Vol. 38, No. 2, 1981

IRISH FORESTRY

JOURNAL OF THE SOCIETY OF IRISH FORESTERS

ISSN 0021 - 1192

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1981, Volume 38, No. 2.

Published twice yearly. Price £2.

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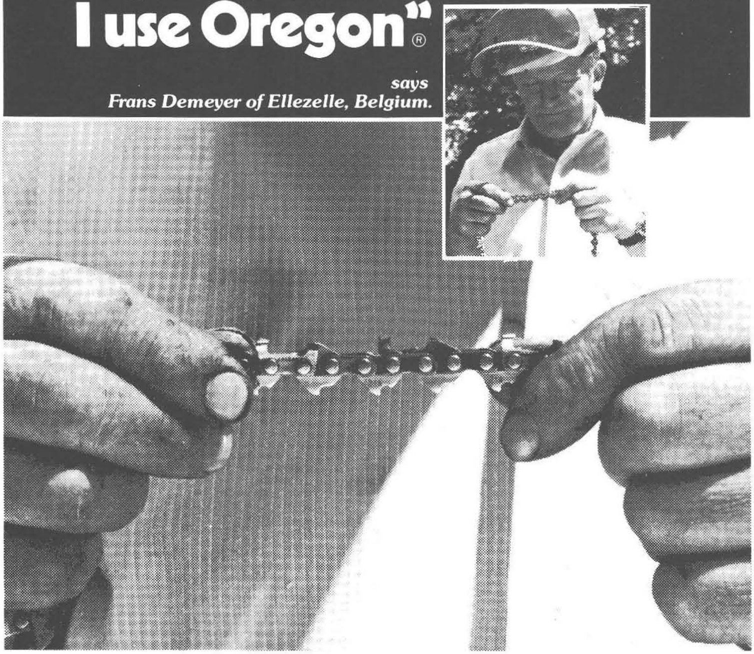

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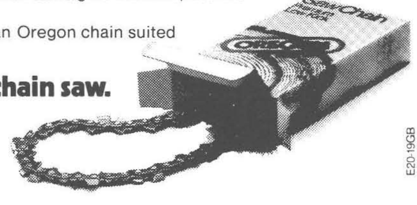

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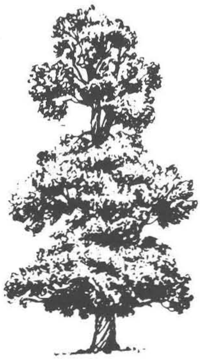

JOURNAL OF THE SOCIETY OF IRISH FORESTERS

1981, Volume 38, No. 2.

Notes for the Assistance of Contributors

The following notes are designed to aid the speedy processing of scientific contributions to the journal. Authors should comply with them in so far as this is possible.

1. Two copies of each paper should be submitted, in typescript, with double spacing and wide margins.

2. Diagrams and illustrations should be clearly drawn in black ink on good quality paper. Captions should be written on the back of each illustration. Illustrations, wherever possible, should be drawn in an upright position (x axis narrower than y). The approximate position of diagrams and illustrations in the text should be indicated in the margin.

3. Tables should not be incorporated in the body of the text, but should be submitted separately at the end (one table per page). Their approximate position in the text should be indicated in the margin.

4. Nomenclature, symbols and abbreviations should follow convention. The metric system should be used throughout.

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8. Reprints can be supplied as required by the author. The cost of reprints will be charged to the author at a standard rate per page. *Reprints must be ordered when returning corrected proofs to the editor.*

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Note: The opinions expressed in the articles belong to the contributors

Cover: Springtime in Abbeyleix Woodlands

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Printed by the Elo Press Ltd., Dublin 8, Ireland

Council

of the

Society of Irish Foresters

EDITORIAL

Rally Round the Flag

This issue of *Irish Forestry* and the preceding one (Vol. 38, No. 1) are the slimmest to take their places on member's bookshelves for many a long year. While obviously a smaller journal offers less to its readers, the standards established in presentation and material have been maintained. The reason for cutting back is one of money. Subscription rates are too low. Since the last time they were increased, in 1977, costs have risen two and a half times (Irish Forestry, Vol. 38, No. 1, p. 49, minutes of 39th A.G.M.). The problems facing the Society are common to all similar societies. there is a reluctance to increase subscriptions to more than is patently required to meet expenses. Constitutional constraints impose a considerable delay on the implementation of a decision to increase them. Together these factors are enough in times of rapid inflation to tip the balance from black to red remarkably quickly.

Most members are by now aware of the increase in subscriptions for 1982. The increase is large but in terms of todays cost of living the price is small and value for money is given. What the Society needs now is loyality, a commitment to its future. If the Society of Irish Foresters is worthy of support, if the continuance of its most expensive activity, the publication of the journal is worthwhile then give it your support. If, on the other hand, you feel that the journal does not meet member's requirements, then let us know. You have a forum either at the A.G.M. or through the letters page of the journal.

The Society needs you now. Give it your support. Contribute to improve it if you will. But don't, whether through lethargy or the initial shock of a subscription increase let your participation fall by the wayside of indifference.

The Society of Irish Foresters

The Society of Irish Foresters was founded in 1942 to advance and spread in Ireland the knowledge of forestry in all its aspects.

The main activities of the society centre around:

(a) Annual study tour

(b) Indoor and field meetings on forestry topics

(c) Production of two issues annually of Society's journal "Irish Forestry"

(d) Annual Forest Walks held on 2nd Sunday of September

There are three types of membership:

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Submissions to the journal will be considered for publication and should be addressed to: Dr. E. P. Farrell, Editor, Irish Forestry, Department of Agricultural Chemistry and Soil Science, University College, Belfield, Dublin 4. The attention of contributors is drawn to "Notes for the Assistance of Contributors" on page 56.

Sales and advertising are handled by: Mr. J. Fennessy, Business Editor, 29 Ardmore Lawn, Bray, Co. Wicklow. Tel. 01-867751.

Sitka spruce or lodgepole pine?

A financial appraisal

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ABSTRACT

Problems arise in growing Sitka spruce on certain deep peat and Old Red Sandstone derived mineral soils due to lack of available soil nitrogen. Results from a number of experiments show that the species responds well in growth to nitrogen application in these situations. The object of this study was to make a financial comparison between growing Sitka spruce, using fertiliser nitrogen, and lodgepole pine which grows vigorously without any inputs of nitrogen. Japanese larch/Sitka spruce mixtures are also included in the appraisal.

The results suggest that the economics of growing pure crops of Sitka spruce on impoverished O.R.S. mineral soils using fertiliser nitrogen are questionable. Lodgepole pine or Sitka spruce/Japanese larch mixtures would appear more attractive options. However, the lower nitrogen inputs necessary to sustain production on some peat soils, and the lower production potential of the lodgepole pine, result in the spruce being the far more attractive option under certain circumstances, particularly if the price of nitrogen does not increase in real terms. The larch/spruce mixture appears an attractive proposition on O.R.S. mineral soils.

INTRODUCTION

The extension of afforestation in recent years in the Republic of Ireland on to increasingly difficult land has resulted in a sharp decline in the area being planted with Sitka spruce (*Picea sitchensis* (Bong.) Carr) and in a corresponding increase in area of coastal lodgepole pine (*Pinus contorta* var contorta loud). Whereas Sitka spruce comprised 66% of the total planting programme in 1973, the figure had dropped to just under 43% in 1980 (Fig 1).

This change in attitude is a reflection of the quality of the land concerned and its assumed problems in relation to the successful establishment and growth of Sitka spruce. Although the species can be successfully established on a wide range of site types, provided adequate phosphorus is applied at planting, both research and

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management experience showed in the nineteen sixties that growth fell off gradually after a period of years in many areas due to nitrogen deficiency.A condition known as "check" frequently developed. O Carroll (1962) commented: "Most of our Sitka spruce on peat seems to be living a life only bordering on the healthy".

The reason for this was partly because the initial quantity of phosphorus applied (usually about 30kg/ha) was inadequate to sustain growth and because it was spot rather than broadcast applied. As a result, most of the crops in this category were given a broadcast application of rock phosphate (92kg P/ha) in the late nineteen sixties and early nineteen seventies. This had a positive effect on growth in most situations except on the very impoverished sites where increment fell off again after a period of 3 to 5 years. This condition usually developed on soils derived from Old Red Sandstone (O.R.S.) where *Ulex gallii* was absent, certain unflushed (oligotrophic) blanket peat soils and on midland raised bogs. It was usually caused by nitrogen deficiency and was very often accentuated by the presence of heather which is known to adversely affect the uptake of this element (Handley, 1963).

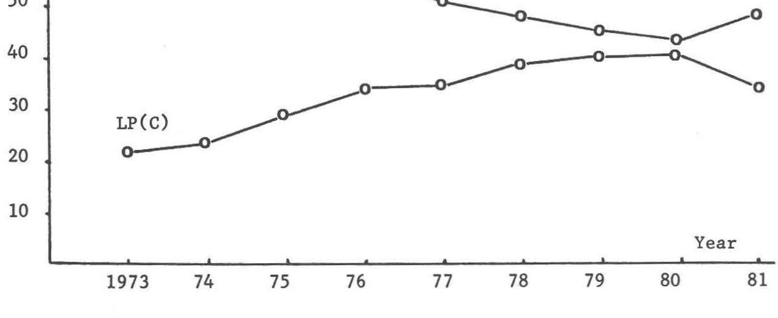


Fig. 1 Percentages of total area planted by the Forest and Wildlife Service with Sitka spruce (SS) and coastal lodgepole pine (LP(C)) 1973-1981.

Because of these experiences it is not surprising that attitudes changed and tended to favour the less demanding lodgepole pine. Despite the low availability of soil nitrogen, this species grows vigorously, provided adequate phosphorus is applied at planting time (Carey, 1981b). However, although the choice of lodgepole pine involves a lower input regime, providing what is now considered an excellent raw material at the end of the rotation, some concern has been expressed in recent years with regard to certain aspects of the species. This includes the problem of basal sweep, susceptibility to wind and snow damage, the Pine Shoot Moth and the recent outbreak of the Pine Beauty Moth in Scotland. These risks, together with the nutritional problems associated with growing Sitka spruce, result in the forest manager being faced with a dilemma in relation to the choice of species on the sites concerned.

In recent years a considerable amount of research has been carried out on the nutrition of Sitka spruce on both deep peat and O.R.S. derived soils. The basic problems of nitrogen availability have not yet been solved on a practical scale but research in progress would suggest that they can. However, enough knowledge has been gathered to enable a financial comparison to be made between the cost of growing Sitka spruce using fertiliser phosphorus and nitrogen and coastal lodgepole pine using phosphorus only. The aim of this paper is to present the results from such a study and in so doing to provide a more rational basis for choosing between the two species.

FERTILISER INPUTS

General

Phosphorus, applied as ground rock phosphate at a rate equivalent to about 500kg/ha (72.5kg P/ha), is essential in order to ensure good establishment and growth of both species on the sites concerned. Although further inputs of P may be necessary on some sites there is no reason at present to suspect that these will differ for either species.

Sitka spruce

The problem areas for Sitka spruce have, in general, been associated either with mineral soils derived from O.R.S. or raised or blanket bog peat soils. Although extreme variation occurs between and within these groups in relation to both soil chemical and physical characteristics, they all present the same basic problem in relation to the growth of Sitka spruce, lack of available nitrogen.

Research in recent years has shown that there are a number of broad site types which differ significantly in their requirements in this respect:

O.R.S. mineral soils: Results from experiments in a number of State forests have shown that nitrogen application is essential in the third year after planting in order to sustain vigorous growth unless a nitrogen fixing species such as *Ulex gallii* is a dominant feature in the vegetation. Large responses in growth are obtained in such instances to nitrogen application the magnitude of which is increased further where competing heather (if present) is eradicated through spraying. Although the optimum rate of application appears to be in the order of 200-220kg N/ha, the growth response appears to last only about 3 years after which the trees generally return to a checked condition unless nitrogen application is repeated.

Blanket peats: It is now established that Sitka spruce will grow vigorously after broadcast application of phosphate on a wide range of blanket peat sites for at least eight years, often up to ten or twelve years, before inputs of nitrogen are required. Some shallow peat areas, (say less than 1 metre deep), found in association with knolls or hillocks tend to show check symptoms somewhat earlier, probably because heather tends to be more vigorous in these drier situations compared with the deeper peat areas.

The response of slow growing or checked crops of Sitka spruce on high level blanket bog to fertiliser nitrogen is as striking as that found on O.R.S. derived mineral soils but the effect appears to last longer — up to five years, depending on the amount applied (Carey, 1980). In two experiments at Mullaghareirk and Newmarket State forests, the growth rates achieved correspond with those for yield class 18-20 of the Forest management Tables (Hamilton and Christie, 1971).

Although the quantity of nitrogen needed on peatland sites needs further refinement, the present recommendation would be similar to that for the O.R.S. mineral soils, 220kg N/ha. However, it would seem possible to extend the application cycle from three to five years.

Midland Raised Bogs: The situation on midland raised bogs would appear rather similar to that on high level blanket bogs. Heather control is desirable in about the fourth growing season after planting and, if carried out properly, is likely to delay the onset of nitrogen deficiency.

Cutaway Bogs: Substantial areas of peatland — particularly the raised bog type — have been cut over for fuel in Ireland over the last two centuries. In general these are highly productive forest soils, although problems may arise locally with Sitka spruce due to strong heather competition and/or copper deficiency. Because these are the exception, this site type is not considered further herein.

Application of fertiliser potassium to spruce plantations is a relatively common practice on certain peat soils in Britain (McIntosh, 1981) but significant and worthwhile responses to this element have so far only been found in the Republic of Ireland on either fen peats (O Carroll, 1966) or on flushed mesotrophic blanket peats carrying a dense sward of *Molinia*. Because it is most unlikely that either fen or mesotrophic peat will require inputs of nitrogen it is assumed for simplistic reasons that potassium application will not be needed on the sites discussed herein. Where it is needed, its cost will be more than offset by those included for nitrogen inputs.

In this study allowance is made for the basic differences that have emerged in recent years on the requirements of these broad site types. Because it is unclear at present whether nitrogen application will be necessary after canopy closure in order to sustain growth, separate calculations are presented for both possibilities i.e. nitrogen application at fixed intervals up to the end of the rotation and nitrogen application up to canopy closure. This question concerning fertiliser inputs following canopy closure is a key one and, although there is little hard information on it at present, evidence throughout the world suggests that most of the nutritional requirements may be satisfied through recycling at this stage of crop development. The poor response of polestage crops of Sitka spruce both in Britain and Ireland to fertiliser inputs in experiments over the last decade would support this hypothesis although few of these were in fact located on deep peat soils.

Lodgepole pine

No further fertiliser inputs other than P are envisaged at this point in time for lodgepole pine. Although potassium deficiency symptoms are a common feature on many young crops on peatland, the response to K application in general on the sites concerned does not justify the cost involved. This may be a function of both the extent of the maritime influence and the ability of the species to intercept K from the rainfall (Carey & O Carroll, 1981).

PRODUCTION

Sitka spruce:

The best guide to potential production for any given site must be existing healthy crops in the area concerned showing no nutrient deficiencies. The forest inventory books serve as an ideal data source in this respect. The average Yield Class for the species in the country as a whole is in the region of 16. Provided soil factors are not limiting (e.g. lack of N, P or K), Yield Classes of 18-20 plus seem attainable on a wide range of sites at elevations below about 250m. (This latter figure is by no means absolute and can be considerably affected by other site factors).

Lodgepole pine:

Evidence from many areas suggests that lodgepole pine can attain a Yield Class between 12-16 (occasionally 18) on the site types in question unless some factor such as elevation becomes a limitation. The mean Yield Class for the species in the Republic of Ireland is currently 12 and a survey of inventory records for 35 State forests known to be dominated by either O.R.S. mineral soils, blanket peat soils or raised bog soils gave mean Yield Classes of 12, 11 and 14 respectively for crops planted between 1958 and 1968. The calculations presented include data for a range of Yield Classes from 12 to 18 thereby enabling the manager on the ground to decide what option corresponds most closely to the average production in his area.

METHODS AND ASSUMPTIONS

Economic Methods: The usual method for comparing two or more silvicultural options is that known as net discounted revenue or N.D.R. In this approach all costs and revenues are discounted at a set rate of interest to year 0. Subtraction of one from the other gives the N.D.R. This can be negative or positive depending on the actual costs and revenue figures involved and the interest rates used. The N.D.R. figures can then be used as basis for comparison between the various options. It was decided to use a discount rate of 6% in these calculations. Lower interest rates are commonly used in forestry calculations of this kind. However a subsequent sensitivity test on the data using a 4% interest rate showed that the same conclusions emerged. The actual figures in each case were multiplied by the "infinite rotation adjustment factor" which allows for the N.D.R. for an infinite number of future rotation.

Assumptions: In order to calculate the N.D.R. for any treatment option certain assumptions must be made both with regard to the actual costs that are likely to accrue during the rotation and on the revenues that will arise from sales of timber. Data on costs were based on the most up to date available in January 1981 from F.W.S. Work Study Section. These are of necessity *average* data, the actual figures being very dependent on the nature of the site etc. Costs for fertiliser nitrogen represent the average retail prices pertaining in January 1981 for the country as a whole. Other assumptions made were as follows:

1. That a single application of 500kg of rock phosphate/ha at establishment is sufficient to ensure a production of 12-18m^3/ha/annum for lodgepole pine and that no further fertiliser additions will be necessary during the rotation.

2. That rotation lengths for Sitka spruce will be 20% less than the age of maximum mean annual increment for the yield class concerned. In the case of lodgepole pine final felling year will be equal to the age of maximum mean annual increment. This is in line with current policy on rotation lengths for both species and is influenced in the main by marketing considerations.

3. That all fertiliser materials will be applied from ground spreaders or by hand. Aerial application would very likely reduce costs in favour of the spruce options.

4. That stability or form is not affected by any of the treatment options.

5. That volumes produced correspond to those given in the British Forestry Commission Management Tables (Hamilton and Christie, 1971) for Sitka spruce and Forest and Wildlife Service Tables (Anon, 1975) for lodgepole pine. The Stand Assortment Tables (Hamilton and Christie, 1971) were used to quantify the amounts of timber in each category. It was also assumed that, because of basal sweep in the lodgepole pine, 20% of the sawlog category would be downgraded to boxwood and 5% of the latter to pulpwood. Finally, two variations on the current average price structure were tested in order to see what effect if any this would have on the end result:
   (i) a 10% reduction in sawlog and increase in pulpwood prices from £1.50 to £4.00/m^3
   (ii) a 20% reduction in sawlog and a 100% increase in pulpwood prices.

6. That timber prices are similar for both species and are as follows:
   Pulpwood, Top Diameter $<$ 14cm £1.50/m^3
   Boxwood, Top Diameter 14-20cm £10.50/m^3
   Sawlog, Top Diameter $>$ 20cm £24.50/m^3.
   These prices are based on January 1981 average data.

7. The cost of nitrogen: One of the major imponderables in a calculation of this kind rests in possible future trends in the price of nitrogenous fertilisers. This uncertainty, in association with a widespread belief that nitrogen prices were tied to oil prices, has contributed in no small way towards the decision to plant more lodgepole pine. In fact nitrogen prices have decreased significantly relative to the retail price index in the Republic of Ireland over the past 10 years (see Table 1) and it is highly unlikely that they will show a substantial increase in real terms in the foreseeable future. This is because energy costs account for only about 25 per cent of fertiliser costs and also because there is at present an excess of urea manufacture in particular, on the world market. Many countries besides Ireland have become committed to this industry in recent years and are unlikely to cease manufacture in the foreseeable future. In these calculations two

assumptions have been made in relation to the price of nitrogen fertiliser:

(a) That there will be no real increase in the prices of nitrogen over and above the rate of inflation.

(b) That the price of nitrogen will rise by 6% per annum in real terms.

8. Management costs common to the different options are excluded.

Options tested:

1. The yield classes tested for lodgepole pine were 12, 14, 16 and 18 and for Sitka spruce 16, 18, 20 and 22 except where stated using either SMB or DMB ploughing.

2. Sitka spruce. Phosphate at planting. SMB ploughing (or ripping). Nitrogen (N) application, 220kg N/ha (as urea[1]), and heather control year 4 and N application every 3 years thereafter (O.R.S. mineral soils and some shallow blanket bogs).

3. Sitka spruce. As in option 2 but N application only up to year 16.

4. Sitka spruce. Phosphate at planting. DMB ploughing. Heather control year 5. N application at year 10 and every 5 years thereafter. (Raised bog and high level blanket bog situations).

5. Sitka spruce. As in option 4 but N application only up to year 15.

6. Sitka spruce. Phosphate at planting. DMB ploughing. Nitrogen application at year 8 and every 5 years thereafter. Low level blanket bog.

7. Sitka spruce. As in option 6 but N application only up to year 13.

8. Sitka spruce/Japanese larch 50:50 mixture in lines.[2] Heather control year 4 and N application to the spruce only at year 4 and 8 (O.R.S. soils). Assume Yield Class 8 for JL and 16 or 18 for Sitka spruce.

9. Sitka spruce/Japanese larch 50:50 mixture. No treatment other than phosphate (peat soils). Assume Yield class 8 for JL and 18 for Sitka spruce.

Note: 1. Experiments to date show that urea and calcium ammonium nitrate are equally effective on the range of sites concerned. The former is preferred because of lower transport costs.

Note: 2. Treatments 8 and 9 were included because of the well established nursing ability of Japanese larch for Sitka spruce (see O Carroll, 1978). Recent observation suggests that N application and heather control may be essential in the earlier years for the spruce in O.R.S. situations.

Table 1: Retail price index in relation to the cost of fertiliser nitrogen 1970-1980 (Source: Nitrigin Eireann Teoranta).

Year	1970	1980
Retail Price Index	100	259
Cost of nitrogen	100	150

RESULTS

Data on net discounted revenues for the various options and assumptions in relation to production and the price of nitrogen are presented in Table 2. These are relative rather than absolute data because of the exclusion of management costs common to the various options. Because the type of ploughing varies with the nature of the ground. (O.R.S. v deep peat), data are included for both SMB and DMB in the lodgepole pine option. A flowchart guide to the use of the data in Table 2 in selecting between the species is shown in Figure 2.

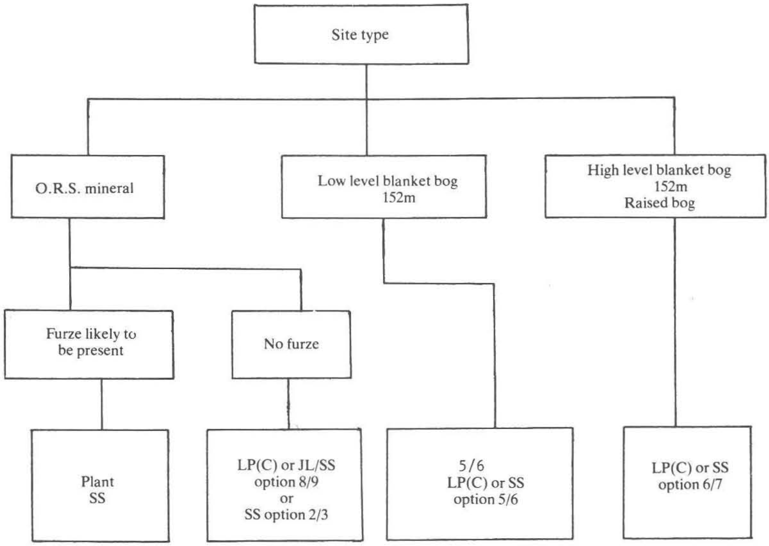
Net discounted revenues for the lodgepole pine options vary between £162 (Yield Class 12, SMB) and £815/ha (Yield Class 18, DMB). If it is assumed that there will be no *real* increase in the price of nitrogen it is apparent that a crop of lodgepole pine Yield Class 16 is more profitable than a crop of Sitka spruce Yield Class 18. Also a crop of lodgepole pine, Yield Class 18, is generally an economically better proposition than even Sitka spruce at Yield Class 20. However, the number of sites on which lodgepole pine production exceeds of Yield Class 16 seem to be the exception whereas Yield Classes of 18 to 20 are common in Sitka spruce. For this reason the data presented in Table 2 suggest very strongly that Sitka spruce, grown with the aid of fertiliser nitrogen, may be a far more profitable option than the pine with the exception perhaps of the O.R.S. sites. Spruce would still remain highly competitive and in many situations better than the lodgepole pine up to a 6% real increase in nitrogen prices.

Table 3 shows the effect of varying sawlog and pulpwood prices for the different options tested. When the price of sawlog falls by 20% and the price of pulpwood increases to £3/m^3, all the NDRs drop in value. However, this disimprovement is more acute in the higher yield classes for both species. If the price of sawlog only falls by 10% and the price of pulpwood increases to £4/m^3, then all the pine options become more economic than at the prices presently pertaining. Essentially speaking, however, the variations in NDRs

Table 2: Net Discounted Revenue for each option, Yield Class and N price assumption. (£/ha). Discount rate: 6%.

Option	YC m³/ha	Cultivation		N price increase assumption % 0	6
		SMB	**DMB**		
1. LP	12	162	219		
	14	377	434		
	16	596	653		
	18	758	815		
2. SS	16	SMB/Ripper		–188	–718
N+2,4-D	18	SMB/Ripper		98	–433
yr. 4+N every 3 yrs.	20	SMB/Ripper		400	–132
	22	SMB/Ripper		710	177
3. SS. N+2,4-D	16	SMB/Ripper		–37	–186
Year 4+N every	18	SMB/Ripper		250	100
3 yrs up to yr 16	20	SMB/Ripper		550	400
	22	SMB/Ripper		860	710
4. SS. 2,4-D yr 5 and N	16	DMB		149	–145
at yr 10 and every	18	DMB		436	141
5 yrs	20	DMB		736	444
	22	DMB		1047	753
5. SS. 2,4-D yr 5 and	16	DMB		238	166
N at yrs 10 and 15	18	DMB		524	452
	20	DMB		825	753
	22	DMB		1135	1063
6. SS. N at yr	16	DMB		155	–185
8 and every 5 yrs	18	DMB		442	101
	20	DMB		742	401
	22	DMB		1053	712
7. SS. N at yrs 8	16	DMB		266	202
and 13	18	DMB		552	488
	20	DMB		853	789
	22	DMB		1163	1099
8. SS/JL	**SS JL**				
	16 8	SMB/Ripper		176	156
	18 8	DMB		222	202
N+2,4-D yr 4 and	18 8	SMB/Ripper		296	276
N yr 8 to SS only	18 8	DMB		342	322
9. SS/JL	18 8	SMB/Ripper		398	ND
No N or 2,4-D		DMB		443	

N=Not determined.



* Option numbers refer to the data for N.D.R. presented in Table 2.

Examples: 1. Potential yield class 16 for LP and 18 for SS both species (based on inventory records for adjacent stands). Site type O.R.S. with no furze (*Ulex*).
N.D.R. in Table 3 is £653/ha for LP and £98 or £250 for SS.

2. Potential yield class 20 for SS, 14 for LP (from inventory records). Site type low level blanket bog.
N.D.R. in Table 3 is £434/ha for LP and £742 or £853 for SS.

Fig 2 Simplified flowchart guide to decision making in species selection between LP(C) and SS* caused by varying the prices for the different timber categories do not alter the previous conclusions in relation to the profitability of either species.

In general the NDR data for the Japanese larch/Sitka spruce mixture tend to be lower than those for most of the other treatment options. This is a result of the low yield class associated with the larch component in the mixture which essentially reduces the overall production to about $12m^3$/ha/annum, depending on that achieved by the spruce. However, on O.R.S. mineral soils in particular, the mixture appears more profitable than Yield Class 18 Sitka spruce grown on its own using regular inputs of fertiliser nitrogen. On peat soils, the mixture is far less profitable than Yield Class 16 lodgepole pine. However, if the potential Yield Class of the site for the pine is less than 14 then the mixture deserves serious consideration.

The question of whether inputs of nitrogen will be essential after canopy closure has a major effect on the results for the various spruce options for obvious reasons. If nitrogen application can cease at between 13 and 15 years, without adversely affecting production, then Sitka spruce would in general appear a far more attractive species in money terms.

DISCUSSION

Because of the many assumptions made herein, the results, must of necessity, be interpreted with caution. Nevertheless, they do provide a good indication of the relative profitability of both species for the broad site types described and, when used in combination with local production data from inventory books, their reliability should improve considerably. For instance, if the General Yield Class for the particular species in adjacent properties or compartments to that in question is 14 or 16 or 18, then it can be reasonably assumed that similar rates of production are achievable, provided the nutritional needs are satisfied.

On site types with a potential Yield Class of 16-18 for lodgepole pine, and where nitrogen inputs would be essential to grow Sitka spruce, the results in general endorse the increase in popularity of lodgepole pine in recent years. However, such sites are the exception and of the 35 forests referred to earlier in relation to inventory records only 3 had a mean Yield Class for this species of 16 or more. These were all on lowland sites probably dominated by raised bog soils. Twenty forests had a mean Yield Class for the

Table 3 The effect of varying sawlog and pulpwood prices on the NDR for a selected number of options (No nitrogen price increase and constant boxwood prices) £/ha.

Option	YC m^3/ha	Current Prices Sawlog £24.50 Pulp £1.50 /m^3	Sawlog (–20%)=£19.60 Pulp (+100%)=£3.00 /m^3	Sawlog (–10%)=£22.05 Pulp (+166.6%) =£4.00/m^3
1. LP	14 DMB	434	386	473
	SMB	377	329	416
	16 DMB	653	579	681
	SMB	596	521	524
	18 DMB	815	719	837
	SMB	758	661	780
2. SS Nitrogen+ heather control at yr. 4 & N every 3 yrs thereafter	18 SMB/R*	98	–8	121
	20 SMB/R	400	248	410
	22 SMB/R	710	510	700
3. SS Nitrogen + heather control at yr. 4 & N every 3 yrs up to yr 16	18 SMB/R	250	143	273
	20 SMB/R	550	400	562
	22 SMB/R	860	661	851
4. SS N at yr 10 and every 5 yrs thereafter	18 DMB	436	330	460
	20 DMB	736	578	738
	22 DMB	1047	832	1020
5. SS N at yr 10 and 15	18 DMB	524	418	548
	20 DMB	825	666	827
	22 DMB	1135	921	1108

R=Ripper

species equal to or less than 12. The data suggest that it is difficult to justify the planting of the pine in such situations, assuming the spruce attains Yield Class 18 or more although crops of LP(C) planted since 1968 may tend to have a somewhat higher Yield Class than those established in earlier years due to increased phosphorus fertilisation. However, on peat soils in particular, and in situations where higher levels of production can be attained, say Yield Class 20-22, Sitka spruce would appear to be a far more profitable option, regardless of whether nitrogen inputs are required. Although a figure of 22 may appear high, this figure is now being exceeded in the early years in a number of young (7 yr old) experiments on both blanket and raised bog sites which have so far only been given a broadcast application of rock phosphate. The Sitka spruce growing in the recently publicised tunnel plough experiment at Glenamoy forest (O Carroll, Carey, Hendrick and Dillon, 1981) has a Yield Class at age 19 of between 18 and 22. This is growing on typical low level Atlantic blanket bog and has not received any fertiliser nitrogen, nor is it likely to need any.

One of the major difficulties associated with species selection is to pinpoint those sites on which nitrogen deficiency will be a limiting factor. Although the problem may appear clearcut on O.R.S. mineral soils it is often confounded by the so far unpredictable invasion of certain sites by *Ulex gallii,* which, when it occurs, will more than likely satisfy the total nitrogen economy of the stand. On peat soils, the differences between those site types requiring and not requiring nitrogen are also difficult to identify and, until the present generation of fertiliser trials are more advanced, and relevant soil analytical methods are developed, local knowledge will remain the most reliable guide. However, when judging the performance of existing crops cognisance must be taken of their past history. Most of the checked areas of Sitka spruce visited for advisory purposes in recent years, for instance, were either spot treated with rock phosphate initially or were missed out entirely due to uneven application of the fertiliser material. This underlines the importance of evenness of fertiliser spread and similar arguments apply to the control of heather. *The treatment must be done properly if it is to be effective.*

Much of the experience with Sitka spruce on peatland sites was obtained during the era of spot application of fertiliser phosphate. The change over from spot to broadcast fertilising in the late nineteen sixties has had a profound effect on the development of the native vegetation and on the incidence of check on a wide range of site types. Whereas spot fertilising with rock phosphate and ploughing favoured the development of heather, where it was initially present, broadcast fertilising very often tilted the balance in favour of a *Molinia/Eriophorum* dominated sward. Because of the problems associated with heather, broadcast fertilising therefore resulted in a considerable improvement in many areas in site fertility for Sitka spruce.

The main argument put forward against planting more Sitka spruce instead of lodgepole pine centres around the extra cost that may be incurred as a result of having to purchase more chemicals and/or fertilisers. In small economies subject to tight constraints on cash flow at periodic intervals, lodgepole pine may be the safer option, provided that some of its associated diseases and pests do not get out of control. Others argue against the use of nitrogenous fertilisers on the grounds of an alleged pollution hazard. The quantities of nitrogen suggested herein are between 10 and 15 per cent of those used by grassland and tillage farmers, and recent indications are that the amounts concerned can probably be reduced. The energy equation in which a high energy product such as urea is applied to a low energy raw material, wood, has also been questioned. A simple calculation will show that the difference in total production at age 40 between Yield Class 16 and 20 Sitka spruce is about $180m^3$/ha. In energy terms this is equivalent to about 17 tonnes of urea/ha. Although not redeemable until the end of the rotation, this is of far greater magnitude than the amounts suggested here as being necessary for O.R.S. and peat soils to grow Sitka spruce, (5.0 and 1.3 tons/ha respectively).

The final controversial issue associated with the choice between the two species centres around the greater susceptibility of Sitka spruce to windblow because of its shallower rooting habit, particularly on deep peat soils where the watertable in the early years, following conventional ploughing, is seldom below 30cm. Although there is little evidence yet of windblow in spruce plantations in such situations, this may be a function of the small areas of deep peat that have been planted with the species and also because few if any crops have reached a top height greater than 12-14 metres. However, this extra risk must be seen in the context of the poor form in many plantations of coastal lodgepole pine. It can probably be reduced by tunnel ploughing as suggested by O Carroll *et al* (1981).

The final decision on species selection rests with the forest manager. This paper is nothing but a first attempt at putting more rationale into the decision making process. With time, and more research on the inputs required by both species, and on their production capabilities on different site types, it is hoped to put more refinement into the process.

ACKNOWLEDGEMENTS

The ideas presented are based in part on results from fertiliser trials in both species, on general observation and in conversation with both management and research personnel in recent years. Mr. B. Maloney and Mr. E. Quinn supplied information on costs. The assessments in the fertiliser trials referred to were carried out by Mr. T. Hogan, Mr. M. Davornen, Mr. T. O'Sullivan, Mr. A. Buckley and Mr. J. Hogan. Mr. T. Layton and Mr. D. O'Brien assisted in the computation of the data.

REFERENCES

ANON, 1975. Revised Yield Tables for Coastal Lodgepole pine. Forest and Wildlife Service, Dublin, Unpubl.

CAREY, M. L., 1977. Nutritional disorders in Sitka spruce in the Republic of Ireland. Irish Forestry 34(1). 40-46.

CAREY, M. L., 1980. Research Report. Forest and Wildlife Service, Dublin. In press.

CAREY, M. L., 1981a. Nitrogen problems in the afforestation of soils derived from Old Red Sandstone. Soil Science Society of Ireland. Symp. University College, Dublin. Unpubl.

CAREY, M. L., 1981b. Why plant lodgepole pine? Society of Irish Forestry Symp. on Lodgepole pine — what is its future. Unpubl.

CAREY, M. L. and O'Carroll N., 1981. Potassium accretion by *Pinus contorta* on oligotrophic peat in the West of Ireland. Plant and Soil. 60(3)473-475.

DAVIES, E. J. M., 1979. High input prospects, Scottish Forestry 33(2) 120-132.

DICKSON, D. A., 1977. Nutrition of Sitka spruce on peat — problems and speculations. Irish Forestry 34(1). 31-39.

HAMILTON, G. J. and CHRISTIE, J. M., 1971. Forest Management Tables. Forestry Commission Booklet No. 34. 201pp.

HANDLEY, W. R. C., 1963. Mycorrhizal associations and calluna heathland afforestation. Bull. For. Comm. London 36.

McINTOSH, R., 1981. Fertiliser treatment of Sitka spruce in the establishment phase in upland Britain. Scottish Forestry 35(1) 3-13.

O CARROLL, N., 1962. Peatland afforestation in the Republic of Ireland. Irish Forestry 19(1) 93-101.

O CARROLL, N., 1966. Growth check of Norway spruce and Scots pine. Irish Forestry 23(2). 36-41.

O CARROLL, N., 1978. The nursing of Sitka spruce. 1. Japanese larch. Irish Forestry 35(1). 60-65.

O CARROLL, NIALL, CAREY, M. L., HENDRICK, E. and DILLON, J., 1981. The tunnel plough in peatland afforestation. Irish Forestry 38(1). 27-40.

The Native Sawmilling Industry and Irish Forestry[1]

Sawmilling and the Economy

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VOLUMES AVAILABLE FROM STATE FORESTS

The Irish people have invested heavily over the past 50 years in the creation of a forest estate. The results of their sacrifices are now coming to fruition in the form of increasing volumes of wood coming on the market. The volumes in Table 1 will be available for harvest in the coming decades.

It can be seen that between 1980 and 1990 the availability of sawlogs (down to 20 centimetres top diameter) from State forests will increase by 283 per cent. The average annual compound growth rate in the availability of sawlogs and pulpwood combined will amount to 9.7 per cent over the 10-year period.

Lumber (by which I mean sawlogs and boxwood) in 1980 will comprise 54 per cent of the wood available from State forests, and this will increase to 57 per cent in 1990 and 68 per cent by the year 2000. Thus lumber is already the largest component, by volume, of wood available from State forests, and this predominance will increase.

More recent projections of wood availability have the effect of increasing the volume available in earlier years, and reducing the amount in later years.

1 An earlier version of this paper was presented at the Annual General Meeting of the Irish Home Grown Timber Merchants Association, Dublin, December 11, 1980.

IRISH FORESTRY, 1981, Vol. 38, No. 2: 78-91

Table 1: Wood Harvest Projections, State Forests, Ireland.

	Volume (000s M^3)				
Year	Sawlog	Boxwood	Sawlog and Boxwood	Pulpwood	Total
1979 (Actual)	60	172	232	86	318
1980	185	182	367	311	678
1985	289	275	564	523	1086
1990	524	405	929	694	1623
1995	675	577	1252	836	2088
2000	1237	814	2051	974	3026
2010	1707	1109	2816	1136	3952

Note: These are more conservative in the early years than more recent projections prepared in 1979.

Source: Irish Forestry Policy; NESC Report No. 46; Govt. Publications, Dublin, 1979, p. 214.

State Revenue Implications

The market for all types of wood raw material, including lumber, is at present depressed, due primarily to the impacts of the recession. Prices in 1980 for standing timber-based on timber merchants' estimates — seem to be about £17.5/M^3 and £10.5/M^3 for sawlog and boxwood respectively; if we assume that these will apply in the future we can project the following gross revenues:

	Gross State Revenue (000s 1980 £)		
	Sawlog	Boxwood	Total
1985	5057	2887	7944
1990	9170	4252	13422
1995	11813	6058	17871
2000	21648	8547	30195

Thus, in 20 years time lumber sales will be yielding more than £30 million (1980 £) to the State treasury.

Employment

It is notoriously difficult to make employment projections in any area which is exhibiting dramatic growth. Making some rather crude assumptions regarding output increases per cubic metre per worker per year, I estimate that the following employment will be generated by the harvest, transport and processing of sawlogs and boxwood from State Forests (Table 2).

There will be, in addition, at least 35,000 M^3 of sawlog size coniferous material available from private lands, which will, using the employment intensities noted above, add 118, 91 and 63 jobs respectively in 1980, 1990 and the year 2000.

Table 2: Employment Projections Generated by Sawlogs and Boxwood from State Forests.

Year		Harvest	Transport	Mill	Total Employment
	M^3/Worker/Yr.	833	6250	500	
1980	Volume (000s M^3)	367	367	367	
	Employment	441	59	734	1234
	M^3/Worker/Yr.	1200	7000	720	
1990	Volume (000s M^3)	929	929	929	
	Employment	1000	133	1290	2423
	M^3/Worker/Yr.	1500	7500	1000	
2000	Volume (000s M^3)	2051	2051	2051	
	Employment	1367	273	2051	3691

Sources: *Irish Forestry Policy,* NESC Report No. 46, and Industry Sources.

Balance of Payments

It is interesting to look at the pattern of coniferous sawnwood imports (Division 24321 pre 1978 and div 24821 post 1978 in the Trade Statistics) since 1973 (Table 3). We can see that, after the 1974 peak, the real (net of inflation) average price dropped sharply over the next five years and is still below the 1973 level (Fig. 1).

In 1980 sawn coniferous imports accounted for 0.75 per cent of total imports in recent years (Table 4). Sweden's share held fairly steady at about 30 per cent of total imports in 1977, '78 and '79, but fell back to 24 per cent in 1980 and 23 per cent in 1981. Finland increases its share from 30 per cent in 1977 to 43 per cent, 40 per cent and 41 per cent in 1978, 1979 and 1980, but fell back to 35 per cent in the first four months of 1981. Canada's share fell from 30 per cent in 1977 to 15-21 per cent in 1978-'80, but this increased to 29 per cent in early 1981.

Table 3: Imports of Coniferous Sawnwood, 1973-1981

Year	Quantity (Metric Tons)	Value (Current £)	Value/M.T. (Current £)	CPI (1968=100)	Value/M.T. Constant (1968 £)
		('000)			
1973	168,766	12,761	76	150.8	50
1974	232,492	26,511	114	176.4	65
1975	121,793	14,334	118	213.2	55
1976	190,242	23,239	122	251.6	48
1977	190,629	27,377	144	285.9	50
1978	223,113	30,214	135	307.7	44
1979	270,423	42,844	158	348.4	45
1980	211,662	40,500	191	411.9	46
1981[1]	57,753	12,513	217	461.6	47

1 January-April.
Note: 1 metric ton=1.85 M^3 of sawnwood.
Source: *Trade Statistics of Ireland,* successive December issues, and issue for April 1981.

The sharp fall in the price of Finnish timber from 1977 to 1979 relative to Swedish imports may explain in part the growth in Finland's market share over the 1977-80 period. The widening price advantage which Canadian wood has been showing contributes to its recent increase in the share of the Irish import market (Fig. 2).

Since Irish and Canadian wood compete to some extent in the same markets, the fact that in early 1981 Canadian lumber, at £37 per metre tonne (1968 £) was at its lowest level in the 1977-'81 period, is indicative of the difficult market conditions now being faced by Irish sawmills.

The overall picture is now clear: a rapid increase in the availability of sawlog size wood raw material will allow expansion in domestic output, at a compound annual average growth rate of almost 10 per cent over the coming decade; this in turn will allow employment to increase to 2400 by 1990 and approach 4000 in the year 2000. Annual State revenues (1980 £) from sawlog and boxwood sales can grow from £7.9 million in 1985 to £30.2 million in the year 2000. However, to achieve this level of output will require that Irish timber be able to initially capture a predominant share of the domestic market and then export successfully.

Table 4: Major Sources of Sawn Coniferous Imports, by Volume and Value (1968 £), 1977-1981.

		Sweden	Finland	USSR	Canada	Total	Grand Total
	Volume (M.T.)	57513	57777	10663	57685	183638	190614
	Value (000s £)	8424	9147	1690	6766	26027	27370
1977	Value/M.T. (current £)	146	158	158	117	142	144
CPI=285.9	Value/M.T. (1968 £)	51	55	55	41	50	50
	Percentage of Grand Total (by volume)	30	30	6	30	96	
	Volume (M.T.)	68229	95351	13535	33435	210550	222450
	Value (000s £)	9948	12577	1652	3946	28123	30103
1978	Value/M.T. (current £)	146	132	122	118	134	135
CPI=307.7	Value/M.T. (1968 £)	47	43	40	38	44	44
	Percentage of Grand Total (by volume)	31	43	6	15	95	
	Volume (M.T.)	74906	107157	15406	53762	251231	270423
	Value (000s £)	12680	15900	2425	7476	38481	42844
1979	Value/M.T. (current £)	169	148	157	139	153	158
CPI=348.4	Value/M.T. (1968 £)	49	42	45	40	44	45
	Percentage of Grand Total (by volume)	28	40	6	20	93	
	Volume (M.T.)	50870	86483	12565	46108	196026	211662
	Value (000s £)	10650	15754	2708	7602	36714	40500
1980	Value/M.T. (current £)	209	182	216	165	187	191
CPI=411.9	Value/M.T. (1968 £)	51	44	52	40	45	46
	Percentage of Grand Total (by volume)	24	41	6	22	93	
	Volume (M.T.)	13390	20343	1845	16590	52168	577513
	Value (000s £)	3275	4654	463	2833	11225	12513
1971[1]	Value/M.T. (current £)	245	229	251	171	215	217
CPI=461.6	Value/M.T. (1968 £)	53	50	54	37	47	47
	Percentage of Grand Total (by volume)	23	35	3	29	90	

1 January to April.
Note: 1 Metric Ton=1.85 M^3 of sawnwood.
Source: Successive December issues of *Trade Statistics of Ireland* and the April 1981 issue.

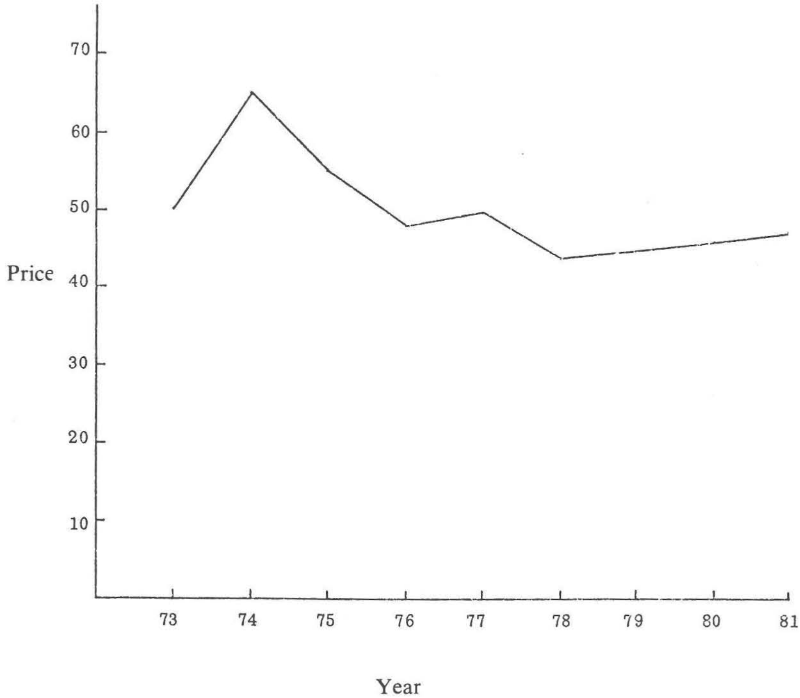

Fig 1 Average Price per Tonne of Imported Sawwood. (Constant 1968 £).

Source: Table 3.

FUTURE MARKETS

For 1979, multiplying metric tons of imports from Table 3 by 1.85 yields M^3 of sawnwood; multiplying this in turn by 2 will yield a crude estimate of volume of roundwood equivalent in M^3. Adding State sales of 232,000 M^3 to an estimated 35,000 M^3 from private lands results in the following (Table 5).

It is not known how much of the 1.1 million M^3 (roundwood equivalent) is technically substitutable by Irish wood. If we make the (probably conservative) assumption that 70 per cent of this market could be met by Irish wood, we can see that there exists domestically a 700,000 M^3 (roundwood equivalent) market for Irish timber, based on 1979 consumption levels. The joint IIRS/Forest and Wildlife Service study of the sawmilling industry provides a

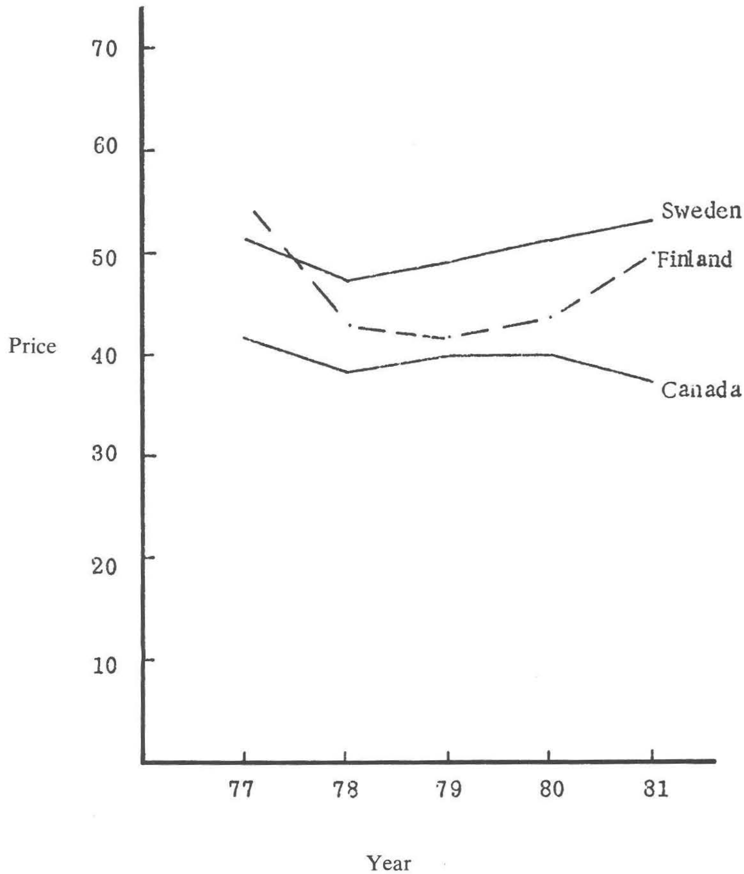

Fig 2 Average Price per Tonne of Imported Sawwood from Sweden, Finland and Canada. (Constant 1968 £).

Source: Table 4.

much more detailed review of the markets for 1977 (Table 6). It is clear that the best opportunity for expansion is in the construction sector, and the IIRS/FWS projected a 20 per cent annual growth rate in the penetration of native timber in this market, with sales to this sector growing from 97,000 M^3 (roundwood equivalent) in 1977 to 420,000 M^3 in 1985.

We are now in a position to make a few observations on the symbiotic relationship between the sawmilling sector and forestry.

Table 5: Apparent Softwood Lumber Consumption, Imports and Domestic Production, 1979.

	Apparent Lumber Consumption 1979	
	Roundwood Volume, 000s M^3	% of Total
Imports	1001	79
Domestic		
State	232	18
Private	35	3
Total	267	21
Grand Total	1268	100

Source: Tables 1 and 3.

Table 6: Irish Market for Sawn Softwood Timber, 1977 000s M^3 of Roundwood Equivalent.[1]

End Use	Total Apparent Consumption	% of Total	Native Timber Quantity	% of Total	Share of Market held by Native Timber
Construction	725	72.5	97	44	13
Pallets & Packaging	67	6.7	53	24	79
Fencing	62	6.2	48	22	78
Furniture	39	3.9	2	1	6
DIY	25	2.5	2	1	9
Miscellaneous	82	8.2	18	8	21
Total	1000	100	220	100	22

1 The original IIRS/FWS data are converted to roundwood equivalents by multiplying by 2; this is misleading for some end-uses, but facilitates comparison with data in Table 5.

Source: Institute for Industrial Research and Standards and Forest and Wildlife Service Study of the Irish Sawmilling Industry.

SAWMILLING AND FORESTRY

1. The sawmills now provide outlets for more than half of the output of our forests and this proportion will grow over time.
2. Sawmills provide the bulk of the revenues to both the State and private forests.
3. Employment per unit of wood processed will typically be greater in sawmills than in other processing units.
4. Sawn wood has a large domestic-substitution market, mainly in construction.

It is clear that the profitability of the State forestry enterprise in Ireland depends crucially on a thriving sawmilling sector. We can anticipate that the industry will be able to achieve economies of scale and possibly reduce log haulage distance as a result of the rapid increase in wood raw material availability. The interesting questions are; will the industry be able to capture the bulk of the domestic construction and other markets and thereafter export successfully into the highly competitive British market? On a closely related theme, will the Forest and Wildlife Service transfer the wood to the industry in the quantities and in a manner that will ensure a prosperous sawmilling sector, and at the same time protect the interests of the resource owners (the taxpayers)? The future of Irish Forestry depends on how we in the forestry community act on these issues.

FOREST PRODUCTS DEVELOPMENT BOARD

With regard to the first, in my NESC study I suggested the formation of a Forest Products Development Board (FPDB) which would have on its staff people with expertise in wood marketing, harvesting, forest products, industrial processes, product development and marketing. The Board would have responsibility for developing and implementing wood utilisation plans, for deciding on the wood sale methods, for sponsoring product research and development and for market development. Clearly, many of these functions are being, or could be, undertaken already by the Forest and Wildlife Service, the Institute for Industrial Research and Standards, the Industrial Development Authority, and Coras Trachtala. However, I feel that there would be a real payoff to concentrating responsibility for these assignments in one organisation which is given sufficient resources and freedom to do the job on a continuing basis. This unit could draw on skills in other Government and private agencies as required. In the NESC report I discuss various means of linking the Forest Products Development Board with the Forest and Wildlife Service.

I feel that the real competition in the lumber scene is about to begin. We're facing long-standing experienced producers in a very competitive environment, and we've simply got to take full advantage of every opportunity to give ourselves a competitive edge. It might well be asked, why should Government intervene? Will the market not guide sawmillers and others to the most efficient allocation of resources? I envisage the Forest Products Development Board as a complement to market forces, not in any sense as a means of thwarting them. In market efficiency terms the case for the Board can be made as follows:

(i) The State in a real sense makes the market for stumpage (standing trees); within wide limits the Forest and Wildlife Service can move this stumpage price up (and down) by contracting (expanding) the volume of wood on offer. (This circumstance where one seller faces several buyers is called monopsony in economics parlance). Since the Government is one of the primary determiners of market price, it behoves it to know and be capable of evaluating the full implications for downstream activity of its marketing choices.

(ii) The price of standing wood is a residual — what is left after the costs of processing, transport and harvesting have been netted out of the product sale price. It follows that it is in the State's immediate (commercial) interest to encourage the achievement of both premium prices for mill output and reductions in cost of harvesting and processing; much of the benefit resulting therefrom will be reflected in stumpage price.

(iii) The competition — Sweden, Finland and Canada — all have the benefit of strong experienced marketing organisations, backed by a base of State-supported research (basic and applied) and development work. This also applies to a lesser extent to domestic substitutes for wood. The *Roadstone Book of House Design* provides a very attractive and sophisticated vehicle for selling the use of various materials in house construction; native timber does not feature prominently therein.

Stumpage Marketing

Two separate issues arise regarding the disposal of State-owned stumpage — the quantities which are to be put on the market, and the manner in which these are sold. Taking each of these in turn:

Quantity: As noted earlier, the State, with a near monopoly of wood supply, is, withing wide limits, a market price setter. If it sees the price falling below "target", it can contract supplies and move the price upwards; likewise the upward movement of price can be dampened by increasing the volume of wood placed on the market. The ceiling price is set of course by the competition from imports for the end products. What should be the appropriate role of forestry policy in this situation? It seems to me that it is appropriate for Government to play a countercyclical role, but within clearly specified limits. Thus the *range* of stumpage within which the quantity made available annually will fall should be established; except in exceptional circumstances, the volume offered should be within this range.

It is interesting to compare projected availability in 1979 with actual sales (000s M^3).

	Projected Volume[1]	Actual Sales	Difference	Difference as % of Actual
Sawlogs	192	60	132	220
Boxwood	190	172	18	10
Total	382	232	150	65

1 This is a much more conservative projection than that prepared in 1979, which estimated an availability of 344,000 and 215,000 cubic metres of sawlogs and boxwood respectively in 1979.

Overall, projected exceeded actual volume sold by 65 per cent; the excess was a dramatic 232 per cent for sawlogs, but only 10 per cent for boxwood.*

I want to emphasise that no large policy conclusions can be drawn by examining one year's data. All kinds of good reasons could explain the difference, such as, for example, the collapse of the pulpwood market, which would reduce the volume of associated sawnwood being sold.

* Sales in 1980 amounted to 120,000 M^3 and 151,000 M^3 of boxwood and sawlogs respectively. Projections for 1980 were 182,000 M^3 and 185,000 M^3, so that projected sales of boxwood and sawlogs exceeded actual by 52% and 23% respectively.

Furthermore, when the current stumpage price estimates provided by timber merchants are compared with those obtaining in July-December 1977, we don't find evidence to support the hypotesis that the State is capturing real price increases by restricting supply.

	Sawlogs Price/M^3		Boxwood Price/M^3		CPI
	Current	Constant (1968 £)	Current	Constant (1968 £)	
1977	15.99	5.49	6.83	2.35	291.25
1980	17.50	4.15	10.50	2.49	421.8

We can see that over the period real sawlog price has declined, while boxwood price shows a slight increase. I emphasise that too much should not be made of the apparent implications of selectively chosen statistics of this nature. What I do want to stress is that we need to devote far more attention than heretofore to developing policy concerning the *quantity* of stumpage to be placed on the market by the State over time, and the price implications thereof. I turn now to stumpage sale methods.

Stumpage Sale Methods: Given that the State has decided to dispose of x thousand cubic metres of stumpage annually, how should this material be allocated among prospective users? It is well to recognise that the interests of the general taxpayers and the individual mill can be antagonistic. The mill wants the wood as cheaply as possible; the taxpayers are trying to maximise the return on their investment by getting the best price.

We have, up to now, depended almost exclusively on price to allocate wood among competing users; this has been effected by the use of sealed bids. I am strongly in favour of continuing to use price as the primary allocation mechanism; the user who can pay the most for the material should generally get it. However, I recognise that there is sometimes a balance to be struck between maximising net benefits in the short and the long run and that there can be in addition non-market considerations involved. The large increases in volume becoming available provide an opportunity to test alternative wood disposal mechanisms. In my NESC report I discuss a number of alternative approaches. I recommend that these be tested carefully so as to yield information on the most satisfactory mix of marketing strategies to adopt.

Summary and Conclusions

The softwood sawmilling industry has the potential for becoming one of the most dynamic sectors in the economy over the next two decades. Sawlog and boxwood volumes becoming available from State forests will increase from 232,000 M^3 in 1979 to 929,000 in 1990 and 2,051,000 in the year 2000.

State stumpage revenues will increase (applying 1980 prices) to £13.4 million in 1990 and £30.2 million in the year 2000 (1980 £). Employment in harvesting, transport and processing can be expected to grow from about 1200 in 1980 to close to 4000 in the year 2000.

In 1979 softwood lumber imports amounted in value and quantity to £42.8 million and approximately 1 million cubic metres of roundwood equivalent respectively; it was estimated conservatively that native timber could technically substitute for about 70 per cent of these imports. However, with over 2 million cubic metres of sawlog and boxwood available by the year 2000, it is clear that over the next two decades Ireland will have become a major sawnwood exporter, unless there is a sharp increase in domestic consumption.

Finland, Canada and Sweden are now our major suppliers. In the 1977-80 period Finland increased market share in part by a fall in price. In early 1971 Canadian lumber, much of which competes directly with native supplies, appeared to be doing likewise. The increasing volumes of wood becoming available should help the industry achieve economies of scale in production and reduction in log haulage distances.

To help the industry take full advantage of the opportunities before it, I recommend:

(i) The establishment of a Forest Products Development Board, with responsibility authority and resources to support the industry by preparing and then implementing wood utilisation plans, by sponsoring or undertaking product research and development, and developing wood markets. This can be justified on the part of the State because most of the net value added to wood product price will recrue to the wood owner (the State), and our competition has comparable back-up services.

(ii) A policy on the range within which the quantity offered for sale will typically fall from year to year.

(iii) Carefully monitored experimentation of alternative sale methods, with a view to arriving at the optimum sales method mix.

The Irish sawmilling industry is on the threshold of great things. I believe that the kind of steps which I have outlined can help ensure that the entire forestry business, from growing the trees to marketing the final product, will prosper.

Forest Clearance and Land Use in Mayo around 3000 B.C.

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SUMMARY

For thousands of years man inhabited the post-glacial forests of Europe but it was not till the advent of farming that his impact on the forest becomes significant. Stone axes are the most widespread if tenuous evidence of early forest exploitation. Because of special circumstances in the west of Ireland the actual landscape of the Stone Age farmers is still available for study. The discovery of extensive land enclosure under blanket bog which must have been preceded by major forest clearance is changing our view of the nature and scale of early farm settlements in Ireland.

FOREST EXPLOITATION BY HUNTERS

The earliest direct evidence for tree felling with stone axes in these islands is the felled birch tree still preserving the axe marks on its tapered end which was discovered on the excavation at Star Carr in Yorkshire (Clarke, 1954). Radiocarbon dates indicated that the site was used by hunters about ten thousand years ago. A number of crude stone axes which presumably were used for tree felling were also found on the excavation. Organic material such as wood will not normally survive to be recovered on excavation but numerous stone axes from other sites do point to an exploitation of the forest and its products. Outside of Ireland the intact forests of Europe maintained a limited human population whose economy was based in part at least on the exploitation of the large herbivorous animals; wild cattle, elk, red deer, pig and roe deer. It is difficult to determine what contribution plant foods of the forest made to the diet but it is known that hazelnut shells are very common finds on sites of this period. It is thought that because they can be stored so readily hazelnuts may have been a standby food for times of emergency.

IRISH FORESTRY, 1981, Vol. 38, No. 2: 92-100

Settlements of this pre-farming period (8000 to after 4000 B.C.) are rare in Ireland and those sites which are known are almost invariably beside water and suggest fishing rather than hunting communities. The explanation for this contrast between Ireland and elsewhere in Europe could be the very limited forest fauna present in Ireland. Of the five large herbivorous mammals named above which were commonly hunted elsewhere, only the red deer and wild pig were present in Ireland and it would seem that a hunting economy based on such a specialised resource was not viable here.

The post-glacial forests of Europe remained virtually intact from human interference for over four thousand years until the arrival of farming communities sometime after 4000 B.C. Farming demanded land on a large scale and forest clearance must have been one of the major tasks during the initial colonising of new territory. Throughout western Europe there has for long been clear evidence for this human impact on the forests both from botanical studies and more indirectly, from archaeological material. Pollen analyses of peat samples show major reductions in tree pollen coinciding with the expansion of grassland, of weeds of cultivation such as plantago and the certain evidence of man, the pollen of the exotic foods, wheat and barley which, in Western Europe, have to be the result of man's activity.

Forest Clearance by Farmers

The main archaeological evidence for forest exploitation and clearance is the well recorded occurrence of polished stone axes. The production and trading of axes on a massive scale and over great distances show not alone a great demand for these forest tools but a sophisticated and organised society where such production and trading was possible. In the south of England for example, deep flint mines were sunk in the chalk rock to extract the raw flint. The axes were firstly roughly chipped from the flint and then laboriously polished on a grindstone. At a number of sites in western Britain metamorphic rock was quarried and worked in the same way to produce the main artifact of the stone age farming period — the polished stone axe. At these sites axes were produced in large quantities vastly in excess of what was required locally and they were traded extensively from these axe factories.

Stone axes are very common finds in Ireland and are the products of numerous small "factories". One major factory has been identified in north Antrim on the slopes of Tievebulliagh mountain. Roughly blocked-out axes of Tievebulliagh rock have been found in their thousands on the mountain and within a ten mile radius. The finished products — the polished axes of Tievebulliagh rock — are found over much greater areas. Tievebulliagh axes have been found as far southwest as Co. Limerick and even more surprisingly in southern England in Kent and Dorset (Mitchell 1976, 121). The distribution of the partially worked and the complete products suggests that the Tievebulliagh quarry was exploited by communities within a ten mile radius who in a few minutes could roughly block out the axe at source to minimise the weight to be transported from the mountain and who then completed the processing of the axes by many hours of grinding at their home bases. It is less clear how the finished products were dispersed so widely — but the most commonly held view is that their dispersal is the result of trading or gift exchange.

Experiments carried out with polished stone axes show that they are quite effective for cutting trees even in the unskilled hands of the modern experimenter. Iversen (1956) showed that a 30cm diameter tree could be cut down in 30 minutes using such an axe.

THE CLEARED LANDSCAPE

Up to recent years it was usual to consider the early farmers as having practised a shifting agriculture, clearing small areas of the forest and after the fertility of the soil had been used up, moving on and allowing the forest to regenerate itself. This view of early farm settlements has been radically altered in recent years by research into the Stone Age landscape of Co. Mayo (Caulfield 1978).

Mayo offers a unique set of circumstances for the study of land use by these early farmers. Northwest Mayo is covered by the most extensive tract of blanket bog in Ireland. Radiocarbon dates have established that this bog had commenced growing well before 2000 B.C. The landscape beneath the bog is therefore very much the landscape as it existed for the early farmers "put on ice" by the blanket bog for over four thousand years. It was known before the landscape research began that north Mayo was intensively settled by early farming communities as their characteristic tombs — the megalithic court tombs — occur in great numbers here.

Research by the writer in recent years in north Mayo has recorded other more pertinent evidence of landscape use at over sixty sites in the region. Ordinary stone walls and clay fences, exactly similar to the stone walls and fences in use in the area today have been uncovered under blanket bog throughout north Mayo. These walls are built on the mineral soil and predate the growth of bog. They must date therefore to some time in the Stone Age before

2000 B.C. What makes Mayo such a rich source of information in regard to study of the early landscape are the following:

1. The region was intensively settled in Stone Age times as can be shown by the megalithic tombs and the field boundaries which are so widespread here.

2. The early man-altered landscape was fossilized by having a deep growth of blanket peat form over it.

3. Much of the blanket peat in the area has been and is being cut away by hand for fuel and this provides massive free excavation and access to the early landscape under two metres of peat.

When the bog has been cut away for fuel stone walls appear on the mineral soil often as no more than intermittent rows of stones. The main reason for this is that the walls tend to be largely covered up by the top sod or "scraw" which is not burnt and is discarded onto the cutaway surface every year. Formal archaeological excavation at three sites — at Carrownaglogh near the Ox Mountains by Professor Michael Herity and at Behy/Glenulra and Belderg Beg on the north Mayo coast by the writer — have shown that sizeable well built walls lie virtually intact under the blanket bog.

Of the three sites excavated and surveyed Behy/Glenulra is the largest even though its full limits were not established. The site lies on the shoulder of a hill which ends in the sheer cliffs at Céide. This hillside includes portion of the townlands of Behy and Glenulra. The hillside was covered to a depth of 1.5-2.0 metres of peat but in this century turf banks have been cut over an area approximately 800 metres by 12-1300 metres in extent. Fig 1 shows the plan of the early settlement discovered in the cutaway bogs. A number of distinct monuments occur within this Stone Age landscape. "A" is a court tomb excavated by the late Professor R. de Valera, Dr. Seán Ó Nualláin and Professor Michael Herity (de Valera and Ó Nuall ain, 1964). "B" is an enclosure about 25 metres across excavated by the writer which produced pottery, flint implements and a stone axe, all objects which could be compared closely with those from the Stone Age tomb. A number of other enclosures were located in the cutaway bog but were not excavated. As evidence of what a Neolithic farmed landscape must have looked like however, the most important results were achieved by the survey of exposed walls in the cutaway bogs. Nine roughly parallel walls spaced 150-200 metres

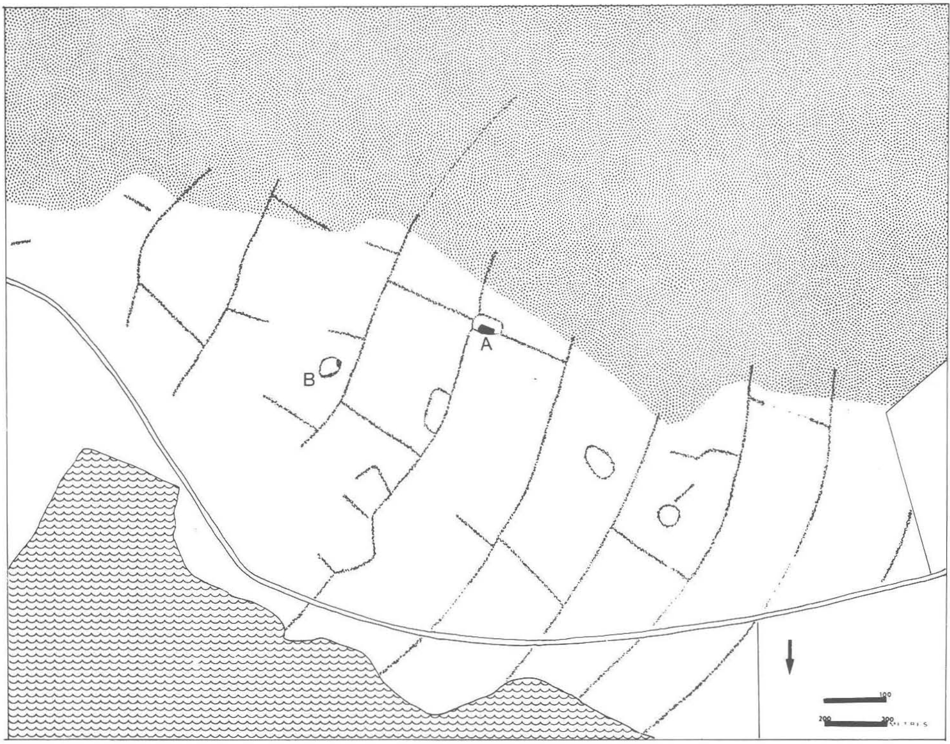

Fig. 1 Behy/Glenulra pre-bog farm settlement. A. Behy court tomb. B. Glenulra enclosure. Strippled area at top indicates uncut blanket bog.

apart were built from the cliff edge inland for an unknown distance. All of these walls continued into uncut bog so their limits could not be readily traced. However it would seem that the settlement still to be traced under the uncut blanket bog is at least as extensive as that already surveyed. The long parallel immediately to the right of the excavated enclosure was traced for a distance of almost 300 metres by probing with a long iron probe through the two metres of blanket bog. Also, other walls are visible in erosion gullies about a half a mile to the south of the cutaway bogs which suggests that the settlement is a least twice as large as the $1km^2$ already surveyed. The strips of land formed by the long parallels are divided by offset cross walls into large rectangular fields. Only at one location at bottom centre is there a more irregular pattern of smaller fields.

It is obvious that the older view of early farmers (clearing small patches in the forest and then moving on after a few years) cannot be reconciled with the permanency and scale of settlement which this plan represents. The plan is witness to an organised community who either at the dictate of a single leader or as a result of a more democratic decision clear the forest, divide the landscape and subdivide it into fields, all as a single operation. The larger field pattern is clearly not the result of piecemeal clearance and enclosure. If it were such one would not find the regular pattern of striping which is almost of the standard of Congested Districts Board striping in the early years of this century. Communal work is implicit in the scale of forest clearance needed for this settlement, in the laying out of the fields, in the building of the tomb and in the use of the tomb. On the other hand, the division of the total area into fields of this size could indicate individual farm ownership. The fields are much too large and the area too exposed to have been suitable for cereal growing. If as seems probable, these are pasture fields then the division into fields would seem to point to individual farms. Another possible explanation is that the fields were used for herd management such as weaning or to prevent overgrazing and cutting up of the ground on the partially sheltered lower hillside.

The work of forest clearance which preceded the laying out of the fields was probably more arduous and time consuming than the building of the miles of boundary walls. Stone axes were probably uses but it is likely that fire was also a clearance method. The fields are so regularly laid out with scarcely any deviation from their sinuous courses that there cannot have been any groves of trees still in existence to block out the sight lines and obstruct the run of the walls. Burning would seem the most likely method of such large scale clearance. Charcoal occurs in the mineral soil throughout the entire settlement area and appears to be the result of forest burning before the growth of the blanket bog.

While today the use of land for forestry or agriculture can be a vexed question there is no doubt but that the clearance at Behy/Glenulra increased its potential for human settlement many hundredfold. Using figures from modern forestry management studies it is likely that the total exploitable biomass of deer and pig in a pine forest would be of the order of 400-500kg/km^2 at most (Mellars 1975, 52). With a one-sixth annual cull and a killing out rate of 60% clean carcass weight to live weight the animal food to be "cropped" from this site would be 40-50kg per annum — sufficient only for the total food requirements of one family for one week. Cleared of forest and organised into fields as it is, this same area could have provided six forty-acre farms which could have maintained as many families on a year-round basis. Beef production on grassland around 3000 B.C. would have benefited from the superior average temperatures current then. At present grass growth is maintained for 9-10 months in this part of Ireland and research has shown that every 1°C increase in winter temperature represents an extra month's grass growth. It is thought that the post-glacial climatic optimum reached over 2°C warmer than at present and around 3000 B.C. it is thought to have been 1°-2°C higher than at present. The grass growing season could therefore have been between 10-12 months every year. These calculations in themselves help to explain the intensity of Neolithic farm settlements as against the virtual absence of the Mesolithic hunters.

Behy/Glenulra is just one of over sixty pre-bog sites now identified in North Mayo though it must be made clear that no more than a few are as extensive as Behy. Many in fact are no more than a short length of wall occurring in isolation in modern bog cuttings but nevertheless they do indicate human settlement and land utilisation. At Belderg Beg, four miles west of Behy, excavation by the writer has uncovered plough marks in the subsoil and ridges similar to potato ridges (identical ridges were used in places in Ireland even into this century for cereals) (Fig. 2). Similar cultivation ridges were discovered by Professor Herity at Carrownaglogh.

While Mayo appears to have the greatest concentration of pre-bog settlement in Ireland these structures are fairlly widespread along the western blanket bog area from Kerry to Donegal and into central Ulster. Much of this bogland both uncut and cutaway bog is considered suitable for afforestation. The writer would welcome any report of prebog structures which may come to light as a result of forestry survey or plantation.

Fig. 2 Belderg Beg. Cultivation ridges and round house at bottom centre.

ACKNOWLEDGEMENTS

The Archaeological excavations at Behy/Glenulra and Belderg Beg have been financed in the main by grants administered by the National Monuments Branch of the office of Public Works on the recommendation of the National Committee for Archaeology of the Royal Irish Academy. Financial support has also been given by University College, Dublin.

BIBLIOGRAPHY

CAULFIELD, S. 1978. Neolithic Fields: The Irish Evidence. In *Early Land Allotment in the British Isles*. Eds. H. C. Bowen and P. J. Fowler, British Archaeological Reports 48: 137-143.

CLARK, J. G. D. 1954. *Excavations at Star Carr*. Cambridge.

DE VALERA, R. and Ó NÚALLÁIN, S. 1964. *Survey of the Megalithic Tombs of Ireland. Vol. 2 Co. Mayo*. Dublin.

IVERSEN, J. 1956. Forest Clearance in the Stone Age. Scientific American, *194* 36-41.

MELLARS, P. 1975. Ungulate populations, economic patterns and the Mesolithic Landscape. In *The Effect of Man on the Landscape: The Highland Zone*. Eds. J. G. Evans, S. Limbrey, H. Cleere. C. B. A. Research Report No. II: 49-56.

MITCHELL, F. 1976. *The Irish Landscape*. London.

Book Reviews

STRATEGY FOR THE UK FOREST INDUSTRY.

Centry for Agricultural Strategy Report No. 6, February 1980, £8.50 (sterling).

"The first effect of plenitude of inhabitants is the destruction of wood," said Samuel Johnson in his account of his celebrated visit to the Western Islands of Scotland at the end of the 18th century.

Forestry policy in the United Kingdom in the 20th century has been directed aggressively at reversing this tendency. The shortages engendered by two world wars provided the primary stimulus to this end. Two implementation mechanisms emerged; direct action, whereby the Forestry Commission acquired and afforested land on behalf of the state, and the provision of tax and grant incentives which resulted in significant expansions of the privately owned forest area. By 1977 there were 1.766 million hectares (4.364 million acres) of productive forest in the United Kingdom, of which 51 per cent was State owned, with the balance (49 per cent) in private hands.

However, the rate of expansion has fallen sharply in recent years, for a number of interrelated reasons: the investment opportunities easiest and/or most profitable to undertake have already been undertaken; those remaining tend to be less attractive. The Forestry Commission has been restricted in its land acquisition efforts by minimum rate of return requirements on its investments and by administrative constraints. The confidence of private investors has been shaken by sudden changes in he tax code which make future returns more uncertain. The strategic arguments which provided the *raison d'etre* of British forestry in this century are considered to be no longer valid; the next war (we are told) will be short and probably final. The environmental implications of large-scale upland afforestation have given rise to adverse comment by influential environmental interests. Finally, the antipathy evinced by the current Conservative Government to public endeavour and expenditure generally, has combined with the other influences to leave the practioners of forestry in the UK without a clear sense of purpose.

The report under review could be interpreted as an effort to define a mission for the profession, and to provide the intellectual and practical rationale for what is proposed. An incisive analysis of the causes of the malaise would provide a logical basis from which to derive some prescriptions. However, such an analysis has not been undertaken, although some of the issues listed above are touched on. The early chapters provide the context, by discussing current and prospective timber demand in the UK, the EEC and the world. In later chapters investment appraisal aspects are explored, alternative increased afforestation schedules are discussed, and the implications of these for regional development, agriculture, water, game, conservation and landscape, and recreation are examined. In the final chapter, aims and methods of achieving forestry expansion are outlined.

In its 341 pages of text (including appendices), the authors provide a storehouse of useful information, which will be of great value to analysts in Ireland and elsewhere. However, this report gives a sense of the converted addressing the converted. The evidence and arguments presented do not of themselves fully convince; one is expected to have the faith already. To illustrate: Taxpayers would more easily be convinced to keep funding the expansion of the UK's forest estates if it could be shown that they have received value for money on what has already been expended to this end. However, the historic evidence in this regard was largely ignored. In similar vein, the robustness of the analysis presented depends to some extent on anticipations concerning stumpage (standing timber) price, which again are not in this study validated on the basis of actual UK experience. Much is made of price elasticity studies, but a simple time series of average stumpage prices actually received by the Forestry Commission (or other vendors) is not presented. The price of standing wood is a residual; if the costs of harvesting, transportation and processing rise faster than the price of the end product, a rising price for sawnwood can be associated with a declining price for stumpage, and the latter is the crucial consideration for purposes of investment appraisal.

It would also have sharpened this analysis, and the force of the conclusions, if a marginal approach had been adopted to the various scenarios. In this way the increment in cost associated with the first level scenario, could then have been compared with the associated marginal returns, and so on. This would focus data gathering, analytical and policy makers' attention on the most relevant dimensions.

For Irish readers then, the detail in the report makes it very worthwhile, but it provides little to guide us in answering the questions which we too should soon face, namely, how much forest is enough, and who should provide it?

Frank J. Convery.

INVESTMENT APPRAISAL IN FORESTRY WITH PARTICULAR REFERENCE TO CONIFERS IN BRITAIN

R. J. N. Bushy and A. J. Grayson
Forestry Commission Booklet 47, HMSO, London, 1981, £3.75 (sterling).

In the past decade, United Kingdom investors including private individuals and institutions such as banks and insurance companies have realised the attractions of forestry as an investment outlet. Recently, Irish investors have begun to show an interest in forestry. Certain investors are attracted to forestry for taxation reasons and the time span of their interest is short-term. (Generally, the tax advantages of forestry are greater in Britain than in Ireland). The bulk of investors, however, (and particularly the institutions), regard forestry as a long-term investment suitable, for example, for pension fund monies which can remain tied up for periods of twenty years or more. It is to the latter group that this booklet is primarily aimed. It should also, however, be relevant to farmers and landowners considering the use of part or all of their holdings for forestry.

The organisation of the booklet is as follows:

Part I covers the general principles involved in any form of investment appraisal. Here, concepts such as discounting, fixed and variable costs, real returns, etc. are explained.

Parts II and III show, using a large number of marked examples, how these principles can be used to evaluate different forest projects.

This booklet can be regarded as essential reading, not only for the investor without a previous forestry background, but also for the forester wishing to add a financial perspective to his work. To my knowledge, an equivalent booklet has not recently been published. In a number of respects the booklet is disappointing, however. Two particular problems I believe, complicate investment appraisal in forestry and their treatment in this booklet I would regard as inadequate. These are:

(i) The difficulty of identifying yield class,

(ii) The choice of discount rate.

The 'yield class problem', if I can call it that, works as follows.

The analyst may wish to value either bare land destined for forestry, or a young forest plantation. This can be done using the Management Tables provided the yield class of the land can be identified. All the figures derived from the tables hinge upon the identification of yield class. However, most foresters would regard an assessment of yield class as being tentative, and subject to significant revision until well into the establishment of a plantation. Thus, the approach to investment appraisal outlined in the booklet could give the spurious appearance of scientific accuracy where the yield class estimate itself is tentative.

I am unhappy also about the treatment of discount rate in the booklet. This is the compound interest rate which is used to express expenditures and revenues in present value terms and which represents the return derived by the investor. The choice of discount rate is thus vital — it it a major determinant of whether a given project is viable and should be undertaken. If investment appraisal in forestry is to be technically acceptable, the compound interest rate should be consistent with that used to appraise other projects which are open to the investor. By using three discount rates, 3%, 5% and 7%, the authors effectively avoid this question since for long-term projects, even a 0.5% change in discount rate can critically influence the returns abtained. The first step for the rational investor would involve ascertaining the general rate applicable to risk-free borrowings (e.g. investment in Government stock); to this should be added a margin which takes account of the uncertainty and risks involved in forestry investment. (Currently the real return on UK government stock lies between 2½% and 3%: (equivalent figures are not available for Ireland.) Today's investor should therefore, I feel, use a figure of the order of 4¾% (2¾% risk-free rate plus a margin of 2%).

This publication is certainly of interest to Irish investors, but its relevnace is limited by its heavy reliance on Forestry Commission Management Tables. This highlights the need for revision and extrapolation of those tables to account for provenance differences and faster growth rates in this country. Such information, made publicly available, would provide a valuable stimulus to private sector forestry investment.

D. Bradley.

THE ECOLOGY OF EVEN-AGED FOREST PLANTATIONS

E. D. Ford, D. C. Malcolm and J. Atterson, editors.

Proceedings of the Meeting of Division 1, International Union of Forestry Research Organisations, Edinburgh, September 1978. Institute of Terrestrial Ecology, Cambridge. 582 pages.

Of the 30 papers contained in this book only one attempts to inspire the reader. John Davies, Forestry Commission Conservator for Southern Scotland, writing not on the ecology but on the management of even-aged plantations is the author of a stirring plea for high input forestry. His paper, although it contains sometimes outrageous generalisations and over-simplefication has a clear message: "the time has come for the general manager to weld all these (the conclusions of research workers) together and, like the great Victorian scientists such as Darwin, who could see all creation as one, prescribe a comprehensive, if somewhat imperfect treatment, simple and clear." The contrast with the measured assertions and qualified statements of so many other papers in this volume is striking and forces one to consider the role of forestry research and how research can best contribute to better management. Davies' approach is a reproof to the cautious scientist and calls to mind the words of Cardinal Newman: "A man would do nothing if he waited until he could do it so well that none would find fault with what he has done."

The papers presented at this conference cover every concievable aspect of the subject. Unfortunately the end product is very uneven. Often a pretentious title, suggestive of a definitive review, is followed by a disappointingly limited discussion of a handful of experiments in Scotland. Many of the contributions are pedestrian, quite a few are competent and informative but only rarely do they inspire or stimulate. We are told that even-aged plantations are now found throughout the world, that fertilizers are used in forestry in a great many countries, that exotic species are used extensively. What a pity then that 24 of the 33 invited contributions were from one country (Great Britain) and that one or two of the "foreign" contributions were of a particularly low standard. The broad coverage suggested by the title of the conference is quite misleading. For example, apart from Kormanik's contribution on the mycorrhizal work of the USDA Forest Service at Athens, Georgia, work much promulgated often more elegantly than on this occasion, there was no paper dealing with plantation forestry in the southeastern United States. This was disappointing considering the very excellent and interesting work being done there by the Forest Service, universities and other private companies in for example North Carolina and Florida.

These criticisms, while displaying a general dissatisfaction with the proceedings of this conference, should not detract from the value of a number of excellent contributions. Of the two papers on site classification, that of Kreutzer provides a useful review of the factors involved in stand productivity estimation procedures. Both this paper and the other by Toleman discuss site productiviey estimation on non-forested land, an important subject, but one which has received relatively little attention in this country.

These papers can usefully be linked with Ford's contribution entitled "An ecological basis for predicting the growth and stability of plantation forests". In this well researched paper, I found the discussion of the deficiencies of the yield table approach to growth prediction and the difficulties of developing an ecologically based system most interesting. His review of the ecology of windthrow merits careful study.

For me, the outstanding contribution to the proceedings was that of David Perry from Oregon under the title "Variation between and within species". He presents an interesting and wide ranging discussion. He puts two questions to the reader concerning the manipulation of gene pools, namely: How much can we change? and How much should we change? His discussion on how forest yield may be improved through genetic selection at both organism and community level I found quite stimulating. His arguments supporting mixed forests give food for thought to both the tree breeder and silverculturalist alike. The latter, however, may be put off by excessive use of jargon which devalues the paper for those outside the field.

Several other papers provide useful reviews of their subjects and almost all are well referenced. For most people there is something useful in this book. The problem for many will be how to find it.

E. P. Farrell.

OTHER PUBLICATIONS RECEIVED

FOREST AND WILDLIFE SERVICE, DUBLIN

Páirc Foraoise na hArdaidh, Ards Forest Park, 36pp. £0.40.

FORESTRY COMMISSION, LONDON

Booklet No. 48, Edwards, P. N. 1981. Yield Models for Forest Management, 32pp.

Occasional Paper No. 10. Research for Practical Arboriculture, Proceeding of the Forestry Commission/Arboricultural Association Seminar at Preston, February 1980, 1981, 132pp. Price in U.K. £2.00 (sterling).

Occasional Paper No. 11. Holden, A. V. and Bevan, D. (editors) 1981. Aerial Application of Insecticide against Pine Beauty Moth. 112pp. Price in U.K. £2.50 (sterling).

Report on Forest Research 1981, 97pp. Price in U.K. £5.40 (sterling).

ACADEMIC PRESS, LONDON

Thirgood J. V. 1981. Man and the Mediterranean Forest. A history of resource depletion. 193pp. Price in U.K. £12.00 (sterling). (For review in next issue).

INTERNATURAL UNION FOR CONSERVATION OF NATURE AND NATURAL RESOURCES, WASHINGTON, D.C.

Parks. An International Journal for Managers of National Parks, Historic Sites and Other Protected Areas. Vol. 6, Number 2, July, August, September, 1981.

INSTITUTE OF TERRESTRIAL ECOLOGY, CAMBRIDGE

Ranwell, D. S. (editor) 1980. Sand Dune Machair 3. Report on meeting in the Outer Hebrides, 14-16th July, 1978, 46pp.

Last, F. T. and Gardiner, A. S. (editors) 1981. Forest and Woodland Ecology. I.T.E. Symposium No. 8. 158pp. Price in U.K. £5.00 (sterling). (For review in next issue).

NATIONAL BOARD FOR SCIENCE AND TECHNOLOGY

Science Budget 1981, 85pp. Science Budget 1981, Executive Summary, 1981, 6pp.

FEDERATION OF SWEDISH INDUSTRIES/THE SWEDISH INSTITUTE, STOCKHOLM

Hellvarsson, Mats, 1981. Swedish Industry Faces the 80s. 212pp.

THE INSTITUTE OF ECONOMIC AFFAIRS, LONDON

Miller, Robert, 1981. State Forestry for the Axe. Robert Paper No. 91, 69pp. Price in U.K. £1.50 (sterling). (For review in next issue).

ISSN 0021 - 1192