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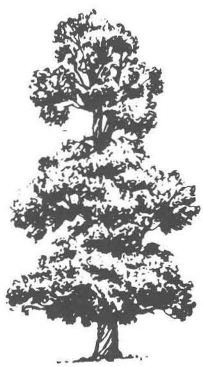

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Contents

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

Cover: Oak Tree — Avondale Forest Park *(Photo: P. McCusker).*

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EDITORIAL

All you need to go to the Moon is Science

In 1980 the great funambulist Karl Velander fell to his death while walking a wire rope stretched between two sky-scrapers. One can speculate on the cause of the accident — a swirl of wind bouncing off one of the buildings, a lack of concentration, a fault in the equipment. To successfully stroll the straight and narrow of such an act demands an understanding of physics, a head for the job, and good equipment. Any rope-walker will tell you that his job is an art, an art that would not, however, be so spectacularly successful unless it was keenly woven into the latest in science.

Forest management too is an art. It is not a science. It is an art sheathed in a thick coat of science, and as a consequence made immeasurably more efficient. Modern trends show a danger of the fine coat smothering the man at the core. The profession of forestry will loose a lot if that finally happens. The man, having been given satisfactory direction, must, at the end of the day be allowed to manage his forest. Deny him responsibility, run the show on dictates and you can still produce timber — but do not expect such a man in his Sunday clothes to get out of his car to clear a blocked drain. It takes a private concern, not science, to clear a blocked culvert on a Sunday morning.

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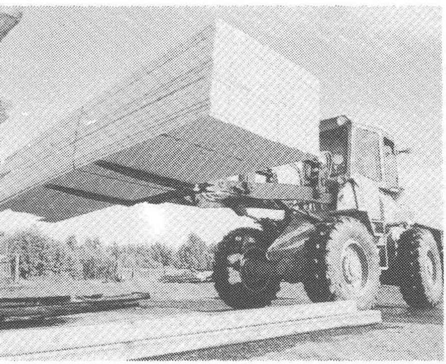

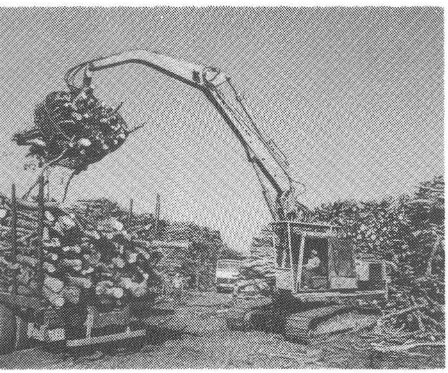

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Scots Pine — The Forgotten Species of Irish Forestry?

O. V. Mooney
6 Brewery Road, Stillorgan, Co.Dublin

HISTORICAL BACKGROUND

Scots pine *(Pinus sylvestris L),* otherwise but less frequently known as Scotch pine, Scots fir, fir deal and other variants, is the most widely distributed of the pines. Its natural distribution ranges from Scotland through the Northern European countries and south by occasional occurrences as far as Spain, France,Italy,Yugoslavia to Northern Turkey and on north-eastwards through Russia to the Sea of Okhotsk,a distance of some 8,000 kilometers. The Gaelic name for pine in Ireland is gíus (Dineen), while octac is also mentioned (Henry & Elwes). These names may possibly stem from the time when Scots pine may have survived in Ireland as an indigenous tree and variants of gíus are used to describe bog deal and so in that sense apply to the native tree rather than any of the introduced pine species. The name gíus or octac are of rare occurrence in Irish place names, while the equivalents are quite frequent in Scotland.

While vast areas of Ireland, both mountain and lowland, were covered by Scots pine forests in pre-historic times and, possibly, survivors continued into comparatively recent times, it is generally accepted that there is no provable survivor of the native species today. In 1908 Henry and Elwes in mentioning records of possible native pine forests at Killarney, Nephin and Crossmolina stated "there is very scanty evidence of its existence as an indigenous tree in modern times", while Lloyd-Praeger writing in 1936 said "the recent complete disappearance of the pine as a native is the most notable event in the history of Irish trees". In a recent Faunistic study Martin C. D. Speight in the Irish Naturalists Journal concludes "there would then be virtually no faunal basis for arguing that indigenous *Pinus sylvestris* had survived in Ireland until the tree was re-introduced to the Irish flora by man".

Nevertheless, while the weight of opinion is that the native pine has not survived as a tree into the present time, the intriguing question remains as to what might be the reasons for the disappearance of a species which covered vast areas of Ireland up to circa 1,500 B.C.,and may well have survived in a minor way into early Christian times and later. The effects of over two thousand years of agricultural development, of shifting cultivation and, probably, extensive forest fires, the utility of the timber and so on, may offer the most reasonable explanation for the assumed extinction of the native species but perhaps to the wishful if not objective thinker there remains a grain of doubt. A surmise that "it may have survived as a native tree long enough to have been propagated in nurseries" (Forbes,1933) would seem a possibility as would likewise the perpetuation of the genes by isolated survivors to the time of the early introduction of the species and continuance by inheritance in that way.

INTRODUCTION OF THE SPECIES

With the establishment and development of the estates and demesnes in Ireland came the tree planting vogue — mainly and increasingly from the beginning of the 18th century and with it earlier the introduction of Scots pine about the middle of the 17th century. Fitzpatrick records that the first genuine 'Scots' pine in Ireland may possibly have been one planted about 1652. Subsequently, it came to be used extensively in private demesnes and was, with larch, the main conifer species planted. These early introductions, and indeed later ones too, must have come mainly from seed sources of the indigenous forests of Scotland. The use of the species continued until the decline in estate planting about 1900, but survivors of the later plantings are still to be seen in some private woodlands and are valuable in providing proof of the tree's capability.

Following the establishment of the State Forestry Service in Ireland in 1903,the popularity of Scots pine as the main conifer species was maintained in a rapidly increasing annual planting programme until about 1950 when a dramatic decline took place. In 1933-34 Scots pine made up 31% of the total State planting programme in that year, in 1949-50 it was 20%, in 1952-53 it had dropped to 6%, and by 1956-57 it had faded to 3.4%, declining further to 1.1% in 1970, and to 0.4% in 1980, and to further insignificance at the present time. In terms of area the decline has been from 3036 ha planted in 1936-40 to 679 ha in 1966-68, and some 20 ha or less annually for the last few years.

The causes of this decline may, briefly, be attributed to the failure of the species to give satisfactory results over substantial areas and the growing evidence that better results could be obtained by lodgepole pine (*Pinus contorta.* Dougl. Fr. Laud), coastal provenance, on poor mountain sites for which Scots pine had generally been selected until the early 1950s. It might be added that the essential economic considerations, the motive of early return on capital investment, dominant in forestry thinking over the last three decades or so have favoured the selection of faster growing species in preference to Scots pine on good sheltered soil, sites for which the latter was often selected in earlier times when economic consideration did not take precedence. Indeed, in circumstances where the now known silviculturally appropriate species Douglas fir, and even Sitka spruce in certain cases, can produce a timber crop from 35 years on, with Scots pine at its top yield class,(14), there is a further wait of 15 years or more for saw log dimensions. It is difficult to foresee a time when Scots pine will find more than a minor role on these good sheltered mineral soil site types. There are many on-ground examples of this contrast still extant in Counties Wicklow, Tipperary and other places.

SILVICULTURAL CONSIDERATIONS

The reasons for the decline and near rejection of Scots pine in Irish forestry may be attributed to a number of factors acting singly or in combination. Substantial areas of high-lying and exposed mountain podsols and other heather site types, notably midland peats, were planted but due to exposure, soil infertility, adverse competition by heather or other vegetation, or a combination of some or all of these factors, the plantations failed to produce satisfactory growth. In pre 1950 times silviculture here was very much influenced by Continental and Scottish thinking in which Scots pine was held in high regard as the elite quality tree. Indeed, it is perhaps fair to say that Scots pine in these early days was regarded as the ultimate in perfection and one can recall the somewhat contemptous term of "yard a year trees" in regard to Sitka spruce and other fast growing species, implying inferiority to the more refined and high quality ideal. Prof. M. L. Anderson, an internationally distinguished Forester and one time Director of the State Forestry Service in Ireland, in his recommendations for choice of species designates grass-heath, calluna-heath, vaccinium, calluna-lichen communities as suitable for Scots pine.

Neither can the question of seed provenance unsuitability be disregarded as an occasional adverse factor. This consideration of provenance is perhaps emphasised by the fact that while some very good stands have been grown on more fertile sheltered sites, notably bracken, vaccinium, luzula and calluna-briar types, unhealthy crops of very poor form appear on these sites also. Although it is probable that most pre 1900 private estate crops came from Scottish sources, supplies of seed for the State Forest

Nurseries in pre 1930s came not only from Scotland but also in some quantity from Northern European sources, from Hessen, and other places of unknown origin. While the importance of suitable seed sources was generally understood in the early times of State forestry, the stage had not been reached when favoured seed sources could be specified and provenance research was yet to come. Indeed, not seldom, considerarions of cost gained preference in the purchase of seed lots when no positive provenance knowledge was available to justify rejection. It can be said, however, that some very fine stands survive still, both from estate and State plantings, and in the latter these have been identified and studies on the potential of their progeny to produce crops of vigour and fine form are underway. In particular, the progeny of one such stand at Clogheen Forest is proving equal to or superior to other known select provenances from Scotland in comparative trials. Recent successes with home and select Scottish provenances on midland peats, both raised and cut-over, open up new and very hopeful prospects for the effective and competitive use of the species in these areas.

The influence of Continental silviculture is again in evidence in the close espacements of the earlier State plantations where spacing from 3ft x 3ft (.91m) to 4.5ft x 4.5ft (1.37m) were used frequently.Conservative thinning practices in well growing stands, together with the difficulty of marketing thinning produce, has in many cases delayed first and subsequent thinnings leading ultimately to diameter dimensions below the potential of their particular yield class. The practice of selective exploitation of poles for transmission has also contributed abnormality in some stands.In the private sector, with some exceptions, silviculturally managed pure stands are infrequent, but substantial evidence of the potential to grow high quality timber exists in surviving stands and groups of trees, some of them emanating from larch or broadleaf mixtures. The European larch (*Larix decidua,* Miller) and Scots pine mixture was much favoured in estate planting, and in the early days of State forestry and, with the early removal of the larch for pit props, fencing, and other small produce, led ideally to a final crop of Scots pine.

Younger stands planted in a limited and experimental way in the last 20 years show great promise on a variety of raised and cut-over midland peats. Yield class levels are consistently between 12 and 14, and occasionally 14+, and tree form is excellent. These stands have been established with modern techniques of ploughing, fertilising, and from select seed sources. The stability of Scots pine on peatland media and the absence of 'basal sweep' is a very evident advantage over lodgepole pine, whilst its frost hardiness might find favour also over other species in certain midland situations.

Cases have been observed on raised bogs where Scots pine crops of over 10 years and with similar establishment treatment have grown better and look better than Sitka spruce in juxtaposition and showing down in growth and with symptoms of nutrient deficiency. In this context it is suggested that more intensive silvicultural attention to spacing, thinning and pruning with Scots pine would be rewarding. Better techniques of establishment and improved seed provenance giving faster earlier growth may justify wider espacements with early pruning of select final crop stems aimed at producing high quality timber and avoidance, to some extent, of unsaleable early thinnings thereby also modifying difficulty with pine shoot beetle.

Nursery techniques for raising Scots pine are well known and uncomplicated, and the main pest Needle cast (*Lophodermium pinastri*) can now be easily controlled.Other main pests during the life of the species are Pine weevil (*Hylobius spp*), Pine sawfly (*Diprion pini* and *Neodiprion sertifer*), Pine bark beetle (*Tomicus piniperda*), Pine shoot-moth (*Rhyacionia bouliana*) and to a lesser degree the fungi Butt rot (*Fomes annosus*) and Honey fungus (*Armillaria mellea*). Although some of these pests can be very damaging to crops from time to time, none are a major deterrent. Periodic out-bursts of activity of Red squirrel (*Sciurus vulgaris* (Linn)) are associated with serious damage to the upper main stem. One such out-break, notably in midland and southern areas, in the early 1970s, devastated some stands of Scots pine. The damage is deforming and permanent, resulting from internodal debarking of the upper stem and no effective measures of control have been devised.

Specimens of fine free standing trees are still to be found in many of the estates. Mitchell records a tree at Curraghmore planted in 1770 which was 120ft (36.5m) in height and 9ft 9ins (3m) in circumference in 1968. The 1966 and 1968 Mitchell-Hanan surveys mention other fine specimens, notably at Mt. Usher, Castle Forbes and Adare Manor, and there are many others. As to longevity, Mitchell (1972) mentions a tree at Inverary blown down in 1951 which was 128ft (39m) tall, dating from about 1620. The now seldom visited Scots pine plot at Avondale planted in 1905, while abnormal, is of interest. Rough measurements in this stand, which was under-planted with *Tsuga heterophylla* circa 1950, indicate as follows, Yield Class 10, Av. diameter 43.2cms, S.P.H. 330. Individual trees contain $2m^3$ and boles of some trees have been cleaned up to 15m or thereabouts by the effect of the underplanted Tsuga.

CONTEMPORARY CONSIDERATIONS AND CONCLUDING COMMENT

There has been and still is ample evidence that Scots pine crops of high yield class and of good timber quality can be grown in this country. It is estimated that there is some 9,000 ha of pure Scots pine crops both in State and private ownership in the Republic. It can be assumed that the vast majority of these crops stand on good mineral soil sites where the optimum yield class compares unfavourably with species such as Douglas fir (*Pseudotsuga menziessii* (Mirb)), Sitka spruce (*Picea sitchensis* (Bong) Carr) and other conifer species whose growth potential meet the demands of contemporary economic forestry practice by the earlier production of saw log material, the greater utilisability of the thinning produce, and substantially shorter crop rotation. Faced with these facts, Scots pine is certain to be replaced by other species on the better sites in following rotations. The species, therefore, can only fill a very minor role, if any, in future, as a forest crop on mineral soils, though it will have its uses as an amenity tree in many situations and is highly regarded for that purpose.

One of the big problems of land utilisation in the future is the apparently as yet undecided role of the present and eventual cut-over Bord na Mona midland bogs. The area of these cut-over peats is variously estimated but is likely to be of the order of 151,000 acres (60,728 ha). With commendable foresight and on cut-over midland peat made available by Bord na Mona, the Forest and Wildlife Service established species x fertiliser trial plots at Clonsast in 1955 and, with the provision of further adjoining ground, has expanded these studies. The results are highly informative and promising for a number of species, including Scots pine, on the basis of which the case for forestry to play a major part in the ultimate utilisation of these peats is irrefutable. It is contended that Scots pine should have a substantial part to play on these cut-over peats with the aim of growing a specially high quality timber product. Another advantage that might accrue would be the part it could fill, because of its longer rotation, in an intermingled Shelterwood system with other species, and perhaps indeed with agricultural or horticultural crops.Overall, it could be argued that Scots pine could have a place and perhaps an ecological niche on certain peat types of the variable cut-over peats.

It can be expected that with the modernisation and refinement of the timber industry to meet the increasing produce of the forest that in the future high quality products will attract better price distinction than it seems to do in present circumstances. As is well known, Scots pine, as Red deal, is being imported from the Baltic States as one of the main timbers used in constructional work and house building. It is a versatile timber, being suitable not only as a building timber but also for transmission poles, for chip and fibre board, and paper pulp. Besides it is very acceptable for indoor decorative panelling and for furniture. It may be remembered that kiln dried Scots pine was used as exterior weather boarding in a number of foresters' houses built by the Forestry Service in the mid 1950s and it apparently has survived the test of time since then.

Problems of marketing, availability, and inadequate treatment have more often than not militated against the timber emerging from the mill in optimum condition, but there is ample evidence that the quality product can be produced if properly handled. There is no reason why we should not accept the statement that, "given fair treatment, home-grown Pine wood (Scots pine) is as good as, or better than, the imported timber" (Edlin) and work towards that aim in our silviculture and our sawmill practices.

ACKNOWLEDGEMENTS

I am indebted to former colleagues in the Forest and Wildlife Service who have been very helpful in providing information as requested. The on-ground access allowed to various State Forests was an essential basis for the article and is also much appreciated. Both the foregoing sources have provided useful background for the formation of any views — which are my own — expressed in the article. I am grateful too to Lord Ardee for permission to visit his woods at Kilruddery and to Dr. Ted Farrell (former Editor S.I.F.) for reading the first draft and making some useful suggestions.

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Coppice Wood Management in the Eighteenth Century: an Example from County Wicklow

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ABSTRACT

The extent and commercial significance of semi-natural coppice woods in Ireland in the past are far from clear and relatively little detailed analysis of coppice management using primary sources has been undertaken. Employing a collection of documents relating to the Watson-Wentworth estate in Co. Wicklow, coppice wood management in the first half of the eighteenth century is analysed. Evidence is presented which shows that during that period coppice woods covering more than 800 hectares were managed in a fairly sophisticated way, resulting not only in the preservation of important semi-natural woods but also in the production of a wide range of commercial products. The woods made an important contribution to the income of the estate, generated local employment, developed trading links over a surprisingly wide area and provided a renewable supply of raw materials for a number of important manufacturing industries.

INTRODUCTION

The extent and commercial significance of semi-natural coppice woods in Ireland during the three centuries before the First World War remain unclear despite a longstanding interest in the exploitation and preservation of native woods. Arthur Young in the late eighteenth century appeared to suggest a fairly widespread distribution, being of the opinion that the surviving woods in Ireland were 'what in England would be called copses' (Young, 1892 edn., vol.2, p. 90), but he is often better remembered for his view that woods had been 'destroyed for a century past, with the most thoughtless prodigality' (Young, 1892 edn., vol. 2, p. 85). Durand (1980), for example, in a review of the history of forestry in Ireland stresses wasteful exploitation and clearance for agriculture in the seventeenth and eighteenth centuries and planting during the nineteenth century; no mention is made of coppicing in his account. Others, though acknowledging the role of landowners in planting and preserving woods during the eighteenth century, are equally silent about coppice management (e.g., Freeman, 1969). Those writers who do acknowledge the existence of coppice management either lament (Hayes, 1822) or record (e.g., McEvoy, 1944; Fitzpatrick, 1966; McCracken, 1971) its limited role, geographically, commercially, or both. Eileen McCracken, for instance, in *The Irish woods since Tudor times* mentions coppicing four times and devotes only 16 lines to it in 137 pages. She suggests that coppice management was restricted to a few localities, principally Co. Wicklow, and in that county refers to it only in connection with charcoal production.

How widespread was coppice management? What were its origins in Ireland? How long did it persist? Was it limited to the estates of a relatively small number of aristocrats and gentlemen? Was it restricted to the maritime economy within easy reach of the coast and the largest towns and cities? Were coppices felled 'smack smooth' (McEvoy, 1944) or were there marked variations in practice with simple coppicing in some areas and coppice with standards in others? How efficient was coppice management in preserving woodland and producing a range of serviceable woodland products? Was it commercially successful? Were markets local or regional or did they extend beyond the island?

These and other related questions are unlikely to be convincingly answered until a substantial number of case studies of coppice management on individual properties — large and small, of resident and absentee landlords and in the maritime fringe and less accessible locations — has been accumulated. Rackham (1976), commenting on McCracken's few references to coppicing, wonders whether it really was as restricted as she seems to suggest or whether there is simply a lack of written evidence. It is certainly likely that much potentially valuable archive material has not survived: it is equally likely that evidence does exist in widely dispersed estate archives and that it has not been fully exploited. Smyth (1976) points out that estate records — account books, rentals, estate correspondence, valuation surveys, deeds and leases — have been surprisingly under-used by geographers involved in analysing the transformation of the Irish landscape in the landlord era and, with a few notable exceptions such as Crawford's (1964) study of woods on the Brownlow estate in Armagh and Mrs. McCracken's pioneering work, the point is applicable to research into the history of the management of Irish native woods.

It may be, of course, that estate archives have not survived in sufficient quantity to build up a coherent picture of coppice management throughout the island in the period in question or if quantity is not a problem bias may be: continuous management details are most likely to have survived for the largest and most durable estates and they may not constitute a representative sample of silvicultural practice. However, these potential weaknesses will not be confirmed or repudiated, nor will the specific questions about coppice management raised earlier be able to be answered, even in part, until more surviving estate archives have revealed their secrets. The objective of this paper, therefore, is to make a modest contribution to this end by summarising the main features of coppice wood management on one absentee landlord's property in Co. Wicklow in the first half of the eighteenth century as revealed by surviving estate records for that period.

THE WATSON-WENTWORTH IRISH ESTATE

The estate in question was that of the Watson-Wentworth family whose home estate was centred on Wentworth Woodhouse in south Yorkshire. Thomas Watson, the third son of Lord Rockingham of Rockingham Castle, Northamptonshire, inherited in 1695 the English and Irish estates of his uncle, William Wentworth, second Earl of Strafford, who had died childless. The properties then descended from father to son through two generations until 1782 when Thomas Watson-Wentworth's grandson, Charles, second Marquis of Rockingham, died without issue. The estates then passed to his nephew, Earl Fitzwilliam.

The Watson-Wentworth estate in Ireland lay in six blocks (Fig. 1). Five of these were in Co. Wicklow at Shillelagh (including one farm across the Co. Wexford boundary), Cosha or Cashaw (including an outlier at Toorboy), Rathdrum, Wicklow and Newcastle. The sixth block was in Co. Kildare near the town of Naas. The entire estate totalled some 56,000 plantation acres (about 91,000 statute acres or 37,000 hectares).

SOURCES OF DATA

The surviving records of the Watson-Wentworth/Fitzwilliam estates are widely dispersed. Important collections are to be found in the county record offices in Northamptonshire and North Yorkshire, in the archives division of Sheffield City Libraries, in the muniment room at Wentworth Woodhouse and in the National Library of Ireland in Dublin. Additional, Aalen (1970) reported the existence of copies of two important eighteenth century surveys in the Fitzwilliam estate office at Coolattin.

The present study is based on documents in the collection known as the Wentworth Woodhouse Muniments (WWM) in Sheffield City Libraries. In that collection there is a continuous record of coppice wood management on the Irish estate throughout the eighteenth century though after 1749 the information is less

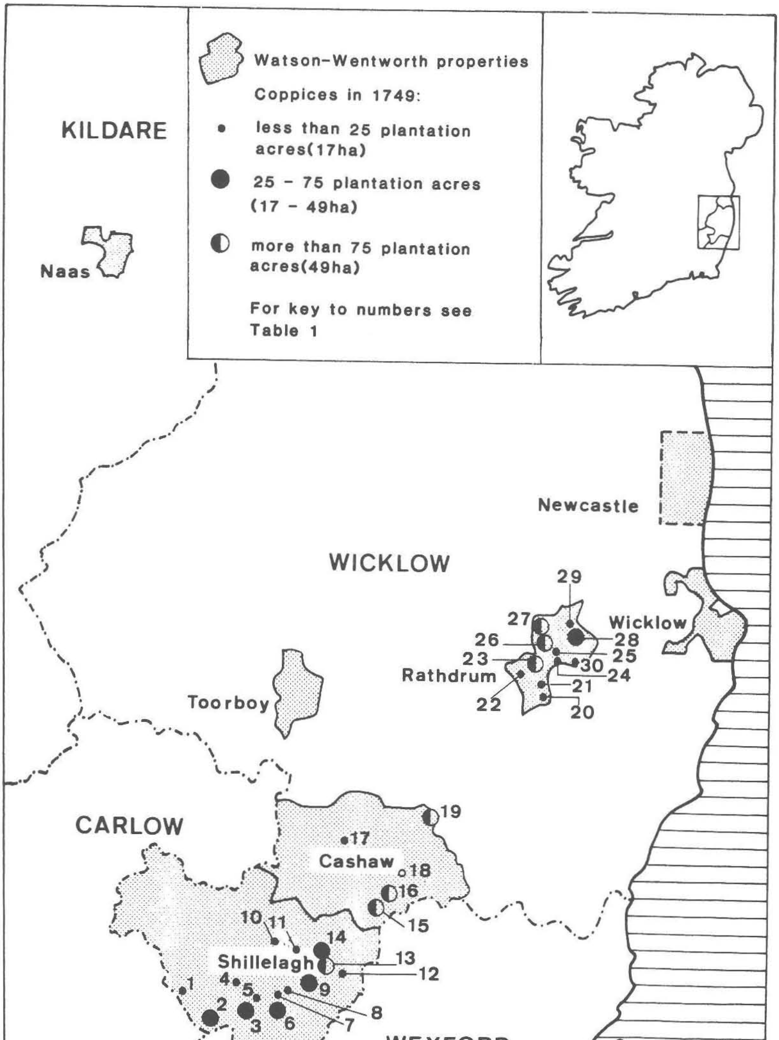

Fig 1. For key to numbers see Table 1.

Table 1: Watson-Wentworth coppices in Co. Wicklow: their sizes in 1724 and 1749, contemporary comments on their sites, and their composition in 1749.

No. on Fig 1	Name	Area in Plantation Acres 1724	Area in Plantation Acres 1749	Site	Composition 1749
1	**Moylisha**	7	8	on very rough ground	chiefly oak, some alders and sally
2	**Raheengraney**	25	35	low side wet and boggy	oak, ash, birch, alder and sally
3	**Balisland**	19	30	—	birch and sally, some oak
4	**Ballard & Minmore**	—	22	—	chiefly oak, some birch and hazel
5	**Ballynockers**	6	14	—	mostly oak, some alders and birch
6	**Cronyhorn**	28	30	hilly, barren	mostly birch
7	**Carrig**	—	19	hilly, barren	mostly birch
8	**Coolattin Scrub Wood**	25	21	—	mostly oak and ash, hazel underwood
9	**Coolattin Wood**	65	63	—	mostly oak, some ash and birch
10	**Cronelea**	2	2	—	mostly oak, some alders
11	**Nickson's Brow**	—	17	—	oak, birch, sally
12	**Paulbeg**	2	2	—	mostly oak, some hazel
13	**Tomnifinnogue & Ballykelly**	131	126	—	birch, hazel, oak
14	**Ballyraheen**	27	41	—	oak, birch, sally, alder
15	**Killaveny**	84	84	—	chiefly birch, some oak and ash

No. on Fig 1	Name	Area in Plantation Acres 1724	1749	Site	Composition 1749
16	**Coolalug**	102	97	—	chiefly birch, some oak and ash
17	**Corndog**	4	20	—	old part oak, new part mostly birch
18	**Tomcoyle**	14	15	—	birch and oak
18	**Ruddenagh**	112	104	—	mostly birch, good no. of oak and ash
20	**Upper Corballis**	11	15	ground very craggy	mostly ash, some oak
21	**Lower Corballis**	10	11	very steep hillside	mostly ash, some oak and alders
22	**Round Coppice**	16	17	cold, hungry ground	oak
23	**Ballygannon**	80	95	poor, hungry ground	oak
24	**Glasnarget**	4	8	—	oak and birch
25	**Keys' Coppice**	—	17	—	oak and birch
26	**Stump**	113	125	—	oak and birch
27	**Cronybyrne**	120	120	ground dips/hangs	oak and birch
28	**Ballynakill**	30	32	a deep glen	oak, birch, ash
29	**Barnbawn**	15	17	—	oak, birch, ash
30	**Bahana**	14	18	—	oak, a few birch
	Total	1,066	1,225		

Sources: WWM A764, A766, A767, A770.

detailed, being just one element of the general estate account books.

For the first half of the century the records are varied and voluminous. There is a general survey of the estate by Moland completed in 1728 consisting of a survey book (WWM A769) and a related, but incomplete, set of maps (WWM MP96) on which coppices are marked and named. Of central importance are five surveys of estate coppice and scrub woods for the years 1724; 1728; 1731; 1747 and 1749 (WWM A764; WWM A766; WWM A770 (containing the 1731 and 1747 surveys) and WWM A767). These surveys include observations on woodland sites, the age and state of the underwood, underwood composition, numbers of standards set out and valuations of underwood poles, cordwood and bark. The 1747 survey also contains some information from a survey of 1743 and a scheme for a 'Revolution of Falls' covering the period from 1748 to 1769. For the period 1707-21 there is a remarkable series of account books (WWM A758-763) in which woodland management matters and woodland products and sales are itemised in meticulous detail. For part of this period (1714-19) there is also a separate coppice trespass book (WWM A765). Finally, the papers dealing with a case in Chancery, concerning Dr. John Griffith who was agent of the Irish estate from 1742 to 1747, give details of woodland management and mismanagement in the 1730s and 1740s.

In the following analysis the records covering the whole of the period from 1707 to 1749 are used to describe the coppice woods and to outline the main features of coppice management on the estate in the first half of the eighteenth century and the detailed account books for the 1707-21 period are employed to describe the wide range of products derived from the coppice woods, to enquire into trading patterns and to evaluate the significance of the coppice woods to the estate and to consider their role in the local and regional economy in the first two decades of the century.

The Coppices and their Management 1707-49

Coppices and scrub woods

By 1749 about 2.5 per cent of the total area of the Irish estate, some 1,450 plantation acres (2,356 statute acres or 954 hectares), were coppices and scrub woods, about 1,225 plantation acres (805 hectares) being coppice woods proper. All the coppices and almost all the scrub woods lay in Shillelagh, Cashaw and Rathdrum and represented the remnants of a much more extensive woodland cover that had been cleared relatively recently. A survey of 1,656, for example, gave a figure of 5,609 plantation acres of woodland in

Shillelagh alone, more than 20 per cent of the total area. Although the Shillelagh woods produced timber commercially throughout the seventeenth century it is not clear when coppice management (i.e., rotational felling of underwood in *fenced* woods) began. The earliest record found of a coppice wood being cut is for 1698.

Although many of the scrub woods were managed as coppice woods and provided a modest but regular source of income for the estate they were not fenced and this is what distinguished them from the coppices. Among reasons given for the absence of fences was their shape (a number were specifically described as 'a scattering of trees' or as 'reyns') and their location out of danger of cattle. Besides the coppices and scrub woods there were also the famous Shillelagh Oaks in the deer park at Coolattin, numbering 2,150 according to the survey of 1728 when the were described as 'The Glory and ornament of the Kingdom of Ireland' and valued at £8,317. The deer park oaks had been even more numerous in 1725 when nearly 900 were sold to Jonathan Chamney, an ironmaster, and were felled for the use of tenants.

By 1749 there were 30 coppice woods on the estate and these are located on Fig 1 and listed in Table 1. The coppices varied enormously in size from over 125 plantation acres to less than two. During the first half of the eighteenth century adjustments were made to the numbers and sizes of the coppices, sometimes through planting but more usually by taking in adjacent scrub woods. It should not be assumed, however, that all the increases in size between 1724 and 1743 shown in Table 1 were the result of coppice enlargement; some of the differences shown were undoubtedly due to surveying and transcription errors. The increase in the size of Corndog coppice in Cashaw from four to 19 acres was certainly a real increase, the old part and the new part being clearly differentiated in the 1749 survey. The additional 15 acres were the result of enclosing an adjacent scrub and planting up a vacancy. Small enlargements were also recorded in the 1749 survey at Bahana, Upper Corballis and Cronyhorn coppices. Not only were existing coppices extended, but completely new ones were created by enclosing good scrub woods. The account book for 1707-13, for example, records the making of a new coppice in the deer park at Coolattin and in 1711 fifty six acres were taken from a tenant to add to an unidentified coppice. The 1749 surveyor noted that two of the coppices described in that survey — Nickson's Brow coppice and Keys's coppice — had been created since 1728. In 1728, Nickson's Brow, then a scrub wood, was already a candidate for conversion to a coppice, the surveyor noting that 'if well reserved and fenced will make as good A Springe if not The Best in Shelelagh'.

Coppice sites and species composition

The coppices were located for the most part on agriculturally unattractive sites; on the wet floor of the valleys of the Derry River and Derry Water in Shillilagh and Cashaw, on steep hillsides, particularly those above the floor of the Avonmore valley in the Rathdrum area, and on high ground. The contemporary observations on sites given in Table 1 speak for themselves. Where scrub woods occupied land with good agricultural potential there was pressure to clear; on the other hand thriving scrub woods on poor soils or difficult terrain were suggested as future coppices. In the 1749 survey, for example, three scrub woods in Shillelagh were said to be not worth coppicing as they were on very good land, whereas another was reckoned to be well worth making into a coppice, 'the wood being thriving & the ground bad'.

The coppices were mainly composed of oak (*Quercus petraea*) although, as Table 1 shows, birch was an important component of most woods. If the eighteenth century surveys are taken at their face value, in addition to what appear to be almost pure oakwoods there were three other well defined stand types. First, on the valley floors and lower slopes, were birch-hazel-oakwoods (e.g., Tomnifinnogue and Ballykelly coppice). Secondly, at higher elevations and on steep slopes were birch-oakwoods without hazel as a Cronybyrne and Stump coppices. Thirdly, again on steep slopes on freely draining soils, were ash-hazel-oakwoods as at the two Corballis coppices on the steep slopes of the Avonmore valley south of Rathdrum. On wet ground alder and willow ('sally') were locally important and holly was said to be an important constituent of one coppice in 1724. Rowan (*Sorbus aucuparia*) rarely absent from native Irish woodlands, is not mentioned in any of the surveys. It is probable that species composition was gradually changed in the coppices through planting and the suppression of less valuable species. The process would necessarily be a slow one and evidence, such as it is, is sparse and circumstantial. For example, in Tomnafinnogue/Ballykelly coppice in 1724 approximately half of the underwood was said to be holly and the wood agent who surveyed it wondered whether it was worth managing as a coppice in its then present state. It also contained a vacancy of 30 acres. By 1749, although the vacancy remained, it was still a coppice and the underwood was said to be mostly birch and hazel with some oak 'of the best sort'.

Coppice with standards management

The coppices were worked as coppice with standards thus combining the growing of mixed underwood with timber trees of selected species and of various sizes. The intervals between successive cuttings of the underwood (the coppice cycle) varied according to site, demand and management efficiency. During the first half of the eighteenth century known cycles varied from 16 to 33 years, with a mean of 25 years, but this period included a phase of lax managment in the 1730s when some coppices were allowed to stand beyond their projected felling dates. The 1748 scheme assumed 22-year coppice cycles for all the woods with coupes of 41-90 plantation acres, with an average of about 65 acres per year.

Alder, ash, birch, hazel, holly, oak and willow would all have contributed to the underwood but the standards were overwhelmingly oak. In the 1749 survey the species of the standard trees were given for 12 of the 30 coppices: oak was named in all 12 (in six it was the only species named), ash in six and alder in one.

In 1749 the stocking of standards in existing coppices varied from nine to 129 per plantation acre (6 to 80 per statute acre). The coppicing scheme projected to run from 1748 to 1769 laid down that at each fall 60 standards per plantation acre (37 per statute acre) should be left. These figures may be compared with the 40 timber trees per statute acre suggested as traditional in Britain by Evans (1984) and contemporary practice on the Watson-Wentworth estates in south Yorkshire where surviving schemes for 1727 and 1749 stipulate 75 per statute acre.

The standards (in general referred to as reserves) were not even-aged. After each fall of underwood they usually consisted of a large number of young trees (wavers) of about 20 years of age, presumably saplings or single poles retained from coppiced stools, together with a small number of more mature trees (black barks) grown on through a number of coppice cycles. The wavers were thinned at later falls leaving a few selected trees to reach full maturity. The proportion of wavers to black barks varied. The 1748 scheme stipulated that at each fall ten black barks and 50 wavers per plantation acre should be left.

Protection of coppices

The most vital element in coppice management is the protection of young growth from grazing animals and around the Watson-Wentworth coppices in Co. Wicklow ditches (i.e. ditched banks) were made for this purpose. In some cases double ditches were constructed. For the 1707-21 period for which detailed records have survived there is only one reference to building a stone wall around a coppice 'where it was so Rocky it could not be ditched'. On the banks whitethorn hedges were planted, sometimes with the addition of hazel, birch and willow. In some cases there was a double hedge. There are also references to coppice hedges being laid ('plashed') but not enough to make it certain that this was an invariable practice. Existing ditches were periodically scoured and remade where necessary at the beginning of new coppice cycles.

Views of the period during which animals should be excluded from coppices have shown wide variations. In some coppices in Dunbartonshire in Scotland in the eighteenth century grazing was allowed after as little as two years (Lindsay, 1974). Some writers believed that grazing and the development of young coppice were incompatible, Monteath (1824), for example, being of the opinion that ten years was the minimum protection period. Although income was received for hay cut in young coppices in the second decade of the eighteenth century, nowhere in the surviving documents for the 1707-49 period is there any reference to authorised grazing in coppices. Whether permitted or not in the later stages of coppice cycles, browsing by domestic animals was blamed for the poor condition of coppices on a number of occasions. For example, when a new agent took up his position in 1748 he noted that Ballyteige, a 54-acre wood on the Rathdrum property, had formerly been a coppice but after being cut in the 1730s had been allowed to be grazed by cattle so that by 1748 scarcely any remains of a coppice were to be seen. Twenty years earlier the wood surveyor sent from England to value the coppices complained of the depredations by cattle in four of them noting that part of Ballyraheen coppice was 'Eaten as Bare as A Bowling Green'.

Coppice managers and workpeople

The coppice woods were the responsibility of the resident land-agent. He was assisted by a clerk, a small team of coppice keepers or woodrangers and a substantial but fluctuating force of woodmen recruited from among the estate under-tenants and their families.

During the 1707-21 period the land-agent also had a general factotem, a relative of the agent and a chief tenant on the estate. The general factotem dealt with the tanners coming to the estate to buy bark and spent a good deal of his time travelling through eastern and southern Leinster and sometimes into neighbouring parts of Munster settling with tanners and other purchasers of woodland products.

There were two types of coppice keeper, 'area' keepers, one each for Shillelagh, Cashaw and Rathdrum, and keepers of individual coppices recruited from among the woodmen and based in particular coppices during and immediately after a fall to prevent trespass, theft and browsing by domestic animals. The woodmen, who worked on a piece-work basis, included woodcutters, squarers, sawyers, cleavers, barkers, ditchers, hedgers and carters.

The land-agent, in his capacity as woodward, arranged for the falls of underwood and great timber, the sale, and often the delivery, of woodland products, the setting out of reserves, the fencing in of coppices, the building and repair of bark mills, the payment of wages and the receipt of payments from dealers. He was also an assiduous pursuer of trespassers and thieves. Expert assistance was available to him in the form of the periodic valuations undertaken by visiting English wood agents. The resident agent was expected to pay close attention to their observations and valuations. In the 1720s and 1730s these were liberally annotated by Thomas Watson-Wentworth the Younger (later the 1st Marquis of Rockingham) who had inherited the estate in 1723 and who took a close interest in coppice management on his properties.

End-Uses and Markets for Underwood and Timber, 1707-21

It is not possible with certainty to separate the products of the underwood from those of the timber trees; bark and cordwood for charcoal production came from both sources as did small building materials, but large building timber came from mature timber trees. The main products were ship timber, building timber including items for industrial use, bark, cordwood, coopers' ware and a miscellaneous group of small stuff dominated by items used in furniture production, farm implements, vehicles and fencing. The very full and itemised accounts for the period from Lady Day (March 25) 1714 to Lady Day 1720 show that the average annual gross income from the sale of timber, wood and associated products during that period was £3,923 of which 50 per cent was earned from the sale of ship and general building timber, 36 per cent from bark sales, eight per cent from cordwood and six per cent from coopers' ware and miscellaneous small products.

Ship timber

Ship timber, like general building timber, was sold squared, sawn and in the round. It was sold in the woods, at the timber yards and delivered, sometimes at the estate's expense, sometimes at the buyer's. It was generally sold direct to shipbuilders whose buyers came to the estate, but some went to dealers and some was carried to Wicklow 'to be laid on the Murrow for Sale'.

All types of ship timber were sold: keels, keelsons, futtocks, stems, skegs, rudders, ship frames, deck beams, boat boards, ship planks or plank logs, gunwales, knees, bowsprits and masts, besides many 'bend trees' for unspecified uses. Scaffolding poles and bilgeways (cradles used when launching vessels) were also sold to shipbuilders and treenails, described in the accounts as 'trunnils' or 'shipp pins', were sold by the thousand.

Most ship timber went to Dublin and Wicklow, although a substantial proportion of that carried to Wicklow was then shipped to England. Between 1707-20 twenty-one different shipbuilders and ship timber dealers were mentioned by name. Of the 16 for whom a location was given, two, apparently dealers, were from within the estate itself, one was from Arklow, four were from Wicklow, four were from Dublin and five were from Whitehaven in Cumbria. There are several references in the accounts of timber for Whitehaven shipbuilders being taken by car to Wicklow for despatch.

Building timber

Building timber was sold by named piece and in undifferentiated lots. Named pieces included unworked wood described as poles and saplings and semi-finished and finished articles such as riberrys (cleft-spars), principals, purlins, beams, collar-beams, hammer-beams, rafters, laths, shingles, lintels, doorcases, clapboard and 'window stuff'. Named industrial items included helves, millshafts and timber for waterwheels.

Timber was also provided for a substantial number of named building projects including Dublin barracks for which £1,453 were received in 1708-09, Dublin 'Colledge' (£410 in 1719), courthouses at Athy, Carlow and Wicklow, repairs to market houses at Blessington and Newtown Mount Kennedy, new churches at Coolkenna, Dunard, Inch and Kilcullen, church repairs at Ballymore, Baltinglass, Carnew, Clonegall, Donaghmoor, Hackettstown, Hollywood, Kilcommon, Lymrick and Tullow, a new gaol at Carlow, five bark mills and a fulling mill. The accounts reveal a great diversity of business with buyers great and small. Jostling with the purchasers of many tons of timber were customers like the one in 1715 who bought ten round poles for a dog house.

Bark

Bark for tanning was sold by the barrel. A barrel was, according to the valuation of 1747, '4 bushels upheaped wn. cut'. The accounts for 1709 record a payment of ten shillings 'for making showels for measuring Bark'. The bark was not differentiated by species; Clarkson (1974), states that in England until the 1790s oak bark was the only bark used by commercial tanners and in the absence of evidence to the contrary it is assumed that most of the bark described here was oak bark.

The whole of the barking operation from the felling of the trees to the grinding of the inner bark into small pieces was done by undertakers who operated with teams working particular coppices from particular bark mills. Most of the bark was peeled in large pieces after felling by a first team of barkers; some bark, inevitably, remained on the trees which were re-worked by a second team and their product was called 'pickt bark'. Bark was also knocked off old, decaying trees. The peeled bark was 'stucked' (stooked) to dry and then stacked under cover at the bark mills before being shaved and ground there. The bark mills, of which eight were in operation during the 1707-20 period, though never more than four at one time, were simple premises with wattle and daub walls and thatched roofs. Clarkson (1974, p. 145) writing about bark production in England, suggests 'about the third quarter of the eighteenth century, if not earlier' for the replacement of hand operations by bark grinding mills, the simplest being horse powered and more sophisticated ones employing water power. The mention of making mill wheels for a bark mill in 1711 and the record of a water course being dug for the use of another in 1715 suggest that water powered bark mills were in use at the Watson-Wentworth coppices as early as the beginning of the second decade of the eighteenth century if not earlier. As falls were completed in particular woods and bark production brought to an end, mills were taken down and re-erected in or near coppices that were due to be cut next.

Annual output between 1707 and 1720 was very uneven, being related not only to the amount of wood and timber being cut but also to the proportion of oak felled. It varied from over 7,400 barrels in 1707 to less than 1,400 barrels in 1712. Over the 13-year period from 1707 to 1719 annual output averaged almost 3,500 barrels. Calculating the gross income from bark sales for a particular year's output is difficult because payment was sometimes spread over more than one year and some bark was sold and payment received before it was peeled, as in 1712 when Thomas Murphy and Bryan Bracken, Dublin tanners, paid £100 'before hand for bark to be delivered'. The highest annual gross income from bark sales in the 1707-20 period was £2,772 in 1707; the lowest was £840 in 1711. The average annual gross income from bark between 1707 and 1720 was in excess of £1,500, the equivalent of almost 40 per cent of the annual rental income from those parts of the estate (Shillelagh and Cashaw) where it was produced.

Although there were some substantial buyers of bark a typical year's production was sold to between 10 and 20 tanners in an area extending as far as 40 miles from the estate. In 1713, for instance, there were 16 different customers for bark; five years earlier the agent had settled with 18 tanners in Dublin alone. Besides Dublin, which was the largest market, bark was sold in Baltinglass, Dunlavin, and Wicklow town in Co. Wicklow, Ballycarney, The Deeps, Enniscorthy, Gorey and Wexford in Co. Wexford, Athy and Naas in Co. Kildare and in Carlow town in Co. Carlow.

Cordwood for charcoal making

The market for the wood destined to be made into charcoal lay, as far as is known, entirely within the barony of Shillelagh where the Chamney family had an ironworks in the form of a furnace and forge in the townlands of Ballinultagh and Ballard and where two other English tenants had a forge in Balisland townland. Wood for charcoal making was sold by the cord, a cord on this estate being a pile of underwood and branches from timber trees cut into short lengths (and barked if oak) measuring four feet high, three feet broad and eight feet long. The average yearly production from 1714 to 1720 was about 1,200 cords.

What is surprising, in view of the emphasis McCracken placed in her two brief references to the Wicklow coppice woods on their relationship with ironworks, is that compared with shipyards, tanneries and general building projects, the ironworks were, in the early eighteenth century at least, only minor consumers of coppice wood products. During the 1714-20 period, for example, gross income from cordwood sales amounted to a little over £1,805; for bark it was nearly £8,500. Nor is this difference reduced if costs of production are taken into account: payments for cutting and cording cordwood between 1714 and 1720 amounted to £485; the cost of felling, peeling, stooking, stacking shaving and grinding bark and for making and repairing the bark mills in the same period was £1,108. Cordwood must, in this period at least, be seen as a by-product of bark and timber production in the Watson-Wentworth coppices.

Coopers' ware and other products

Income from the sale of coopers' ware in the form of staves, though small in comparison with that from ship and building timber and bark, was derived from a wide geographical area. Besides local sales of staves for barrels, half-barrels, pails, churns, piggens and keelers and of hazel and willow hoops, staves for barrels, firkins and hogsheads were sold to coopers in the ports of south-east and southern Ireland, namely Dublin, Wexford, Ross, Waterford and Cork. Of these Waterford was the main destination of stave wood, the two largest single transactions in the 1707-21 period involving that port: 4,000 barrell staves in 1707 and 9,000 in 1708.

There was also a brisk trade in the all-purpose farm and general haulage vehicle, the car. The account books record the sale of complete vehicles and parts including solid wheels, axle-trees, bodies and shafts. Estate tenants were important customers. It was on such vehicles that timber for the Whitehaven shipbuilders was recorded to have been taken to Wicklow and bark taken to Dublin. Coach wheel spokes were also made.

Among the smaller products made in and sold from the coppice woods was a wide range of fencing material including stakes, rails, oak pales, hurdles, sheep pens, gate posts and gate bars. Parts were also made for farm implements notably plough beams, crosses and soles and handles for pitchforks and rakes. Chairbacks, stool legs and planks for cupboards and dressers also found a ready market. The smallest items derived from the coppice woods were wooden buttons, 'button mould timber' being sold on a small but regular basis.

SUMMARY AND CONCLUSIONS

The evidence presented here shows that by the end of the period in question more than 800 hectares of coppice wood were being managed in a fairly sophisticated way. Woods were not only preserved, they were extended and some new coppices were created through planting and the taking in of scrub woods. Standards of oak, ash and alder and mixed underwood dominated by oak and birch provided a wide range of commercial products. In the early eighteenth century there was a wide sales area and there is no reason to believe this later decreased in size: sales destinations were distributed widely in counties Wicklow, Kildare, Dublin, Carlow and Wexford and stavewood went as far as the Munster ports of Waterford and Cork. Oak timber for ships also found favour beyond the Irish Sea at Whitehaven in Cumbria. The coppice woods were also important creators of employment, not only directly through the recruitment of coppice keepers and woodmen, but also indirectly in the building industry, shipbuilding, tanning and iron manufacture in the local area and the wider region. They also stimulated the carrier trade to the extent that an observer in 1732 wondered what local car men would do 'now all the woods are fallen'.

Income for the estate from the coppices in Shillelagh, Cashaw and Rathdrum was considerable, easily taking care of the costs of administering that part of the estate and thus turning the rents from gross income into net income and still returning a sizeable profit. For example, in the 1714-20 period gross average annual income from the Shillelagh, Cashaw, Rathdrum and Kildare parts of the estate was £7,805, of which almost exactly half came from rents and half from sales of timber, wood and bark. Average annual outgoings during the same period were £1,250.

Were the Watson-Wentworth coppices unique in Ireland? The answer is emphatically no, though such woodland management was undoubtedly not common. It is stating the obvious to say that more light from primary sources needs to be shed on the extend, form and significance of coppice management in Ireland.

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Growing Ash for Hurleys

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Abstract

A project to determine the optimum size butt in monetary terms for the production of hurleys from the Common Ash (*Fraxinus excelsior* L.) is described and the results presented. A system for growing ash for hurley production is outlined. A variety of silvicultural systems for ash are examined for profitability and compared with likely returns from Sitka spruce on the same sites.

Introduction

The genus *Fraxinus* consists of about 65 species mainly found in temperate latitudes of the Northern hemisphere. Only one is native to Ireland, the Common Ash, *Fraxinus excelsior* L. It is mostly found in lowlands but will grow to altitudes of up to 450m. Though ash has been planted in relatively small amounts it is probably the most common naturally occurring hedgerow tree in the country. Little information is available on seed origin. Trials in Britain from the 1930s detected little provenance differences. It was claimed in Germany that there were two distinct races, "water-ash" and "limestone-ash" however this is not certain and the apparent differences may be due to site factors.

Individual trees may bear wholly male, female or hermaphrodite flowers; males often exhibit the best stem form as female flowers are terminal. It flowers in April or May and the winged seeds ripen in August. In natural stands it usually occurs in mixtures, frequently with oak. Oak and ash woods can support a rich flora as both come into leaf late in the season. Though ash attains its best growth on rich, basic lowland soils, where it can grow to 40m, it usually occurs naturally in pure stands only on dry limestone sites where other tree species cannot compete. It has a lifespan of about 200 years. Ash produces a strong, springy timber and is used in the manufacture of furniture, tool handles and sports goods. In Ireland, the latter use is the major reason for the interest in the growing of ash on a commercial basis.

Ash for Hurleys

Every year about 450,000 hurleys are used in Ireland. They are all manufactured from the butt-section of the native Common Ash. Only the bottom 1.5m of the tree is used. The remainder is useless for this purpose. A consequence of this is that the butt is worth on average about ten times as much per m^3 as lengths further up the tree. It is the most valuable of all home-grown timber. At the prices currently prevailing it is possible to grow ash profitably. There is probably no other broadleaf tree to which this applies in Ireland.

One of the reasons ash butts are so valuable is that trees suitable for hurley-making are scarce. Demand exceeds supply. In the past there has been little planting of ash explicitly for this purpose. It is one of the most abundant of native tree species and occurs throughout the country, so there seemed little danger of a shortage occurring. However, most of the trees occur in scattered locations, being widespread in hedgerows, appearing in mixtures, in scrub and in the few remnants of broadleaf woodland. These trees are frequently not suitable for hurley-making, harvesting costs are considerable and the logistics of locating and harvesting such trees make them unsuitable for modern methods of large-scale hurley production.

Since plantation forestry commenced, ash has been planted occasionally in small patches but more usually in mixtures with conifers, particularly Norway spruce. These stands comprise the main source of hurley ash today. They are usually managed to provide commercial lengths of ash as well as hurley butts and increasingly they are failing to meet the demands of hurley manufacturers as other sources of ash outside the Forest and Wildlife Service (FWS) are exhausted. Recently ash has been imported, especially from Wales. Because of this the FWS has investigated the growing of ash specifically for the hurley market, to assess its commercial prospects but primarily to ensure that sufficient material is produced to allow the survival of the game of hurling and of the manufacturing industry by supplying enough ash to enable hurleys to continue to be put on the market at a reasonable price. This paper describes these investigations and their results.

Hurley Ash Project

The first question to be answered was what were the requirements of the hurley-makers, both in terms of quality and size of butt. Discussions with various manufacturers provided no clear consensus. The scale of operations varied considerably as did the production techniques. Preferences depended in part on the type of operation and on tradition. It was decided that from the point of view of growing ash profitably we would assume the most modern production systems and the co-operation of a hurley-maker was secured in a project to determine the optimum size and quality of hurley-butt.

(A) Material

Four size classes and three quality classes of butt were sampled from a stand of ash in Donadea forest, Co. Kildare. The breakdown is given in *Table 1.*

Table 1: Number of ash butts selected in each category.

	Size (Diameter at 1.3m in cm)				
Quality	18	22	26	30	46
Good	4	4	4	4	2
Fair	4	4	4	4	
Poor	4	4	4	4	

The quality of the stems was assessed standing by the hurley-manufacturer. The ash was planted in the period 1940-1946 and has an estimated average yield class (YC) of 8. The soil profile and site details are given in *Appendix 1.*

After selection a description of the stems was recorded and each tree was photographed on its 'best' face, as normally assessed, and at right angles to that direction. This was in an attempt to produce some objective grading system for assessing standing trees by relating their appearance to the actual hurley production.

The butts were then harvested in the normal manner and converted into hurleys. *Table 2* gives the results in detail. *Appendix 2* describes the conversion process and explains the hurley classification system.

(B) Results

(a) *Size of butt*

A monetary value was assigned to each butt based on the valuation of hurleys as described in Appendix 2. The curve for DBH v. an index of value/m^3 of butt is shown in *Figure 1.*

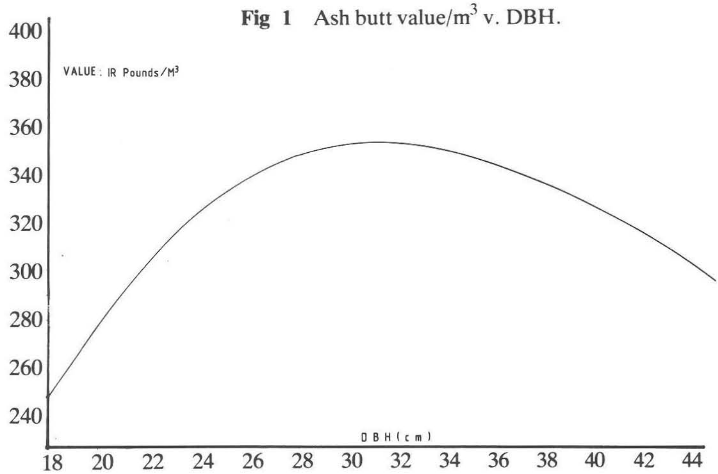
Table 2: Results of conversion of ash butts to hurleys.

Tree No.	Diam. Class (cm)	Rating (Standing) by Manufacturer	Assessment (Planked) Manufacturers Comments	Hurley Output				
				37"	36"	34"	32"	30/28"
1	18	Good	Fair	1				6
2			Fair	2	1	2	3	1
3			Fair			1	3	3
4			Fair				2	3
5	18	Fair	Poor				2	5
6			Bad			2	2	2
7			Bark Damage		1	2	5	1
8			Bad			2	1	1
9	18	Poor	Poor				2	8
10			Bad				3	2
11			Poor				4	3
12			Bark Damage		1	4		5
13	22	Good	Good	2	2	2	7	
14			Good		2	4	4	2
15			Fair	3		3	4	4
16			Fair		2	2	4	2
17	22	Fair	Poor	5		2	3	4
18			Fair	1		3	2	3
19			Fair		2	2	5	5
20			Poor		2	4	4	2
21	22	Poor	Poor		2	3	3	3
22			Fair	3	2		2	6
23			Bad		2		4	3
24			Bad		1	3	3	6

Table 2: Results of conversion of ash butts to hurleys (contd.)

Tree No.	Diam. Class (cm)	Rating (Standing) by Manufacturer	Assessment (Planked) Manufacturers Comments	Hurley Output				
				37"	36"	34"	32"	30/28"
25	26	Good	Good	5	3	3	1	5
26			Good	6	3	4	2	2
27			Good	6	5		3	1
28			Fair/Poor		2	4	6	4
29	26	Fair	Fair/Poor	2		6	4	5
30			Fair	1	4	5	2	4
31			Fair/Good	4	4	4	3	4
32			Fair	1	3	2	3	5
33	26	Poor	Fair	3	3	3	1	6
34			Fair	5		2		
35			Poor	1	4	2	1	8
36			Good	1	1	4	6	3
37	30	Good	Excellent	10	6	2		5
38			Excellent	8	2	5	3	5
39			Excellent	12	6	6		2
40			Good	8	5	6	1	1
41	30	Fair	Fair/Good	7	3	8	3	1
42			Poor	4	3	4	5	3
43			Good	6	3	5	5	1
44			Good	2	7	8	1	3
45	30	Poor	Fair	1	4	6	3	3
46			Bad	3	6	3	6	2
47			Fair	9	1	1	3	2
48			Fair/Good	4	2	2	5	8
49	46		Fair/Good	15	11	4	2	3
50	46		Fair	13	3	4	5	9

Fig 1 Ash butt value/m^3 v. DBH.



From this it can be seen that the optimum size of butt is in the region of 28-32cm DBH. The reason for the decline in value after this point is that in very large stems the timber in the centre of the tree is not used for hurleys, the butts are sold by the m^3, thus in larger butts there is an increasing amount of less valuable material.

(b) *Quality of butt*

An analysis of butt value by quality class indicated that the visual standing assessment by the hurley manufacturer was reasonably accurate. Table 3 gives a breakdown for each of the 4 size classes of value by quality class.

Table 3: Hurley value index (one senior hurley=1.0)
(Figures are relative units of value per unit volume)

Size Class	Quality Class		
(DBH cm)	Good	Fair	Poor
18	112	104	115
22	166	138	132
26	168	148	136
28	195	172	113

It can be seen that the larger the stem size the better the standing visual assessment of the worth of the butt. Only in the 18cm size class was this evaluation wrong. Based on these findings a visual grading for hurley butts can be described.

Fig 2 Quality Class 1: Good. Stems which are straight, free of branching or defects such as extraction damage or other injury. Even and well-developed buttressing of the roots, 4 roots being optimal.

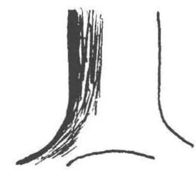


Fig 3 Quality Class 2: Fair. Straight stem, free from defects. Buttressing poorly developed or uneven, but with at least two good roots.

Fig 4 Quality Class 3: Poor. Swept stem or a stem with minor damage. Buttressing very poor or else very uneven. Similar to trees which might be found growing on the side of a hedgerow.

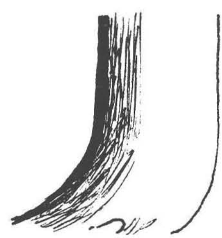


Fig 5 Quality Class 4: Unacceptable. Forking or branching below 1.5m.

(C) Use of Root Collar Diameter as Predictor of Butt Value

A measurement of the diameter of butt at ground level of all the trees used in the conversion study was taken. It was hoped that this statistic might give a better estimate of value than DBH. However, it proved less useful. The reason appears to be the many abnormally high readings which frequently did not reflect hurley production. The measurements were taken too close to the ground and perhaps a reading at about 0.3m up the stem might indeed improve prediction, unfortunately the measurement was not taken.

Rate of Growth

An important feature of a good quality hurley butt is that it be fast-growing. Quite apart from the economic benefit of attaining optimum size in as short a time as possible (which is dealt with later), slow grown trees do not provide the springy timber required by the hurley-manufacturer. Flexible hurleys absorb the shock of impact during the course of a game. It has long been an accepted fact by those who play hurling or those who make hurleys that fast growth produces stringy timber. A simple test is to be conducted at the Institute of Industrial Research and Standards to confirm this, however results are not yet available.

Growth and Yield

Information on the growth patterns of ash in Ireland is sparse. There are British Forestry Commission (BFC) yield tables for the species, however these are based on an initial spacing of approximately 1.8m and thinning is to marginal intensity. Only one experiment examining wider spacings exist on a reasonably good quality site. This is in Knocktopher, Co. Kilkenny. Details of the experiment are given in Appendix 3.

Because of the variability of the site, interpretation of the results is difficult. Differences in height growth within treatments exceed that between treatments. The yield class based on the BFC top height/age curves for 0.9m and 2.7m plots cannot be directly estimated. This is because spacing usually has a significant effect on height growth in broadleaved species — the wider the spacing the lower the height. Even on a site such as Knocktopher this trend is evident, though not statistically significant.

Table 4: Mean top height (m) by treatment. Knocktopher 1/63 at age 19 years.

Treatment:	0.9	1.8	2.7
Top Height:	11.43	10.90	9.03

An examination of the 1.8m plots would indicate that basal area growth for all three plots was close to that given in the yield tables for the yield class indicated in BFC Booklet No. 34. The Booklet states that for ash the sycamore/ash/birch table to be used should be one yield class less then indicated by the top height/age curves. For YC 10 ash, planted at 1.8m spacing and managed according to the management tables the main crop after thinning statistics in Table 5 would apply:

Table 5: BFC YC 10 table stocking/mean DBH/age (Figures rounded).

Age	Stems/ha	Mean DBH (cm)	Largest 350 stems (DBH cm)*
15	1120	10	13
20	660	15	18
23	660	18	21

* Estimates based on examination of Knocktopher data.

If we assumed that the mean difference in top height between the 1.8m and 2.7m plots of approximately 2m (Ref. Table 5) represents the true height depression due to wider spacing then the adjusted reading of the top height/age curves indicate yield classes of 4 for one of the 2.7m plots and YC 8 for two of them at age 23. Two of the 1.8m plots are YC 6 and one is YC 8. A comparison of the YC 8 plots of the three treatments is given in Table 6.

Table 6: Comparison of mean DBH and DBH350* for YC 8 plots at age 23.

	0.9m	1.8m	2.7m
Mean DBH (cm)	10	13	15
DBH 350 (cm)	13	16	18

* Mean DBH of 350 largest stems/ha.

With 1360 stems/ha the 1.8m plot above is considerably overstocked when compared with the yield table (890 stems/ha). This is reflected in the depression of mean diameter which the tables suggest as 15cm. In the 2.7m plot where stocking is close to the figure in the table the mean diameter is 15cm. Examination of the tables would suggest that thinning to marginal intensity would give a mean DBH of about 18cm at age 23 (Ref. Table 9) for YC 10.

If the increase in mean diameter with reduced density as illustrated in Table 6 is maintained with lower stocking levels than given in the yield tables a further increase in mean DBH of 2cm does not seem unreasonable if initial stocking is 1111 stems/ha (3m spacing). An examination of edge trees in Knocktopher would indicate that this assumption is probably conservative. Thus the statistics for such a crop are given in Table 7 below.

Table 7: YC 10, 3m initial spacing, thinning to marginal intensity.

Age	Stems/ha	Mean DBH	DBH 350
15	1111	12	15
*20	660	17	20
25	450	23	26

*Unthinned before this age.

If, instead of thinning to marginal intensity the number of stems were reduced to 700 at age 15 and to 350 at age 20 then greater diameter increments can be expected.

It is on the basis of arguments such as outlined above that Hurley Ash yield tables have been constructed. Obviously, given the extremely limited data-base they can only be validated by time and further experimentation; however, the assumptions are at all stages reasonably conservative.

Table 8: Yield Tables for Hurley Ash.
Initial spacing 3m (1111 stems/ha).
First Thinning (T1) leaves 700 stems remaining.
Second Thinning (T2) leaves 350 stems remaining.

YC	Age of T1	(Mean DBH)	Age of T2	(Mean DBH)	Age of C/fell	(Mean DBH)
10	15	(15)	20	(20)	25	(28)
8	18	(15)	24	(20)	30	(28)
6	22	(15)	31	(20)	40	(28)

Diameter refers to crop after thinning.

SITE AND NUTRITION

(1) *Soil*

Perhaps the greatest obstacle to the successful growing of hurley ash is the identification of good sites. Optimum sites occur in deep, moist, free draining soils in sheltered locations which are not prone to late spring frosts. These areas are also excellent agricultural land and are not commonly available for forestry. Good sites will normally occur in small patches. A rough breakdown of soil types ranked by suitability for ash is:

Good sites:
Well drained, moist brown earths.*

Moderate sites:
Surface water gleys not excessively water-logged.

Poor sites:
Peats.
Any water-logged soils, very dry or shallow soils.

The only definite indication of a good site is the existence of mature ash which is growing rapidly. The presence of prolific natural regeneration of ash, as is often found, for example, on gleyed soils after the removal of tree cover is not necessarily an indication of a good site.

(2) *Nutrition*

Ash is one of the most nutrient demanding of all tree species grown in Ireland and as such the question of fertiliser applications must be considered. Results from an ash manurial trial in Gorey, Co. Wexford, indicated that on a brown podsolic site the application of NP and K, lime, or both NPK and lime gave a positive response, with NPK only giving the best results in Gorey.

Details of the Gorey fertiliser trial and results are given in Appendix 4. On the basis of these results it is suggested that a positive response to applications of NPK can be expected on mineral soils of less than YC 10 which are neither water-logged nor excessively dry. On slightly acidic sites the application of lime should be considered. The optimum pH range for the growth of the species is thought to be 6-7.

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* Ref. Appendix 1. The site in Donadea which produced the ash used in the conversion study is described in detail to illustrate an example of an excellent ash site.

(3) *Other Site Considerations*

Protection from late spring frosts is a major consideration when selecting a site for hurley ash. Ash is very susceptible to spring frosts which damage and cause distortion fo the stem, and as it is vital to produce straight, clean stems up to about 1.5m for hurley production, frost-prone sites should be avoided. Exposed sites should be avoided. Ash performs best in a sheltered environment.

PRESCRIPTION FOR HURLEY ASH

Planting Stock: As there is no information available on provenance variation within ash it is recommended that seed be collected from straight, well buttressed, fast grown timber. Nursery practice should avoid the production of the typical J-root which can lead to uneven buttressing. Ash should be planted out as clean, single stemmed two-year seedlings, at least 50cm in height.

Planting and Site Preparation: Ash should not be planted on ploughed ribbons but be pit- or mound-planted. Steeply sloping sites should be avoided. These measures are to help ensure even buttressing. Spacing of about 3m square is recommended (1100-1200 stems/ha). At this spacing competition from ground vegetation will persist for several years therefore grass cleaning is critical as good survival rates are important.

Protection: Ash grows well in mixtures and likes a moist, sheltered micro-climate so it should be interplanted with Christmas trees, either Norway spruce or Noble fir. The number of Christmas trees to interplant can range from 1100 to 3300 stems/ha and the decision will depend mainly on the likely market. It is important that they be removed before they start to compete with the main crop. They will serve to surpress ground vegetation and protect the ash from frost and exposure.

Protection from rabbits, hares and sheep is essential. For the latter the usual sheep fencing should be used. In the case of rabbits and hares fencing is expensive and often not effective, so chemicals may have to be used. The timing and frequency of applications will depend on the severity of attack.

Tree guards have many advantages and their use is discussed in the section on economics.

Fertilisation: 800kg/ha 10:10:20 should be applied one year after planting and again every five years until clearfelling. If the site can be established as having a very high yield class (YC 10+), fertilisation is probably not effective.

Pruning: By about 6-9 years of age when the Christmas trees are harvested, approximately 700 of the best stems should be selected and all branches below 1.5m should be removed. Branches above this point should be left because they contribute to butt growth.

Thinning and Clearfelling: Timing of thinning will depend on growth rate. Assuming a good site and fertiliser application YC 10 should be achieved. In this case first thinning will be at 15 years of age and all stems except the selected 700 should be removed.

At age 20 the 350 of the remaining trees should be harvested and these will provide many butts suitable for hurleys. The best stems should be left. The minimum butt size acceptable is approximately 18cm. Finally, at 25 years of age the stand should be clearfelled. Anything less than YC 6 is considered unsuitable for hurley production. Even YC 6 is unlikely to produce a high proportion of top class hurleys due to its slow growth.

Table 9: Thinning and Clearfell ages for different yield classes.

YC	1st thinning Mean DBH 15cms	2nd thinning Mean DBH 20cms	Clearfell Mean DBH 28cms
10	15 yrs.	20 yrs.	25 yrs.
8	18 yrs.	24 yrs.	30 yrs.
6	22 yrs.	31 yrs.	40 yrs.

The system outlined above is aimed at getting a final crop of virtually open-grown trees to produce a mean DBH of 28-30cm in the shortest possible time while also giving the reasonable shelter which the trees need to thrive. This diameter has been calculated at the optimum in terms of hurley value per m^3 of butt.

Hurley Production

Based on the hurley ash yield table (Table 8) and the results from the conversion study, Table 10 gives the anticipated total production in terms of hurleys/ha/year.

As is evident from the results of the conversion study (Table 2) there is a very considerable difference in hurley output between butts of the same size. The figures in brackets in Table 10 show the production which could occur if butts of the very highest quality were grown; the non-bracketed figures are the numbers produced if the average stem quality is assumed equal to the best butts in the conversion project.

Table 10: Hurley Production (Hurleys/ha/year).

YC	Senior Hurleys	Others	Total
10	130 (180)	290 (320)	420 (500)
8	110 (150)	240 (270)	350 (420)
6	80 (115)	185 (200)	265 (315)

SUPPLY SITUATION

The Gaelic Athletic Association (GAA) estimate that about 450,000 hurleys/annum are used (all sizes). Based on the figures in Table 10 above and assuming the average production from good quality butts it is calculated that 47.6 ha annually of YC 10 Ash would be required to supply the market. Obviously if the very best quality butt could be achieved in each case the total production (from Table 10) would be greater and so the area required would be less.

Given a 25 year rotation, the amount of hurley ash plantation (pure, YC 10 and widely spaced) which would be necessary is about 1190 ha. So what is the acutal supply situation at the moment?

FWS Inventory figures indicate that in 1973 there were approximately 5,500 ha of ash plantation in private hands. However, much of it was regarded as over-mature by that time. Almost no private planting of ash has taken place since then, so it is likely now that much of the remaining area of private ash is unsuitable for hurleys. Eventually this area will be exhausted in terms of suitable hurley timber. There were about 1230 ha of ash in State plantations at the time. While this was generally younger than the private stock it was far from optimal in terms of usefulness for hurleys. As can be seen from Table 11 much of it is well past the stage at which it is likely to interest a hurley manufacturer. Table 12 shows the pattern of FWS planting since 1970. It can be seen that only in 1981 was the area planted close to the estimated area required, even assuming YC 10 sites. This situation is unlikely to be critical while relatively large areas of old ash remain which will always contain some suitable stems. However, discussions with purchasers and the recent surge in ash prices indicate this source may be drying up.

The difficulty for the FWS in trying to alleviate the problem is simply a shortage of suitable sites. Yield Class figures for broadleaves are not available but the mean YC of FWS ash is probably about 6, or just on the margins of butt suitability for hurleys and profitability for the grower. Given this type of land

Table 11: Ash in FWS Plantations by age class (area in ha).

Planting Period	Area	Planting Period	Area
Pre 1921	193	1945	145
1925	9	1950	131
1930	55	1955	87
1935	124	1960	70
1940	337	1965	53
		1970	23

Table 12: Areas of ash planted by the FWS since 1970.

Year	Area (ha)	Year	Area (ha)
1971	18	1977	36
1972	30	1978	18
1973	20	1979	8
1974	10	1980	0
1975	N.A.	1981	42
1976	27	1982	7

about 80 ha/annum would need to be planted, and the quality of the hurleys produced would be poor. As mentioned previously, the best ash soils are deep, free draining brown earths and as these soils are excellent agricultural soils they are unlikely to be acquired by the FWS. It therefore seems essential that State plantings be supplemented by private plantations. As little as an average of 2 ha per county per year of ash grown on good sites and carefully maintained should be sufficient to ensure future supplies of hurleys.

A comparison of GAA estimates of hurley use and FWS sales of ash butts appears to indicate that at present about half of the ash used comes from private sources. If this situation is to be maintained, private planting will have to recommence quickly.

Economics of Growing Ash

However successful the grower is at producing sufficient hurleys to meet the demand, he must anticipate a financial reward to justify doing so. Not only that, but in a commercial forest enterprise the return must be at least as good as the best alternatives. The analysis presented below examines the Net Discounted Revenue (NDR) for a variety of silvicultural regimes for ash and compares them with the expected returns from Sitka spruce on the same sites. Three site types are examined which typically would be likely to produce the three growth rates of ash of sufficient vigour to produce acceptable quality hurley butts. Details of the results by site are given in Tables 13-15. The assumptions taken in the analysis are outlined in *Appendix 5*.

The Sites

(a) Brown Earth
The best site for ash with a YC 10 achievable, often without fertiliser application. On such a site Sitka spruce should attain YC 22.

(b) Brown Podsolic
YC 8 ash and YC 20 Sitka might typically be found on soils of this kind, provided other factors are favourable. Fertiliser application could probably boost many of these sites to YC 10 ash.

(c) Gley
Ash is unlikely to reach more than about YC 6 on these sites due to impeded drainage. They are frequently excellent Sitka spruce soils and YC 24 is not unusual for the species.

These three sites are isolated merely as examples of the sort of comparison that must be made to assess the financial aspects of planting ash. Obviously every individual site would have to be examined on its merits and an estimate of the yield class of ash and the alternative species made together with some judgement on the likely response of ash to fertiliser on the site in question.

The Silvicultural Systems

(a) Sitka spruce
The management system assumed is the normal practice of planting 2,500 stems/ha and thinning to marginal intensity. Felling age is 80% of the age of maximum mean annual increment, which is standard in the FWS.

(b) Ash only; 1100 stems/ha
This system assumes management according to the Hurley Ash Yield Table (Table 8). However, no Christmas trees are included.

(c) Ash only; 1100 stems/ha plus tree guards
As above, except it is assumed that all stems are encased in plastic tree guards 1.3m high. The guards have two main advantages, firstly

growth is accelerated greatly in the first few years thus aiding the trees in getting above competing vegetation; secondly, and perhaps more importantly, they afford protection from hares and rabbits. While in this regime tree guards are regarded as optional they may be essential in some areas with low density initial stocking if establishment is to be successful at all.

(d) Ash 1100 stems/ha (no tree guards); Noble fir 1400 stems/ha
The Noble fir are added for the reasons given in the section on 'Prescription for hurley ash'. They are also a valuable cash crop as will be seen.

(e) Ash 1100 stems/ha with tree guards: plus 1400 Noble fir/ha
As for (d) above, with tree guards added.

(f) Ash 700 stems/ha with tree guards plus 3300 Noble fir/ha
The ash are reduced to the number at which all stems are expected to produce hurleys and the number of Christmas trees increased to maximise the cash crop and eliminate 'non-productive' ash plants. At such a low density of ash, tree guards are assumed to be essential.

(g) Ash 3000 stems/ha, 'Normal Management'
Ash planted at the density assumed in the British Management Tables and thinned accordingly. Trees of sufficient size when harvested are divided into hurley butts and 'commercial' ash.

The results

Table 13: Brown Earth; Ash YC 10, Sitka spruce YC 22.

System	NDR IR£(1985)	No. Hurleys /ha/annum
(a) Sitka spruce 2,500 stems/ha	4886	
(b) 1100 Ash only	4506 (3911)*	420
(c) 1100 Ash and tree guards	3447 (2852)	420
(d) 1100 Ash + 1400 Noble fir	6247 (5652)	420
(e) 1100 Ash (tree guards) + 1499 Noble fir	5188 (4593)	420
(f) 700 Ash (tree guards) + 3300 Noble fir	6847 (6252)	420
(g) 3000 Ash 'Normal Management'	4357 (3610)	320

* Figures in brackets give NDR assuming fertiliser application as discussed.

Table 14: Brown Podsolic; Ash YC 8, YC 20.

System	NDR IR£(1985)	No. Hurleys /ha/annum
(a) Sitka spruce 2,500 stems/ha	4047	
(b) 1100 Ash only	3600 (2923)	350
(c) 1100 Ash and tree guards	2468 (1791)	350
(d) 1100 Ash+1400 Noble fir	5341 (4664)	350
(e) 1100 Ash (tree guards)+ 1400 Noble fir	4209 (3532)	350
(f) 700 Ash (tree guards)+ 3300 Noble fir	5868 (5191)	350
(g) 3000 Ash 'Normal Management'	3153 (2348)	260

Table 15: Gley; Ash YC 6; Sitka spruce YC 24.

System	NDR IR£(1985)	No. Hurleys /ha/annum
(a) Sitka spruce 2,500 stems/ha	5701	
(b) 1100 Ash only	2177 (1375)	265
(c) 1100 Ash and tree guards	929 (127)	265
(d) 1100 Ash+1400 Noble fir	3918 (3116)	265
(e) 1100 Ash (tree guards)+ 1400 Noble fir	2670 (1868)	265
(f) 700 Ash (tree guards)+ 3300 Noble fir	4329 (3527)	265
(g) 3000 Ash 'Normal Management'	1503 (605)	180

DISCUSSION

All three sites are assumed to be bare ground and reasonably flat, with no scrub present. These would be categorised in the FWS as 'Easy Mineral' sites. More difficult sites are considered unsuitable for the production of hurley butts. (The only exception to this would be reafforestation on similar ground). No roading costs are included. In many cases, such as small plantations or farms, no roads would be constructed and much of the suitable sites on FWS land are already roaded. The overall NDR values are therefore high, but, as discussed, not unrealistic for many potential ash sites. If the land has to be purchased the cost would have to be subtracted from the figures given to get the real return. On the first two sites types this would be a major consideration, as it would involve good quality agricultural land.

Comparing the ash treatments, on all three sites the rankings are the same. The ash plus Christmas trees are considerably better than the 'normal management' or widely spaced ash only. The 1100 stems/ha 'ash only' system produced better than 'normal management', however on the best site the difference is slight.

Without the addition of the Christmas trees the ash alone cannot compete with Sitka spruce on any of the sites. However, on the two better sites the difference between 'normal' ash and the spruce is small and it would take a premium of less than 10% in the value of commercial ash over the spruce wood to make the ash more profitable. If there were a sustained supply of good quality ash available this seems very likely to be achieved.

Only on the gley soil does the gap seem unbridgeable, yet given the favourable cost factors assumed, even ash of YC 6 can be grown profitably using conventional silviculture. Pruning costs are not included in the analysis (some pruning would be required for commercial lengths) yet on the better sites, given a more favourable supply and marketing structure, ash, even when not grown specifically for hurleys, could be a competitive option.

In terms both of hurley production and profitability widely spaced ash combined with Christmas trees is clearly the best option. The consistantly best system, 700 ash and 3300 noble fir must be treated with some caution. Despite the impressive lead the extra fir give this option, the Christmas trees contribute only about one third of the revenue and with only 700 main crop trees this regime is very dependent on virtually all of them surviving and producing good quality hurley butts. To a lesser degree the same agrument could apply to the theoretically second most profitable option, 1100 ash and 1400 noble fir. The next option (e), where the tree guards should ensure the survival of most of the ash appears the safest bet.

Despite the added cost of the guards on the two best sites it is still somewhat more profitable than Sitka spruce.

The selection of this latter option as the best depends largely on ones assessment of the gains in terms of protection afforded by the tree guards. Any significant losses in the non-guarded treatments would quickly tip the balance of profitability.

A consequence of the good performance of the 'normal management' ash is that in the event of a glut of hurley ash causing prices to drop sharply (a situation which could easily develop) a net loss should not be incurred on the better sites.

Finally, the benefits of fertilisation are clearly illustrated by comparing NDRs after the application of 800kg of 10:10:20/ha at five year intervals (in brackets, Tables 13-15) of the YC 10 ash site with the figures for the unfertilised YC 8 systems. In every case it can be seen that YC 10, even with this intensive fertilisation is better than YC 8 without it. The benefits are even more pronounced when going from YC 6 to YC 8.

ACKNOWLEDGEMENTS

We would like to thank especially Mr. Pat Staunton, hurley manufacturer, Ashford, Co. Wicklow, for assessing and converting the ash in the conversion project and for his invaluable advice at all stages. Also Mr. J. I. Kilbride and J. Treacy who assisted in the early stages.

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APPENDIX I

Site details of ash stand used in the conversion study.

All trees used were from Compt. 259 I, Donadea Forest. The bulk of them came from Subcomparment 4, a stand of 0.9 hectares, though many were taken from adjoining sub-compts., which also contained ash. All the ash used was planted between 1940 and 1946, in mixtures of varying types with an initial stocking of about 4,800 stems/ha (all species included).

As most of the trees came from subcompt. 4 and it was the only stand which was predominantly ash, site details are given for this stand. Only the species mixture and planting year was different in the other stands.

Comp. 259 I Sub-Compt. 4.

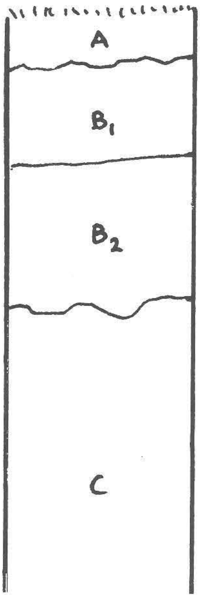
Area: 0.9 ha. Elevation: 90m. Aspect: Gently sloping to South.

Planted in 1940, pit planting. Soil Type: Brown Earth.

Ash YC 8. No fertilisation.

Soil Profile:

Surface vegetation, grass, briars in places
No organic horizon.



A horizon: 5cm.
Dark loam, no stones, much humus and many roots.

B_1: 5-15cms.
Clay/loam, merging with A horizon, few roots, no humus, high clay content. pH 5.3.

B_2: 15-30cms.
Dark brown, free-draining clay loam.
Many lumps of charcoal present.
Many small-medium sized stones.
Merges to subsoil. Many roots. pH 5.8.

C: 30-100cm+
Reddish-brown, many medium-sized limestone stones.
Moister than other horizons.
Deep, no parent material at 1m depth.
Rooting to about 50cm.
Parent material; limestone drift.

Stocking (per/ha):
Ash 275 (mean DBH 25cm)
Larch 110 (mean DBH 31cm) Total: Approx. 600 stems/ha
Oak 110 (mean DBH 15cm)
Beech 100 (mean DBH 17cm)

APPENDIX II

Manufacture of Hurleys

1. The tree is felled by firstly clearing away earth and debris from around the base of the stem, then making several cuts with a chainsaw (depending on the number of buttresses) angled downwards. The base of the tree thus felled will have a somewhat pointed butt.

2. The stem is cut off at about 1.5m above the base. The extra length (greater than the length required for hurleys) is to allow for vertical cracking of the stem which occurs at the cut surface on drying.

3. The butt is removed and cut into slabs. These are flat boards, parallel to the direction of the buttresses. The number of slabs will depend on the number and size of the buttresses.

4. From each slab a hurley is cut and turned. They can be made individually or several at a time using a template.

Classification System

For the purposes of this study the hurleys produced were divided into five categories, depending on length. The most valuable category, 37" long are referred to as senior hurleys. The others are 36", 34", 32" and 30/28".

To determine the worth of the ash butts all hurleys produced were assigned relative values. A senior hurley was regarded as having a value of 1. The relativities are based on the selling price of the hurleys.

The values are:

37" =1.000	32" =0.562
36" =0.875	30/28"=0.375
34" =0.687	

APPENDIX III

Details of ash spacing trial at Knocktopher, Co. Kilkenny.

Site: Brown earth.
Flat, former nursery site, small patches poorly drained.

Treatments: Initial stocking levels of 12,100; 2,900 and 1,340 stems/ha.
Randomised block, 3 replications.

Owing to the effect spacing has on height growth of ash, and in the absence of suitable yield tables the precise yield class of the 0.9m and 2.7m plots can only be estimated. However, top height and basal area figures indicate considerable variability in site productivity. This appears to be mainly due to the plots being on a former nursery site.

This variability was further compounded by the fact that 3 years after establishment each plant got a spot application of 'Potatoe manure' (1 part sulphate of ammonia; 3½ parts superphosphate; 1¼ parts muriate of potash) resulting in greater fertilisation of the closer spacings:

1140 kg/ha in the 0.9m plots
260 kg/ha in the 1.8m plots
125 kg/ha in the 2.7m plots

The response to an application of NPK in 1981 is discussed in Appendix 4.

Due to the poor growth the experiment was not intensively maintained for many years resulting in considerable overstocking in the more vigorous plots.

APPENDIX IV

Response of ash to fertiliser

1. Details and results of an experiment in Gorey Forest, Co. Wexford to test the effect of ground limestone and nitrogen, phosphorus and potassium fertilisers on the growth of polestage ash.

   Crop history: Planted in 1958. Single mouldboard agricultural pough. Initial stocking 3,700 stems/ha. Ground rock phosphate spot applied in 1971 at 375 kg/ha.

   Soil: Podzolic gley — brown earth (localised).

   Treatments (per ha braodcast in 1978):

   (1) 1.5 tonnes ground limestone

   (2) 3.0 tonnes ground limestone

   (3) 3.0 tonnes ground limestone plus 800kg 10:10:20

   (4) 800kg 10:10:20

   (5) Control

   Results: In the period 1978-1980 there were significant responses in basal area increment to treatments 2, 3 and 4 with the NPK treatments both being better than the lime only.

   From 1981-83 treatments 2, 3 and 4 were again significantly better than 1 and the control. However, the NPK treatments were no longer significantly better indicating that perhaps the response to NPK is short term, and that further applications may be warranted.

   Overall the NPK only treatment was best though the difference was not statistically significant.

   Analysis of basal area growth rate indicates an increase in yield class of from 4 in 1978 to YC 8 in 1983 in the plots which received 800 kg/ha 10:10:20.

   (Details from M. Carey and E. Hendrick, Research Branch, FWS).

2. Based on the early indications from the Gorey experiment an application of 800 kg/ha of 10:10:20 was applied broadcast to all the plots in the ash spacing trial in Knocktopher (ref. Appendix 3). The results are very encouraging. Table A below shows the yield class distribution of the plots in 1981 before fertiliser application and the figures in brackets the yield classes of the same plots in 1985, four growing seasons after application:

Table A:

0.9m	1.8m	2.7m
<4 (4)	4 (6)	<4 (4)
6 (8)	4 (6)	4 (8)
8 (10)	6 (8)	6 (8)

All plots were one yield class higher after four years. Increases in top height (m) over the four year period is given in Table C.

Table B

0.9m	1.8m	2.7m
2.7	4.0	3.3
3.1	3.8	4.2
3.2	3.1	2.9

These figures indicate current growth rates of YC 10 or greater for all plots indicating a dramatic response to fertiliser application. The change is clearly evident by visual observation of the experiment.

APPENDIX V

Assumptions used in economic Analysis.

1. All costs and revenues in IR£1985.
2. For Sitka spruce and commercial lengths of ash the 1974-1984 DBH/price per m^3 curve (all FWS sales) is used.
3. Hurley ash is valued at £350/m^3 for 30cm DBH butts and all other size butts related to this using the DBH v. value/m^3 curve (Figure 1).
4. Net revenue from Christmas trees at harvest: £2/tree for systems including 1400 Noble fir/ha and £1.80 for 3300/ha.
5. Costs of site preparation, plants, planting, fencing and protection standard FWS costs for 1985 for 'easy mineral' sites. Rabbit fencing is included at 200m/ha on the ash systems where tree guards are not included. For grass cleaning atrazine application is assumed. Pit planting and no ploughing for hurley ash regimes; in the case of Sitka spruce and 'normal management' ash, agricultural plough and slit planting.
6. No roading costs included.
7. For all ash systems firewood is taken as equal to cost of marking and measuring the thinnings and clearfells.
8. For Sitka spruce standard FWS marking and measuring costs are taken.
9. Single rotation only calculated.
10. No land price is included.
11. The discount rate used is 4%.

The Management of Oak in Germany: A Silvicultural Note

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INTRODUCTION

The forests of Western Germany, in common with those of other European countries, have been greatly influenced by man.Over most of the country the indigenous forest was very different, both in species composition and structure, from that which exists today. A classification of the original forest types for the Federal Republic (Anon. 1962) shows the predominant position of pedunculate oak (Quercus robur L.) in the northern half of the country. From north-west Germany through Lower Saxony to the Basin of Münster and Cologne oak-hornbeam mixtures occupied the better sites with oak-birch on the poorer soils. Throughout the uplands of Hesse and towards the south-east in the Spessart oak-hornbeam forest covered the lower slopes with beech at the higher elevations. To the west in the Pfalzer Wald oak occupied the sunny slopes with beech on the north-facing shaded aspects.

These forest types have changed dramatically during the 19th and present century. Large afforestation projects have created the vast pine-dominated forests of northern Germany: spruce has advanced into Lower Saxony and Hesse and pine is spread widely in the Pfalz. Yet two regions still remain associated with the indigenous broad-leaved forest. These are the uplands of the Pfalz and the Spessart. Here the indigenous sessile oak stands have been subject to careful management over the centuries and are today considered to represent all that is best in quality oak production. They vary in composition from the irregularly distributed 250 year or more old specimen oak (Plate 1) through the more uniformly stocked middle-aged stands to the well planned closely spaced artificially regenerated young crops.Although silvicultural treatment and philosophy may vary somewhat between regions, the management objectives are ever the same — the production of a product whose value is epitomised in the phrase 'every tree a Volkswagen'.

SPECIES CHARACTERISTICS

Sessile oak (*Quercus petraea* Lieb.) and pedunculate oak

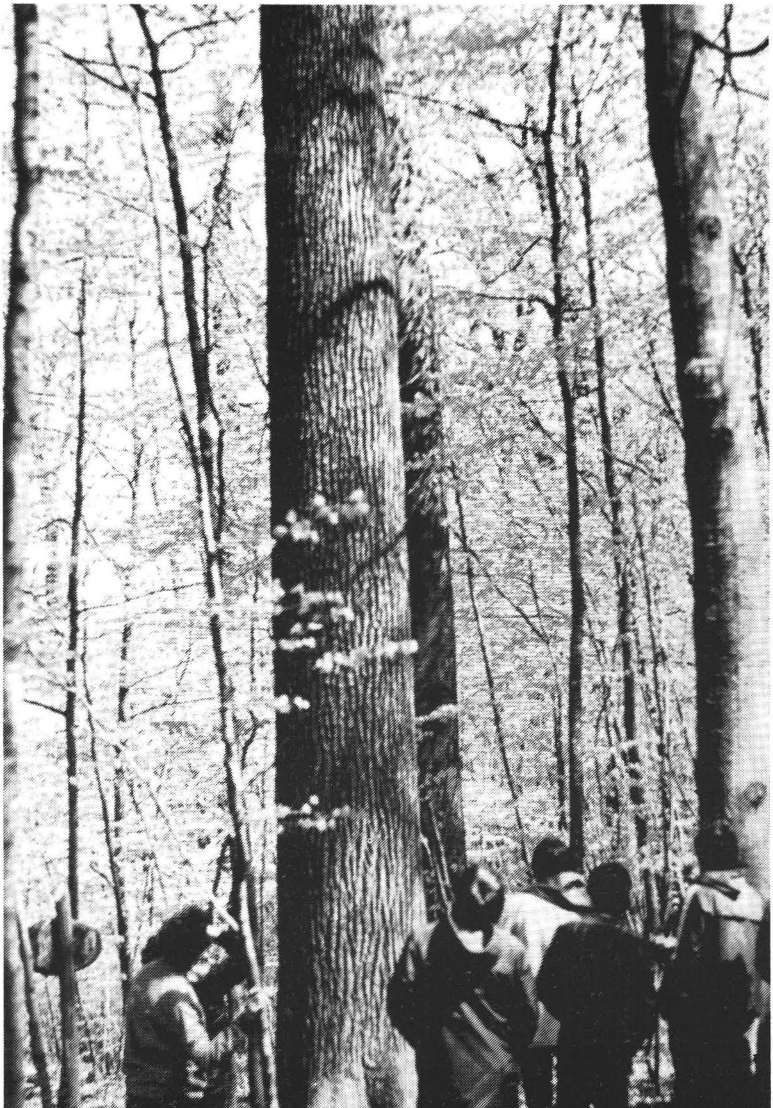
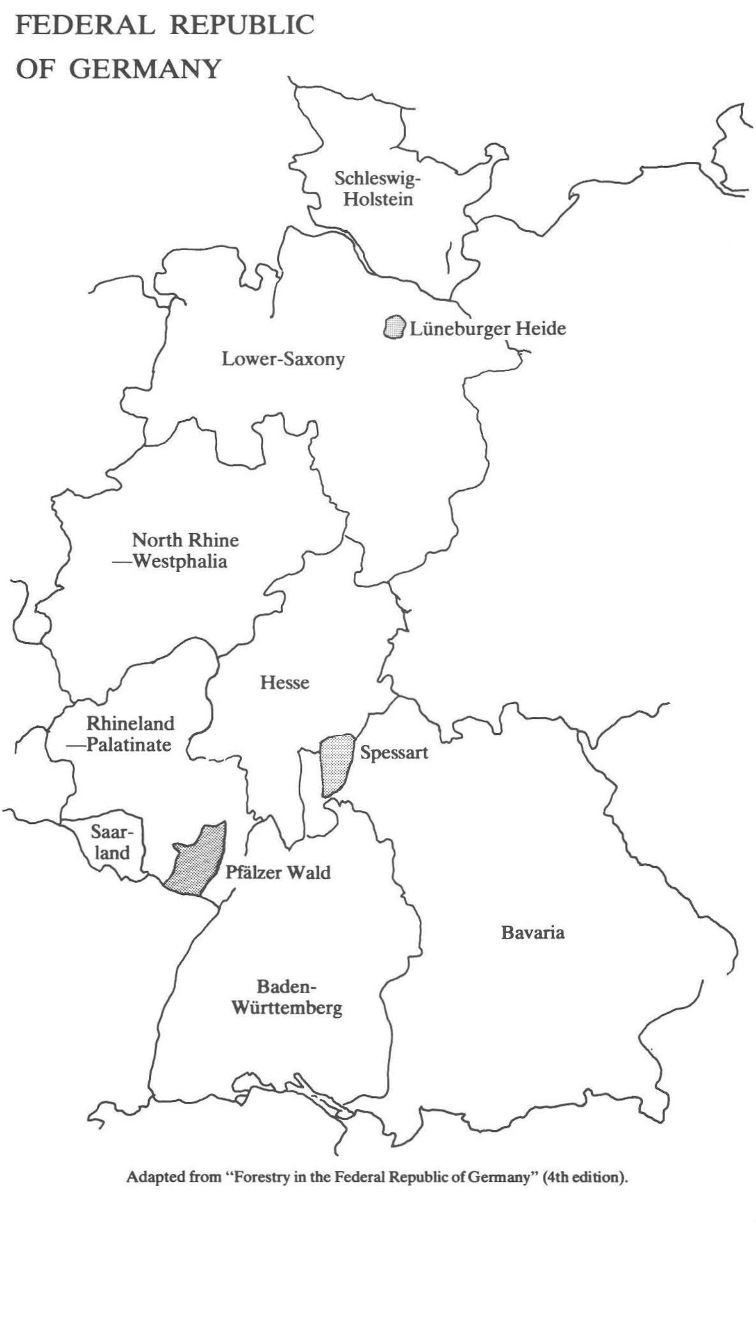


Plate 1 "Der Präsident". Johanniskreuz, Pfalzerwald.

Plate 2 Natural regeneration of *Q. robur* by Uniform System (Großschirmschlag). Biebertal, Hesse.



Adapted from "Forestry in the Federal Republic of Germany" (4th edition).

(*Quercus robur* L.) have many attributes in common. They are both light demanding and have the ability to reach a great age without deterioration in health or wood quality. By comparison with conifers both grow relatively slowly. Height increment of sessile oak culminates at 30 to 35 years for the best yield classes and at 40 to 45 years in poorer stands. Volume growth culminates later. In contrast to other light demanding species, both height and yield increment decrease very gradually after reaching the point of culmination. Both species retain the ability to react to increased growing space by crown development into old age. Beyond 150 years of age, however, they will often response to thinning by the production of epicormic branches in profusion. Thus heavy thinning after crops reach 150 years of age may mean a loss of increment and value (Petri, 1983).

The two species have highly contrasting preferences in regard to site. Sessile oak makes very little demand on the nutrient status of the soil and prefers the predominantly sandy soils (*Buntsandstein*) which occur in the upper regions of the Spessart and Pfalz. Pedunculate oak grows best on the nutrient rich, heavy, wet soils of the lowlands.It is particularly prominent in the meadow forests along the Rhine and on lower terraces where the soil water table is near the surface. The quality of its wood is, in general, not as good as that of sessile oak because of its coarse growth. Nevertheless, in the required dimensions and specified grades it is much in demand for veneer and saw timber.

The sessile oak of the Pfalz is reputed to be phenotypically homogenous and not inclined towards the development of epicormic shoots (Petri, 1983). The same is said to apply to the sessile oak of the Hessen Spessart (Langhammer, 1984). It is unclear if hybridisation occurs between the species in any region. Certainly it is not always possible to differentiate morphologically between the two. However, in the majority of cases, research has shown that it is possible to say with a high degree of probability that a foliar sample is either sessile or pedunculate.

Production Objectives

Because of the very long rotations involved and the relatively low volume yield, the establishment of oak can have no objective other than the production of high quality, high value logs for veneer and sawn lumber manufacture. Sessile oak stands with a pronounced veneer potential require a rotation of at least 240 years to reach an average 60 cm d.b.h.. Stands with a provisional potential for high quality log production need a rotation of 160 to 240 years, with the longer rotation yielding the greater proportion of veneer logs.

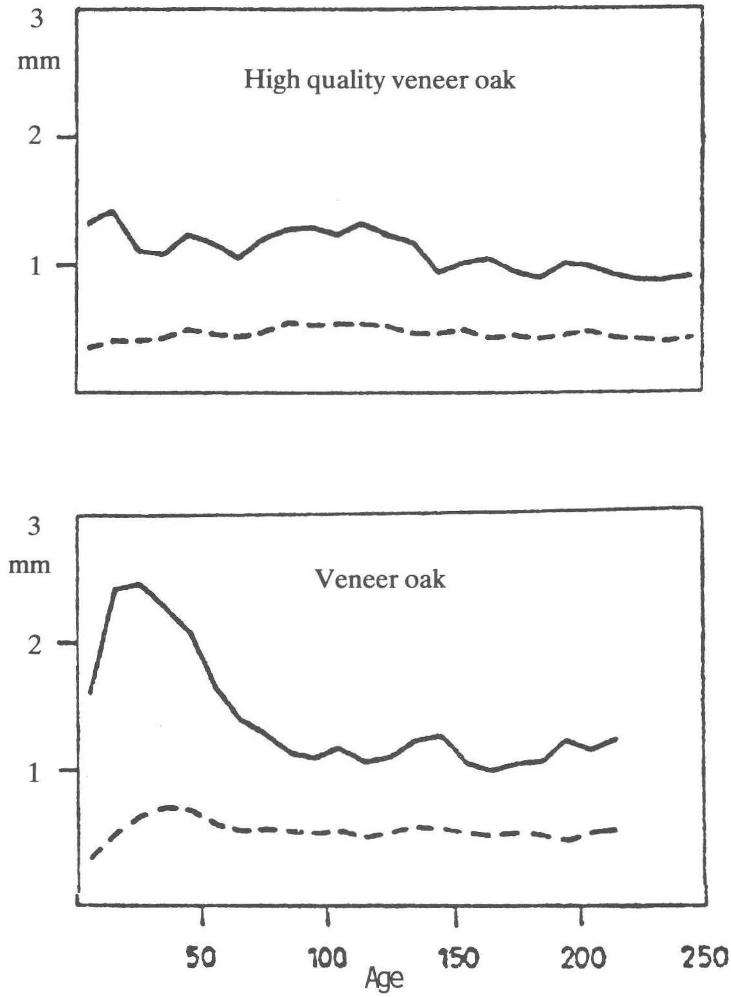


Fig 1 Average width of ring and early wood in two veneer quality groups.

(*Source:* H. Schulz, "Untersuchung uber Bewertung und Gütemerkmale des Eichenholzes aus verschiedenen Wuchsgebieten", Schriftenreihe der Forstlichen Fakultät der Universitat Gottingen, Band 23).

According to Fleder (1981) veneer quality logs must be between 55 and 75 cm in diameter; they must be free from knots and have a regular, uniform growth pattern with ring width between 1 and 2 mm. In addition, the wood must be of a light clear colour and must have good workability properties. Figure 1 shows the annual ring width and early wood growth patterns for two grades of veneer oak.

STAND ESTABLISHMENT

Regeneration operations are heavily concentrated in mast years which occur on average once or twice each decade. Stands are prepared well in advance, in order to take full advantage of each seed year and to make maximum use of the mast available. In general, the regeneration areas range from a minimum of one hectare to a maximum of three hectares.This upper limit is determined by a number of factors such as the availability of seed or plants, the location of the area in the felling coupe and the facilities available for wood storage and utilisation.

Natural regeneration is more the exception than the rule, particularly for sessile oak. When practised in accordance with the prescriptions of the Uniform System it can lead to very successful crop establishment (Plate 2). For optimum natural regeneration conditions, the ground should be free of weeds. Seed trees of birch and aspen should be removed from the site and the immediate environs. It is also good practice to scarify or lightly rotovate the ground at time of seed fall to curtail the growth of grass. A number of the oak seed trees should be retained for 2 - 3 years to give a light shade which checks weed growth and protects the seedlings from sun-scorch. The danger from late frost during the young growth phases should not be underestimated. Destruction of the unfolding primary leaves causes loss of increment and results in prolonged competition from grass and weed growth. Sessile oak is more sensitive to this kind of damage than pedunculate. The likelihood of damage can be counteracted by establishment under shade.

(a) The Pfalz and Bavarian Spessart

In the Pfalz and Bavarian Spessart, sessile oak for the production of veneer quality logs are almost exclusively established by means of seeding. This procedure is regarded as the most effective and surest method of regeneration. Broadcast seeding is generally ruled out because of the cost of subsequent cleaning and tending. Hence, direct sowing of acorns in rows or drills is the preferred method of plantation establishment.The following outline, provided by Nusslein (1984) for *Forstamt Rothenbuch* in the Bavarian Spessart typifies the general procedure. The area to be regenerated is reduced to 0.5 stocking density and fenced against deer. Seed is collected in October, taken to the site where it is to be sown and spread out on the ground. A disc plough is used to cut furrows at one metre intervals. Ploughing cuts through the humus layer and penetrates to the mineral soil. The seed is bagged as required and distributed along the plough lines. Autumn sowing is carried out in October-November and up to the 20th of December or first snow fall. Sowing density is in the range 750-850 kg/ha^{-1}. The acorns are then covered to a depth of 5cm with mineral soil and firmed in. Sowing at this density usually results in about 200,000 seedlings per hectare (Plate 3). Many factors including felling of the overstory, subsequent extraction, mice, deer and jays contribute to a reduction in this number. The overall objective at this stage is to have sufficient trees for natural pruning to occur and to have a stocking density which ensures small annual growth rings.In this early stage the overhead canopy provides protection against frost and suppresses the growth of grass and weeds. Suppression of grass growth is important as mice cause much greater damage where grass exists.

The presence of some beech in the overstory is desirable because it will provide natural regeneration of this species, without which it is impossible to grow veneer quality oak. If no natural regeneration of beech (hornbeam, lime) occurs, approximately 5000 are planted per hectare, when the overhead canopy is removed. Oak is a strong light demander and although the seedlings will survive for 10 years under the 0.5 density of canopy, they will not grow well. The deer fence usually remains effective for about 12 years. With normal growth the oak should then be two metres in height and safe from deer damage. Variations on this Bavarian Spessart approach include spring sowing and a greater distance between the rows. Spring sowing entails storage of the acorns in such a way as to avoid self-heating and mould growth. Drying out of the acorns may lead to lower germination. In the Pfalz, the distance between the rows is generally 1.20m to 1.50m. In practice 1.5m spacing and a sowing density of 600 kg./ha^{-1} gives approximately 15 to 20 acorns per linear metre.

(b) The Hessen Spessart

Although the production objectives remain exactly the same in the Hessen Spessart, regeneration practice and the philosophy of oak establishment are entirely different. The main differences are described by Langhammer (1984) as follows: (1) regeneration areas are completely clear-cut; (2) establishment of the new crop is by planting rather than by sowing; (3) in subsequent cleaning operations, final crop trees (Z-stems) are identified (Plate 4). In this operation planting stock is generally 2+0 or 3+0 undercut seedlings. The distance between the planted rows is usually 1.2m to 1.5m and plants are spaced at intervals of 30cm to 50cm in the rows. Results from spacing experiments in Hesse suggest that the optimum spacing is 2m between the rows and 50cm within rows.

GRASS-CLEANING AND WEEDING

Grass cleaning measures are similar to those applicable to other species. It is strongly recommended that old, seed bearing, birch be removed from the neighbourhood of young oak stands and that young birch growing in the area be wrenched out (not cut). Herbicides are useful for the control of grass and weeds in sessile oak stands, but care is necessary to apply the correct amounts and to use appropriate application techniques.

Weeding out of inferior oaks begins for all yield classes at about 25 years of age, when the crop height is about 8m. The purpose of the operation is to ensure that the growth potential of the final crop trees will not be impaired by competition from 'wolf trees' or unwanted species. Dominant stems of unwanted species are removed or topped back. Subdominant broadleaves, where they occur, are retained. Timely intervention is particularly important on sites susceptible to damage by snow break. The weeding process should provide growing space for the good stems which will later form the population from which the final crop stems will be selected. These stems should, at the commencement of thinning, have branch-free stem lenghts of 8m to 10m. Weeding should also admit sufficient light into the stand to ensure survival of the understory. One intervention per decade should be sufficient under normal circumstances. The weeding phase ends for all yield classes when the crop reaches 50 years of age.

THINNING

The integration and continuity of weeding/thinning phases is more critical for future value production in sessile oak stands than for any other species. Thinning begins where weeding ends and when the stand top height is in the range of 14m to 18m. First thinnings should be light and the cycle should be short. The aim should be a gradual diminution of the high stem numbers, through a selective form of crown thinning. Some 140 to 300 final crop trees per hectare are selected from the predominant and dominant classes. These should have good straight leaders, good crowns and healthy, undamaged, branch-free boles. These are the Z-stems which are of potentially high quality and value. They should be capable of sustained, vigorous, uniform growth. They are usually marked for identification and to protect them from damage during forest operations. As in the 'Scottish Eclectic' thinning method, (McDonald, 1961), thinning should give preference to the development of those stems. Suppressed trees should be gradually and carefully removed. The objectives of this thinning are not only to develop a well formed crown, but also to avoid the formation of epicormic branches. The danger of epicormic branch development is most acute when the crowns are small and slender. Thus the maintenance and development of a uniform understory of beech, lime or hornbeam is essential, as is the promotion of volume increment. When a broadleaved understory does not exist at the beginning of the thinning phase, a heavy thinning is needed to facilitate its development. However a great deal of caution is necessary in order to achieve a balance which will prevent epicormic formation and at the same time promote understory development.

The ability of the sessile oak crown to respond to thinning ends at about 120 to 150 years of age. Up to 120 years of age the aim of each thinning must be towards good crown formation in the selected stems. Thus, thinning proceeds in the following sequence:

From 50 to 80 years: average, two thinnings per decade.
From 80 to 100 years: one thinning per decade.
From 100 to 150 years: less than one thinning per decade.

PRUNING

Pruning of sessile oak is not considered necessary, although epicormic branches may be knocked off. The initial high stocking density and the subsequent cultural operations are intended to ensure a good selection of branch-free, final crop stems at a relatively early age. However, it is now proposed to prune the selected Z-stems in the recently planted thicket stage stands of the Hessen Spessart. This will be done before formation of heartwood.

MIXTURES AND OTHER FACTORS

For ecological reasons, for soil protection and, particularly for the production of high value produce, it is imperative that sessile oak is grown with a nursing mixture of broadleaves. Generally these consist of groups of either beech, lime of hornbeam. They may constitute 15-20% of the upper canopy, in addition to the middle story and understory trees.The mixture of beech (lime or hornbeam) is generally introduced artificially, since it is rarely possible to achieve the desirable mix of species through natural regeneration from a shelter-wood. The subordinate species may be introduced either immediately after establishment or at the pole stage. In the former case, beech may be introduced through enrichment (*Nachbau*), some 3 to 5 years after establishment of the oak. Strong beech plants (1+1 or 1+2) can be planted at wide espacement (2m x 2m to 3m x 3m) in existing open spaces. An irregular arrangement rather than line planting is recommended. Technically underplanting at the pole stage should follow a thinning, to ensure that sufficient light reaches the ground for the survival of the young beech. Beech planted at the pole stage generally survive until the oak is mature. A disadvantage of underplanting at the pole stage is the necessity to fence against deer. Fencing at this stage restricts thinning and may lead to the neglect of cleaning operations.

The Economics of Oak Growing

Even in present-day terms, the establishment of sessile oak is a capital intensive operation. The cost of ground-preparation, sowing, fencing, protection and cleaning has been estimated to be about 10,000 DM (IR£3,350) per hectare. Positive returns from thinnings do not begin until after the trees have reached 80 years of age. Material extracted at this stage may be sold for the manufacture of parquet flooring and other relatively low value products. Thinnings from middle-aged stands command better prices and the value of the wood increases steeply as the trees grow into veneer sizes. The best price obtained in the Spessart in recent years was 42,000 DM (IR£14,000) per m^3 for the very highest quality veneer logs. Many stems, however, are sold for around 5000 DM (IR£1,700) per m^3. The final yield of about 350 m per hectare is small for the length of rotation required and only a proportion of this yield may meet the standard needed for quality veneer. Although individual logs may realise exceptional prices, the combination of low yield and long production period militates against profitability if the high establishment costs are compounded even at low interest rates. Yet, in the Spessart and Pfalzerwald, oak takes precedence over other species in reforestation wherever the site is suitable.

There are two general viewpoints of maximising returns from an operating forest and both of those have their origins in German forestry. One is the *Bodenerwartungswert* (land expectation value) developed by Faustmann; the other is *Waldreinertrag* (forest rent) which measures the average annual net revenue. In the long established regulated forests of Germany forest rent is deemed to be the more appropriate measure. The forest property is viewed as a single entity, organised for continuous production and not as an independent series of age classes.

Plate 3 *Q. petraea* regeneration by sowing. Rothenbuch, Bavarian Spessart.

Plate 4 'Z' stem selection. Bad Soden-Salmünster Hessen Spessart.

Applied to the management of oak, forest rent carries implications of continued supply and a responsibility to maintain a good forest structure. It is argued that oak is available today because of the efforts of previous generations of foresters. To harvest without sowing would be tantamount to exploitation. It would conflict with the principle of sustained yield, the forestry precept of *Nachhaltigheit.*

ACKNOWLEDGEMENT

The foregoing is a synthesis of the views expressed to the senior author during a tour of the Spessart, augmented by excerpts from "Waldbaurichtlinien für die Wälder von Rheinland-Pfalz 2. Teil" made available by Dr. Petri.

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Windthrow Hazard in Conifer Plantations

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Forestry Commission, Roslin, Scotland

INTRODUCTION

This paper describes the development and applications of the Forestry Commission's windthrow hazard classification system, and outlines current research aimed at improving the prediction of windthrow in spruce plantations.

Serious economic implications arise from the scale of plantation windthrow in Britain: in an average year, it is estimated that up to 5000 hectares of spruce plantations are affected by windthrow, either as fresh initiation of damage, or as progressive spread of earlier damage. Although it is difficult to quantify to economic penalties of this damage precisely, a current annual loss of up to £3 million is estimated. If it were possible to grow Sitka spruce plantations on the 25% of our forests which lie on the most vulnerable sites, for an extra 1 metre in height before wind damage develops, this could give sustained additional timber revenue of over £1 million per annum. As the extensive areas of forest planted on the more exposed wet upland sites since 1970 develop to a vulnerable stage, the scale of economic loss will rise rapidly.

In Britain we recognise 2 categories of wind damage: firstly, catastrophic damage resulting from the infrequent storm events which appear to affect some part of the country about once in every 15 to 20 years. The great storm of 1968 across west and central Scotland is the most obvious example (Holtham, 1971). A similar storm also affected a narrow belt across central Wales, the Midlands and East Anglia in 1976. Very severe localised damage, including a substantial proportion of stem snap, arose in these cases, affecting both windfirm and relatively unstable stands, but catastrophic damage is associated with relatively long recurrence periods of around 15 years in Britain. Of greater importance is the problem of *endemic windthrow* which arises in most upland forests every year, as a result of normal winter gales. Endemic windthrow comprises either individual stem blowdown, or groups of blown trees, and spreads progressively over several years. Damage is normally confined to sites which are recognised as inherently unstable, due to soil type or topography, and usually affects stands above a particular height. Uprooting of spruces on wet or compacted soils is the predominant effect. On a national scale, endemic damage is certainly associated with economic penalties which are substantially greater than the loss arising from localised catastrophic damage. Since endemic windthrow appears to be related to particularly vulnerable sites, and because damage recurs on an annual, or regular basis, greater efforts have been applied to the problems of predicting where and when this type of damage will arise, and investigations into methods preventing or delaying onset of endemic windthrow has been given higher research priority.

WINDTHROW HAZARD CLASSIFICASTION

Before describing the system of windthrow hazard classification in detail, it is important to outline the underlying concepts of critical and terminal heights in windthrow prediction and management of windthrow susceptible sites. 'Critical height' is defined as the stand top height when initial endemic windthrow arises, and is indicated when 3% of the stems become windthrown. 'Terminal height' is the residual stand top height when terminal damage levels have developed, and between 40% to 60% of the stems are windthrown. This is normally the stage when clearfelling of the residual stand is required to recover the tree growth potential of the site. In economic terms, a stand becomes terminally damaged when the increase in value of the residual stand is exceeded by the interest occurring on the investment.

The Forestry Commission's windthrow hazard classification (WHC) (BOOTH, 1977; Miller, 1985) developed from the need to produce a general or national system of windthrow prediction, to identify the nature, location and extent of windthrow problems which would arise in the future. By the 1970s, it had become clear that endemic windthrow would dominate much of our harvesting and marketing activity, through its effects on rotation length, felling ages, tree sizes and thinning activity.

During the mid 1970s, an extensive programme of windthrow surveys was undertaken, involving both aerial photographic interpretation and ground truth surveys in several key forest areas, where endemic windthrow was becoming a serious problem. By assembling detailed crop and site data for compartments where new damage had arisen, it was possible to carry out statistical analysis to determine the site factors most closely associated with the observed damage patterns. Eventually, 4 primary site related components detailed below were isolated as the main interacting factors which could explain most of the variations in windthrow in stands of different top heights.

1. *Windzone.* The more northerly and western parts of Britain experience higher windspeeds and a greater frequency of gale events than the south east.Coastal areas are also windier than inland areas. The windzone map shown in Fig 1 is a very approximate zonation of Britain, and was assembled by analysing the regional variation in flag tatter rates over a range of site elevations, and combining these with published Met. Office mean windspeed maps (Hardman et al,1973). These regional changes in wind conditions will clearly affect the windthrow vulnerability of forests in any particular part of the country.

An attempt has been made to produce an equivalent windzone map for Ireland in Fig 2. This map is based on some exposure flag data from Northern Ireland, which was extrapolated across the whole of Ireland using published maps of physiography and regional variation in mean annual windspeed.It is important to appreciate that these Irish windzones are very much a first approximation and much more exposure flag data is needed to give an accurate wind zonation.

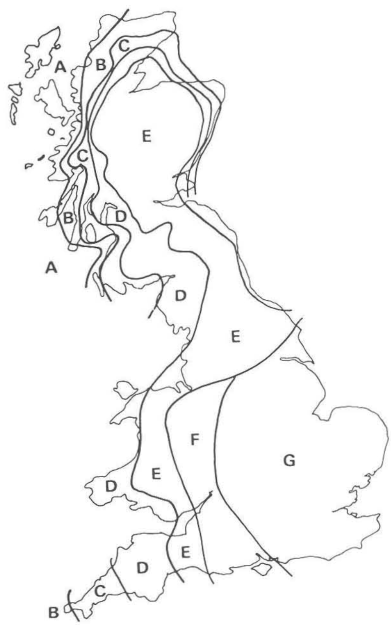

Fig 1 Wind Zonation of Britain.

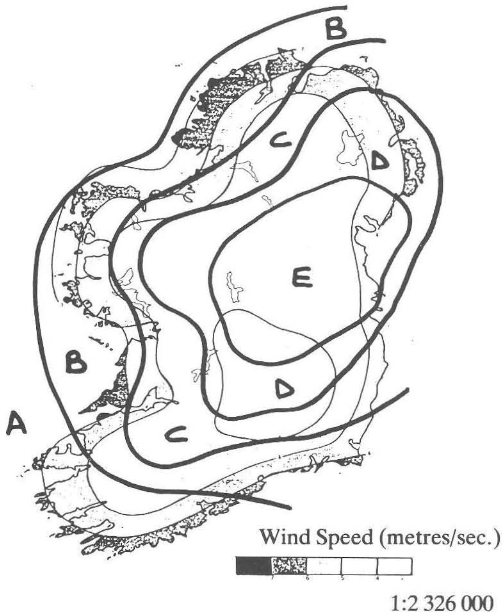

Fig 2 Preliminary Wind Zonation of Ireland, based on limited exposure Flag Data.

2. *Site elevation.* Mean windspeeds increase with elevation, and the frequency of gale events also rises at higher elevations, both affecting the recurrence of potentially damaging winds, and windthrow vulnerability of particular sites.

3. *Site topex.* The topography of forest areas affects windthrow vulnerability. In particular, the nature of surrounding topography will influence local windspeeds and turbulent wind structure. The precise relationships between wind structure and topography are poorly understood at present, but effects such as the upslope acceleration of wind, flow separation over hilltops with strong leeslope turbulence, and the funnelling of wind up valleys are all likely to be important in determining the windthrow vulnerability of any particular location in a forest area. In order to take some account of topographic effects on windflow, the simplified system of topex was developed (Malcolm and Studholme, 1972). This system involves the measurement and summation of 8 skyline angles, spaced at 45 degrees, for each assessment point. Sheltered sites, having substantial surrounding high ground, subtend a large cumulative skyline angle, and a correspondingly high topex score.

The particular influence of topography on wind conditions will depend on the wind direction prevailing, but topex in its basic form does not incorporate a directional weighting. Nevertheless, topex remains a useful index for quantifying local site exposure, and topex assessments are relatively simple to carry out for incorporation in WHC appraisals.

4. *Soil types.* Soil type exerts a major influence on the windthrow vulnerability of forest areas by affecting root develop and tree anchorage. Endemic damage in Britain is most commonly observed on soil types with physical characteristics which impede vertical soil water movement and root development. In particular, the hazardous gley soils, with high bulk density, low hydraulic conductivity and prolonged winter waterlogging are associated with low soil shear strength and shallow tree root systems, and consequently with low resistance to uprooting of trees during windloading. Although it is recognised that site preparation will strongly influence root architecture and hence the resistive anchorage of trees to overturning forces under windloading, it is possible to adopt a simplified approach to characterising the soil/rooting status of forest areas, based on soil type alone. Most forest areas have detailed soil maps available, and component scores for WHC purposes can be attributed to each soil type. Even in the absence of a detailed soil survey, it is possible to simply classify forest sites by their approximate rooting depth potential, and derive appropriate scores for WHC in this way.

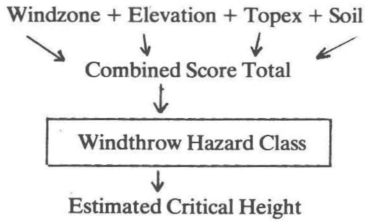

Fig 3 Schematic Derivation of WHC of any Forest Site

By assessing each of these 4 variables, calculating their appropriate scores, and adding these together, the WHC of the site is found as shown in Fig 3. Details of appropriate scores to match particular site conditions are contained in Forestry Commission Leaflet Number 85 (Miller, 1985) referred to previously. A total of 6 windthrow hazard classes is recognised, covering the full spectrum

Table 1 Estimated Critical Heights (M) for 6 WHCs under different thinning methods.

WHC	Selective Thin	Systematic Thin	Non Thin
1	25	25	28
2	22	22	25
3	19	18	22
4	16	14	19
5	13	12	16
6	10	9	13

of windthrow vulnerability of forest sites from highly windfirm to highly unstable. Each hazard class is associated with a critical height, indicating the stage when initial endemic windthrow is likely to arise. Critical heights, shown in Table 1, relate principally to stands which have been treated by selective or systematic thinning at management table times and intensity, or stands managed as non thin. Stand management practices which may confer increased stability, such as non-thin management, or wider spacing, will be associated with increased critical height, and in the case of non-thin management, the increase in critical height is of the order of 3m, or equivalent to a reduction of one hazard class in stands so managed. Conversely, very heavy or delayed thinning and systematic thinning practices are often detrimental to stand stability, and reductions in the calculated critical heights are appropriate for the higher windthrow classes, where the adoption of harsh thinning regimes can precipitate early onset of windthrow. Insufficient information exists at present to quantify precisely the effects of different thinning and spacing or respacing practices on critical heights in each of the 6 windthrow hazard classes, but local estimates of these effects can be used to modify the critical heights indicated by WHC.

Assessment methods

Although it is theoretically possible to assess the WHC distribution for a complex forest area, simply as a desk exercise (assuming detailed soil survey and topex maps are available), many forest managers will be faced with a field survey committment to define soil and topex variations over their forest areas. It is normally desirable to combine soil and topex assessments into a single survey, and the intensity of sampling is determined mainly by the variation in soil and topography across the forest area being surveyed. Vegetation changes are useful indicators for soil survey, and topex sweeps should be carried out at points, coinciding with soil pits, approximating with a grid at intervals not exceeding 500 m. The use of a prismatic compass and optical clinometer are normally required for topex assessment, and clear visibility to ensure accurate location of the skyline is essential. Topex assessments of thicket and polestage stands are particularly problematic due to restricted visibility to the skyline. Windthrow hazard maps are normally the final product of the assessment. These are prepared by overlaying soil and topex maps, one of which must contain contours to derive the elevation score, and by numerical interpolation of the WHC component scores, the boundaries between windthrow hazard classes can be drawn.

Predictive precision of the windthrow hazard classification

Validation surveys carried out in forests in the uplands of Britain indicate a fair precision of the system, with average observed height of the onset of damage falling reasonably close to the estimated height derived from windthrow hazard classification. Fig 4 illustrates the results of a series of validation surveys, comparing actual critical heights with the calculated critical heights for 5 WHCs. There is the possibility of some bias in these validation surveys, since mainly wind damaged stands were surveyed, with undamaged stands tending to be ignored by local managers and not identified to the surveyors.

Applications of windthrow hazard classification

It is important to appreciate that the WHC is a rather crude method of predicting the differential vulnerability to endemic windthrow within extensive forest areas. The system necessarily involves many simplifications, which limit both its predictive precision, and the range of applications. In particular, WHC is designed to predict the 'average' response of many individual compartments to the highly variable and uncertain effects of gales. Inevitably, some stands will become unstable at an earlier stage than expected, and others will endure well beyond the critical height calculated by the WHC method. For this reason, WHC is of relatively little value in the management of individual compartments or small isolated forest areas, and its main application in Britain is to assist in regional timber production forecasting. In this role, early wind damage in some locations is

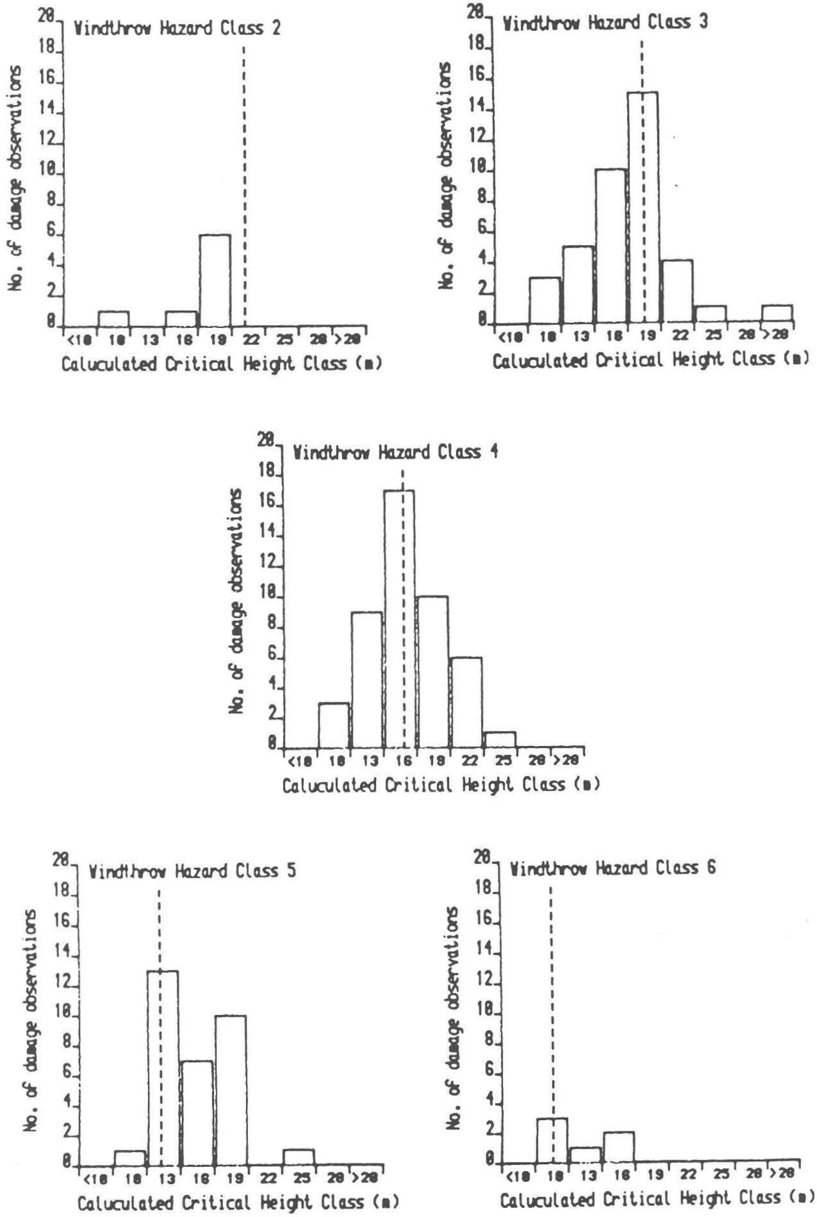

Fig 4 Results of Validation Surveys of 131 Damaged Stands in 5 Windthrow Hazard Classes (1980-84)

counterbalanced by other areas where windthrow does not develop as rapidly as expected. Overall, regional timber yields are close to that calculated by combining the WHC distributions for different forests, and the utility of the system is quite high. In addition to refining strategic marketing plans, regional managers are also able to plan ahead more realistically for harvesting resource changes necessary to accommodate thinning and clearcutting operations as affected by vulernability and the incidence of damage.

It is possible to use the WHC system, at a more local level, for operational planning.In Britain, the most vulnerable windthrow hazard classes 5 and 6 are normally scheduled for non-thin management. The intermediate hazard classes 3 and 4 require care in selecting the timing, pattern and intensity of thinning, and hazard classes 1 and 2, on windfirm sites, are fairly unconstrained in thining options. The definition of the WHC4/WHC5 boundary (thin/non-thin boundary) is clearly important, and the particular thinning methods to be employed in hazard classes 3 and 4 are strongly influenced by windthrow hazard. In this way, the WHC can assist in identifying sections of forest where harvesting activity will be concentrated in the future, and indicates appropriate operational methods, thereby incorporating windthrow vulnerability into harvesting resource allocation and local production planning. By combining local estimates of the rate of spread of wind damage with the calculated or observed critical heights for different WHCs, it is possible to predict approximate terminal heights, and adjust local or regional clearcutting plans to accommodate the shorter rotations from windthrow susceptible areas.

Limitations of windthrow hazard classification

As indicated previously, the windthrow hazard classification system described is a practical approximation intended to facilitate the broad zonation of forest areas, generally greater than 500 hectares in extent.

1. Knowledge of the WHC distribution gives a general indication of appropriate silvicultural treatment, but does not provide a satisfactory basis for detailed, subcompartment management prescriptions. Windthrow hazard is only one of several factors to be taken into account in deciding whether to thin or fell any individual stand. These decisions must accommodate the other demands and constraints applying to the forest area, and windthrow susceptibility is only one such constraint, and in many cases may not even be the primary one.

2.The WHC was primarily developed from observations of damage in pure Sitka spruce stands in the Scottish borders, with gently rolling terrain, and extensive areas of uniform gley soil. In these conditions, the predictive precision of WHC is high. In more complex topography, and with greater soil and species variation, precision of windthrow prediction is generally lower.

3. The WHC is based on the concept of critical height. Following initial damage windthrow usually spreads progressively through the stand over a period of years, until terminal damage levels are reached. Terminal heights are of much greater importance than critical heights, but it is not yet possible to predict these with a simplified system like the WHC. Although the rate of spread of windthrow appears to be controlled by broadly the same site factors that affect windthrown gaps. Local observation with map-form recording there is the additional problem of exposed edges in windthrown gaps. Local observation with map-form recording of typical damage extension rates is the only feasible way to estimate terminal heights.

4. The WHC system described was derived from observations of wind damage in stands established between 1940-1960. Site preparation during this period involved either shallow single mouldboard ploughing, or combinations of shallow ploughing and spread turves, and tree spacing at establishment was between 1.5 and 1.8 m. Since 1960, there has been a progressive shift towards deeper ploughing, and double throw plough configurations, and in more recent years, the use of subsoiling techniques have become more common. It is probable that root architecture and tree anchorage will be different in these more recently developed techniques, and the resistance to overturning under windloading will alter. Similarly, the effects of wider spacing in more recently established crops will produce individual trees with different stem form and crown shapes which will alter their momentum absorption and dissipation characteristics under dynamic windloading. The extent to which these more recent changes in silvicultural practice will alter windthrow response and sustain the predictive precision of the WHC is uncertain, but as information from research experiments and field surveys of windthrow stand becomes available, it will be possible to modify WHC scoring to accommodate these factors.

Future refinements of windthrow hazard classification

In its present form, WHC offers a useful means of incorporating windthrow vulnerability in production forecasting and harvesting planning. It is unlikely that further major improvements in the overall predictive precision could be achieved by fine tuning of the system, and in Britian, several adjustments to wind zonation boundaries and soil scoring have already been incorporated over the past 8 years since the inception of WHC system. Local modifications to the WHC, based on systematic observation of windthrow, may improve its local precision. Forestry Commission research is now tending to concentrate on means of improving windthrow resistance of stands, mainly by investigating the mechanisms of windthrow in plantations. Progress to effective preventive measures will almost certainly lead to improved windthrow prediction in established stands.

The main research project geared specifically to improving windthrow prediction concerns investigation of the airflow/topography interaction.Local windspeeds, surface shear stress, and turbulence levels are all affected by topographic configuration of the upwind fetch, and certain locations within any forest area will be subject to a higher incidence and recurrence of potentially damaging wind conditions. Research into these effects is being undertaken, using both fullscale wind recording in complex terrain, and by testing of scaled topographic models in boundary layer wind tunnels (Booth, 1974). In the future, it may be possible to routinely test topographic models of areas of up to 10,000 hectares in extent, using wind tunnel techniques, and use the results to improve WHC estimates of critical heights.

The second current research project which related to windthrow prediction concerns the question of windloading and momentum absortion in stands established under wider spacing. Widely spaced, or respaced stands on windthrow susceptible sites are likely to comprise individual trees with deeper crowns, and stems with a lower height to diameter ratio. The alteration to stem form produced by wider spacing is likely to confer considerable benefit to the trees stability (Petty and Swain, 1985): the centre of gravity will lie lower down the stem, and there will be less flexural response to windloading in the middle stem region. Under windloading, the crown mass will have a lower horizontal displacement, and contribute less to the overturning moment at the rootplate. Unfortunately, these resistive advantages are likely to be counterbalanced by increased 'windloading' on the larger crown area, and perhaps reduced crown contact to damp out tree swaying.

In addition, deeper wind penetration into the canopy will arise, and increased turbulence in the upper canopy may be generated due to the increased surface roughness in the wider spaced stand. The changes in aeromechanical coupling in low density stands must be adequately quantified, to determine where the balance of the stability advantage lies, on sites with severely restricted tree anchorage. In addition, the reduced timber quality in lower density stands (Hands,1985) will also influence the degree to which wider spacing/respacing can be adopted on windthrow susceptible sites. An investigation is currently in progress, to measure changes in turbulent wind structure and momentum transfer to widely spaced stands.

The use of boundary layer wind tunnels to simulate the forest/turbulence interaction is also being examined, using 1:75 scale model trees at various spacings, and with different shapes and flexibilities of stem and crown.Progress in this aeromechanical research should enable the definition of optimum stand density targets for plantations, to maximise rotation lengths and increase stand values on vulnerable sites.

Any possible improvements in the tree anchorage, resulting from the adoption of alternative site preparation methods which avoid or limit the use of open furrows and continuous plough ridges, will have implications in windthrow prediction. At present, the benefits of non-ploughing methods to root architecture and major stand stability are still to be fully demonstrated and quantified, but any improvements arising can be incorporated into the assessment of site windthrow hazard by soil score modification. Considerable research effort is being applied to the questions of mechanical interaction between tree, root and soil in upland spruce plantations to determine the most effective rooting configuration for improved stability (Coutts, 1983). It is intended that these investigations will precede and underlie any future shift in British forestry practice towards alternative site preparation techniques such as subsoiling, mounding or ridge replacement ploughing. Preliminary analyses of root systems do indicate some modest improvement in root spread on subsoiling. However the potential stability benefits from this improved rooting is counterbalanced by establishment penalites on subsoiling which limit the widespread adoption of the technique to more uniform surface water gley soils (Miller and Coutts, 1986).

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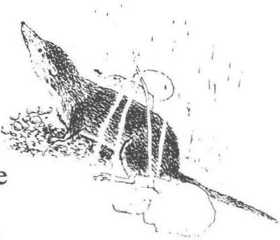
Acknowledgement

On behalf of the Society I wish to thank Dr. J. Gardiner for his skill and enthusiasm as Editor of this Journal over the last three years. On a personal level I thank him for his sound advice given to me as incoming Editor.

Pat McCusker.

The Other Ingredient

Something strange in the forest



Some time ago, Alistair Pfeifer and John Fennessy, of the Forest and Wildlife Service, Research Section, noticed a strange thing in the Burncourt River that cuts through Glengarra Forest, Co. Tipperary. The object was over 100mm long with a uniform thickness of no more than 1mm. The creature swam in the manner of a small snake or eel. Neither of the men could tell the creature's head from its tail — it looked simply like a piece of thin wire moving through the water. The undulating piece of wire was coaxed into a glass bottle and brought to Dublin for examination.

Very little is known about horse-hair worms. They belong to the genus Gordius of the obscure invertetrate phylum NEMATOMORPHA. Information about these worms is fragmentary and some of it is of doubtful pedigree. As far as can be ascertained the life history of these worms is as follows:

The adults inhabit small streams and ponds where they lay their eggs. When seen these worms commonly occur in bundles like an entanglement of horse hair floating in the water. The young gordiid worms on hatching seek out the larvae of Chironomid midges or other small aquatic insects. The worms become internal parasites of the midge larvae. When such midges hatch from the water they are commonly preyed upon by Ground Beetles. Within the body of a Ground Beetle the gordiid worm continues to grow until it reaches its full size. At this stage the beetle, now dying from the effect of the parasitic worm, seeks out a source of water at which stage the hair-worm slips from the insect's body and back into the stream or pond to lay its eggs.

(Life cycle of the gordiid worm kindly supplied by Dr. M. Speight of the Forest and Wildlife Service).

Forestry News

XVIIITH IUFRO WORLD CONGRESS

Takes place in Yugoslavia on 7-25 September 1986. The Congress sessions will be held at Cankayev Dom Congress and Cultural Centre in Ljubljana. After the Congress nineteen scientific excursions will be organised throughout Yugoslavia.

PINE NEEDLE BOARD

Experiments have been carried out in Jammu, India on the production of fibreboard from pine needles. A small factory has gone into production blending pine needles with straw or waste paper for the production of fruit boxes to aleviate the excessive demands on timber supplies in this part of India.

THE WOODEN ARM OF THE LAW

The policeman's baton carried by members of the Garda Siochána has traditionally been made of home-grown oak, hickory or hornbeam. Hornbeam is the favoured wood at the moment.

A standard garda baton is 38cm long with a tapering width that averages out at 3.2cm. Each of the 11,500 members of the force is issued with such a baton. In forestry terms this means that the equivalent of eight medium size hornbeam trees are carried about by the Irish police force in the course of its duties. (Information on batons kindly supplied by Garda Inspector P. Kilalea and Sergeant P. Cotter).

BRACKEN CONTROL?

A South African moth — Parthenodes angularis — which appears to be bracken specific may be the answer. The insect kills the plant by tunnelling through the stem. (Credit for this discovery goes to scientists at the University of York).

FACT

An *Albizzia falcata* tree growing in Malaysia reached 30.48m (100 feet) in height in five years and four months.

SILVA INTERNATIONAL CONFERENCE ON TREES AND FORESTS

Paris, February 1986

Concern over desertification in Africa and forest decline in Europe lay behind President Mitterand's initiative to host one of the largest ever political gatherings to discuss the threat to trees and forests. Almost three hundred delegates, including ten Heads of State and many government ministers from twenty seven African and twenty two industrialised countries, agreed on a series of resolutions and a Solemn Appeal aimed at reversing current trends and increasing co-operation between developed and developing countries.

The Irish delegation was headed by an Taoiseach, Dr. Garret FitzGerald, who in his address to the opening session outlined the reasons why Ireland is sensitive to the problems caused by a lack of trees and charted the progress in afforestation in this century. He also stated that whereas most of Ireland's foreign aid up to now had concentrated on rural development and educational and health programmes, it was his intention to have the possibility examined of increasing significantly the proportion going to the problems caused by deforestation.

In their Solemn Appeal the politcal leaders made a commitment to protect trees and forests from threats of all kinds, to fight desertification and increase tree cover, and to expand research and training and promote exchange of knowledge on forestry.

(Dr. M. Carey)

VISIT OF FORESTRY GROUP FROM CANTON, FRIBOURG, SWITZERLAND

In May 1985 the staff of the forest office of the Canton of Fribourg, Switzerland visited Ireland. The 20 members of the party and their wives were shown different aspects of Irish forestry in the east, south and west of the country. Many members of the Society participated in hosting the various stops. As a sign of appreciation for the success of the tour Dr. A. Brülhart presented a cheque for 500 SFr. to the Society.

(Mr. J. O'Driscoll)

(The editor encourages readers to submit items of interest for inclusion in "Forestry News")

Letter to the Editor

Dear Sir,

Recently there have been a series of newspaper articles complaining about the afforestation of peatland areas. Reasons given are typically confused. Occasionally economics are mentioned. Usually the two major objections are on the grounds of conservation and aesthetic values. The conservation arguments, dubious though they are, at least lack the total subjectivity of the aesthetic appeals.

The real motivation of the objectors is a prejudice against plantation forestry based on a hazy notion that artificial peat wastelands are somehow more 'natural' than plantations. Thus, incredibly, scenery is introduced as an argument for keeping huge featureless, unappealing tracts of bog free from the undoubted benefits of forestry. While the idea that blanket bog looks better than wooded countryside may seem absurd to most of us, we, as foresters, should beware lest such fashionable ideas interfere with the afforestation programme. The danger of this is illustrated by statements from influential people that planting of western blanket peats be discontinued, not for economic, but for aesthetic reasons.

It is time for those of us, who like coniferous woodlands, to speak up. Last night I asked five people whether or not they thought that, in general, conifer plantations improve the landscape. Four of them thought they did.

I suggest that this survey of mine is a more objective analysis of the aesthetic aspects of afforestation than was ever carried out by the objectors.

Yours sincerely,

B. Fitzsimons,

99 Killarney Hgts., Bray,
Co. Wicklow.

(Readers' comments please: Editor)

Book Review

THE PUBLIC IN YOUR WOODS — An Owner's Guide to Managing Urban-fringe Woodland for Recreation

J. A. Irving, Packard Publishing Limited, Chichester, United Kingdom. 147 pages. Black and white photographs. Soft back. £5.95 Sterling or £6.00 Sterling including postage from Land Decade Educational Council, 9 Queen Anne's Gate, London SW1H 9BY.

They say that when a man is strapped into the electric chair he is well sedated first so that he can take what might come in his stride. Books of this type under review can benefit from the same approach. The work is crammed with compressed fact after compressed fact from the first sentence. It is, I suppose, on my part, a simple and innocent proclivity, but I would have preferred to have been eased into the study on the slow lane of a chapter on the history of woodland recreation. An introductory paragraph or two on why modern man, in particular, feels he has a need of woodlands as a place of recreation, would have done. Certainly the important element, the forest visitor, might hae been brought more sharply into focus. Who is he? Why does he come? His expectations when he arrives? To some extent all of these points are covered but as a thin gruel that seeps through the general discussion. It would have made the work more readable to have concentrated this aspect as an introduction to the study. That the book is a result of the author's two year followship with the Land Decade Educational Council may account for the strict format.

The strength of Mr. Irving's book is that it is a box of condensed information on the state of the art of woodland recreation development. It is to be recommended on that account. It does not deal in depth with any one aspect of recreation. This is a benefit, not a disadvantage, to any one newly coming to this field. I find however, a difficulty with the publication. The answers offered to many of the problems are far too neat and tidy. The statement on page three — "This book also hopes to reassure landowners . . . that coping with increased access and other urban-fringe pressures, is no more difficult than the other forest management problems they face" — bears this out. I suspect the writer has had little direct experience in managing recreation woodland where a cross-fire of conflicting and often bedevilling and inconsiderate demands are common. This is not said to diminish the work but the book should be read as a useful introductory study to forest recreation and not as the final word on the matter.

Strangely, the author has chosen to aim this book exclusively at the private woodland owner. I feel it would also be of value in the hands of those responsible for recreation management in state owned forests. The 27 pages of appendices is singularly useful, if not to Irish readers, then certainly to United Kingdom readers. These pages offer a comprehensive list of agencies from whom technical and finalcial advice in this area of woodland management can be sought.

One forceful point the author makes in the summary section is a statement that should be engraved with Franz Kafka's 'Harrow' on each woodland planner's heart — "planned provision for increased public use is far better than belated attempts to control de facto access". How true that is!

Pat McCusker.

Society Activities

COUNCIL REPORT 1985

Symposium
"Stability of Forest Crops" was the theme of the symposium held at U.C.D. on 29th March. Six papers were presented on the subject. The symposium was attended by 200 members.

Annual Study Tour
The tour was held in Cork from 21st-23rd May and a full account of what took place is in Irish Forestry Vol. 42(2).

Meetings
Two meetings were held during the year. The first was held in the Sligo/Leitrim area in June and it considered the feasibility of thinning Sitka spruce on gley soils. The other meeting was held in September in Co. Tyrone. At Baronscourt, the thinning, spacing and provenance of Sitka spruce were discussed and at the Abercorn Estate the re-establishment of hardwoods was considered, including a look at the performance of oak and beech, and larch in tree shelters. Both days were very well attended. One evening meeting was held in Limerick in April — it was a repeat of the meeting 'The Silviculture of Ash for Hurley Production' which was held in Dublin in December in 1984.

Guided Forest Walks
Walks were held at 23 centres throughout the country on 8th September. Attendances were very satisfactory.

The Society wishes to thank those who presented papers at the symposium, all those who helped in organising the field days and evening meetings and the Convenor and leaders of the Forest Walks. Thanks are also due to the Forest and Wildlife Service and the Northern Ireland Forest Service and University College Dublin, for their co-operation and assistance during the year.

Annual General Meeting
The AGM was held at U.C.D. on the 28th March. The Minutes were published in Irish Forestry, Vol. 42(1).

Publications
Irish Forestry Vol. 42 was published.

Examinations
No candidate sat for examinations.

Education Award Fund
The winners of the 1984 prizes (each of £100 worth of forestry books) were Mr. J. Galligan, Bray (U.C.D. recipient) and Mr. P. Egan, Killaloe (Kinnity Forestry School recipient). The winner of the current year's prize was Mr. E. O'Driscoll, Dublin (U.C.D. recipient). Please note that only one prize was awarded in 1985 because the Kinnitty Forestry School closed in 1984.

Following a forestry tour of Ireland in 1985, foresters of the Canton of Freiburg (Switzerland) presented the Society with 500 francs. Council decided that the money be placed in the above fund.

Oireachtas Joint Committee on Forestry and Forest based Industries.

The Council submitted the same submission that was sent to the Review Group on Forestry, to the Joint Committee.

Visit from Abroad

The Society in conjunction with the Forest and Wildlife Service, organised and hosted a week's study tour for 38 members of the Society of American Foresters, in September.

Elections

Three posts of Technical Councillor (for 2 years), one post of Technical Councillor (for 1 year, due to a Councillor resigning), and one post of Associate Councillor were filled by election. As there was only one candidate for each of the other posts they were filled without election. The total valid poll in the 1985 election was 168.

Membership

Number of members on 31st December 1985:

Technical	*Associate*	*Student*	*Total*
468	114	53	635

New members elected in 1985:

17	13	15	44

We note with regret the deaths of the following members: Mr. E. Daly, Mr. J. Kelleher, Mr. B. Loughrey, Mr. S. Switzer.

Attendance at Council Meetings

Six meetings were held during the year. Attendance was as follows:

E. Griffin, L. Furlong, M. O'Brien, P. Raftery .... 6 meetings

J. Fennessy, J. Gardiner, E. Hendrick .... 5 meetings

M. Carey, J. Prior .... 4 meetings

E. Farrell, J. O'Driscoll, A. Pfeifer .... 3 meetings

B. Hussey, D. Ward .... 2 meetings

K. Hutchinson .... 1 meeting

E. Morrissey .... 0 meetings

Please Note: E. Morrissey tendered his resignation at the first Council meeting and E. Farrell was co-opted in his place. D. Ward resigned from Council at the 4th meeting, and K. Hutchinson was co-opted in his place. Therefore E. Farrell and K. Hutchinson could have only attended a maximum of 5 and 2 Council meetings respectively.

Signed: E. Griffin,

March 1986. *Hon. Secretary.*

MINUTES OF THE 44th ANNUAL GENERAL MEETING
THURSDAY 20th MARCH, 1986
AGRICULTURAL BUILDING, U.C.D., DUBLIN

The President, Mr. M. O'Brien took the chair.

Attendance

E. Griffin, A. Pfeifer, P. McCusker, F. Mulloy, I. Booth, J. O'Driscoll, E. Hendrick, J. Gardiner, L. Furlong, J. Fennessy, D. Magner, J. Neilan, J. Griffin, B. Fitzsimons, J. Mackin, S. Milner, W. Wright, B. Lacey, R. Keogh, G. Murphy.

Apologies

P. Burton, P. Joyce, N. O'Carroll.

Secretary's Business

The minutes of the 43rd Annual General Meeting, having already been circulated to members, were agreed, and signed by the President.

Matters Arising from Minutes

None.

Council's Report for 1985

The Report, having already been circulated to members was taken as read. F. Mulloy asked how many people had attended the Forest Walks held last September. P. Raftery stated the attendance amounted to around 4,500. F. Mulloy remarked that this was the only event open to non-members. He felt that the public now seem to be tutored on forestry matters by non-members and that the Society is becoming introverted — what about the Press being allowed into symposia? J. Gardiner stated that this proposal had been discussed last year by Council but that it decided against it. Council felt that the media tended to misrepresent issues and that speakers would not be in as free a position to talk on issues lest they be misconstrued. P. McCusker stated that on forestry matters the Society should be replying to bad press. The President said there had been a sub-committee considering ways of promoting the objectives of the Society and that this work will be continued by the incoming Council. The Council Report was proposed for adoption by E. Hendrick and seconded by J. O'Driscoll.

Abstract of Accounts

P. Raftery presented the Statement of Accounts for the year ended 31st December 1985. Subscriptions accounted for around £6,000 during the year. Interest on investments was up on last year's figure — however this interest will be subject to a new 35% tax this year because of changes brought about by the recent Budget. The cost of producing the Journal has risen by less than 5%. However, the cost of postage has increased by 33% due to the new weight and size of envelope regulations of An Post. The Treasurer expected that receipts will equal expenditure during 1986. However, the balance to credit is presently almost £8,000. A question was raised as to whether the subscription rates should be increased. The President replied that Council had considered the matter during the year and had decided not to propose an increase. P. Raftery also presented a statement on the Education Award Fund. The statements were proposed for adoption by A. Pfeifer and seconded by D. Magner.

Confirmation of Elections

The meeting confirmed the 1986 Council Elections as follows: President, M. O'Brien; Vice-President, J. Prior; Hon. Secretary, E. Griffin; Hon. Treasurer,

G. Murphy; Editor, P. McCusker; Business Editor, E. Hendrick; Hon. Auditor, W. Jack; Technical Councillors, D. Magner, J. Neilan, J. O'Driscoll, E. Farrell (for one year only); Associate Councillor, L. Furlong; Northern Ireland Regional Group Representative, J. Griffin.

Proposed by I. Booth.
Seconded by J. Fennessy.

Any Other Business

G. Murphy asked in what way had the Society contributed to last year's International Year of the Forest? E. Griffin said that Council had tried to organise the making of a video on forestry but various attempts had been unsuccessful. It was as a result of this that a sub-committee had been formed to seek ways of promoting the objective of the Society. B. Fitzsimons suggested that Council should seek sponsorship from the Forest and Wildlife Service to make a video. It was agreed that the incoming Council would consider seeking sponsorship for same.

The meeting concluded at 9.00 p.m.

SOCIETY OF IRISH FORESTERS — STATEMENT OF ACCOUNTS FOR YEAR ENDED 31st DECEMBER, 1985

1984	*RECEIPTS*		*1985*
7,223.56	*To Balance from Last Account*		6,813.71
	To Subscriptions Received		
	Technical 1985	4,235.76	
	Technical 1984	275.50	
	Associate 1985	816.70	
	Associate 1984	92.00	
	Student 1985	88.45	
	Student 1984	10.00	
	Other Arrears	215.20	
6,109.74	Advance Payments	202.87	5,936.48
	To Interest on Investments		
	Savings Account	*61.16*	
	Educational Building Society	*9.14*	
921.70	*Lombard & Ulster*	*871.56*	*941.86*
	To Journal		
	Sales	1,400.39	
1,969.90	Advertising	1,611.00	3,011.39
	Examination Fee		25.00
33.86	Gains on Sterling		42.98
	Forest Walks		3,000.00
	Donation		12.50
16,258.76			£19,783.92

1984	*PAYMENTS*		*1985*
82.06	By Stationery and Printing		134.95
3,871.00	By Printing of Journals		4,059,00
1,081.13	By Postage		1,440.90
100.00	By Expenses re Meetings:		110.00
25.10	By Bank Charges		49.49
1,504.80	By Secretarial Expenses		1,820.35
549.90	By Value Added Tax		509.51
90.30	By Examination Expenses		151.60
50.47	By Miscellaneous Expenses		79.10
	By Honoraria:		
	Secretary	50.00	
	Treasurer	50.00	
	Editor	50.00	
200.00	Business Editor	50.00	200.00
430.00	By Study Tour Expenses		240.00
501.84	By Forest Walks		3,008.76
	By Balance:		
	Current Accounts	662.60	
	Savings Account	516.17	
	Educational Building Society	139.44	
6,813.71	Lombard & Ulster	6,662.05	7,980.26
16,258.76			19,783.92

I have examined the above accounts, have compared them with vouchers, and certify same to be correct, the balance to credit being IR£7,980.26 which is held in current accounts at the Ulster Bank. (IR£1,240.87 less IR£578.27 uncashed cheques). Ulster Bank Savings Account, B2960, Educational Building Society Account 130441, and Lombard and Ulster Savings Deposit Account No. 675146F. There is also a holding of £100 Prize Bond No. R855061/080. IR£1,171.47 is held in Trustee Savings Bank Account 323 001 35909 for the Education Award Fund.

Dated: February 11th, 1986 — *Signed: W. H. Jack, Hon. Auditor*

SOCIETY OF IRISH FORESTERS — EDUCATIONAL AWARD FUND FOR YEAR ENDED 31st DECEMBER, 1985

1984	*RECEIPTS*	*1985*	*1984*	*PAYMENTS*	*1985*
916.61	To Balance from last account	877.50	877.50	By Balance	1,171.47
67.17	To Interest	100.18	106.28	By 1985 Award	—
—	To Donation (Swiss Foresters)	193.79			
£983.78		IR£1,171.47	£983.78		IR£1,171.47

I have examined the above account and certify same to be correct, the balance to credit being IR£1,171.47 which is held in the Trustee Savings Bank Account 323001 35909.

Dated: February 11th, 1986

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

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