the *relative* exposure between sampling points. However, because measurements taken in any one P-year overlap in time with those in the previous and following P-years it is possible to predict what tatter values would have been at any point in any of the years sampled. Of course such estimates are liable to increasing amounts of error as time from the datum year increases. In the analyses described below, only actual tatter values were used, not predicted tatter values, except for the data used in preparing Figure 1 where predicted tatter for 1965 was used for the P65 and P69 areas at Beaghs. This was done in order to remove the effect of different levels of exposure in years sampled for P65 and P69.

2 *Relationship between exposure and tree growth*

Acceptable data on the growth of Sitka spruce at a number of tatter points was available for seven P-years at Beaghs and for two P-years at Ballintempo. The number of points from which measurements were taken varied from 8 to 32 in individual P-years. For each P-year linear regressions were calculated using tree height, usually at several ages, as the dependent variable and mean daily flag loss in cm^2 during one of the years sampled as the independent variable.

Out of the seven P-years at Beaghs Forest, significant relationships at the 95 percent probability level or better, between total height and exposure were found in four of them: P60, 61, 65 and 69. The relationship in a fifth P-year (P64) was significant at the 90 per cent probability level. At Ballintempo Forest a significant relationship was found in one of the two P-years.

These regressions are shown in Table 3. Some of them suggest a trend of improving relationships between height and exposure as age increases. Thus in the P60 area at Beaghs, mean height in 1964 (age 5) had a correlation with tatter of —0.59, which improved to —0.82 when mean height in 1973 (age 14) was considered. (This did not happen in the P69 area at Beaghs however.)

The reason for this is that young trees, when newly planted, are of a fairly uniform height. Only over a period of years do the differences due to exposure begin to manifest themselves. Differences

TABLE 3—LINEAR RELATIONSHIPS BETWEEN TOTAL HEIGHT AND EXPOSURE

		Variables					
P Year	Age	(Y) Tree Height (cm) in	(X) Tatter (loss in cm^2/day)	Regression Coefficient of Y on X	Regression Constant	R between X and Y	Residual df
				Beaghs Forest			
60	14	1973	1965	—71.2	813.1	—0.823***	10
	13	1972	,,	—65.0	739.2	—0.830***	,,
	12	1971	,,	—57.3	653.8	—0.844***	,,
	11	1970	,,	—47.5	564.0	—0.830***	,,
	10	1969	,,	—37.5	475.5	—0.797**	,,
	9	1968	,,	—29.3	398.8	—0.776**	,,
	8	1967	,,	—21.2	318.8	—0.738**	,,
	7	1966	,,	—15.2	257.9	—0.715*	,,
	6	1965	,,	— 4.3	205.9	—0.704*	,,
	5	1964	,,	— 2.6	156.5	—0.595*	,,
61	13	1973	1965	—41.5	593.7	—0.767**	9
	12	1972	,,	—38.9	548.1	—0.780**	,,
	11	1971	,,	—35.4	489.3	—0.796**	,,
	10	1970	,,	—31.4	432.4	—0.794**	,,
	9	1969	,,	—24.9	353.0	—0.761*	,,
	8	1968	,,	—19.1	281.2	—0.746*	,,
	7	1967	,,	—14.1	217.5	—0.713*	,,
	6	1966	,,	—13.3	201.8	—0.868**	,,
	5	1965	,,	— 3.7	150.6	—0.894**	,,
65	6	1970	1967	—11.1	234.7	—0.501*	21
69	5	1973	1970	— 9.5	222.8	—0.691**	11
	4	1972	,,	— 7.5	174.3	—0.647*	,,
	3	1971	,,	— 6.4	131.5	—0.738**	,,
	2	1970	,,	— 3.9	87.4	—0.834***	,,
				Ballintempo Forest			
67	6	1972	1969	— 6.7	195.4	—0.611***	30
	5	1971	,,	— 5.0	141.7	—0.577***	,,
	4	1970	,,	— 3.1	93.7	—0.528**	,,
	3	1969	,,	— 1.9	61.3	—0.511**	,,

in growth are cumulative in terms of total height of the trees and so become more pronounced as the years go by.

Figure 1 illustrates this point more clearly. In it the relationships between the regression coefficients for all P-years in which significant

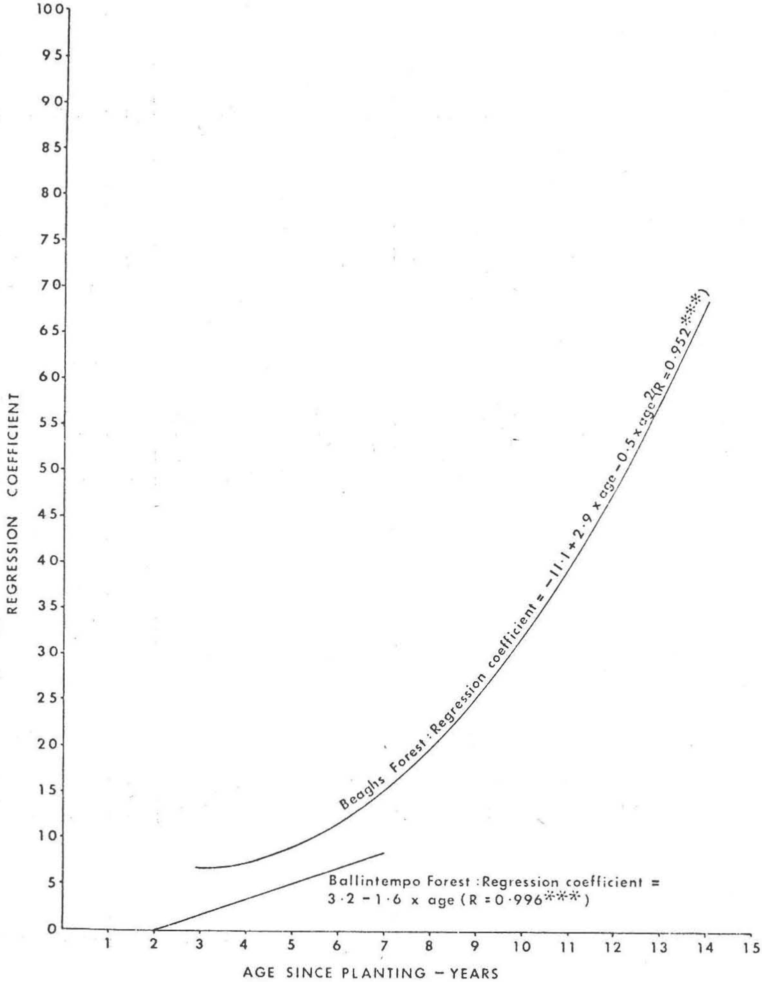

Figure 1: Relationships between regression coefficients from Table 3 and crop age, i.e. reduction in height in cm for each additional 1 cm² flag loss per day.

Note—Estimated coefficients for 1965 tatter values used for P65 P69 areas at Beaghs.

regressions were found, and crop age are shown. These coefficients represent the deduction, in cm, which must be made from the height of a crop for each additional 1 cm²/day of flag loss. So, at age 6 at Beaghs, about 13 cm must be deducted from the height of the crop for each additional cm² of daily flag loss. This increase to 65 cm at age 14.

The apparent difference between the regressions for each forest

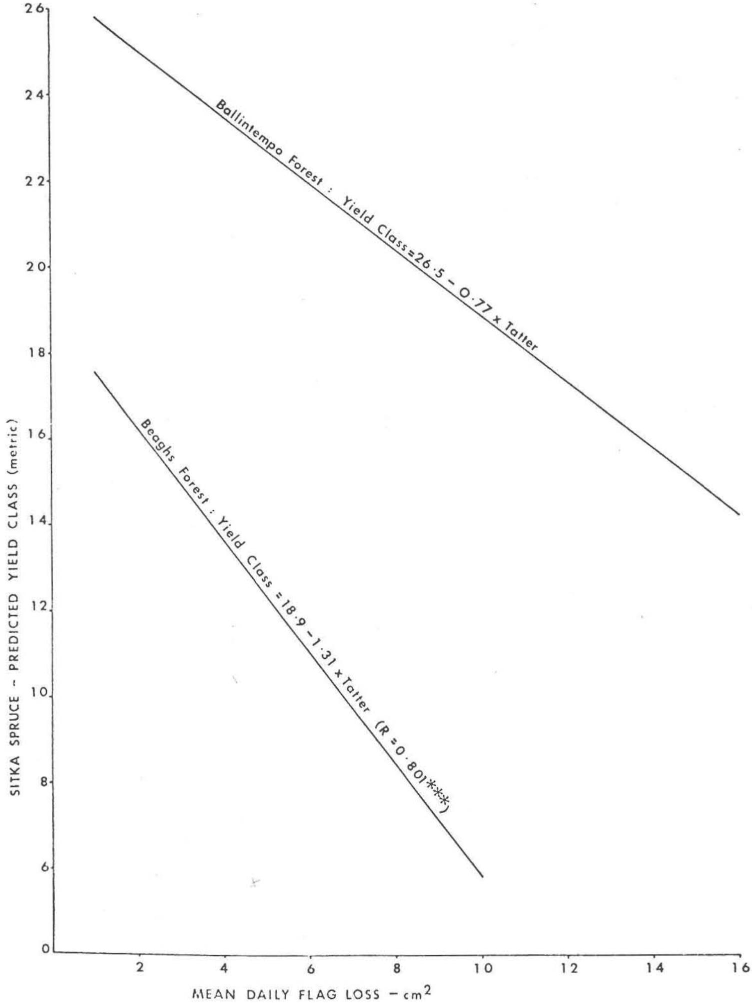

Figure 2: Relationships between predicted yield class and flag tatter.

is partly caused by the fact that the line for Ballintempo is based on measurements of all 20 trees per plot, while at Beaghs only the 5 tallest were measured. There were also large differences in the rate of growth between the two forests and, as can be seen from Table 3, much less data were available for Ballintempo Forest.

These results can be translated into more commonly understood terms if they are expressed as the effect of exposure on predicted yield class. At the particular stage of development, all the crops examined were too young to assign with any certainty to a yield class in the Forestry Commission's tables (Hamilton and Christie, 1971), but at least tentative predictions can be made. The relationships found are shown in Figure 2. In the case of Beaghs Forest the line is based upon the combined data for the two oldest (P60 and P61) areas. The line for Ballintempo is based on the P67 area only.

It will be seen that at Beaghs Forest predicted yield class falls off rapidly with the increasing exposure, from YC15 where mean daily flag loss is 3 cm^2 to YC6 where flag loss is 10 cm^2. The major difference in the case of Ballintempo is that for apparently similar exposure values, crops are about 11 yield classes higher than at Beaghs. This difference in growth rate may be caused at least in part by the influence of slightly different peat types and of the warmer climate in the west which is indicated in meteorological office records. It must also be caused in part by the fact that differences in climate, particularly rainfall (Rutter, 1966) influence the rate of tatter of cotton flags, so that the factors which contribute to a given level of tatter in one place may be quite different from those which contribute to the same level in another. The fact that the P67 area at Ballintempo was fertilised with broadcast rock phosphate, while at Beaghs the fertiliser was basic slag put into the planting hole may also contribute to the difference, but it is commonly observed that even where fertiliser treatments and soils are the same, growth in Ballintempo is invariably better than at Beaghs.

Relationship Between Altitude and "Exposure"

It is well recognised that as elevation above sea level increases, "exposure" also increases. To determine the relationships between the two, the elevations of the tatter flag points on the P60 and P61 areas at Beaghs were estimated by scaling between 100 ft (30 m) contours on 1:10560 ordnance survey maps. This could not be done for Ballintempo because almost all the plots for which growth measurements were available lay on a plateau at about 300 m which made the estimation of elevations from a map impossible. There are sufficient changes in topography however to understand subjectively the differences in rates of tatter.

The relationship at Beaghs where elevations ranged from 250–350 m was:

Flag loss in $cm^2/day = -20.5 + 0.0922 \times$ altitude (m)

($R = 0.72^{***}$)

The correlation coefficient is sufficiently good go indicate that elevation plays a very important part in influencing the rate of flag tatter.

Relationships Between Altitude and Growth of Sitka spruce

Mayhead (1970) has demonstrated relationships between elevation and yield class for different regions in Britain, and has shown that they are not constant. The regions investigated were Forestry Commission Conservancys, each about as big as the whole of Northern Ireland.

On the much more local scale of investigations in Northern Ireland it was possible to eliminate major differences in soil fertility by

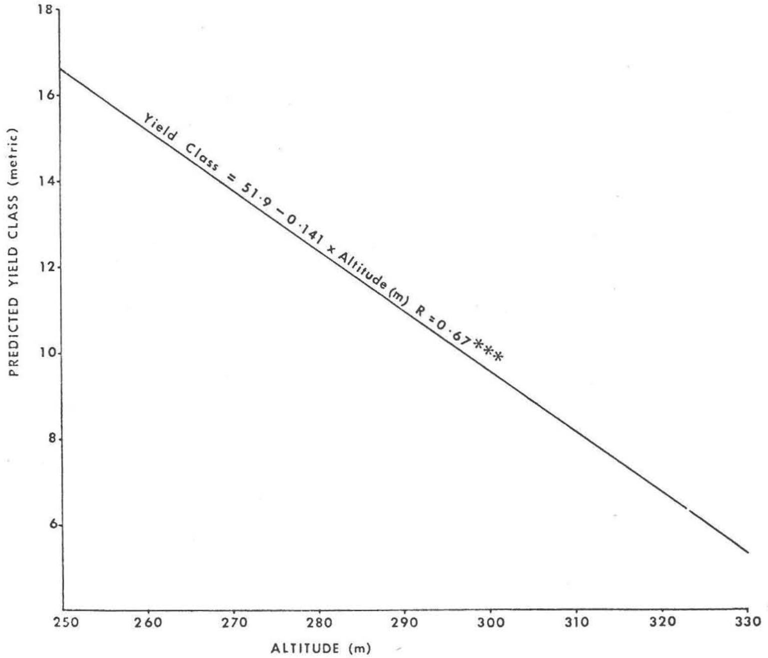

Figure 3: Relationship between predicted yield class and altitude at Beaghs forest.

selection of sampling sites, so the main influences causing differences in growth were likely to be climatic.

Using the same sample plots as were investigated for tatter flag purposes in the P60 and P61 areas at Beaghs, the relationship between yield class and altitude is shown in Figure 3. This relationship is not quite so good as those between crop height and flag tatter shown in Table 3.

Although no regression could be calculated for Ballintempo for the reasons given above, it is certain that if a similar yield class/elevation relationship did exist there it would differ significantly from that at Beaghs, in the same way as the relationships between flag tatter and yield class differed. This is because elevations at both forests were very similar, if not slightly greater at Ballintempo but yield classes at Ballintempo were on average much higher than at Beaghs.

Discussion

Work carried out at Beaghs and Ballintempo Forests has confirmed that the relationships between tree growth, "exposure" and elevation are sufficiently good to be of practical use. However, if a plantable boundary based on predicted yield class is being sought, then this can only be determined for a reasonably localised area. The two forests studied are separated by a distance of 120 km yet differences in response to apparently similar levels of exposure amounted to about 11 yield classes in conditions where soil and elevation did not differ very greatly.

Coefficients of correlation between exposure and yield class, and altitude and yield class were rather variable, and while both could be regarded as being reasonably acceptable for use on a local scale, there is a fairly strong suggestion that exposure expressed as tatter provides the more reliable indicator of growth differences.

While neither method provides a means of explaining anything like the total variability in growth, both explain sufficient of it to make them reasonably acceptable for determining a plantable limit objectively. It is known that correlations with other factors, such as temperature and the supply of nutrients can be found (Malcolm and Freezaillah, 1973).

In the past it has been the normal practice to determine economically plantable boundaries on subjectively assessed altitudinal limits. They are usually modified from place to place by differences in aspect, soil or equally subjective opinions as to the degree of local shelter. It is of interest to note that an isopleth ("contours" of exposure) map of Beaghs forest, produced from tatter flag results agreed remarkably well with one produced by the local forestry staff who assessed relative exposure levels purely from their own knowledge and experience, and without access to tatter flag data.

If this can be done elsewhere, it appears to be necessary only to establish the relationship between exposure and yield class on a small part of an area under consideration and for experienced foresters to decide where similar levels of exposure would be found elsewhere. An acceptable economically plantable limit could probably be produced in this way.

Acknowledgments

Thanks are due to the two research foresters in Northern Ireland who have been responsible for recording details of several thousand tatter flags over the years; also to the staff of the Department of Agriculture's Biometrics Division for help with the statistical work.

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Depth of Water Table in a *Picea Sitchensis* Fertilization Experiment on Blanket Peat

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Abstract
Depth to water table was measured at weekly intervals over a one year period in each plot of a N/P factorial, Sitka spruce (*Picea sitchensis* (Bong.) Carr.) fertilization experiment on deep peat in western Ireland. The relatively rapid adjustment of water table levels to changing precipitation patterns suggested that no extreme deficits occurred in the peat during the growing season. While tree growth was increased by both N and P fertilizers, depth to water table was significantly increased only in the phosphate-treated plots. These plots showed consistent water table depression, particularly during May and June when weekly rainfall levels were at a minimum. The greatest depression was recorded at the lowest level of added phosphate. This curvilinear response, which may reflect a complex evapotranspiration effect of components of the tree stand, persisted late in the growth season when the linear response had disappeared. It is difficult to evaluate the long term effects of tree growth on this peat. Information is needed on the relationship between peat moisture content and water table depth and on the optimum moisture conditions for tree growth on this site.

Introduction
This paper is concerned with the water using powers of forest crops in an area of water surplus. At Glenamoy, Co. Mayo, in the blanket peat (1) area of western Ireland, there is an annual water surplus (rainfall minus evapotranspiration plus deep seepage) of 660 to 760 mm. Effective drainage of this low permeability peat requires 1 m deep drains at 5 m intervals (6). In a comparative study, depth to water table at Glenamoy was greater under a mixed species forest tree shelterbelt than under grassland (13).

This investigation was initiated in 1969 in a N/P fertilization experiment on Sitka spruce (*Picea sitchensis* (Bong.) Carr.) at Glenamoy (5). Water table levels were examined under the conditions of differential productivity created by the fertilizer treatments.

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Experimental

The experimental plots were located on blanket peat at Glenamoy State Forest, situated at Glenamoy in north-west Co. Mayo. The climate of the area is extreme maritime; annual rainfall is 1,400 mm, distributed over 270 days. The wind climate is very severe with gales in almost every month. The *Schoenus nigricans* L. association dominates the natural flora (12). Principal species include *Schoenus nigricans* L., *Molinia caerulea* Moench., *Eriophorum angustifolium* Honck., and E. *vaginatum* L. The top 50 cm of peat has an ash content of 2.5 per cent and humification 5 to 6 on the Von Post scale (18). Bulk density (wet basis) ranges from 0.95 g per cc at the surface to 1.01 g per cc below 30 cm; air filled pore space after drainage was 5 per cent to 8 per cent by volume at the surface and the hydraulic conductivity of undrained peat was about 1 cm per day (3).

Preliminary drainage to 1 m depth was carried out at 31 m spacing in 1954. Prior to afforestation in 1962, the area received double mouldboard ploughing producing an 18 cm deep drainage channel and two continuous lines of planting turves. The area was planted to Sitka spruce at 1.5 m $\times$ 1.5 m spacing in 1962. The trees received a spot application of ground rock phosphate per plant at planting. The fertilization experiment, 48×0.03 ha plots, was installed in 1967. A randomized block design was employed with four levels of ground rock phosphate (0, 55, 110, and 220 kgP/ha designated P_0, P_1, P_2 and P_3 respectively) and three levels of sulphate of ammonia (0, 132, and 234 kgN/ha designated N_0, N_1, N_2) in factorial combination, replicated four times. Sulphate of potash (42 per cent K) was applied to all plots at 125 kg/ha and copper sulphate (25 per cent Cu) was applied at 11 kg/ha. All fertilizers were applied broadcast, without incorporation, in April 1967. In 1969, the 132 kgN/ha sulphate of ammonia treatment was repeated on those plots which had received it in 1967.

Depth of peat measured in 1967 ranged from 1.0 m to 4.4 m in the experimental plots, with a median depth of 3.0 m. Moisture content ranged from 85.2 per cent to 91.2 per cent by weight with a mean of 88.8 per cent.

In August 1969, one slotted PVC drainage pipe, 7.0 cm diameter, 1.6 m long, was installed in a bore hole at the centre of each plot. The method of installation has been previously described (13). Depth to water table was measured at weekly intervals from 9 October 1969 to 8 October 1970, with the exception of one week in December 1969. This was a total of 52 weekly readings. Results are expressed on the basis of (a) the whole 52 weeks and (b) a 26 week period, 2 April 1970 to 24 September 1970, considered to approximate the growing season. Tree height measurements were taken prior to the 1967 season and at the end of each season 1967-1970. Height growth data, and mean depth of water table for the two periods were both subjected to analysis of variance. Sums of squares for N and P were subdivided using a series of mutually orthogonal comparisons. The relationship between depth to water table and precipitation in the preceding 21 day period was analysed by multiple regression techniques.

Results and Discussion

Precipitation for the year-long experimental period ending 8 October 1970, totalled 1,481 mm. Precipitation for the 26 week "growing season" period totalled 634 mm, a weekly average for this period of 24.4 mm. There was a highly significant inverse relationship between depth to water table and precipitation in the preceding 21-day period (Table 1). Precipitation in the seven day period immediately preceding water table measurement made the greatest contribution to the regression indicating a relatively rapid adjustment of water table levels to changing precipitation patterns. The rate of adjustment suggests that no extreme water deficit occurred in the peat during the growing season. Peat has a high water holding capacity. On drying, this storage capacity of the dry layers of the peat will have to be filled before penetration of subsequent rainfall to the water table is possible.

TABLE 1

Multiple regression analysis of water table depth (cm) on precipitation (mm) in the three preceding seven day periods.

Precipitation period	Regression coefficient	SE regression coefficient	t value
1-7 days before watertable measure X^1	—0.383	—0.082	4.64**
8-15 days before water table measure X^2	—0.109	—0.087	1.25
16-21 days before water table mfasure X^3	—0.141	—0.100	1.41

Analysis of variance for the regression $F = 10.19$**

Coefficient of determination $= 58.1\%$

Prediction equation: $Y = 49.32 — 0.399X_1$

Level of significance: *0.05, **0.01

TABLE 2

Depth to water table (cm) in treatment plots.
Means of 52 weeks and 26 weeks.

Treatment	Depth to water table (cm) 52 weeks	26 weeks
N_0	35.9	40.8
N_1	35.7	40.3
N_2	33.2	37.8
P_0	32.8	36.6
P_1	37.4	42.6
P_2	34.6	39.8
P_3	35.0	39.6
S.E. of mean	2.27	2.30
Significance of Effects		
N	NS	NS
P	NS	*
N × P	NS	NS
P components[1]		
linear	NS	NS
quadratic	*	**

Significance level: NS not significant; *0.05; **=0.01

[1] Component effects calculated after removal of P_3 level data from analysis of variance.

Mean depth to water table increased as a result of phosphate application (Table 2). The effect of nitrogen was slight, the greatest depth to water table being recorded at the P_1 level of application (55 kg P per hectare). If the data are recalculated, omitting the highest level of phosphate application, the remaining levels form an arithmetic progression. This permits the use of orthogonal polynomials to test the degree of curvilinearity in the regression of water table depth on level of phosphate application. This was done for both the mean values and for those weekly measurements which showed a significant main-effect response to phosphate in the preliminary analysis (Table 3). The results are given in Tables 2 and 3. Examination of weekly water table data shows that while the response to phosphate was consistent throughout the growing season, the effect of the fertilizers was greatest in May and June (Table 3), when weekly rainfall levels were at their minimum and mean depth to water table was at its maximum for the year. Water table depression at the P_2 level of application was most pronounced at this time also. Towards the end of the season there was little or

TABLE 3

Weekly depth to water table (cm), rainfall levels (mm) and treatment main effects during the 26 week growing season period, 2 April to 24 September 1970.

Depth to Water Table
Mean weekly rainfall, 2 April—24 September 1970—24.4 mm.
Mean water table depth, 39.5 cm.

Week	Date	Rainfall preceding 7 days (mm)	Mean (cm)	SE of Mean	Treat-ment Effects	Component[1] Effects (P)	
1	April 2	30.4	29	2.61			
2	April 9	16.7	35	2.72			
3	April 16	17.3	32	2.72			
4	April 23	44.9	25	2.47			
5	April 30	14.4	35	2.58			
6	May 8	29.2	32	2.64			
7	May 14	2.5	42	2.25	N* P*	linear**	
8	May 21	13.8	42	2.99	N*		
9	May 29	12.9	48	2.61	P**	linear*	quad**
10	June 3	7.5	52	3.02	P**	linear**	quad**
11	June 11	7.6	56	2.83	N* P**	linear**	quad**
12	June 18	4.6	62	2.34	N* P**	linear**	quad**
13	June 25	34.7	52	4.26	P**	linear**	
14	July 2	45.4	40	3.05	P*	linear*	quad**
15	July 9	34.6	30	3.57			
16	July 16	19.2	41	2.72			
17	July 23	8.7	46	2.87	N*		
18	July 30	20.1	46	2.77	P**	linear**	quad**
19	Aug. 6	15.6	47	2.68	P*	linear**	
20	Aug. 13	32.2	38	4.05			
21	Aug. 20	51.5	38	2.38	P*		quad**
22	Aug. 27	2.5	46	2.32	P*		quad**
23	Sept. 3	29.5	37	3.43			
24	Sept. 10	56.4	21	2.30			
25	Sept. 17	69.7	21	2.38			
26	Sept. 24	15.5	38	2.36	P**		quad**

Level of significance: *0.05; **0.01; quad=quadratic.
1. Component effects calculated after removal of P_3 level data from analysis of variance.

no depression at the P_2 level, but the curvilinear element of the response persisted. Crop root systems, however, will respond not to the average depth to water table, but rather to the duration of water table depression. The aerobic limit (point where anaerobic conditions prevail) in peat is usually closer to the surface than the water table and responds only slowly to depression of the water table (7, 8). As the optimum depth to water table on peat soils has not been established for Sitka spruce, 40 cm was chosen as an arbitrary level for illustration of treatment effects (Fig. 1). The results (highest phosphate level omitted) follow the pattern established by the depth to water table anslyses (Table 4), the quadratic component showing a high level of significance.

The mechanism of the fertilizer effect may be attributed to increased evapotranspiration from the forest stand (including ground vegetation). It may be assumed that the effect of the fertilizers in increasing tree growth was accompanied by an increase in transpiration which would reach a maximum during the period of most active growth. While Penman (16) has warned of the effect of differences in crop height between adjoining plots on rates of

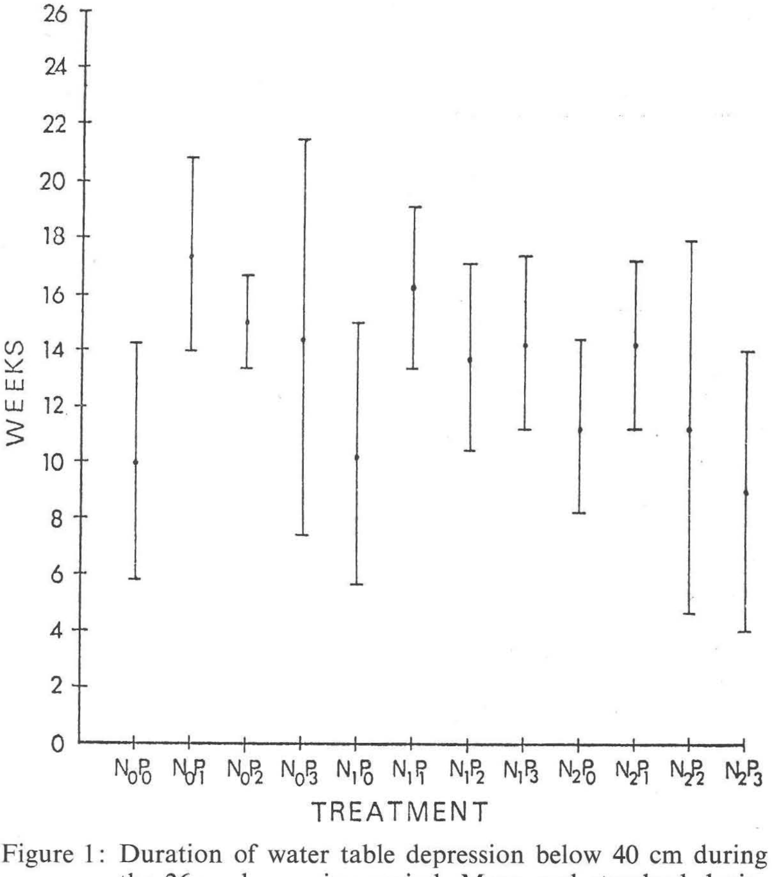

Figure 1: Duration of water table depression below 40 cm during the 26-week growing period. Mean and standard deviation for each treatment.

TABLE 4

Duration of water table depression (weeks) below 40 cm during the 26 week growing period.

Treatment	Duration (weeks)	Treatment	Duration (weeks)
N_0	14	P_0	11
N_1	13	P_1	16
N_2	12	P_2	13

SE of mean = 1.76.

Significance of Effects		P Components	
N	NS	linear	NS
P	**	quadratic	**
N×P	NS		

Significance level: NS, not significant; *0.05; **0.01.

TABLE 5

Effect of treatment on tree height growth (m), 1967-70.

Treatment	Total Height 1970	Height Increment 1967-1970	Height Increment 1969-1970
N_0	2.86	1.67	0.55
N_1	2.98	1.83	0.58
N_2	3.18	1.95	0.64
P_0	2.43	1.20	0.37
P_1	3.20	1.97	0.61
P_2	3.28	2.08	0.73
P_3	3.12	2.01	0.68
	SE of mean = 0.13	SE of mean = 0.12	SE of mean = 0.0 6

Treatment Comparisons and Interaction

N_0 vs (N_1+N_2)	*	**	NS
N_1 vs N_2	*	NS	NS
P_0 vs $(P_1+P_2+P_3)$	**	**	**
(P_1+P_2) vs P_3	NS	NS	*
N×P	NS	NS	*

N_1 treatment was repeated in April 1969.
Significance level: *0.05; **0.01; NS, Not significant.

transpiration and evaporation, it is unlikely that mean depth to water table has been greatly influenced by the relatively small differential heights recorded in forest tree experiments. Height growth for the experiment (summarized in Table 5) showed positive responses to both fertilizers (5), but the data do not follow the same pattern as recorded for water table depth. Interception of rainfall and subsequent evaporation from foliage surfaces represents a major component of total evapotranspiration in forests. Figures quoted for Norway spruce (*Picea abies* (L.) Karst.) crops of about 10 m height in Britain suggest that precipitation reaching the forest floor represents 50 to 60 per cent of that in the open (14, 11). Päivänen (15) recorded an 8 cm depression of the water table resulting from the fertilization (NPK) of a 50 year old Scots pine (*Pinus sylvestris* L.) stand on peatland, which he attributed principally to increased interception by the tree crop due to increases in needle length and canopy closure. However, the distribution of precipitation on the forest floor may be quite irregular (4, 17), particularly in the present study, as canopy closure was incomplete. Ground vegetation was plentiful in the experimental plots and showed a clear quantitative response to fertilizer treatment.

It is likely that the curvilinear response to phosphate application can be accounted for by the interaction of the transpiration and interception effects of the tree and/or ground vegetation components of the forest stand. While the depression of the water table was consistently most pronounced at the P_1 level of phosphate application, the persistence of this effect towards the end of growing season suggests an active transpirational loss induced, perhaps, by the extension of the growth season of a component of the system.

The results illustrate the complexity of site response to fertilization. Annual height extension was the only measure of tree growth made in this experiment. Diameter growth may vary to some extent independently of height increment and is certainly not confined to such a sharply delimited period of growth. While both height and diameter are meaningful measures of growth response to fertilization, they are poor indices of biomass increment. The need for an integrated approach to forest fertilization has been emphasized by some workers (9, 10), who consider the fertilizer as a catalyst, increasing the efficiency of energy utilization by the tree stand, but producing a series of complex changes throughout the ecosystem. Some of these may run contrary to the aims of management. Marked reductions in peat moisture content, accentuated by fertilizer application, were recorded in a long term study of Lodgepole pine (*Pinus contorta* Dougl.) and Scots pine on peat in Scotland (2). Large cracks have developed in the peat and irreversible drying of shallow peat has occurred. The increase in depth to water table recorded in the present study will be of benefit to the tree crop in the short term, if it results in deeper rooting and improved crop stability. It is difficult to evaluate long term effects. Information is needed on the relationship between peat moisture content and water table depth on this peat type and on the optimum moisture conditions for three growth on this site.

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Resource Allocation for Forest Fire Protection[1]

J. Cantwell[2]

Abstract

In this paper a practical procedure for assisting forest management in allocating funds for fire protection in plantations is proposed and its application to a specific situation discussed. The procedure can also be used to establish norms for expenditure on protection in individual plantations and assist towards ensuring that the same standards of protection apply in all plantations.

1 Introduction

Each year forest management has to decide on the level of funds to be allocated for fire protection in the plantations under its control.

Traditionally this decision has been based on experience and judgment with due regard for local conditions and the success or failure of previous policies. This practice can give rise to wide disparities in protection policy between different plantations and make it difficult for management to control expenditure or to ensure that funds are being allocated effectively.

In this paper a practical procedure for assisting forest management in allocating funds for protection is proposed and its application to a specific situation discussed. The procedure can also be used to establish norms for expenditure on protection in individual plantations and assist towards ensuring that the same standards of protection apply in all plantations.

In order to deal with the complexities of the situation it has been found necessary to make several simplifying assumptions and to adopt a fairly crude approach. Thus it is important to stress that this procedure is not expected to provide an optimal solution. At best it is no more than an attempt to introduce an analytical base for decision-making into a situation where management tends to rely heavily on experience and judgment. In addition, it should be noted that the procedure is still very much at the development stage and much work remains to be done.

A plantation can be damaged by a fire which may start outside the plantation and then sweep in through the vegetation which

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1. Paper presented to the 2nd National Conference of the Operations Research Society of Ireland, October 1973.

2. Government Operations Research Unit, Dublin.

usually grows along the perimeter. Alternatively, fires can start inside the boundaries of the plantation and spread from there. Various protective measures can be taken ranging from the posting of fire warning notices, to patrolling or to clearing vegetation from around the edge of the plantation. The actual measures taken depend on local conditions, the nature of the hazard and the judgment of the local forester.

The system which usually operates is that each year the local forester submits his proposals for protection for the following year together with the cost of the work for approval by district management. These proposals depend to a large extent on the forester's expectation of what may happen next year and can be influenced by what has happened in previous years. Other factors taken into account include the type of land surrounding the plantation and the use to which this land is put, the habits of the local farmers or sheep owners in relation to the burning of vegetation, the size, value and vulnerability of the plantation, its accessibility, the extent to which it is frequented by the public and finally the degree of confidence he places in his ability to control a fire if one should occur.

The district manager receives similar proposals from the other foresters in his area and may suggest certain modifications before giving his approval. Again, because of the lack of objective criteria upon which to base his decisions, he has to rely heavily on his own experience and judgment.

2 The Model

It is proposed that protection should be allocated in proportion to the relative values of index numbers calculated for each plantation. These index numbers are calculated as the product of two other numbers, one indicating the risk or chance that the plantation will be threatened by a fire and the other the value of the plantation.

$$\text{or } \frac{E_1}{E_2} = \frac{R_1V_1}{R_2V_2}$$

where E_1 = proposed expenditure on plantation 1
E_2 = ,, ,, ,, plantation 2
R_1V_1 = the risk/value index number for plantation 1
R_2V_2 = ,, ,, ,, ,, ,, ,, plantation 2

A risk/value index is calculated for each plantation and the protection budget allocated according to their relative values.

The level of expenditure per unit of the risk/value index number provides an objective method for comparing protection expenditure on different plantations. An examination of the distribution of expenditure per unit of risk/value index will draw attention to plantations which on this basis appear to be over or under protected. The means of the distribution indicates a norm for expenditure on protection and can be used as a guide-line for control purposes.

In Sections 3 and 4 following, the components of the model are discussed in greater detail and methods for assessing risk and value described. The calculation of the risk/value index is described in Section 5. In Section 6 the application of the procedure to a practical situation is demonstrated and suggestions for its use as a control mechanism for expenditure outlined.

3 Calculation of Risk

It can be shown that the number of fires which occur in a sample of plantations can be characterised by the Poisson distribution. This hypothesis was tested with data relating to fires which occurred in or near 36 plantations over a 10 year period, i.e. 360 readings in all.

The data are tabulated in Table 1 below.

The probability density function of the Poisson distribution is

$$P(n) = \frac{u^n e^{-u}}{n!} \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (1)$$

where u = the average or expected number of fires per plantation per year

In this case u = 0.25

Solving equation (1) for n=0, 1, 2 and 3 gave the expected

TABLE 1
ACTUAL AND EXPECTED NUMBER OF FIRES OCCURRING IN A PLANTATION IN A YEAR

Number of fires occurring in a plantation in a year	Actual frequency of occurrence	Expected frequency of occurrence
0	285	280
1	61	71
2	13	8
3	1	1

$X^2 = 4.62$

number of fires predicted by the Poisson distribution as shown in Table 1.

Comparing the expected frequency with the actual frequency of occurrence and applying a X^2 goodness of fit test indicated that the Poisson distribution could be regarded as a reasonable predictor of the number of fires to be expected in the future. In other words, past data on the occurrence of fires is a useful guide to future behaviour.

Although the number of fires which occur can be predicted reasonably accurately by the Poisson distribution it is obviously more important to be able to predict where the fires are likely to occur. A close examination of past data on the incidence of fires in individual plantations will indicate that some plantations appear to be more suseptible to fires than others. In other words some plantations have a higher probability of fires than others and it is probably reasonable to assume that high risk plantations in the past are likely to be high risk plantations in the future. This assumption may not be true in every case, land may be reclaimed or indeed neglected, new plantations will be established but, as a first approximation, it can be assumed that data on where fires occurred in the past are a useful guide to where fires are going to occur in the future.

Assume that data on the number of fires which have threatened two plantations over, say, the last twelve years can be tabulated as in Table 2.

TABLE 2
NUMBER OF FIRES THREATENING TWO PLANTATIONS OVER THE YEARS 1962 TO 1973

Plantation	62	63	64	65	66	67	68	69	70	71	72	73
Carrigatubrid	1	1		1		1			1			
Mullenbeg	1		2			3			2	1		

On the basis of these data Carrigatubrid is assigned a risk index of $^5/_{12}$ and Mullenbeg $^9/_{12}$. If no fires had threatened either plantation in that period the risk is set arbitrarily at $^1/_{20}$, i.e. it recognises that there is no such thing as a plantation which cannot in any circumstances have a fire, but on the other hand the historical data is respected by assigning a value of risk which implies that on average there will be only one fire every two decades.

This crude measure of risk has the advantage that it is easy to calculate as records of the occurrence of fires which threaten plantations are usually available.

4 Calculation of the Value Index

The actual cash value of a plantation is difficult to establish apart altogether from the question of its amenity value. If one assumes an annual appreciation rate and ignores all considerations of amenity a value index can be calculated on the basis of the area and age of the plantation together with a measure of the type and quality of timber in the plantation. The type and quality of the timber in a plantation is usually described in terms of yield class. Yield class is essentially a measure of the quantity of timber a plantation will yield during one complete cycle. It is calculated from measurements taken during the early years of growth. A "good" plantation would be described as 22 yield class, whereas a "poor" plantation may belong to the 6 or 8 yield class category

If we assume that the value of a plantation increases at the rate of x% per annum then the value index (V_t) at time t is given by

$$V_t = AY\left(1 + \frac{x}{100}\right)^t$$

where A = area
Y = average yield class
t = average age of the plantation
x = annual appreciation rate

It is necessary to use average age and average yield class because a plantation is usually composed of a number of sections or compartments of various ages and yield class. Furthermore, the composition of a plantation can change over time, parts of it may be cut down and replanted, parts which have failed may be cleared and replanted or enriched by replacing some of the failed trees.

As an example of the calculation of the value index assume the data shown in Table 3 is available for the two plantations mentioned previously, also assume an annual appreciation rate of 5% per

TABLE 3

AREA, AVERAGE AGE AND AVERAGE YIELD CLASS FOR TWO PLANTATIONS

Plantation	Area (hectares)	Average age (years)	Average yield class
Carrigatubrid	82	11	10
Mullenbeg	19	17	9

annum, then the value index for Carrigatubrid is 1,403 and for Mullenbeg 393.

Data for the calculation of this index are usually available in plantation census documents and planting files.

5 Calculation of Risk/Value Index

A risk/value index for each plantation can be calculated by multiplying the risk as measures in Section 3 by the value index described in Section 4.

For Carrigatubrid and Mullenbeg plantations the risk/value index would be calculated as in Table 4.

TABLE 4

THE RISK/VALUE INDEX FOR CARRIGATUBRID AND MULLENBEG PLANTATIONS

Plantation	Risk index	Value index	Risk/value index
Carrigatubrid	$^5/_{12}$	1,403	585
Mullenbeg	$^9/_{12}$	393	295

The risk/value index of 585 for Carrigatubrid compared to 295 for Mullenbeg indicates that, on the basis of the value of the plantations and the risk that they will be threatened by a fire, management would be justified to spend practically twice as much protecting Carrigatubrid as Mullenbeg.

6 Application

The application of this procedure is demonstrated by the following example. The pattern of fires over twelve years for 15 plantations was found. This is shown in Table 5 below. The final column shows the risk index calculated according to the method outlined in Section 3.

The value index for each plantation was then calculated and combined with the risk index to give the risk/value index shown in Table 6.

The pattern of expenditure on protection for the 15 plantations over a two year period 1971 and 1972 is compared with the risk/value index profile in Figure 1.

The model postulates that the ratio of expenditure on protection per unit of risk/value index should be constant for every plantation. This ratio for the 15 plantations is shown in Table 7, and the distribution of the ration is shown in Figure 2. An examination of the

TABLE 5
INCIDENCE OF FIRES IN 15 PLANTATIONS OVER A 12 YEAR PERIOD AND THE CONSEQUENT RISK INDEX ASSIGNED TO EACH PLANTATION

Plantation	62	63	64	65	66	67	68	69	70	71	72	73	Risk
Carrigatubrid	1	1		1		1			1				5/12
Listrolin (1)													1/20
Listrolin (2)		1	1	1								1	4/12
Corbally													1/20
Dowling													1/20
Ashtown													1/20
Mountain Grove													1/20
Templeorum													1/20
Gortrush													1/20
Glenbower	1												1/12
Garryduff													1/20
Beatin													1/20
Bregaun		1	1	1						2		1	6/12
Mullenbeg	1		2				3		2	1			9/12
Moonveen							1						1/12

TABLE 6
THE RISK/VALUE INDICES FOR THE 15 PLANTATIONS

Plantation	Risk Index	Value Index	Risk/Value Index
Listrolin (2)	4/12	2,561	854
Carrigatubrid	5/12	1,403	585
Corbally	1/20	6,371	319
Mullenbeg	9/12	393	295
Bregaun	6/12	512	256
Gortrush	1/20	2,527	124
Garryduff	1/20	2,238	112
Glenbower	1/20	974	81
Dowling	1/20	1,343	67
Mountain Grove	1/20	861	43
Moonveen	1/20	473	39
Ashtown	1/20	532	27
Listrolin (1)	1/20	288	24
Beatin	1/20	295	15
Templeorum	1/20	72	4

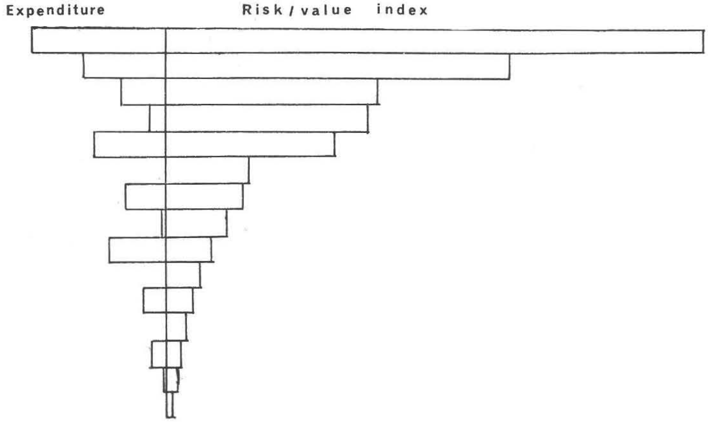

FIGURE 1: Comparison of risk/value index profile with protection spending profile for 1972 and 1972.

distribution immediately draws attention to those plantations which on this basis appear to be over or under protected. The means of the distribution indicates what the norm for expenditure on protection has been and can be used as a guide-line for control purposes. In this case a norm of £1.50 per unit of risk/value index could be used.

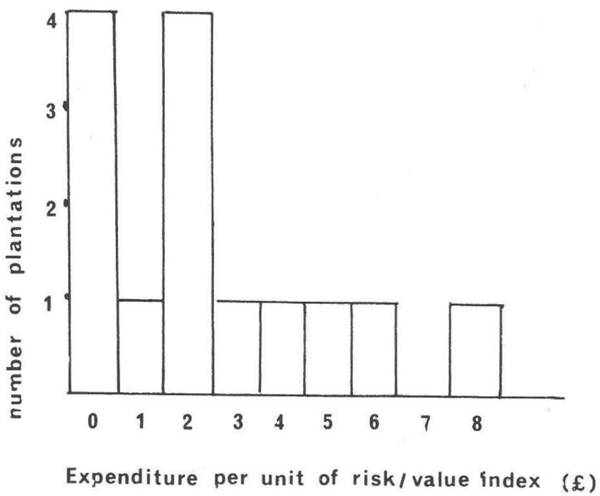

FIGURE 2: The distribution of expenditure per unit of risk/value index.

TABLE 7
THE AMOUNT SPENT ON PROTECTION DURING 1971 AND 1972 PER UNIT OF RISK/VALUE INDEX

Plantation	Risk/Value Index	£ Spent on Protection (1971 and 1972)	£ / Unit of RV
Listrolin (2)	854	1,057	1.24
Carrigatubrid	585	671	1.15
Corbally	319	376	1.18
Mullenbeg	295	133	0.45
Bregaun	256	597	2.33
Gortrush	124	0	0
Garryduff	112	347	3.10
Glenbower	81	49	0.61
Dowling	67	480	7.16
Mountain Grove	43	0	0
Moonveen	39	195	5.00
Ashtown	27	0	0
Listrolin (1)	24	121	5.04
Beatin	15	22	1.47
Templeorum	4	0	0

7 Conclusion

The procedure described in this paper is by no means complete. Much work remains to be done. The use of historical data as the only indicator of risk ignores many factors which may influence the situation, in particular, the age of a plantation. Current studies are attempting to identify and quantify these factors to differentiate between the risk that a plantation will be threatened by a fire and the vulnerability of the plantation. A way must also be found to take account of the amenity value of a plantation. However, the procedure as it stands has the advantage that it is easy to understand and can be calculated from data already available. As was pointed out in the introduction it represents a first attempt to introduce an objective decision-making mechanism into a situation where management has traditionally relied on experience and judgment.

8 Acknowledgments

The author wishes to thank the Forest and Wildlife Service for permission to publish this paper, and to acknowledge the contribution which his colleague Mr. N. Honeyman has made to the study on which this paper is based, and the active assistance given by the Divisional Inspector, District Inspectors and Foresters in the Kilkenny Division, and the Work Study and Statistics Sections at Headquarters throughont the period of the study.

Abstract

Furze

"ALTHOUGH it is now regarded as little better than a troublesome weed, furze formerly played a very considerable role in the rural economy of large areas of Ireland. It was put to such an astonishing number of uses that there can hardly be any other plant in the Irish flora which has been pressed into service for so many and for such a variety of purposes. While some of these are to be appreciated to the full only when seen in their historical perspective, most of them, if no longer alive, are still remembered in the countryside, at least among the older people."[1]

Furze belongs to the family *leguminosae* which includes peas, beans, clovers, etc. It can survive and indeed thrive on shallow dry soils even under exposed conditions by virtue of its spiny condition. The evolution of spines rather than normal leaves has minimised the leaf surface area and the consequent water loss by evapo-transpiration. They are also a deterrent to grazing animals. Photosynthesis occurs both in the leaf-spines and also on spines of shoot origin thus compensating to some extent for the reduction of photosynthetic surface associated with the spiny condition. The furze, in common with most other members of the *leguminosae*, is equipped with root nodules which contain bacteria capable of fixing nitrogen from the air.

Two species of furze are found in Ireland.[2] The larger and more common species (*Ulex europaeus*) grows from two to five feet and over in height and flowers from March to May. It is rarely seen above 500 feet in the west or 800 feet in the east of the country, and generally avoids extreme soil conditions; wet peats and limestone crag are usually avoided. The only regions in which it appears to be completely absent are north-west Clare (the Burren region) and parts of north-west Mayo and Donegal. There is evidence that it has been introduced into some of its western and north-western stations, including some sea islands, probably in the first half of the last century. It is most abundant in the south-eastern quarter of the country.

The second species is the dwarf furze (*U. gallii*) which usually grows from one to two feet and flowers in August and September.

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1. *Furze—A survey of its history and uses in Ireland*, by A. T. Lucas, Stationery Office, Dublin, 1960.
2. *The Census Catalogue of the Flora of Ireland,* by M. J. P. Scannell and D. M. Synott (Stationery Office, Dublin, 1972) lists a third species *U. Minor* which has been found in only one station in Co. Down. (Abstractor's note.)

It grows best on thin peaty soils and is very rare on calcium rich substrates. In contrast with the last species it is more distinctly southern and eastern in distribution, being absent from considerable areas in the northern half of the country. It can also grow at higher altitudes.

The common name for the plant in Irish is *aiteann* though many variants exist. A closely related form is found in Welsh—*eithin*. Both versions are of great antiquity.

Two English names are in current use in the country. In the northern half "whins" is the name generally used and in the southern half "furze". Both are plural forms, the singulars being given as a "whin bush" and a "fur" (or "fur bush") respectively. "Furry" or "Furzy" are frequently used as the adjectival forms of furze.

The terms for distinction between the two species vary according to the region. Where *U. gallii* is rare or absent—in the northern half of the country, there is often no attempt to distinguish between the two even when they are recognised as separate species. Most of Munster and part of Leinster contrasts with Ulster and much of Connacht in that there is a well developed terminology in both Irish and English distinguishing between the two species. Generally in English *U. Europaeus* is known as "English Furze" but in some areas is known as French Furze, e.g. in parts of Wicklow. The name in Irish for this species is *aiteann gallda* (i.e. English or "foreign" furze) in parts of Clare, Cork, Kerry, Tipperary, and Waterford and in one locality in Connaght (Moyrus). *Aiteann francach* is also in use in parts of Cork and Kerry; *Francach* here being used for foreign rather than French. The dwarf species—*U. gallii* in English is generally known as "Irish furze". In Irish the almost universal name is *aiteann gaedhealach* or a variant thereof.

A large body of evidence is discussed showing that furze was of great economic importance from the fifteenth century to the beginning of the nineteenth. It is thought that this importance dates from Norman times or possibly much earlier.

From the time of the land enclosure Acts in the first quarter of the eighteenth century furze came to be associated with the "ditches", i.e. bank and dyke, thrown up to separate the fields, owing to the practice of planting furze on top to provide shelter, fuel, fodder, etc. Seed (collected locally or imported) and occasionally young transplants from waste places were used for this. What is often not appreciated is that in addition to its use on hedge banks furze was also grown extensively as a crop, the plants in a few years being sufficiently large to harvest for fodder in the first instance and later for fuel, etc. These furze "breaks" also supplied shelter for animals in winter.

Lucas' survey revealed furze culture to be an established practice through the southern half of the country and sporadic elsewhere. The practice was most strongly concentrated in the band of country stretching from Kerry to Wexford, including the southern fringes of Clare, Limerick, Tipperary and Kilkenny.

Several methods were and are used for harvesting furze, depending largely on the size of the plants being cut and the purpose for which they were to be used. The furze was generally cut with a sickle while being held down with a forked stick, usually known as a *g bhlóg* (i.e. a little fork). More recently, especially where the furze is old and woody, the sickle is replaced by the bill hook.

The scythe superseded or supplemented the sickle in many areas being well suited to cutting large areas of young plants. Especially strong scythes were sometimes made for this purpose. When using the sickle or bill hook, the hand was protected by a mitten ("*Dornóg*") of strawrope (*sugán*) or by a leather guard.[3] Transport home or to market was by any means available, and each method had established procedures for loading etc. associated with it.

The uses for furze were legion and only the principal ones will be mentioned here. The furze, less the woody material, was prepared as fodder by methods based on chopping or pounding or a combination of both. The operation was generally carried out in a stone or less frequently, wooden trough. A special chopper like a weighted sharp spade was used for cutting it up, or occasionally an old sythe blade was sometimes fitted with a handle and used for this purpose as well as for cutting up other types of fodder. Pounding or "bruising" was usually done with a mallet which was sometimes fitted with blades to effect a cutting action also. In the mid-nineteenth century hand-machines were used for the purpose. Furze was an important food for horses in winter. It was of lesser importance for other livestock. It was occasionally fed to cattle or calves, especially if they were in poor condition. It was sometimes boiled and then fed to pigs and poultry. However its importance as cattle fodder was probably very great in early times prior to the introduction of other winter foods.

Furze makes an excellent rapid-burning fuel and this has always been one of its major uses both at farm level and in urban centres. It was of special value for firing bakers' ovens and was greatly valued for this purpose. It was also used for the following purposes: animal bedding, roof construction in houses, sheds and cattle shelters; as a

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3. Largely superseded by a piece of rubber boot or car tyre. (Abstractor's note.)

binder in mud walls; construction of field drains; road foundations, foundations of hay and corn stacks; harrowing; hurleys; walking sticks; chimney cleaning; dyeing in addition to other miscellaneous uses.

Lastly a formula has been recorded from Kerry which classifies soils according to the vegetation:

An t-ór fé'n aiteann,
an t-airgead fé'n luachair,
agus an gorta fé'n bhfraoch.

(Gold under furze, silver under rushes and famine under heather.)[4]

M. J. NEFF

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4. The Welsh hill farmers have a similar rule according to W. M. Candry, in *The Snowdonia National Park* (1967):

Aur dan y rhedyn
Arian dan yr eithyn
Newyn dan y grug

Gold under bracken, Silver under gorse; Famine under heather.
(Abstractor's note.)

Trees, Woods and Literature—10

Grandma walked a lot. Round the garden, and usually all round the Nut wood, but if she was going to the farther away woods, Parc na Carragh, the Isabella or towards Inchy, she'd go in the donkey trap. Tommy was a dear kind donkey, but not very interested in what went on, and he wandered along as slowly as he could. When we went with Grandma we could make him trot now and again with the use of a great deal of screaming "go on outa that", and the use of ash sticks, which raised a great deal of dust from his fur, but which he treated with a certain amount of disdain. Grandma never used a stick on him. She had a spud, which she carried everywhere with her, partly as a walking stick, but she loved to attack thistles and nettles growing near her beloved young trees, and she used this spud to prod Tommy whenever he stopped in his tracks; now and again he must have felt it, as Grandma always got to where she wanted in the wood, and of course once he was headed for home, there was no need for a goad.

* * * *

Grandma adored the woods, and taught us such a lot about them. Every year she planted a lot of young saplings, and endlessly walked round looking at her young plantations, tearing ivy away from the older ones, and seeing that the wire netting was safely around the smaller ones to keep the rabbits away. The weather had to be very bad indeed to keep her from visiting at least the nearest seedlings. She always wore galoshes over her shoes, cotton gardening gloves over her mittens, and armed with her spud went forth daily to wage war against thistle, ivy, nettle, convolvulus and rabbits. I think one of the few times I saw her really furiously angry was when she found that several of her beautiful young larches had been cut down and taken away.

"If only they'd asked *me", she said when she got home, "I'd have given them some timber. I've never denied anyone, as they well know, and I could have taken one here and one there and thinned them out at the same time. But to go and cut ten trees from the same spot is sheer vandalism, and I hope they will be found and punished." I had never heard her speak like this of anyone before—not even when the Black and Tans killed Malachi Quinn's young wife—shooting at everything as they drove along the road, for fear of being ambushed they said.*

From *Me and Nu: Childhood at Coole* by Anne Gregory. Published by Colin Smythe, 1970. Reprinted by kind permission of the publisher.

"Grandma" is Lady Gregory, co-founder and director of the Abbey Theatre, folklorist, playwright and encourager of artists, and Coole is the Gregory estate in Co. Galway, now part of Gort state forest. She occupied the house and estate from the death of her husband in 1892 until her death in 1932, with the intention of saving them for her grandchildren, but financial difficulties forced their sale and on 20th October 1927 "Mr. Reed, of the Land Commission, and Mr. Donovan, of the Forestry Department, came and formally took over Coole, took possession . . . Giving it into the hands of the Forestry people makes the maintenance and improvement of the woods secure." (*Lady Gregory's Journals* 1916–1930. Ed. Lennox Robinson, 1946.) She remained as a tenant for the rest of her life but after her death the house was sold for demolition.

The best known aspect of Coole is the "autograph tree" in the garden on which eminent established men of letters and artists were invited to carve their initials, successor to a series of fans which Lady Gregory had formerly used as autograph books. Growth and subsequent unsolicited carvings have not added to the value of the tree as a literary relic, and it is arguable that it would be better now to fix what remains rather than allow the living tree to continue its natural efforts to obliterate its wounds.

The old names of the woods, "The Seven Woods of Coole" were kept in use by the forest workers, at least until relatively recently.

In case any degree of callousness in the face of local suffering might be inferred from the last sentence of the passage from *Me and Nu*, it is only fair to add that Lady Gregory's great anger at the activities in general of the Black and Tans, and in particular at the shooting of Eileen Quinn are well documented in her *Journals,* cited above.

Meeting

Forest Fertilization, Paris

F.A.O./I.U.F.R.O.

AN International Symposium on Forest Fertilization arranged jointly between F.A.O. and I.U.F.R.O. was held in Paris from 3rd–7th December 1973. It was attended by about 100 delegates from thirty countries, including five from Ireland.

The symposium was divided into sixteen sessions, each of which considered different aspects of forest fertilization. The more important of these included a review of the effects of forest fertilization on the nutrient cycle, the diagnosis of nutritional disturbances in forest crops, kinds of fertilizers and methods of application, the effects of fertilizers on wood quality and the environment and the economics of forest fertilization.

The general impression obtained from the papers presented and

Three members of the Irish delegation in conversation with STIG HAGNER (*second from left*), Chief Forester of the Swedish Cellulose Association. Dr. Hagner has been responsible for the aerial fertilization of large tracts of S.C.A. forests in Sweden in recent years.

the discussions that followed was that, although a considerable amount of research has been and is being carried out on forest fertilization in different countries, there is still a considerable paucity of data on all the above topics. For instance, the longevity of the effect and the fate of fertilizers within different forest ecosystems is very incompletely understood. This has importance from two points of view, the economic and the environmental. Little quantitative information is available on the effect of different cultural treatments such as thinning, spacing, brashing and soil preparation on nutrient cycling. Further research is also needed to ascertain whether or not wood quality is significantly affected by fertilizer applications. The general opinion seems to be that it is not but that even if it was such factors could be overcome in the manufacturing process.

The symposium, recognising the need for an increased wood production on an ever diminishing land base, put forward the view that the effective use of fertilizers on nutrient deficient forest areas is one of the most promising means of improving timber production and at the same time maintaining or improving the other features of the forest environment. This could only be achieved by a thorough understanding of the complete transformation that takes place on the forest floor, and in the soil, and of the changes in tree metabolism following the addition of fertilizers. More intensive research on many aspects of forest fertilization was therefore recommended.

M. L. CAREY

Notes and News

FOREST RESEARCH INSTITUTE, ZVOLEN, CZECHOSLOVAKIA

In the course of a recent stay in Czechoslovakia I visited the Forest Research Institute at Zvolen, in Slovakia, where I met the Director, Professor Ing. Dušan Zachar and many of his staff. The Institute is responsible for a wide range of forestry research. The research unit of the Institute comprises four departments—each consisting of several divisions. One division is concerned with the cultivation of fast-growing species and is at present testing selected cultivars of black, balsam and white poplars. The Technical Department has produced a forest site classification system on the basis of accessibility and the suitability of the site to various logging and extraction techniques. While in Ireland an ecological basis for site classification might seem more appropriate , the incorporation of factors such as the ease of extraction or suitability for roading would have advantages for management. The Division of Silviculture, one of the oldest in the Institute, has recently devised a system for the regeneration of oak stands and has made recommendations for management of high quality stands.

The Institute has a total of 253 staff (54 scientists). During the period 1968–1972 a total of 123 research projects were completed and about 1,200 research, information and extension papers were published. Outlets for scientific research are well organized by the Institute which publishes a series of periodicals and bulletins. Perhaps of most interest to Irish readers is *Acta Instituti Forestalis* of which four volumes have been published to date (1968, 1971, 1972, 1973). Papers are published in English or German and all carry English summaries. The most recent volume includes a paper on the development of new yield tables for Czechoslovakian forests and an interesting discussion on the co-ordination of multiple use objectives in forest management. Volume 3 (1972) included papers on the effect of root desiccation on the performance of spruce transplants, the effect of spacing on height and diameter growth of spruce stands and the use of fertilizers in forest nurseries. *Vedecké Práce VULH vo Zvolene* (Scientific Works of the Forest Research Institute in Zvolen) is published in Slovak but carries English summaries of all papers. The monograph series *Lesnícke Štúdie* and *Lesnícke Informácie* are published in Slovak or other languages, again with English summaries. Since 1971, game and wildlife research papers have been published in *Pol' ovnícky Zborník* (Game Management Almanac). This is in Slovak with summaries in several languages including German. An English summary is included in another game management publication (*Pol' ovnícke Štúdie*) which appeared for the first time in 1973.

The application of research findings to management operations is considered an important part of the Institute's activities. This is organized systematically and involves the organization of symposia, conferences and training courses as well as direct[consultation and advice. Certain research projects are conducted with the collaboration and involvement of management personnel and a series of publications is issued giving recommendations and guidelines based on research experience.

E. P. FARRELL

INVESTMENT OPPORTUNITY

An advertisement in an English Sunday newspaper last November offered for sale the freehold title to land and trees of 5-acre blocks of 15-year old plantations in Scotland, priced at "from £380 an acre". Further enquiry elicited the name and location of the plantation (Cobairdy Wood Plantation in Aberdeenshire) and the information that they had been planted in 1959 with Douglas fir, Sitka spruce, Norway spruce, hybrid larch and mixed Sitka spruce, Scots pine, European larch and Corsican pine. Photographs of some of the plantations were included in the brochure. Prices "from £380 an acre" were confirmed but with the qualification that "obviously availability at this price is strictly limited". Arrangement of mortgages up to 75 per cent over five years was also offered. The plantations would be managed by the Company under the direction of Dr. Cyril Hart, Senior Verderer of the Forest of Dean.

This is an interesting indication of the increasing attractiveness of forests as an investment opportunity under present inflation and taxation conditions.

SO NOW WE KNOW

The appropriate discount rate in calculating present values of forest costs and revenues for comparison with agriculture continues to be controversial. But why not use the same rate as that claimed by those involved in agriculture? In rejecting the Government's proposals for a wealth tax in April 1974 the Irish Creamery Milk Suppliers Association stated that it was "entirely out of proportion, in that capital invested in agriculture normally yields a return of less than 3 per cent". (*Irish Times,* 2/4/74).

COMMENDABLE SOLICITUDE

In an impressively glossy publication giving details of their proposals on the environmental aspects of the development of the Navan zinc lead mine, the largest base metal deposit of its kind in Europe, Tara Mines Limited, the operating company, state:

"Policy has been to beautify the landscape both for the internal and external viewer. Pleasing surroundings provide a valuable visual therapy for the employee and contribute substantially to company spirit and job satisfaction. Special care will be taken with the design and layout of car parks and pedestrian ways on the site.

"This aesthetic impact will be created more by the use of trees, shrubs, grass and earth mounds than with flower beds of blazing colour, although these will also have their place in the total design. Specific areas will be illuminated at night to add to the total effect and *to ensure an attractive aspect for night shift workers*." (Italics ours.)

JOB QUALIFICATION

The following advertisement appeared in a recent issue of a British forestry journal.

Near Oxford

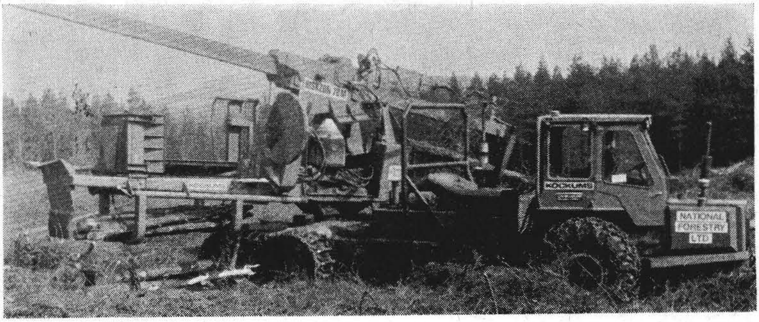
> Experienced single handed woodman required for interesting woodland estate. Excellent house in village. Applications up to the age of 55, please send details of age, experience to:
>
> (Name, Address and telephone number.)

This is not so strange as it reads. Obviously the advertiser had a "bellyful" of two handed woodsmen who told him that on the one hand he could do this and that on the other hand he could do that. Tired of ambivalent, ambidextrous woodsmen, he looked for a single handed woodman that might get things done.

J. D. ROBINSON and G. de BRIT

HARVESTING DEMONSTRATION

A demonstration of timber harvesting equipment was arranged by National Forestry Ltd., Portlaoise, in Rathdrum state forest on 13th March 1974. The equipment demonstrated consisted of a processor, a forwarder and road trailers. The processor, manufactured by Kockum Soderhamn, Sweden, was the most revolutionary and impressive item. Following clear felling, it picks up a whole tree, de-limbs it, saws it into selected lengths, and separates out the pulpwood, which it collects in an underslung basket, all under the control of one operator. (See photograph.) This is understood to be the biggest machine of its kind in these islands, and certainly points the way to the future in the field of timber harvesting. The equipment is available through Cahir House Garages Ltd.



Reviews

TREES AND TIMBERS. Herbert L. Edlin. London, Routledge and Kegan Paul, 1973. Line-drawings and photos, pp. 78. Price £2.

THIS short book would not hold the interest of the adult reader. It is aimed squarely at students of Primary and Secondary school ages and it succeeds admirably in its intention.

Trees and Timbers is one of a number of books in the Local Search Series whose aim is more to stimulate rather than to teach. The main ambition of this book is to guide school children in project works relating to trees and their habitats.

In brief this short volume identifies with the help of excellent line-drawings the more common species of trees. A chapter devoted to woodland vegetation and on the effect which the dominating tree canopy has on such growth forms. Another chapter explains the process of converting a standing crop into commercial lumber. A third chapter skilfully leads the reader from the woodlands of the British Isles into the exotic forests of other lands. One section on "trees in landscape, art and literature" deserves a high degree of praise for its originality. Too few books of a forestry nature attempt to confront this important aspect of trees and forests in relation to human spirituality.

As has been mentioned the author's aim is not primarily to inform but to stimulate in his reader ideas for school projects. A book of this size could not possibly supply adequate answers to all the questions which the author raises. He expects from his readers that they will seek such answers in books of a more specific nature. On a number of occasions perhaps this technique has been carried to a fault: where answers have not been supplied to the most important questions raised, I feel that the author could have been more helpful in suggesting possible sources of information. After all his readership is of a tender age!

In chapter two it is suggested that by counting the number of branch whorls on a pine tree one can estimate the age of the tree. It is not mentioned that this method is only possible with relatively young trees. Omissions of this sort could prove irritating to the serious young reader who may accept such facts as gospel and attempt to apply them in practice.

In conclusion, considering the readership it is aimed at, perhaps this book is rather expensive at £2. However, without hesitation, I would recommend that school libraries consider purchasing a copy of *Trees and Timbers*. It will prove itself a most worthwhile addition to their shelves.

P. MAC OSCAIR

ASPECTS OF FOREST MANAGEMENT. A. Noirfalaise. Council of Europe. 1968.

THIS booklet of twenty-eight pages, subtitled *Ecological consequences of the intensive cultivation of resinous* (sic) *trees in the deciduous zone of temperate Europe*, has just reached us. Although it is stated that "the opinions expressed in this publication are those of the author and do not necessarily reflect the views of the Council of Europe", nevertheless the association with that body require that we at least accord to the booklet the courtesy of careful examination. On doing so we find that it overstates its case to a degree which to any careful and informed reader will do it more harm than good. We find many of the old arguments which we are familiar with from our own "anti conifer" lobby, arguments which should be countered whenever possible in order to reduce, if possible, the very great amount of public misinformation on this subject.

There is hardly a page without a questionable assertion, but space is limited and printing is expensive, so we must limit ourselves to a few examples.

"The growing of conifers . . . can podsolise such soils to a depth of 20 or 30 cm. So what? If conifers grow happily on podsols and greatly outproduce hardwoods why object if they bring the soil into a condition which is more natural for them?

"It is also frequently noted that on such soils there is a drop in productivity from the second plantation onwards." So would there be also under agricultural crops if they were grown without adding fertilizers to replace the nutrients removed by the crop. Presumably the reason that no such drop has been observed under hardwoods is because the production is so low and the rotation so long that it is not worth looking for.

Irish foresters will be interested to read that "it is a well-known fact that plantations are unlikely to succeed when the depth of peat exceeds 100 cm or 40 cm depending on whether the subsoil is sandy and permeable or clayey and impermeable". (Remember Lewis Carroll's Bellman's classification of Snarks: *Distinguishing those that have feathers, and bite, / From those that have whiskers, and scratch.*)

On page 16 we are given a "hypothesis requiring checking", about the relative water consumption of conifers and hardwoods. A paragraph later this has become "initial conclusions" which are "supported in theory by what is known nowadays about the mechanism of water and energy exchange in plant masses".—As nice an attempt at "blinding with science" as you would be likely to meet with in a day's walk.

But perhaps the kernal of the matter may be found in the statement that "nature can be commanded only by obedience to her laws". This is a craven and defeatist attitude. The essence of civilization is the overcoming of natural laws and instincts, and the subjection of natural processes, through understanding, to the rational will of mankind.

N. O'CARROLL

OTHER PUBLICATIONS RECEIVED

A survey of cutover peats and underlying mineral soils, Bord na Mona Cnoc Dioluin group, by T. A. Barry, M. L. Carey and R. F. Hammond. Soil Survey Bulletin No. 30. Published jointly by Bord na Mona and An Foras Taluntais. (To be reviewed in our next issue.)

The open forest. A guide to areas open to the public. Forest and Wildlife Service, 22 Upper Merrion Street, Dublin 2. (A county by county guide to state forest properties open to the public with notes on location and special features, and concluding with a "country code". More than 300 areas are listed.)

Future utilisation of peatland in Ireland. Agricultural Science Association, 21 Upper Mount Street, Dublin 2. (The report of a sub-committee.)

FORESTRY COMMISSION PUBLICATIONS

Booklet No. 37. *Volume tables for smallwood and round pitwood*, by G. J. Hamilton, 12p.

Forest Record No. 88. *Cold storage of forest plants*, by R. M. Brown, 22p.

Forest Record No. 88. *Cold storage of forest plants*, by R. M. Brown, 22p.

Research and Development Papers (Unpriced)

No. 98. *International Norway spruce experiment at The Bin, Huntly forest, Aberdeenshire. Results up to twenty-five years*, by R. Lines.

No. 99. *Inventory provenance test with Norway spruce in Britain: first results*, by R. Lines.

No. 100. *Check list of Forestry Commission Publications, 1919-1973*, by P. Mayne.
No. 101. *Flushing time for Norway spruce*, by A. B. Lewis and R. Lines.
No. 102. *Production planning in the Forestry Commission*, by D. R. Johnston.
No. 104. *Public demands on forests in relation to forest wildlife*, by Judith J. Rowe.

Society Activities

WEEKEND MEETING BASED AT CARRICK-ON-SHANNON

Saturday, *29*th September *1973*: Lough Key Forest Park. Leader: Mr. John Duane.

Sunday, *30*th September *1973*: Drumkeeran Forest. Demonstration and discussion of findings on forest production potential as part of a resource survey of Co. Leitrim. Leaders: Dr. G. Gallagher, Messrs. J. Dillon and M. Bulfin.

EVENING MEETINGS

Friday, *30*th November *1973*: Wicklow's deer populations, by Mr. Rory Harrington. R.D.S. Dublin.

Friday, *22*nd February *1974*: Forest growth potential on Leitrim soils, by Dr. G. Gallagher, Messrs. J. Dillon and M. Bulfin.

Obituary

ALFRED LEONARD
1904–1973

Alfie, as he was affectionately known to all inside and outside the Forest Service, will best be remembered for his great fund of general knowledge and his keen awareness of the world of nature around him. He loved the Irish countryside. He was botanist, biologist, ornithologist, ecologist, dendrologist, silviculturist etc. all rolled into one. As if by intuition, he was first to hear the cuckoo's call in early summer, hf saw the first swallow, the rare stonecrop, the pine marten on his rare appearance, the regeneration of a shy species like Cryptomeria, the phenomena in the geology of his limestone crags, the slightest damage by a late frost. A great champion of the natural forest, the hardwoods and the European conifers his classic species and the Scotch foresters his idols. His keen discernment in the use of those species, is plainly evident in the great tract of tree clas land between the great lakes and known to us as Cong Forest. "Everything in its place and a place for everything".

Essentially a family man, his interest centred mainly in his home, his family, his flowers and shrubs and, of course, his gem of a garden where, like Raftery's Killeadon, he had "sméar a's sughcraoibh ann a's meas ar gach sórt". Of a pleasant disposition—likeable—he could always come up with some colourful utterance and interweave some subtle bit of humour in his conversation at the most unexpected place. He could, when occasion demanded, be very direct and forthright in manner and have very decided views on management of his forest.

Like many of the early recruits to the new Forest Service he arrived on the forestry scene with a good knowledge and background of trees and timber, growing up as he did among the woods and gardens of Mount Hazel in his beloved Ballymacward.

One of the early group who trained under Paddy Barry and Neil Diver at Baunreagh, he spent a year at home after training. Next we meet him assisting the late Mickie Swords in Newtownbarry, Gilbert McCool in Glen of Imaal and back again as foreman to the students in Emo Park. He was in charge of Durrow Forest in the early thirties and after stints at Glenmalure, Glendalough, Ballymahon and Aughrim (twice), he arrived in Cong in 1941—the youngest Head Forester in Ireland at the time.

Always a man to probe deep into his chosen subject, we find him joining the Royal Scottish Forestry Society tour in the summer of

'33 and visiting such well-known estates as that of Sir George Campbell and in later years sending rare species to Kew Gardens for identification and frequently corresponding with the late Curator of the National Botanic Gardens about such subject matter as the seven (known to him) variations of Lawson Cypress at Cong.

Let the splendid woods he left behind be a living testimony and witness to his memory.

To his wife and family we render our deepest sympathy.

Go ndéanfaidh Dia trócaire air".

T. DE GRUINEIL

Erratum

Irish Forestry, Vol. 30, No. 2, 1973

p. 69 For 1973 read 1972.

p. 70 Lines 33-35 should read: Although these three features appear useful in determining red x sika deer hybrids in Wicklow, red-deer-like hybrids may be impossible to identify in the field in areas where introgression is incomplete

Most of the addresses on page 119 of *Irish Forestry*, Vol. 30, No. 2, were misplaced. The following is a corrected list of those which were in error.

Fahy, Finian	"Fuinseog", 12 Ballymany Park, Newbridge, Co. Kildare.
*Fahy, Mrs. Margaret	"Fuinseog", 12 Ballymany Park, Newbridge, Co. Kildare.
Fahy, Hugh	Forestry Office, Bellview Estate, Delvin Road, Mullingar, Co. Westmeath.
Fahy, Joseph	Fathbaun Road, Castlebar, Co. Mayo.
Fahy, Philip	Sharonra House, Donegal Road, Ballybofey, Co. Donegal.
Fallon, Patrick J.	13 Lower Sunnyhill, Killarney, Co. Kerry.
Fanning, James	High Street, Graiguenamanagh, Co. Kilkenny.
Farmer, Charles I.	Leskey, Boho, Co. Fermanagh.
Farragher, Gerard	Glebe House, Crossmolina, Co. Mayo.
Farrell, Dr. Edward	Soils Department, U.C.D., Glasnevin, Dublin 9.
Fee, Frank	Beach Road, Ballycastle, Co. Mayo.
Feeney, T. J.	Dowra Road, Drumshambo, Co. Leitrim.
Fennessy, John	41 Foyle Road, Fairview, Dublin 3.
Finnerty, A. M.	Tree Tops, Bailieboro, Co. Cavan.
Finnerty, Patrick	Pearse Road, Sligo.
FitzPatrick, H. M.	Nuns Cross, Ashford, Co. Wicklow.
FitzPatrick, J.	Tollymore Forest Park, 176 Tullygrannigan Road, Newcastle, Co. Down.
Flanagan, Eamon S.	Greenhall, Carrigtwohill, Co. Cork.
Flanagan, John	c/o Brennan's, Bunclody, Co. Wexford.
*Flannery, Michael	Clonoola, Greystones, Co. Wicklow.
Fleming, Jerry	Rosslea Road, Clones, Co. Monaghan.
*Flood, Donal T.	97 Seafield Road, Clontarf, Dublin 3.
Flynn, John	17 Leahy's Terrace, Sandymount, Dublin 4.
Flynn, Patrick	6 Westgate, Bishopstown, Cork.
Fogarty, Michael	Woodford, Loughrea, Co. Galway.
Forde, Michael	Dowra Road, Drumshambo, Co. Leitrim.
*Franklin, Sean	Avonbeg, Shandangan, Pallasgreen, Co. Limerick.
Freeman, Joseph	Circular Road, Sligo.
Friel, Brendan	c/o Mrs. Morris, Abbeystown, Boyle, Co. Roscommon.
*Fuller, Thomas	Grianan, Skibbereen, Co. Cork.
*Furlong, Lily	"Silverne", 150 Clontarf Road, Clontarf, Dublin 3.

Founder Members in black type
Associate Members marked with asterisk


£35.00 an acre—
For TREE PLANTING!
MORE — for scrub clearance
— planting hardwoods
FREE — advice; booklet
WRITE — Forest and Wildlife Service
Department of Lands, Dublin2