Lodgepole Pine — An Important Species?

IRISH FORESTRY

JOURNAL OF THE SOCIETY OF IRISH FORESTERS

Volume 45, No. 1, 1988

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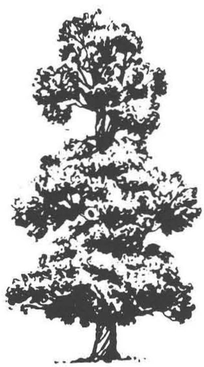

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(b) Indoor and field meetings on forestry topics

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Notes for the Assistance of Contributors

The following notes are designed to aid the speedy processing of scientific contributions to the journal.

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

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.

5. References should be in the following form:
   GALLAGHER, G. and GILLESPIE, J. 1984. The economics of peatland afforestation. Proc. 7th Int. Peat Cong. Dublin. Vol. 3: 271-285.
   KERRUISH, C. M. and SHEPHERD, K. R. 1983. Thinning practices in Australia. A review of silvicultural and harvesting trends. New Zealand Journal of Forest Science, 47: 140-167.
   Forestry Abstracts may be used as a guide in the abbreviation of journal titles.

6. A short summary of the paper should be included. It should precede the main body of the text.

7. Proofs will be sent to the senior author for correction. Proof corrections are costly and authors are requested, as far as possible, to confine alterations to the correction of printer's errors.

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.*

Contents

Note: The opinions expressed in the articles are those of the contributors.

Cover: Lodgepole Pine, seed stand, Kilworth Forest. P. Yr. 1935. (Photo: J. O'Driscoll)

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EDITORIAL

GUTS and Management of the 'High Greens'

Theoretical physicists are attempting to bring into existence a mathematical equation that will describe most forces of nature as the manifestation of one general force. This activity is referred to as the 'Grand Unified Theories' — or GUTS.

Another force exists that lies dormant. Across this planet there exists a web of trained foresters of many cultures, of many languages, who collectively hold in trust the forests of the world for the people of the world.

Not all areas of wild forest can or should be preserved under National Park/Reserve legislation. Those that are not, however, do clearly need responsible forest management if they are to continue without impairment as productive forests.

Within countries, within regions, there are, to varying degrees, links of forestry associations — FAO; IUFRO; AFA; ISTF etc. However, there is a need of one voice that can speak on issues of importance to world forestry. Broad-issue matters, trans-regional matters that can affect large areas of forest cover is the concern here.

Perhaps now is the time to create such a voice. A voice that can speak out on matters that threaten our world forests. Extensive atmospheric poisoning and nuclear radiation are grounds of concern. So too is a more subtle danger — that of political or economic pressure that threaten the basis of 'sustained yield forestry'.

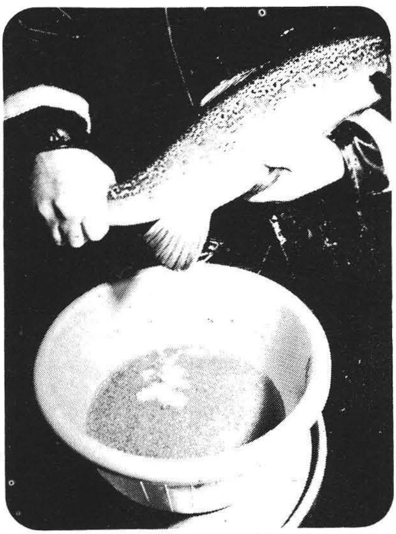
A world forestry agency could prove an effective voice against large scale unsustainable logging. It could publicly argue against agricultural practices that put in jeopardy the continuation of forest growth. It could voice its concern against industrial practices that threaten the health of forests.

Where persuasion fails such a body would need sanctioning instruments of trade or aid restrictions. These restrictions could be enforced until the threat to forests and to their wise management were alleviated.

A world voice on forestry matters could do these things. We owe it to the profession of forestry to consider this. the 'High Greens' now need a voice that will speak for their continuance.

The Ones that Get Away...

Salmon angling at Castleconnell, Co. Limerick.



Salmon 'stripping' at the E.S.B. Hatchery and rearing station, Parteen.

About 700 hen salmon get away every year - away from the ESB's Hatcheries at Parteen and Carrigadrohid - but they leave their eggs behind and from these the ESB fishery experts rear up to 5 million fish every year, salmon which are then planted out in Ireland's rivers to improve fish stocks and to provide better sport for Irish and visiting anglers.

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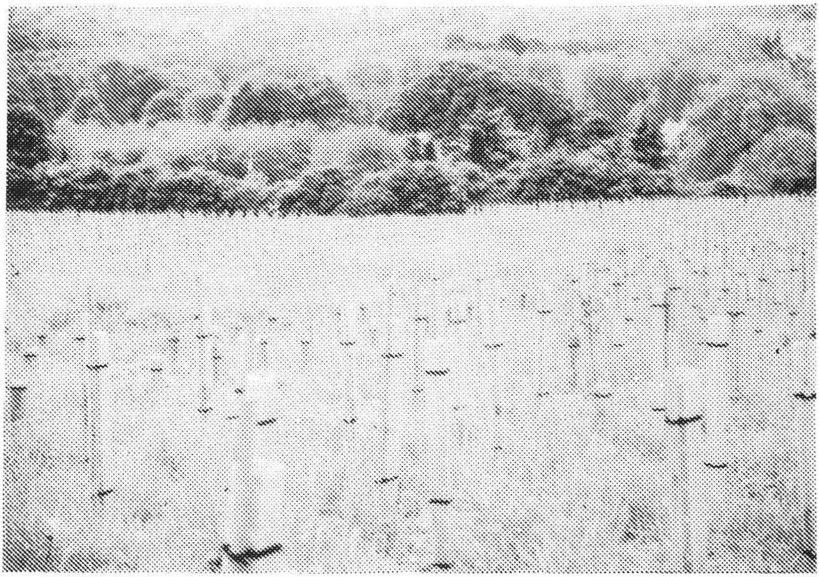

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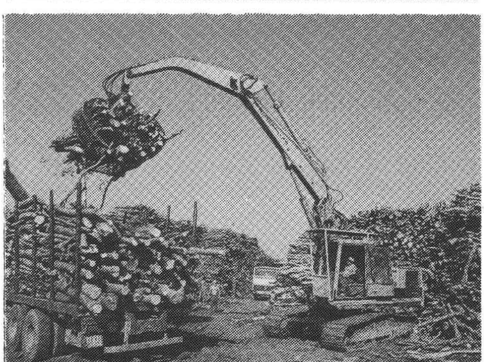

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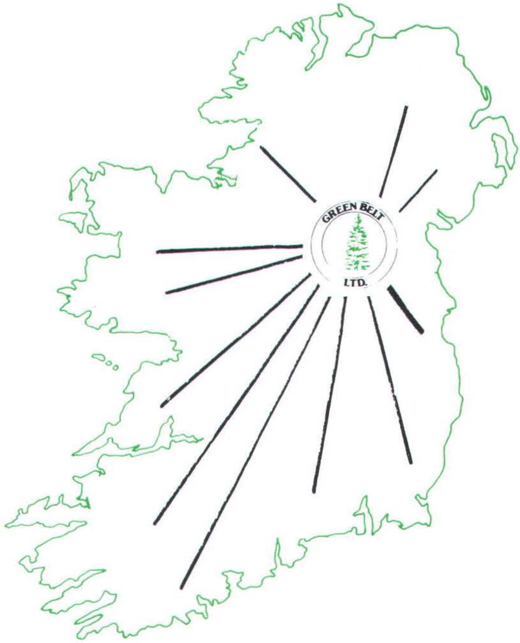
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More on Nursing Mixtures

M. L. Carey[1], R. G. McCarthy[1], H. G. Miller[2]

[1]Forest Service, Sidmonton Place, Bray, Co. Wicklow, Ireland.
[2]Forestry Department, University of Aberdeen, Scotland.

Abstract

A series of experiments in Ireland and Britain have demonstrated that the growth of Sitka spruce (*Picea sitchensis* (Bong.) Carr) can be enhanced on poor soils by the presence of Japanese larch (*Larix leptolepis* Sieb.), Scots pine (*Pinus sylvestris* L.) and lodgepole pine (*Pinus contorta*). The improved growth, or so called "nurse effect", is related to greater availability of soil nitrogen and a more rapid turnover of nitrogen in mixtures compared with spruce monocultures. It becomes noticeable some 8-10 years after planting. Research results suggest that the effect is closely related to the root activity of the nurse species and substantial differences have been found in the mycorrhizal fungal flora on pure spruce compared with spruce grown in mixture with larch or pine.

Mixtures are now advocated for site types such as oligotrophic peats and podsolised mineral soils where nitrogen deficiency is often a problem. Although they may be more difficult to manage than monocultures, their use is likely to greatly reduce the need for top dressing with fertiliser nitrogen and at the same time add diversity to species selection. Self-thinning mixtures of spruce and a slow growing provenance of lodgepole pine or Scots pine are suggested as an option for high production wet mineral soils where windblow is often associated with conventional thinning.

Introduction

The positive effect of one species of tree on the growth of an adjacent different species has long fascinated foresters, some of whom have advocated mixed species forests rather than monocultures. As a result there are now about 42,000 ha of mixed plantations in the Irish Republic of one kind or another, representing about 11 per cent of the forest estate. There are also substantial areas of mixtures in Britain (Garforth, 1979).

Besides planting mixtures because of the so called "nursing" or beneficial effect of one species on the other two other philosophies have played a part in their popularity over the last thirty years or so. One related to uncertainty as regards what to plant on poor land and anxiety over its potential to grow Sitka spruce satisfactorily without regular inputs of fertiliser nigrogen. The other was very likely influenced by Anderson's (1950) ideas on species selection. Besides advocating that species should be site adapted, he encouraged the planting of mixed crops so as to exploit any potential synergistic effects and as well as this strengthen ecological stability. There is little hard evidence worldwide now to support the hypothesis of monocultures being less stable than mixed forest plantations (Will, 1984). Nevertheless, Anderson's views were often in foresters' minds when it came to deciding on planting mixtures, best expressed perhaps in the concept of "not putting all of one's eggs into one basket".

Although it was observed as early as the mid 1930s (Zehetmayr, 1960) that Sitka spruce growing on heather dominated heathlands often recovered from check if planted near pine or birch, real evidence for a beneficial effect has been hard to obtain. Recently, however, there have been several observations, in properly designed experiments on poor soils, in both Ireland and Britain, of improved growth of Sitka spruce (*Picea sitchensis* (Bong.) Carr.) when planted in mixture with larch or pines (both lodgepole *Pinus contorta* Dougl. and Scots pine *Pinus sylvestris* L.). This improved growth relates to better nitrogen nutrition when spruce is planted in mixture rather than in monocultures. Pure spruce crops growing on such soils do respond well to top dressings of fertiliser nitrogen (Carey & Griffin, 1981, McIntosh, 1983). However, the cost element of the operation, and uncertainty over the number of doses necessary to sustain an acceptable growth pattern, has added weight to the mixtures option. As a result substantial areas of mixed spruce and pine have been planted in Scotland in recent years (Taylor, 1985) and research programmes, supported by EEC funding and aimed at gaining an understanding of the "mixed effect", have been intensified.

The purpose of this presentation is to describe the relevant experiments in both Ireland and Scotland and to provide a summary of the recent research that has been carried out. Secondly, based on the results from these investigations, recommendations will be made on the possible role of mixtures in future planting programmes and finally comments will be made on the extent and management of existing mixed plantations and of the role of self thinning mixtures on unstable sites.

Mixture Experiments

There are four experiments pertinent to the present discussion, details of which are outlined in Table 1. Three are in Britain: Inchnacardoch, Mabie and Culloden forests; the fourth, the oldest and now 27 years of age, is situated at Avondhu forest, Co. Cork in the Republic of Ireland. Other experiments have been laid down in recent years but none has yielded results yet.

Table 1: Experiments in Ireland and Scotland where growth of Sitka has been improved by the presence of a nurse species.

Location	P/Year	Site Type	Species/Provenance Used as Nurse
Avondhu	1960	ORS*	Inland lodgepole pine & Japanese larch
Inchnacardoch	1965	Blanket bog	North coastal lodgepole pine Skagway, Alaska. Also Japanese larch
Mabie	1967	Lowland raised bog	North coastal lodgepole pine Petersburgh, Alaska. Also Hybrid larch
Culloden	1969	ORS*	Scots pine

* ORS=Old Red Sandstone

There are a number of features common to all four experiments:

1. All were established on poor soils known to be deficient in nitrogen for Sitka spruce.

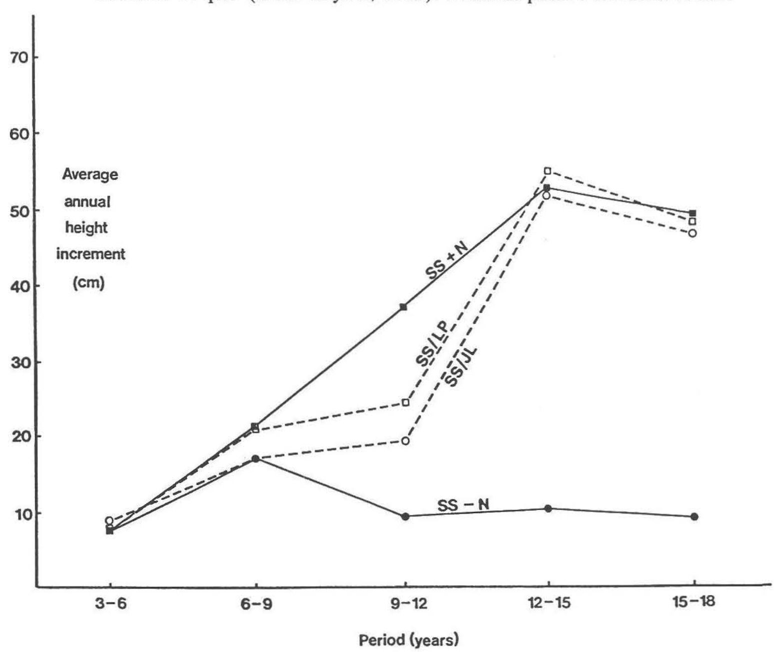
2. No measurable effects of the nurse species on tree growth were observed at any of the sites until some 8-10 years after planting.

3. Substantial improvements were obtained in height and diameter growth and dry matter production of spruce when grown in the presence of pine or larch, with a few minor exceptions, at (i) Avondhu where the pine effect (inland provenance), although statistically significant, meant little from a practical viewpoint and at (ii) Mabie forest where the spruce was totally suppressed by the lodgepole pine. On the lowland raised bogs of south west

Scotland lodgepole pine performs particularly well and even the slow growing provenances out-grow Sitka spruce (Taylor, C., personal communication).

It is not intended to pursue the results from each experiment in detail. The Avondhu trial has already been written up in an earlier issue of this Journal by O Carroll (1978) and other experiments are described comprehensively by Carlyle and Malcolm (1986) and in reports prepared for the European Commission (Carey *et al,* 1986; Miller *et al,* 1986). However, the Inchnacardoch and Culloden trials will be referred to briefly because of their significance to Irish forestry. The former, located on acid (pH 4.0) blanket bog in Scotland, had the following treatments: (1) pure Sitka spruce without fertiliser; (2) pure Sitka spruce with fertiliser (nitrogen was added when needed, a total of 804 kg/ha N in 5 applications between 1969 and 1984); (3) Sitka spruce/lodgepole pine mixture, and (4) Sitka spruce/Japanese larch mixture. Significantly tree growth in the pure spruce with nitrogen fertiliser was only marginally better than the spruce in the mixture plots (Figure 1).

Figure 1 Average annual height increment for different treatments at Inchnacardoch 164p65 (from Taylor, 1985). Blanket peat. Elevation 295m.



Nitrogen was not included as a treatment at the Culloden site (an Old Red Sandstone soil). The control plots (pure Sitka spruce) were badly affected by nitrogen deficiency within ten years of planting whereas the spruce grown in the presence of Scots pine were vigorous and had satisfactory nitrogen levels in the foliage. Scots pine, although popular in planting programmes in Ireland between 1930 and 1950, has been largely replaced by the more vigorous lodgepole pine, a species not without its problems (Carey & Hendrick, 1986). Although Scots pine was not included as a treatment in the Irish experiment, there is circumstantial evidence in some plantations in the Old Red Sandstone region in the southerly part of the country, that the species is having a positive effect on the growth of adjacent Sitka spruce. Thus, although Japanese larch has been reasonably effective on both the Old Red Sandstone and Blanket peat soils (Avondhu and Inchnacardoch) it is possible that Scots pine may be an acceptable alternative as a nurse on the Old Red Sandstone site types. Its overall poor performance on blanket peat in the west of Ireland suggests, however, that it (Scots pine) would not be effective in such situations.

The Nurse Phenomenon

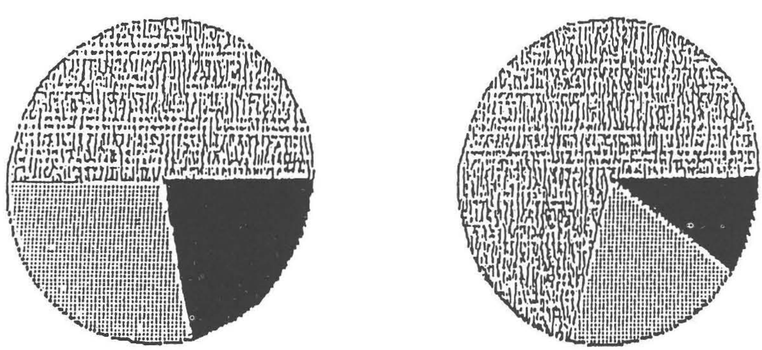
Besides the practical significance of mixed as against pure plantations, one of the questions that has been foremost in the minds of some forest scientists in recent years has been the nature of the mechanism behind the nursing phenomenon. If the effect was fully understood then it is conceivable that it could be simulated in the absence of the nurse species thereby enabling forest productivity to be increased without the need to apply nitrogenous fertilisers. The result would have advantages both economically and environmentally. With this in mind, two research teams, one in Ireland (the Forest Service), the other in Scotland (Macaulay Institute, Aberdeen, in association with Edinburgh University and the Forestry Commission of Great Britain), set out in 1983, with the aid of EEC funding, to study in greater detail the processes operating in a number of the treatments at the Avondhu, Inchnacardoch and Culloden sites.

Earlier work by O Carroll (1978) at the Avondhu site had shown that the presence of Japanese larch resulted in increased availability of nitrogen for Sitka spruce but it was far from clear how the effect arose. It was suggested that the annual litterfall from the deciduous larch might serve as a source of nitrogen for the spruce, although doubts were raised over whether the decomposition of the litter would be sufficiently rapid to enable such an effect to occur. Other suggestions included the possibility that nitrogen was being fixed by the nurse species – as in the case of clover in agriculture, although studies by Carlyle (1984) subsequently ruled out this option. Other suggestions included the possibility that rainwater passing through the forest canopy actually leached nitrogen from the foliage of the nurse species which was passed on to the spruce and/or that mycorrhizal fungi might be involved in the overall process.

The EEC funding, together with that provided by the organisations in both Member States, enabled all of these possibilities to be investigated. Details of the studies and their results can be found elsewhere (see Carey *et al* and Miller *et al,* 1986). In summary they showed that:

1. There were considerably higher nitrogen concentrations in the spruce trees in mixed plots compared with pure spruce plots. This was also reflected in the overall nitrogen budget for both situations. At Avondhu, for instance, the total nitrogen content of the larch and spruce trees (including roots) came to 307 kg/ha compared with 110 kg/ha in the pure spruce plots (Figure 2). The spruce trees in the mixture plots contained 210 kg of the 307 kg of nitrogen present in the treatment.

Figure 2 Distribution of nitrogen in the pure Sitka spruce plots and in the mixture plots (kg ha^{-1}) at Avondhu.

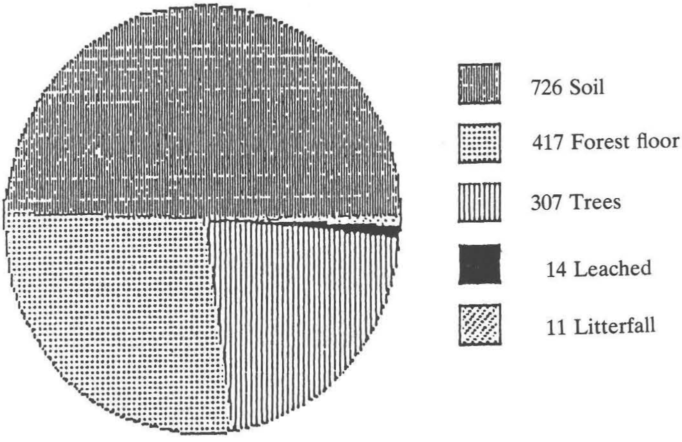


Soil	726	[soil pattern]	853
Forest Floor	417	[forest floor pattern]	238
Trees: Spruce	210	[black]	110
Larch	97		-
	307		110

2. The extra nitrogen present in the trees in the mixed plots came from the soil; the soil in the mixture plots showed a corresponding decrease in total nitrogen.

3. There was more rapid turnover of nitrogen in the mixtures compared with the pure spruce plots. For instance, litterfall contained higher concentrations and contents of nitrogen but the differences were not sufficient to explain the enhanced growth pattern of the spruce when grown in the presence of larch or pine. Throughfall in the mixed plots also contained substantially more nitrogen than that in pure spruce at all the study sites. There were also strong suggestions at Avondhu that some nitrogen (about 14 kg/ha/annum) was leached from the tree canopy by the rainfall (Figure 3). However, the amount, as in the case of litterfall, would not be sufficient to account for the extra growth recorded for the spruce in mixed plots at any of the study sites.

Figure 3 Avondhu Forest, Experiment 4/60. Nitrogen budget in the SS /JL mixture plots (kg N ha^{-1}).



4. Although the mycorrhizal studies did not commence until the latter stages of the project in 1985, there were strong indications of substantial differences in the fungal flora associated with spruce mycorrhizae from pure and mixed stands. Differences in other associated fungi were also evident. The results suggested that it was possible that the improved nitrogen status of spruce in mixed stands may be due to direct transport of nitrogen from either the nurses species, the soil or both. Until more work is carried out this must remain conjecture; however, there remains the fact that

the nursing effect does appear in one way or another to be closely related to root activity. This is evident not only in mixture experiments but also in plantations generally where pine or larch and spruce are grown alongside each other on poor soils. Invariably the enhanced growth of the spruce extends over a distance of three to four metres from the nurse species. On ploughed ground the effect is much more pronounced along rather than across the ribbons or turves, a feature that has practical implications when it comes to decide on spatial arrangement – see below. Much of the rooting activity on ploughed ground occurs in the ribbons or turves, particularly on wet peatland sites where the watertable is high.

Sites Suitable for Mixtures

1. Nitrogen deficient soils

(i) Oligotrophic (i.e. low nutrient status) peats in blanket and raised bogs.

As Carey and Griffin (1981) point out, nitrogen deficiency usually does not occur on these sites in Ireland until some eight to ten years after planting, provided phosphate has been applied at planting. This period of stress coincides with the time when the nurse species becomes effective in terms of stimulating growth of the spruce, as shown in the experiments.

(ii) Mineral soils derived from Old Red Sandstone parent materials, particularly those where the nitrogen-fixing species *Ulex gallii* is absent.

On poor Old Red Sandstone soils, nitrogen deficiency is likely to occur as early as three to five years after planting. In such cases one application of nitrogen to the spruce may be necessary to ensure it maintains pace with the nurse species before the latter becomes effective. The problems of nitrogen deficiency on these site types and the responsiveness of Sitka spruce growing on them to nitrogenous fertilisers have been described in previous papers (e.g. Carey and Griffin 1981, Carey and Hendrick 1986).

2. Surface water gleys

On unstable fertile soils, particularly surface water gleys, the idea of self-thinning mixtures of pine and spruce are also worth consideration. There are several examples of the system working out very satisfactorily in Ireland and Britain. One such example is at Swanlinbar Forest, Co. Cavan. The stand, planted in 1962 on surface water gley at an elevation of 150m, is composed of a row by row mixture (i.e. 1:1) of Sitka spruce and Inland lodgepole pine. The initial stocking was 3100 stems/ha, but the present live stocking is at 1840 stems/ha, 84 per cent of the lodgepole pine having been suppressed by the spruce, the yield class of which is equivalent to 22.

Apart from the highly desirable level of self-thinning occurring at this site the other, and probably more outstanding feature of the crop, is that there has been no windblow. This is all the more noteworthy for two reasons: (1) windblow is widespread in the adjacent pure spruce crops and (2) the site was cultivated using a single mouldboard plough, a method notorious for predisposing crops to windblow. The use of self-thinning mixtures appears to be a highly promising approach, and may be the only one, to growing Sitka spruce to full rotation on the highly fertile but windblow-susceptible gley soils.

Effective Nurse Species

The experiments have shown that lodgepole pine, Scots pine and Japanese larch are equally effective as a nurse, depending on provenance and site type. In addition, Douglas fir has recently been observed to have a powerful nursing influence on Sitka spruce at Ballyhoura Forest, Co. Cork, the effects of which have been measured over the last three years (in press). South coastal provenances of lodgepole pine are most unsuitable for nursing spruce – they are far too vigorous and will probably suppress the spruce. Alaskan provenances are most effective and the much maligned Lulu Island provenance, which was planted quite widely in Ireland in the 1960s, appears particularly promising. While lodgepole pine appears equally effective on both organic and mineral soils as a nurse species, this is not so with either Scots pine or larch, both of which should be confined to the mineral soils where mixtures are being considered. Larch tends to suffer badly from exposure on blanket peat and Scots pine, as pointed out earlier, generally grows poorly on such sites.

Spatial Arrangement and Proportion of Nurse Species

In the experiments reported, the nurse species comprises between 50 and 75 per cent of the crop. The spatial arrangements vary as follows:

Avondhu

(1) intimate mixture of nurse with Sitka spruce and
(2) alternative double rows of nurse and Sitka spruce .

Inchnacardoch

one pure line of the nurse species with neighbouring line consisting of three nurse plants to three Sitka spruce.

Culloden and Mabie

lines consisting of groups of three nurse and three Sitka spruce plants. Sitka spruce bound by nurse triplets in neighbouring lines.

There are indications that a lower proportion of the nurse species would be equally effective, particularly if the two species are mixed intimately along rather than across the lines of plants. A one (nurse) in three plants is suggested. Although planting the nurse species in lines may be preferable from a management point of view, it is likely to be less effective in terms of nitrogen nutrition because there is less opportunity for close interaction of the root systems of the nurse and Sitka spruce, essential it seems to the nursing effect. Maintaining the proportion of the nurse species in or around 33 per cent will ensure a good stocking of spruce and very likely result in the nurse dying out after canopy closure when its original objective has been completed. Increasing the proportion of nurse species above 50 per cent will present management problems at the thinning stage and very likely reduce overall production potential. However, on poor sites with difficult access, a "no-thin" regime may be indicated and in that case a 50/50 mixture would be best, 2-SS/2-nurse in the same line. 2 row/2 row Sitka spruce/Scots pine mixtures are proving quite successful on heathlands in eastern Scotland (Taylor, C., personal communication).

Management of Mixtures

The immediate objective in the management of mixtures is to achieve satisfactory crop establishment, thereby reaching thicket stage with little or no need for nitrogen fertiliser inputs. The ultimate objective is to maximise the growth of the primary species, that is, the species being nursed.

It should be borne in mind that even though the primary species is normally more valuable financially than the secondary species (nurse) it may not be the dominant one in the canopy. Indeed it is a feature of many mixtures that the nurse is the dominant species. This is often the position for example where Sitka spruce is in mixture with the more vigorous provenances of lodgepole pine. In these situations it requires much skill and attention by the forester to promote the growth of the primary species in the most effective way possible.

Mixtures composed of compatible species (that is, where the primary species is not dominated by the nurse species) are clearly much more cost-effective since they require less management than where the nurse species is dominant. It is crucial therefore to select the right nurse species at planting, that is, one appropriate to the site and to the species to be nursed. More information is required on what constitutes the ideal mixture species for particular site types and regions, and this is one of the subjects being actively pursued in current research programmes.

There remains the question of how to manage existing mixture crops which are in varying degrees of stand development and perhaps including features (such as, an over-dominant nurse species) that it should be possible to avoid in future through a more prudent selection of species at planting. The following situations are the most common mixture problems faced by foresters and the solutions offered for each should be seen as general guidelines as to how to deal with mixtures:

1. Thicket stage crops, where the nurse species is dominant, and the stand top height is up to 5-6m.

Solution: Respacing should be considered, with emphasis on removing the nurse species. Of all mixture situations these young crops represent the greatest scope for promoting the growth of the primary species.

2. Young pole stage crops, where (i) both species are growing well, or (ii) one species is completely suppressed with a top height difference greater than 2m.

Solution: Manage as if crop were pure, applying normal management principles.

3. Young pole stage crops, where the top height of the nurse species exceeds that of the primary species by less than 2m.

Solution: Such situations usually indicate that the primary species will respond to thinning. Lines of trees at wide intervals may be removed, with a selection thinning in between, the aim being to favour the primary species. Further selection thinnings may follow, leading to a final crop composed mainly of the primary species.

4. Advanced pole stage crops, where the top height of the nurse species exceeds that of the primary species by less than 2m, with indications that the primary species will respond to thinning but thinning is inadvisable due to windblow risk.

Solution: A chemical thinning of the nurse species could be considered. The object would be to kill most of the nurse species (with herbicide) leaving no need for conventional thinnings, whilst at the same time creating the conditions for a growth response from the primary species with minimum risk of windblow.

5. Advanced pole stage crops, where at least 500 stems/ha of the primary species are sufficiently free from competition to form the final crop.
Solution: No thinning treatment is necessary, or indeed desirable on windblow-susceptible sites.

Three important points must be borne in mind if mixtures are to be successfully managed:

(1) adequate phosphorus levels are essential to effective nursing.

(2) removal of the nurse species in one operation is not advisable because:

(a) this may allow growth of vegetation antagonistic to the primary species e.g. heather, and

(b) it may result in check where the nursing effect was still active (however, total removal of the nurse species may be feasible where furze, a source of nitrogen, is present).

(3) a fertiliser application may be required in conjunction with thinning or respacing. Foliage analysis will verify whether this is necessary. Sitka spruce in mixture with south coastal lodgepole pine on mineral soils often shows phosphorus deficiency at age 10-15 years, which can easily be rectified.

Conclusions

Although a full explanation has yet to be provided on the processes involved in mixed stands whereby the nurse species enables spruce to grow satisfactorily, it has been clearly demonstrated that the effect is real across a range of site types and that mixtures offer considerable promise as a silvicultural option on poor or impoverished soils. Besides the experiments reported, there is also widespread evidence in plantations throughout Britain and Ireland of satisfactory growth of spruce, particularly in the presence of pine. However, without proper replication, it is often difficult to state categorically that the good growth experienced by spruce at any particular site is due to the presence of the nurse species.

From a forester's viewpoint there is no doubt but that the overall management of mixtures is more difficult than that of monocultures. Initially there is the burden of the extra cost of planting two species followed by the necessity for the development of a compatible growth relationship between the nurse and the nursed species if one or other is to avoid being suppressed in the earlier years. Later there is the problem of deciding what to do when it comes to first thinning. As Garforth (1979) points out, the number of occasions when the relationship works out well are rare. Nevertheless there is abundant circumstantial evidence now of successful mixtures of Sitka spruce and slow-growing provenances of lodgepole pine planted on impoverished mineral and peat soils in Ireland and Britain, yielding well at first thinning and with continued good prospects. In the situations where there is likely to be uncertainty over funding for fertiliser nitrogen the mixture option is an alternative worthy of serious consideration.

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

B. Fitzsimons

(Research Branch, Forest Service)

INTRODUCTION

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

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

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

*Formerly Forest & Wildlife Service.

IRISH FORESTRY, 1988, Vol. 45, No. 1: 21-34.

METHODS AND MATERIALS

The project was divided into two parts:

1. A basal sweep survey of LPC crops on ploughed ground to estimate the amount of sweep present in such crops.
2. An examination of LPC logs from trees with the degree of sweep indicated by the above survey to determine

   (a) The results of drying such material
   (b) The results from manufacturing the timber into finished joinery products.

This paper describes part 1 of the project.

Basal Sweep Survey

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

Two situations were examined:

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

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

The sampling procedures were as follows:

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

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

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

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

4. Twelve (12) final crop trees were selected within each plot. This was a subjective selection and was a compromise between straightness and vigour. They were selected as if choosing a final crop with a view to thinning subsequently to favour those trees.

This was to give an estimate of the degree of sweep which might be expected in the final crop if the stand is thinned.

These trees were marked with white paint.

5. A further 12 trees were selected systematically throughout the crop, regardless of form, but omitting trees less than:

10cm if plot is YC 12
11cm if plot is YC 14
12cm if plot is YC 16
13cm if plot is YC 18 or greater.

This was to give an estimate of the degree of sweep which might be expected at clearfelling if the stand is left unthinned.

These trees were marked with coloured paint.

Note: It happened that some of the same trees were picked in both selections. This was acceptable provided the second sampling was systematic and trees picked by the first method were never deliberately re-selected.

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

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

For each overall sub-compartment the following were recorded (if available).

(a) Record of Fertilisation.
(b) Brashing/pruning.
(c) Elevation and aspect.

7. For each tree measured the following were recorded:

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

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

MEASUREMENT OF DEGREE OF SWEEP

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

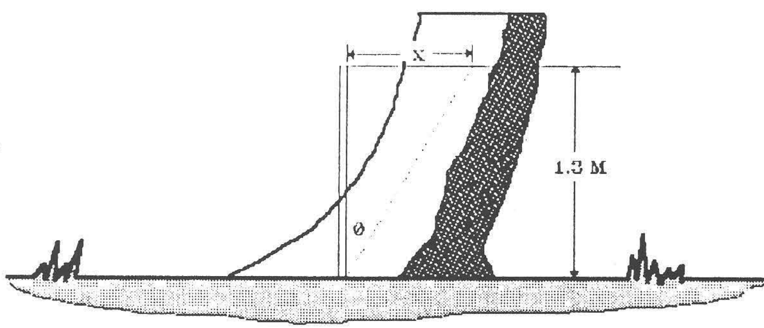

Figure 1.

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

SYSTEMATIC SELECTION OF TREES

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

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

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

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

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

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

Results

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

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

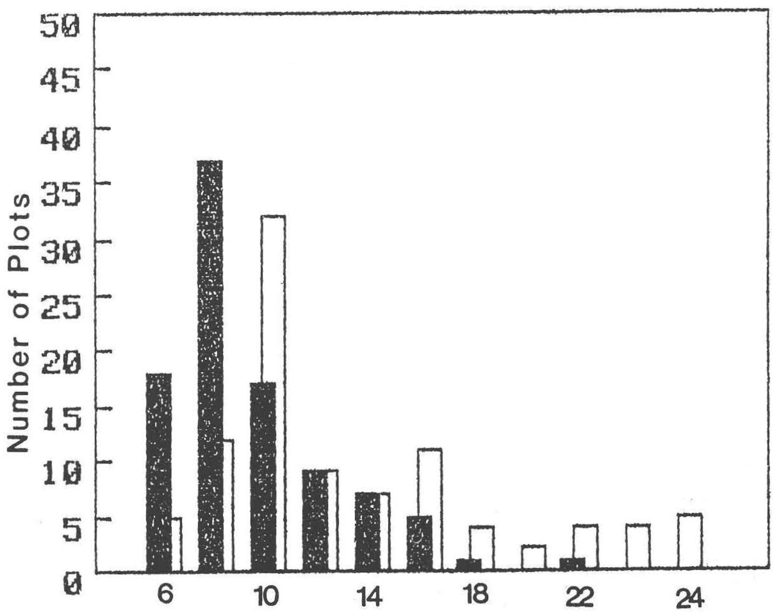

Figure 2 Mean Angle of Plot.

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

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

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

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

Discussion

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

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

Accepting that stands with a mean basal sweep of 12° or less can substitute for imported red deal, the implications are illustrated in Figure 3. This shows the cumulative percentage of stands surveyed which have a degree of sweep equal to or less than the figure given on the horizontal axis. The two sets of silvicultural options discussed are shown: (i) selective thinning or re-spacing and (ii) systematic thinning or no-thinning. Looking at the histograms for 12° it is seen that over 80% of the stands, if selectively treated, can achieve this degree of straightness or better. Even without selection 60% of the stands appear to have joinery potential.

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

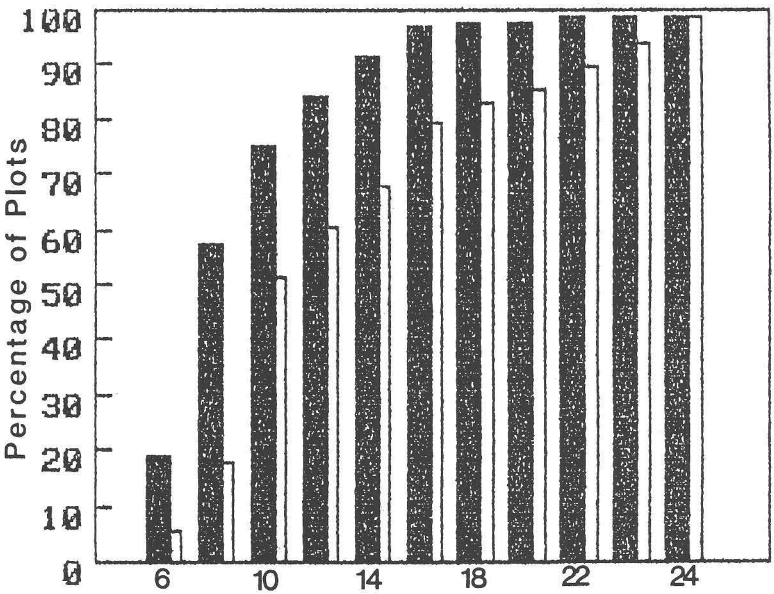

Figure 3 Mean Angle of Plot.

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

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

Limitations of the Study

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

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

Explanation of Variability

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

Acknowledgements

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

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

REFERENCE

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APPENDIX 1

LPC BASAL SWEEP SURVEY — SUMMARY

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

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

APPENDIX 1 (continued)

LPC BASAL SWEEP SURVEY — SUMMARY

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

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

APPENDIX 1 (continued)

LPC BASAL SWEEP SURVEY — SUMMARY

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

Explanation of abbreviations in Appendix 1.

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

Potential End-Use Applications of Lodgepole Pine in Ireland

J. A. Evertsen

(Forest Products Department,
Institute for Industrial Research and Standards)

SUMMARY

During the next decade lodgepole pine will become available to the home market in large quantities. To date its potential as a high end-value product has not been realised. Optimising this potential will be paramount to its success as a new commercial species available to the processing and manufacturing industries. An outline is given of its timber properties and its silvicultural management in Ireland. The realisation of the potential of lodgepole pine will be in import substitution. The extent and value of the relevant import markets is indicated and the status of the processing and manufacturing industries which should provide the impetus for substitution are surveyed. A TASKFORCE has been set up to provide a technical and commercial input to ensure an optimised utilisation of this new commercial species.

INTRODUCTION

Lodgepole pine (*Pinus contorta* Dougl. ex Loud.), was first introduced into Ireland in 1884. Several trees were planted as specimens in Cong, Co. Galway (O'Driscoll, 1980). However, it was not until 1916 that lodgepole pine was first planted with a commercial intend at Avondale, Co. Wicklow. Experimental plots of South Coastal and Inland provenances were layed out for the selection of commercially viable varieties that were most suitable for Irish conditions. A number of these trees are still extant. The performance of the South Coastal provenance was quite impressive. On the strength of this, the Director of Forestry, A. C. Forbes, initiated the promotion and planting of lodgepole pine. Large quantities of seed of the South Coastal type were imported from Washington and Oregon coastal regions of the United States of America (U.S.A.). The precise origins are unknown (Lines, 1957). The first commercial lodgepole pine forest was planted in 1918 at Ballyhoura, Co. Cork (Edwards, 1955; Lines 1957). At present lodgepole pine accounts for 26% of the state owned forests and 21% of the total national afforestation (Purcell, 1982; Review Group on Forestry, 1955).

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During the 1980s, for the first time large volumes of lodgepole pine will mature and will be brought onto the Irish timber processing and manufacturing market. The wood quality and the timber properties of this fast grown species are not sufficiently known to decide on the most suitable end-use applications. In this paper, a background on the wood quality aspects of lodgepole pine will be given along with some of the existing technological and commercial realities.

Lodgepole Pine and its Origin

Lodgepole pine had its origin in the north-west of North America, where it was also known as "Shore" or "Beach pine". Lodgepole pine is a pioneering species, hence, it is adaptable to various growth conditions, both geographically and ecologically. Geographically, it grows between 31° to 64° northern latitudes on the western side of the Rocky Mountains. Within this area, it is found from sea level to 2,000m in British Columbia and up to 3,800m in the south west of the U.S.A. (Edwards, 1954). Ecologically, lodgepole pine has a great capacity to adapt to diverse and often adverse growing conditions. As a pioneering species it can withstand the affects of exposed conditions, infertile sites, competing vegetation, extreme seasonal temperatures and high levels of rainfall (Edwards, 1954; Lines, 1966). It is successful on most soil types, except on the heavier soils, where penetration by the taproot is inhibited (Edwards, 1954). The natural variation within lodgepole pine is probably greater than in any other softwood species. Edwards (1954) reports that by IUFRO agreement, the various provenances of lodgepole pine are actually various ecotypes of the species. Separation into different races is still continuing. Two distinct types of lodgepole pine are recognised, "coastal" and "inland". The coastal type is generally found along the coast at an elevation up to 170 metres, while the inland type is found further inland and at an elevation generally higher than 330 metres. Their phenotype characteristics are quite different, principally in their growth and branching habits. The coastal type has a denser growth habit with heavier branching (Lines, 1966).

Some Silvicultural Aspects of Lodgepole Pine in Ireland

Being a pioneer species lodgepole pine was planted mainly on poorer sites where Sitka spruce would not perform adequately or not at all (Brazier, 1980). Up to 1963, three provenances were planted in Ireland, South Coastal, Lulu and Inland. The volume of production of Lulu and Inland provenances did not meet expectations and only South Coastal has been planted since then. South Coastal is the more vigorous of the three provenances. The average annual volume production fo South Coastal is yield class 12 (Fitzsimons, 1982). However, South Coastal does have some problems. It does not grow as straight as the other two provenances. Macdonald (1954) found however, that of the fast growing coastal types one in three trees had a straight stem. Macdonald did not quantify the parameters which qualified a straight stem. South Coastal also branched more profusely and the branch members were generally greater. Lines (1957) was of the opinion that stands which had trees with bad stem form and heavy branching, came originally from seedlots of true scrubby shore pine. In contrast, the stands of good form and finer branching came from the forest areas of good growth, but still near the coast. The coastal types that had their seed origin in the states of Washington and Oregon appeared to produce trees that had the greatest growth in height (Macdonald, 1954). The variability in growth appeared also to have been influenced by environmental conditions, such as soil types, spacing and exposure (Lines, 1957). There is no single best provenance in lodgepole pine. The "best" provenance is that which is best suited to a particular end-use and offers a compromise on stem form (Lines, 1966).

The actual silvicultural regime that is applied to lodgepole pine is determined mainly by three factors:

1. End-use products and their market,
2. Stability of the crop during its life,
3. Profitability to the grower.

In this paper the discussion will be restricted to the implications of silvicultural management on timber quality and its effect on the end-use products and their market.

Silvicultural Management and Timber Quality

The quality of timber and its intrinsic properties can be influenced by various types of silvicultural management. These management practices strongly influence the quality of the log that is produced. The properties that are of primary concern in lodgepole pine, South Coastal provenance, are stem form and the extent and intensity of branching.

A. *Stem Form*

The causes of stem form distortion or basal sweep appear to be many and varied. The main predisposing factors seems to be (Hendrick, 1984):

1. Low root/shoot ratio of transplant stock,
2. The method of planting,
3. The method of ground preparation.

Basal sweep, results in commercial loss of the lower part of the bottom log – the most valuable section of the tree. The crooked sections of the log must be discarded since it is not possible to process these sections with the standard log conversion systems. Basal sweep can affect the stem up to 3 metres from ground level. Even if small section sizes, such as pallet wood, are extracted, the yield from a sawlog can still be as low as 30%. Sweep measurements made at 1·3m can give a reasonably accurate estimate of log yield that can be expected (Fitzsimons, 1982).

The effect of the leaning of the stem on wood quality is principally in the formation of compression wood. The behaviour of timber containing appreciable amounts of compression wood differs from timber free of such compression. In compression wood, the tracheids are shorter and have a thicker cell wall. Stability, shrinkage, strength and density are generally appreciably affected. In a study on the effect of compression wood on the strength properties of Sitka spruce, Dhubhain found that planks containing more than 10% compression wood will rupture in a brash fashion, while over 20% compression wood will actually lead to a decrease in the strength properties of the timber (Dhubhain, Evertsen and Gardiner, in press).

B. *Branches and Knots*

The intensity and extent of branching is the second most important factor that affects timber quality. Although knots may be aesthetically desirable in the case of pine furniture, their presence can result in significant degrading effects when grading this material for joinery and other high value end-uses. Knot size and position in the machined joinery section has a great influence on the quality grade when graded in accordance with the relevant timber standard. Even though 'live' knots in lodgepole pine machine well they do increase the wear and tear on processing machinery. Techniques, such as finger-jointing, have been developed to cut out severe knots and produce knot-free timber lengths.

Relatively knot-free timber can be produced through several silvicultural management practices. Pruning, spacing and thinning regimes can be used to reduce the intensity of branching. Spacing and thinning will of course affect the growth rate as well. O'Kelly (1952) suggested that it would be necessary to prune lodgepole pine as early as the 14th year. This was recently confirmed by Fitzsimons who indicated that thinning and pruning beyond the age of 12 could adversely affect the stability of the crop (pers. comm.). Phillips (1980) found that even though spacing did increase both the stem volume and the diameter of branches, the branch/stem ratio remained virtually unchanged. The number of branches per whorl did not increase with wider spacing either. The ultimate effect of thinning and spacing did however result in an increase in the total knot volume in the log. O'hEigeartaigh, Evertsen and Stephen (1985), demonstrated for Sitka spruce that at the time of log conversion, the effective knot volume in a log could be reduced by rotating the log into an optimal position. A reduction of up to 12% in the cumulative knot volume of the sawn timber could be achieved.

Phillips (1979; 1980) carried out a preliminary evaluation of the effect of pruning, thinning and spacing on timber grade out-turn in lodgepole pine, yield classes 12-14. These findings showed that with intensified silvicultural management, timber quality could be improved. The economics of this intensive management will depend on the end-use products manufactured from these trees. In the same study, Phillips (1979) could not find a relationship between branch size and overall grade.

Wood Properties of Lodgepole Pine

The quality of a timber and its end-use application is determined by the interaction and cumulative expression of individual wood properties. These properties can best be described when grouped into two separate categories that deal with the intrinsic wood properties and the performance of wood as a material.

A. *Intrinsic Wood Properties*

This category refers to those wood functions which have an influential role in the determination of the quality of wood and the likely level of its performance.

1. *Wood density* is a property generally associated with the mechanical strength properties of timber and paper pulp yield. Lodgepole pine has a somewhat different type of wood from that of Scots pine and Corsican pine, and could be placed between the soft pines, such as yellow pine (*Pinus strobus*) and the harder pines, including Scots pine (*Pinus sylvestris*). Wood density values varying from 415-372 kg/m^3 have been reported (Anon., 1955, 1960). The variation is due principally to provenance and growth conditions (Brazier, 1980). Density is an intrinsic wood property that can be genetically passed on. The variations that exist between provenances and between individual trees, can be exploited to the

benefit of crop and tree quality improvement through selective breeding programmes.

2. *Growth rate* is greatly influenced by growth conditions. In one of the consignment reports, carried out by Princes Risborough Laboratories, an average growth rate of 4·5 growth rings/2·5mm was found (Anon., 1960). Vigorous growth is generally evident during the first 10-15 years after which a tapering off occurs (Anon., 1967b).

3. *Fibre length* is important to the quality of paper products. It plays a significant role in the tearing strength of paper. Fibre length varied between provenances (Brazier, 1980; Henderson and Petty, 1972), between trees in a stand and within the tree (Taylor et al., 1982). Within the tree, the juvenile wood produces a shorter fibre than the adult wood. Similarly, in compression wood the fibre can be up to 30% shorter when compared with "non-compression wood" fibres in the same ring (Henderson and Petty, 1972).

Fibre length can also be promoted through selective breeding programmes. It is claimed to be the easiest intrinsic property to alter through tree breeding (Taylor et al., 1982). Lodgepole pine does produce a moderately long fibre suitable for paper making (Anon., 1967b). In a study by the Princes Risborough Laboratory on lodgepole pine, fibre length measurements were compared with Sitka spruce and Scots pine. Lodgepole pine had a fibre length of 2·4mm, while Scots pine fibres were 2·5mm and Sitka spruce 3·0mm (Anon., 1960, 1966).

4. *Compression wood* is one of two types of reaction wood formed by the tree, generally to counteract adverse effects of environmental factors to which the process of wood formation is subjected. The fibres in compression wood are shorter and have a greater cell wall thickness. Compression wood has an adverse effect on the quality of the timber, regardless of its end-use destination. In lodgepole pine the occurrence of compression wood is common. It is largely induced by the lean of the stem in the direction of the prevailing wind. In the Princes Risborough Laboratory study reaction wood was found both on the shortest and longest radii – this coincided with the south-west and north-east cardinal points respectively (Anon., 1966). The prevailing wind is from the south-west. The occurrence of compression wood often appears to be throughout the stem, distributed in a spiral fashion along it (Fitzsimons, 1982). There does not seem to be a specific association between the formation of compression wood

and provenance (Anon., 1967a; Brazier, 1980).

5. *Slope of Grain* in timber affects the stability of the material, especially during drying. In severe cases, degrading of the mechanical strength properties can result. In lodgepole pine slope of grain has been shown to be of minor importance and is unlikely to be associated with provenance selection (Anon., 1960, 1966, 1967a & b; Brazier, 1980). Inclined grain has been found in both the butt logs and nodal areas, and is due to basal sweep and the heavy branching habit respectively (Anon., 1960, 1967a).

6. *Heartwood and sapwood* are of interest, especially with regard to the lack of natural durability which is particularly evident in the sapwood area. Sapwood generally occupies the outer 13-15 annual rings – approximately 44-85% of the stem cross section, depending on the height of measurement along the stem. With an increase in height, the number of rings in sapwood is slightly less, but the proportion of sapwood area increases (Edwards, 1955; Brazier, 1980). This is less than in Scots pine, where up to 75-88% of a cross section can be sapwood (Anon., 1955, 1960; Brazier, 1980). Some variability appears to exist in sapwood width between provenances on any one site (Brazier, 1980). In contrast to species like Douglas fir, lodgepole pine does not show a great colour differentiation between heart and sapwood areas (Edwards, 1955).

B. *Properties Influencing Performanace and End-Use*

The interaction of the intrinsic wood properties affects the behaviour and performance of timber, which in turn strongly influences its end-use application.

1. *Drying:* Lodgepole pine behaves in a stable manner when air or kiln dried. Little splitting, checking or collapse develops. the distortions (spring, twist, bow and cup), that do occur, are generally of an insignificant nature. The loosening of dead knots, can pose a major problem (Anon., 1955, 1967a). Lodgepole pine has been dried under relatively severe conditions without any adverse degrade (Edwards, 1955; Anon., 1966; Brazier, 1980). A drying schedule with a temperature of 82°C and 12% humidity has been successfully used. Recent drying experiment showed however that both the sawing pattern and the size of the timber section played a significant role. Boxed heart sections of 75×115mm, used in joinery manufacture, were more liable to split than smaller section sizes. It appears that adult wood was more stable than juvenile wood (Anon., 1967b). A variation in stability is found to occur between provenances. Inland provenance generally performs better (Brazier, 1980).

2. *Strength:* The physical and mechanical strength properties of lodgepole pine were found to lie between that of spruce and Scots pine (Gallagher, 1979), although the strength properties of Irish grown lodgepole pine were somewhat better than those of Irish grown spruce (Dunleavy, 1969; Anon., 1970). Grading studies carried out by Knaggs (1978) and Phillips (1979, 1980) have shown that a major factor causing degrade in Irish grown lodgepole pine is the presence of knots. These were the result of heavy branching, especially in the South Coastal provenance.

3. *Durability:* Lodgepole pine is a non-durable wood species. When the exposed sapwood area of a log or sawn timber is not dried rapidly it is very susceptible to blue-stain infection. The effect of the blue-stain infection is purely of an aesthetic nature and does not affect the strength properties of the timber. Infected timber has however, had a tendency to absorb a greater amount of preservative. The commercial implication of blue-stained timber is generally a down grading of the quality and the sales price of the material. Heartwood is the more naturally durable section, but it is less permeable to preservatives than the sapwood. In the heartwood, the aspiration of border pits prevents the diffusion of preservative throughout the section.

In preservation experiments, lodgepole pine has been pressure treated with creosote. The sapwood was found to be readily permeable, while the heartwood showed only minimal absorption (Anon., 1966, 1967b). The Electricity Supply Board carried out treatment trials of lodgepole pine transmission poles and found that the uptake of creosote by this species was greater than in other species more commonly used for transmission poles. Consequently, this would render the use of lodgepole pine in transmission lines too expensive (O'Kelly, 1952). Copper/Chrome/Arsenic and organic solvent preservatives have also been successfully used on sawn lodgepole pine timber (Gallagher, 1979).

4. *Machining Properties:* Lodgepole pine machines very easily and gives a good surface finish upon planing (Edwards, 1955; Anon., 1966, 1967b). It stands up well to mortising and profile cutting (Gallagher, 1976). Lodgepole pine has a gradual transition from earlywood to latewood, giving it a very uniform texture and colour (Brazier, 1985). The timber causes only slight dulling effect when machined (Anon., 1955). Good machinability and uniform texture are primary requirements for successful usage in joinery manufacture.

AVAILABILITY OF LODGEPOLE PINE

In the assessment of the potential end-use of fast grown lodgepole pine in Ireland, the log availability and quality will greatly influence the demand on this species by the various end-use markets. In this section the availability of lodgepole pine in the period 1988-1997 will be summarised. Four categories of timber material can be distinguished.

1. Large sawlog, with a top diameter greater than 20cm.
2. Small sawlog, logs with a top diameter between 14 and 20cm.
3. Pulpwood size logs, with a top diameter between 7 and 14cm.
4. Forest and sawmill residue.

With the increasing volume of mature lodgepole pine coming to hand, the availability of the first three categories, as projected by the Forest Service, will be discussed (L. P. O'Flanagan, pers. comm.).

The total production of lodgepole pine is made up of three provenances, South Coastal, Lulu and Inland. These provenances make up 72%, 19% and 9% respectively of the total volume produced (Evertsen, 1986). In the decade leading up to the year 2000, lodgepole pine will produce a volume of 350,000m^3. The mean annual availability during 1988-1992 will be 290,000m^3, while 412,000m^3/annum will be available during the following five year period (Table 1). The total volume produced will be forthcoming from both clearfellings (45%) and thinnings (55%). Between these two harvesting categories, large sawlog, small sawlog and pulpwood will be produced (Figure 1).

Table 1: Total volume (000m^3) of lodgepole pine roundwood available during 1988-1997. (L. P. O'Flanagan, Forest Service).

	Pulpwood	**Small Sawlog**	**Large Sawlog**	**Total**
1988-92	1075	250	125	1450
1993-97	1515	360	175	2060
TOTALS	2590	610	300	3510

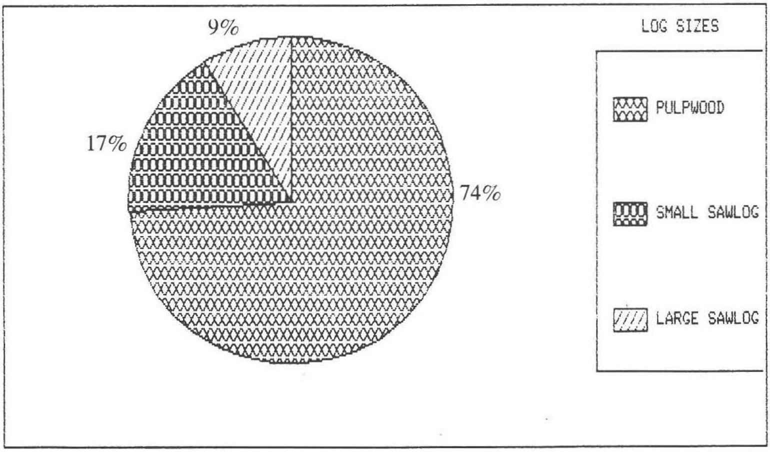

Figure 1 The availability (%) of lodgepole pine log sizes during 1988-97 (all provenances). (Forest Service)

Considering the problems with stem form and subsequent optimal primary processing in the sawmill, the actual volume of pulpwood will most certainly be increased by the sawmill generated residues. Fitzsimons (1982) estimated a conversion rate of 32%, while Atanackovic and Evertsen (unpublished date) determined recently a conversion rate of 38% for home-grown lodgepole pine. Assuming a mean conversion rate of 35%, then 590,000m^3 of sawlog residue will be produced during the next decade in the form of butt-ends, slabs and sawdust. With pulpwood, this would produce approximately 3,180,000m^3, 91% of timber volume harvested, for the timber reconstitution industry.

Potential End-Use Markets for Lodgepole Pine

In North America lodgepole pine has been used over the years for a diverse range of products. It was lodgepole pine that provided the sleepers for the "GRAND TRUNK PACIFIC RAILWAY" through the Prince George region in Canada during 1913-1914. Lodgepole pine was used in a great diversity of both high and low end-value products. These ranged from telephone and transmission poles to pit-props, piling, fencing and packaging. In Alberta it is used as one of the major construction, carpentry and joinery timbers (O'Kelly, 1952; Anon., 1955; Edwards, 1955). During the last number of years, the Canadian producer BALFOUR initiated an export campaign, promoting the use of Canadian grown lodge pole pine as a joinery material in the United Kingdom (Kloos, 1986).

Lodgepole pine has also been successfully used in the manufacture of reconstituted timber products. Ramaker et al. (1976) have successfully used lodgepole pine in the manufacture of flakeboard, while Taylor et al. (1982) successfully veneered lodgepole pine for the production of structural plywood. Lodgepole pine has also been used for high grade paper pulp suitable for newsprint, wrapping paper and high-grade printing paper (Edwards, 1955).

To optimise the return on lodgepole pine grown in Ireland, import substitution would be the obvious objective. In order to do this effectively, "product groupings" with the most rewarding returns should be identified and evaluated.

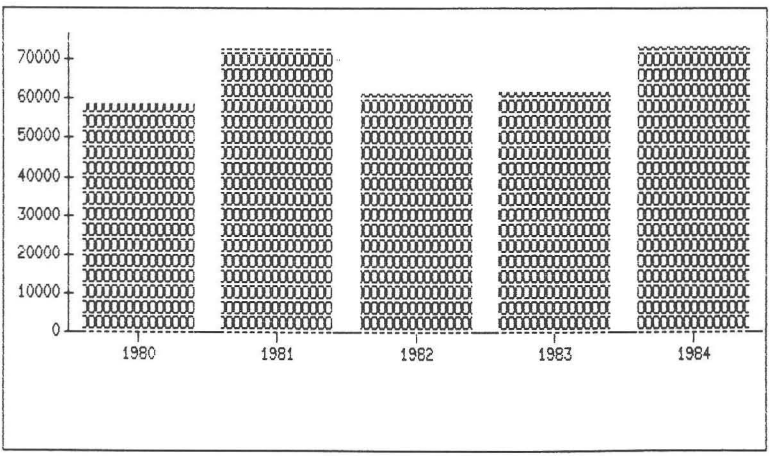

Figure 2 Annual import values (£000) of softwood products and sawn timber during 1980-84. (Central Statistics Office)

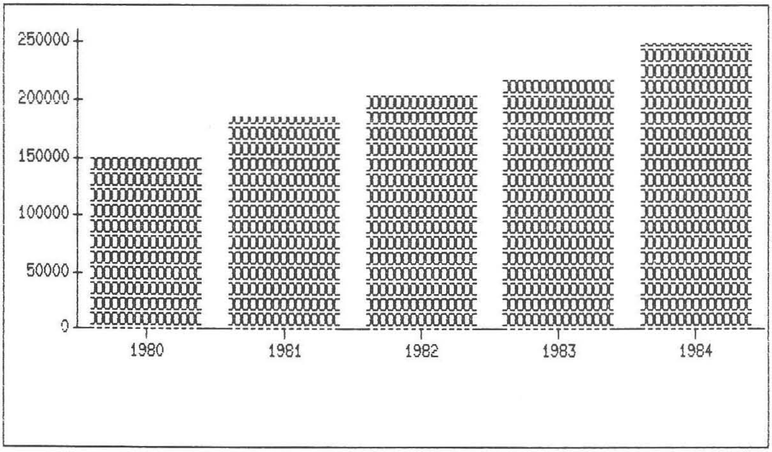

Figure 3 Annual import values (£000) of paper and paper products during 1980-84. (Central Statistics Office)

1. *Sawn timber and reconstituted timber products.* The information on softwood imports from the Central Statistics Office (CSO) records can basically be divided into ten product groupings. Since no distinction is made between softwood species in the import records of the CSO, the relevance and value of potential import substitution by lodgepole pine can be assessed by first examining those product groupings which have a significant monetary value. In addition, the suitability of lodgepole pine for the products in these product groupings needs to be evaluated.

The import of softwood and softwood products has maintained a steady trend over the five year period between 1980 and 1984. The annual import bill fluctuated between £58,000,000 and £71,000,000 (Figure 2).

Three product groupings in particular had a significant impact on the cost of imports. The import cost relevant to these three product groupings accounted for 92% of the total softwood import bill for the 1980-1984 period. Individually, the product groupings of sawn timber, reconstituted wood and builder's carpentry and joinery, accounted for 61%, 19% and 12% of the imports respectively. During the 1980-84 period this amounted to an average of £64,000,000 a year.

2. *Paper and paper products.* Lodgepole pine, as a species, is considered to be suitable for paper manufacturing. The paper and paper products available on the market greatly vary in their requirements for specific wood properties. These requirements are generally met by a combination of a specific pulping process and a specific timber species or mixture of species. At present Ireland does not have a paper pulp manufacturing industry. Hence, paper pulp and a substantial amount of paper and paper products have to be imported. During the period 1980-1984, the annual paper import bill to Ireland nearly doubled, from £149,000,000 to £250,000,000 and this pattern is continuing (Figure 3). The category of paper and paper products imports is very diverse. Principally, three product groupings are of significance and account for 93% of paper and paper products imports:

(i) packaging and packaging related materials.

(ii) newsprint and writing paper.

(iii) tissue types of paper.

On average these groupings accounted for 54%, 27% and 12% respectively, of the annual import bill over the period 1980-1984. In monetary terms packaging and packaging related materials amounted to an annual average value of £107,000,000. Printing, newsprint and writing papers were valued at an annual average of £54,000,000, while tissue types of paper accounted for an annual average of £24,000,000 over the same period. The general trend in all cases showed a continual annual increase during the 1980-84 period.

Lodgepole Pine in the Present Irish Wood Processing Industry

Both the sawmilling and manufacturing industries were surveyed and questionnaires were specifically formatted for both sections of the industry. A total of 130 survey circulars were distributed. The selection of the companies that were circulated with the questionnaire was made by the following method:

(a) sawmills known to have a minimum output of 1000m^3 per annum were included – this amounted to a total of 37 sawmills,

(b) in the case of the manufacturing industry, two groups of manufacturers were distinguished, the joinery and the furniture manufacturers. The number of joinery companies was quite large. A selection was made by selecting those manufacturers who contribute most significantly to the joinery market. A total of 56 joinery manufacturers were circulated. The furniture manufacturers were selected form the "Directory of Irish Furniture and Floor Coverings Manufacturers" (Irish Goods Council). Manufacturers that used pine were included. A total of 37 furniture manufacturers were circulated.

Even though not all companies that made returns used home grown lodgepole pine they did contribute to the survey by submitting their experiences. The sawmilling industry responded with a 35% return rate (13 out of 37 questionnaires).

Of the sawmills that responded 62% were using lodgepole pine. The majority of those mills did not process more than 500m^3 of lodgepole pine per year. Only 15% of the mills processed in excess of 5000m^3. Their product outlet was mainly pallet production. The majority of mills would not process more lodgepole pine, primarily because there was no specific demand for it (23% of the sawmill which did handle less than 500m^3 of lodgepole pine per year, did not find that they obtained a profitable return from it).

Claims of conversion rates varied from between 60% to 38%. A sawmill claiming a 60% recovery rate defined half of its product range as furniture. Sawmills that claimed a lower conversion rate were geared to the pallet and the fencing markets. Apart from the Dundrum sawmill (Forest Service), no other sawmill appeared to produce lodgepole pine for use in joinery manufacture.

Of the mills surveyed 88% did not experience any great difficulty in obtaining lodgepole pine, although it was obtained mostly as a minor species in mixed lots. That it was obtained in mixed lots and that the log quality of lodgepole pine was perceived as poor, may have influenced the opinion of the trade that lodgepole pine was over-priced. In addition, there was no demand for greater quantities of lodgepole pine, especially with poor stem form. The trade, however, did not eliminate the possibility of the use of lodgepole pine in the future. This attitude should make the acceptance of more straight stemmed material easier.

There was a divided opinion on the occurrence of knots; 44% considered knots to be frequent while a further 44% considered the knot occurence to be excessive. The latter group produced solely for the pallet market, while the former group produced for both the pallet and furniture markets. (56% found the knots in sawn timber to be in the range of 20-40mm in diameter).

Blue-stain: The majority of sawmills found blue-staining of the timber a severe problem. The food industry does not accept pallets which contain blue-stained timber. In the furniture industry, the staining renders the material unacceptable. The blue-stain causing fungi thrive especially on freshly cut surfaces. Hence the time lapse between felling, conversion and drying is critical. 78% of the sawmills claimed to receive their logs within two weeks after felling and 44% converted the logs within one week of reception at the mill. Conversion was achieved by all mills within four weeks after reception at the mill.

In the survey 67% of the mills found that blue-stain occurred in the majority of their logs before conversion. When no blue-stain was present at the time of conversion, blue-stain developed on the sawn timber before drying. Subsequent to sawing, the timber was generally stickered for kiln drying and left uncovered. The majority of sawmills kiln-dried their sawn timber, commencing within seven days after log conversion.

The overall sawmillers' opinion of lodgepole pine was that it was a poor quality raw material that had a bad stem form and was knotty. There was great variation in log quality, especially between stands and between forests. However, selected logs were highly praised.

The manufacturing industry: This industry (furniture manufacturers; joinery manufacturers) responded by returning 14 out of 92 questionnaires – a 15% return rate. Of the eight survey returns made by the furniture industries, only two companies stated that they had used lodgepole pine. Two major reasons appeared to be central to the very limited usage of lodgepole pine in the furniture manufacturing industry:

1. The industry did not know the properties of this timber, and
2. Twenty five percent stated that they did not know where the material could be bought.

One of the two companies that did use lodgepole pine ceased using this species on the basis of their experience with one experimental batch. In their experience the main disadvantages were blue-stain in 30% of their stock upon kiln drying and "moisture pockets" along the timber length which caused the moisture content to vary between 10 and 20%. In spite of these problems this manufacturer still has an open mind about the use of lodgepole pine in furniture manufacture.

The second company produces 1500 furniture units ($40m^3$) per year and used lodgepole pine exclusively. They considered however that the quality of the material available was poor and thought that a quality grading system was needed, especially if this pine was to be extended into more upmarket products. They also felt that the supply of timber was very limited and erratic. The company purchased their timber kiln dried, but found that the timber was affected by excessive shrinkage, twist, and loosened knots upon kiln drying. Blue-stain occurred in approximately 10% of the stock. Whenever blue-stain did occur it was severe and rendered the material unsuitable for the intended end-use. Lodgepole pine machined easily and gave a smooth surface finish, better than that of Scots pine. Lodgepole pine was also considered to be easy wearing on machining tools and compared favourably with Scots pine. No glueing or nail and/or screw holding problems had been experienced. The surface-coating finishes such as sealer, stain and clear finish did not pose any problems.

None of the six joinery companies that returned the questionnaire used home grown lodgepole pine in the manufacture of joinery. The primary reasons were that they did know the properties of the timber and they did not know where the material could be bought.

Discussion

At present lodgepole pine comprises 21% of the total afforestation in Ireland. During the next decade, large volumes will be brought onto the timber processing and manufacturing markets for the first time. In contrast to North America, lodgepole pine grows at a much faster rate in Ireland. In anticipation of the maturing and coming on stream of this species, options for optimal end-use utilisation should now be examined.

End-use application and choice of timber products is strongly influenced by log quality and timber properties. Concise silvicultural management of lodgepole pine is crucial to the improvement of log quality. Basal sweep and heavy branching are the principal factors that affect log quality. These factors appear to be peculiar to the South Coastal provenance, which was selected over the Inland and Lulu provenances for its greater volume production. Planting techniques and green pruning are the key management practices to achieve the log quality improvements required. Fitzsimons (Forest Service) has found that intensive management can be applied up to the age of 13. Beyond this age, crop stability can be impaired.

The potential range of end products for lodgepole pine is substantial. The primary objective in utilising this species is as a substitute for costly paper and timber imported products. From the literature it is evident that lodgepole pine can be used in both low and high end-value products.

Sawlog: Large sawlog will comprise 9% of the total volume of lodgepole pine available during the next decade. Due to bad stem form a mean log conversion rate of 35% could be expected. This would produce 105,000m^3 of sawn timber over the decade, enough to provide for $\pm$ 15% of the needs of the joinery industry. (Imported Red Deal for the joinery market is valued at approximately £270/m^3 of rough sawn timber).

The volume of pulpwood that will become available is forecast at 259,000,000m^3 during the next decade. In addition to this, 65% of sawlog will be sawmill residue in the form of crooked butt ends, slabs, bark and sawdust. Of this volume 13% can be accounted for as bark and 5% as sawdust. Hence an additional 485,000m^3 can be added to the pulpwood category, which will comprise 91% of the total volume of lodgepole pine to be harvested during the decade.

Potential end-uses for pulpwood material is in reconstituted products, such as paper pulp, various types of reconstituted boards and various types of laminated timber products. All of these could be classified as high end-value added products. Paper and paper products imports into Ireland amounted to an average of £200,000,000/annum during 1980-84. If the expected volume of pulpwood becoming available during the next decade were to be processed to paper pulp, at a pulp yield of 45% and a wood density of 450 kg/m^3-550,000 tons of paper pulp could be produced, at a market value of £250/ton, this would value at approximately £140,000,000.

In the case of reconstituted timber products, medium density fibre boards and laminated products would belong in a similar high end-value product range. In addition to substituting imported products the manufacture of paper pulp and laminated products in particular will also initiate the establishment of new industries in Ireland.

The present timber processing and manufacturing industries do not appear to optimise the potential utilisation of lodgepole pine. The primary outlet for the sawmilling industry using this pine appears to be pallet wood: it is used in very limited quantities in the manufacturing industry. This situation is largely due to this pine being seen as of inferior quality and also due to a lack in awareness of its existence and of its potential.

These attitudes can be changed through educational and promotional programmes. Inferior quality of the sawn timber is largely due to blue-stain and knots. The former can be effectively solved through sawn timber production management by the introduction of a chemical treatment after sawing. When knots are not desirable finger-jointing can be used to produce knot-free material. The introduction of these non-traditional practices, should be carried out in conjunction with an appropriate product marketing initiative. The creation of awareness and introduction of new manufacturing technology will be vital in the continuing development of the processing and manufacturing timber industry.

In anticipation of optimising the utilisation of fast grown lodgepole pine a lodgepole pine TASKFORCE was set up in 1986. Input to the TASKFORCE is at present concerned with the sawn timber potential of the pine, particularly in the joinery industry. Although pulpwood material will comprise 91% of the total lodgepole pine volume available during the next decade, the processing of pulpwood would require the initiation of new industry. Rationalising available volumes of sawlog has an immediate input into existing industries and also contributes directly to import substitution.

CONCLUSION

The potential of fast-grown lodgepole pine in Ireland is very encouraging. However, to optimise this potential, an intensive programme of education, and of the development of the growing, processing and manufacturing industry is required. The major volume influx of available lodgepole pine will commence by the early to mid-1990s. The preparation of industry in order to absorb this potentially high end-value timber will be of great importance if we are to optimise a heretofore considered inferior raw material. Using a TASKFORCE format, developments in the growing, processing and manufacturing industries should be promoted by:

1. intensification of silvicultural management practices through breeding programmes, selective thinning / respacing and green pruning:

2. identification and examination of potentially high end-value product areas;

3. encouraging the introduction and development of new products and associated technologies in the existing industries;

4. identification of new industries, in particular those directed at import substitution; and

5. developing the potential and marketing of lodgepole pine both as a raw material and as a finished product.

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A Thinning Experiment in Avoca Forest: Results Over 23 Years

Ted Lynch

Research Branch, 2 Sidmonton Place, Bray, Co. Wicklow.

Background

During the spring of 1964, a thinning experiment was established in Avoca Forest, Co. Wicklow. The object of the experiment as stated in the Working Plan was "to determine the effects of thinning to different levels of standing basal area after treatment, on basal area and volume increment, diameter and height of the 40 largest stems per acre and diameter assortments of the crop". At that time, management tables had not yet been constructed and there was no recognised thinning prescription consistent with crop productivity. British forest management tables first appeared in 1966 (Bradley et al., 1966). These were in imperial units and were followed in 1971 (Hamilton and Christie) by tables in metric units and, more recently, by a wider range of yield models (Edwards, 1981)). Thinning grades, defined by the Forestry Commission of Great Britain varied from "A" or no thinning to "D" or heavy thinning.

The Experiment

The experiment is located in a crop of Sitka spruce at Avoca Forest, compartment 81032G. The site is 160 metres above sea level and slopes gently southwards. Soil type is a brown earth, previously cultivated for agricultural purposes. Provenance is uncertain, it is probably Washington coast.

The crop was planted in the spring of 1943 at an average spacing of 1·5 metres or 4,000 plants per hectare. No site cultivation was carried out.

Local yield class is in the range 20-24m^3, maximum mean annual increment.

Three thinning treatments described as light, moderate and heavy are compared. Experimental design is a randomised block with each treatment replicated twice. Plot size is 0·04 hectares.

History of Thinning

The crop was 21 years of age when the experiment was established and first thinnings felled. Subsequent thinnings followed at 25, 29, 34, 39 and 44 years. All six thinnings were low and selective in type. The experiment has survived intact, no windblow or other

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Avoca Forest, Sitka spruce age 26 moderate thinning.

damage has occurred. A full assessment was taken at each thinning with an additional assessment at 37 years.

OUTLINE OF EXPERIMENTAL TREATMENTS

The present paper sets out details of all full assessments in the familiar "yield table" format (Tables 1, 2 & 3). Effects on growth of the three thinning treatments are outlined with special emphasis on heavy thinning: a breakdown into the important sawlog categories are presented.

All data refer to live stems whose diameter is 7m or greater at breast height.

The following observations are relevant to the three tables:

1. In Table 1, which itemises the light thinning treatment, a small thinning was removed at 44 years which has been ignored in the table so that the details presented are for the total crop before thinning.

2. In the present context, the light thinning treatment may be regarded as a control. It is safe to assume that the thinnings removed represent the trees which would have died in a real, no-thin situation.

Table 1 Avoca 1/64, Details (per ha.) of Light Thinning.

		MAIN CROP AFTER THINNING							THINNINGS					TOTAL CROP		
Year Ended	Age	Stems	Top Ht (m)	Mean Ht (m)	Diam (cm)	Basal Area (m^2)	Vol. 7 (m^3)	Mean Vol (m^3)	Stems	Diam (cm)	Basal Area (m^2)	Vol. 7 (m^3)	Mean Vol (m^3)	Basal Area (m^2)	Vol. 7 (m^3)	M.A.I. (m^3)
1963	21	2,856	12.4	10.5	13.9	43.6	220.5	.077	1,126	9.1	7.3	23.2	.020	50.9	243.7	11.6
1967	25	2,522	15.0	13.2	16.0	51.0	327.4	.130	334	11.0	3.2	13.8	.041	61.5	364.4	14.6
1971	29	2,274	17.0	15.5	18.0	57.8	467.4	.206	247	12.0	2.8	17.0	.069	71.1	521.4	18.0
1976	34	2,136	20.1	18.2	19.3	62.3	584.5	.274	62	13.6	0.9	6.4	.103	76.5	644.9	19.0
1979	37	2,136	21.8	19.3	19.9	66.6	647.4	.303						80.8	707.8	19.1
1981	39	2,000	23.2	19.6	20.7	67.6	698.2	.349	No	Live	Trees			81.8	758.6	19.4
1986	44	1,828	25.6	20.9	22.6	73.2	797.3	.436						87.4	857.7	19.5

Table 2 Avoca 1/64, Details (per ha.) of Moderate Thinning.

		MAIN CROP AFTER THINNING							THINNINGS					TOTAL CROP		
Year Ended	Age	Stems	Top Ht (m)	Mean Ht (m)	Diam (cm)	Basal Area (m^2)	Vol. 7 (m^3)	Mean Vol (m^3)	Stems	Diam (cm)	Basal Area (m^2)	Vol. 7 (m^3)	Mean Vol (m^3)	Basal Area (m^2)	Vol. 7 (m^3)	M.A.I. (m^3)
1963	21	1,817	12.8	11.4	16.0	36.8	196.8	.108	1,880	11.2	18.4	79.5	.042	55.2	276.3	13.2
1967	25	1,496	15.0	13.6	18.9	42.1	297.3	.199	322	14.3	5.2	33.0	.102	65.7	409.8	16.4
1971	29	1,236	16.8	16.7	21.8	46.2	401.2	.324	260	16.8	5.8	48.4	.186	75.6	562.1	19.4
1976	34	1,074	19.8	19.5	24.2	49.6	506.2	.471	160	19.1	4.6	40.9	.256	83.6	708.0	20.8
1979	37	1,074	22.0	20.8	25.4	54.4	558.4	.520						88.4	760.2	20.5
1981	39	952	22.8	21.4	26.7	53.3	583.9	.613	123	21.3	4.4	42.4	.345	91.7	828.1	21.2
1986	44	814	26.0	24.7	30.2	58.4	725.6	.891	136	22.9	5.6	62.0	.456	102.4	1031.8	23.4

Table 3 Avoca 1/64, Details (per ha.) of Heavy Thinning.

		MAIN CROP AFTER THINNING							THINNINGS					TOTAL CROP		
Year Ended	Age	Stems	Top Ht (m)	Mean Ht (m)	Diam (cm)	Basal Area (m^2)	Vol. 7 (m^3)	Mean Vol (m^3)	Stems	Diam (cm)	Basal Area (m^2)	Vol. 7 (m^3)	Mean Vol (m^3)	Basal Area (m^2)	Vol. 7 (m^3)	M.A.I. (m^3)
1963	21	1,162	13.0	12.0	18.1	30.0	165.6	.142	1,916	13.4	27.1	136.9	.071	57.1	302.5	14.4
1967	25	890	15.4	14.6	21.7	32.8	230.0	.258	272	17.6	6.6	43.4	.160	66.5	410.3	16.4
1971	29	655	17.3	16.8	26.1	35.0	305.8	.467	235	21.8	8.8	75.8	.323	77.5	561.9	19.4
1976	34	543	19.9	19.6	29.4	36.8	365.0	.672	111	25.3	5.6	52.0	.468	84.9	673.1	19.8
1979	37	543	22.4	21.1	31.3	41.8	421.0	.775						89.9	729.1	19.7
1981	39	432	23.1	22.5	33.6	38.2	417.0	.965	111	28.1	6.9	71.5	.644	93.2	796.6	20.4
1986	44	333	26.0	25.2	39.7	41.2	471.8	1.417	98	33.0	8.4	95.8	.978	104.6	947.2	21.5

3. Neither treatment has a pronounced effect on top height. Mean height is increased by heavy thinning due to the successive removal of small stems. The differential between top and mean height narrows significantly with heavy thinning.

4. Total volume removed in six thinnings amounted to 306·2m^3 with moderate thinning and 475·4m^3 with heavy thinning, or 29·7% and 50·2% of total production, respectively.

5. Cumulative production expressed as volume to 7cm top diameter is greatest after moderate thinning.

6. There is no indication that mean annual increment figures have yet maximised.

Effect of Thinning on Diameter

Since all thinnings at Avoca were selective, mean diameter growth is a reflection of two concepts:

1. Removal of small-diameter trees in thinning.

2. Enhanced growth rate resulting from thinning to various intensities.

No attempt has been made to separate the two elements.

Table 4 demonstrates the classification of stems after thinning at 44 years into a range of diameter classes.

Table 4 Avoca 1/64: Diameter Distributions — standing crop at 44 years (Stems/ha).

Diameter (cm)	Light Thinning	Moderate Thinning	Heavy Thinning
0-19.9	827	12	—
20-29.9	815	457	12
30-39.9	160	346	210
40-49.9	25	12	74
50 and over	—	—	37

It is obvious that both thinning treatments lead to an enhanced growth rate as evidenced by the numbers of stems in the larger diameter classes. Only heavy thinning yields stems in excess of 50cm diameter at breast height.

Determination of Yield Class

The yield class system outlined by Hamilton and Christie (1971) is used in Ireland to determine crop productivity. General Yield Class (GYC) is derived from top height and age and forms the basis of production forecasting.

Estimates of GYC at Avoca vary from 20 (at 21 & 25 years) to 18 (at 29, 34, 37 and 39 years) to 20 (at 44 years) based on top heights averaged over all 6 plots.

Yield Class is expressed in terms of maximum average volume production per hectare per annum, or maximum mean annual increment (MMAI). Reference to Table 2 indicates an MMAI figure for the crop at Avoca of at least 23. This would indicate that the Production Class for the crop (Hamilton and Christie, 1971) is rated "A" or greater. A local yield class of 24 is possible and should be verifiable at the next assessment.

Effect of Thinning on Production

A differential in standing volume between the three treatments already existed when the experiment was established at 21 years. When allowance is made for these initial differences by use of the covariance analysis technique, adjusted increment values for the 23-year thinning period are derived. These are itemised in Table 5.

Table 5 Volume Increment at Avoca (m^3ha).

Treatment	Initial Volume	Adjusted Increment in the Period:						Adj. Total
		21-25	21-29	21-34	21-37	21-39	21-44	
Light	243.7	106.7	257.2	377.3	437.8	468.7	555.4	799.1
Moderate	276.3	134.4	287.1	433.3	485.7	555.0	759.6	1035.9
Heavy	302.5	120.8	278.5	392.8	451.1	537.1	699.2	1001.7

The moderate treatment consistently accounts for the greatest growth rate. Heavy thinning has reduced increment by 60m^3/ha adjusted, but the effect on total production is minimal. The most significant effect is evident in the control treatment where more than 200m^3/ha production has been lost compared to moderate thinning – increment has fallen off dramatically from about 37 years.

The Effects on Volume Assortments

Three categories of volume assortments are normally recognised. These are defined as "large sawlog" (volume from base to 20cm top diameter), "small sawlog" or "boxwood" or "palletwood" (volume from base to 14cm top diameter and/or the portion from 20cm to 14cm top diameter) and pulpwood (volume from 14cm to 7cm top diameter). A minimum length of 3 metres applies to base lengths to 14cm or 20cm, it does not apply to mid-portions of small sawlog. No minimum length applies in the case of pulpwood. Timber prices vary for each category, large sawlog being the most lucrative.

Taking each treatment at Avoca separately:

Light Thinning: as previously stated, it has been decided to ignore the thinnings removed by this treatment so that only the total crop at 44 years is relevant.

Table 6 Volume Categories from Light Thinning (m^3ha).

Status	Volume	Diam. (cm)	Large Sawlog	Small Sawlog	Pulpwood
Total Crop	797.3	22.6	308.4	315.0	173.9

Moderate Thinning: Both first and second thinnings comprised only pulpwood. Table 7 itemises the situation pertaining to all thinnings, the present standing crop and the total crop.

Table 7 Volume Categories from Moderate Thinning (m^3ha).

Age in Yrs.	Status	Volume	Diam (cm)	Large Sawlog	Small Sawlog	Pulp-wood
21	First Thin.	79.5	11.2	—	—	79.5
25	Second Thin.	33.0	14.3	—	—	33.0
29	Third Thin.	48.4	16.8	—	29.2	19.2
34	Fourth Thin.	40.9	19.1	4.0	26.5	10.4
39	Fifth Thin.	42.4	21.3	8.4	23.9	10.1
44	Sixth Thin.	62.0	22.9	26.4	27.5	8.1
44	Main Crop	725.6	30.2	595.2	99.9	30.5
44	Total Crop	1031.8	—	634.0	207.0	190.8

A total thinning output of 306·2m³/ha comprised 38·8m³ large sawlog, 107·1m³ small sawlog and 160·3m³ pulpwood.

Heavy Thinning: First thinning was comprised only of pulpwood. Table 8 contains relevant details.

Table 8 Volume Categories from Heavy Thinning (m³ha).

Age in Yrs.	Status	Volume	Diam (cm)	Large Sawlog	Small Sawlog	Pulp-wood
21	First Thin.	136.9	13.4	—	—	136.9
25	Second Thin.	43.4	17.6	—	22.4	21.0
29	Third Thin.	75.8	21.8	32.1	29.0	14.7
34	Fourth Thin.	52.0	25.3	31.6	16.1	4.3
39	Fifth Thin.	71.5	28.1	54.4	13.2	3.9
44	Sixth Thin.	95.8	33.0	81.2	11.2	3.4
44	Main Crop	471.8	39.7	441.5	21.8	8.5
44	Total Crop	947.2	—	640.8	113.7	192.7

Six heavy thinnings yielded 475·4m³/ha of which 199·3m³ was large sawlog, 91·9m³ was small sawlog and 184·m³ was pulbwood.

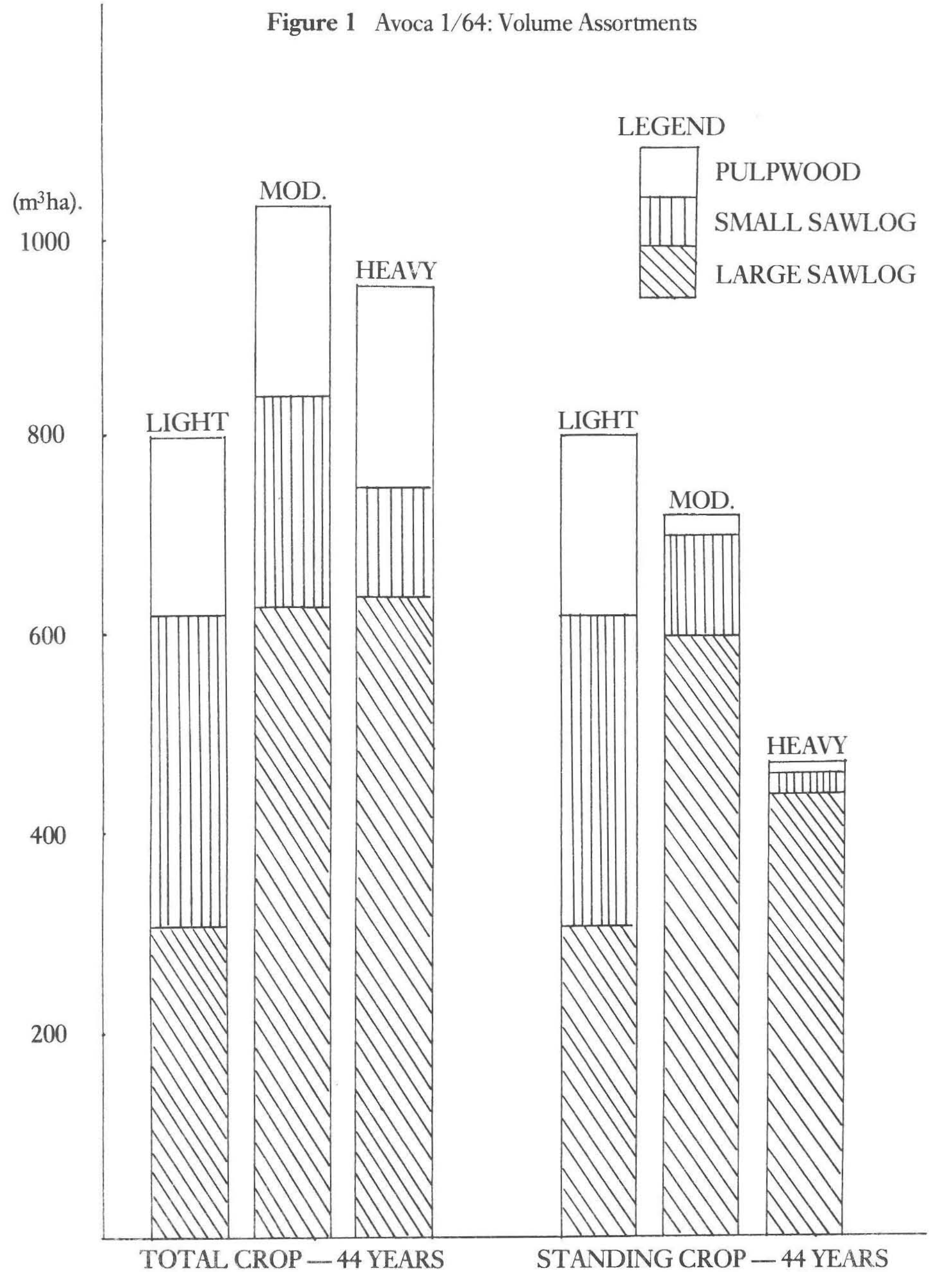
Figure 1 outlines the situation in histogram form for the total crop and the main crop after sixth thinning. the heavily thinned standing crop is composed almost entirely of large sawlog.

The large sawlog element of cumulative production is very similar for both thinning treatments but is significantly in excess of that in control. At 39 years, the differential between the thinning treatments was wider – 401·9m³/ha large sawlog with moderate thinning compared to 493·8m³/ha after heavy thinning. The fact that equalisation is now evident is explained by the increased increment in the moderate treatment during the 39-44 year interval being composed entirely of large sawlog.

Thinning Intensities at Avoca

Hamilton and Christie (1971) discuss the concept of "marginal thinning intensity". They recommend it as the optimum intensity to which forest crops should be thinned. Marginal intensity is reasonably close to an intensity which in terms of annual rate of volume removal is 70% of the yield class. Production forecasts for this country assume the application of marginal thinning intensity unless special constraints apply.

Figure 1 Avoca 1/64: Volume Assortments



In order to express total thinnings felled under the moderate and heavy thinning regimes at Avoca, the following assumptions are made:

1. Both crops will be clear-felled at 49 years.
2. Yield class is 24.
3. A thinning range of 23 years applies.

Based on these assumptions, moderate thinning (306·2m^3/ha removed) is equivalent to 55% of yield class while heavy thinning (475·4m^3/ha removed) equates to 86% of yield class, lighter and heavier, respectively than that normally assumed.

To Sum Up

The experiment at Avoca has proved extremely valuable in providing a comprehensive quantity of data over a full thinning period. Crops of Sitka spruce similar to those at Avoca would normally be clear-felled at about 46 years (indicated age of maximum mean annual increment). However, it is intended to retain the plots at Avoca indefinitely so that growth trends can be monitored into the future. Felling of thinnings in the heavy treatment will be suspended, although in the remaining plots it will be continued.

It is of interest in passing to note that the project was almost abandoned at the outset because of persistent invasions by starlings which ended only when first thinnings were felled.

The heavy thinning treatment is of particular interest. It describes a thinning intensity far in excess of that recommended or practiced in this country. On free-draining, stable sites it offers a series of lucrative thinnings with very little deleterious effect on production. Thinning to this intensity can significantly shorten the economic rotation of a Sitka spruce crop due to the early attainment of tree sizes of maximum value.

A further reflection of the effects of thinning systems such as those applied at Avoca, is seen in the sale price for the standing crop alone after thinning at 44 years. Using current prices for standing timber, the lightly thinned crop (1,828 stems) is worth approximately IR£11,000 per hectare. Equivalent prices for the moderately (814 stems) and heavily (333 stems) thinned crops are IR£17,000 and IR£13,000 per ha respectively. The price for the heavily thinned crop is a reflection of the significant amount of large sawlog present for which a premium price is obtainable.

The experiment at Avoca is unique in that it is the only stand of timber in Ireland which has been carefully monitored throughout its full thinning cycle. The present paper has highlighted only a portion of the data available form the experiment, emphasis has been placed on those areas considered to be most relevant to the Irish forestry situation.

ACKNOWLEDGEMENTS

The experiment was established by Professor P. M. Joyce, University College, Dublin and was the responsibility at various stages of Gerhardt Gallagher and Dermot O'Brien. Since its inception the experiment has been managed by Bill Luddy, research forester, Wicklow.

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A Comparative Study of Wind Damage to the Leaves of Ash (*Fraxinus excelsior* L.) and Sycamore (*Acer pseudoplantanus* L.)

Brian S. Rushton and Anne E. Toner

Department of Biology, University of Ulster, Coleraine,
Northern Ireland, BT52 1SA.

Summary

Wind damage to the leaves of Ash (*Fraxinus excelsior* L.) and Sycamore (*Acer pseudoplantanus* L.) was assessed on 15 trees of each species growing together at the same site, about 5 km from the coast in Co. Londonderry, at the end of the growing season in september, 1986.

99·2% of all leaves of Sycamore and 88·8% of all leaves of Ash showed some degree of wind damage. The mean area of damage for all the sycamore leaves was 2·41% whilst that for Ash was significantly lower at 1·38%. The damage to Sycamore leaves consisted of a combination of discoloured areas, lesions, tears and actual loss of lamina area whilst damage to the Ash leaves was largely confined to the leaflet tips which were either dead or missing. It is suggested that in the case of Ash the damage was the result of excessive drying-out of the leaflet tips whilst for Sycamore the damage seemed to be the result of abrasion with adjacent leaves and twigs.

Regression analysis established that there was a positive relationship between percentage damage and leaf area in Sycamore but the relationship for Ash was not significant.

Introduction

Both Ash (*Fraxinus excelsior* L.) and Sycamore (*Acer pseudoplantanus* L.) are extensively planted around farmsteads etc. in the north of Ireland. Mitchell (1982) described Sycamore as being able to stand up to the most severely exposed conditions of coastal areas better than any native tree species and this point was reiterated in Edlin (1968) who noted that Sycamore is wind-firm and is capable of withstanding the very worst exposure either inland or near the sea. Caborn (1965) has also described Sycamore as an important, dependable and outstanding shelter tree. Much of the usefulness of Sycamore as a shelter species derives from its well-formed canopy and dense foliage. However, the costs to the tree are also high and extensive wind pruning leading to canopy deformation is a common feature of Sycamore growing in coastal or otherwise windy areas. Under such conditions Sycamore still manages to attain a reasonable height and to maintain a dense though distorted canopy and it is this ability which makes Sycamore such a useful tree. Wilson (1980, 1984) and Rushton and Toner (1988) have shown that as well as these more obvious features of wind damage on Sycamore, individual leaves themselves may sustain extensive damage due to abrasion with other leaves or twigs.

Opinion regarding the usefulness of Ash as a shelter species is rather more mixed. Edlin (1968) concluded that Ash was a poor shelterbelt tree though he did point out that it is very hardy and may survive in hilly areas. Mitchell (1982) emphasised this point and noted that it grows well when exposed to sea winds. Caborn (1965) regarded Ash as a wind resistant tree only if it was on good sites and that in coastal areas it may do well but that it is affected by sea winds.

A limited study of two Sycamore trees by Wilson (1980) indicated that damage to individual leaves by wind could be extensive and that few leaves actually escaped damage completely. Rushton and Toner (1988) were able to demonstrate, for a much wider sample of 75 trees covering five sites with differing degrees of exposure, that the levels of leaf damage caused by wind were related to general site exposure. The present paper reports a comparative investigation of the levels of wind damage to the leaves of both Ash and Sycamore trees growing at one site in Northern Ireland.

THE SITE (Grid reference C841345)

Although both Ash and Sycamore are relatively common trees in the north of Ireland (Webb 1977), sites which contain more or less equal numbers of mature specimens of the two species are difficult to find. The site chosen for study was an area of open land to the north-west of the main campus of the University of Ulster at Coleraine (Fig 1A). The general campus site is relatively flat and about 20m above sea level. To the north and north-west, there is little shelter afforded to the campus and to the south runs the valley of the River Bann. The site is about 5 km from the coast and it is conceivable that because of the lie of the land some winds, particularly from the north-west coming down the Bann

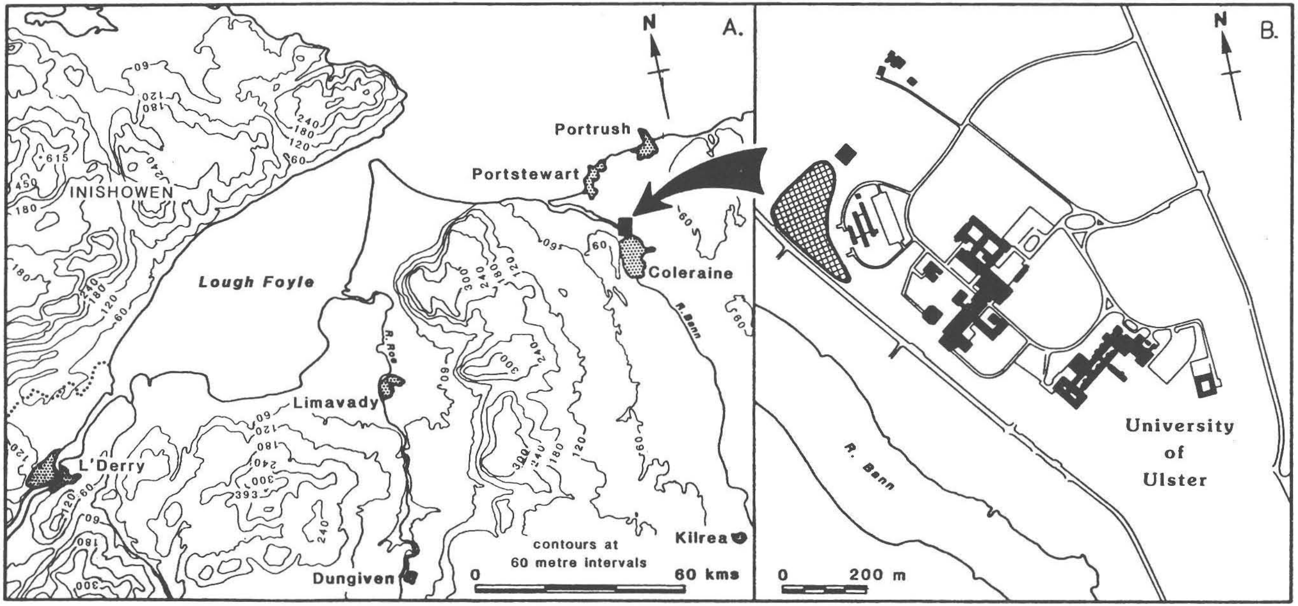

Figure 1 Location of the study site. A. General area showing main topographic features. B. Site location (hatched) in relationship to the main university buildings (black).

estuary, could carry salt. To the west and south-west, the land rises to over 300m whilst to the east, the nearest high ground is the Glens of Antrim, which rise generally to 400m and are about 30 km away. In between, the land is relatively flat and is generally less than 100m high.

The sampled trees lie on an area which gently slopes down to the River Bann (Fig 1B). The nearest buildings of any major size are at least 100m away to the east and the very large campus buildings are about 400m away. Consequently, most winds approaching the site are likely to be laminar, and turbulence due to buildings or other obstructions is likely to be low. Nevertheless, some of the more mature trees on the site do show evidence of wind pruning (assessed by general canopy asymmetry) as do many others on the rest of the university campus. In these cases, the general direction of pruning would appear to correlate with winds from the west and north-west.

Sampling and Scoring

Trees were sampled in September, 1986. Fifteen trees of Ash and fifteen trees of Sycamore of comparable size were chosen at random. From each tree 25 leaves were removed from a height of about 6m; all aspects of the canopy were represented in the sample and effort was made to ensure equal representation of all canopy aspects. Due to the effects of wind pruning this was not always possible and some error may have been introduced at this stage. Small twigs were cut and, from these, the pair of lateral leaves at the terminal bud were removed and lightly pressed in newspaper in order that flat specimens were available for scoring. Scoring of damage was carried out within a few days of collection and before any deterioration of the leaves.

Wilson (1980, 1984) has described the patterns of damage on Sycamore leaves caused by wind. These include lesions, leaf distortion and lamina tearing which can, in extreme cases, lead to loss of lamina. Levels of damage was assessed by placing over each leaf a transparent grid ruled in 0·5cm squares. Total leaf area was estimated by counting grid squares. The total area of damage was estimated by counting the total number of squares showing more than 50% damage. This is likely to provide a slight underestimate of damage since very small areas (less than about 0·25cm x 0·5cm) would not be counted. However, most damage was greater in area than this and therefore the error is probably not serious. From the total leaf area and area of damage a value for percentage damage was calculated for each leaf. In cases where portions of the lamina had been lost the lamina outline

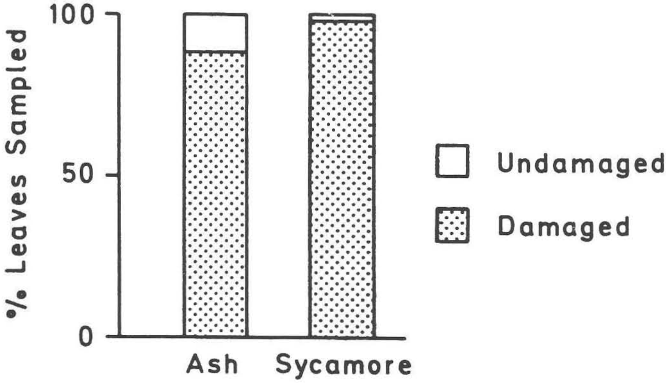

Figure 2 Percentage of leaves showing wind damage and percentage of undamaged leaves of Ash and Sycamore sampled in September, 1986.

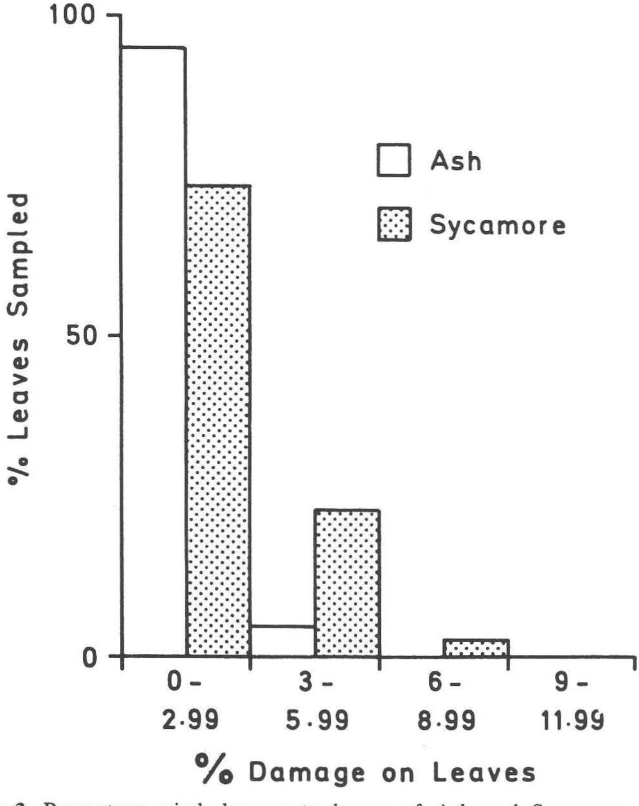

Figure 3 Percentage wind damage to leaves of Ash and Sycamore sampled in September, 1986.

was reconstructed from the remaining portions and an estimate for the damaged area derived. This procedure follows Wilson (1980). Whilst this constitutes another source of error, very few leaves were so badly damaged.

Whilst estimating damage, care was taken to exclude damage attributable to other sources, in particular front damage and grazing damage by insect larvae (see Rushton and Toner 1988). Despite the resistance of Sycamore leaves to low temperatures (-2·5°C) (Sakai and Larcher 1987), in some years very late air frosts might be sufficiently low to cause frost damage in the Coleraine area thought in most years, this would not be a problem. Since Ash leafs considerably later than Sycamore, frost is unlikely to cause any damage to Ash leaves.

RESULTS

Fig 2 shows the percentage of damaged and undamaged leaves of Ash and Sycamore. Most leaves of Sycamore (99·2%) and a substantial number of leaves of Ash (88·8%) showed some signs of damage. In the case of Ash, damage was largely confined to the leaf tips which were either dead or missing. The damage to Sycamore leaves was more extensive across the whole lamina surface and consisted of discoloured areas, lesions, tears and loss of lamina area although arc-shaped tears seemed to be the most common.

Examination of the actual percentage damage levels on individual leaves (fig 3) indicated that not only were more leaves of Sycamore damaged compared with Ash, but that greater areas of damage were sustained per leaf. This difference proved to be significant (Table 1). The mean levels of percentage damage per tree re-inforced this conclusion: only one Ash tree had a mean percentage damage in excess of 2% whilst 10 out of the 15 Sycamore trees sampled had damage greater than 2%.

Regression analysis of percentage leaf damage on leaf area was carried out and is presented in Fig 4 and Table 2. The regression for Ash proved to be non-significant; that for Sycamore showed a positive significant relationship. The damage to leaves of Ash was remarkably constant (fig 4) regardless of leaf area which ranged from less than 100cm^2 to over 240cm^2. On the other hand the much smaller range of leaf areas of Sycamore, from 68cm^2 to 138cm^2, was accompanied by increases in leaf damage from 1·28% up to 3-4%. Regression analysis of percentage leaf damage on leaf area was also carried out on the results from individual trees. Where these proved significant, the trees have been individually identified in Fig 4. Five trees, three Sycamore

Table 1 Means, standard deviations and % coefficients of variation for percentage damage to leaves of Ash and Sycamore, and their analysis.

	Mean	Standard deviation	% coefficient of variation
Ash	1·38	0·94	67·9
Sycamore	2·41	1·52	63·2

Source of variation	Degrees of freedom	Sums of squares	Mean square	F-ratio	Probability
Between species	1	196·8	196·8	61·3	0·001
Within species	373	1196·9	3·2		
Total	374	1393·7			

(Data were transformed using the arc-sine transformation prior to analysis (Sokal and Rohlf, 1969).)

Table 2 Regression analysis of percentage leaf damage on leaf area for Ash and Sycamore.

	Explained sums of squares	Unexplained sums of squares	F-ratio		Regression equation a	b
Ash	0·1547	2·8342	1·41	NS		
Sycamore	4·7073	5·1986	11·77	**	-1·2470	0·0078

NS=non significant; **, p=0·01-0·001.

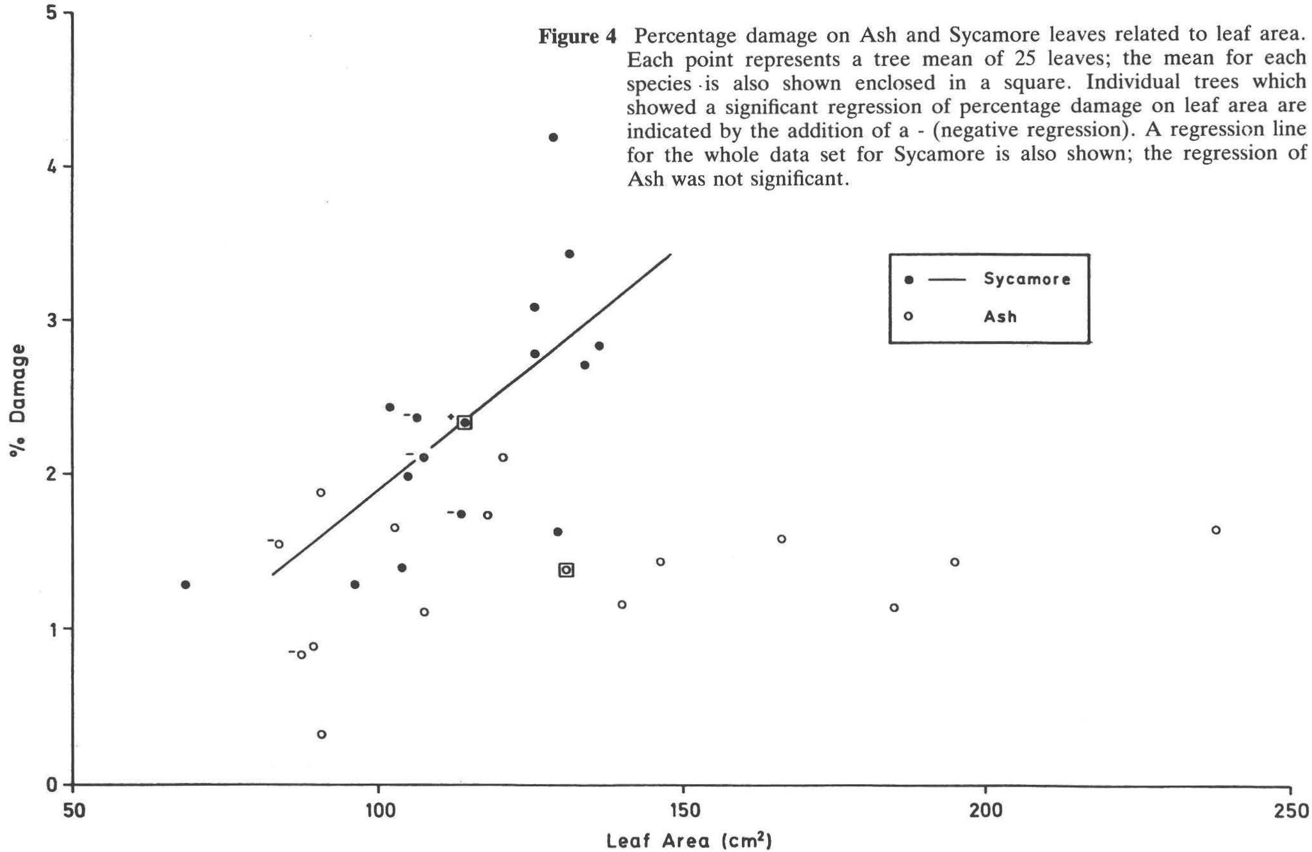

Figure 4 Percentage damage on Ash and Sycamore leaves related to leaf area. Each point represents a tree mean of 25 leaves; the mean for each species is also shown enclosed in a square. Individual trees which showed a significant regression of percentage damage on leaf area are indicated by the addition of a - (negative regression). A regression line for the whole data set for Sycamore is also shown; the regression of Ash was not significant.

and two Ash showed significant relationships and in all cases, the relationships were negative. In the case of the two Ash trees, these also had the smallest leaf areas (Fig 4).

Discussion

The general levels of damage on the leaves of Sycamore are more or less in agreement with those observed by the present authors when recording damage at a number of sites along the north coast (Rushton and Toner 1988). In that survey, five populations were studied and the mean percentage damage for the populations were 1·30%, 1·68%, 3·59%, 4·12% and 4·65% for leaves sampled in September, 1986. The two populations with the lowest percentage damage were well-sheltered, whilst the other three sites were more exposed and, in the case of the population showing the highest damage levels, the site was probably subjected to considerable turbulence. The level of damage recorded here for Sycamore (2·41%) lies between the sheltered and exposed values recorded previously.

The very different levels of damage sustained by Ash and Sycamore could have a number of explanations. It would be tempting to argue that the differences between the species are related to leaf morphology and that the broader, more entire leaf form of Sycamore was more susceptible to wind damage than the well-separated, small leaflets of Ash and this is almost certain to be the case for damage sustained during the main part of the growing season once the leaves have unfolded and hardened. However, it is felt that a more likely explanation for the differences probably lies in phenological differences between the two species.

Rushton and Toner (1988) and Wilson (1980) have recorded leaf expansion beginning in late April/early May for Sycamore and Wilson (1980) observed that nearly all leaves sustained damage during the 2-3 weeks following bud-break and that by the end of May, most damage had already occurred to Sycamore leaves. Similarly, Rushton and Toner (1988) showed that there was little increase in damage to Sycamore leaves between samples taken in June and September indicating that most wind damage to leaves occurs early in the growing season when the leaves are expanding and not sufficiently hardened to resist the buffeting against adjacent leaves and twigs brought about by gusting. In contrast, Ash leafs much later and the leaves would not generally be expressed from the buds before early May (Mitchell 1979). Along the north coast of Ireland and at the site studied here, Ash leafs even later than this and it would be mid- to late-May before leafing takes place. This Ash would appear to avoid the damaging spring winds that cause significant damage to the leaves of Sycamore.

The damage to Sycamore leaves is undoubtedly due, for the most part, to abrasion of the lamina surface with adjacent leaves and twigs. In the case of Ash, the localisation of damage to the leaflet tips suggests that the damage here may be a more indirect effect of increased transpiration during windy conditions which results in excessive and lethal water loss in those areas furthest from the water supply i.e. the leaflet tips. Thus although the damage to Ash leaves had the general appearance of physical damage, it is felt that the death of leaflet tips is more likely due to lack of water.

The results presented in Fig 4 confirm the previous work by the current authors. They were able to show (Rushton and Toner 1988) that in sites which were probably exposed and subject to turbulence, there was a negative relationship between percentage damage and leaf area – it was suggested that this was because excessive damage early in leaf expansion prevents leaves expanding to their full extent (see Parkhurst 1972). At less exposed sites there was either no clearly established relationship or the relationship was positive. It was suggested in this latter case that the levels of damage were insufficient to inhibit leaf expansion and the leaves expanded to full size. This would appear to be the case with Sycamore leaves at the site studied here.

It should however be noted (Fig 4) that three of the eight smaller-leaved Sycamore trees (i.e. trees with mean leaf areas less than 114cm^2, the population mean) had significant negative relationships between percentage leaf damage and leaf area and that of the remaining five smaller-leaved trees, four showed a negative relationship although these were non-significant. Conversely, of the seven large-leaved Sycamore trees (with mean leaf areas in excess of 114cm^2) only two showed negative relationships although again these were non-significant. Thus inhibition of leaf expansion by wind damage is also demonstrated by these data even though the general population trend for Sycamore is positive.

The relationship between percentage damage and leaf area was overall non-significant for Ash though the two trees with the smallest leaf areas did show a significant negative relationship.

It would appear therefore that one of the reasons why Ash may survive in windy areas and in particular in upland sites is that the leaves are produced so late in spring that they escape most of the windier conditions in late winter and early spring and the leaves are thus comparatively free of wind damage. Sycamore, on the other hand, leafs much earlier and therefore suffers much higher wind damage levels. This may of course be compensated for by the longer growing season that Sycamore experiences through earlier leafing but the actual effects of wind damage to leaves on the growth rates of Sycamore trees remains unknown.

ACKNOWLEDGEMENTS

We would like to thank a number of people who have contributed significantly to this work: Miss Sara Corkery helped with data preparation, Mr. K. E. McDaid prepared the figures and Mr. Pierre Binggeli gave a great deal of useful initial advice and subsequently commented on a draft of this paper.

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Letter to the Editor

Dear Sir,

Your editorial on p.6 in the most recent number of "Irish Forestry' (Vol. 44; No. 1) puts a very important question to Irish forestry in particular, but essentially to the whole of the people on this "green and misty isle" of ours.

I could summarise the problem by quoting you — 'The question then arises — to what degree is the argument of "the common good" to be allowed to conflict with the objective of wealth generation through efficient timber production'.

As in most cases of head-on confrontation, an acceptable solution is most likely to be achieved through some kind of compromise, but as a prelude to realistic discussion, it seems essential that whatever Forestry Acts now govern the area of national policy, they should be given a thorough overhaul.

When the Coolattin oakwoods debacle first made the headlines, I was astounded at the deafening silence from the Society and from our academics. Are we back to the bad old days when forestry policy was dictated by "faceless bureaucrats"? Are there no lingering feelings of guilt in regard to the felling of Lady Gregory's historic house at Coole?

Apart from family roots in Gort, my memory is still clear enough to recall the final weeks of the Forestry degree course in U.C.D., when in about May 1941, as part of the "Grand Tour" (by bicycle), four of us stayed for a week in Gort and visited Coole Park. The big house was standing in its prime, unoccupied then, but with no broken panes of glass or other signs of deterioration. A grand-piano could be seen in the centre of a deserted lounge. The next time I visited Coole, there was not a stone left upon a stone. The Yahoos had struck.

In the case of the Coolattin oak, I am astounded that a clear-felling method was sanctioned. Conceding that most of the oak was mature, maybe some of it over-mature; and allowing that, in the final analysis, one grows timber for ultimate use, I still fail to see why a stipulation was not included in the Felling Licence (I assume there had to be one) to ensure that individual trees were removed in such a manner as to cause the least amount of damage to the oncoming generation of younger trees.

There are no marvellous skills required in this kind of situation: any trained forester would take it in his stride. As well as leaving some of the trees for side and overhead shelter, he would also ensure the survival of suitably-spaced parent trees for regeneration of the forest area. This, however, is leaving out our Yahoo.

Current indications are that the moneybags are moving in on Irish forestry. A couple of months ago, my early morning radio alarmed me with the news that the Bank of Ireland was buying some area of the nation's State Forest inheritance. I am assuming this is true and not just some form of kite-flying. I ask myself if there is anyone at the tiller or are we just drifting?

Can we get something moving urgently on a complete revision of whatever 'Forestry Act' there may be? I feel the legal and constitutional/policy aspects of this matter are of vital importance, as without proper controls, Irish forestry may end up in a big shambles.

Meanwhile, I am hoping that the C.B.T.R. (Cheque Book Timber Realists) will keep their greedy eyes off Killarney until such time as satisfactory controls can be established.

Diármuid O Morgáin (Dermot Mangan)
Imleach Droighneach, Imleach Mór,
Cill Airne, Co. Ciaraidhe.

(In the interest of brevity editor reserves the right to shorten letters).

Erratum: In the 'Letter to the Editor' of the Autumn 1987 issue of the journal there were two errors in first box of statistics. The corrected box is printed below. The editor regrets the mistake.

1	2	3	4	5	6	7	8
Ownership	Conifer	Broadleaf					Total (2+7)
		High Forest		Scrub		Total Broad-leaf	
		Non Protected	Protected*	Non-Burren Type	Burren Type**		
State	309,839	12,509	2,700	1,213	250	16,672	326,511
Private	17,610	32,347	—	33,102	22,498	87,947	105,557
Total	327,449	44,856	2,700	34,315	22,748	104,619	432,068

*Includes 1,700 ha of woodland in statutory nature reserves and about 1,000 ha of forest in national parks.

**Burren (Co. Clare): a region of 45,000 ha of carboniferous rock outcrop.

Forestry News

CONKERS IN KERRY

The Turks brought horse chestnut seed with them on their invasion of Europe. They had discovered that extracts from leaves, bark and seed helped alleviate the pain of rheumatism.

Today this tree gives employment in Co. Kerry. Seven to nine tons of seed are processed for their extract each week by the pharmaceutical firm of Klinge and Company of Killorglin, Co. Kerry. The seed is brought by container truck from Poland and Hungary.

The active ingredient of the seed is 'Escin' a mixture of at least 36 similar chemical compounds. These chemicals have the effect of reducing swellings. Escin is therefore effective in treating all sorts of sprains. It is commonly used in the treatment of swellings which result from sports injuries. 'Sports gel' is produced with Escin as one of the ingredients.

Escin is found in the leaves, bark and the seed of horse chestnut. However, it is in the seed that the greatest concentration occurs. The bitter taste of Escin makes the seed unpalatable to grazing animals. Sunlight during flowering and seed pod formation is largely responsible for the amount of Escin produced. At best Irish grown horse chestnut seed produces about 5% Escin. Polish grown seed produce over 20% of the chemical. There seems therefore little prospect that Irish plantations of this species could compete with east European trees for such a market.

The Polish seed is dried and crushed before transportation to Kerry. In Killorglin extraction is carried out in large 'Tumblers' using an ethanol/water mixture. The solution is filtered and concentrated to a fine brown powder called 'horse chestnut extract'. This can be treated further to isolate the active ingredient 'Escin' – which is a fine white powder.

Both of these products are sold by Klinge and Co. as bulk chemicals. The principle customer is the parent company in Munich. After extraction the resultant residue can be used as a cattle feed: it is quite palatable with the Escin removed.

(Details kindly supplied by Klinge and Co., Killorglin. My thanks also to Mr. D. Walsh for making the initial contact. Ed.)

MUSEUM ITEM

The query in the last issue of the journal regarding an item obtained for the forest museum brought two replies from readers. Both replies, furnished with documentation, suggest that the correct name of the implement is a 'planting bar'. A planting bar was commonly used for 'compression planting' on sandy soil or for planting hard or rocky sites. My thanks to those two readers. Ed.

FORESTRY 88

A national forestry show entitled 'Forestry 88', organised jointly by the Irish Timbermens' Association and the Society of Irish Foresters will be held at Garryhinch Property, Emo Forest, on September 9 and 10th, 1988.

The show, which will cater for specialist and general interest groups, will include trade display areas for forest machinery, nurseries, sawmills and chemical supply companies. The finals of the National Chainsaw Competition will also form part of the show, as will demonstrations in establishing, maintaining and harvesting plantations. There will be a full programme of events over the two days including guided tours of the forest, illustrated talks on forestry, a dendrology display and woodworking/woodcraft displays.

A show catalogue, which is currently being prepared, will not only be informative and educational in content but will also be the first important directory for the forestry industry in the country. Forestry 88 will be the most extensive exhibition of forestry technology and expertise ever assembled in Ireland. As such it will attract a very large audience and command very considerable media coverage. Members interested in renting stand/display space or catalogue advertising are invited to contact Forestry 88, Mountrath 0502-32576. We look forward to the participation of all members in Forestry 88.

SIGN OF THE TIMES?

Seen outside O'Brien's Pub in Dunshaughlin.

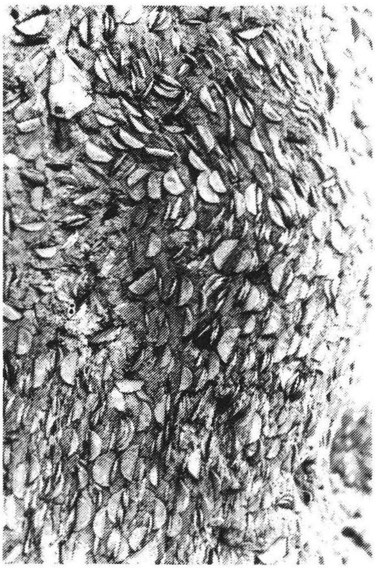
AIDS

The seed of an Australian chestnut tree yields a drug called 'Castanospermine'. There appears to be possibilities that this drug may interrupt the AIDS virus's ability to reproduce itself.

THE MONEY TREE

On the side of the main road between Portlaoise and Mountrath is an unimposing sycamore tree, unimposing until you draw close to it. The first two metres of this tree are studded with densely packed coins. This is the money tree.

The tree is on the site of a famous monastery and school of the sixth century known as the Gallician School. It was founded by St. Fintan in 548.



In the 1940s it was common to hang rags of cloth on the tree at which time it was called a 'rag tree'. The hanging of rags was to seek favours or cures from St. Fintan. On occasions old people still leave rags. (One rag was there when the photo was taken — May 1988). Now, however, it is more common to leave coins.

Obituary

SEAN MacBRIDE, S.C.
1904-1988

Sean MacBride will not be remembered by the foresters of Ireland as an international Statesman, as a Nobel Peace Prize winner or as a Lenin Peace Prize winner.

He will be remembered by us as the man with the unshakable view of the importance of forestry and of the possibility of forestry for this island. More than that – when it was not popular to hold such ideas he spoke of his conviction to those who would hear, and to those who would not hear, and his words were of metal that stood out in their logic against the immutability of men of lesser vision.

Where a country has no trees neither policy nor science will create forests – it takes vision to do that: it takes vision in a man who can give that vision political expression.

The Committee on Irish Forestry appointed by the Department of Agriculture in 1907 concluded that "All the men of experience and expert knowledge are agreed that in soil and climate, Ireland, for forestry purposes, is particularly well favoured . . . On the question of her capacity to grow timber as well as any other country in Northern Europe there can be no doubt whatsoever".

Sean MacBride said that one of the reasons which prompted him to undertake the founding of Clann na Poblachata in 1946 was his failure to convince Mr. Eamon de Valera to pursue a more active afforestation policy.

He secured in the first Inter-Party Government an annual planting rate of 25,000 acres per year and succeeded in getting this endorsed by Dail Eireann in the Economic Recovery Programme.

In correspondance with the Taoiseach in 1981 he expressed the view that: "our state forests are probably the most valuable natural renewable resource we have".

At the AGM of Trees for Ireland in 1980, at which the author was present, Mr. MacBride expressed the view that "we should seriously consider increasing our plantation rate from the present 25,000 acres per year to 40,000 acres per year by annual increments of 1,000 additional acres each year".

"For a human being to reveal truly exceptional qualities, he must be observed over a long period of years." This is an extract from *The Man who Planted Trees* by the French writer Jean Gioro. Sean MacBride's sustained belief in the value of forestry must allow us to conclude that he too had exceptional quality in this regard. He will now be missed. He will be missed by those who believe in the potential of Irish forestry.

Pat McCusker

Book Reviews

NORTHERN IRELAND FOREST SERVICE — A HISTORY
C. S. Kilpatrick. 1987. 98 pages. Soft back. B & W photos. Price £3 sterling. Book may be purchased from Department of Agriculture, Forest Service, Room 34 Dundonald House, Upper Newtownards Road, Belfast BT4 3SB.

For a complete understanding of the development of forestry in Ireland since 1900 this book should be read in conjunction with one other – 'The Forests of Ireland' edited by Dr. N. O Carroll for the Society of Irish Foresters, 1984. Published by Turoe Press, Dublin. This latter book, based on observations and research over 80 years, draws into focus the silvicultural and growth conditions necessary to grow forests well on this island.

C. S. Kilpatrick's book on the other hand examines the discussions and policies that led to the formation and development of forestry in Northern Ireland. Leaving the statement like that, however, would not be fair to this book. There are fascinating accounts here of matters in the early years which influenced the thinking that brought the Forest Service in the south into existence.

The first three chapters are of particular importance in that they deal largely with the logic out of which both forest services were born. They peruse several of the more important land acts extant at the turn of the century which forced debate on the question of afforestation. One especially telling comment deserves a mention here. In 1900 Dr. Robert Cooper, a medical practitioner, gave a lecture in the Rotunda Rooms, Dublin, entitled "Ireland's real grievance, the deforestation of the country". He proposed a Forestry Department with a programme of two million acres of afforestation. He returned to the matter in 1903 when he gave a second lecture 'Treeless Ireland'. This lecture was given very broad support and on the strength of that support he quickly founded the Irish Forestry Society with himself as its first president. Since what is now the Forest Service in the south grew out of discussion in 1904 and out of the 1908 Committee on Irish Forestry and given that the Northern Ireland Forest Service came into existence in 1910 one cannot but conclude that the two forest services have a common origin and that Dr. Robert Cooper was, if not the founding father, then the catalist of state forestry on this island.

The next five chapters swing away from any reference to forest development south of the border. They concentrate on the recruitment and the development of staff in the growing Ministry of Agriculture (NI) – Forestry Branch. Ken Parkin, who took over duties in 1957 as Chief Forest Officer, receives a particularly glowing mention. He seems to have been especially keen on the value of forest recreation "as a haven of peace and tranquility from the pressures and stresses of modern society". He also advocated Sitka spruce as the species for planting "the deepest of peats to the mountain tops". Twenty oak trees planted inside the gates of Pomeroy Forestry School are an attestation to 20 years of service as Chief Forest Officer. He was a man indeed well liked.

A point of interest to readers of this journal is that during C.S. Kilpatrick's presidency of the Society in 1966 the constitution was amended to make the organisation a truly all-Ireland society: a move that must be commended. While he was president it seems that C. S. Kilpatrick received a letter from India addressing him as 'President of Ireland': perhaps there are yet greater things in store for one of the past presidents of this society!

The final chapters of the book step us down from the high ambitions of the Forest Service (NI) into the now familiar contractions of state forest services under the new economic stringencies that have overtaken all our forest ambitions of late.

In conslusion when I sat back, having read this book, the feeling that most strikingly came to me was the warm humanity and sense of purpose that seems to pervade the Northern Ireland Forest Service. Perhaps it is the nature of the job of forestry that this be so.

It is interesting to realise the parallel developments that have occurred in the maturation of the two state bodies into modern forest enterprises. Ultimately it will be this revelation that will make this book significant and indeed endearing to all foresters on this island.

Pat McCusker

WORLD WOODS IN COLOUR

William A. Lincoln. Stobart and Son Ltd., London. pp 320. Colour pix. 1986. Price £19.50 sterling.

When I was asked to do a review on "World Woods in Colour" I did not know what I was letting myself in for, but fifteen months and many phone calls later, I was eventually persuaded to put my pen to paper. At this stage I must compliment the editor for his patience and perseverance.

When I set out to review this book what hat do I wear – do I wear my hard headed business hat, my forestry hat or my sawmiller's hat? After long deliberations I have decided to wear my old woodwork teacher's hat. He inspired in us a love for wood in its many aspects be it young oak starting on its long road to maturity, a tall spruce or a larch stand changing colour in the autumn.

A piece of furniture made by a true craftsman or a delicate piece of woodturning each in its own way showing that wood growing or as a piece of furniture is a thing of beauty and joy forever.

The author in his introduction has set out a number of ground rules as it were to identify, classify and categorise the 269 species illustrated. His ground rules are very straightforward and can be interpreted by the botanist who needs to know the scientific name of the wood as well as its genealogical relations. The DIY man can also follow his comments.

I like his practical approach to describing the various woods. He first of all gives the wood its common name followed by its botanical name. He then goes on to give a general description, describing the colour, grain, texture and finishes with specific gravity which I think is useful as it allows a person to compare an unknown species with a well known one.

The mechanical properties are listed, also how it reacts to seasoning. For the machinist he lists the working properties of wood – for example if resistant to cutters, type of finish screw holding properties, durable or non-durable properties, if it is permable to preservation treatment. Finally a list of the most common uses are given.

Brousing through this book I came up with some interesting items. There are 70,000 different woods known to man. "Aspen" is used to make brake blocks. Yew is a softwood and was used for bowstaves by Robin Hood and his merry men. "Balsa" is a hardwood and when sawn contains 200-400% moisture and can absorb 792%.

I was a bit disappointed that the Rowan tree with all its mystical properties was not mentioned.

This is not bedtime reading rather it's a book to spend a spare hour admiring the very fine colour plates and picking up snippets of information.

To conclude, this is a book to settle arguments because as the "Seanachai" says it will give you its seed, breed and generation as well as where it came from.

Patrick J. Glennon

THE ANATOMY OF WOOD: ITS DIVERSITY AND VARIABILITY

K. Wilson and D. J. B. White. Stobart and Son Ltd., London. 1987. Price £20. ISBN 08544 0339.

Appraisal of this book must be made against the authors' stated intention to write a work similar in its content and purpose to "The Structure of Wood" by the late F. W. Jane. This latter book is now out of print but it had become outdated in its treatment of many aspects of wood structure (spiral grain, juvenile wood, pit aspiration) which have assumed much greater significance with the development of plantation forestry.

This new book which in intended primarily for student of timber technology rests widely on Jane's work, but draws much of its new material from the relevant literature of the subject as the list of references indicates. An outline of the chemical and physical structure of wood furnishes a background of understanding of some of the physical properties of timber generally. The diversity of wood anatomy is described and illustrated. The variability of wood within and between trees and its bearing on timber utilisation is also described. The approach to wood identification focuses attention more on these anatomical features which have been found useful in distinguishing one wood from another, rather than on the whole structure.

However, the treatment of wood anatomy is spread over several chapter and it is sometimes difficult, without resorting to the index, to know where to look for any particular feature. One also wonders about the extent (33 pages) of the chapter on the "Ultrastructure of Wood", particularly in view of the limited nature of the keys for identification of timbers. Figure in wood is always an attractive subject and while this is adequately dealt with in the book, the chapter title is, "Wood Surfaces and Their Underlying Structure". This appears to be change for the sake of change.

It would be easy to carp over these and other points in this excellent textbook, but too much emphasis on small points would denigrate this book too much. The authors have made a valiant effort to produce a balanced and up-to-date book on wood technology, for which there was a need. They have succeeded in producing a book which will be widely used by all wood technologists who seek to understand the relationships between wood structure, wood properties and wood use characteristics. The book is well illustrated with a combination of photographs and line drawings.

Jack Gardiner

Society Activities

COUNCIL REPORT 1987

Symposium

"Broadleaves — have they a Future in Irish Forestry?" was the theme of the Symposium held at UCD on 3rd April, which was attended by 191 members. Six papers were presented on the subject and published in Irish Forestry Vol. 44 (2).

Annual Study Tour

The annual study tour was held on Southern England from 17th-23rd May and a full account of which is in Irish Forestry Vol. 44 (2).

Meetings

Two, one-day meetings, were held during 1987 in the Spring and Autumn. The first was held on the 24th of April on Tollymore Forest, Co. Down, was concerned with the end of Rotation-Harvesting in an Environmentally Sensitive Area. A full account of the meeting was published in Irish Forestry Vol. 44 (2).

The second one-day meeting was held on the 9th October in the north Tipperary/east Limerick area. The morning session consisted of a tour of the Forest Service's sawmill in Dundrum.

The Society wishes to thank those who presented papers at the Symposium, all those who helped in organising the field days. Thanks are also due to the Forest Service, Dublin, the Forest Service, Belfast and University College, Dublin for their co-operation and assistance during the year.

Annual General Meeting

The Annual General Meeting was held at UCD on 2nd April. The Minutes were published in Irish Forestry Vol. 44 (1).

Publication

Irish Forestry Vo. 44 was published.

Examinations

Three candidates have taken the written examination and practicals are in the course of completion.

Educational Award Fund

The winner of the current year's prize is Mr. Gary Williamson, Dublin. (U.C.D. recipient).

Elections

Three posts of Technical Councillor and one of Associate Councillor were filled by election. The successful candidates, subject to the approval at the next Annual General Meeting, are Technical — D. Magner, J. Neilan and P. Breathnach; Associate — L. Furlong. As there was only one candidate for each of the other posts they were filled without election. The total valid poll was 222.

Membership

Number of members on 31st December, 1987:

Technical	*Associate*	*Student*	*Total*
456	140	59	655

New Members elected in 1987:

11	11	0	22

Attendance at Council Meetings

Five meetings have been held during the year. Attendance was as follows:

J. Prior, K. Collins, E. Hendrick .... 5 meetings

P. McCusker, G. Murphy, L. Furlong, D. Magner, B. Wright, J. Fennessy .... 4 meetings

R. Whelan, J. O'Driscoll, J. O'Dowd, A. J. van der Wel .... 3 meetings

J. Neilan .... 2 meetings

J. Griffin .... 1 meeting

Signed: K. Collins,
Hon. Secretary.

March, 1988.

MINUTES OF THE 46th ANNUAL GENERAL MEETING
THURSDAY 7th APRIL, 1988
AGRICULTURAL BUILDING, U.C.D., DUBLIN

The President, Mr. J. Prior took the Chair.

Attendance

J. Fennessy, J. O'Driscoll, E. O'Driscoll, P. McCusker, N. Ni Phlaithbheartaigh, P. Diffley, P. Curtis, T. Houllihan, B. Wright, P. Joyce, E. Hendrick, L. Furlong, L. O'Flanagan, G. Murphy and K. Collins.

Apologies

F. Mulloy, M. O'Brien.

Secretary's Business

The minutes of the 45th Annual General Meeting, having already been circulated to members were agreed and signed. Proposed by P. Joyce and seconded by J. O'Driscoll.

Council Report for 1987

The Report having been circulated to members was taken as read. Proposed by E. Hendrick and seconded by E. O'Driscoll.

Abstract of Accounts

G. Murphy presented the Statement of Accounts for the year ended 31st December 1987. The balance to credit is down over the 1986 figure because revenue from subscription was less and the Journals cost more to print. Proposed by P. Curtis and seconded by J. O'Driscoll.

Confirmation of Elections

The meeting confirmed the 1988 Council Elections as follows: President, J. Prior; Vice-President, B. Wright; Hon. Secretary, K. Collins; Treasurer, G. Murphy;

Editor, P. McCusker; Business Editor, E. Hendrick, Hon. Auditor, W. Jack; Technical Councillors, D. Magner, J. Neilan, P. Breathnach; Associate Councillor, L. Furlong. Proposed by J. O'Driscoll and seconded by J. Fennessy.

Proposed Changes to the Constitution

Two motions for amendments to the Constitution were put forward:

1. PUBLIC RELATIONS OFFICER

That a Public Relations Officer post be created on the Council of the Society, to be filled annually by election. Subject to the adoption of this motion the following addition and amendments to be made to the Constitution.

a. DUTIES OF THE PUBLIC RELATIONS OFFICER

RULE 12. The Public Relations Officer shall be responsible for conducting the Society's relations with the public media and for communicating and promoting the objectives and interests of the Society.

CONSEQUENTIAL AMENDMENTS

ARTICLE X on page 5. In sub-paragraph (i) and in the last paragraph include Public Relations Officer.

ARTICLE XI on page 6 in first paragraph include Public Relations Officer.

(The present RULE 12 and subsequent RULES will be renumbered to take account of the insertion of the new RULE).

The proposed changes to create a PRO post was proposed by E. Hendrick and seconded by K. Collins. A discussion followed. P. Joyce stated that this motion was desirable in projecting the image of the Society in the media. It was unanimously agreed that this motion should be adopted and that J. Gardiner should be appointed to the post until the next elections.

2. INCREASE IN ANNUAL SUBSCRITPION RATES

That the annual subscription for Technical and Associate membership be increased from £10 to £15; the new subscription rate to come into effect from the 1st of January, 1989.

This motion was proposed by G. Murphy and seconded by K. Collins. G. Murphy stated that expenditure was exceeding revenue and the reserves of the Society were being depleted. The subscription rate for student members remains at £5. The Auditor agrees that an increase is necessary. The motion was adopted unanimously.

Any Other Business

A two day Forestry Show is being organised for this September. This is a joint venture with the Irish Timbermans Association and will include trade displays and demonstrations. J. Gardiner will act as PRO for the Show.

The Council have decided to appoint two Regional Convenors to organise public meetings in their areas. One Convenor will be from the North-west region while the second will be from the south east.

The poor attendance at the AGM was discussed and various reasons were put forward. A motion that a reprimand be sent to all absent Council members was proposed by P. Joyce and seconded by E. Hendrick. To avoid poor turn-out in future it was proposed to hold the AGM in conjunction with a lecture or day meeting. This matter will be on the agenda of the next Council meeting.

The Society have purchased Public Liability Insurance to cover all meetings.

The meeting concluded at 9 p.m.

SOCIETY OF IRISH FORESTERS — STATEMENT OF ACCOUNTS FOR YEAR ENDED 31st DECEMBER, 1987

1986	*RECEIPTS*		*1987*
7,980.26	*To Balance from Last Account*		8,580.82
	To Subscriptions Received		
	Technical 1987	3,994.39	
	Technical 1986	344.40	
	Associate 1987	903.00	
	Associate 1986	92.50	
	Student 1987	60.00	
	Student 1986	25.00	
	Other Arrears	166.28	
	Advance Payments	217.14	
6,472.16	Overpayments	327.86	6,130.57
	To Interest on Investments		
	Savings Account	23.13	
	Educational Building Society	9.35	
737.64	Lombard & Ulster	764.99	797.47
	To Journal		
	Sales	1,183.76	
3,336.85	Advertising	2,601.00	3,784.76
25.00	Examination Fee		—
14.82	Gains on Sterling		12.46
3,008.76	Forest Walks		—
21.55	Donation		10.00
21,597.04			£19,116.08

1986	*PAYMENTS*		*1987*
140.82	By Stationery and Printing		109.90
5,274.00	By Printing of Journals		9,631.70
1,559.39	By Postage		1,613.54
115.50	By Expenses re Meetings:		103.40
55.92	By Bank Charges		113.50
1,877.00	By Secretarial Expenses		2,116.00
483.89	By Value Added Tax		549.41
—	By Examination Expenses		50.00
59.60	By Miscellaneous Expenses		—
	Return of overpayments (1986)		262.44
	Return of overpayments (1987)		327.86
	By *Honoraria:*		
	Secretary	50.00	
	Treasurer	50.00	
	Editor	50.00	
200.00	Business Editor	50.00	200.00
250.00	By Study Tour Expenses		520.00
3,000.10	By Forest Walks		—
	By *Balance:*		
	Current Accounts	215.03	
	Savings Account	345.63	
	Educational Building Society	157.67	
8,580.82	Lombard & Ulster	3,000.00	3,718.33
21,597.04			19,116.08

I have examined the above accounts, have compared them with vouchers, and certify same to be correct, the balance to credit being IR£3,718.33 which is held in current accounts at the Ulster Bank. (IR£4,445.40 plus refund due IR£103.50 less IR£4,333.87 uncashed cheques and credit transfers), Ulster Bank Savings Deposit Account, 6751465, Educational Building Society Account 130441, and Lombard and Ulster Savings Deposit Account 675146F. There is a holding of IR£100 Prize Bond No. R855061/080. IR£1,453.47 is held in Trustee Savings Bank Account 323 001 35909 for the Education Award Fund.

Dated: February 26th, 1988 — *Signed: W. H. Jack, Hon. Auditor*

SOCIETY OF IRISH FORESTERS — EDUCATIONAL AWARD FUND FOR YEAR ENDED 31st DECEMBER, 1987

1986	*RECEIPTS*	*1987*	*1986*	*PAYMENTS*	*1987*
1,171.47	To Balance from last account	1,508.73	—	By Awards	182.47
87.26	To Interest	100.59	1,508.73	By Balance	1,453.47
250.00	To Donation	—			
—	To Dirt Refund	26.62			
IR£1,508.73		IR£1,635.94	IR£1,508.73		IR£1,635.94

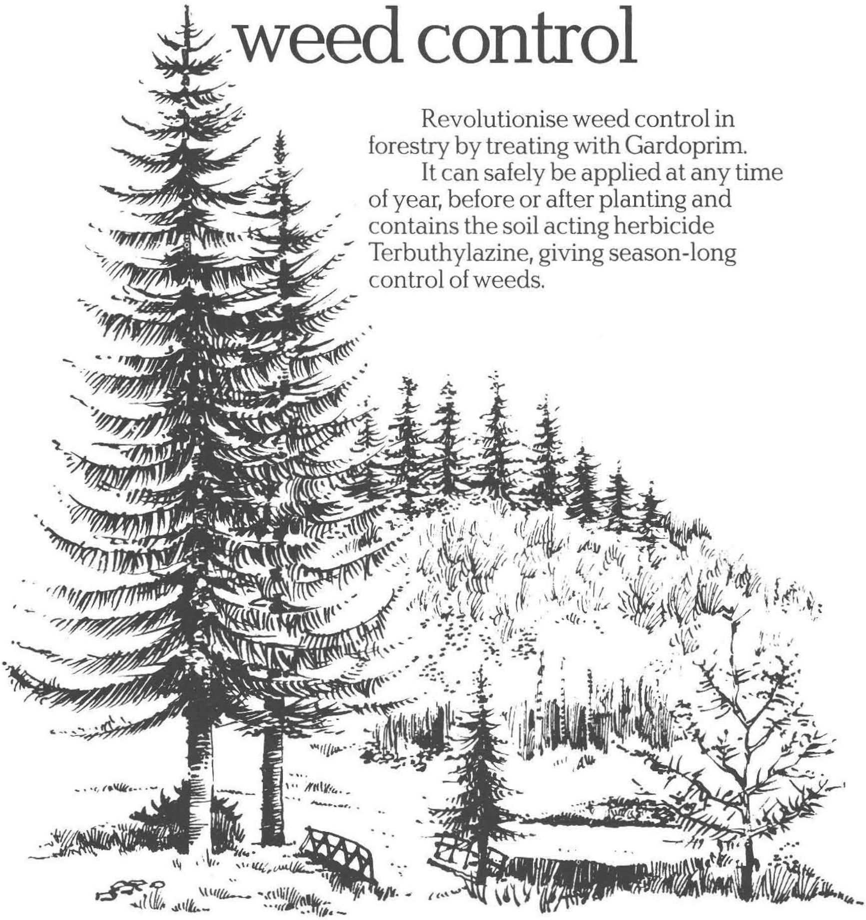
I have examined the above account and certify same to be correct, the balance to credit being IR£1,453.47 which is held in the Trustee Savings Bank Account 30013591 for the Educational Award Fund.

Dated: February 26th, 1988

Signed: W. H. Jack, Hon. Auditor.

The ground rule in caring for trees- Gardoprim® 500FW

weed control



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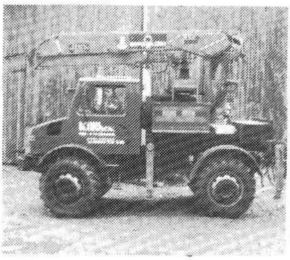

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