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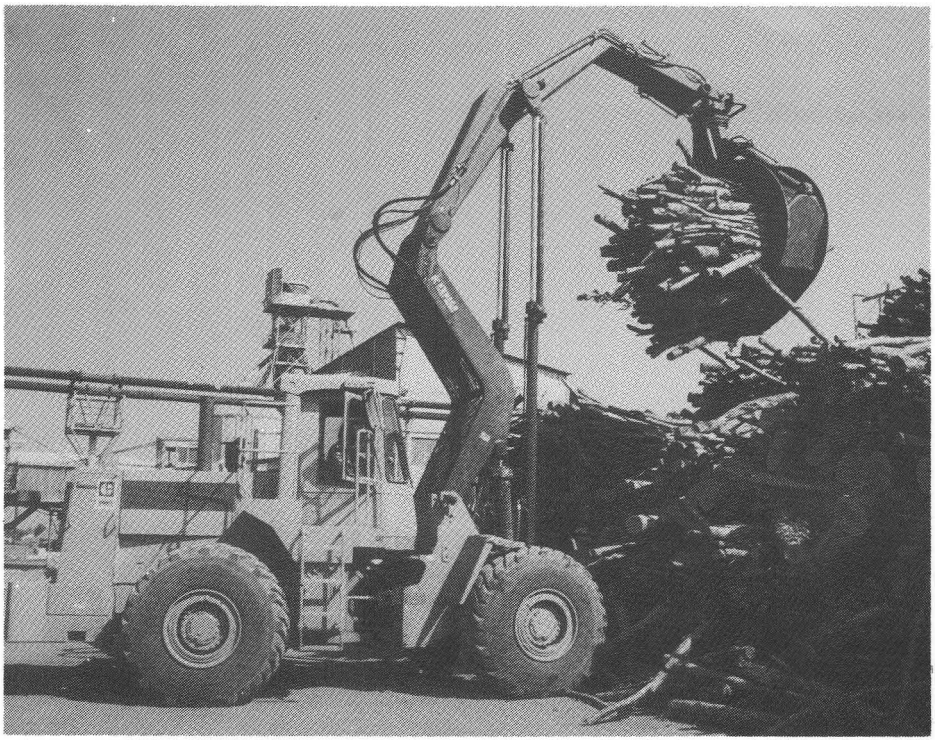

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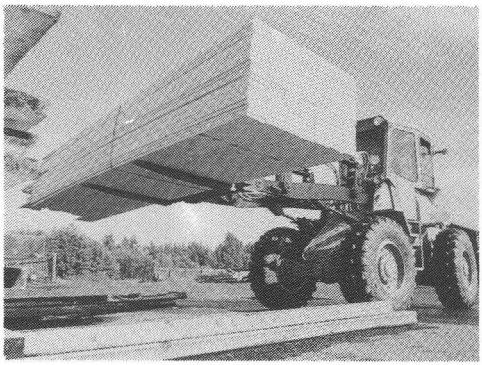

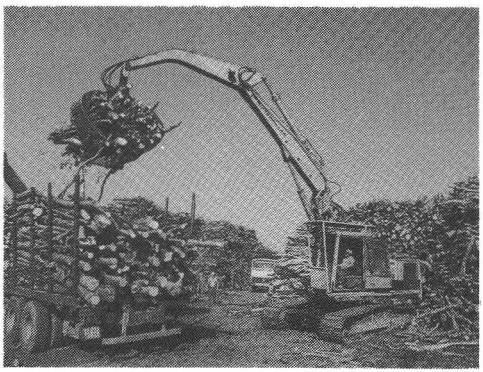

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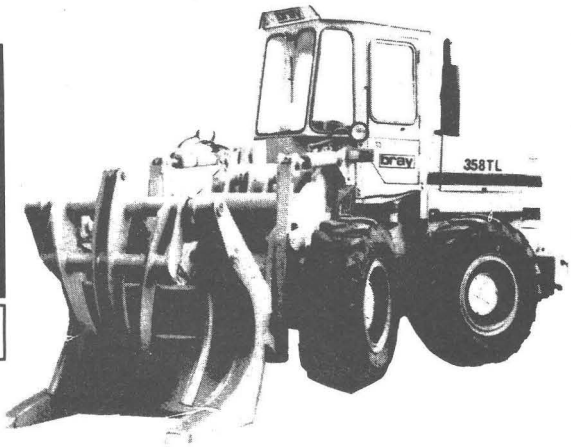

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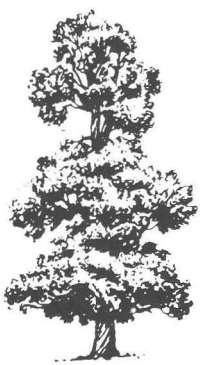

JOURNAL OF THE SOCIETY OF IRISH FORESTERS

Volume 41, No. 1, 1984

Notes for the

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

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

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

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Contents

Erratum, Vol. 40, No. 2, 1983, p. 102
Volume Equations should read:
Ye(1)=–4.265123+1.954895 (Log DBH)+0.921085 (Log H)
Ye(2)=–4.407932+2.099353 (Log DBH)+0.863421 (Log H)

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

Cover: Birch Stand in Finland. (Photo: U. Viinikka).

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EDITORIAL

Rights and Absolute Rights

"When I return home from little countries like Denmark, Holland and Belgium, it makes me mad to look at the criminal misuse of the best land in Europe . . . . ." wrote Michael Davitt in a Letter to Mr. Hannay on the 4th April, 1906. This statement raises the issue of the rights and absolute rights of landowners in Ireland.

In any democracy an asset holder has the right to use his assets in any way he wishes, subject to certain legal constraints. But do landowners have the absolute right to underuse, misuse or even, abuse, such a vitally important and limited national asset? Should landowners be obliged to afforest land which is submarginal for agriculture or should such land be taken over by the State and planted?

"If the charge of the land is specially entrusted to any man or set of men, it can only be enjoyed by them within the limits of that term — held in trust for the good of the community and subject to such restrictions as the community, in the person of the State may think fit or find it necessary to impose" — Michael Davitt.

The recent report of the National Planning Board appears to endorse these views of Davitt. They advocate *". . . . . disincentives which would penalise underutilised land"* and recommend the imposition of a land tax *". . . . . to stimulate better land use and/or transfer of management control"*.

If this interpretation of the report is correct, then the expansion of the forestry estate in Ireland in the coming years must be bright.

Facts and Figures from Finnish Forestry

R. VUOKKO and J. J. GARDINER

Department of Forestry, University College, Dublin.

INTRODUCTION

Finland is about 337,000 square kilometers in extent. It has a population of about 4.7 million people and population density at 15 per square kilometer is very low. As in most European countries, demographic change has been marked over the past 30 years. In 1950 more than 45% of the workforce ws employed in forestry and agriculture. Today only 12.7% of workforce is directly employed on the land, while 87% work in industry and services.

The country stretches from 60° to 70° north latitude and about one-third of it lies within the Artic Circle. However, only the northern tip is tundra and the rest of the country falls within the northern coniferous belt. The climate in general is continental with cold winters and warm summers. The coldest month is usually February, with mean temperatures of –6°C in the south and –14°C within the Artic Circle. The warmest month is July with mean temperatures ranging from 17°C in the south to 14°C in the north. The annual rainfall of about 600mm is evenly distributed throughout the year. The main bedrock type is granite. The soils are derived from this bedrock and are acidic in nature. Glacial ground morraines dominate although post-glacial alluvial sands and clay deposits also occur. Peat soils are common, covering about 30% of the land area. This is usually blanket peat, which seldom exceeds three meters in depth.

About 66% of the land surface is forested and this makes Finland the most densely forested country in Europe (Table 1).

A further 10% is farmland, while 21% of the land is unproductive peatland and tundra.

The forests are mainly on mineral soils but some 5.5 million hectares of peatland have been drained for forestry.

FOREST OWNERSHIP

About two-thirds (13.3 million ha) of all forests are privately owned (Table 2). This is made up of about 350,000 separate holdings each consisting of approximately 40 hectares. State forests tend to be located on the less productive sites and hence their annual increment is low.

IRISH FORESTRY, 1984, Vol. 41, No. 1: 7-13.

Table 1: Area of Forests in Some European Countries.

Country	Forest Area (Millions of ha.)	Forest Area as A % of Toal	Forest Area (ha per capita)
Finland	20	66	4.6
Sweden	23	57	2.7
Norway	8	27	1.9
France	13	25	0.25
West Germany	7	29	0.12
Britain	2	8	0.04
Denmark	0.5	11	0.10
Ireland	0.4	5	0.12

Table 2: Forest Ownership in Finland

	Area (%)	Growing Stock (%)	Increment (%)
Private	63.9	70.5	76.3
State	23.9	18.5	11.7
Companies	8.0	6.9	7.8
Co-Operatives (Communes, Parishes)	4.2	4.3	4.2

Species and Growing Stock

The principal species are Scots pine (45% of growing stock), Norway spruce (37%). Birch (*Betula verrucosa* and *Betula pubescens*) (15%) and Alder plus Aspen (3%). All of these species are indigenous. Trials with exotic species have shown that Lodgepole pine and Siberian larch can give fast growth rates on some sites. However, at the present time there is no demand for the large scale introduction of these exotics. Most of the spruce is found on moist, fertile, mineral soil sites in the southern half of the country. Scots pine is the predominant species on less fertile, dry, mineral soil sites and on most of the drained peatland. As this species is considered a more valuable commercial species, general policy is to extend its use. Birch (*B. verrucosa*) is found principally in central Finland where as hairy birch (*B. pubescens*) in particular is common on drained peatlands all over the country.

The total growing stock in the country has been estimated at about 1640 million m^3 or $81m^3$ per hectare. The mean volume per hectare naturally tends to be higher in the south than in the north ($101m^3$ v. $52m^3$). The total annual increment is about 65 million m^3 or $3.3m^3$ per ha and it has been forecast that this will increase to 75 million m^3 within 25 years. The total growing stock is now larger than it has ever been since the first national inventory in the 1920s. The age-class distribution of the forest estate is normal with a small proportion of overmature stands (Table 3).

Table 3: Age Class Distribution of Finnish Forests by Area (Millions of Ha.).

Age Class	0-20	21-40	41-60	61-80	81-100	101-120	121-140	Over 140
Area	3.80	3.28	3.40	3.92	3.06	1.38	0.46	0.18

The volume of timber harvested in 1980/81 was 56 million m^3, about half of which was sawlog sized material.

SILVICULTURE

All mature stands are more or less natural. Natural regeneration is still widely used in reafforestation but this technique is more commonly practised in Scots pine plantations than in Norway spruce stands. The pine grows on poorer sites where vegetation regrowth does not unduly interfere with natural regeneration. The silvicultural systems used to obtain regeneration are the shelterwood uniform systems for both spruce and pine and clearfelling in strips for pine. Where the uniform system is used the number of seed trees remaining on the ground is usually 50-100 per ha for pine and 200 per ha for spruce. The use of bare-rooted and containerised planting stock for reafforestation is, however, increasing (Table 4). Total annual plant production is 230 million and about 40% of this is container grown. The usual containers are paper pots and peat pots.

Dry mineral soils are scarified with heavy disc ploughs before planting. These help to break down and windrow the lop and top as well as giving mechanical preparation of the planting site. Moist sites and shallow peat soils are ploughed and deep drains are excavated where necessary. The spoil from deep drains is spread to provide mounds for planting. Planting is at a rate of 2000 per hectare. In all reafforestation weed control is a major operation due to the natural regeneration of unwanted species. Weeding is frequently chemical or by using rotary disc saws. First thinning is

carried-out when crops are about 10m high and at 10-20 year intervals thereafter. Fertiliser application is necessary on some peatland and the poorest peats may need repeated applications of N, P and K every 15 years to prevent crops from stagnating. Boran deficiencies have also been noted in crops growing on peat. Spruce crops are not pruned but selective pruning of Scots pine crops is becoming more popular. However, pruning is confined to the final crop trees in the best quality stands. Rotation lengths vary according to species but are about 60-70 years for birch, 80-100 for spruce and 80-130 for pine. The lower figures generally apply to the southern half of the country.

Table 4: Methods of Forest Regeneration.

Method	% of Total	System	Quantities Per Ha
Natural	40	Shelterwood Uniform System for Pine and Spruce. Clearcutting in Strips for pine.	50-200 Seed Trees
Artificial	60	Direct Seeding	0.3-0.5kg Seed
		Planting Pine or Spruce Stock	2000 Plants
		Planting Birch or Larch	1600 Plants

HARVESTING AND PROCESSING

Logging is mainly motor-manual, with conversion into pulpwood and sawlog at stump. Extraction is mainly by forwarders but many farmers use ordinary farm machinery. Current standing prices are about £25/m^3, £20/m^3 and £22/m^3 for pine, spruce and birch sawlog respectively. Pulp sells for approximately £12/m^3. These current prices are well below the peak prices of 1974/75 (Fig 1). For the past twenty years Finnish wood processing industries have fully utilised the annual cut of about 60 million m^3 and currently imports an additional 3-5 million m^3 of wood per annum. The emphasis now is upon the manufacture and export of high value processed products. Thus the export of wood pulp has decreased dramatically while the export of paper products has greatly increased (Table 5). Wood processing industries in Finland are modern and highly integrated. Because of this they have been able to survive the difficulties created by high energy costs, high raw material costs, and stringent

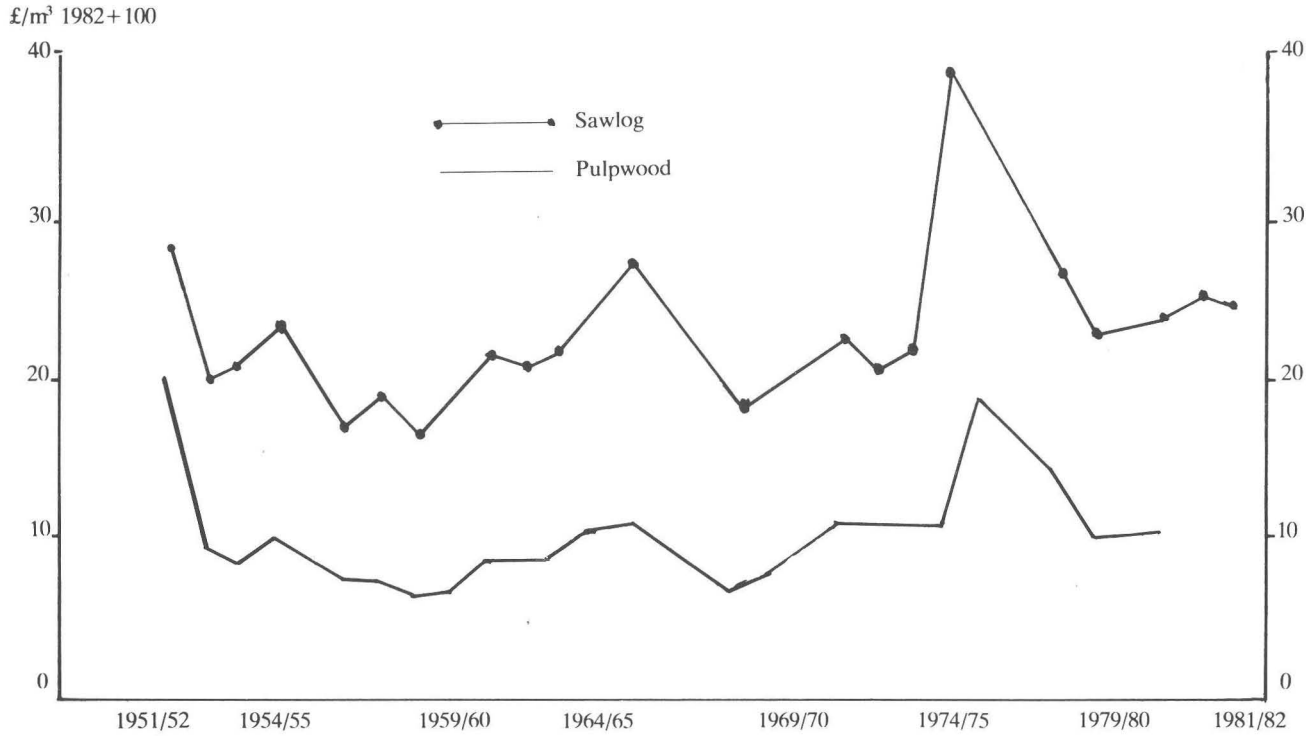

Fig 1: Stumpage Prices in Finnish Forests in the Period 1951-1952 in 1982 Money Value.

environmental quality standards. The main problem of industry is the low amount of own-captial. Industry is also very worried if the private owners will, in the future, sell enough wood at a price which industry can pay without losing competitiveness. The number of people in processing wood is around 100,000 and it has been estimated that a further 250,000 jobs in service industries depend upon forestry. The number of people directly employed in forestry is about 50,000. This number includes 30,000 forest workers, 14,000 foresters and 6,000 transport workers. The number of foresters represents one forester to every 4700 hectares.

Table 5: Finnish Forest Industry in 1982.

Production Plant	No. of Mills	Production	Exported (%)
Sawmills	320*	7,300,000m^3	63
Plywood & Veneer Mills	28	596,000m^3	87
Particle Board Mills	12	636,000m^3	38
Wallboard Mills	5	136,000 t	46
Mechanical Pulp Mills	22	2,326,000 t	1
Semi-Chemical Pulp Mills	3	309,000 t	—
Kraft Pulp Mills	18	3,488,000 t	31
Sulphite Pulp Mills	8	591,000 t	59
Paper Mills	30	3,672,000 t	82
Paperboard Mills	16	1,451,000 t	80

*This figure does not include 8500 local sawmills.

Thus, the total employment attributable to forestry comes to 400,000 or 20% of the labour force.

PRIVATE FORESTRY

In general one family in every three owns a woodlot of approximately 40 hectares. The proportion is higher for rural families but about 40% of woodlots have either been inherited or purchased by people other than farmers. Local management associations provide a professional advisory service for private owners. There are 377 such associations (one per district) and each maintains a staff of foresters and forest workers. Many owners carry out their own forest operations but many contract their forest work to the local management associations. Provincial forestry boards supervise the work of the management associations and provide specialised services such as the drawing-up of working plans, the provision of planting stock, the development of forest roads and regional drainage. The average income from a woodlot is

in the region of £1500/£2000. Generally forest owners pay for the services provided by the management associations and the provincial boards. However, if the income from clear-felling is below a certain threshold, loans and grants are available for reafforestation. Loans and grants are also available to all woodlot owners for weed control, fertiliser application, drainage of peatland, pruning and road construction. These finds are made available from the central exchequer but are channelled through the provincial forestry boards.

Forestry provides the raw material for a vast export industry in Finland. In recent years forest producers made up about one-third of all exports and have been valued at around £5566 million per annum. Forests also have a great non-commercial value since they dominate the landscape and provide a refuge for wildlife. They are also extensively used for jogging, orienteering, hunting, berry-picking and skiing. The Finnish people are very much aware of the overriding importance of forestry to their ecomony. They are aware too of many problems within the industry and of the increasingly stiff competition for world markets. However, forest management is good and the forest industries have all the advantages that modern equipment and scale can create. So they are confident that their forest products can compete on the world's markets and can continue to bring foreign exchange.

Nitrogen accumulation by *Ulex gallii* (Planch.) in a forest ecosystem

P. O'TOOLE, J. DOWDS and E. P. FARRELL

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Faculty of Agriculture, University College, Dublin 4.

SUMMARY

Accumulation of nitrogen was assessed under naturally occurring, 5 year old *Ulex gallii* (Planch.), dwarf furze, on impoverished soils formed from Old Red Sandstone. Nitrogen accumulation in *U. gallii* and non-*Ulex* vegetation (including litter), in roots and soil (25 x 25 x 20cm cores) was estimated within 5 x $2m^2$ subplots chosen subjectively on the basis of legume occurrence within a single, phosphate-fertilised plot of a forest experimental site at Kilworth, Co. Cork. The influence of *U. gallii* on carbon and nitrogen mineralisation in litter and soil (A1 horizon) was also evaluated.

A close correlation ($r=0.99$; $p<0.05$) was found between *U. gallii* cover (2.4 to 19.9 t DM ha^{-1}) and the nitrogen content of the total vegetation (220 to 495kg N ha^{-1}, resp.). The relationships between *U. gallii* occurrence and soil nitrogen (2325 to 2588kg N ha^{-1}, resp.) or soil plus vegetation N (2545 to 3085kg N ha^{-1}, resp.) were weaker ($r=0.72$ and 0.86, resp.). The correlation between legume cover and the nitrogen content (% DM) of the non-*Ulex* vegetation was $r=0.83$. The annual accumulation of nitrogen within the vegetation was estimated to be 55kg N ha^{-1}.

Only *Ulex* litter released appreciable quantities of nitrogen after 80 days incubation at 20°C — 5.89 compared to 1.17 and 2.28mg N g^{-1} total –N by senescent *Ulex* spines and non-*Ulex* litter, respectively. Mineralisation of soil nitrogen after 112 days incubation at 20°C was considerably greater under *U. gallii* than under other vegetation (*Calluna-Molinia spp*) — 3.3% and 0.4% of soil –N, respectively. These results were corroborated by CO_2 evolution studies.

The results are discussed in the context of the nitrogen requirements of Sitka spruce stands on these soils and the distribution and exploitation of *U. gallii* as a nurse crop.

INTRODUCTION

Biological nitrogen (N_2) fixation by both legume and non-legume plants has long been exploited in forestry (Baule and Fricker, 1967; Gordon and Dawson, 1979) Currently, there is much interest in the development of nitrogen fixation for forest production to the level achieved in agriculture (Haines and de Bell, 1979).

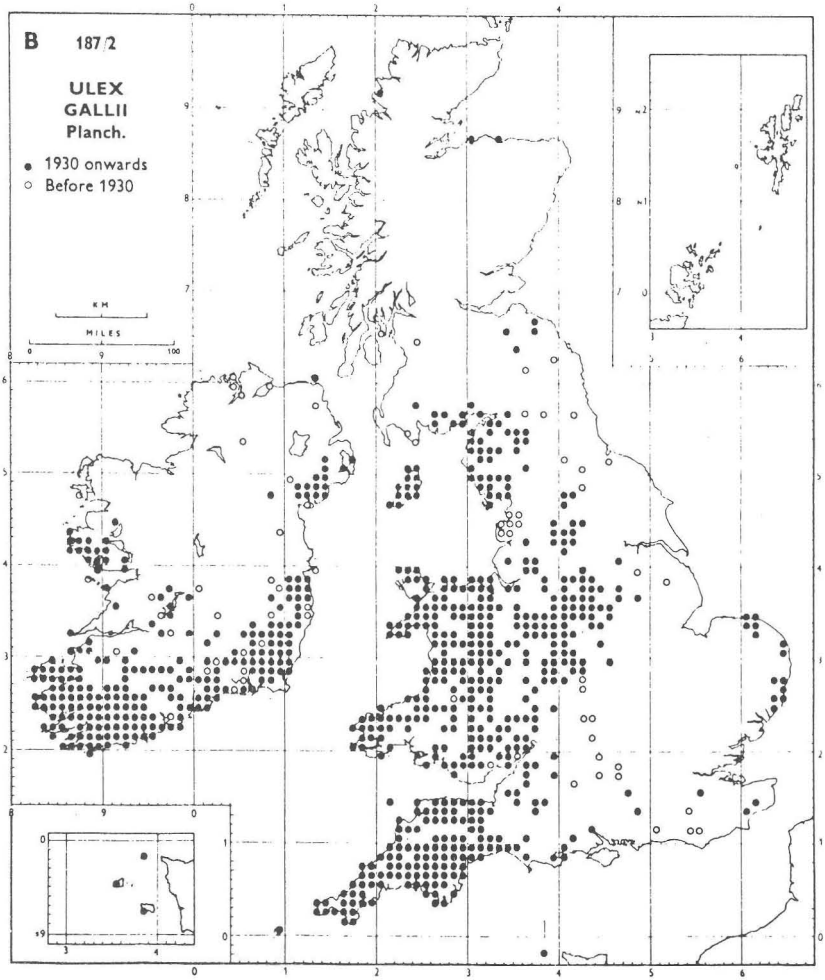
In the Republic of Ireland, potential exploitation of nitrogen fixation is of critical interest because 75,000 ha, approximately, of

State forests are planted on very poor, nitrogen-deficient soils formed on Old (Devonian) Red Sandstone (ORS). Many of these forests commonly achieve only very slow growth rates (i.e. are in "check") due to nitrogen deficiency (Carey and Griffin, 1981). The soils include moderately well drained or gleyed podzols associated with the absence or presence of indurated irons pans (Dillon *et al.*, 1977). Their poor nitrogen status results, at least in part, from previous removal of peaty layers for fuel. Moreover, responses by Sitka spruce (*Picea sitchensis* (Bong.) Carr) to nitrogen fertilisers on these soils have been disappointing and are generally considered uneconomic (Carey and Griffin, 1981).

Tree lupin (*Lupinus arboreus* Sims.) and common broom (*Cytisus scoparius* L. syn. *Sarothamnus scoparius* Wimm.) have been evaluated as nitrogen-fixing nurse-crops for Sitka spruce in field trials set up on ORS sites in the early 1960s (O'Carroll, 1982). Although legume establishment was satisfactory, the lupins persisted for only 3-5 years, in agreement with New Zealand experience (Gadgil, 1977). Nevertheless, highly significant growth responses to lupin and broom mixtures are clearly evident after 20 years (O'Carroll, 1982). This duration of response to legumes has been noted previously and contrasts sharply with that to nitrogenous fertiliser (Baule and Fricker, 1967; Carey and Griffin, 1981). The benefit of these legumes, however, is not fully established under Irish conditions as yet.

O'Carroll (1982) and others (e.g. Carey and Griffin, 1981; Dillon *et al.*, 1977) have noted marked improvement of Sitka spruce growth on sites/plots spontaneously colonised by the shrub legume, furze or gorse (*Ulex* spp). Similar observations have been reported in the United Kingdom by Nimmo and Weatherell (1962). A number of workers have reported on nitrogen fixation by gorse (*U. europaeus* L.) in forestry and in land reclamation (Nimmo and Weatherell, 1962; Skeffington and Bradshaw, 1980). Of the two species, *U. galli* is the more attractive under Irish conditions because of its smaller (<1m), less vigorous growth habit and its widespread distribution especially on the ORS soils in Munster (Fig 1). *U. gallii,* thus, offers a widely distributed hardy legume which is less likely to suppress tree growth than *U. europaeus* (Nimmo and Weatherell, 1962) and which is apparently adapted to very infertile soils.

To the authors' knowledge, however, there have been no reports concerning nitrogen accumulation by *U. gallii.* Furthermore, there is little reliable information on the factors which govern its distribution. Compared to *U. europaeus, U. gallii* is apparently favoured by relatively cool temperatures and low light intensities



Perring, F.M. & Walters, S.M. 1962.

Fig 1 Distribution of *U. gallii* in Ireland.

and is seemingly confined to moderately to well drained, acid soils while being very responsive to fertiliser phosphate (Moore, 1960).

The purpose of this investigation was to establish whether *U. gallii* can make a nitrogen contribution to forest crops on ORS sites, to attempt to quantify this contribution and to assess whether biological activity and nitrogen mineralisation are enhanced by its presence in the ecosystem.

MATERIALS AND METHODS

Vegetation and soil samples were collected at a site in Kilworth Forest, Co. Cork (grid ref. RO5 83) which had been clearfelled and laid out in experimental plots by the Forest and Wildlife Service in 1976, when Ground Rock Phosphate fertiliser was applied. Site particulars include 160m O.D., SSE aspect, gentle slope, moderately good drainage and 1,000mm annual rainfall. The major soil type is a podzol of sandy loam texture, with a non-indurated B2ir at 15-25cm, formed on Old (Devonian) Red Sandstone (ORS) glacial drift (Table 1). The dominant vegetation comprises *Calluna vulgaris — Erica tetralix — Molinia caerula.* Following fertiliser application, the phosphate-treated plots became extensively colonised by the two gorse species, *U. gallii* and *U. europaeus.* Control plots were not invaded by the legumes.

Table 1: Selected properties of a "modal profile", Kilworth Forest.

Horizon	Depth cm	Textural Class	Org. C %	Total N %	pH	CEC meq $100g^{-1}$
A1	0-5	sandy loam	6.2	0.29	3.8	5.2
A2	5-15	sandy loam	0.7	0.09	3.9	4.2
B2	15-16	sandy loam	1.5	0.08	4.2	4.9
B3	>16	loam	0.1	0.03	4.3	4.0

Sampling for nitrogen accumulation study

Sampling for this study was done in December 1981 within a single phosphate-fertilised (30kg P ha^{-1}) plot planted with Douglas fir (*Pseudotsuga menziesii* (Mirb.) Franco) and displaying a wide variation in the extent of *U. gallii* occurrence.

Five 1.43m x 1.4m subplots were chosen subjectively on the basis of variation in *U. gallii* cover and the absence of trees and

U. europaeus. All above ground material, which included both vegetation and litter, within each subplot was harvested and separated into its *Ulex* and non-*Ulex* components which were then dried at 105°C for 48 hours and weighed.

Four randomly located 25cm x 25cm soil cores were taken to 20cm depth within each subplot. After air-drying, the entire core sample was weighed. Oven-dry weights of coarse (>8mm) and fine (>2 to <8mm) roots, soil (<2mm) and gravel (>2mm) were recorded. Soil bulk densities were calculated from the weight and volume of material in each core (cf Table 2).

Table 2: Properties of soil cores (mean of four cores)

Subplot No.	Soil Core wt kg a.d.	Bulk Density g o.d. cm^{-3}	Total N % o.d.	Organic C % o.d.	C : N Ratio
1	16.6 (1.61)	1.19 (0.16)	0.11 (0.03)	2.1 (0.67)	18
2	15.2 (1.55)	1.07 (0.12)	0.10 (0.02)	1.7 (0.46)	17
3	15.7 (1.92)	0.99 (0.19)	0.13 (0.03)	2.7 (0.73)	21
4	18.5 (1.59)	1.28 (0.20)	0.11 (0.03)	1.7 (0.50)	16
5	15.4 (1.75)	1.10 (0.15)	0.13 (0.02)	2.2 (0.35)	16

Standard Deviations in parentheses.

Sampling for nitrogen mineralisation study

Samples were taken in March 1982 from a replicate of the above plot. Two subplots were sampled, one with almost complete *U. gallii* cover and one virtually devoid of the legume — "high" and "low" *Ulex* plots, respectively (cf Table 4). *U. europaeus* was absent from both subplots. Plant tops and "litter" were collected separately. Three "litter" types were collected viz. *Ulex* (UL) and non-*Ulex* (NUL) litter and senescent spines from live *Ulex* shrubs (SU). The litters were stored at 4°C until used. The vegetation was dried and weighed as described above.

Six 25cm x 25cm soil cores were taken from the A1 horizon (4 to 9cm) in each subplot — "high" (HUS) and "low" *Ulex* (LUS) soil, respectively (Table 4). These samples were also stored at 4°C until used. The samples were well mixed prior to incubation.

Incubation methods

Both biological activities (estimated as CO_2 evolution) and patterns of nitrogen mineralisation of litter and soil samples were studied. For the CO_2 evolution studies, *Ulex* and non-*Ulex* litter

materials were air-dried and finely ground in a Glen Creston mill and the soils, which were not dried, were passed through a 3.5mm sieve. Samples of the litters (≡10g o.d. material) and of the soils (≡60g o.d. material) were adjusted to 80% water-holding-capacity (WHC) and then incubated at 20°C for 91 days in 250ml Ehrlenmeyer flasks fitted with a CO_2 trap modified from Nömmik's (1971) design. Determinations of evolved CO_2 and corrections for sample moisture losses were conducted weekly. The results are means of 4 replicates and are expressed on an o.d. basis in mg CO_2–C evolved per g organic–C incubated.

Nitrogen mineralisation in the materials was studied using unground (but <8mm), undried samples (=8g o.d. material) of litter incubated in 1,000ml containers and using undried soil samples (≡20g o.d. soil; <3.5mm) incubated in 220ml jars. The incubation vessels were covered with polythene and all samples were incubated for 80 days at 20°C and 80% WHC. Moisture deficits were corrected every 8 days where necessary. Four replicates of each treatment were destructively analysed for NH_4^+– and NO_3^-–N at 16 day intervals. Results are expressed as mg mineral ($NH_4^+ + NO_3^-$)–N per g total–N incubated (o.d. basis).

Analytical

Organic–C was determined by Ball's (1964) procedure and CO_2–C by Nömmik's (1971) method. Ammonium and nitrate nitrogen were measured as described by Bremner (1965). Available phosphorus was determined according to the method of Olsen and Dean (1965). The WHC is expressed as the volume of water (% o.d. wt) retained by samples under 100cm tension using a sandbox (Stakman *et al.*, 1969). Totol –N, pH, exchangeable Al, H and bases and textural analyses were conducted by conventional procedures. Cation-exchange capacities (CEC) were calculated as the sums of exchange acidities plus total exchangable bases.

RESULTS

Nitrogen accumulation under U. gallii

Estimated accumulation of nitrogen in the vegetation and of nitrogen in soil cores from the individual subplots, extrapolated to a per ha basis, are given in Table 3. The data show that estimated *U. gallii* DM production ranged from 2.4t DM ha^{-1} in Subplot 1 to 19.9t DM ha^{-1} in Subplot 5. The latter represents a rather higher density of the legume than commonly observed in phosphate-treated plots at this site. Growth of other vegetation was affected by *U. gallii* invasion only in Subplot 5 where a reduction in its DM production was recorded (Table 3).

Table 3: Extrapolated dry matter weights of vegetation (including litter) and estimated nitrogen contents of vegetation, roots and soil cores in experimental subplots

Subplot No.	Vegetation			Estimated N Content (kg ha^{-1})				
	Type	% N DM	t DM ha^{-1}	Surface Vegetation	Roots	Total Vegetation	Soil	Soil+ Vegetation
1	*Ulex*	1.31	2.4	32				
	Other	0.83	13.3	110				
	Total		15.7	142	78	220	2325	2545
2	*Ulex*	1.14	4.9	55				
	Other	0.69	13.7	94				
	Total		18.6	149	121	271	1942	2213
3	*Ulex*	1.27	6.3	81				
	Other	0.89	12.9	115				
	Total		19.2	196	74	269	2037	2306
4	*Ulex*	1.13	9.5	107				
	Other	0.98	13.4	131				
	Total		22.9	238	118	356	2274	2630
5	*Ulex*	1.33	19.9	264				
	Other	1.08	9.9	107				
	Total		29.8	371	124	495	2588	3085

Table 4: Some properties of litter materials and soils for incubation experiments

	Litter Material			Soil	
	*Ulex*1/	Senescent *Ulex*1	Non-*Ulex*2/	High *Ulex*1/	Low *Ulex*2/
Total–N (%)	1.69	1.48	0.82	0.42	0.3
Organic–C (%)	51	52	ND	9.6	8.6
C:N	30	35	ND	23	29
pH	5.6	5.7	4.9	4.1	4.1
Extr. P (ppm)	—	—	—	11.7	2.8

1/, 2/: estimated *U. gallii* cover: 14,325 and 5kg DM ha^{-1}, resp.
ND: Not determined.
–: Not detectable.

There was little pattern apparent in the fluctuations in nitrogen concentration in the *U. gallii* vegetation (1.31% to 1.33% DM) across the subplots (Table 3). The nitrogen concentration in the other vegetation, however, tended to increase progressively with increasing legume cover, i.e. from 0.83% to 1.08% DM. Although the number of data points are rather few for meaningful statistical analysis, it is interesting to note that the correlation coefficient found between the weight of *U. gallii*/subplot and the nitrogen concentration of the other vegetation was $r=0.83$, which is quite strong albeit non-significant.

The data in Table 3 also show that increases recorded in *U. gallii* cover between Subplot 1, in which the legume comprised 15% of the vegetation DM weight, and Subplot 5, which contained 67% *Ulex* by weight, were associated with progressive increases in the nitrogen contents of the total (*Ulex* plus non-*Ulex*) vegetation (including roots) from 220 to 495kg N ha^{-1}, respectively. Bearing in mind the small number of data points, the correlation found between the weight of *Ulex* and total vegetation nitrogen proved highly significant ($r=0.99$, $p<0.05$).

The nitrogen contents of the soil and the soil plus total vegetation also tended to increase with increasing *Ulex* cover (Table 3). These relationships, however, were also non-significant viz. $r=0.72$ and 0.86, respectively. A number of factors possibly weakened these relationships. Real effects of *Ulex* on nitrogen content of the soil during the comparatively short timespan since invasion of the site by the legume (5 years) were difficult to detect against a large background of $\geq$2,000kg soil N ha^{-1} (Table 3). Furthermore, the soil nitrogen contents (kg ha^{-1}) were calculated from nitrogen concentration (% o.d. soil) and soil bulk density values. The wide range of soil bulk densities encountered (Table 2) probably reflected, at least in part, the large variations in soil organic matter content at this site (Table 2) caused by previous removal of peaty layers.

Incubation Studies

Selected properties of the litters and soils used in the incubation studies are listed in Table 4. The results (Fig 2) indicate similar patterns of CO_2 evolution in the two litter materials. Weekly rates of CO_2 evolution from *Ulex* litter, however, significantly ($p<0.01$; $p<0.001$) exceeded those from non-*Ulex* litter at each sampling period, except week 12 (data not shown). After 91 days, cumulative CO_2 evolution amounted to 90 and 77mg CO_2–C g^{-1} organic–C from these materials, respectively (Fig 2).

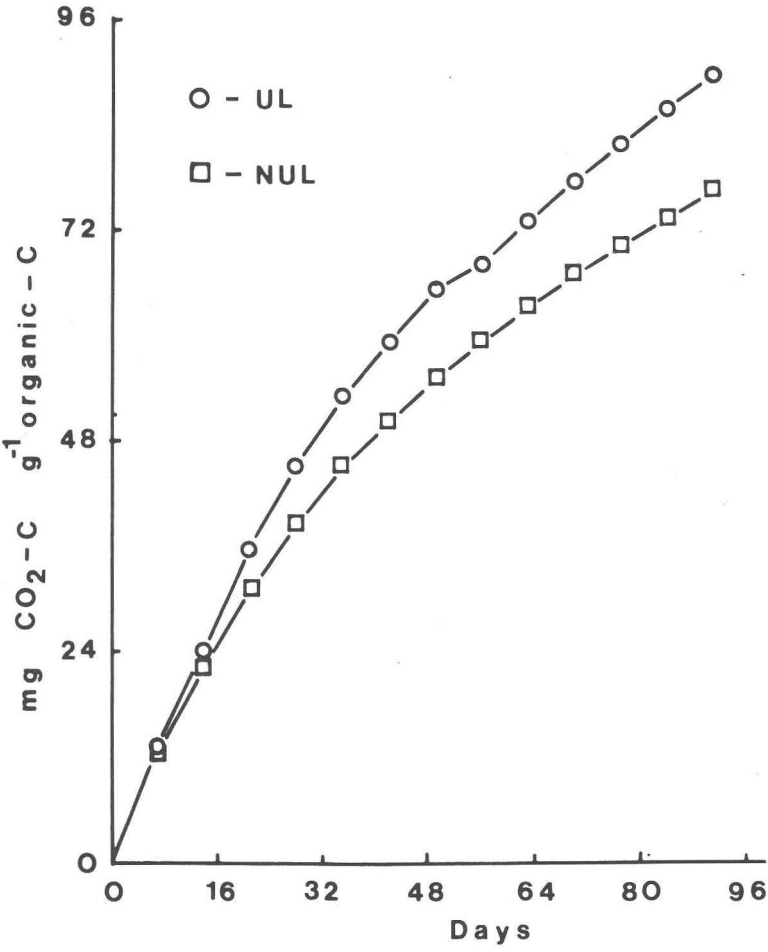


Fig 2 Cumulative evolution of CO_2 (mg C g^{-1} organic C) from *U. gallii* (UL) and non-*Ulex* (NUL) litter during incubation (means of 4 replicates)

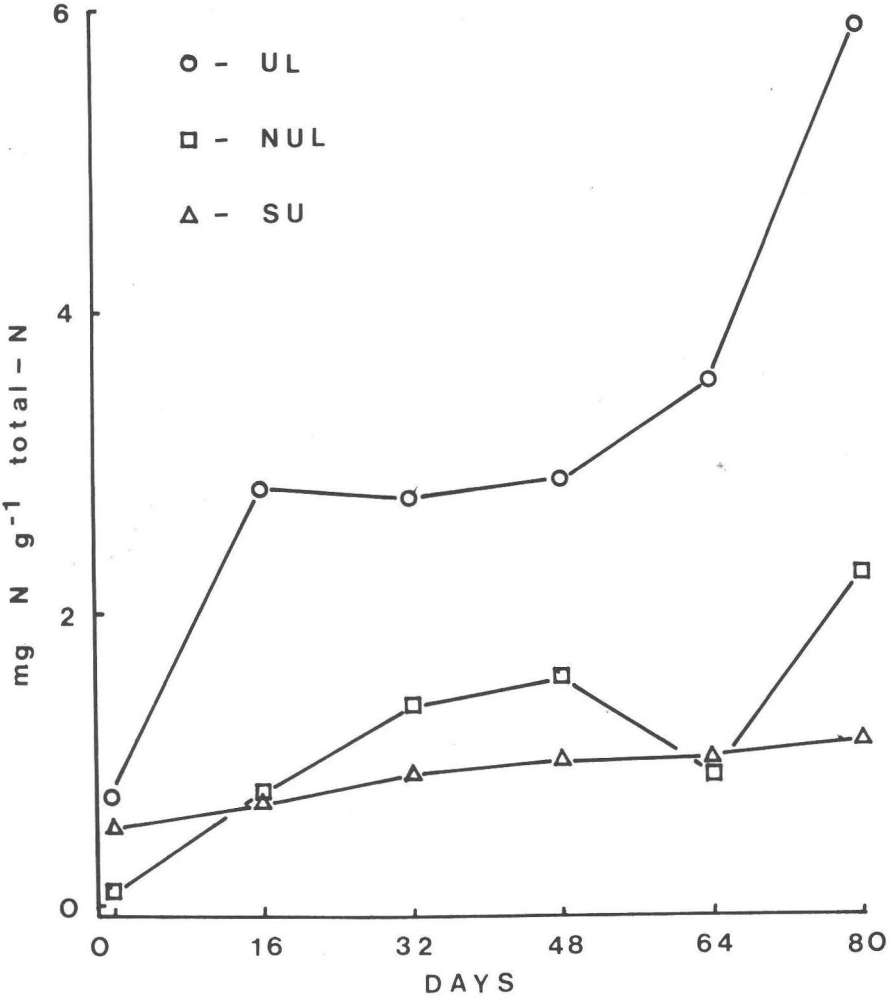


Fig 3 Mineralisation of nitrogen (mg $NH_4^+ + NO_3^-$–N g^{-1} total –N) by *Ulex* (UL) and senescent *Ulex* (SU) litter and by non-*Ulex* litter (NUL) (means of 4 replicates).

Although there was a lengthy delay prior to onset of active nitrogen mineralisation in the *Ulex* litter (UL; Fig 3), this material released significantly ($p < 0.001$) more mineral-nitrogen during 80 days incubation than either senescent *Ulex* (SU) or non-*Ulex* (NUL) litter. Cumulative mineralisation of nitrogen in these materials was 5.9, 1.2 and 2.3mg Ng^{-1} total–N, respectively (Fig 3). Ammonium –N comprised >90% of the nitrogen released by each material. The increase in the rate of mineralisation in *Ulex* litter after 48-64 days was confirmed in a further 112 day incubation in which 17.2mg Ng^{-1} total –N were mineralised under otherwise identical conditions.

In contrast to the litter samples, similar patterns, rates and quantities of CO_2 emission were observed from the "high-*Ulex*" (HUS) and "low-*Ulex*" (LUS) soils. Although significant differences between weekly CO_2 evolution rates were detected between the two soils at some sampling times, the actual differences were small and were not consistent throughout the incubation. Cumulative CO_2 production was 27.2 and 23.2mg CO_2–Cg^{-1} organic–C from the "high" and "low" *Ulex* soils, respectively.

The patterns and quantities of nitrogen mineralisation from these soils, however, differed markedly (Fig 4). Release of soil nitrogen commenced without delay in the "high-*Ulex*" (HUS) soil and increased significantly ($p < 0.001$) up to c. 96 days of incubation. In contrast, nitrogen mineralisation rates in the "low-*Ulex*" soil (LUS) remained very low throughout incubation and were very much ($p < 0.001$) inferior to rates in the "high-*Ulex*" soil (Fig 4). Cumulative mineral-nitrogen production after 112 days incubation comprised 3.3% of total–N in the "high-*Ulex*" soil compared to only 0.4% in the "low-*Ulex*" soil ($p < 0.001$). Again, little nitrate–N was produced in either soil.

Discussion

The results (Table 3) provide good presumptive evidence that the presence of *U. gallii* can substantially increase the nitrogen content of an ecosystem and improve site fertility through enhanced nitrogen availability. All *Ulex* plants excavated were nodulated, although quantitative studies were not undertaken. Other nitrogen-fixing plants were not present and non-biological inputs of atmospheric nitrogen at this site should be minimal, i.e. $< 5kg\ ha^{-1}\ yr^{-1}$ (Matthews and McCaffrey, 1977). Progressive increases in *U. gallii* cover were strongly, albeit not significantly ($r = 0.83$), associated with enhanced nitrogen concentrations in the other vegetation. Hence, it is reasonable to infer that the observed accumulation of nitrogen in this ecosystem resulted from the nitrogen-fixing activities of the legume.

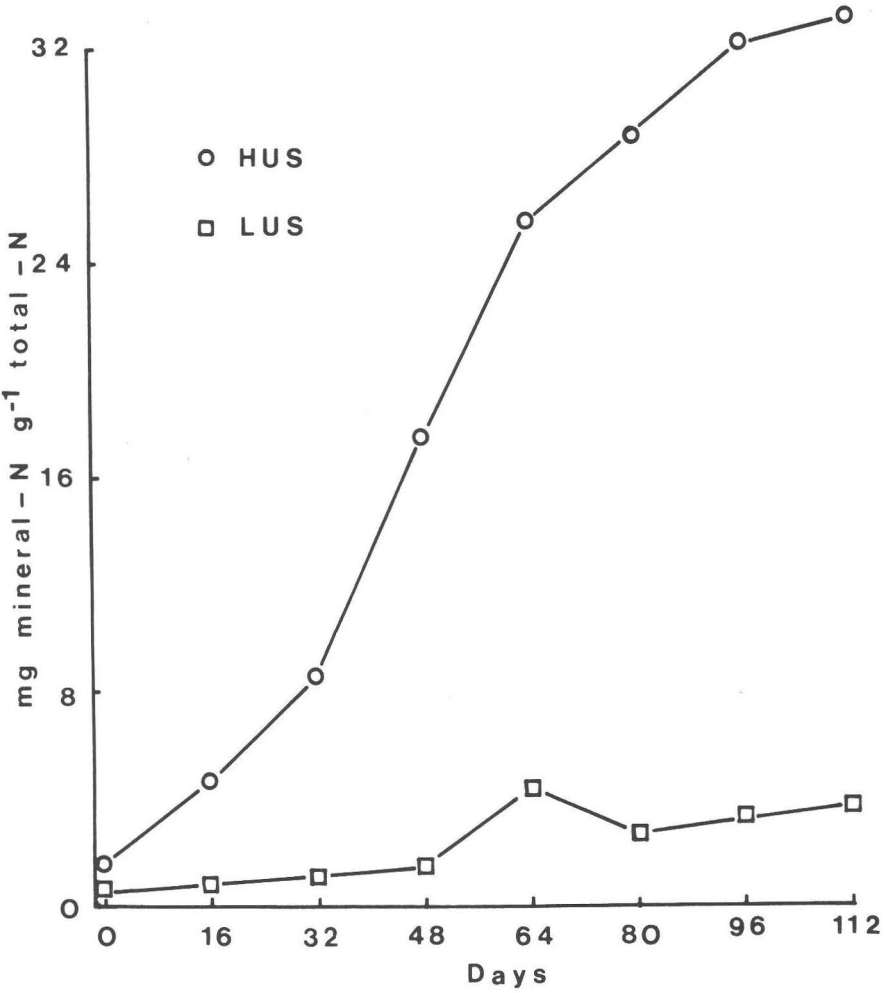


Fig 4 Nitrogen mineralisation (mg $NH_4^+ + NO_3^-$–N g^{-1} total –N) in soil dominated by *U. gallii* (HUS) or other (LUS) vegetation (means of 4 replicates).

The alternative hypothesis that invasion of the site by *U. gallii* occurred in response to higher levels and/or availability of soil nitrogen appears less tenable. *U. gallii* is a hardy legume, adapted to infertile conditions, and possesses the considerable ecological advantage of the ability to utilise atmospheric nitrogen and thus be independent of soil supplies for its growth and site colonisation, especially where phosphate is not limiting.

Accumulation of nitrogen associated with *U. gallii* growth (Table 5) was calculated on the assumption that the increases in the nitrogen contents of the *U. gallii* plus non-*Ulex* vegetation and soil recorded between the subplots with highest (subplot 5) and lowest *Ulex* cover (subplot 1) represent accumulation of nitrogen by the legume. On this basis, 540kg N ha^{-1} were accumulated in soil plus vegetation (Table 5). Of this extra nitrogen, roughly 50% (263kg N ha^{-1}) was found in the soil and 50% (275kg N ha^{-1}) in the vegetation (including roots), while the estimated nitrogen accumulation in *U. gallii* shrubs was 232kg N ha^{-1} (Table 5). These estimates may be compared to observations on *U. europaeus* growing on Cornish clay wastes reported by Dancer *et al.* (1977), although it should be noted that these wastes were extremely deficient in nitrogen (approx. 450kg N ha^{-1}).

The accumulation of 275kg N ha^{-1} in total above ground vegetation (Table 5) represents a maximum rate of nitrogen accumulation of 55kg N ha^{-1} yr^{-1} since clearfelling. This estimate compares favourably with nitrogen fixation rates of 26kg N ha^{-1} yr^{-1} estimated from field-conducted acetylene (C_2H_2)–reduction assays of 1-3 year old *U. europaeus* growing on china clay wastes (Skeffington and Bradshaw, 1980). Reported rates of nitrogen fixation by other legumes and non-legumes, however, are considerably greater e.g. 185kg N ha^{-1} yr^{-1} by *Lupinus arboreus* on china clay wastes (Palaniappan *et al.*, 1979).

Whether an accumulation rate of 55kg N ha^{-1} yr^{-1} is sufficient to meet the requirements of Sitka spruce plantations growing on impoverished ORS soils is uncertain. Unfortunately, little information is available on the nitrogen requirements of Sitka spruce during the early stages of the rotation. However, recent data for a 7 year old stand of Sitka spruce growing on mineral soil suggests a requirement as low as 7kg ha^{-1} yr^{-1} at this stage of crop development under Irish conditions (Carey *et al.*, in press).

The present results also indicate a considerably greater availability of the nitrogen stored in litter and soil in sites dominated by *U. gallii* compared to the sites dominated by heath vegetation (Figs 3 and 4). However, the nitrogen mineralisation patterns observed imply a delayed transfer of *Ulex* nitrogen to associated

Table 5: Calculated quantities of nitrogen accumulated in components of the ecosystem at Kilworth Forest

Component	kg N ha^{-1}
Vegetation+Soil	540
Soil	263
Vegetation (including roots)	275
U. gallii	232
Other vegetation	–3
Roots	46

Data calculated from results in Table 3.

trees. Such a delay in nitrogen release might be anticipated in view of he rather wide C:N ratios (30 and 35:1; Table 4) and woody nature of the *Ulex* litter materials (Alexander, 1977). Similar nitrogen release patterns have been reported previously for woody legumes. Active nitrogen transfer from tree lupin (*L. arboreus*) commenced only after four years growth on china clay wastes (Palaniappan *et al.*, 1979).Conservation of accumulated nitrogen in *Ulex* vegetation and litter and in underlying soil and its subsequent release predominantly in the NH_4^+–N form at rates to meet tree requirements, however, would confer considerable silvicultural advantages by minimising losses of nitrogen from the system.

Exploitation of *U. gallii* as a forest nurse crop presents a number of problems, not least of which is the fact that it is regarded as an unwelcome weed by forest managers. A more fundamental problem is the paucity of information concerning the soil factors which govern the shrub's widespread but unpredictable distribution on the ORS soils. It is clear, however, that phosphate plays a major role and growth of both *Ulex* species at Kilworth Forest (and other sites) is virtually confined to phosphate-fertilised plots. The effects of phosphate, and indeed of a number of trace elements (e.g. Co, B, Mo), on *Ulex* growth, rhizobial activity, effective nodulation and nitrogen fixation in these soils is entirely unknown. Nevertheless, *U. gallii* offers a number of advantages. In contrast to its sister gorse species, broom or some alders, it is less likely to suppress tree growth and, consequently, should not require periodic removal. A primary advantage of *U. gallii* is its natural occurrence on many

nitrogen deficient soils in the south of Ireland. Successful understanding and exploitation of its natural distribution could be of considerable advantage to forestry on these soils.

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Driven Woodcock Shoots at Cong

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INTRODUCTION

The old traditionalists boast of the prized "Driven Woodcock Shoots" at Cong Forest and it is now pretty well accepted that it is the only one of any significance in Europe. The driven woodcock shoot is classed as the most sporting of all shoots. The Cong shoots, usually of six days duration, in early December and late January, have always been regarded as sporting, social and calendar events. Apart from their undoubted sporting aspect, their social side has always been important in the life of the poorer community of the area. In the late twenties, the thirties, forties and even fifties, local families depended on the December shoot for that 'something' for the Christmas dinner table. The January outing was relied upon for the provision of a pair of shoes or possibly for an item of badly needed clothing. The shoots were definite calendar dates in the area and one still hears of 'such and such' a thing happening "before the first shoot" or "just after the January shoot".

THE ORGANISATION OF A WOODCOCK DRIVE

For those not conversant with a driven woodcock shoot, it literally means what it says. "Driven", because the birds are flushed and driven towards the guns on the right and left of the "beat" (Fig 1). A beat can vary in width from 100m to 200m and can be anything from 500m to 1000m in length. The beat is flanked on all sides by shooting paths and is worked to obtain the longest "drive". The personnel associated with a shoot are as follows: Guns (usually seven), Gamekeeper, Head Beater, Beaters (not less then twelve), Pickers (at least two), Loaders (one with each gun) and Dogmen (not less than three). The guns are positioned on the shooting paths, usually four on the right and three on the left. Each gun is numbered according to his allocated position with gun numbers one, two, three and four always on the right of the beat. (Fig 1). Positions are allocated by draw. To eliminate any advantage, the position of each gun changes, usually downward (seven to six, six to five, etc.) after the completion of each beat. Gun numbers one and seven start

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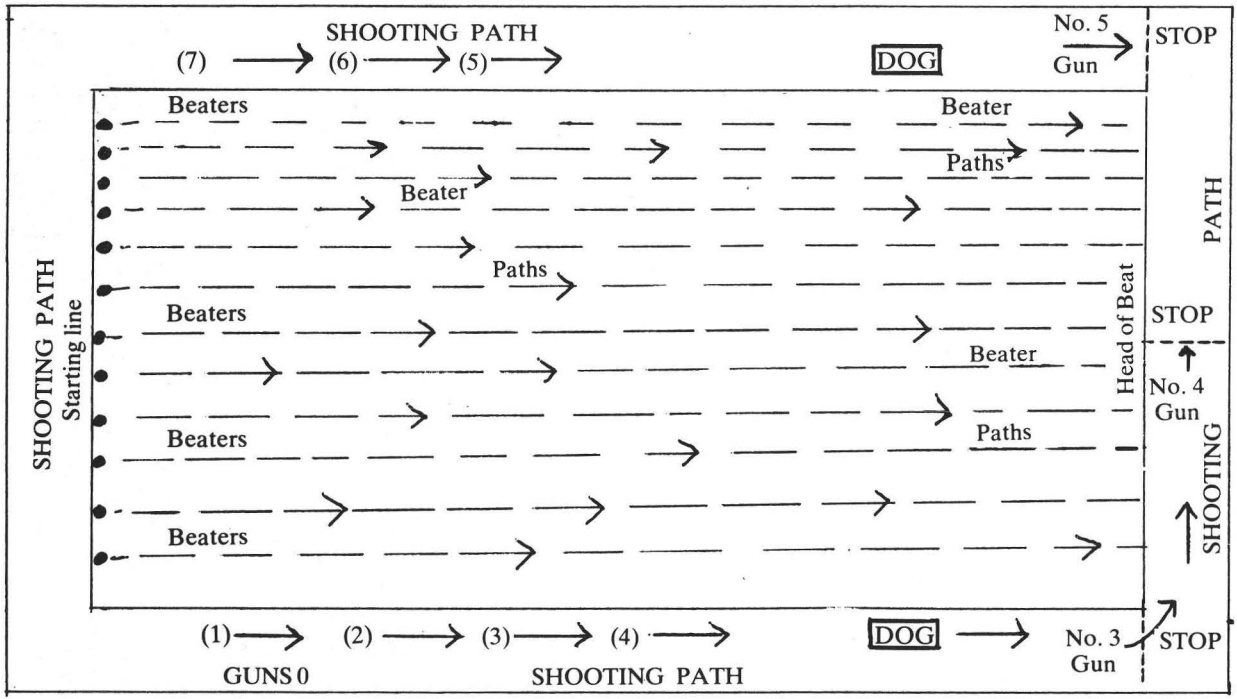

Fig. 1. Sketch of Beat.

roughly 25m from the beginning of the beat with the next gun 100m further on. Guns generally respect their distances from one another and to do this it is imperative that they keep pace with the beaters. Safety precautions are always a foremost consideration. Firing low is strictly forbidden. A bird must be clear of the beat before being shot. A loader handing an unbroken loaded gun to any person can expect instant dismissal. These safety precautions have paid dividends over the years, with only one minor accident in eighty years.

At the beginning of a beat, all the beaters are lined up across the starting line and the gamekeeper gives the starting signal. The head-beater leads his beaters along the beater paths, making as much noise as possible. The distance between beaters is normally 20m, though closer spacing is sometimes desirable. On flushing a bird, the beaters scan its direction of flight and shout to the gun nearest its line of flight. If the gun is successful, the gamekeeper may signal a halt to allow the bird to be retrived. When the woodcock is bagged, the signal to restart is given. This process is repeated as often as necessary to the end of the beat. The picker is expected to be blessed with almost uncanny perception, as he has to anticipate where the downed bird will fall. This is referred to as "marking a bird". Injured birds must be picked and dealt with as speedily as possible. The picker is also responsible for keeping an account of the number of birds shot by each gun. The dead birds are carried along the beat in a gamestick. (Plate 1).

Plate 1. The "Bag" on "Gamesticks".

The role of the gamekeeper is that of Director of Field Operations and he is also responsible for cleaning and oiling the guns after each day's shooting. He is the powerhouse of any shoot and his knowledge of the birds' haunts, local geography and terrain is of paramount importance for the success of any shoot. The present gamekeeper at Cong, seconded by the Forest and Wildlife Service since 1974, compares favourably with the best of his predecessors.

The Evolution of Driven Shoots at Cong

Lord Ardilaun, who owned Ashford Castle Estate from 1868 until his death in 1915, planted big areas with trees after acquiring the Estate. One of the objectives was to provide shelter for game. Towards the end of the century, this strategy began to pay dividends and these coverts, together with the natural growth of hazel, began to attract big numbers of gamebirds, particularly woodcock. At the turn of the century, the continuous influx of woodcock prompted thoughts of exploiting the situation and the idea of a driven woodcock shoot was conceived. The inaugural shoot was tentatively fixed for the year 1905. Lord Ardilaun considered the shoot such a momentous undertaking that he invited the Prince of Wales to participate and the first shoot actually took place on the 25th January, 1905. Six guns shot with the Prince. The shoot lasted for five days and a bag of 462 woodcock was returned. Shoots were then organised annually until 1910. The shoot was then allowed to lapse, due perhaps to the age or the failing health of Lord Ardilaun. The records indicate that the shoot was next held in 1917, when The Honourable A. E. Guinness took over the Estate. The four days shoot in late February, 1917, returned a bag of 390 woodcock for seven guns. Shoots were also held in 1918 and 1919 with bags of 182 and 203 respectively. However, the record books are blank for the period 1920 to 1927 and it is unlikely that shooting took place. This may have been due to unrest in the country. The shoot restarted in all its former splendour in 1928, with an eight day show for seven guns and a bag of 636 birds.

With the exception of the years 1935 and 1936, shoots were then held annually until 1938 under the direction of The Honourable A. E. Guinness. The 1930 shoot was noteworthy because Lord Oranmore and Browne participated for the first time and he was to remain associated with the shoot, in one capacity or another, for the next fifty years. During the 1938 shoot the beaters withdrew their labour on a number of occasions thus disrupting the shoot. This and other difficulties so irked The Honourable A. E. Guinness that he decided to sell the Estate and the Forestry Division took over as the new owners in 1939.

In their first year of ownership the Forestry Division offered to let the sporting rights on a ten year lease. Lord Oranmore and Browne, together with the Marquis of Sligo, submitted a joint tender and their offer was accepted. At this time the fine stands of commercial timber on the Estate and the fine arboretum were showing evidence that good forestry and good shooting were not incompatible. Further evidence for this can be seen in the excellent bags returned for the shoot over the past 75 years. (Table 1). It is worth mentioning that on the 31st January, 1910, a British and Irish record for one day's shooting for seven guns was established at Cong, with a bag of 236 birds.

Table 1 Shoot returns at Cong for selected years during the period 1905-1983.

Year	Duration of Shoot (Days)	No. of Guns	Bag	No. of Birds Flushed
1905	5	7	462	—
1906	6	7	280	—
1907	6	7	393	—
1908	6	7	434	—
1909	6	7	454	—
1910	6	7	571	—
1917	4	7	390	—
1918	4	7	182	—
1919	4	7	203	—
1928	8	7	636	—
1929	11	7	752	—
1930	11	7	569	—
1931	14	7	656	—
1932	13	7	522	—
1933	9	7	354	—
1934	10	7	509	—
1937	9	7	722	—
1938	7	7	526	—
1940	7	7	400	—
1941	6	7	326	—
1951	10	7	485	—
1961	5	6	88	—
1971	6	8	104	—
1974	6 (Dec. only)	7	48	243
1975	12	7	129	392
1976	6	7	81	345
1977	12	7	118	424
1978	12	7	79	406
1979	9	7	106	427
1980	11	7	168	699
1981	13	7	251	902
1982	12	7	187	708
1983	6 (Jan. only)	7	80	332

Woodcock Habitat

In 1940 Lord Oranmore and Browne and the Marquis of Sligo held their first shoot. It lasted seven days and the bag was 400 birds. On this occasion many more woodcock were sighted, but again the beaters withdrew their labour three times, thus causing a number of problems. After this time Lord Oranmore and Browne is of the opinion that bags generally got smaller due to the lack of maintenance of beater and shooting paths. However, it may be significant that about this time the Forest and Wildlife Service was embarking on an extensive afforestation programme in the northwest and the author believes that the new forests may have provided suitable stopping-off places for the incoming woodcock. Alternatively, the creation of an increasing area of suitable habitat may have led to the dispersal of the birds.

Prime habitat is of course vital in maintaining woodcock numbers and experience at Cong suggests that these birds although classed as waders, are happiest, and constantly frequent small heights under unthinned Sitka spruce, Norway spruce, Douglas fir, Grand fir and Western Hemlock. Observation over many years leads to the conclusion that when these species close canopy to provide good, dry ground cover, woodcock flock into them. The sheltered sunny sides of such coverts appear to provide prime habitat. Bag returns from these areas confirm this observation. The numbers of birds inhabiting such stands decreases when they are thinned and the pattern of appreciation wanes further with the normal development of the plantation. Experience at Cong also suggests that the majority of woodcock do not go in their nocturnal sojourns to stand on their heads in some marshy feeding grounds, but feed day and night in their selected haunts. The extensive borings (presumably for food) carried out by these birds in their normal habitat provides some evidence for this conclusion. The woodcock's number one enemy at Cong forest is the Pine Marten. Although the cock has excellent camouflage and all-round binocular vision, it still falls victim to this protected "predator".

Recent Developments

In an effort to make the shoot more amenable and to enhance its attractiveness, the Forest and Wildlife Service began in 1969 to widen ride-lines cum shooting paths to 10 metres. Thus a strip five thousand metres in length was widened by bulldozer in 1969, 4000m was treated in 1970 and a further 2000m of path was widened in 1971. This widening is carried out in conjunction with normal thinning operations in so far as possible by removing lines of trees. In addition, beater paths are maintained annually to keep the event mobile. These measures have ensured that woodcock shooting at Cong has retained its attractiveness for the usual continental clientele. Long may it last.

Measuring Values in Recreation: Six Different Approaches

Wm. MURPHY and J. J. GARDINER

Department of Forestry, University College, Dublin.

INTRODUCTION

The increase in demand for outdoor recreational resources is increasing the pressures on the landbase which is already under heavy demand from agriculture, urban development, industry, transport and even forestry. In Ireland, recreation has the greatest impact on the urban fringe where the conflicting demands are also greatest. Recreation must be able to compete with other uses if it is to be regarded as a legitimate land use. It is also important in an era of financial constraint that investment should not continue on the vague notion that it is "a good thing" especially where no demand exists. It is, however, essential that recreation should not suffer because of financial constraint when the demand is very likely to increase in the future due to changing patterns in society.

The recreation land manager and those responsible for resource allocation, both financial and natural, must be able to examine proposed recreation projects using cost benefit approaches. There are two separate aspects to benefit calculation. Recreation managers must be able to estimate the level of demand or consumption, which should be measured in visitor days as opposed to visits, and the willingness of users to pay for the service. This paper deals with the techniques which are available to measure user's willingness to pay for recreation services.

Many people question the feasibility of placing a value on an experience as personal as an afternoon spent in the forest or a day spent hiking in the hills. However, Knetsch and Davis (1967) stated that "outdoor recreation facilities differ only in kind, but not in principle, from other goods and services".

As with other goods and services, Clawson and Knetsch (1966) suggested that recreation values "are reflected . . . by what people are willing to give up to obtain them". Therefore, by measuring what people are willing to give up in order to enjoy recreation, whether it be travel costs or payments or any other measure, the value of the activity itself can be measured.

IRISH FORESTRY, 1984, Vol. 41, No. 1: 36-44.

Benefit Measurement Techniques

Six methods were field tested during this study. Some of the methods, for example the travel cost methods, have a common basis, but all interpret the date in a different way. The six methods studies are outlined below.

Method I — The Cost Approach

One of the earliest methods for measuring recreation benefits was that of the U.S. National Park Service which proposed that benefits would equal twice the costs. This method proposed that primary benefits, i.e. benefits to the users, equally costs, while secondary benefits, i.e. benefits to the local community, equalled primary benefits (Trice and Wood 1958). However, in the present study secondary benefits were not included since there was no benefit accruing to the local community.

Methods II and III

Travel costs, i.e. the cost of travel to the recreation area, are important and are widely used in methods of visitor benefit calculation. Travel costs were first proposed by Prof. Harold Hotelling in a submission to the National Park Service in 1947 (Prewitt 1949). Hotelling's approach proposed that those travelling the greatest distance to a recreation area set the price for that area. Therefore, those travelling from a nearer zone made a saving (the consumer surplus) which was a measure of the benefit accruing to them. Those travelling from Zone C (Fig 1) pay $3.00 while those travelling from Zone A only pay $1.00 and therefore make a saving of $2.00 per trip. However, from Hotelling's basic model two different interpretations have resulted, the first proposed by Trice and Wood (1958) and the second proposed by Clawson (1959).

Method II — The Trice and Wood Method

These latter workers followed closely Hotelling's approach. However, they used the average consumer surplus per visit which they calculated by subtracting the average cost per visit from the cost at the 90 per cent level of attendance. This eliminated those who travelled from extremely long distances. For example in Fig 2 the average cost would be 1.8 units while the cost at the 90 per cent level is 5.8 units. This gives an average consumer surplus of four units.

Method III — Clawson's Approach

Clawson (1959) developed the consumer surplus to its present and most widely used form. The method developed by this worker

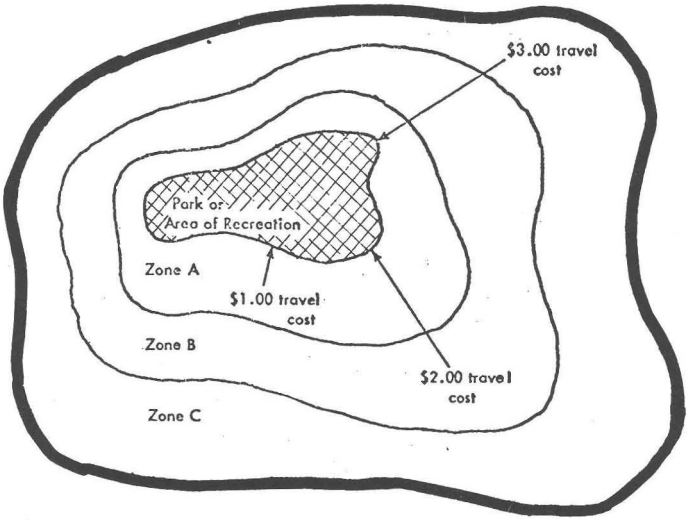

Fig 1 A representation of Prof. Harold Hotelling's Concentric Travel Cost Zones around a hypothetical recreation area. (After Trice and Wood 1958).

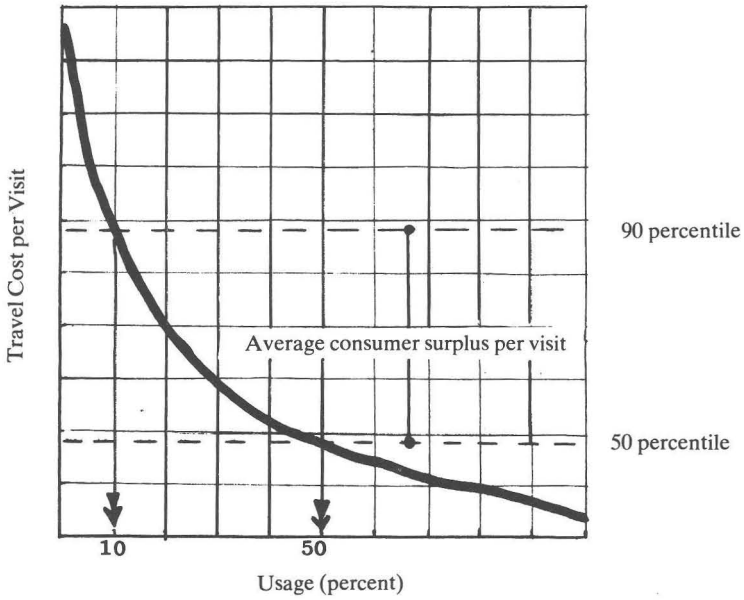

Fig 2 Calculating the consumer surplus using the model proposed by Hotelling and adapted by Trice and Wood (1958).

involved the construction of a demand curve for the recreational experience. Clawson defined distance zones and collected data on the number of visitors from each zone. He then simulated a demand curve for the recreational facility. The actual responses to travel costs, (in visits per head of population), were used to simulate hypothetical increases in entrance fees. Clawson proposed that the area under this derived demand curve (Fig 3) was therefore a measure of the total consumer surplus for the area.

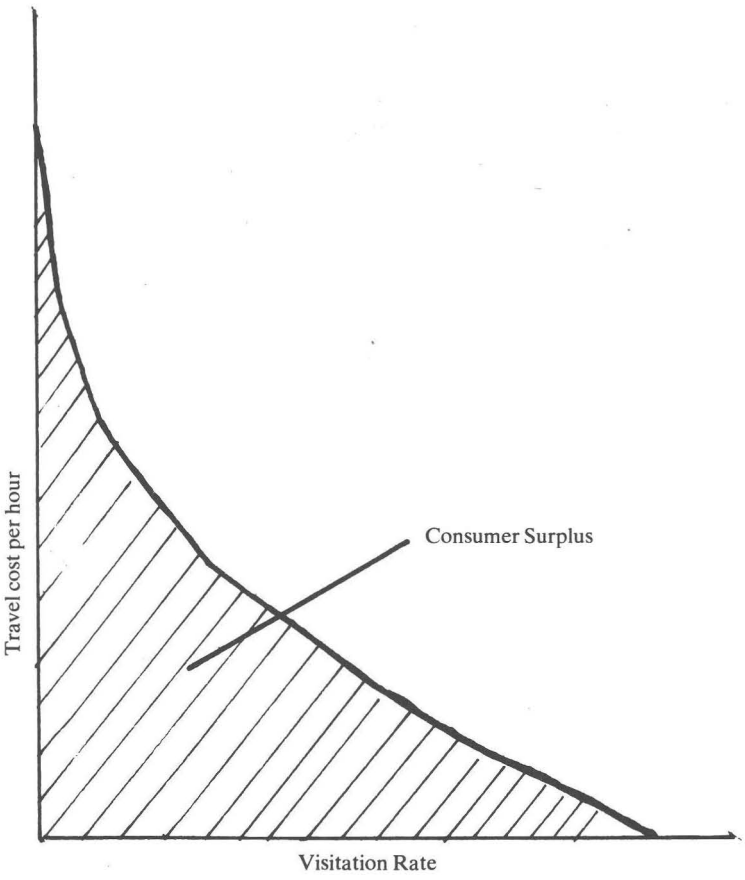

Fig 3 Hypothetical demand curve using Clawson's method of consumer surplus simulation. (After Clawson 1959).

Methods IV, V and VI

The second group of methods involved direct questioning of the visitors to infer willingness to pay.

Method IV — Cost-Less Choice Method

Romm (1969) suggested the use of the cost-less choice method. Respondents were asked to choose between the service under investigation and products and services of a known value. The known products were arranged in order of decreasing value (Table 1). If the respondents chose the alternative 'A', (for example Clean Air), in all cases, as in Col. 3 then the value of one year's clean air would be $1,900. If the response was similar to Col. 4 then clean air has no value. Inconsistent responses, such as those in Col. 5 cannot be interpreted however.

Table 1 Possible responses using cost-less choice method.

(1)	(2)	(3)	(4)	(5)
Alternatives	Cost	Possible Responses		
New Family Car	1900	< A	> A	> A
New Swimming Pool	1600	< A	> A	> A
Family Holiday	1000	< A	> A	< A
New Furniture	850	< A	> A	> A
New Television	650	< A	> A	> A

Method V — Willingness to Pay

This method made use of Bohm's suggestion (1971, 1972) to overcome bias. Two questions were used. One elicited the upper limit of payment, while the second elicited the lower limit of payment. The true value was said to lie mid way between the responses.

Method VI — Willingness to Travel

The willingness to pay method might fail because of the free nature of recreation in Ireland. Murphy and Gardiner (1983) found that some respondents were unwilling to indicate willingness to pay when questioned. Therefore a willingness to travel question elicited information on the respondents' willingness to travel which was used as a surrogate price or payment. The time allowed for extra travel was also requested and this was used to check responses by simple correlation of indicated travel time and travel distance. It was felt that respondents were unlikely to cheat on both.

Field Tests

Shankill Wood, a small, frequently used recreation area, seven miles south west of Dun Laoghaire, was chosen as the location to field test the various methods. The area is surrounded by private land which is not suitable for recreation and which made it ideal for this study since there were no competing attractions adjacent to the area. Therefore, values could be attributed to the area solely.

A questionnaire was used to collect data (Appendix A) on randomly selected days from July 4th to September 11th, 1983. A personal interview method was used as this method maximised response (Shafer and Hamilton 1967).

Data from the questionnaires provided the basic information for all the methods with the exception of the cost approach. In the case of the cost approach costs were obtained from the Forest and Wildlife Service. These included annual site management and maintenance, lost timber production and site construction calculated as an annual payment. These costs were transformed to give a value for the period July to September. The number of visitor hours 'consumed' during the period was also estimated using the model proposed by Schreuder *et al* (1981). The total cost for the period divided by the total number of recreation hours 'consumed' gave the value per recreation hour.

All the evaluation methods employed in this study attempted to measure the same value, that of one hour of forest recreation. In order to examine the various methods' ability to give accurate and consistent estimates of this value, the approach adopted by Beardsley (1970) was used. Beardsley suggested that where clustering of values occurred, it gave increased confidence in the ability of the methods to give accurate estimates. Therefore, where two or more values were similar, they were assumed to be the most accurate.

Results

The value of a recreation hour at Shankill Wood determined by the six methods are listed in Table 2 for comparison. The values range from £0.061 to £0.93 per hour. Two sets of values cluster around the same point. Clawson's method and the cost method, with values of £0.075 and £0.061 respectively, and the Projected Travel Cost and Willingness to Pay methods, with values of £0.179 and £0.149 clustered around two points. This would indicate that the time value of the recreation hour lies in the lower values as opposed to the values indicated by the two remaining methods.

Table 2 The value of a recreation hour determined at Shankill Wood.

Method	Value (IR£)
Cost Method	0.061
Clawson's Method	0.075
Trice and Wood's Method	0.330
Projected Travel Cost Method	0.179
Willingness to Pay Method	0.149
Cost-Less Choice Method	0.930

Discussion

A number of methods have been developed for the evaluation of recreation values. Six of these were field tested in this project. It was found that a number of them suffer from defects which render them of limited value. The costless choice method, for example, failed in field use for two reasons. Firstly, the users were probably biased towards forest recreation when answering the questions because they were acutally involved in recreation at that time. In addition, the list of alternatives may not have been activities which all respondents would have undertaken. Similarly the recreational value obtained by the cost method is highly suspect since total revenue remains the same irrespective of the number of users. This is at variance with normal economic theory. Clawson's method also seems to have underestimated the true value of a recreation hour at Shankill Wood. This has been found to happen in other field tests where the recreation area is not the only attraction in the area (Grayson et al, 1972).

The method of Trice and Wood has also been found in previous studies to overestimate recreational values, since the value is set by the visitors who travel the greatest distance. These visitors probably set a higher subjective valuation on the recreational facility. In this study the methods which infer willingness to pay through questioning appeared to be most correct. The fact that these values are close supports this reasoning. The correlation between indicated travel time and travel distance (+0.723) increases the confidence in the results.

Thus it appears that these latter methods of recreational evaluation can be modified to give valid results under Irish conditions. Ideally, both methods should be used in any one situation so that they can validate one another. In view of the

emphasis placed upon cost-benefit evaluation of recreational investment by the National Planning Board (Anon, 1984) it appears reasonable that these methods should now be tested on a wider scale in the country.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. J. Mannion, Dept. of Agriculrural Extension, U.C.D., for his aid in the preparation of the questionnaire and to the staff of the Forest and Wildlife Service, notably Mr. P. McCusker, Mr. D. O'Brien and Mr. M. Duggan for providing both facilities and information to aid this study. The authors also wish to thank the Forest and Wildlife Service for permission to use Shankill Wood.

APPENDIX A

QUESTIONNAIRE

Date: ..... Time: ..... Weather: .....
Interviewee Details: .....
Length of Stay: ..... Occupation: .....

1. Origin of Visitor: .... Miles
2. Is this site your only destination on this visit? Yes ..... No .....
3. Mode of transport: Car ..... Bus ..... Bike ..... Foot ..... Motor Bike .....
4. No. in Groups: Adults ..... Children .....
5. Is Killiney Hill or any other forest nearer to you? Yes ..... No .....
6. How long did the journey from your home to here take? ..... Hours
7. If this area was further away would you still travel to it? Yes ..... No.....
8. If yes to 7, how much further would you travel?
   .....5 .....10 .....15 .....20 .....25 .....30 .....35 .....40 miles
9. What is the maximum time you would spend in travel to an amenity like this?
   .....¼ hr. .....½ hr. .....1 hr. .....1½ hrs. .....2 hrs.
10. In relation to each of the following which would you prefer to do? (Assume both cost the same).
    Visit Shankill Wood ..... or visit Zoo .....
    Visit Shankill Wood ..... or visit Musuem/other forest .....
    Visit Shankill Wood ..... or visit Cinema .....
    Visit Shankill Wood ..... or attend Football or Sports Match .....
    Visit Shankill Wood ..... or visit Seaside .....
    Visit Shankill Wood ..... or visit Powerscourt Waterfall .....
11. If a charge was introduced to cover some of the cost of upkeep would you still visit?
    Yes ..... No .....
12. If yes to 11, what is the maximum charge per person you would be willing to pay?
    .....10 .....20 .....30 .....40 .....50 .....75 .....£1
13. If an honesty box was in use how much would you feel obliged to pay per person?
    .....0 .....10 .....20 .....30 .....40 .....50 .....£1

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OBITUARY

Timothy McEvoy

(1917-1984)

First we heard of a heart attack. A few hours later the final news was brought. *What instruments we have agree/The day of his death was a dark cold day.* It was February 10th 1984.

Timothy McEvoy, usually referred to as "Mr. McEvoy" and by his friends as "Tim", was born in Urlingford, Co. Kilkenny, the son of a sea captain, on 24th March 1917. He attended the Chirstian Brothers' School in Tipperary until 1936, and University College, Dublin, from 1936 to 1942. He was awarded the degrees of B.Agr.Sc. (Forestry) with 1st class honours in all subjects in 1941, and of M.Agr.Sc. in 1943 for a dissertation on the Ecology of Native Woodlands, which was in itself a pioneering study. He was encouraged by his professors to proceed to a Ph.D. degree, but this did not happen.

He spent his practical year (1938-39) in Killavullen Forest (where he is still remembered: "always the boy for the books") and in Ballygar Forest, under the late Harry Silke. ("Why wouldn't he get on", said Harry, years afterwards, "didn't I train him!")

His first employment in the State Forest Service was as Foreman in Glendalough Forest in 1942. Subsequently he worked in Glenmalure, Avondale and Rathdrum Forests until, his appointment as Assistant District Inspector in Rathdrum in 1945.

Promotion to a Grade 2 post in Dublin came in 1949, where his task was to develop and set up the land acquisition system which still operates. He was promoted Grade 1 in 1950, Senior Inspector in 1964, Inspector General in 1966 and Chief Inspector in 1973. He retired in March 1982.

In the course of his career he was President of the Society of Irish Foresters in 1950-51 and 1954-55; Editor of *Irish Forestry* in 1946-49, and Business Editor in 1944-45. He was both Chairman and President of the Institute of Professional Civil Servants and he represented the Forest Service of the Republic of Ireland at World Forestry Congresses in Madrid, Buenos Aires and Jakarta. At the time of his retirement he gave the proceeds of a presentation collection by colleagues to the Society of Irish Foresters as the foundation of an educational awards fund for young foresters.

Tim McEvoy was above all a professional forester. He was involved quietly in the background in most of the important developments in Irish Forestry from the middle 1940s onwards. That was his way, and in line with the pattern of his life — effective without trying to be spectacular.

With colleagues and subordinates he listened a lot, and listened actively. He was quick to spot inaccuracies and inconsistencies. To answer his questioning was no easy exercise, but it was an intellectual challenge, never a personal affront. When he spoke his words were always informative or illuminating. In all aspects of the work which he controlled he insisted on, and therefore got, the highest possible standards.

Tim McEvoy was interested in and concerned about the human side of every individual. If at times he seemed to enquire very closely this was because of a deep concern for personal circumstances and he always took those into account where necessary. He was shrewdly aware of the motivation behind every action or intention, and would respond accordingly. To anyone with a technical, personal or any other kind of problem he was always available to listen and to give useful and helpful advice. He did not court easy popularity by trying to explain publicly the valid, often compelling reasons behind difficult and unpopular decisions.

He mixed freely on social occasions, and enjoyed good conversation and laughter. He was careful about his appearance which was always discreet but appropriate.

Many of his colleagues have known the hospitality of his house, and the welcome always extended by his wife, Maura, to whom, as his widow, our sympathy is offered.

The science and practice of forestry in Ireland, the forestry profession, and many people within it (including the present writer), are greatly in his debt.

Niall O'Carroll

Society Activities

COUNCIL REPORT 1983

Symposium

'The Role of Forestry in Land Use' was the theme of the 1983 Symposium held at Belfield on 15th April. Six papers were presented on the subject. The Symposium was as in previous years well attended.

Annual Study Tour

The Annual Study Tour was based in Arklow and visited areas in the south Wicklow and north Wexford region. A full account of what took place is in Irish Forestry Vol. 40, (2).

Meetings

A very successful field day was held in Co. Mayo on the future of Lodgepole pine. Unfortunately no evening meetings were held during the year but there are plans for at least two such meetings in 1984.

Guided Forest Walks

Walks were held at 22 centres on 11th September. Almost all leaders reported that attendances were higher than expected. The walks were organised this year through a Walks Committee, rather than a Walks Convenor.

The Society wishes to thank those who presented papers at the symposium, those who acted as Forest Walk Leaders, and those involved in Society committees. Thanks are also due to the Forest and Wildlife Service, Dublin and the Northern Ireland Forest Service for their help during the year.

Annual General Meeting

The A.G.M. was held at University College, Belfield on 14th April. The Minutes were published in Irish Forestry Vol. 40 (1).

Publications

Irish Forestry Vol. 40 (1 & 2) was published.

Examinations

Five candidates sat the 1983 Forester's Certificate Examination. One candidate achieved an Honours Mark, two passed with Distinction, and two others passed.

Henry Memorial Plot (Avondale)

A committee was formed to ensure that the Plot is well maintained. A report on the Plot will henceforth be included in each Annual Council Report.

Elections

Four posts of Technical Councillors and one post of Associate Councillor for the period 1984-86 were filled by election. As there was only one candidate for each of the officer posts these were filled without election. The total poll in the 1983 election was 231.

Membership

Number of members at 31st December, 1983.

Associate	*Student*	*Technical*	*Total*
109	40	490	639

New members elected in 1983.

9	5	15	29

Temporary lapsed members (now paid up to date).

1	—	11	12

Five members died during the year. Three members resigned from the Society.

Attendance at Council Meetings

5 Council Meetings were held during the year. Attendance at Council Meetings was as follows:

N. O'Carroll, E. Griffin, P. Raftery, J. O'Driscoll, J. Prior ..... 5 meetings.
J. Gardiner ..... 4 meetings.
M. O'Brien, J. Fennessy, C. Farmer, E. Hendrick,
E. P. Farrell, L. Furlong ..... 3 meetings.
P. Crowe, L. Quinn, P. Glennon ..... 0 meetings.

Signed: E. GRIFFIN,
Hon. Secretary.

March, 1984

MINUTES OF THE 42nd ANNUAL GENERAL MEETING HELD ON THURSDAY, 5th APRIL, 1984 IN THE AGRICULTURAL BUILDING, U.C.D., BELFIELD.

In the Chair: Dr. N. O'Carroll, *President.*

Present: J. Fennessy, J. O'Driscoll, R. Keogh, M. Carey, B. Lacey, B. Murphy, B. Fitzsimons, G. Murphy, C. Boyle, M. MacSiurtain, T. Clear, O. V. Mooney, P. M. Joyce, L. O'Reilly, M. O'Brien, P. MacDonnell, P. Raftery, E. Griffin, L. Furlong.

Apologies: H. M. Fitzpatrick, S. McBride.

The President, opening the meeting, sadly recalled the recent death of Mr. T. McEvoy, who was a regular attender and contributor to the Society's Annual General Meetings.

Secretary's Business

The minutes of the 41st Annual General Meeting, having already been circulated to members, were agreed and signed by the President.

Matters Arising from Minutes

It has been decided by the Council that the fund set up by the late Mr. T. McEvoy to aid in the advancement of young foresters be called "Society of Irish Foresters Educational Awards Fund". It has also been decided that the prize will consist of £100 worth of forestry books. In the current year two of these prizes will be given — one to the student attaining the highest honours standard in the 2nd year University

Examination and the other to the student who achieves the highest mark in the Kinnity Final Examinations. Both the Dept. of Forestry at U.C.D. and the FWS have agreed to this proposal. The fund will be used up relatively soon, but it is hoped that other individuals or groups might contribute to its continuance in the future.

The President then raised the question of the dissatisfaction felt by members at the fact that the Press were not invited to attend Symposia. He felt that the purpose of the Symposium was to educate Society members on forestry matters, and the members in turn could educate the public on same. He stated that the forthcoming publication of the revised 'Forests of Ireland' would provide sound technical facts about forestry in Ireland to the general public. He stated that the Press had a habit of distorting the facts.

A question as to whether the Society was going to reply to the many letters being printed in the papers, most of which were derogatory towards the forestry profession. The President stated that no one member could speak on behalf of the Society as a whole, as there were differing views throughout the membership — he felt that the Society would be wiser to avoid controversial issues being raised in the Press. One of the members said he thought that if controversy did arise from time to time within the Society, it would be a healthier thing for the Society.

The Council's Report for 1983, having already been circulated to members, was proposed for adoption by P. M. Joyce and seconded by Ml. Carey.

C. Boyle said that he had heard complaints from a number of people about the reduction in the number of walks which took place in 1983. However, it was explained that the organisation of the walks was a very laborious task and that there had been a conscious decision made to concentrate the walks near areas of large population.

M. Carey raised the question of the lack of attendance by some Council members at the Council Meetings held during the year. However, it was stated that there was no particular pressure that could be put on such members; the only way to solve the problem was by not voting for such members at election time.

Treasurer's Business

Mr. P. Raftery stated that the Society funds were up by £3,300 at the close of 1983. It had been decided, therefore, not to impose an increase in subscriptions charges. The contents of the Journal have been increased again, and it is likely that the next number of Journals will be of a similar size. Adoption of the 1983 Abstract of Accounts was proposed by T. Clear and seconded by O. V. Mooney.

Presentation of Certificate

The President was pleased to present the Foresters Certificate to Mr. L. O'Reilly.

Confirmation of Elections

The Meeting confirmed the 1983 Council Election as follows: President, N. O'Carroll; Vice-President, M. O'Brien; Hon. Secretary, E. Griffin; Hon. Treasurer, P. Raftery; Editor, J. J. Gardiner; Business Editor, J. Fennessy; Hon. Auditor, W. H. Jack; Technical Councillors, E. P. Farrell, E. Morrissey, J. Prior, D. Ward; Associate Councillor, L. Furlong.

The President thanked the outgoing Council for their work during the year.

Election of Honorary Members

The following people were put forward by Council to be elected as Hon. Members: Prof. T. Clear, Mr. H. M. Fitzpatrick, Mr. S. McBride, Mr. O. V. Mooney.

The motion was duly accepted.

The following are the citations which were read at the Meeting:

Thomas Clear carried alone for many years the burden of the professional education of foresters at University level in Ireland. As Professor of Forestry at U.C.D. he directed the development of a school of forestry whose graduates have found employment throughout the world. He was responsible for the prompt introduction of modern quantitative silvicultural techniques and for the implementation of economically effective management techniques in private forestry. He was Honorary Secretary of this Society from 1943-1960 and also held the office of Treasurer for most of that time.

Maurice Fitzpatrick is remarkable for his long and devoted service as a private individual to the promotion of forestry in Ireland. He compiled a botanical key to the identification of conifers, published in 1929, which became a standard reference work in both Ireland and Great Britain. He edited and supervised the production fo the first edition of The Forests of Ireland and has, over many years, contributed to the advancement of forestry as a consultant and by his countrywide lecturing and writing.

Sean MacBride has devoted life-long efforts to the promotion of forestry. Specifically, he was personally responsible, as a Minister in the 1948-1951 Inter-Party Government, for the adoption and implementation of the policy which set an afforestation target of 10,000 hectares per year.

Owen Mooney first made his mark as a skilled silviculturalist. He presided over the initiation and development of the Republic's forest research organisation and was acknowledged as a source of encouragement and firm support by that developing service. In the course of his official attendances at meetings abroad he became widely known and accepted as an international ambassador for Irish Forestry.

Both Professor Clear and Mr. Mooney expressed their gratitude to the Society on bestowing such a great honour on them.

Appointment of Trustees

The following members were put forward to be Trustees of the Society: Prof. T. Clear, Mr. O. V. Mooney, Mr. H. Sullivan.

The motion was duly accepted.

Any Other Business

The President stated that the revised book on the Forests of Ireland will be published after Easter at a cost of approx. £5 for the paperback, or £12 for the hardback. A discount will be given to each member who wishes to purchase the book. Once the publisher has cleared his initial costs, a royalty per copy will be paid to the Society.

M. L. Carey asked that the decentralisation of the Society Meetings should be considered by Council.

One member said that the last number of Journals contained too many specialised technical articles; many members were, therefore, becoming disillusioned with the Journal. A discussion followed, and it was put forward that an Editorial Board to vet articles might be set up. It was stated the main problem arising was the very few articles that were being submitted to the Editor. One member suggested that articles on world forestry should be included. It was agreed that the incoming Council would consider the present situation.

Professor Clear requested that it might be worthwhile to revive the practice whereby the President would review the year's events in forestry at each A.G.M., as some members, especially through retirement, were a little out of touch with forestry matters.

M. MacSiurtain put forward the following proposals that the Society should:

(a) assume a leading role in the formulation of a National Forest Policy,

(b) act as the voice of foresters in Ireland by preparing statements for release to the media which counteract the adverse criticism to which the forest sector is quite often subjected,

(c) address the serious unemployment problem among foresters and graduates, and

(d) provide the opportunity to foresters in other parts of the country to organise and host the Symposium.

It was agreed that the proposals should be submitted to the Secretary and would subsequently be discussed by Council.

J. Fennessy proposed that a guest speaker be invited to speak after or during the A.G.M., this might increase attendances. It was also stated that this could take place during the day of the Symposium. The President said that Council would consider ways of increasing the attendances.

R. M. Keogh said that in view of the mountains of agricultural produce in intervention in the E.E.C., and the severe shortfall in timber supplies, that the Society should push afforestation in the media, at meetings, etc.

The Meeting finished at 10.00 p.m.

PUBLICATIONS RECEIVED

Forestry Commission

Forest Record 125. Rabbits.
A. M. Tittensor and H. G. Lloyd. £1.75.

Leaflet 83. Coppice.
R. E. Crowther and J. Evans. £1.75.

Arboricultural Leaflet 2. Honey Fungus.
B. J. W. Greig and H. G. Strouts. £1.80.

Packard Publishing Ltd.

Economics of Woodland Management.
D. R. Helliwell. £6 hardback; £3 paperback.

Options in Forestry.
D. R. Helliwell. £4.50.

SOCIETY OF IRISH FORESTERS — STATEMENT OF ACCOUNTS FOR YEAR ENDED 31st DECEMBER, 1983

1982	*RECEIPTS*		*1983*	*1982*	*PAYMENTS*		*1983*
788.74	*To Balance from Last Account*		3,473.94	76.80	*By Stationery and Printing*		59.49
				3,632.00	*By Printing of Journals*		3,302,00
	To Subscriptions Received			834.17	*By Postage*		1,055.23
	Technical 1983	4,213.07		320.50	*By Expenses re Meetings:*		110.00
	Technical 1982	324.69		16.65	*By Bank Charges*		24.58
	Associate 1983	757.10		976.65	*By Secretarial Expenses*		903.45
	Associate 1982	56.00		517.00	*By Value Added Tax*		300.10
	Student 1983	69.00		120.54	*By Examination Expenses*		133.42
	Student 1982	3.50			*By Honoraria:*		
	Other Arrears	38.00			Secretary	50.00	
	Advance Payments	209.50			Treasurer	50.00	
6,189.51			5,671.68		Editor	50.00	
					Business Editor	50.00	
	To Sale of Dublin Corp. 9×% Stock		206.19				
	To Interest on Investments			120.00			200.00
	Dublin Corporation	20.10					
	Savings Account	314.24		—	*By Advertising*		67.51
	Educational Building Society	9.17		—	*By Study Tour Expenses*		200.00
	Lombard & Ulster	220.09		—	*By Miscellaneous*		12.80
438.15			563.60	2,700.92	*By Forest Walks*		2,508.44
					By Balance:		
	To Journal				Current Accounts	1,871.38	
	Sales	318.02			Savings Account	314.24	
2,511.96	Advertising	1,696.01	2,014.03		Educational Building Society	121.33	
				3,473.94	Lombard & Ulster	4,000.00	
2,700.92	*To Forest Walks*		3,000.00		Cash for Edu. Award Fund	916.61	7,223.56
125.00	*To Examination Fees*		200.00				
22.10	*To Donations*		21.98				
12.79	*To Gains on Sterling*		32.55				
—	*To Educational Award Fund*		916.61				
12,789.17			**16,100.58**	**12,789.17**			**16,100.58**

I have examined the above accounts, have compared them with vouchers, and certify same to be correct, the balance to credit being £7,223.56 which is held in current and savings accounts at the Ulster Bank, and in the Educational Building Society Account 130441, in Lombard and Ulster Sevings Deposit Account No. 751371-B, and in cash for the Educational Award Fund. There is also a holding of £100 Prize Bond No. R855061/080. At 31st December, 1983 there were outstanding debts of £501.84 for forest walk expenditure in 1983.

Dated: February 25th, 1984

Signed: W. H. Jack, Hon. Auditor

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* **£800 per hectare maximum grant.**

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Enquiries to:

Forest and Wildlife Service,
Department of Fisheries and Forestry,
Leeson Lane,
Dublin 2.

Three ways to keep trees weed-free with Roundup

Pre-plant treatment

Overall spraying of plantation areas prior to planting. Target weeds should be actively growing, with sufficient leaf area to give good reception of the spray. Woody weeds, heather and bracken are best treated in full leaf or frond, before the foliage changes colour in the autumn. Best results are obtained between mid-July and end-August, when brambles and most scrub species will also be susceptible.

Overall treatment

During their dormant season, the following species are tolerant to Roundup:

Pine: Corsican, Scots, Lodgepole.
Spruce: Sitka, Norway.
Douglas Fir*
Japanese Larch**

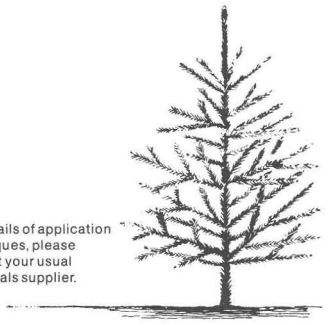
Roundup applied from August to end-February, after extension growth has ceased and before buds swell in early spring, will control actively growing grass, broad-leaved and woody weeds.

* *treat only in late summer months: avoid early spring treatments.*
** *treat only during autumn and winter.*

Selective treatment

During spring and summer, Roundup may be applied using a knapsack sprayer or Micron 'Herbi.'
Care should be taken to prevent the spray from contacting any part of the tree. Use a tree guard to protect tree growth from drift in inadvertent spray contact.
Selective application of Roundup herbicide can also be made using specialised hand-held applicators, such as the Weedwiper Mini.

For details of application techniques, please contact your usual chemicals supplier.



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