IRISH FORESTRY

JOURNAL OF THE SOCIETY OF IRISH FORESTERS

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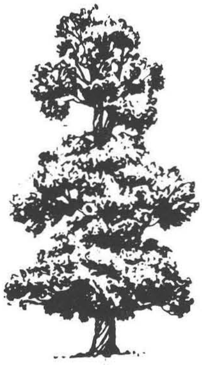

JOURNAL OF THE SOCIETY OF IRISH FORESTERS

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The Society of Irish Foresters

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

The main activities of the society centre around:

(a) Annual study tour

(b) Indoor and field meetings on forestry topics

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

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

There are three types of membership:

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Technical Members shall be persons desirous of promoting the objectives of the Society: at the time of election hold a degree or diploma in forestry of a recognised University, or who have successfully completed a full time course at a forestry school or who hold the Foresters Certificate of the Society; in all cases subject to approval of council.

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Submissions to the journal will be considered for publication and should be addressed to: Mr. P. McCusker, Editor, Irish Forestry, Forest & Wildlife Service, 2 Sydmonton Place, Bray, Co. Wicklow. The attention of contributors is drawn to "Notes for the Assistance of Contributors".

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Notes for the Assistance of Contributors

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

1. Two copies of each paper should be submitted, in typescript, with double spacing and wide margins: correct spelling and punctuations expected.
2. Diagrams and illustrations should be clearly drawn in black ink on good quality paper. Captions should be written on the back of each illustration. Illustrations, wherever possible, should be drawn in an upright position (x axis narrower than y). The approximate position of diagrams and illustrations in the text should be indicated in the margin.
3. Tables should not be incorporated in the body of the text, but should be submitted separately at the end (one table per page). Their approximate position in the text should be indicated in the margin.
4. Nomenclature, symbols and abbreviations should follow convention. The metric system should be used throughout.
5. References should be in the following form:
   GALLAGHER, G. and GILLESPIE, J. 1984. The economics of peatland afforestation. Proc. 7th Int. Peat Cong. Dublin. Vol. 3: 271-285.
   KERRUISH, C. M. and SHEPHERD, K. R. 1983. Thinning practices in Australia. A review of silvicultural and harvesting trends. New Zealand Journal of Forest Science, 47: 140-167.
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Contents

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

Cover: Snow at Killakee forest *(Photo: P. McCusker)*.

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EDITORIAL

Calico and Lace

The policy of man-made forests the world over is efficient timber production. Gone are the days of romantic silviculture. Now it's logs on roadside as fast as possible. What business man can fault this ambition? Modern forest practice is rammed through with this tenet of stream-lining wood production to the degree that it would bring water to the eyes of the Great Impaler himself.

Silvicultural practice, in this modern sense, holds this commitment close to its heart. Such efficiency demands uniformity. It demands the removal of chance occurrence. It demands the reduction of 'forest' to the simpler term of 'timber crop'. Forest practice that does not directly contribute to quickness of growth is not efficient under this definition.

Modern artificial forests are therefore largely lacking in spontaneity. As a consequence they are visually impoverished. By contrast the complex tapestry of a natural forest with its rich variety of age classes and species differences is found interesting. That contrast is the public relations problem for modern forest management.

Society demands that state forests be efficient machines of wood production. Society then demands that forests contribute in a planned fashion to the beauty of the countryside. The question then arises — to what degree is the argument of "the common good" to be allowed to conflict with the objective of wealth generation through efficient timber production?

If society demands good forest landscapes — society must pay for what it wants. Larch, where spruce would grow better — is a cost against efficiency. Deplanting land to expose a fine view — is a cost against efficiency. Holding a crop beyond its financial rotation to retain a landscape — is a cost against efficiency. Plantations should not be asked to carry these expenses in hidden measure. All such costs should be spelt out, isolated and defended.

Good scenery is not an inevitable spin-off from forest activity. Landscape enhancement has a price tag. If townspeople want good country landscape, if hoteliers and the tourist trade apply pressure for such landscapes — the argument of cost — and who should pay — should be presented.

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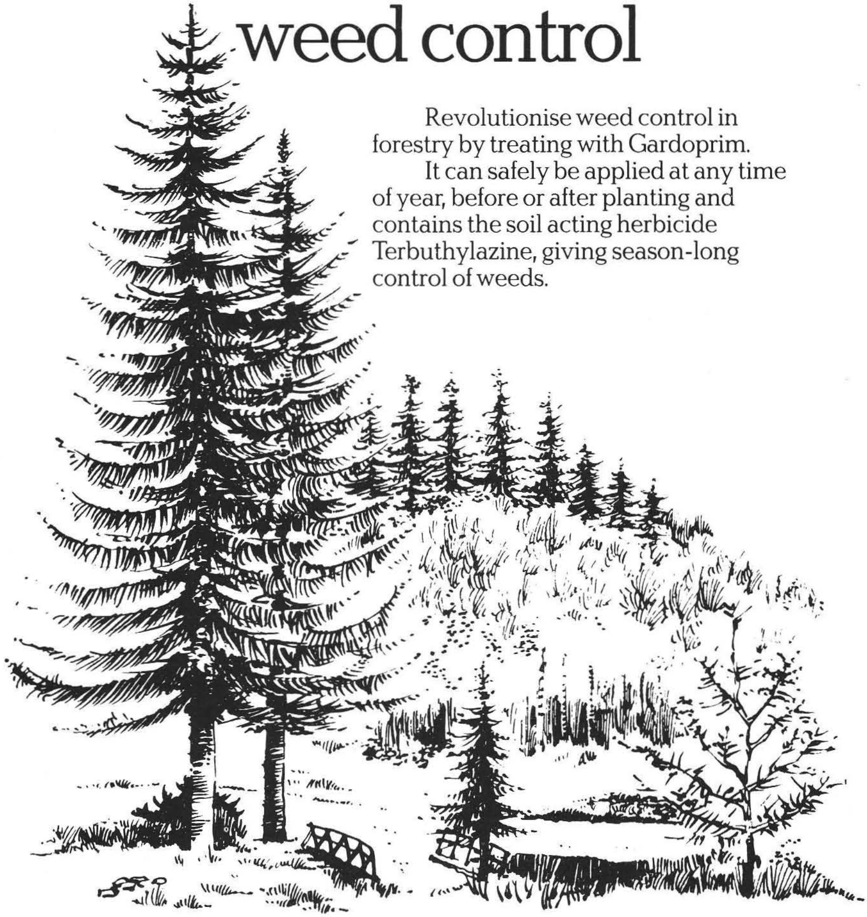

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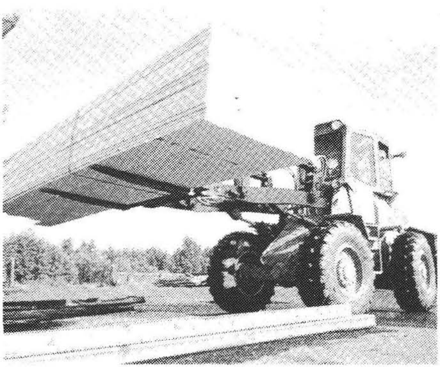

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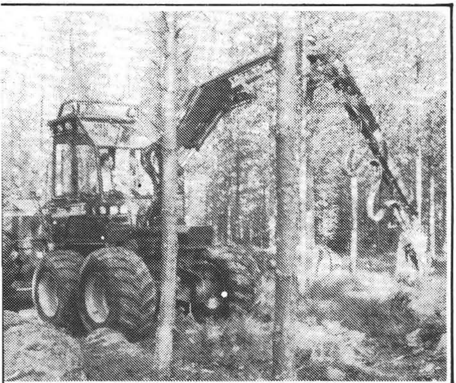

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CEMET-AGRIP

Forest Decline and Acid Rain — Some Facts and Fallacies

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ABSTRACT

The acid rain controversy and forest decline in Europe are reviewed. Although forest damage is extensive, there are suggestions that much of it may be due to factors other than changes in atmospheric chemistry. A combination of elevated ozone levels, acid mists, fogs and frosts, following drought years, seems the most plausible hypothesis in areas worst affected. Low soil fertility may accentuate the problem. Rainfall acidity is less in Ireland compared with the rest of Europe and projected emissions of sulphur dioxide from generating stations appear to be of little consequence for Irish forests.

INTRODUCTION

The concern in recent years over acid rain and its alleged association with forest decline or dieback stems from alarming German survey figures in the early 1980s on the extent of forest damage in the Federal Republic, the high amenity value associated with areas such as the Black Forest and problems over the future availability of wood for industry in Europe where already there are major supply deficits. Irish foresters might perhaps feel justifiably uneasy. Our proximity to Britain, echoes of Sellafield and Chernobyl, the concentration on monocultures of exotic species, and the establishment of Ireland's largest generating station at Moneypoint in Co. Clare, based on coal, are seen by some as a combined threat to what is often referred to as the most productive forest estate in Europe.

The purpose of this review is to consider the nature and status of forest decline within the European context. Secondly, to outline the main factors, including acid rain, that are considered to be contributing to the problem and finally, to comment on their significance for Irish forestry, particularly in the context of Moneypoint.

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FOREST DECLINE

Forest decline is by no means a new phenomenon in Europe. Binns and Redfern (1983), for instance, point out that silver fir (*abies alba*) dieback has been known for more than two centuries, the species having reached its maximum extent about 1600. Several episodes of fir dieback have been reported since then. It is the recent outbreaks, however, dating from 1972, and the drought year of 1976, and their extension to Norway spruce, now the most important tree in Germany, that has caused alarm.

Surveys in Germany in 1982 suggested that 8 percent of the forest area was damaged. The estimate rose to 34 percent (2.5m ha) in 1983 and 50 percent in 1984 (Anon). Since then the rate of increase in damage appears to have decreased, the 1985 figure being 52 percent (Anon, 1985). The survey results recently published for 1986 suggest a significant reduction in the area showing damage, particularly for conifers (Anon, 1986). Although the figures are high, they must be interpreted with caution. Firstly, there are no data for damage prior to 1982 and secondly, as has been pointed out by Binns *et al* (1984), the statistics are presented in terms of hectares of damaged forest whereas in fact the areas represent the sum of small areas occupied by individual trees. Thus the 1984 German survey report gives an area of 11,000 ha of dead trees but points out that these were usually individual trees scattered over a wide area. Apart from a few limited cases, it was not possible to find any groups of dying trees.

Damage has also been reported from other European countries: France, Belgium, the Netherlands, Switzerland, northern Italy and southern Sweden. Reports cite 15-40 percent damage in broad-leaved and coniferous forests but again there are difficulties in interpreting data due to differences in methodology, presentation, and on what constitutes "damage". There appears to be a consensus that the damage is of a new kind, termed "novel forest decline" by Krause *et al* (1985), and not something that can be attributed to straightforward pollution or a soil nutrient deficiency. Much of the dieback in the German Democratic Republic, Poland and Czechoslovakia does appear to be due to sulphur dioxide damage and differs from that being experienced in West Germany and other central European countries. Damage has also been observed in some of the eastern States of North America; Johnston *et al* (1983) report on growth decline in red spruce (*Picea rubens*), pitch pine (*Pinus rigida*) and shortleaf pine (*Pinus enchinata*) but fail to establish whether the problems relate to pollution or a series of dry summers or a combination of both. Widespread damage to Ponderosa pine (*Pinus ponderosa*) due to high concentrations of ozone in the San Bernadino Mountains east of Los Angeles is reported by Davis (1983).

Because of the general concern over forest decline, uncertainties relating to what constitutes "damage" and differences in survey methodologies etc., the EEC introduced in November 1986 a Regulation on the protection of forests against acid depositions. This will help clear up some of the ambiguities, particularly in relation to methods used to assess and report statistics on damage.

Forest Damage Symptoms

Damage symptoms most widely reported for the two species mainly affected are listed in Table 1.

Table 1: Damage symptoms reported from West Germany for silver fir and Norway spruce affected by forest decline. (Based on Krause *et al,* 1985).

Silver Fir	Norway Spruce
— Chlorosis and yellowing of needles, mainly on upper side.	— Yellowing of older needles, mainly on upper side. Typical magnesium deficiency.
— Premature loss of needles.	— Premature loss of needles.
— Premature reduction in height growth — resulting in "storks nest formation".	— Drooping of branches and twigs.
— Reduction in fine roots and mycorrhiza.	— Reduction in fine roots and mycorrhiza.
— Injury first observed on exposed and dominant trees.	— Injury first observed on exposed and dominant trees.

Because of the yellowing, and its association with magnesium deficiency, much of the research has involved an evaluation of magnesium status and the response of trees to magnesium and lime application (Huttl, 1984). However, needle analysis from healthy and damaged trees do not always show distinct differences in nutrient levels.

Damage has also been recorded in Scots pine, beech and oak, but to a lesser extent. Again dominant trees are first affected and the yellowing of the foliage is the most characteristic symptom.

Possible causes of forest decline

Besides being influenced by atmospheric chemistry, tree growth is also affected by a range of climatic and edaphic factors. Small shifts in climate, particularly in marginal situations, as in the case of silver fir in central Europe over the last two decades, may result in changes or stress in species (Baumgartner, 1979). Climate also influences diseases and pests. A good example is the association between the outbreaks of *Elatobium abietinum* and mild winters in Britain and Ireland. Rehfuess (1985) cites the extensive occurrence of attacks of needle caste fungi, *Lophodermium spp.* and *Rhizosphaera kalkhoffii* in Norway spruce in southern Germany in 1982/83 and their relationship with frost shocks as another example. The resulting defoliation contributed in no small way to the high figures reached for needle loss in subsequent forest damage surveys.

Exposure can also be a major constraint, and where extreme, can result in atmospheric drought, characterised by drying out and browning of the needles. Much of the forest damage in central Europe is associated with high elevation sites greater than 600 metres above sea level. Growth is also affected by the supply of a number of major and minor soil elements. Some elements are both essential and potentially injurious. The classic examples are sulphur and nitrogen, both of which are required for photosynthesis. Gaseous sulphur and nitrous oxides can, as pointed out below, be damaging if present in sufficiently high concentrations. Similarly, excess amounts of some trace elements can be harmful. Aluminium is the most abundant potentially toxic element in soils and its availability is strongly influenced by acidity and in turn by the occurrence of acid rain. Finally, the long life span of forest trees, and their known capacity to scavenge and absorb nutrients from the athmosphere (Miller & Miller, 1980) makes them sensitive not only to pollution but to all sorts of environmental stress and change. With age, they also become less adapted by their mere increase in size to environmental change. Much of the forest damage reported in Europe is confined to trees over 80 years of age (Binns & Redfern, 1983).

Air pollution hypothesis and forest decline

Air pollution influences on tree growth can be subdivided into two main categories:

(i) Direct effects through the leaf stomata of gaseous pollutants such as sulphur dioxide and nitrous oxides, including interaction with wet deposition on above ground parts of trees, followed by indirect effects on the root system.

(ii) Indirect effects on above ground and below ground parts of trees due to the accumulation of wet and dry deposited substances in soils.

Sulphur dioxide:

Sulphur dioxide (SO_2) is the classical air pollutant and when present in high concentrations is known to adversely affect the health and growth of trees. The gas is emitted from many sources, but mostly from the burning of coal and also from refining and smelting plants and from industries that manufacture or use sulphuric acid. The worst example of tree damage by SO_2 in Ireland occurred in the early 1970s at Shelton Abbey in Co. Wicklow where it was found that about 40 ha of the forest surrounding the N.E.T. fertiliser factory were severely damaged (McAree, D., unpublished: Forest and Wildlife Service). This coincided with regular recordings of 500 micrograms m^{-3} (ug m^{-3}) of SO_2 in the area. Mean annual levels at the Valentia meteorological station in Co. Kerry in 1981 were 0.8 ug m^{-3} (McCaffrey, F., personal communication). Dublin city in 1981 had a mean annual concentration of 62 ug m^{-3}.

One of the difficulties in establishing a relationship between SO_2 levels and forest decline is that emissions have tended to fall in Europe since 1970 (Sartorious, 1984) during a period when damage to forests appeared to increase. Another difficulty relates to establishing threshold levels for SO_2 damage. Controlled environment experiments have attempted to establish such relationships but their relevance to field conditions where concentrations fluctuate daily and seasonally, and where episodic extreme concentrations may be more important is questionable (Last, 1982). According to Mukammal (1976), threshold levels for acute injury are about 850 ug m^{-3} and about 140 ug m^{-3} for chronic injury. Below these levels he considers SO_2 to be generally non injurious to forest trees in the sense of producing visible evidence of damage. Keller (1984) on the other hand showed that carbon dioxide uptake by Norway spruce could be reduced by up to 50 per cent when exposed to continuous concentrations of SO_2 of 260 ug m^{-3} even though there were no *visible* signs of injury. Anderson (1983) suggests that growth decreases can be expected at yearly concentrations of 25-50 ug m^{-3} of SO_2. This is in agreement with results from studies carried out by Soikkeli (1981) in industrial areas of Finland. In contrast to this a major summary report (I.E.R.E., 1981) suggests that the long term threshold concentration for yield reduction in trees lies between 100 and 150 ug m^{-3} with the possibility of a lower threshold in regions with extreme climatic conditions.

Following a review of ambient SO_2 levels in areas affected by forest decline, Krause *et al* (1985) concluded that the gas could be eliminated as an overall cause of the problem. This is not to say that SO_2 cannot directly result in forest damage in countries such as Czechoslovakia where peak levels of 1800 ug m^{-3} can occur. The fact is however that damage has been reported from areas with SO_2 concentrations as low as 2-3 ug m^{-3}, in Switzerland for example (Bucher, 1985b).

Nitrous oxide:

Gaseous nitrogen compounds are less toxic than SO_2 and any effects on growth resulting from increased nitrogen deposition are likely to be indirect through the soil rather than directly on tree foliage. In parts of southern Sweden total nitrogen deposition in precipitation has reached 70 kg/ha/annum (Nihlgärd, 1985) a figure seven times greater than that recently measured at Avondhu Forest in Co. Cork (Carey, *et al,* 1986). About half of this originates from nitrous oxide emissions and other combustion processes, the remaining portion from volatilisation of ammonia from the agricultural sector. Such "oversaturation" of the soil with ammoniacal nitrogen, Nihlgärd, argues, rather speculatively, adversely affects the forest ecosystem through enhanced leaching of nutrients, increased susceptibility to frost and pathogens and decreased soil microbial activity. Many scientists do not share this view.

Ozone:

Ozone is a secondary air pollutant formed under the influence of reactions between ultra violet light — bright sunshine — and nitrous oxides and hydrocarbons. The gas occurs naturally in the stratosphere some 25 km from the earth but elevated levels can occur near ground level if conditions are favourable for its formation. It is considered the most phytotoxic air pollutant in the United States (Davis, 1983) where the high concentration of automobiles and weather conditions in areas such as California combine to provide ideal conditions for its formation. There are no data available for levels in Ireland.

Krause *et al* (1985) reports increases in ozone concentrations, particularly in rural parts of West Germany, and suggests that peak value years (over 500 ug m^{-3}) correspond more or less to the increase in observed forest injury. The primary site of ozone attack is the cell membrane. This leads to enhanced leaching of foliage nutrients, including magnesium causing yellowing of foliage, and increased susceptibility to pathogen attack.

Acid rain

Because of the presence of carbonic acid the pH of unpolluted rain is about 5.6 and acid rain has come to mean precipitation (rain, fog, dew, snow) containing sufficient amounts of acidic air pollutants to produce a pH less than this figure. Sulphur dioxide and nitrous oxides are the main gases responsible for a lowering of the pH in polluted atmospheres.

Rainfall acidity has increased in industrial countries since the

1950s due to the increased combustion of fossil fuels. It has been estimated hat 90 percent of all sulphur falling on northern Europe is derived from man-made sources (Overrein 1983). In Ireland the proportion is less due to the lower industrial base and our proximity to seawater.

Rainfall acidity has also increased in Ireland since the early 1960s (Matthews *et al,* (1981). In 1985 fifty four percent of the samples collected had a pH less than 5.6. Recent studies by An Foras Forbharta in the Dublin region gave a mean pH of 4.7 for five collection stations, some of the lowest values being associated with the Glencree Valley (Bailey *et al* 1986). The study also showed lowest pH readings and highest SO_2 concentrations occurred when winds came from an easterly direction. Recent studies by the Forest and Wildlife Service at Avondhu Forest in Co. Cork gave a mean pH of 5.6 over a two year period (Carey *et al op. cit*). The pH of rainfall in substantial areas of Britain and Europe has a pH of 4.4 or less. The mean value for Norway and Sweden is about 4.2. Because pH is expressed on a logarithimic scale, rainfall with a pH of 4.4 contains 10 times more hydrogen ions than that with a pH of 5.4.

Although potential direct effects of acid rain on trees have been listed, Morrison (1976) concluded that visible damage was unlikely to occur unless the pH of the rain was 3.00 or less when lesions of the leaves could be expected.

Most of the interest in acid rain has centred on its indirect effects on the release of soil cations such as calcium and magnesium and, in particular, the potentially toxic aluminium. Chief protagonist has been Ulrich (1983) who suggests that the resulting solubilised aluminium damages tree roots and ultimately causes dieback. Other German scientists disagree (e.g. Rehfuess *et al,* 1983) and Alexander and Miller (1985) report satisfactory growth of seedlings at higher aluminium concentrations than those found in Ulrich's studies. Furthermore, forest decline has been reported from areas in Germany with low levels of soil aluminium. In Norway and Sweden the dying off of fishstocks in thousands of lakes is attributed to the release of soil aluminium by acid rain into streams and rivers. Despite this evidence, the damage to forests appears far less than in central Europe and tree ring studies have failed to establish any relationship between growth and acid rain (Jonsson and Svenssen, 1972).

Moneypoint

The main concern expressed about the new 900 MW electricity generating station at Moneypoint in Co. Clare relates to the emission of SO_2 following the combustion of some 2 million tonnes of coal annually in a plant where no desulphurisation equipment has been fitted. Studies by the Electricity Supply Board, (Lawlor, 1978) suggest that in the area of maximum impact — some 10 km from the plant — annual means of 12-14 ug m^{-3}, monthly means of 30-60 ug m^{-3} and daily mean maxima in the order of 100 ug m^{-3}, can be expected. Outside this zone, levels will fall off sharply. Mangan (1985) predicts a figure of 1 ug m^{-3} for the Burren area. Assuming these estimates to be reasonably correct, it would appear that it is most unlikely that direct visible damage to trees will occur, particularly in the context of the suggested threshold levels mentioned earlier. Overall the increased deposition of SO_2 is predicted to be approximately 50,000 tonnes/annum. This compares with a total national figure for SO_2 emissions of 155,000 tonnes in 1984 and 234,000 tonnes for 1979 (Bailey, 1984). Thus when the station is working to capacity, total emissions for the country will be 12 percent less than the figure for 1979 before the commencement of the change over to natural gas. Big changes in rainfall acidity are therefore most unlikely. If changes do occur, they are likely to be small and of little if any consequence for tree growth. However, the evidence would seem to suggest that there may be a greater tendency for soil acidification to be enhanced as a result of forest growth (Likens and Bornmann, 1974). There is increasing evidence of such long term changes in Britain, particularly in parts of Wales, where concern has been expressed over the increased levels of aluminium in some water courses. However, the current total generating capacity for the UK based on coal is some 35,000 MW, many individual stations having a capacity of 2,000 MW. When looked at in this context Moneypoint (900 MW) would appear to be of little environmental concern, particularly when it is borne in mind that the Forestry Commission in Britain have so far found no relationship between forest health and rainfall acidity or sulphur deposition (Binns *et al* 1984). However, it may well be that ecosystems other than forest, for example certain aquatic systems, are more sensitive to small changes in atmospheric chemistry. It is also possible that organisms other than the trees within the forest ecosystem, for example certain mirco-organisms, could be adversely affected by minor changes which have so far gone undetected.

As part of their environmental programme the ESB have installed a number of monitoring stations for measuring SO_2 and rainfall acidity. These are sited at Kilrush, the Burren and in a Forest and Wildlife Service plantation in the Slieve Bloom Mountains. The Forest and Wildlife Service has also established a series of forest health plots nationwide which will be monitored annually.

Discussion and Conclusions

The available evidence suggests that a number of factors are responsible for the dieback and decline of European forests. There are some suggestions that the problem may have been overstated somewhat and there is certainly still a large degree of uncertainty in relation to what constitutes "damage". Air pollution due to high concentrations of SO_2 has been killing trees locally for centuries and is currently responsible for extensive forest dieback in countries such as Czechoslovakia and Poland but it is a long way short of explaining the forest decline phenomena reported from Europe in recent years. Neither is acid rain directly responsible, although indirectly it may accentuate stress on infertile soils of low base status. The most plausible theory currently advanced is that the drought years of 1976, 1982 and 1983 put trees under stress on a wide scale and that elevated ozone levels and, in some instances, acid mists and fogs at high elevations, are responsible for the damage. These weaken cell membranes and accelerate the leaching of calcium and magnesium from foliage, increasing its susceptibility to frost damage. In areas where the rainfall is strongly acid, the calcium and magnesium are eventually leached from the soil resulting in foliage yellowing. Lime, magnesium and potassium applications are now being tested as remedial treatments in a number of countries. There are a number of examples of unhealthy trees and plantations in Ireland but these can invariably be related to poor soils or incorrect choice of species rather than acid rain or pollution. Projected emissions from generating stations such a Moneypoint would appear to be far below what are considered potentially damaging although areas within 10 km of the plant might be expected to show some indirect effects in the long term, the significance of which remains conjecture at this point in time. According to Last (1982) Norway spruce and Scots pine are amongst the most pollution sensitive conifers. Sitka spruce is susceptible but less sensitive than Norway spruce. Lodgepole pine and western red cedar are considered the most tolerant species.

A positive aspect of the current debate is the large injection of funds that have been made into European forestry research programmes. Although these may not necessarily solve or contain the problem of dieback, they will provide an insight into what the key stress factors are and ultimately the basis for improved productivity and stability in forest ecosystems.

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Availability of land for forestry in Ireland and its suitability for Sitka spruce

(Picea sitchensis (Bong.) Carr)

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INTRODUCTION

The afforestation programme of the Republic of Ireland is at a cross-roads. Whether this cross-roads heralds a major crisis or presents new opportunities is still hidden in the future. The roads leading to this junction come from opposing directions. First and most disquieting is the rapid cutback in the State afforestation programme. At a time when land prices have fallen the State, through fiscal stringencies, is unable to avail of this oppotunity to consolidate its forest holdings. If there is to be stability in the flow of raw material to the timber processing industries then we need a planting programme of at least 10,000 hectares for at least a further 15 years. Secondly, much hope is now being placed in private forestry — in this case, institutional private forestry — but this approach to afforestation also has its constraints. It is unlikely that institutional afforestation will fully replace the hectares lost through the FWS cutback in the near future. The second set of opposing roads which converge on our afforestation cross-roads and the one which will determine the eventual long term direction of the national afforestation programme — is the relative support systems for agriculture and forestry emanating from Brussels (Anon 1985, Andriessen 1986). On the agricultural side, the reduction in the milk quota and the stagnation or actual decline in the price supports for other farming systems, such as beef and cereals, has led to a distinct lack of confidence in the future within the farming sector. These constraints, which now enmesh much of the traditional farming enterprises which are possible in Ireland, have instigated a search for alternative land-use systems. Such a search has led to a more open-minded approach to forestry. If a proper support system of grants for farmers switching to forestry were devised — then

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this third apex of the afforestation triangle, farmer forestry, could make a substantial contribution to the national afforestation programme. There is little doubt, that under Irish conditions, forestry offers the only alternative land-use system which can utilise extensive areas of marginal agricultural land. On the forestry side the supports and grants to those who plant are becoming increasingly attractive. These supports are not originating as part of a rational Irish forest policy but are rather the adjuncts of regional or EEC agricultural policy. Thus, there is now a greater interest in forestry at all levels of public awareness than there has ever been before.

It is in this context that a closer look at the possible land base for forestry is necessary. As all land in the country is privately owned, commonages, while jointly held, are still privately owned, mostly by farmers — any increase in forestry must use land coming from the agricultural sector. It is most likely that it will be the marginal farmer — in the economic sense — who will sell out or plant his land. As this type of farmer is normally located on difficult agricultural soils it is essential that the forestry potential of these soils should receive most attention.

SUITABILITY

Methodology

The Republic of Ireland occupies an area of 6,805 million hectares excluding rivers, lakes and major urban areas. Gardiner and Radford (1980) in their work 'Soil Associations of Ireland' recognised 44 major Soil Associations in the country. Gardiner and Radford define a Soil Association as follows: "The soil association is not a soil classification category but is a cartographic (or mapping) unit. It consists of two or more soils, usually formed from the same type of parent material, which are associated on the landscape in a particular pattern. For example, one may have an association of two soils — one a well-drained Brown Earth which occurs in the more favourable topographic positions and a poorly-drained Gley soil occurring in the depressional positions". They have further indicated the agricultural potential of these Soil Associations by grouping them into six land-use categories from wide to extremely limited. In subsequent work they have reduced the number of land-use categories to five (Gardiner and Radford, 1981). This paper uses the latter as the basis of its agricultural land-use categories.

On the forestry side, soil productivity is measured by the yield class (YC) system (Hamilton and Christie, 1971). However, the yield class system is species dependent — the same site can have many different yield classes depending on what species is present. A site may have a YC 8 for oak while being rated YC 20 for Douglas fir. For the purposes of this study Sitka spruce (Picea sitchensis (Bong.) Carr.) is used as the indicator species. Sitka spruce is now the most frequently used species in Irish forestry and is capable of adapting to a variety of widely differing sites. Its range of yield classes is probably the greatest for any conifer in the country. For these reasons it is the obvious choice as indicator species for forest productivity.

Forest productivity is broken into five production categories ranging from 'Very Good' to 'Extremely Limited'. These categories while similar to those used in the agricultural land-use side, have no direct comparative economic or production relationship — they are simply used to describe the perceived value of the various production categories within their own enterprise system.

Each Soil Association, with three exceptions, is assigned to a single yield class category. Because there are still discernible soil differences within a single Soil Association each Association is assigned to a yield category which has a range of possible yields, rather than one exact yield class. The yield class categories used are; YC 0-8, 6-12, 10-16, 14-20 and 18-20 corresponding to "Extremely Limited", "Very Limited", Moderate to Good", "Good" and "Very Good" respectively. Thus Soil Associations assigned to the "Moderate to Good" category may encompass soil areas with yields ranging from YC 10 to YC 16 although the bulk of soils will probably have productivity levels in the middle of the range. The production assessment, therefore, is closer to that of an extensive area of forest rather than to that of a fully stocked, uniform hectare of forest as envisaged by the actual yield class Tables. Finally, it should be understood that this study is only a first approximation and that many of the assessments of Soil Association potential are tentative and need further study. In general, assessments tend to be on the conservative side, particularly in the assignment of Soil Associations to the extreme categories of "Very Limited" and "Very Good". This paper represents a more detailed analysis than that attempted at the Forest and Wildlife Service, Private Forestry Seminar, in Kilternan (Bulfin, 1984). Soil Associations are assigned to a yield class category on production information gathered from a number of different sources: The Leitrim Resource Survey (Bulfin, Gallagher and Dillon, 1973); information published with the various Soils Bulletins (Bulfin, 1977; Bulfin, 1983; and Finch, 1971); from other published information (Carey and Griffin, 1981; Carey, Hammond and McCarthy, 1985; Dickson and Savill, 1974;

Gallagher and Gilespie, 1984; O'Flanagan and Bulfin, 1970; Savill and Dickson, 1975): from current work under an EEC contract (Bulfin, 1986): from other unpublished sources within the Agricultural Institute and from numerous discussions with forestry colleagues in various parts of the country.

Analysis of Difficult Agricultural Soils

The word difficult is used to denote the physical difficulty which these soils present to farmers trying to work them. Because of these difficulties they are also likely to be economically marginal for agriculture. Gardiner and Radford, (1980) identify 1,958 million hectares (28.8%) of the soils of the Republic of Ireland as being extremely limited for agricultural production. This land is mostly located in the Mountain and Hill Physiographic Division mostly with blanket peat and lithosol soils but also including low level blanket peat soils on the west coast and the midland peats. With the exception of the midland peats, where major (and expensive) reclamation work can produce a valuable agricultural soil — all of the soils in this category have "severe (and permanent) limitations due to high altitude, rock outcrop, shallowness, steep slopes, wetness and inaccessibility".

Soils classed as extremely limited for agriculture

Table 1 shows the forestry potential of these soils. There is a definite correlation between land that is extremely limited for agriculture and land that is extremely limited for forestry. Thus, 17.1 of the whole country (representing 59.7% of the "Extremely Limited" category) is classed as "Extremely Limited" for both forestry and agriculture. Of the remaining 11.7% of the country occupied by this category, half of this is occupied by midland peats. These peats, which in the raw or in the hand-cutaway state are extremely limited for agriculture, are classed as having a "Limited to Somewhat Limited" to "Moderate to Good" productive capacity for forestry. More recent research is indicating that the Bord na Mona milled peat cutaway has a high potential for forestry and this is mostly placed in the "Very Good" category with expected yield class in the range YC 18-24, (Carey, Hammond and McCarthy 1985). The remaining 6.0% of soils in this agriculturally "Extremely Limited" category are composed of peaty gleys and peaty podzols mostly at high elevations and these have been placed in the "Very Limited" and "Moderate to Good" forest production categories.

Table 1: Soils classed as agriculturally "Extremely Limited" — distributed by forestry potential.

	Forestry Yield Class Category Yield (M3/Ha/An)				
	Extremely Limited (0-8)	Very Limited (6-12)	Moderate to Good (10-16)	Good (14-20)	Very Good (18-24+)
Ha	1,162,752	384,945	220,507	111,600	78,033
%	17.1	5.7	3.2	1.6	1.2
		Total Area in Category 1,957,837		28.8%	

Table 2: Soils classed as agriculturally "Very Limited" — distributed by forestry potential.

	Forestry Yield Class Category Yield (M3/Ha/An)				
	Extremely Limited (0-8)	Very Limited (6-12)	Moderate to Good (10-16)	Good (14-20)	Very Good (18-24+)
Ha			50,488	260,252	452,918
%			0.7	3.8	6.6
		Total Area in Category 763,658		11.1%	

Table 3: Soils classed as agriculturally "Limited" — distributed by forestry potential.

	Forestry Yield Class Category Yield (M3/Ha/An)				
	Extremely Limited (0-8)	Very Limited (6-12)	Moderate to Good (10-16)	Good (14-20)	Very Good (18-24+)
Ha			316,338	138,244	185,994
%			4.6	2.1	2.7
		Total Area in Category 640,516		9.4%	

Soils classed as very limited for agriculture

Table 2 deals with the category of soils classified as agriculturally "Very Limited" which contains a total area of 0.764 million hectares (11.15% of the country). This category represents the poorer, from an agricultural point of view, wet mineral lowlands composed of gley soils on both drumlin and non-drumlin topography. The major limitation of these soils, for agriculture, is poor drainage originating in a number of different ways: either from a heavy texture and poor structure; from a high water table; or from the presence of seepage sources or springs. Most of these soils have a very high potential for forestry as documented in a number of studies. (Bulfin, Gallagher and Dillon, 1983: O'Flanagan and Bulfin, 1970). These are the soils which have given Ireland its reputation for high forest productivity — although there is relatively little afforestation on them. Some 0.713 million hectares (10.4% of the country) of these wet mineral soils are classed in the top two forestry production categories with expected yield classes ranging from YC 14 to 24 and above. If a rational land-use policy were to be adopted, then the nation would look to these lands and, possibly, to the midland peats for the bulk of its afforestation programme. However, from the agricultural and social point of view, these soils present certain problems for forestry development. These points will be touched on late in the paper.

Soils classified as of limited use for agriculture

Table 3 gives details of soils which, while of better agricultural value, still present definite difficulties in farm management. This category of soils of "Limited" potential for agriculture, occupies an area of 640,516 ha (9.4% of country) and is mostly composed of wet mineral lowland soils along with some lowland podzols in the west. These particular wet mineral lowland soils are of a somewhat better potential than those in the previous category, partly due to slightly better internal drainage and partly due to being located in lower rainfall areas. As expected this category, with a predominance of wet mineral soils, has a high potential for forestry. While these soils have an obviously high potential for forestry, they may not be easily or readily available for afforestation. They are located in what are generally considered better farming areas where, in some cases, dairying is the major agricultural enterprise e.g. east Cavan and parts of Monaghan.

Summary of all soils with agricultural limitations

Table 4 summarises the information from the previous four tables. The total area of marginal agricultural land in the Republic of Ireland amounts to some 3,362 million hectares or 49.3 per cent of the country. Perhaps the most significant fact to emerge from this Table is that 1,163 million hectares (17.1 per cent) of the country is classed in the "Extremely Limited" forestry potential category. This includes much of the high mountain areas at elevations over 305 metres and the most inhospitable and exposed western blanket peats and lithosol areas such as the Burren. A further 5.7 per cent of the country (0.385 million hectares) is classed as "Very Limited" for forestry production. In the categories with definite potential for forestry 0.587 million hectares (8.5 per cent) have an average yield class in the "Moderate to Good" category. The average yield class for this category is close to the current national average of YC 14 for state forestry. The final two categories, with most potential for forestry, occupy 1.227 million hectares (18 per cent) of the country. These are mostly the wet mineral lowlands, which have a proven potential for forest production, and the midland milled peat areas. Thus, of the marginal agricultural soils of the Republic of Ireland 26.5 per cent or 1.8 million hectares are suitable for forestry with 1.25 million hectares of land capable of producing some of the highest yields in Europe.

Table 4: All soils with agricultural "Limitations" — distributed by forestry potential — Summary.

	Forestry Yield Class Category Yield (M3/Ha/An)				
	Extremely Limited (0-8)	Very Limited (6-12)	Moderate to Good (10-16)	Good (14-20)	Very Good (18-24+)
Ha	1,162,752	384,945	587,333	510,096	716,945
%	17.1	5.7	8.5	7.5	10.5
			Total Area 3,362,071	49.3%	

LAND AVAILABILITY

Availability can be interpreted as the willingness of the landowner to either plant his own land or to sell for state or private planting. While land may be classified as very suitable for forestry, this does not mean that it is available for planting. Availability is determined by a number of complex factors, which depend on the economic and social constraints impinging on the landowner. It is not possible to give a detailed analysis of land availability in this paper — only an outline of possible factors influencing availability can be touched on.

Owner planting

The willingness of any landowner to plant some or all of his land will depend to a considerable extent on his own personal circumstances. Owners can first be categorised as to whether they are owner occupiers or absentee owners. Absentee owners are more likely to afforest or to sell their land for afforestation. They are also more likely to have small non-viable holding or marginal land and also a secure source of income or employment elsewhere. Very little information is available about the number or status of absentee owners, who currently are some of the key people either planting their own land or selling it for planting.

Landowners who farm their own land are less likely to undertake any serious afforestation. Resident farmers, large or small, are not in a position to lose current income by locking land up under forestry for long periods. The position is all the more intractable because there is no tradition of farmer forestry in Ireland and so they cannot look to their neighbours for example. In this we are in direct contrast with almost all mainland EEC countries. Until they are offered serious incentives, which match — or better — those which currently support them in agriculture, farmers will not seriously consider forestry as a viable option. EEC forestry officials, coming from countries with a long tradition of farm forestry are likely to expect too much from the operation of a simple grant scheme under Irish conditions. Such is, perhaps, the case with 1820/80, the Western Package grant scheme.

Part-time farmers

A possible target group, who could become important contributors to the private afforestation programme, are those who practice part-time farming. In 1978 it was estimated that about 25 per cent of all landowners, with holdings of over 2 hectares, had other jobs besides farming (Higgins, 1983). Their numbers have been on the increase since 1961. Ironically, the largest concentration of these self-employed part-time farmers was in the more prosperous farming areas. It is regrettable that there is a lower rate in the forestry grants for these better farming areas. If planting grants in the east of the country were at the same level as the Western Package grants we could see an upswing of planting on the marginal soils in the eastern part of the country where farm sizes are larger. The number of part-time farmers by farm holding size category is given in Table 5. As is to be expected the largest number of part-time farmers are to be found in the smaller farm size categories. Thus, 39.6 per cent of farmers in the 2-10 hectare category have part-time jobs and this represents 45.3 per cent of all part-time farmers. On average, part-time farmers, who were wage or salary earners, earned 80 per cent of their income, from their part-time occupation in' 1981. Their loss of farm income, if they afforested their land, could readily be replaced by a supplementary grant system.

In the final analysis any landowner, who has not decided to sell out, will be influenced by his immediate income prospects. He can only consider forestry seriously for a substantial portion of his farm if he can see an annual income comparable to that which he is already receiving in agriculture. The prospects for such an annual income, from national or EEC sources, have been discussed elsewhere (Bulfin, 1985; Bulfin, 1986; Bulfin and Connelly, 1986).

Table 5: Number of part-time farmers by farm size — in Republic of Ireland.

Size Class	No. of holdings	With p.t. jobs	% of all p.t. farmers
Ha	%	%	%
2-10	28.4	39.6	45.3
10-20	35.9	21.5	31.2
20-30	11.7	26.9	12.7
30-50	15.1	12.5	7.6
50+	8.9	8.8	3.2
All classes	100.0	24.8	100.0

Source: Higgins 1983

Land sales for afforestation

Ireland is a nation of owner occupiers with 92 per cent of the land in the owner-occupier category (Kelly, 1982). We also have the lowest (for the EEC 9) rate of change in the number of agricultural holdings. It is unlikely that many landowners selling their land will be greatly influenced by the proposed future use of their land, they will be mainly concerned with getting the best price. Thus, the availability of land for private planting is more likely to be influenced by the requirements of the purchaser than by the behaviour of the vendor.

Because of the grant system land being bought for afforestation, by the institutions or by other private investors, is located in the Western Package grant areas. Apart from location investors have parcel size and production or yield class requirements which must also be met. In general, investors appear to be looking for sites of at least 30 hectares and with an expected production level above YC 14-16. They show a definite preference for the wet mineral sites of YC 20 and above. Therefore, the main thrust of investor purchase is in the drumlin areas in the north-west and also in the wet mineral soils of Clare.

From the investors point of view, the required yield classes are readily available in these areas but the parcel size may not be — especially over the longer term. Kelly (1982) indicates that the average total area of land transferred through the market place is some 26,000 hectares (64,000 acres) per year or some 0.55 per cent of the crops and pasture land (which excludes hill and mountain land) of the country. It is always possible to combine a number of purchases but such organisation requires a considerable amount of time, effort and expense. Farm size catergorised by topographical region, is given in Table 6. From this Table it can be seen, for the target wet mineral lowland areas, that over 50 per cent of farms are less then 12 hectares, (Scully, 1971). Only about 4 per cent of farms are over 30 hectares, the preferred size for investor purchase. The reservoir of appropriately sized farms is very limited. The purchase by investors of a considerable number of these larger farms, as they come on the market, would also pose serious structural and social problems for these regions. By taking up these larger farms they not only mop up the main source of potentially viable or viable farms but they also limit the remaining farmers in their efforts to expand their holdings into viable farms. The number of holdings sold and

Table 6: Percentage distribution of farms according to size by topographical region in hectares (acres).

Topographical region	Farm size group				
Ha (acres)	2-12 (5-30)	12-20 (31-50)	20-30 (51-75)	30-40 (76-100)	40+ (100+)
Drumlin-Wet	52.9	27.7	12.5	4.0	2.9
Drumlin-Dry	60.2	22.9	10.6	3.2	3.1
Lowland-Wet	53.0	25.9	12.4	4.6	4.1
Lowland-Intermediate	57.0	26.7	9.0	3.7	3.6
All regions of west	51.2	26.0	12.0	5.1	5.7

Source: Scully, 1971, from appendix Table B.1.

their average area are given in Table 7. This table along with Table 9 indicates the large fluctuations in the number and area of land sold in response to market forces. It also indicates that the average area of farms sold over the period was 17.0 hectares.

Another aspect of the farm size problem is that not only are farms in marginal areas small but they are also fragmented with only a little over 50 per cent of farms in one parcel (Scully, 1971). Table 8 gives details of this fragmentation. Thus, the supply of a sufficient number of parcels of the right size to support a major investor afforestation programme, over the long-term, is problematic.

Table 7: Number of Land Sales in 11 Western Counties 1978-1981.

	YEAR				
ITEM	1978	1979	1980	1981	Average
No. of Sales	3778	2227	1695	1347	2261
Mean Size Ha	17.8	12.3	17.8	22.1	17.0
(Acres)	(43.8)	(30.4)	(44.0)	(54.7)	(41.9)

Source: Kelly (1982)

Table 8: Percentage distribution of farms according to number of separate parcels of land per farm, by size of farm.

Farm size group	Number of parcels of land per farm 1	2	3	4	5+	Total
Ha	%	%	%	%	%	
2-12	58.4	28.1	8.6	2.3	2.6	100.0
12-20	47.4	32.4	11.6	4.4	4.2	100.0
20-30	44.8	31.2	14.0	4.8	5.2	100.0
30-40	51.4	24.3	11.7	6.2	6.4	100.0
40-80	50.5	24.6	11.9	6.9	6.1	100.0
80+	50.9	28.7	7.4	6.5	6.5	100.0
All farms	52.9	29.3	10.4	3.6	3.8	100.0

Source: (Scully 1971)

Finally there is the cyclical state of the market-place with at times a glut of land on offer and at other times a shortage. Table 9 indicates trends in land sales for the eleven western counties over the 1980-84 period. As can be seen the amount of land sold in different years varies considerably. Table 9 gives a breakdown of the area of land sold by Soil Use-ranges as defined by Kelly. These ranges are similar but not identical to the use-range categories by Gardiner and Radfors (1980) detailed above. Use-ranges 1 and 2 are of wide potential, suitable for both tillage and grassland while Use-range categories 3-4 are suitable for grassland only. Categories 5 and 6 are the very marginal mountain and peatland soils of very rough grazing quality. The time series is very short to make any absolute statements but a few observations are possible. It seems that sales of good quality land tend to remain firmer than those of marginal land — six times more marginal land was sold in 1980 than in 1983. An interesting feature of this Table is the steady and marked increase in the sale of Use-range 1 soils, perhaps indicating the decline in confidence in farming.

A viable and significant investor contribution to the private planting sector is essential to maintain continuity and provide a solid backbone of regular private planting to the sector. If such a steady planting programme were maintained by the investor group this would be enough to keep contractors in steady employment. As a first estimate, and under present (1986) agricultural and forestry grant systems there would appear to be a market opening of 2-3000 hectares for the investor group.

Table 9: Percentage area of land by Soil Use Class 1980-1984.

Soil use class	1980	1981	1982	1983	1984
	%	%	%	%	%
1	17.0	16.8	31.2	30.3	27.2
2	5.6	10.5	11.3	12.6	11.8
3	11.9	11.5	11.2	17.5	16.4
4	10.3	12.5	16.3	23.1	21.5
5-6	55.2	48.7	30.0	16.5	23.1
	100.0	100.0	100.0	100.0	100.0
Total area sold '000 ha	41.8	37.6	28.4	23.3	44.5

Source: (Kelly 1986)

CONCLUSION

As stated at the outset while a considerable area of marginal land is suitable for forestry the availability of this land is governed by a complex web of interacting factors. Some of the domestic factors have been dealt with above. However, in the longer term, the two most powerful contributing factors are the economic viability of agriculture and the relationship between relevant grant and support systems being delivered from Brussels for both agriculture and forestry. Both of these factors now seem to be favouring forestry. There is little joy among foresters at the current serious state of agriculture. However, if forestry can — as this author believes it can — make a long term and worthwhile contribution to rural welfare, then circumstances have never been more favourable for its development.

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The Pulp Potential and Paper Properties of Willows with Reference to *Salix viminalis*

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SUMMARY

In view of the early interest shown in growing willows as a novel source of pulpwood in Northern Ireland a review of the pulp and paper properties of the genus *Salix* was carried out. In general pulp yields were acceptable and the quantities of chemicals consumed in the pulping process not excessive.

A practical evaluation of the pulp and paper properties of juvenile *Salix viminalis* stems indicated that the material could be pulped whole but chemical consumption was high. A high-strength pulp with barely adequate drainage properties was produced. This would tend to limit the range of paper types for which the pulp would be suitable but this range could probably be increased by using more mature stems from plants grown on a longer harvesting cycle.

INTRODUCTION

Projected world shortages of wood pulp from conventional forestry led, in 1973, to the initiation of studies in Northern Ireland to evaluate novel plant sources for the production of cellulosic pulps (Anon., 1975). Initial trials on a range of species suitable for growth on poorly drained land showed that species of willow (*Salix*) were most promising (McAdam, 1975). Subsequent research and extension work was carried out on the establishment, growth and harvesting of willows on such land (Anon., 1979; Stott, McElroy, Abernathy and Hayes, 1981). The emphasis of this work was later changed to include the growing of willows as a source of biomass.

It is an essential pre-requisite to embarking on any such programme that the final product is of adequate quality to be readily utilised. Following an extensive review of the literature, the pulping potential of willow was ascertained by carrying out a practical evaluation of the pulping quality of a sample of wood of *Salix viminalis*.

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PULP AND PAPER QUALITIES OF *Salix* spp.

The pulp and paper qualities of *S. babiana* (Dyer, Chase and Young, 1968), *S. viminalis* (Lebska, 1963; Janin and Durand, 1973), *S. vistulensis* and *S. americana* (Marchlewska-Srajer, 1957) and *S. aquatica-gigantea* (Hilf, 1956) have been studied (Table 1). In all these studies the samples were pulped using the Neutral Sulphite Semi-chemical process (NSSC) which combines mild chemical treatment of chips with mechanical separation of the fibres. The chemical stage consists of cooking the wood chips with sodium or mixtures of sodium sulphite and sodium bicarbonate at about 170°C. The cooling liquor is initially alkaline but reaches approximately the neutral point as it reacts with the wood. Cooking is discontinued when sufficient lignin has been broken down to enable the fibres in the chips to be separated with minimum power consumption in disc refiners. The remaining pulp is further washed to remove soluble lignin and then further delignified as necessary using bleaching compounds, giving a higher quality pulp with a corresponding reduction in pulp yield. (See Tables 1 and 5).

All the sources quoted state that willow produces a pulp of satisfactory quality. It is accepted that paper made from juvenile wood pulp will lack the physical properties normal in mature wood. Nonetheless, the pulp made from juvenile wood is adequate for the making of good quality corrugating medium, lower quality newsprint and writing papers.

The yields cited, except for those of 12 year old *S. babiana* (Dyer, Chase and Young, 1968) are satisfactory and the quantity of chemicals consumed in the cooking processes are not excessive. With juvenile wood no difficulty was encountered when the willow was not debarked.

EVALUATION OF THE PULP POTENTIAL AND PAPER PROPERTIES OF 1 YEAR OLD *S. viminalis*

Materials and methods

A sample of 1 year old *S. viminalis* variety 'Northern Ireland' (Scott, 1971) harvested in November from the Department of Agriculture for Northern Ireland's forest nursery at Muckamore, Co. Antrim, was taken to the Paper Industry Research Association (P.I.R.A.) at Leatherhead, Surrey, England where facilities were available for carrying out studies on the pulp and paper properties of raw materials potentially suitable for the paper industry.

Table 1: Summary of results of pulping conditions and yields of six willows (*Salix* spp.)

Species	Age (yrs)	Permanganate number	Sulphidity[1] %	Max temp (°C)	Time to max temp (hrs)	Active[2] Alkali %	Chemical to wood ratio	Yield % air dry raw material	Reference
S. viminalis (+bark)	2	16.9	30	170	1.5	20	—	46.9 (fibre)	Janin & Durand (1973)
S. babiana	12	16.3	25	171	1.0	25	10:1	34.0 (fibre)	Dyer *et al* (1968)
S. vistulensis (+bark)	3		18.7	160	2.0	21	5:1	51.2 (cellulose)	Marchlewska-Szrajer (1957)
S. americiana (+bark)	3		18.7	160	2.0	21	5:1	47.7 (cellulose)	Marchlewska-Szrajer (1957)
S. viminalis 'Clay Rod'			28.6					66-72	Lebska (1963)
S. aquatica-gigantea (+bark)	6							44-51.3	Hilf (1956)

(1) Sulphidity of the cooking liquor has the formula: Sulphidity $= \dfrac{Na_2S}{Na_2S + NaOH} \times 100$

(2) Active alkali is calculated as percentage NaOH

Sample preparation

Stems were cut into 5 cm lengths and, following crushing to increase surface area and subsequent rate and evenness of liquor penetration, were loaded into 1.8 litre digestion 'bombs'.

As the wood was green, a trial digestion was performed to assess the necessary range of pulping conditions. From previous experience at P.I.R.A. it was suggested that 10% sodium sulphite based on oven dry wood would produce a usable high yield unbleached pulp. From the trial digestion it was found that double this concentration would be required for green, immature *S. viminalis.* Unfortunately, while the pulping of green wood invariably provides the strongest pulps, chemicals contained in the wood, and in this case probably in the epidermal layers also, tend to neutralise the effectiveness of the cooking liquors. Fairly typical pulping conditions for hardwood, with the exception of higher liquor concentrations, were therefore chosen.

Processing

A 2x2 factorial experiment was carried out using an electrically heated multiple bomb digester unit. Details of the various processing conditions are given in Table 2.

After digestion, the washed material was dispersed in a propellor disintegrator. Despite the comparatively low yield values (Table 2), none of the pulps produced were properly dispersed. Further treatment was given in the form of disc refining, usually only necessary for semi-chemical pulps with a yield in excess of about 60%.

The conditions for refining were a gap setting between rotating and static discs of 25 micrometres and a pulp consistency of 5% (i.e. 5 g of fibre per 100 cm^3 water). The unresolved fibre bundles remaining after this treatment were screened out on a vibrating 150 micrometer slotted screen (Somerville fractionator).

Since the two pulps produced at the lower liquor concentration (20% Na_2SO_3) were of dark brown colour, indicating reprecipitation of the dissolved lignin, these were discarded.

The other two pulps were normal and similar in appearance but, due to the unexpectedly low yields, were in insufficient quantity to permit a full evaluation of each and were bulked together.

Simple hypochlorite bleaching was carried out to assess the bleachability of the pulp.

RESULTS

Sample material

The fresh wood sample had a moisture content of 48% and the outer epidermal layer was intact. The stems, 4-16 mm in diameter,

Table 2: Pulping details and pulp yields (% air dry wood) of 1 yr old. *S. viminalis* "Northern Ireland" shoots.

Digestion No.	Cooking Conditions: Chemicals	Time (Hr)	Temp (°C)	Liquor Ratio	Cooking Liquor Residues: Na_2SO_3 consumed	pH	Bleach consumed	Total pulp yield	Yield[1] after screening
1	20% Na_2SO_3 4% Na_2SO_3	2	170	4:1	20.0%	7.1	—	47.7	43.8
2	20% Na_2SO_3 4% Na_2SO_3	4	170	4:1	19.9%	7.0	—	45.5	43.9
3	25% Na_2SO_3 5% Na_2SO_3	2	170	4.4:1	20.0%	7.5	9.0% (combined sample)	46.7	45.0
4	25% Na_2SO_3 5% Na_2SO_3	4	170	4.4:1	24.0%	7.5		39.0	37.0

(Bleached yields were not measured as these would not be meaningful. Approximately 10% yield loss was assumed with this treatment).

possessed a pithy centre approximately one third of the total diameter. Pith cells do not contribute to desired paper properties and inhibit drainage. The cambium contained some bast fibre but not in sufficient quantity to have a significant effect on strength properties. Removal of bark, an essential prerequisite in the pulping of mature wood, was not necessary as only the first sign of its formation on the more easily dissolved epidermal layer was apparent.

Pulp bleachability

The chlorine consumption was not excessive, approximately 9% being consumed. Pulp colour was not as bright as might have been expected but commercial scale operation using a bleaching sequence of chlorine (aqueous), caustic soda extraction and chlorine dioxide, for example, would easily provide a pulp of good whiteness with economical consumption of chemicals.

Beating

The unbeaten pulp when made into laboratory sheets displayed a low apparent density compared with those quoted in the literature for willow pulps. The strengths were, however, high in comparison. This indicated that little or no beating was necessary, a fact comfirmed by experimentation. Using a laboratory PFI beater with a normal load and a pulp consistency of 10%, a maximum development was obtained after only 500 revolutions (Table 3). This is about one fifth of the energy needed for a hardwood such as birch and showed the young willow fibre to be weak for papermaking.

Table 3: Bleached pulp freeness (standard Canadian)

Beater	Load		Freeness
PFI	Heavy Load	2,500 rev	(305)
PFI	Light Load	2,500 rev	(305)
PFI	Light Load	500 rev	280
Unbeaten	—		390

N.B.: Bracketed figures indicate invalid results due to inversion because of fines loss.

The resultant pulp gave paper with exceptionally good tensile strength and burst resistance but with tear similar to that obtained from many commercial hardwood pulps. Stretch was, however, poor. (Table 4). The breaking length, burst, tear, grammage and bulk factors for test papers made from the pulp sample were similar to those obtained from willow pulps tested by other workers (Table 5).

Morphology

Due to the presence of pith and retention of the epidermal layers, there was a larger quantity of cells in this pulp than would normally be experienced. This led to problems associated with drainage during pulp washing and sheetmaking. In addition, a rough estimation of fibre dimensions showed that fibre length was lower on average compared with commercial hardwood pulps and that there was an excessive number of very short fibres of less than 0.5 mm. The longer fibres were interesting in that they possessed a greater diameter to length ratio and were of thinner wall thickness than normally experienced (Hyland, 1974). This accounts for the high strength, as an even deposition of fibres with considerable bonding potential is attainable.

Table 4: Physical test data of handsheets made from *S. viminalis* pulp tested at 23°C and 50% rh using method P1F TS 6311/19/5/1971 2nd draft.

		unbeaten	beaten 50 PF1
g/m^2	Grammage cond	68.6	64.7
	OD	62.7	59.2
cm^3/g	Bulk	1.47	1.32
$kPa/g/m^2$	Burst Factor	3.94	6.82
$mN/100g/m^2$	Tear Factor	575	522
m	Breaking Length	8160	11400
%	Stretch	1.3	1.9
		(1.2-1.4)	(1.7-2.1)

Discussion

Pulping wood of the dimensions exhibited by this sample of young willow does not require the removal of the outer epidermal layer. Although, in the main, good overall strength paper may be produced, tear strength and an economic pulp yield would be improved if the wood were more mature.

Table 5: A summary of the physical properties of pulps and paper from some of the willows (*Salix* spp.) referred to in Table 1.

Species	Bulk	KPa/g/m² Burst Factor		Breaking Length (m)		Tear (mN/100g/m²)		Folding	Freeness (CSF)		Grammage g/m²	
	cm³/gm	Unbeaten	Beaten	Unbeaten	Beaten	Unbeaten	Beaten	Strength	Unbeaten	Beaten	Unbeaten	Beaten
S. babiana	1.5			6,430	8,630				492	354		70.0
S. vistulensis		1.7	6.7	4,460	11,480	33	98	633				
S. americana		1.8	5.9	4,460	10,330	49	54	322				
S. viminalis			5.7–		8,290–		67.70	750				
'Clay Rod'			6.5		9,820							
S. viminalis	1.3	5.4	26.8	1,900	5,300	23.3	60.2				65.2	65.5

However, the formation of bark would lead to difficulties in the necessary removal of bark from wood of less than 5 cms diameter by normal commercial practice in which logs in excess of 5 cms diameter are usually debarked.

The consumption of cooking liquors was comparatively high. Although lower consumption might well result from some seasoning before pulping, the coincident comparatively low yields suggests that hemicelluloses and some cellulose are being removed in solution. More mature wood might well provide a more economical operation but it is also possible that research into less conventional chemical concentration and treatment conditions would give better results.

Yields in excess of 60% from mature wood might be feasible, while a bleached pulp of 45% yield should be attainable by conventional processes. It is estimated that the comparable yield range for the sample under evaluation would be 35-50%. The yields of pulps from this samble (Table 3) were similar to those obtained for two year old *S. viminalis* by Janin and Durand (1973) and are within the range of values reported from other tests carried out on willow as a raw material for pulp (Table 5).

With mature woods, neutral sulphite pulps are quoted with whiteness values of 68% whereas the maximum whiteness obtainable with single stage hypochlorite bleaching of year old growth appears to be only about 47%.

The wood appeared not to have an exceptional number of vessal elements present, nor were the epidermal cells likely to cause problems. Cells from the pithy centre, however, could create problems in, for example, printing papers since they would be difficult to screen out from a pulp and would cause 'picking' during printing.

A rough comparison of fibre length with that of a good commercial hardwood pulp is:

Fibre length	Useful minimum	Maximum	Approx. Mean
Commercial pulp	0.6	1.9 mm	0.9 mm
Willow pulp	0.4 mm	1.6 mm*	0.5 mm

* excluding bast fibre

The width of willow fibres tends to be narrower than that of the typical hardwood, approximately in the ratio 3:5.

On beating, the willow fibres tend to retain their shape and stiffness and, since beating must be of low intensity, little or no fibrillation occurs. Compared again with the commercial pulp, the willow fibres have high initial bonding potential which develops on beating to a very high level. These observations correspond to the measured poor tear and very high tensile and burst strengths.

The drainage properties of the willow pulp were not easily measured as many fine fibres passed through the apparatus with the water. Values obtained, however, suggest that the pulp would be relatively difficult to handle but would run on most paper machines. In drainage properties this willow resembles a bleached beech pulp — a pulp which has limited use in some printing and writing papers.

CONCLUSIONS

One year old *S. viminalis* 'Northern Ireland' could be pulped whole but chemical consumptions would be high.

In whole stem pulping there was not sufficient bast fibre present to enhance the tear resistance of paper produced. The pulp would need careful treatment but has the advantage of producing high strength (except tear) and even formation with the expenditure of very little energy.

Drainage properties were just adequate but there would be a limited number of paper types for which the pulp would be suitable. It is possible that with a true semi-chemical pulping the material could form a good fluting medium for corrugated boards. Many properties, at present creating disadvantages in use, could be improved by allowing the willow to mature before harvesting. Other aspects, particularly economic, could also possibly be helped by a longer harvesting cycle.

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Road Systems in Forestry

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ABSTRACT

The high costs of forest road construction, maintenance, and timber transportation warrant extensive planning of forest road network layout. Two factors have to be considered during this planning process: road density, which influences off-road transportation distances, and road class, which relates to trucking and road maintenance costs. In order to establish well planned forest roads, it is essential that the planning process involves the total network, not individual roads or road segments.

Current research, including computerised road location procedures, the use of geotextiles in road construction, and the development of a central tyre inflation concept, will have an important impact on the control of future harvest transportation costs.

INTRODUCTION

The management of timberlands requires easy access to the total production area, and the linkage of resources and processing locations. In general, roads form the major contributor in a forest transportation network. They are both the arteries and veins in the anatomy of the forest products industry. On the basis of ownership the overall road network can be divided into two parts: roads that are in public control, and roads in private control. Both the public and private roads are of critical concern to those involved in the management of forest resources.

Within the (private) forest lands a road network is needed to provide access to the stands of timber for management, protection and harvesting operations. These forest road networks commonly connect the forest area with the public road system, which in turn connects to the processing locations. In some situations, because of vehicle size and weight restrictions for the public road system, it is economically more attractive to expand the private road network all the way to the processing location. In that case it is possible to increase vehicle load size and to reduce transportation costs. If public roads make up part of the transport network from the forest to the processing location, it may still be economically interesting to use oversize vehicles, such as double trailers, on the private forest roads, and to adjust them to public road standards for the remainder of the journey (i.e. move one trailer at a time). However, in most cases a single vehicle configuration, restricted by the public road standards, will be used for the entire network.

ROAD CLASSIFICATION

Most private road networks are divided into classes according to owner policy (Murphy, 1985). The class of the road identifies the functional role of that road in the overall road system. Examples are: Class I=major haul road, primary transportation route; Class II=haul road, access to management units; Class III=operational road, to which the wood is yarded. Associated with each functions class is a list of minimum and/or maximum structural specifications. This list may include minimum and maximum up-hill and down-hill slopes, maximum curvature, minimum road width and right-of-way width, surface type, design speed, etc. Also included in the lists are specifications for related structures such as bridges and culverts. These specification lists are used during new road location and construction, and road maintenance and upgrading procedures. When locating a road of a given class, the location and design of the road are restricted by the structural specifications stated in the appropriate list. This will influence the final road location as well as the amount of construction work required. Maintenance and upgrading procedures should also take into account the class of the road and the required structural specifications. The specifications for each class should be chosen so that the overall cost of construction, maintenance and transportation will be minimised. For instance, in minimising construction costs, it is very likely that maintenance and transportation costs will be very high if the road is used intensively. It may be desirable to increase the construction costs, so that the maintenance and transportation costs will decrease.

ROAD DENSITY

A second major factor which determines the efficiency and effectiveness of a road system is quantity, expressed as road density or road length per unit area. For operational road classes, consisting of the roads to which the timber is yarded, the optimal density depends on the harvesting system used, stand parameters, and road (and landing) constructional costs. In the case of parallel operational roads, where the road sides are used as landing area and two-way extraction is possible, the formula for optimal road spacing is:

$$S = \sqrt{\frac{2R}{MVF}}$$

where S=optional parallel road spacing in 100 metre units,
R=road construction cost in pounds per 100 metres,
M=off-road movement cost in pounds per cubic metre per 100 metre roundtrip,
V=volume to be harvested in cubic metres per hectare, and
F= sinuosity or indirectness factor (=1), equal to the ratio of the actual over the straight-line extraction distance.

If both roads and landings have to be located, the mathematical relationships become much more complex and an iterative procedure is needed to determine the optimal road and optimal landing spacings simultaneously (corcoran, 1973). By shifting of landing locations on alternate roads it will be possible in certain cases to further reduce the total associated costs (Bryer, 1983).

The actual location of operational roads (and landings) in the forest should be performed according to the determined spacing(s), while taking into account the variability of local terrain conditions (Ashley et al., 1973). Special computer programmes have been developed which deal with various terrain conditions and yarding systems (Carson and Dijkstra, 1978; Hogan; Holman et al., 1976). But because of the almost permanent nature of most forest roads, and the changing harvesting systems and stand parameters, the use of constant road service zone widths in road location procedures has been increasing, especially in the case of operational road location.

The haul road densities are dependent on area configuration, harvest volumes, and road construction costs (Carter et al., 1973). The problem is to ascertain the combination of road classes (quality) and road density (quantity) which will minimise the sum of associated yarding, transportation, construction, and maintenance costs (Jonee et al., 1986). It has been claimed that the most valued real estate in forests, on a unit area basis, are the roads. Because of this high value, and also because of the high cost of transportation, the importance of ascertaining the right combination of road quality and quantity is essential for successful forest management.

ROAD NETWORK PANNING

Well planned and constructed roads are fundamental for carrying out harvesting and other operations economically. The planning and construction of good forest roads can therefore be regarded as an excellent investment (Sunberg, 1976). A road should never be planned without considering future roads of the road network as well (Sedlak, 1978). This is a basic rule in forest road planning, but is often not followed, due to short-sighted planning procedures. There is no other field in forestry, where planning mistakes are as irreversible and costly as in forest road construction (Pestal, 1977). Before any road is planned, a general planning for the whole area is necessary, especially for main and secondary roads. During the planning of the whole area, two questions have to be answered for each proposed road. First, how is the road going to be integrated in the overall network, and second, how does the location of the proposed road affect the future expansion of the network.

At this time a decision must be made which function class has to be assigned to each road segment. This decision should be based on the expected traffic intensity, especially of logging trucks, for the completed network. The maximum and minimum intensity levels for each function class are based on the minimisation of the combined trucking, road construction and road maintenance costs. A higher class road means a higher construction cost, but above a certain traffic intensity level this will be compensated for by lower maintenance and trucking costs. The traffic intensity can be estimated by the part of the expected yearly harvest which will pass over that particular road segment (Haussman and Pruett, 1978). In some cases, the amount of non-truck traffic, such as tourist cars, has to be taken into account during the selection of the proper road classes.

As soon as an overall plan has been developed, the planning and exact location of the individual roads can start (Morofsky, 1977). The specifications used for the individual roads should reflect the function of the road in the completed network. In most cases it will be less expensive to over-design the road for the present situation, than having to upgrade it later on when the network expands. The upgrading often means almost complete reconstruction, because of differences in structural specifications, such as maximum slope, width, minimum sight distance, and maximum curvature, for the different road classes.

Except from the planning of roads for the opening up of newly established or planned forests, additional roads may be required because of salvage operations (Corcoran and Nieuwenhuis, 1985), changes in harvesting and/or transportation systems, upgrading of existing network segments, environmental policies, fire control, and recreation.

RESEARCH AND DEVELOPMENTS

During the last decade, the use of computerised geographic information systems (GIS) for forest management has increased rapidly (Tomlin, 1983; Reinders and Wijngaard, 1984). The capability of these systems to facilitate the accessibility of diverse data allows for the inclusion of all essential information in management planning procedures. The use of these systems to assist in the management and development of forest road networks is being studied widely. This includes network inventory systems (Nieuwenhuis, 1983); maintenance and upgrading procedures; road network analysis techniques such as travel time estimation, shortest route determination and capacity calculations (Pulkki, 1984); and new road location and design procedures (Nieuwenhuis, 1986; Sakai, 1984). The ability of GIS users to combine data sets, such as cover type, timber volumes, soil types, elevation, topographical features, and other management information, results in the enhancement of the decision-making processes.

In the area of road construction, the use of geotextiles is growing rapidly (O'Neill, 1982). The use of these materials can reduce the amount of excavation necessary, because it adds strength to the road base. In addition, road construction costs can be reduced because inclusion of geotextiles in road design will allow for the location of roads through areas which previously had to be avoided. The use of geotextiles in forest road construction, both for permanent and temporary roads, is being investigated (Jarrett, 1984; Douglas, 1985).

In areas where transport speeds are low, such as in mountainous terrain, transport cost may be reduced by the introduction of the central tyre inflation concept. A truck-mounted compressor would provide operator type-inflation control. Inflation pressure would be reduced on lower-speed aggregate roads, which can result in a substantial reduction of surfacing requirements, operator fatigue, and truck maintenance (Della-Morretta, 1984). The inflation pressure is increased when road conditions permit. The success of the central tyre inflation concept for log transport could start a major trend in the design and management of forest roads (Sessions et al., 1986).

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The Utilisation of Timber by the ESB

J. Fallon

Electricity Supply Board,
Lower Fitzwilliam Street, Dublin 2.

The Electricity Supply Board (ESB), a state sponsored body, has sole responsibility for generation, transmission, distribution and sale of electricity in the Republic of Ireland.

The ESB, founded in 1927, has its centre in Dublin. It has 25 generating stations, six regional and numerous area offices scattered throughout the country. It has a generating capacity of 3,274 M.watts with an additional 900 M.w. coming on stream in phases during 1987 from the new coal burning station at Moneypoint.

To support the network of cables necessary to carry this amount of electricity through the country both metal and wooden supports are needed in large numbers. The following gives some appreciation of the enormous amount of various types of wood items used in the construction and maintenance of this distribution network.

ESB Usage of Forest Material in 1986

Item	**Size category**	**Numbers used**
Transmission poles	14-23 metres	137
Distribution poles	9-20 metres	30,000
Staylogs	As described	24,000
Cattleguards	,, ,,	20,000
Earth wire guards	,, ,,	7,000
Marker Boards	,, ,,	101,000
Sleepers	,, ,,	800

It might be useful to look at each of these items in turn to see how and why they are used and to establish what is required from each category of timber used.

IRISH FORESTRY, 1987, Vol. 44, No. 1: 50-58.

Transmission Poles

Electricity is generated at a voltage of 17 kiloVolts from oil, gas, coal, turf or hydro power and enters a step-up transformer to increase its voltage to the primary transmission voltages of 400 kV., 220kV. or 110 kV. The 220 kV. voltage is transmitted through steel core aluminium conductors supported on galvanised steel pylons. The 110 kV. voltage is transmitted through conductors supported on wooden poles which range in length from 14-22.9 metres and with a minimum top circumference of 63 centimetres. These poles are used in pairs at five metre spacing to carry galvanised steel crossarms nine metres in length, and disc insulators and steel core aluminium conductor. The span between each pair of poles is approximately 220 metres, and there are 3,500 kilometres of wood supported 110 kV. line in the country. All the ESB's requirements for these poles are met from native sources. The species predominantly used is Douglas fir.

Distribution poles

The distribution network begins at 38 kV. outlets of 110 kV./38 kV. transmission transformer stations, each of which supplies approximately five 38 kV. lines. The conductor used for carrying this voltage is 100 mm., 200 mm. or 300 mm. steel core aluminium which is carried on galvanised steel crossarms four metres in length and insulated by pin or disc insulators. The conductor and headgear is supported overground by wooden poles which range in length from 12-20 metres and with top circumferences ranging from a minimum of 50 centimetres to over 63 centimetres. There are 5,700 km. of 38 kV. lines in the country of which up to two thirds are supported by pairs of wooden poles (portals) at two metre spacing. The span between each pair of poles is about 150 metres and the length of 38 kV. line averages between 10-15 km. The ESB's requirements for this category of pole is fully met by native supplies. The species used are Douglas fir and European and Japanese larch.

Each of these 38 kV. lines supply a 38 kV./10 kV. transformer station which in turn supplies five 10 kiloVolt lines (3 phase) called "backbone lines". The average length of a backbone line is 25 km. with approximately 75 km. of branch or spur lines being supplied from this backbone line. The conductors and headgear of these lines are supported on wooden poles which range in length from 9-11 metres with top diameters of 15 to 26 centimetres. The poles with the heavier top diameters are used as angle or end poles because of the greater stresses involved, while the lighter category of pole is used in intermediate positions. The heaviest category of pole is used to carry transformers which are bolted directly onto the pole. The average span between these poles is 100 metres and the depth of foundation is two metres. This 10 kV. network distributes three phase electricity to every part of the country and is in turn stepped down for domestic consumption.

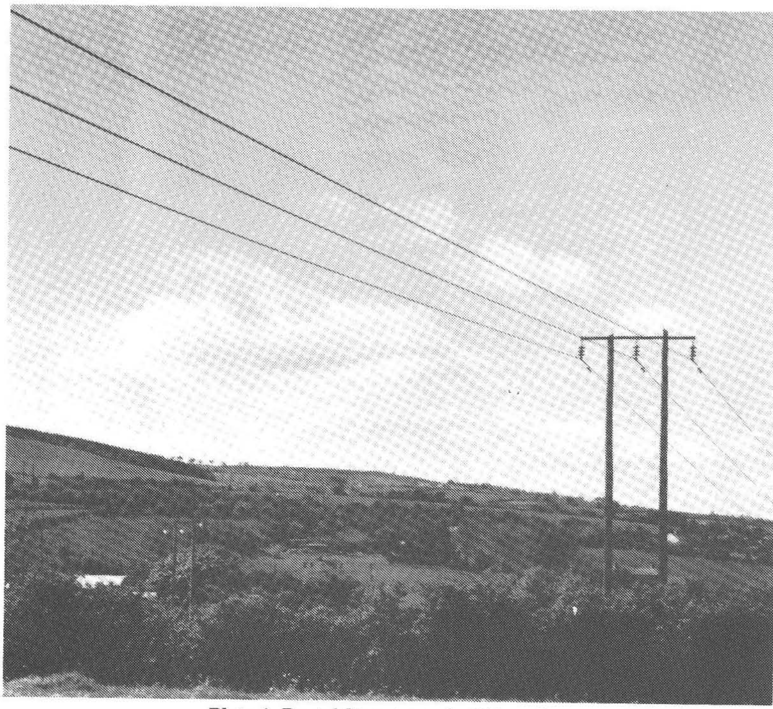

Plate 1: Portal Structure of a 38 k.v. line.

Since the inception of the rural electrification scheme in 1946 over 1.7 million 10 kV./1V. poles have been erected throughout the country. The ESB's needs for this category of pole are not fully met from native sources. The ESB generally obtains between 50-55% of its supply from the home market. The species used are Douglas fir, European and Japanese larch and imported Scots pine. In order to diversify species choice the ESB has engaged in research into other home grown species such as eucalyptus, Corsican pine, Norway spruce and ponded Sitka spruce. Presently the feasibility of using unponded Sitka spruce for 10 kV./1V. poles is being examined.

SMALLWOODS

Besides poles the ESB requires large quantities of smaller wooden material which it defines as "smallwoods". All of the material is supplied by Irish sawmills. These materials fall into the following categories:

Staylogs

Staylogs are half round logs 1.3 m long with a minimum diameter of about 20 cm. These logs are pressure treated and are buried at a depth of 1.2-1.4 metres. Approximately 24,000 pieces of staylog are used annually by the ESB.

Staylogs are in turn attached to "staywire" (strainer wire) which function to give additional stability to end poles or to poles positioned at an angle in the line.

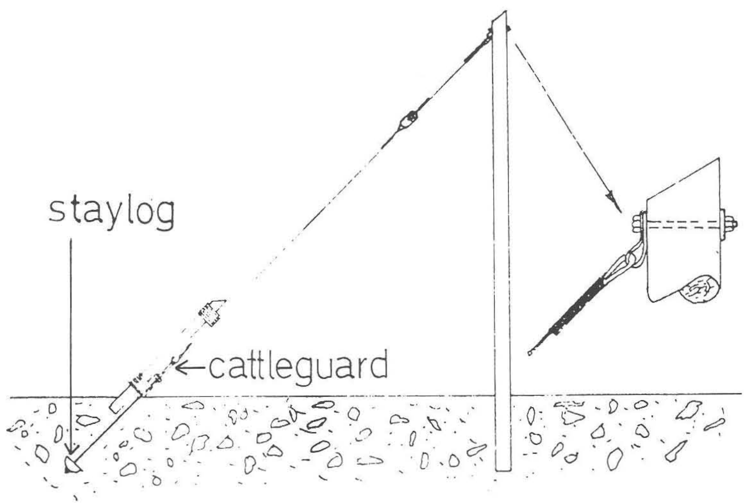

Fig 1: Sketch of Staylog and Cattleguard.

Cattleguards

These are sawn from Scots pine, larch, Douglas fir or spruce and are pressure treated with an approved preservative. Cattleguards are half round logs two metres long with a mid diameter of about 12 centimetres and a minimum diameter of nine centimetres at the small end. Cattleguards, as the name implies, are attached at ground level to 'staybows' (part of the straining wire) to prevent livestock from injuring themselves against the staywire. Somewhere in the order of 20,000 cattleguards are needed each year.

In a typical low voltage line every fifth pole would be earthed. To protect this earth from damage and for safety reasons it is concealed behind one or two wooden guards where the wire approaches ground level. Each earthware guard is grooved on one side to carry the wire and is pressure treated with a suitable preservative. Suitable species for making these guards are the same as for cattleguards and dimensions would run to lengths of 2.3 metres by 5 centimetres x 2.5 centimetres. Wooden guards are being superceded by plastic piping.

Marker Boards

These are used to cover underground cable. Each board is 1.8 m x 15 cm x 2.5 cm. All are pressure treated and sawn from the same species used to make cattleguards. In 1985 enough Marker Boards were used to cover 184 kilometres of cable.

Sleepers

Sleepers are used as temporary transformer foundations and as pole foundations particularly in soft ground. On occasion they are used in loading and unloading of transformers onto ESB transport. This is accomplished using sleepers, jacks and winches. The transformer is jacked up and a foundation is built up under it with sleepers. Steel cables are then tied to the transformer which is then winched from the foundation of sleepers onto the trailer. The reverse happens in unloading.

Bog Boards

These are blocks of wood which are pressure treated and bolted onto the butts of poles which are used to carry an ESB line across bog or marshy ground.

THE SUPPLY OF POLES FROM IRISH FORESTS

The Department of Energy is the main supplier of home grown poles, with a small percentage being supplied by private woodland owners. The suppliers are responsible for the selection, felling, shedding and debarking of the trees. They cut them to the required length and dimensions with the top cut, on the slope, to provide a run-off for rain. The poles are usually placed on a ramp constructed beside the forest road. The ramps should be constructed so as to leave the poles at least 12" clear off the ground and should be located away from overhanging trees. The vegetation under these ramps should be kept under control while the poles are being stored on them.

The Inspection of the Poles

The poles are inspected by an ESB Inspector who ensures that all poles are turned on the ramp. This enables him to spot defects such as splits, cracks, decay, sweep, excessive knots and insect attack. Any poles with these defects are marked for rejection. When all the poles have been turned, he then goes back and measures the poles for length and top diameter. When each pole is measured and accepted by the Inspector he calls the code to a member of the forestry staff who proceeds to chalk the code onto the butt of the pole. (Each size category is coded). The process often involves further cutting to fit a pole into one of the size categories. After all the poles on the ramp have been measured the Inspector stamps the butts of all poles accepted by him with a hammer bearing his initials. The number of stamps denoting species: one stamp — Sitka spruce; two stamps — European/Japanese larch; three stamps — Douglas fir. A tag is affixed to the butt of each pole accepted which is inscribed with a code denoting the size of the pole. Upon completion of tagging, the Inspector records the number of poles accepted against each size category and the number of poles rejected. When all the poles have been inspected in the forest centre an inspection report is prepared. A copy of this report is sent to the ESB Transport Supervisor who makes arrangements with the supplier for the collection of the poles, another copy is sent to the supplier, while a third copy is retained by the Forestry Unit, ESB. The supplier is responsible for loading the poles onto ESB transport. The poles are brought to one of the two creosoting depots in the country where they are offloaded and put into stock to air season.

Timber Preservation

Given the usage to which timber is put in the ESB network preservation of such wood is an important consideration. Untreated timber under such conditions would last perhaps 5-7 years. To extend their service life timber preservative is essential. The ESB expects a minimum service life of 30 years from a creosated pole. However in reality poles are lasting considerably longer than this. At age 42 years 50% of the original population will still be in the sound category (no rot). When poles where examined for rot it was found that of those that showed rot 67% showed external rot and 33% had internal rot. Of the poles showing external rot 90% of these had rot located below groundline to 60 centimetres above ground level. There is no significant difference in rot performance between imported and native grown poles.

Description of Wood Preservatives used by the ESB

(1) Cresote Oil

Cresote oil is a distillate of coal tar which is produced by the high temperature carbonisation of bituminous coal. It is a complex substance that is composed principally of hydrocarbons, tar acids and tar bases. It has a specific gravity of approximately 1.05 kilogrammes/litres and has a distillation range from 200°C-350°C. The tar acids comprise phenols, xylenols and naphthols, all of whlich are toxic to fungi. The tar bases are represented by pyridines, quinolenes and acidines which are mostly toxic. The hydrocarbons comprise the bulk of the volume and include benzene, toluene, xylene and naphthalene. Research has shown that the hydrocarbons which distills between 200°-275°C are more toxic to wood destroying fungi than the whole creosote. A number of individual hydrocarbons found within this boiling range are extremely toxic, while others are not soluble enough to exert their full poisonous effect — hydrocarbons distilling above 275°C are too insoluble to be effective against fungi (Hunt & Garratt, 1953). Cresote confers a degree of water repellency on timber and consequently checking is slight in comparison to poles treated by inorganic salts. It also has a preservation effect on steel in galvanised steel crossarms and coach screws. Poles treated with cresote are not particularly flammable.

(2) Water Borne Preservatives

Water borne preservatives consist of an inorganic preservative with a fixing agent such as dichromate dissolved in water. Its main advantages are cheapness and availability, together with the fact that large stocks of the salts can be stored easily in comparison with the previous two categories of preservative. Another advantage is that this type of preservative is clean and free from odour. Its disadvantages are that wood impregnated with it swells upon treatment and shrinks considerably on drying, often with severe checks.

The ESB utilised this type of preservative on it wood poles. One type consisting of a mixture of arsenic acid, copper arsenate and chromic acid was used on Scots pine in 1954/1955. These poles have been carefully monitored since then and it would appear that this is a very effective preservative.

Preparation of Poles Prior to Treatment

The poles are machine dressed which removes stubs, inner bark and the cambium layer. This process aids penetration and improves the visual appearance of the pole. They are then scribed at at point 3 metres from the butt end. This is to ensure that the pole is placed at the correct depth of foundation. The scribe marks denote year of treatment, species and whether native or imported, e.g.:

D86 — Native Douglas fir	Treated 1986
L86 — Native larch	Treated 1986
86P — Imported Scots pine	Treated 1986

The tops are cut at a slope of 30° (if necessary) and drilling carried out (in the case of transmission poles) prior to treatment, which is standard practice. The poles would have been air seasoned for a period of 12-18 months so that the moisture content has fallen to between 25-30%.

Pressure Treatment of Poles

Pressure treatment of poles is achieved by placing them into cylinders approximately 70'-75' in length and 6' in diameter. The cylinder is sealed and preservative is pumped in and pressed into poles at pressures of 8-10 atmospheres. The various pressure methods used for injecting preservative into wood in closed cylinders may be divided into two main groups: designated full cell and empty cell processes. The object of the full cell process is to inject as much preservative inot the wood during the pressure period as possible i.e. cell walls and cell spaces are filled with preservative. In the empty cell processes part of the preservative injected into the timber is recovered and the cells tended to be coated with preservative rather than filled with it.

Full Cell Process

(a) Bethell Process

The poles are loaded into tram cars or bogies which are then pushed into the treatment cylinder; approximately forty five 10 kV./1V.; fifteen 38 kV. or nine 110 kV. poles per charge. The cylinder is sealed and a partial vacuum of 60 cm Hg is achieved and held for approximately 30 minutes. The purpose of applying this vacuum is to exhaust part of the air from the outer layers of the poles, then while holding this vacuum the cylinger is filled with hot creosote — the temperature of which is maintained at 80°C. When the cylinger is full the pressing pumps are turned on and the pressure is allowed to build up to 10.5 kgs/cm^2 (150 P.S.I.). This pressure is maintained during the pressing period, which in the case of Scots pine (which is classed as moderately resistant) the pressing period may last from 10 minutes-2 hours, although more usually the pressing is completed in 15-25 minutes by which time adequate creosote retentions have been achieved e.g. a minimum retention of 115 kgs/cubic metres. The pressing period for Douglas fir, which is classed as resistent, is eight hours. At the end of the pressing period the cylinder is emptied and a partial vacuum of 60 cm Hg is applied for a duration fo 30 minutes.

The poles generally emerge dry after this process. Average retentions achieved by this process in recent times are as follows:

Douglas fir	— 192 kg/m^3
Scots pine	— 240 kg/m^3
Ponded Sitka spruce	— 211 kg/m^3

Empty Cell Process

(a) Reuping Process

The poles are put into the cylinger which is then sealed. The air pumps are switched on and the air pressure is allowed to build up to 1.75 kgs/cm^2 (25 P.S.I.). While maintaining this air pressure the cylinder is filled with hot creosote at 80°C. When the cylinder is almost full the air is slowly released whilst maintaining pressure. Once the cylinger is full with creosote the pressing pumps are switched on and the pressure is allowed to build up from 1.75 kg/cm^2 to 10.5 kg/cm^2 (150 P.S.I.). The same pressing periods are applied to the different species of timber as for the Bethell process. When the pressing period is completed the cylinder is emptied and a vacuum is applied. This causes the entrapped air to escape and thereby return a proportion of creosote to the cylinder. Typical retentions achieved by this process in recent years are given below:

Douglas fir	— 96 kg/m^3
Scots pine	— 122 kg/m^3
Ponded Sitka spruce	— 118 kg/m^3

REFERENCES

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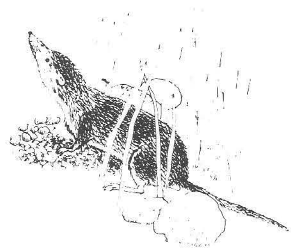
The Other Ingredient



Woodlice are related to lobsters and crabs. To that extent the forests of Ireland and the Department of the Marine have linkage. Forests also display parallel habitat to that of the sea.

What forester has not walked through tall forests and been struck by the thought that in the silence and the half light he could be walking in the depths of the ocean! On stormy days the roar and turbulence in the canopy holds the same frenzy and violence as a storm at sea.

Life lives where light is. In forests great tonnage of insect and arachnid and bird life live out their lives in the canopy layer with no great occasion to visit the lower zones. On death such life may drop through the canopy and tumble down to the forest floor. As in a forest, the photosyntheic layer of the ocean lies as a mesh of soup in the surface layers. Below this 'canopy' all living things depend on the remains of dead creatures — plankton, nexton, bacteria — falling in a continuous rain through the weakening light. They sink past the 800 metre mark and into the dark. They drift down beyond the region of the cephalopods and down further past the blunt snouts of angler fish and some of those that have not simply dissolved their lime shells during the descent slip among the ribs of dead schooners and lie still on the ooze, as ooze, in the never changing darkness.

Whales are like that. It can take up to two days for a dead whale to sink to the abyss. On estimates of mortality it is thought that each 50 square miles of the abyss receives one whale per year. In the same manner it takes less than a minute for a great forest tree to fall. It breaks free of its moorings and pulls its head beneath the canopy and collapses downward to the half gloom of the forest floor below. In both cases, whale and tree, each lie and wait for the inevitable dismemberment. The one, in part, by spiny crabs, the other, in part, by slow fragmentation by woodlice.

There is indeed something to be said for the similarity of seas and forests!

Forestry News

AN IRISH MARKET? — USE OF ASH

N. Hanlon Ireland Ltd., Co. Longford, make about 700 ambulances a year. Of these, 40-50 are sold annually in Ireland with the greater bulk going to the U.K. and the occasional order finding its way to the Middle East.

This is the only company in the Irish Republic that specialises in ambulance building. The company uses in the region of 480 tons of rough-sawn ash a year. The entire frame of each ambulance is made of this wood which in turn is covered by an overlay of fibreglass. The properties of flexibility and resilience of ash is ideal for this purpose.

In the manufacture of each vehicle 106 kilogrammes of finished ash is required. However, a high wastage results to produce the lengths and shapes required. This wastage is burned to heat the factory during the winter.

Most of the ash needed is imported from the U.K. Irish suppliers have difficulty supplying, on a regular basis, straight ash of lengths of about four metres.

(Information kindly supplied by N. Hanlon, Ireland Ltd.).

ALTERNATIVES TO SIMAZINE IN NURSERY MANAGEMENT

The development of simazine-resistant weed populations is a potentially serious problem in nursery management. Experiments suggest that napropamide, a napropamide-simazine mixture and oxadiazon can be used as alternatives to simazine for weed control in transplant lines at time of lining-out.

(Information kindly supplied by Forestry Commission, Forest Research Station, Alice Holt Lodge, Surrey. — Based on Research Info. Note by T. S. P. Sale and W. L. Mason).

FOREST PRODUCTS

High in the mountain woods in Italy the Camaldolese hermits in 1157 made a liqueur from the secretions of scale insect which fed on pine trees. The liqueur was called Lacrima d'Abeto — tears of the pine.

ELECTION TO IUFRO

At the 18th World Congress of the International Union of Forestry Research Organisation (IUFRO) in Yugoslavia in September 1986, Fergal Mulloy of the Forest and Wildlife Service was elected Regional Executive Board member for Northern

Europe. The executive board, among others, is composed of nine Regional members.

Mr. Mulloy is to be congratulated. Election to the executive board is a recognition of the important role Ireland has played in forest research. In particular Ireland has contributed important work in the fields of provenance trials and thinning trials.

IUFRO was founded in 1890/92 to rationalise forest research techniques, to standardise systems of measurement and to promote international co-operation in forest research. To date there are over 600 member institutions incorporating 15,000 scientists from almost 100 countries. Ireland has four organisation members; UCD: FWS: IIRS and Forestry Division, Nothern Ireland.

SHADES OF THINGS TO COME?

Plants vary in their sensitivity to radiation. Radioactive isotopes settling on leaves are absorbed and many move throughout the whole plant.

The degree of sensitivity, research has shown, is linked with the chromosome volume of a species. In general the smaller the volume the less sensitive plants are.

Flowering plant species are less resistant to the effects of radiation than non-flowering species. Conifer forests are more susceptible than broadleaved forests.

(Ref. New Scientist).

HAVE WIND WILL TRAVEL!

In 1924 in Spitsbergen, scattered ove a wide area of snow covered land were found innumerable spruce aphids which were still alive. Obviously they were not feeding on snow. The nearest land mass from which they could have come was the Kaola Peninsula 800 miles away. At the time of the observation wind was blowing from that direction and it was estimated that the insects would have been in the air at least 24 hours to travel a journey of that distance.

FORESTRY CONFERENCE

The Institute of Foresters of Australia is hosting the 1987 International Forestry Conference in Perth, Western Australia between 28th September and 2nd October 1987.

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

Plate 2: Hayesbridge on the River Avonmore at Avondale. Published by J. Fisher August 1792.

Letter to the Editor

Dear Sir,

The theme of this year's symposium, "Broadleaves in Irish Forestry", brings to my mind once again, the restrictive attitude adopted by the Society to this important event in its calendar. As usual, attendance at the symposium is confined to members of the Society. It is not advertised and goes unreported in the national press. I find it difficult to reconcile this introverted policy with Article 11 of the Society's constitution which states

> "The object of the Society shall be to advance and spread in Ireland the knowledge of forestry in all its aspects."

The symposium represents a valuable opportunity for us to do this, with forestry now claiming media attention and, by good fortune this year, a theme which would certainly catch the imagination of many who are interested in the countryside and its development.

Both the State and private sectors have been criticised for the low level of planting of broadleaved species. It would indeed have been a wise policy to let the public see the Society take a positive and constructive view of their place in Irish forestry.

This opportunity has been lost but I would implore the incoming Council to abandon reactionary policies. The Society should now come out and vigorously promote the cause of Irish forestry. What matter if we provoke controversy. This can only stimulate valuable discussion, bring in new ideas and in time, expand and develop our vision and the public's perception of forestry on this island.

Dr. E. P. Farrell.

Book Reviews

SOIL RESOURCE SURVEYS FOR FORESTRY — SOIL, TERRAIN AND SITE MAPPING IN BOREAL AND TEMPERATE FORESTS

K. W. G. Valentine, Monographs on Soil and Resources Survey No. 10. Oxford Science Publications, Oxford University Press, Walton Street, Oxford OX2, 6DP, England.

Several factors have combined to make the current generation of foresters pay more attention to the soils on which trees grow than perhaps their predecessors did. At least this is the position in Western Europe and Northern America where the effects of exploitive forestry practices, common centuries ago, are now being redressed by intensive silviculture. However, the situation in the tropics is less sanguine due to the well-known deforestation practices being conducted there, with inevitable detrimental consequences to the soils. Irish foresters have come to recognise the importance of the soil to the continued well-being of the forest, mainly through experience of destructive effects of modern harvesting machines on soils and also through experience of the ravages of windthrow on particular soils.

Surveys of forest land have not always been regarded as worthwhile and some sitll question their value. However, the author of this book neatly argues in their favour by pointing out that although the source of wood production was generally regarded as the trees it is now more properly perceived as one stage back — in the soil. Also acceptable are his reasons why forest soil-site surveys are peculiarly different to other (agricultural mainly) soil surveys. For instance particular properties need to be emphasised in forest surveys — as an example trees respond more to water and rooting depth and less to immediate nutrient supply than do agricultural crops.

This book contains the minutest details of how to make a forest soil survey. These chapters I fear will interest only those who have to conduct surveys themselves. The specialist therefore will relish those chapters dealing with: (i) the stages of a survey and how to produce a soil map, (ii) the way to plan a survey, (iii) the collection and recording of information in the field, and the equipment required, (iv) the evaluation of information to express the potential of soil and land for forestry, (v) the presentation of information to the forester in the form of soil descriptions, maps and evaluations, and (vi) the use of computers in forest soil surveys.

The general reader will find most value in the early chapters. In these the author describes the nature, management and planning of forests, all the time impressing on the reader the imporance and relevance of soil properties to the various forestry practices employed, in particular how soils influence tree growth and harvesting method. Equally impressive and informative is the presentation of the many kinds of classification systems applied to forest lands, especially the explanation of the differences between them and their application. For these chapters alone I would recommend the book to those who still remain unconvinced of the primary imporance of the soil resource in determining the potential of the forest. Maybe then they will understand why some of us peer into soil pits, and even dig them!

Dick McCarthy.

THE FOX

H. G. Lloyd and R. Hewson. Forestry Commission Record No. 131, 19 pages. Colour and black and white photographs. £2.95 sterling by post. HMSO Publications Centre, P.O. Box 276, London, SW8 5DT.

Space does not allow a long review of this booklet. It is a publication however worthy of comment. I have a feeling that as I try to express a view on the booklet that I am in fact making comment on the collectivised body of 'Forest Records' issued by the Forestry Commission over the years. I have found them always to be singularly informative, useful, precise — and above all readable. This booklet on the fox is no exception to the high standards set. Although the price is high, if you want 19 pages of well presented facts on the ecology of this wild animal, then you would be foolish to pass this booklet by.

P. McCusker.

Society Activities

COUNCIL REPORT 1986

Symposium

"Trees — A Growing Investment" was the theme of the Symposium held at UCD on 21st March, which was attended by 238 members. Six papers were presented on the subject. Papers and presenters were as follows:

PAPER	PRESENTER
Forestry in Europe	Dr. F. C. Hummel, International Forestry Consultant
Productive capacity and availability of land for forestry in Ireland	Mr. M. Bulfin, Agricultural Institute, Dublin
The economics of forestry on different soil types	Mr. D. O'Brien, Forest and Wildlife Service
Forestry Investment from an insurance company's viewpoint	Mr. R. O'Beirn, Irish Life, Dublin
Private Forestry Development in U.K.	Mr. W. B. Walker, Flintshire Woodlands Ltd., Wales
State Forestry in Ireland — The Future	Dr. R. N. O Carroll, Forest and Wildlife Service

Annual Study Tour

The tour was held in Galway from 27th-29th May and a full account of what took place is in Irish Forestry Vol. 43 (2).

Meetings

One day meeting was held at the beginning of May in Co. Wicklow. The morning was spent in Kilmacurra research nursery and was concerned with tree breeding programmes and a visit to the arboretum. The leaders for the morning were J. O'Driscoll, A. Pfeifer, J. O'Dowd and G. Murphy. In the afternoon the group moved to Glenealy forest where J. Neilan spoke on the management of oak woodlands and eucalyptus stands after which much discussion followed.

Guided Forest Walks

Walks were held at 28 centres throughout the country on 14th 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 day and the Convenor of the Forest Walks, Mr. J. Fennessy, and leaders of same. Thanks are also due to the Forest and Wildlife Service, Dublin and the Forest Service, Belfast and University College Dublin, for their co-operation and assistance during the year.

Annual General Meeting

The AGM was held in UCD on 20th March. The Minutes were published in Irish Forestry Vo. 43 (1).

Publications

(i) Irish Forestry Vol. 43 was published.
(ii) Irish Forestry Index Volumes XXXI-XXXX, 1974-1983.

Examinations

At the time of reporting examinations are not yet complete. Four candidates are sitting the examinations.

Education Award Fund

The winner of the current year's prize is Ms. B. Hall, Dublin. (U.C.D. recipient).

Elections

Three posts of Technical Councillor and one post of Associate Councillor were filled by election and approved at the AGM. The names are: Technical — J. Fennessy, R. Whelan and J. O'Dowd; Associate — A. J. van der Wel. As there was only one candidate for each of the other posts they were filled without election. The total valid poll in the 1986 election was 190.

Membership

Number of members on 31st December 1986:

	Technical	*Associate*	*Student*	*Total*
	471	129	55	655
New members elected in 1986:				
	13	21	4	38

Attendance at Council Meetings

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

M. O'Brien, P. McCusker, E. Hendrick,
J. Fennessy, J. O Driscoll, L. Furlong .... 5 meetings

G. Murphy, D. Magner, E. Griffin .... 4 meetings

J. Prior, A. Pfeifer, J. Neilan .... 3 meetings
T. Farrell, J. Griffin .... 2 meetings
B. Hussey .... 1 meeting

Signed: E. Griffin,

April 1987. *Hon. Secretary.*

MINUTES OF THE 45th ANNUAL GENERAL MEETING
THURSDAY 2nd APRIL, 1987
AGRICULTURAL BUILDING, U.C.D., DUBLIN.

The outgoing President, Mr. M. O'Brien took the Chair.

Attendance

J. Fennessy, E. Hendrick, J. Prior, A. Pfeifer, D. Magner, K. Collins, A. J. van der Wel, J. Gardiner, P. Joyce, J. Dillon, D. Dickson, B. Wright, J. O'Driscoll, P. McCusker, S. Milner, J. Griffin, M. O'Brien, R. Keogh, E. Griffin, G. Murphy.

Apologies:

D. McAree.

Secretary's Business

The minutes of the 44th Annual General Meeting, having already being circulated to members were agreed and signed by the President.

Matters Arising from Minutes

None.

Council's Report for 1986

The Report, having already been circulated to members was taken as read.Proposed by J. Fennessy and Seconded by E. Hendrick.

Abstract of Accounts

G. Murphy presented the Statement of Accounts for the year ended 31st December 1986. Interest accrued on investments was down on last year's figure because of the 35% tax imposed. The increase in expenditure on journals was attributed to the increased size and quality of the Journal. The Treasurer highlighted the overpayments in subscriptions. It was reported that there was no need to increase the membership fee this year. The Society has enough assets to withstand a short term loss. It was suggested and agreed that this year's symposium proceedings should be published in a supplementary Journal. The meeting acknowledged the contribution by N. Morris to the Educational Award Fund. Proposed by D. Magner and Seconded by A. Pfeifer.

Confirmation of Elections

The meeting confirmed the 1987 Council Elections as follows: President, J. Prior; Vice-President, W. Wright; Hon. Secretary, K. Collins; Hon. Treasurer, G. Murphy; Editor, P. McCusker; Business Editor, E. Hendrick; Hon. Auditor W. Jack; Technical Councillors, J. Fennessy, J. O'Dowd, R. Whelan; Associate Councillor, A. van der Wel. Northern Ireland Regional Group Representative, J. Griffin. Proposed by P. Joyce and Seconded by J. Gardiner.

Proposed Changes to the Constitution

Article V: Definition of Technical Membership.

"Technical Members shall be persons desirous of promoting the object and at time of election resident in Ireland who hold a degree or diploma in forestry of a recognised university, or who have successfully completed a full-time course at a forestry school or who hold the Foresters Certificate of the Society; in all cases subject to the approval of council.

Titles and Description of Members.

Associate or Student Membership shall not imply a technical competence in forestry."

The proposed changes to Article V of the Constitution of the Society was proposed by E. Hendrick and seconded by D. Dickson. A discussion followed centred on two aspects "at time of election" and "resident in Ireland". It was felt that the latter phrase may lead to the expulsion of existing members. R. Keogh proposed an amendment that the "resident in Ireland" phrase be deleted. This motion was seconded by D. Dickson and was unanimously adopted.

Any Other Business

A sub-committee is assessing the feasibility of organising a Foresters Show. The show will be held in Glenealy Forest and will be orientated towards the general public, along the lines of the Ploughing Championships. Voluntary organisations and companies involved in forestry will be invited. There has been a good response from the 100 firms circulated. The committee estimate that the show will cost £13,000. No final decision has been made on the date or theme for the show.

The meeting concluded at 9.00 p.m.

SOCIETY OF IRISH FORESTERS — STATEMENT OF ACCOUNTS FOR YEAR ENDED 31st DECEMBER, 1986

1985	*RECEIPTS*		*1986*
6,813.71	*To Balance from Last Account*		7,980.26
	To Subscriptions Received		
	Technical 1986	4,283.27	
	Technical 1985	293.50	
	Associate 1986	890.50	
	Associate 1985	74.00	
	Student 1986	84.60	
	Student 1985	5.00	
	Other Arrears	195.15	
	Advance Payments	353.70	
5,936.48	Overpayments	292.44	6,472.16
	To Interest on Investments		
	Savings Account	*10.05*	
	Educational Building Society	*8.88*	
941.86	*Lombard & Ulster*	*718.71*	*737.64*
	To Journal		
	Sales	1,556.38	
3,011.39	Advertising	1,780.47	3,336.85
25.00	Examination Fee		25.00
42.98	Gains on Sterling		14.82
3,000.00	Forest Walks		3,008.76
12.50	Donation		21.55
19,783.92			£21,597.04

1985	*PAYMENTS*		*1986*
134.95	By Stationery and Printing		140.82
4,059.00	By Printing of Journals		5,274.00
1,440.90	By Postage		1,559.39
110.00	By Expenses re Meetings:		115.50
49.49	By Bank Charges		55.92
1,820.35	By Secretarial Expenses		1,877.00
509.51	By Value Added Tax		483.89
151.60	By Examination Expenses		—
79.10	By Miscellaneous Expenses		59.60
	By Honoraria:		
	Secretary	50.00	
	Treasurer	50.00	
	Editor	50.00	
200.00	Business Editor	50.00	200.00
240.00	By Study Tour Expenses		250.00
3,008.76	By Forest Walks		3,000.10
	By Balance:		
	Current Accounts	1,273.28	
	Savings Account	512.50	
	Educational Building Society	148.32	
7,980.26	Lombard & Ulster	6,646.72	8,580.82
19,783.92			21,597.04

I have examined the above accounts, have compared them with vouchers, and certify same to be correct, the balance to credit being IR£8,580.82 which is held in current accounts at the Ulster Bank. (IR£1,314.55 less IR£41.27 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£1,508.73 is held in Trustee Savings Bank Account 323 001 35909 for the Education Award Fund.

Dated: February 2nd, 1987

Signed: W. H. Jack, Hon. Auditor

SOCIETY OF IRISH FORESTERS — EDUCATIONAL AWARD FUND FOR YEAR ENDED 31st DECEMBER, 1986

1985	*RECEIPTS*	*1986*	*1985*	*PAYMENTS*	*1986*
877.50	To Balance from last account	1,171.47	1,171.47	By Balance	1,508.73
100.18	To Interest	87.26			
193.79	To Donation (Mr. N. OMuirgheasa)	250.00			
£1,171.47		IR£1,508.73	£1,171.47		IR£1,508.73

I have examined the above account and certify same to be correct, the balance to credit being IR£1,508.73 which is held in the Trustee Savings Bank Account 30013591.

Dated: February 2nd, 1986 *Signed: W. H. Jack, Hon. Auditor.*

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