IRISH FORESTRY

JOURNAL OF THE SOCIETY OF IRISH FORESTERS

Volume 47 No. 2, 1990

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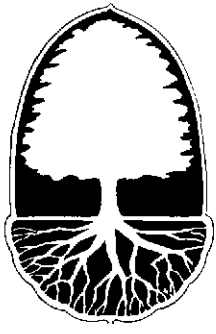
Cover: Low-level blanket peatland in northwest Mayo.
(photo G. Bockett)

IRISH FORESTRY



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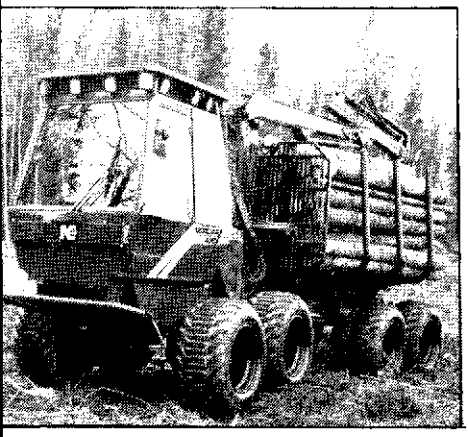

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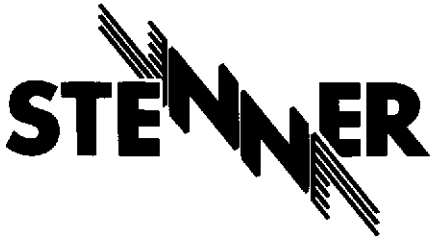

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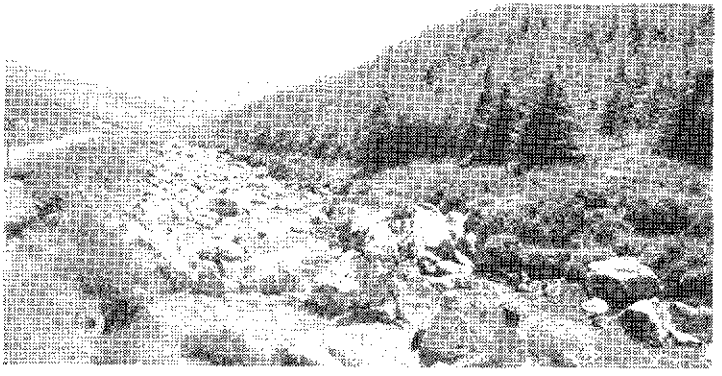

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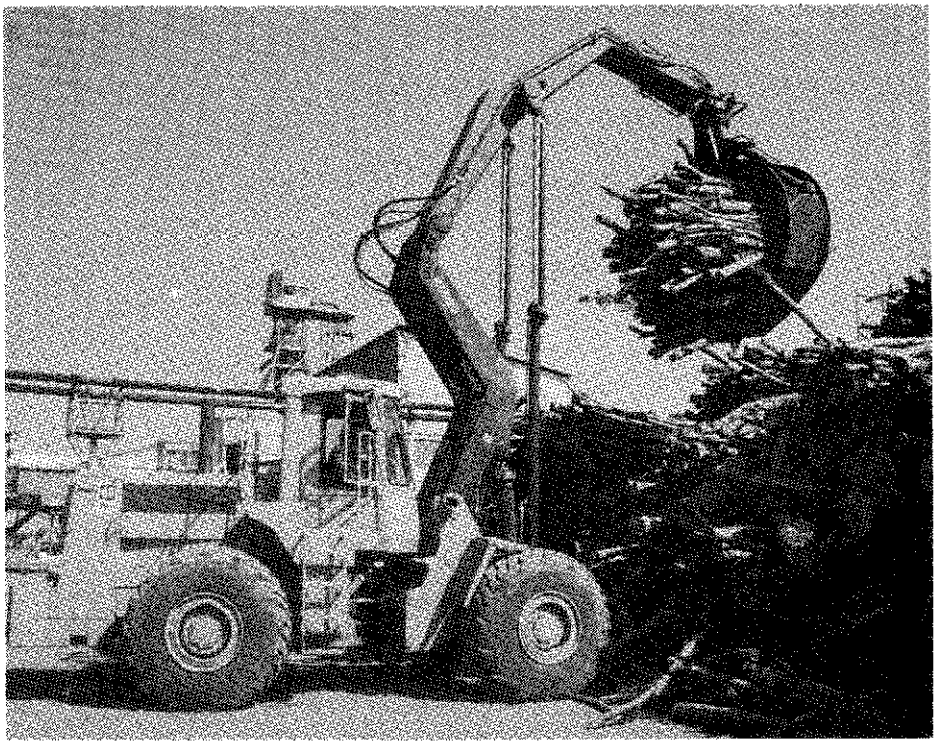

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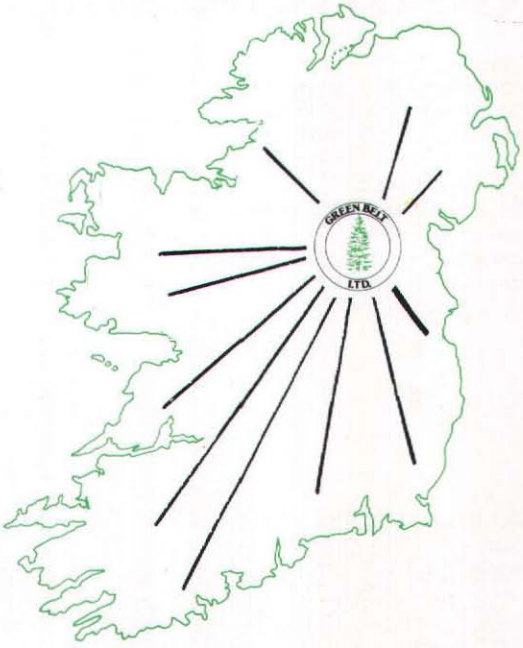

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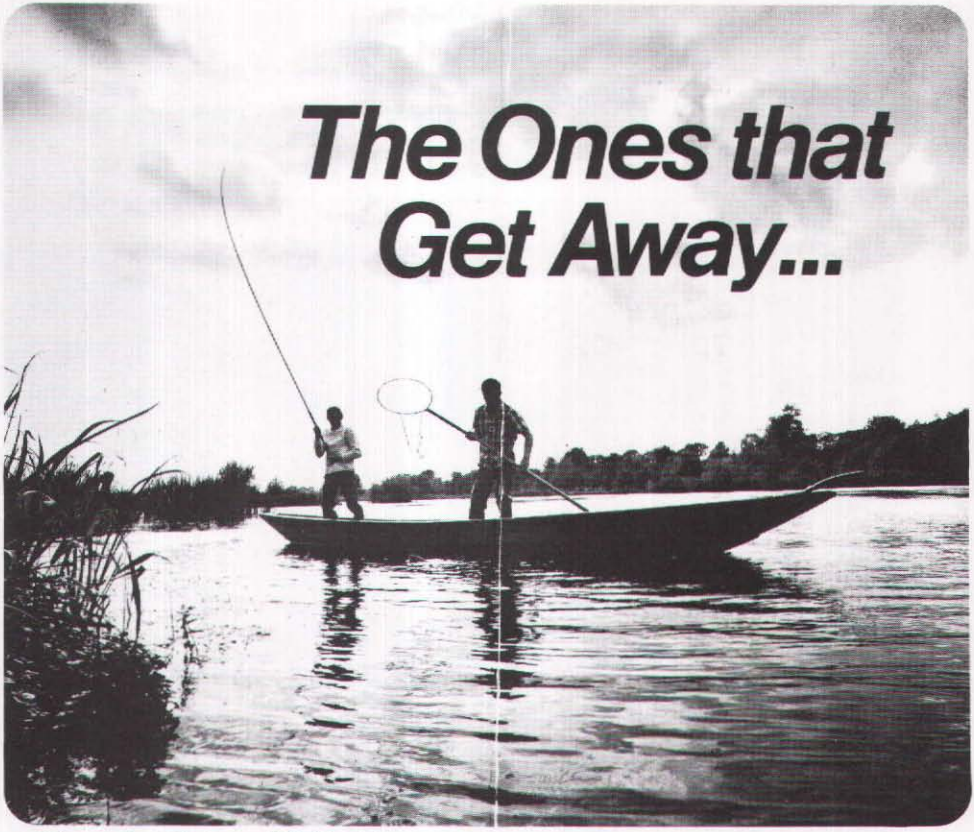

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Peatland forestry in the 1990s. 1. Low-level blanket bog.

E. P. Farrell and G. Boyle

Department of Environmental Resource Management, University College Dublin.

SUMMARY

The afforestation of blanket peatland, the principal peatland type in forestry, commenced in the 1950s. Production in these forests has greatly exceeded expectations. Current yield class estimates of Coillte Teoranta forests on blanket peatland give a mean Yield Class of 13.3 for Sitka spruce (*Picea sitchensis* (Bong.) Carr.). However, investment in blanket peatland forestry cannot be expected to yield returns to compare favourably with those obtainable on good mineral soils. Treeless blanket peatlands are a characteristic feature of western Ireland. Their conversion to plantation forestry drastically disturbs the peatland ecosystem and if carried out on a sufficiently large scale, will profoundly alter the landscape of our western counties. In view of the marginal economic returns which can be expected from forestry investment on blanket peat, it may be in the national interest to reduce incentives for the afforestation of western peatlands.

Introduction

Low-level (or Atlantic) blanket peatland is confined to the western seaboard counties. It occurs at elevations under 150 m in regions where annual precipitation exceeds 1250 mm (Hammond 1981). Above 150 m elevation, it is classified as high-level, or montane blanket peatland (Barry 1954; Hammond 1981). These blanket peatlands represent the principal bog, or acid peatland types of the west. The other major bog type, raised bog occurs mainly in the midlands at low (below 150 m) elevation.

Blanket peatland is the principal peatland type in forestry. No accurate figures are available, but of the total effective forest area of 410,000 ha in the Republic (Anon. 1991), about 50% is on peatland. This represents far and away the largest managed use of peatland in the country. Of the approximately 120,000 ha of peatland in agriculture, most is in poorly managed grassland on reclaimed fen peats. Modern agricultural reclamation operations on peatland are small-scale, concentrating for the most part, on shallow, often heavily eroded hand- (often called farmer-) cutaway peatland.

In its chemical properties, blanket peat is typical of ombrotrophic peats, peats nourished by atmospherically borne nutrients. It is extremely acid and of very low fertility. Nutrients whose concentration in rainfall are low, are in particularly short supply. Phosphorous is the prime example of these elements. The response of the grass *Molinia*, a native peatland species, to rock phosphate in forestry plantations, is evidence enough of chronic phosphate deficiency. Close to the west coast, the atmospheric input of the principal nutrient elements of seawater, magnesium, calcium, potassium and sulphur, is such that, with the possible exception of potassium, supplies are always adequate for tree growth. Nitrogen reserves, however, are not particularly high. It is a common misconception, based on a misinterpretation of soil chemical analytical data, that peat soils contain vast reserves of nitrogen, waiting to be tapped. They do not; in fact, total nitrogen reserves of peat soils are often much less than those of mineral soils. Nevertheless, drainage, peat drying as a result of canopy interception of rainfall, the influence of the same phenomenon of canopy interception in scavenging nitrogen from the atmosphere, and the stimulating effect of fertilizer on organic matter decomposition, all contribute to an enhanced supply of nitrogen to the tree crop, so that fertilizer inputs of this element are required far less often than might have been predicted.

Despite the comparability in chemical composition between blanket peat and the surface peats of the midland (raised-type) bogs, they differ markedly in ease of drainage. Of all the peat types occurring in Ireland, whether surface peats, or peats exposed in the course of Bord na Móna peat harvesting operations, none is more difficult in physical properties than blanket peat. It occurs in the regions of highest rainfall and in the case of the low-level blanket peats, often in terrain of very poor gradients. Blanket peat has a saturated hydraulic conductivity of less than 1 cm per day (Galvin 1976; Gleeson 1985). This represents the maximum rate of water movement through the peat. Given that in the Glenamoy region of North Mayo, annual rainfall averages about 1400 mm and the number of rain days per annum is 270, there will inevitably be many days when the soil is saturated and unable to absorb or transmit incoming rainfall. The poor physical nature of this peat arises in large part, from the plant species which make up the peat. *Sphagnum* species which dominate the surface peats of the raised bogs and confer on them good physical properties, are less important in blanket bogs.

Forestry began the move onto blanket peatland in the early 1950s. Low-ground pressure tractor units and and large heavy-duty ploughs became available and with the simple addition of phosphatic fertilizer, the "wet deserts" of the west could be turned to forest. Initially, this investment in peatland forestry was not evaluated on strict economic grounds. The so-called Cameron Report (Anon. 1951), the product of an FAO Forestry Mission to Ireland in 1950, recommended that 500,000 acres (202,000 ha)

be acquired for a commercial forestry programme and an equivalent area of agriculturally sub-marginal land be afforested in the interests of "soil conservation, regulation of stream flow, stabilization of local populations through provision of employment in congested areas and reclamation of idle lands, such as the extensive blanket bog areas of Western Ireland". These poorer lands were not expected by Cameron "to produce forests as a profitable commercial operation". However, they would produce pitprops and pulpwood material and "would provide a great increase in attractiveness to tourists of large sections of Western Ireland by improving considerably the scenic and sporting amenities". It is hard to appreciate now, the atmosphere of optimism which existed at that time and the enthusiasm for western peatland development. In Mayo, the peatland experimental station at Glenamoy, the grassmeal factory at Gweesalia, the Bord na Móna Oweninny Bog development and the peat-fired power station it supplies, all opened in the late 1950s and early 1960s. Only the Bord na Móna operation and the power station, both now nearing the end of their days, still function. Forestry on blanket peatland is, it seems, the great survivor. In this paper, we examine this tenacity and the wisdom of continuing to support the afforestation of blanket peatland. We present an assessment of the productivity of blanket peatland forests, a financial evaluation of the investment and a preliminary review of the ecological impact of forestry plantations.

Productivity

Most of the blanket peatland forests are less than 25 years old and are only now coming to a stage where productivity estimates based on actual growth data can be made over extensive areas. Mean yield class, weighted by area, of the two major coniferous species, Sitka spruce (*Picea sitchensis* (Bong.) Carr.) and coastal lodgepole pine (*Pinus contorta* ssp contorta Critchfield), for a selection of forests in Co. Mayo, were calculated by species. The data are derived from the Coillte Teoranta (Irish Forestry Board), formerly the Forest Service, 1986 Inventory (Clinch, P., Coillte Teoranta, personal communication). The selection of forests was based on age and site type. These forests consist of crops for which, for the most part, measured estimates of yield class are available (for crops less than eight years of age, yield class is estimated visually without height measurement). In addition, these forests are located almost entirely on blanket peatland, both low-level and high-level (the data do not allow a separation).

Mean Yield Class for Sitka spruce in these forests is 13.3, for lodgepole pine 10.6 (Table 1). These yield projections represent a remarkable success for Irish forestry. While Cameron was content to say of the social forestry programme, that "the forests thus established will be of comparatively

low productive capacity" (Anon. 1951), there is no doubt, based on his estimates for the commercial forestry programme, that yields from our peatland forests are many times greater than would have been projected forty years ago.

Table 1. Mean yield class estimates, weighted by area, for Sitka spruce and lodgepole pine in seven peatland forests in Co. Mayo. (After Farrell, 1990)

FOREST	SPECIES	AREA(ha)	YIELD CLASS
Glenamoy	Sitka Spruce	484.5	12.7
	Lodgepole Pine	1329.5	10.7
Ballycastle	Sitka Spruce	457.4	14.2
	Lodgepole Pine	1810.3	9.3
Crossmolina	Sitka Spruce	739.5	14.6
	Lodgepole Pine	1395.0	11.5
Doolough	Sitka Spruce	572.5	11.4
	Lodgepole Pine	1072.3	12.9
Nephin Beg	Sitka Spruce	578.1	11.8
	Lodgepole Pine	1720.3	9.1
Croagh Patrick	Sitka Spruce	760.9	12.9
	Lodgepole Pine	541.6	12.9
Glenhest	Sitka Spruce	790.9	15.2
	Lodgepole Pine	586.8	13.0
Mulrany	Sitka Spruce	103.6	10.5
	Lodgepole Pine	1641.8	9.9
All the above	**Sitka Spruce**	**4487.4**	**13.3**
	Lodgepole Pine	**10097.6**	**10.6**

Financial Returns

The evaluation of a forestry enterprise on unplanted land is based, in the first instance, on an estimate of the potential productivity of the site. This will vary with species, but the analysis presented here is for Sitka spruce, as it will generally prove to be the most productive and financially rewarding species on all but the least fertile peatland sites.

The estimation of yield class on bareland sites is highly subjective and subject to a wide margin of error. The Coillte data presented in Table 1 are therefore, particularly valuable as they represent the best available estimate of the productivity of blanket peatland forestry. However, it may be argued that it is unduly conservative to limit yield class estimates to the

Coillte average. Careful selection of site and good management may give crop yields of Yield Class 16 over substantial areas and Yield Class 18 on smaller areas. On the other hand, volume production estimates based on yield class assume that growth will follow the pattern predicted by the model throughout the rotation. This assumption may hold reasonably well on inherently fertile sites, but may not be justified on sites of extremely low natural fertility, which require fertiliser additions not alone for growth enhancement, but for the very survival of the forest crop. A decline in yield class over time has been observed in at least one forest fertilisation experimental trial on blanket peat (Farrell 1985).

There is a general acceptance today that a forestry enterprise can no longer be justified on the rather nebulous grounds proposed by Cameron. Peatland forestry must be commercially viable, capable of making a return which will compare favourably with forestry on mineral soils and with other broadly similar investments. The evaluation of viability is, to a degree, subjective, such is the complexity of management options, cost estimates, timber yield projections and financial yield expectations that face the investor. For the financial analysis presented here, the following information is required:

1. The timing and cost of management inputs during the life of the crop.

2. The timing and value of thinning and final crop harvests.

Conventionally, current costs and timber prices are used in the analysis. Thus the effect of inflation is removed from the analysis and returns are calculated in real terms. Forestry enterprises are of their nature, long term. Costs and revenues are discounted back to the start from the year in which they are expected to occur. Thus they are reduced in value at an appropriate compounded rate. This discount rate is again a real rate, net of inflation and represents the annual return which the investor expects from the investment. The rate selected may vary from as low as 3% in the case of some state investment to 6.5% for some private or institutional investors. The discounted value of all revenues, less the discounted value of all costs is known as the net discounted revenue (NDR). Land price is omitted from the analysis presented here. So too is plantation establishment cost. Net discounted revenue then, as we define it, is a residual value which, for a given rate of return, represents the maximum amount which can be paid for the land and crop establishment after grants. For blanket peatland forestry development, land prices are currently in the range £370-620 ha^{-1}. Development costs (estimated at April 1990), net of grants are in the range £370-490 ha^{-1}. £925 ha^{-1} then represents a reasonable working estimate of the combined cost of land and development net of grants.

Calculated net discounted revenue is very sensitive to rotation length

and to discount rate. Table 2 shows net discounted revenues for unthinned Sitka spruce crops over a range of yield classes and discount rates. Yield estimates are based on Forestry Commission data (Edwards 1981). The costs and revenues assumed are in line with current experience in blanket peatland operations. Returns are given for the financially optimum rotation for each yield class. NDR values exceeding the £925 ha^{-1} threshold for land and establishment costs represent a return on the investment corresponding to the indicated discount rate. It is clear that blanket peatland forests can rarely be expected to yield more than 4% on investment. Only at Yield Class 18 can a return greater than 5% be expected.

The data presented are for pure Sitka spruce crops planted at 2 m spacing and managed without thinning. This is a conservative option making the assumption that the risk of windthrow prohibits the adoption of a thinning regime. While there is always an element of risk involved, some managers may argue that with good site preparation and careful management, it will be possible to thin and still run the full rotation on peatland sites. Many Coillte forests on blanket peatland are being thinned at present and while windthrow is a problem, losses are usually at an acceptable level. While returns are better from thinned than from unthinned crops, 4.5% is the best that can be expected from Yield Class 14.

An approach adopted in recent years has been to plant Sitka spruce in mixture with a slow growing provenance of lodgepole pine. There is some evidence that the pine may stimulate the growth of the spruce (probably

Table 2. Net discounted revenue from unthinned Sitka spruce plantations over a range of yield classes and discounted rates. *Land prices and establishment costs are omitted from the analysis.* All values are in Irish £ ha^{-1}. (After Farrell, 1990)

Discount Rate %	Yield Class 10	12	14	16	18
3.0	960	1877	2689	3611	5493
3.5	613	1254	1808	2547	3897
4.0	370	822	1202	1801	2783
4.5	194	514	774	1264	1983
5.0	66	291	468	869	1398
5.5	-30	127	246	575	965
6.0	-101	7	84	355	641
6.5	-155	-82	-34	188	396

Analysis is based on the financially optimum rotation, over an infinite number of rotations for pure Sitka spruce crops at 2 m x 2 m initial espacement, with a no-thin regime. Fertilization at establishment only is assumed. Roading is assumed at 10 m ha^{-1} and £20 m^{-1} in year preceeding clearfell. Insurance (rate 0.35%) and annual management charge (£13 ha^{-1}) are included in the analysis. Costs estimates are based on April 1990 data, revenue assumptions on 1976-1989 CPI adjusted mean timber prices (1989 IR£).

through a mycorrhizal influence). This is accompanied by the expectation that in time, the spruce will supress the pine giving a "self-thinning" effect. Analysis of the most appropriate growth model gives a higher return for Yield Class 14 crops (£1058 at 4.5%). If it is assumed that the expected growth stimulation will produce Sitka spruce Yield Class 16, then the residual sum available for land and development at 5% is £1156.

Ecological Impacts

The potential impact of land use in an ecosystem is inversely related to the complexity of the ecosystem. Oak woodlands, for instance are characterised by a large number of plant and animal species distributed over several vegetation layers. They are remarkably resilient and even after conversion to coniferous plantation many of the ground vegetation species persist and often reappear as the coniferous stand approaches maturity. Ombrotrophic peatland ecosystems by contrast, are simple. Only a limited number of species are adapted to the harsh regime characterised by high moisture and low nutrient supply. Peat soils too are far simpler in composition and in behaviour than mineral soils, lacking as they do the range of soil minerals which by their complex chemical interactions, confer diversity on the processes of ionic retention and release.

Conversion of a previously undisturbed blanket peatland to plantation forest initiates a process of change which profoundly alters the ecosystem and impacts on neighbouring ecosystems. The impact on the ecosystem itself is without doubt, drastic and virtually irreversible. The natural vegetation is eliminated, some species for much of the rotation, others permanently. Peat subsidence occurs, as a result of dewatering and peat oxidation. It is important to appreciate the essential difference between the impact of peatland afforestation and the afforestation of, for example, wet mineral soils of drumlins. The landscape of the drumlin regions is profoundly influenced by forestry, the hydrology of the catchment is modified but the soil with its tough mineral skeleton and complex buffering system, is relatively little altered.

It is reasonable to ask, "Do these changes matter?" All resource development involves modification and often the complete destruction of the natural ecosystem. However, the potential benefits resulting from the development of the resource should be set against the losses, the alteration of the natural environment and the less tangible returns which it may carry, aesthetic benefits, attraction to tourists etc. We need to find the correct balance between economic progress and the conservation of the natural (or what is perceived to be the natural) environment. We also need to understand that there are costs involved in conservation and environmental protection and to identify the means by which these costs should be covered.

The arguments in favour of conserving representative examples of our

blanket peatlands are compelling, but a decision on the area that should be conserved is more difficult to arrive at. The government target, set in 1987, is to conserve 40,000 ha of blanket bog, 5% of the total area of this peatland type. However, if all the remainder were to be developed, the open treeless vistas of western Ireland would disappear forever.

Low-level blanket bogs exhibit considerable diversity, both between regions and within individual bog units. This diversity is based on peat depth, vegetation structure, geographical location and water regime. Rare and protected species of plants flourish in these nutrient poor habitats, each finding its niche in the undulations in the microtopography of the peatland surface. Blanket peatlands are large landscapes and complete hydrological blanket bog units need to be conserved intact, to maintain the integrity of the system. These extensive, open peatlands are rare in Europe, certainly at latitudes as low as ours. These fragile ecosystems are extremely sensitive to change and only by the protection of large units, will the complete range of ecological relationships be maintained.

The role of land-use change and in particular coniferous forestry in the acidification of surface waters has been a matter of study and concern in the United Kingdom in recent years (see Ormerod *et al.*, 1991). It has been concluded that the degradation of aquatic ecosystems in upland Wales is a consequence of air pollution effects (acid rain), but that it is exacerbated by the presence of coniferous forests which trap the air-borne particles in their canopies, thus increasing pollutant deposition beneath the canopy (Gee and Stoner 1989). Increased acid deposition on the soil beneath the forest canopy results in an accelerated rate of soil acidification, increased aluminium solubilisation and the acidification of streamwater. Aluminium is potentially toxic to plants and animals, particularly in certain ionic forms and its presence in excessive concentrations in stream waters leads to physiological disorders and death of fish.

Connemara is famous for its salmonoid fisheries and it is natural that there should be concern over the possible impact of coniferous forestry in the region. However, air quality is believed to be very good and if appropriate safeguards are taken, surface water acidification should not be a serious problem. The limited research carried out to date, however, does give some cause for concern. Two studies on water quality in Connemara were published in 1990. In one (Western Regional Fisheries Board 1990), it was reported that virtually all surface waters in Connemara are sensitive to acidification. In the second (Allott *et al.* 1990) it was concluded that afforestation did result in an increase in acidity and aluminium concentrations in particularly sensitive (poorly buffered) catchments in Connemara and South Mayo. Since the publication of these reports, two new multidisciplinary, inter-institutional projects have been initiated, to examine in greater detail the relationship between forestry and streamwater quality in Connemara, Wicklow and in Munster.

Conclusions

While the productivity of forest crops on western blanket peatlands is remarkably high, the potential financial return to the investor must be considered marginal. Most corporate, institutional, or major private investors aim for a real return from forestry of between 5.5 and 6.5% per annum. While this is attainable over a range of, mainly mineral, sites, blanket peatland cannot yield returns of this magnitude.

Few would argue with the idea that representative examples of blanket peatland should be conserved. More controversial is the area of land which should be set aside and the means by which this should be done. While the government target of 40,000 ha would seem to meet satisfactorily the requirement for the conservation of the blanket peatland ecosystem *per se*, the maintenance of the expansive character of our western landscape would require a significant increase on this target area. Given the limited attraction of this site type to the forestry investor, a case can be made for reducing the rate of afforestation on blanket peatlands in the western counties.

The means used to protect blanket peatland to date have been crude and such blunt instruments inevitably inflict unnecessary damage. The declaration that a particular tract of blanket peatland is an Area of Scientific Interest (ASI) effectively protects it from the developers, as no grant-aid will be forthcoming for such an area, but it may be considered as rough justice by the owner, who sees the opportunity to sell or develop the land taken away, without consultation. While there is undoubtedly a need for the demarcation of Areas of Scientific Interest, the scheme might be more effective in the long run, if it were used with greater sensitivity. Perhaps the best solution would be to apply an informative, consultation procedure, along with the scientific identification of ASIs and to combine it with a modification of the grant schemes, adjusted so as to reduce incentives for blanket peatland afforestation. With this approach, areas which are of scientific importance would be more acceptably protected and afforestation directed towards the most productive sites.

Conservation comes at a price. The owners of land declared as ASIs should be compensated. We must decide if we are prepared to pay that price. The European Community supports the restoration of our forest resource, because it is important to the Community. If the conservation of blanket peatlands is also important to Europe, then the European Community should be asked to contribute to the cost of the conservation of representative areas.

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Podzols and Associated Soils in Semi-Natural Oak Woodlands A Preliminary Report

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Summary

In a survey of semi-natural Irish oak woodlands on podzolised soils fourteen sites were chosen for intensive site investigation, morphological observation and analytical assessment. Historical data yield two important facts relevant to soil formation processes. Firstly, all sites have been disturbed to a greater or lesser degree and secondly, most sites appear to have supported *Pinus sylvestris* before it became extinct. Both these factors would almost certainly have led to the export of bases, curtailed recycling and alteration of the chemical content of the woodland floor. When these factors are considered along with climate, parent material etc. it is difficult to determine if podzolisation was initiated under a dominant oak stand.

These woodlands are located on siliceous parent materials and annual precipitation values exceed 1000 mm. Soil analyses confirm that the soils are highly acidic, very infertile and are very low in clay content. They tend to be free draining coarse sandy or fine silty soils with low cation exchange capacity values.

Introduction

In 1989 a joint study involving University College Dublin and the University of Munich was initiated to determine the occurrence of podzol soils under semi-natural oak woodland sites in Ireland. The objects of the study were to obtain a better understanding of podzolisation in these ecosystems and to ascertain whether podzol forming processes are ongoing, or if the soils are merely relict podzols formed under a different vegetation phase hundreds, or even some thousands of years ago. Studies on the first two of these objectives are described below while work is continuing in an attempt to realize the third.

Podzols under oak woodland are uncommon in Europe as a whole. Their occurrence in Irish oakwoods is therefore of interest, although it has to be said that their apparent prevalence here is partly as a result of the virtual

extinction of the better quality stands on more fertile soils. What we see today are remnants, surviving on the poorest and often least accessible sites (McCracken, 1971). In Ireland, podzols are a common occurrence in upland regions on siliceous parent materials, where precipitation is relatively high (Gardiner & Radford, 1980). Morphologically they are characterized by a peaty surface layer (O horizon) which tends to become darker towards its base due to increased humification. Beneath it is a leached, ash-grey mineral layer (E horizon), which in turn is underlain by B horizons which are yellowish-red in colour. The C horizon is usually extremely stony, originating as till or weathered bedrock.

Conventionally, podzolisation is the formation of an eluvial/illuvial horizon sequence due to the translocation of iron and aluminium with or without humus. A prerequisite seems to be the presence of base-poor parent materials or the acidification of base-rich materials including carbonate removal, if present. Podzolised soils have been associated traditionally with an acid-generating flora such as pine or heather. Their association with oak-dominated deciduous woods in Ireland has therefore focussed attention on the nature of their pedogenic history on these sites. Current interest in accelerated soil acidification as a consequence of atmospheric pollution has made the understanding of natural podzol forming processes more relevant.

Vegetation/soil dynamics

In a review of published data dealing with vegetation/soil dynamics, Stone (1975) has commented that site history, especially in relation to past exploitation, has often gone unrecognized or ignored when foresters and ecologists have sought to explain local differences in vegetation or productivity. Modification of the forests by human influence over the last four thousand years approximately has altered these ecosystems so much that there are probably no pristine native broadleaved woodlands remaining in Ireland. At best the few remaining patches can be described as semi-natural. In Ireland today there are 84,000 ha of semi-natural broadleaved woodland (Cross, 1987).

Numerous accounts outlining the role of vegetation on soil forming processes have been published including those of Dimbleby & Gill (1962) Wilde (1964) Page (1968) and Miles (1985). Overall, it appears that broadleaved species, with the exception of beech, tend to maintain a high base status and to retard podzolisation compared with most conifer species (Miles, 1985). However a number of authors, especially in England, have indicated that podzolisation may occur under oak stands as in the New Forest, Hampshire (Dimbleby & Gill, 1955) and in Sutton Park in the west Midlands (Mackney, 1961). Kubiena (1953) states that iron podzols develop under acid-tolerant oakwood in northern Europe. While deciduous

forest, excepting beech (Dimbleby & Gill, 1955), is not generally associated with podzolisation, oak is found, in the poorest edaphic environments, in association with mor/moder humus forms and podzols. It is difficult, however, to establish conclusively that oak is directly responsible for the initiation of this process as the effects of oak are usually confounded by other factors such as climate, parent material, other tree species, ground vegetation, soil fauna and previous land-use history.

Materials and Methods

General woodland survey

In a reconnaissance survey of soils which support semi-natural woodland, thirty-five sites on a wide range of parent materials were visited. They were all extensively augered to ascertain the dominant soil type. Where podzols predominated, a detailed site investigation was carried out. In all, fourteen sites were selected for further investigation (Fig. 1). At each, a plot 20 x 20 m was demarcated and all trees were measured for diameter at breast height, top height and timber height. Site characteristics such as slope, aspect, altitude, drainage and topography were also recorded. The main ground vegetation species were noted as was any evidence of disturbance.

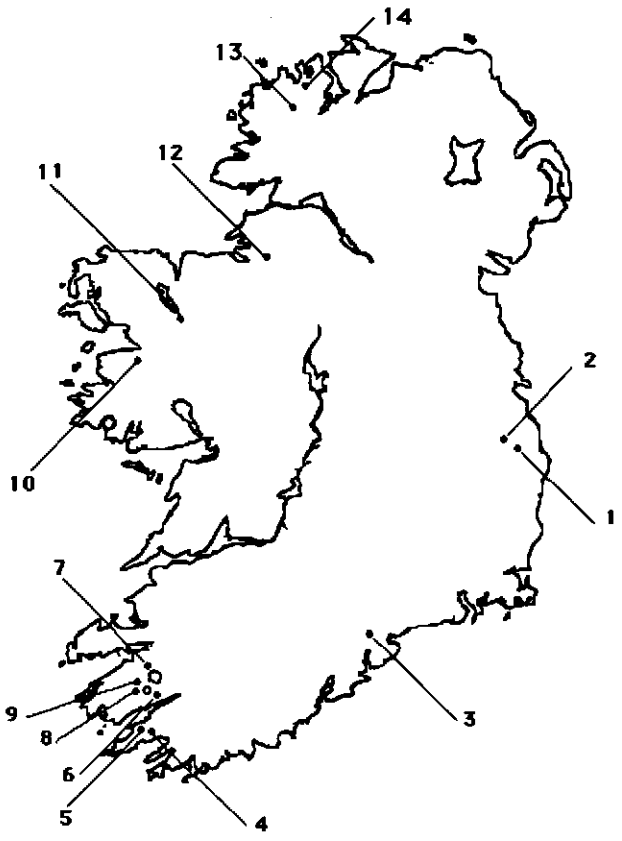
Soil analysis

A pit was dug to expose a soil profile and a soil description made at each site. Soil samples were collected for laboratory analysis which included pH (in H_2O), particle size analysis, organic matter content (loss on ignition), and cation exchange capacity (CEC) using an unbuffered NH_4Cl solution.

Iron oxides were extracted in all horizons from three sites (Clara Vale, Uragh and Brackloon) using sodium tetraborate (Bruckert & Souchier, 1975), ammonium oxalte (McKeague & Day, 1966) and sodium dithionite-citrate-bicarbonate (Mehra & Jackson, 1960). Sodium tetraborate extracts humic iron complexes i.e. organically bound iron (Fe_b), while ammonium oxalate does likewise but also partially extracts poorly crystalline iron oxides belonging to the group of ferrihydrite minerals (Fe_o) (Schwertmann & Murad, 1990). All iron, bound in secondary oxides i.e. the total iron oxides present, is extracted by the dithionite procedure (Fe_d). Thus by using these methods one can differentiate between poorly crystalline organically bound iron, which appears to be most of the iron involved in podzolisation (Farmer et al, 1983), and the total iron oxide content.

Results

Nineteen of the thirty-five sites visited were found to have varying degrees of podzol development. As mentioned previously, fourteen were selected for detailed study. Twelve of these were classified as podzols *sensu*



Site no.	Site Name	Grid Ref.	Parent Material	Dominant soil type
1	Clara Vale	T1892	Shale	Brown podzolic
2	Glendalough	T1196	Schist	Podzol/brown podzolic
3	Lismore	S0502	Devonian sandstone	Podzol
4	Glengarriff	V9256	Devonian sandstone	Podzol
5	Uragh	V8362	Devonian sandstone	Podzol
6	Derrycunihy	V9081	Devonian sandstone	Podzol
7	Tomies	V9188	Devonian sandstone	Podzol (iron-pan)
8	Eamons	V9284	Devonian sandstone	Unclassified
9	Glaisin	V9284	Devonian sandstone	Podzol
10	Brackloon	A9879	Schist/Gneiss	Podzol
11	Laughil	G2005	Granite	Podzol
12	Cullentra	B3478	Gneiss/Quartzite	Podzol
13	Glenveagh	C0220	Granite	Podzol
14	Glen Valley	C0928	Granite	Podzol/brown podzolic

Figure 1: Study sites carrying semi-natural oakwood on podzolised soils.

stricto. Of the other two, one was a brown podzolic and the other was not classified. The latter possessed a leached ash-grey horizon but lacked a B horizon and hence, does not fit neatly into any great soil grouping such as podzols or lithosols. Five sites with soils showing podzolisation were omitted from the detailed study. All occurred in Wicklow, from which two sites were selected. As brown podzolics are the most frequently occurring soils in the Wicklow oakwoods, one site, Clara Vale, was chosen to represent this soil type. Glendalough represents the more podzolised associated soil type. All fourteen soils are derived from siliceous parent materials of either granite, sandstone, gneiss, schist or shale origin.

The geographical spread of the locations of the study sites is shown on the accompanying map (Fig. 1). The principal tree species on these sites are *Quercus petraea, Betula pubescens, Ilex aquifolium* and *Sorbus aucuparia* while the ground vegetation consists mainly of *Vaccinium myrtillus, Luzula sylvatica* and *Calluna vulgaris.*

At sixteen of the original oak-dominated sites, the soils did not show evidence of podzolisation either because of wetness (low humic gleys and peaty gleys), high clay (grey brown podzolics) or unusual biology. At many of these sites the following species were found in addition to oak: *Fraxinus excelsior, Corylus avellana* and, to a lesser extent, *Ulmus glabra* as well as a diverse ground vegetation.

As site history is important in elucidating soil forming processes, information on land use history for each site was researched using a combination of documented accounts, old maps and pollen diagrams. Although it was not possible to obtain a complete historical record for each site – maps are often inaccurate, records invariably incomplete and pollen diagrams more often than not, reflect the vegetation history over large areas – the ornamentation on the maps of the first Ordnance Survey suggests that all sites carried deciduous woodland in or about 1840.

Two important facts relevant to soil formation processes were established. Firstly, all sites have been disturbed to a greater or lesser degree through felling, grazing, burning, the planting of exotics and woodland management. Secondly, all sites (with the possible exception of Lismore) appear to have supported *Pinus sylvestris,* before it became extinct about 2,000 years ago. It is most probable that both these factors would have led to the export of bases, curtailed recycling and alteration of the chemical content of the woodland floor.

Soil analysis confirms that the soils from all fourteen sites are acid, low in bases and generally coarse textured. Typically, pH ranges between 3.5 and 4.5 in the O horizons while values for the deepest mineral horizons never exceed 5.5. Organic matter by loss on ignition varies between 27 and 95% in the O horizons, with most values between 50 and 80%. Values between 0.5 and 16% were recorded in the underlying mineral layers, the lowest values occurring in E horizons. Base saturation values

range from circa 50 to 90% in the O horizons and from 10 to 30% in the mineral horizons. Most of the soils are classified texturally as fine to coarse sandy loams or sandy silt loams with low clay content, the latter never exceeding 25% of the fine earth fraction. A typical example is Brackloon near Westport, County Mayo (Tables 1, 2 & 3). The surface organic layer is very acid with a progressive increase in pH with soil depth (Table 2). Organic matter content is highest in the surface layer, decreasing with depth, with a second peak in the Bh horizon.

At Brackloon there is much schist in the parent material, which weathers to a fine sandy silt loam; the proportion of silt throughout the profile

Table 1: Profile description of a podzol at Brackloon, Westport, Co. Mayo.

Horizon	Depth	Profile description
Of	7-0cm	Dark brown (10YR 3/3-2/2); very fibrous, undecomposed and layered; variable depth containing many fine roots; clear wavy boundary to;
Ah	0-6cm	Very dark brown (10YR 2/2-3/2); greasy/plastic texture; very weak fine crumb structure, some mineral material inter-mixed; abundant fine roots; clear wavy boundary to;
Ea	6-12/32cm	Light grey (10YR 7/2); very fine sandy silt loam; apedal massive structure; stony, mostly platy; fine vertical and horizontal roots; clear wavy boundary to;
Bh	12-15cm	Very dark brown to black (10YR 2/1-2/2); (discontinuous horizon); very fine silty clay; apedal massive structure; stony; fine vertical and horizontal roots; abrupt boundary to;
Bs	15/32-54cm	Reddish yellow (matrix) to strong brown (streaks) (7.5YR 5/8-6/8); fine sandy silt loam; apedal massive structure; stony/bouldery; many fine and coarse multi-directional roots; clear wavy boundary to;
C1	54-64/78cm	Dark greyish brown (10YR 4/2); fine sandy silt loam; apedal massive structure; moderately stony; few fine roots; diffuse wavy boundary to;
C2	78-81cm	Pale brown to light yellowish brown (10YR 6/3-6/4); coarse sandy silt loam; apedal single grain structure; no roots; abrupt boundary to bedrock.

amounts to circa 50% of the total fine earth (Table 2). Where the parent material is derived from schist and/or sandstone the silt content tends to be highest e.g Uragh and Derrycunihy in County Kerry and Lismore in County Waterford. Where granites and shales dominate the parent material, the textures are decidedly sandy. At most sites, the maximum clay content within the soil profile occurs in the B1 horizon and is usually less than 12% of the total fine earth fraction. A typical example is Tomies, County Kerry, where clay content in the Bh is circa 10%.

Table 2: Soil data inclusive of pH, and percentage organic matter (OM), stones, sand, silt and clay for Brackloon podzol.

Horizon	pH	OM %	Stones %	Sand %	Silt %	Clay %
Of	4.1	83.8	–	–	–	–
Ea	4.4	1.1	28.7	33.3	59.6	7.1
Bh	4.4	16.3	12.5	26	48.9	25.1
Bs	4.7	9.9	25.1	39.6	51.5	9
C	5.1	3.6	25.9	40.5	50.7	8.8

Cation exchange capacity (CEC) is closely correlated with organic matter content and a strong relationship also exists between exchangeable bases and both of these parameters (Table 3). The CEC values for Brackloon are quite typical for sites located in western seaboard counties (Gardiner & Radford, 1980). It is apparent from the base saturation data that the O horizon is an especially important source of nutrients leading to an abundance of fine roots in this zone. It is also notable that exchangeable sodium and magnesium values are higher in sites situated on the western seaboard, where the input of these elements in precipitation is high, compared with midland and eastern sites. Magnesium values in the O horizon at western sites range from 4.5 to 11.2 $cmol_c . kg^{-1}$ whereas the corresponding value at Derryad, near Tullamore, County Offaly – which is a midland oakwood site with characteristic podzol morphology – was 3.5 $cmol_c . kg^{-1}$. The corresponding values at the two eastern sites (Glendalough and Clara Vale) were 0.8 and 1.5 $cmol_c . kg^{-1}$. A similar trend for sodium is evident: at western sites exchangeable sodium values in the O horizon range from 1.3 to 3.1 $cmol_c . kg^{-1}$, whereas at Derryad, exchangeable sodium was 1.0 $cmol_c . kg^{-1}$ in the O horizon. The corresponding figures for the eastern sites (Glendalough and Clara Vale) were both 0.5 $cmol_c . kg^{-1}$. The highest values of exchangeable magnesium and exchageable sodium were recorded at sites closest to north-west, west and south-west coasts, especially at high elevation where precipitation is greatest.

Table 3: Exchangeable cations, cation exchange capacity (CEC) and percentage base saturation (BS) data for Brackloon podzol.

Horizon	Ca	Mg	K	Na	H+Al	CEC	BS
			$cmol_c.kg^{-1}$				[%]
Of	11.9	8	3	2.6	1.8	28	92
Ea	0.2	0.2	0.1	0.1	1.6	2.2	24
Bh	0.6	0.8	0.2	0.4	8.2	11	18
Bs	0.1	0.3	0.1	0.4	5	6.2	14
C	0.1	0.2	0.1	0.2	2.4	3	18

Data for extractable iron using the three methods outlined previously are given in Table 4 for Brackloon. The highest values of iron recovered for any of the methods used occur in the B horizons. As humic iron complexes are extracted by both the sodium tetraborate (Fe_b) and ammonium oxalate (Fe_o) extractants, high values for these extracts in the B horizon indicates that there is downward translocation of humic iron complexes. When all the iron values in the B horizons of the three sites chosen for iron analysis (Clara Vale, Uragh and Brackloon) are compared (Table 5), it is interesting to note that even though the value of total iron oxides (Fe_d) is relatively high at Clara Vale (especially in the Bs), the relatively low values of Fe_o and Fe_b indicate that currently there is poor translocation of humic iron complexes. This suggests that podzolisation is at present not as dominant a process at Clara Vale compared to the other two sites i.e. Uragh and Brackloon.

Table 4: Extractable iron data (mg/g) for Brackloon podzol.

Horizon	Fe_d	Fe_b	Fe_o
Of	0.6	0	0.5
Ea	0.4	0	0.2
Bh	48.9	–	32.9
Bs	37.3	0.8	24
C	3.3	0.2	1.6

The ratio of oxalate extractable iron to the total free iron oxide content, which may vary between near zero and 1.0 has proven useful in connection with pedogenetic studies, particularly in humid temperate soils (Schwertmann & Murad, 1990). The closer the ratio is to 1.0, the greater the contribution of iron involved in podzolisaion is to the total iron oxide content present. Calculated ratios for the three soils, Clara Vale, Uragh and Brackloon, were analysed and the ratios calculated accorded well with their observed morphology in the field (Table 4). Clara Vale has a ratio of Fe_o

to Fe_d of 0.2 in the Bs horizon which suggests that translocation of humic iron complexes is not occurring to any great extent here. In contrast, Uragh and Brackloon have ratios of Fe_o to Fe_d of 0.7 in the Bir and Bh horizons, indicating the presence of much larger quantities of the iron forms involved in podzolisation.

The ratio of Fe_d to organic carbon (OC) is calculated for the B horizons (Table 4) in order to classify soils into their sub-groups using the U.S.D.A. classification system (Wiechmann, 1981). The ratios derived indicate that Clara Vale is a ferric podzol while Uragh and Brackloon are orthic podzols.

Table 5: Extractable iron data (mg/g) with Feo:Fed and Fed:OC ratios for three oak woodland podzols.

	Clara Vale		Uragh		Brackloon	
Horizon	**Bs**	**Bw**	**Bir**	**Bhs**	**Bh**	**Bs**
Fe_d	43.2	13.1	30.9	19.0	48.9	37.3
Fe_o	9.5	4.0	21.4	12.8	32.9	24.0
Fe_b	0	0.1	0.7	0.7	–	0.8
Fe_o:Fe_d	0.2	0.3	0.7	0.7	0.7	0.6
Fe_d:OC	10.0	5.6	5.7	4.9	5.3	5.6

Discussion and Conclusion

Regional pollen diagrams suggest that most of the country has supported woodland of some description for a considerable portion of the post-glacial and that *Pinus sylvestris* has been an important component of much of the woodland, including the oakwoods, along the western seaboard (Jessen, 1949). It is concievable then that pine has had a major influence in the formation of many of these podzols.

From about the twelfth century onward, clearance for agriculture and for the utilization of timber resulted in there being only one-eighth of the country wooded by 1600 (McCracken, 1971). As historical records generally date from about 1500 for most of the sites investigated and regional pollen diagrams are not site specific, it is not possible to say with any degree of certainty that all these sites had continuous forest cover. Also, clearance and/or the formation of heath followed by re-invasion of secondary woodland cannot be ruled out at many of these sites. However, the use of local and extra-local pollen diagrams, as in the Killarney woodlands (Mitchell, 1988), help to elucidate the vegetational history within existing woodlands. Thus further paleovegetational analysis could probably be used to determine the vegetational history of many of the sites in this study as they all have mor-moder humus types. This would shed light on whether podzolisation was initiated under woodland or under heath.

After 1500, there is enough evidence to conclude that all these woods have been disturbed mainly through grazing and felling. It is impossible to quantify the influence of historical factors involved in the soil forming process, such as the presence of pine or various forms of disturbance. However, they must be included in any discussion on the formation of these soils as their influence may well outweigh factors which are currently more obvious, such as parent material or present vegetative cover. In addition, the main climatically driven trend of soil development in freely drained soils in north-west Europe is for progressive leaching, with consequent acidification and, in susceptible soils, (e.g. coarse textured soils on acid parent materials), eventual podzolisation (Ball, 1975).

The sites investigated all have acidic parent materials and have annual precipitation values exceeding 1,000 mm. When species composition is compared with other soil types e.g. grey-brown podzolics, brown earths and low-humic gleys, it is found that the podzolised sites support a smaller number of species and a more acidophillous ground vegetation. Unlike the other soil types mentioned above, podzols do not appear to support *Fraxinus excelsior* or *Ulmus glabra* while *Corylus avellana* occurs less frequently.

Podzolisation may have been initiated independent of the presence of oak, around 4,500 years ago, when the climate became much cooler and wetter, with or without clearance due to human impact, encouraging the spread of heath, or even earlier during the pine maximum. The propensity of these siliceously derived soils to nutrient loss render them susceptible to podzolisation.

The iron extracts provide an improved understanding of the podzolisation process in these ecosystems. The data suggest, for two of the three sites analysed (Uragh and Brackloon), that there are, in the B horizons, relatively large quantities of the iron fractions involved in the podzolisation process (Farmer et al, 1983). Data for the third site (Clara Vale), by contrast, suggest that podzolisation is not the dominant process at this site. Further investigations will be carried out to determine if podzolisation is ongoing in these soils.

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The Miombo Woodlands of Central, Eastern and Southern Africa

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Summary

Aspects of the environment and ecology of Miombo woodlands are described. Attention is given to the widespread nature of their distribution area and the role played by Miombo at local and national levels. A matrix of woodland-use is presented. This offers some insight into changing resource-use patterns in Miombo, and highlights the conflicts which may ensue with the adoption of certain woodland management strategies.

Introduction

In Africa, tropical dry forests and woodlands constitute between 70 – 80% of all forested land (Murphy & Lugo 1986). South of the Equator, (5° to 25° S) Miombo woodlands are the main dry forest type in the continent, occupying an estimated area of 7 million square kilometres (Griffith 1961). Thus, Miombo represents one of the most widespread, yet compact forest types in the world. Almost 50% of the land area of both Tanzania and Zambia, and large tracts of Mozambique, Malawi, Zimbabwe, Zaire and Angola support Miombo (Fig. 1). This aereal distribution corresponds roughly to the Zambezian Floral Domain of White (1965), recognised for its floristic richness and the widespread occurrence of the tree genera *Brachystegia, Julbernardia and Isoberlinia.* Despite the widespread nature of this woodland type, its long history of exploitation and the increasing human-related pressure and needs within the countries mentioned, Miombo resource-use remains largely undocumented. The data base on inventory, silviculture,

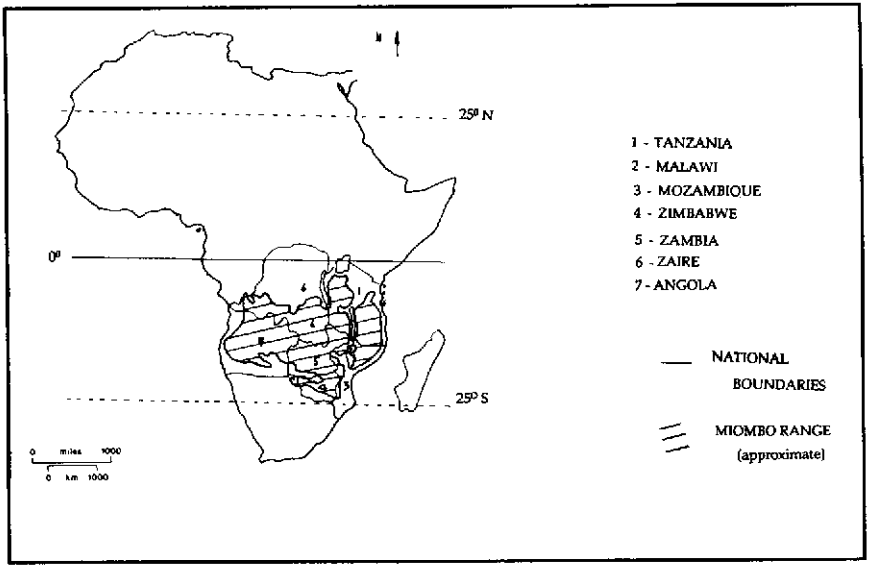


Figure 1: The Distribution of Miombo Woodlands in Africa.

conversion rates, and regional productivity remains scattered and discontinuous.

ENVIRONMENTAL SETTING

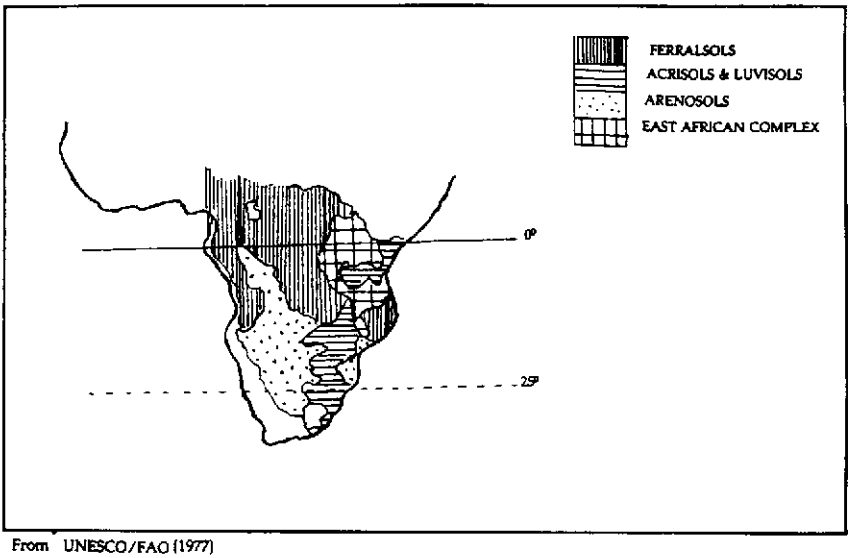
Climate

The natural range of distribution of Miombo woodlands falls between 5 and 25° S. This tropical position means that temperatures are high over most of the area. Thus, precipitation assumes strong significance as a key climatic factor in relation to biological productivity and land-use strategies. Menaut *et al* (1985) distinguished two eco-climatic zones for the areas in question. In the Northern Miombo block, the mean annual rainfall (MAR) ranges between 800-1200 millimetres, with a relatively long rainy season of up to five months. In contrast, the Southern block is characterised by drier climates, with a MAR range of 600-800 mm and a rainy season duration of up to four or five months. In central areas, no rainfall may occur for up to eight or nine months, with relative humidity levels remaining low

throughout the dry season (UNESCO/FAO 1977). Highest temperatures are recorded in October/November prior to the rains. Ernst & Walker (1973) recorded 40° Celsius in shade and 45° C in sun-exposed areas in Zimbabwe. Mean annual temperatures vary from 18° C to 24° C, and are more closely correlated with altitude, than with latitude.

Geomorphology and Soils

Miombo and savanna vegetation occurs largely on the inland plateau of "High" Africa, within an altitude range of 900-1500 metres, most commonly 1200-1500 m above sea level. A granitised basement complex with metamorphic rocks (gneiss, granites and schists) of Pre-Cambrian origin forms one important group of parent materials (c. 600 million years old). Through weathering, this substrate has been worn down. These more resistant strata now stand out as dome-shaped inselbergs amongst the plains. Alluvial sediments form a second group of parent materials, whilst in the highlands, limestone and dolomites provide the third main parent material. Over the whole plateau, chemical weathering is active throughout the year, with high leaching rates, leading to the development of



From UNESCO/FAO (1977)

Figure 2: The Main Soil Groups within the Miombo Eco-zone.

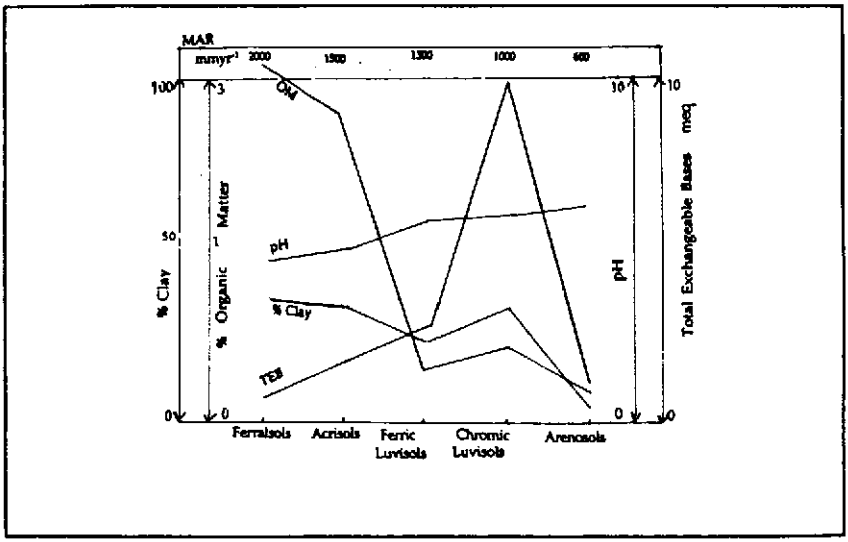


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Figure 3: Physico-chemical Properties of Main Soil Groups within the Miombo Eco-zone.

soils which often bear little chemical resemblance to original parent material (Okigbo 1985).

In general terms, four major soil groups, the Ferralsols, Acrisols, Luvisols and Arenosols (corresponding to the Oxisols, Ultisols, Alfisols and Cambisols of the U.S.D.A. soil classification) can be identified over the range (Fig. 2). Some physico-chemical properties of these soil groups are presented in Fig. 3. Organic matter (OM) content for the Ferralsols and Acrisols is high in comparison to the other two groups. Soil pH ranges between pH 5 to pH 6.5, with the more acid soils found in the higher rainfall areas. Clay content varies from almost 50% in the Ferralsols and Chromic Luvisols to almost zero in the Arenosols.

Most soils in the ecozone have a medium to coarse texture. This increases their vulnerabiltiy to water erosion. Rainfall intensities of up to 60mm per hour have been reported, with an erosive potential which may be up to 16 times greater than most temperate rains (Sibanda & Odra 1988). Slope factors range from 0-30% with mid-slope soil having good drainage properties. These free-draining slopes are preferred for cultivation, although they are often poor in nutrients. The removal of tree and plant cover, followed by permanent cultivation (i.e. without a fallow period), leads to high soil losses. Young (1989), for example, calculated potential losses of 255 tonnes/ha/yr for a ferric luvisol, with a 10% slope (5.7°), and a MAR of ca. 800 mm.

WOODLAND DESCRIPTION

Structural Characteristics

Miombo woodlands have a deciduous or semi-deciduous nature and a canopy arrangement of one to three layers. Malaisse (1978) described the woodland structure as follows:–

- a dominant tree layer of 14 to 18 metres, often over 20 m in height, and a density of ca. 65 stems/ha.
- a secondary tree layer of eight to 12 m, sometimes up to 14 m, with a stem density of ca. 80/ha.
- a shrub layer, less than eight metres tall, with ca. 375 to 500 stems/ha.

Under natural conditions, stem density and height vary considerably. Soil depth, soil texture, and the availability of moisture in the dry season are factors which determine woodland architecture. The influence of fire, clearance, felling and grazing/browsing are regarded as key factors under disturbed conditions. Variation in stem density can be quite wide, e.g. Martin (1974) recorded over 1712 stems/ha in a Miombo shrub layer in Zimbabwe. This is almost five times the figures shown by Malaisse (1978) for Zaire. Tree form may vary from small, twisted and misshapen stems, to tall straight boles. Only one species, *Marquesia macroura,* displays a buttressing habit. Mature woodlands have a canopy which is umbrella-shaped, with the crowns just touching and rarely interlocking. Depending on the degree of canopy closure, a herbaceous layer may develop. In more open sites, grass growth may achieve a height of up to two metres, with as much as 70% ground cover (Walker 1985). This is a factor contributing to the high incidence and intensity of woodland fires in the late dry season.

The canopy is far from continuous in contemporary Miombo, with gaps enlarging over time as shifting cultivation ("chitemene" in Zambia), selective felling and clearance for semi-permanent cultivation occurs. Below this level the understorey is also dis-continuous under natural conditions. The shrub layer, on the other hand, is continuous and quite dense.

Botanical Composition.

The Family Leguminosae is the most frequently encountered Plant Family in Miombo Woodlands. The authors encountered 32 Plant Families within arborescent layers, with 25% of all genera and 22% of all species belonging to the Leguminosae (Tuite & Gardiner 1990a unpubl.). Other important Families included the Rubiaceae, the Anacardiaceae, and the Combretaceae. The floristic composition of the field layer also varies, with the Compositae, Graminaceae, and the Papilionaceae being most common. An interesting component of this field layer in both woodland and cut-over areas, is suffruticose vegetation, found usually below heights of one metre. White (1965) refers to these life-forms as the "underground forests of Africa". Suffrutices have a perennial habit, with aerial parts which

die-back during the dry season, when the incidence and intensity of annual fires are greatest.

Woodland Productivity and Yield

Sawlog yields of 2-14m^3/ha have been estimated for Zambia, with fuelwood yields of 50-150m^3/ha (Celander 1981). In Tanzania, Temu (1979) found total volume to 5 cm top diameter (overbark), to be approximately 120m^3/ha, with 15-20% of the volume suitable for veneer and/or sawntimber. Up to 50% of the volume can be held by branchwood, whilst misshapen stems and short boles with wide-branching habits do not lend themselves easily to economic conversions, with the exception of charcoal and fuelwood billeting. During a survey of wood stocks for charcoal in Zambia, Chidumayo (1987) estimated a stackwood yield of 14.8m^3 per m^2 Basal area (B.A.). This corresponds to 7.74 metric tonnes oven dry weight per m^2 (B.A.). The rate of growth in Miombo is often quite low, and may not exceed 4m^3/ha/ yr. Nilsson (1986) estimated an annual growth rate of 1-2m^3/ha/ yr for disturbed woodlands in Tanzania. Young Miombo in Zambia was found to have an annual increment of 2.5 tonnes/ha fresh weight (= 1 tonne/ha dry weight), and an annual basal area increment of 0.5m^2/ha/yr (Stromgaard 1985).

In general terms, dominant tree layers are often found to represent about 35% of total B.A. When B.A. values are lower than 10m^2/ha, the lower layers and grass/herb strata change, leading to a wooded savanna. Endean (1962) highlighted the rate of increase in B.A. which resulted from selective cuttings, with a 110 to 120% rate of increase following the removal of one-quarter to one-third of basal area. During a study of regressive woodland succession in Zaire, Malaisse (1985) offered comparisons between the stocking levels for Miombo (15 to 25m^2/ha B.A.), dry evergreen forest (30 to 40m^2/ha) and wooded savanna (5 to 15m^2/ha). Some estimations for Miombo stocking levels and biomass production from various sites within the eco-zone area presented in Table 1.

Table 1: Productivity estimations for Miombo woodlands

Region	Woody Biomass (kg dry wt/ha)	Basal Area (m^2/ha)	Source(s)
Zambia	48,000	14	Stromgaard (1978)
Zaire	n.a.	15-25	Malaisse (1985)
Zimbabwe	20,000	n.a.	Martin (1974)
Tanzania			
. . Rukwa	n.a.	14	Boler & Schiwale (1966)
. . Iringa	n.a.	8	Tuite & Gardiner (unpubl)

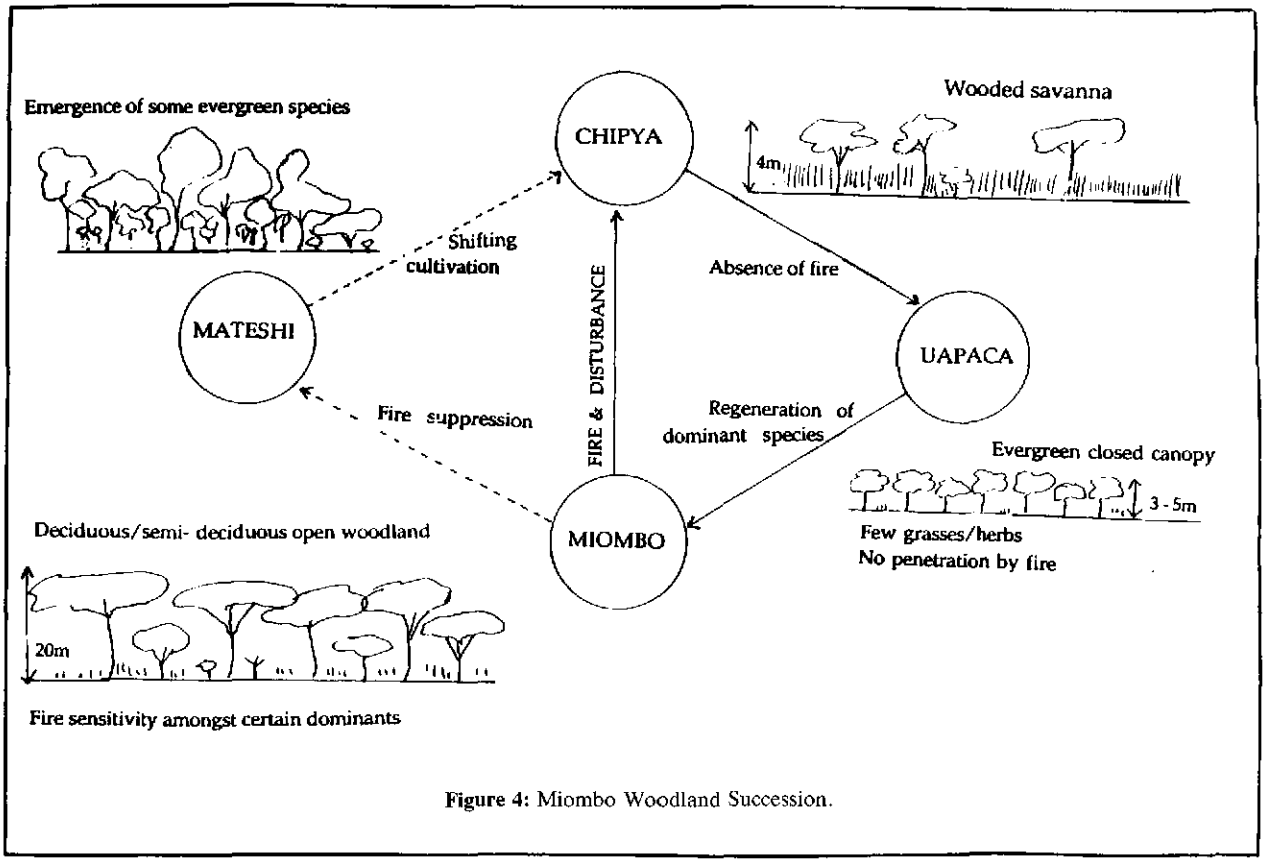

Figure 4: Miombo Woodland Succession.

MIOMBO WOODLAND SUCCESSION

Most ecologists agree that Miombo woodlands represent either a fire or a climatic climax. Three or four seral stages may be recognised (Fig. 4). The Chipya stage may develop where either mature Miombo or Mateshi woodland is opened by fire or shifting cultivation (Fig.4). This chipya stage is characterised by a sparse woody component, with low stature and misshapen form. The grass/herb layer is well developed, often reaching heights of two metres. Repeated burning, overgrazing/browsing, indiscriminate heavy felling and patchy cultivation are regarded as key factors in the development of Chipya (Celander 1981). *Pterocarpus angolensis, Syzygium guineese, Diplornychus condylocarpus, Hymenocardia acida,* and *Vitex doniana* are common tree members in this seral stage. Such species display adaptations to their environment, e.g. *Pt. angolensis,* (mninga), allows its roots to accumulate over a number of seasons without aerial growth. After up to five or six years there is a sudden emergence of a shoot which may elongate up to 1.5 metres in one season. Thus, the new growth is protected to some extent, from intense grass fires. The term "pioneers" has been applied to these Chipya tree species. The term is not entirely accurate however, as they are frequently encountered in more undisturbed areas, where they show better form and attain greater heights.

The Uapaca stage develops in the absence of annual burning and generally less disturbance. It is dominated mainly by *Uapaca kirkiana,* with a closed canopy of up to five metres in height, and almost total suppression of grass/herb layers. Thus penetration by fire is prevented, allowing regeneration of *Brachystegia, Julbernardia* species and other Miombo dominants. Few authors have attempted to put a time-scale on the successional period, from Chipya to Miombo. Stromgaard (1986), in a study of the recovery of Miombo following shifting cultivation, found that after 25 years, the Miombo dominants were still absent in abandoned plots. He also found that a *Combretum* wooded savanna element looked likely to succeed the Chipya, rather than the Miombo stage.

Miombo woodlands are structurally very different from Chipya woodlands, with a canopy arrangement, stocking levels and a floristic richness not found in the Chipya or Uapaca stages. *Brachystegia* and *Julbernardia* spp. are fire sensitive when young, and retain sensitivity into maturity, when fierce, late-season fires occur. Trapnell (1959) showed almost complete loss of *Brachystegia, Julbernardia,* and *Isoberlinia* spp. under repeated burning regimes in Zambia. Regrowth was good however in early-burnt plots. In the absence of fire over prolonged periods, Mateshi, a dry evergreen forest may develop. It has a dense understorey with high numbers of small trees and shrubs, a sparse field layer, and a range of epiphytes and lianas (Fig. 4). Mateshi is rarely found as extensive woodland today, and occurs most frequently as remnants in areas where soil moisture is relatively high.

RESOURCE-USE IN MIOMBO WOODLAND AREAS

Historically, woodland resource utilisation in these areas has been multi-purpose. In areas where the levels of disturbance have been relatively low, one can still observe the diverse range of uses and products derived within a Miombo environment. Figure 5 presents a summary of the various types of uses found by the authors in North Ihowanza in Tanzania. Agroforestry techniques have been traditionally used in Miombo areas to produce staple food crops (millet, sunflower, beans and groundnuts) and to tend herds of cattle, goats and sheep. In many areas, such systems have been maintained, of which the 'chitemene' system (Zambian term) is the most renowned. The practice involves the pollarding of selected trees at 1-1.5m or more (Plate 1). Following cutting, the lop and top is piled into large heaps and later burned *in situ* to provide ash fertiliser. Depending on site productivity, this

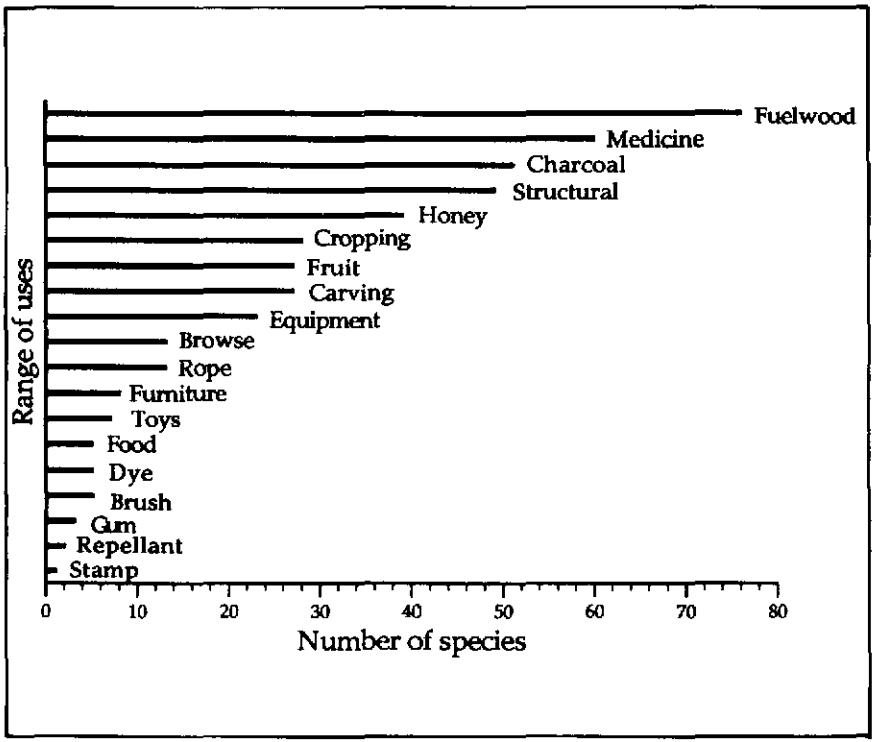

Figure 5: Tree Species Utilisation in Miombo Woodlands (south Tanzania).

Plate 1. Pollarding of Miombo trees prior to cultivation.

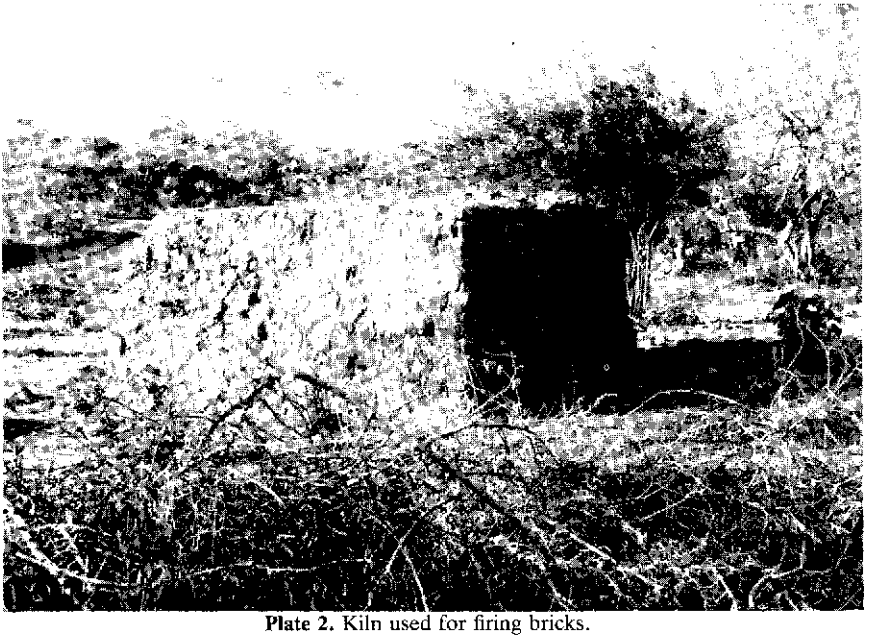

Plate 2. Kiln used for firing bricks.

Plate 3. *Pterocarpus angolensis* D.C. retained in farmland.

form of cropping may continue for up to 4-6 years, when the site is then abandoned, allowing pollard and root sucker regeneration to continue. The interval between abandonment and repollarding varies, but may be up to 7-8 years.

The value of Miombo coppice as potential browse is receiving increasing attention. In areas where the dry season may extend over seven to eight months, both browse and shade are valuable resources. Regrowth brings foliage to within easy reach of cattle, goats and sheep. Woody vegetation flushes as early as July or August, providing browse for up to six months or more, before the rains begin. By October, coppice regrowth in burnt or cleared areas may account for up to 30-35% ground cover (Lawton 1968). The importance of certain species in terms of protein and mineral content is highlighted in Table 2.

Table 2: Crude Protein and Mineral Content % of Browse

Species in Miombo (%)	Crude Protein	%Ca	%P	%Mg	%K
Julbernardia paniculata	12.38	0.70	0.24	0.25	1.50
Strychnos cocculoides	15.50	0.27	0.26	0.29	1.85
Syzygium guineense	11.50	0.28	0.20	0.41	1.8
Brachystegis longifolia	12.13	0.48	0.19	0.27	1.18
Anisophylla boehmii	10.63	0.12	0.17	0.28	1.07
Albizzia adianthifolia	29.13	0.20	0.35	0.20	1.66

Source: Lawton (1968)

(Source: Lawton (1972). meq. No. of Species Source(s) Figure 5 5)

There is a high dependency on natural woody formations for energy in this ecozone, both for domestic and industrial purposes. Fuelwood and charcoal are the cooking and heating materials for rural and urban sectors respectively. Tanzania, in particular, has a high wood energy requirement, with an estimated 95% of all wood harvested being used for energy (Mnzava 1985), and a per capita consumption of 1.5 to 2m^3 annually in the central regions (IRADEP 1987; Ahlback 1988). The conversion of fuelwood to

charcoal for urban centres has become a lucrative market in many areas, with high demand on the one hand, and attempts to control the rate of conversions by the forest authorities on the other. The conversion process dissipates between 20% to 60% of the heating value of the original material (Lewis & Berry 1986), but produces a lighter product which smokes less, is easily transported and is suited to the metal stove used by urban households. The drying process used for important cash crops such as tobacco, tea and coffee relies on wood raw material for energy. It has been estimated, for example, that up to four hectares of fully stocked Miombo may be required to cure one hectare equivalent of tobacco in central Tanzania (IRADEP 1987). On a smaller scale, local enterprises such as brew-making, fish-smoking, sunflower oil production and brick-making derive their energy source from natural woody vegetation (Plate 11).

The exploitation of *Pterocarpus angolensis* (Mninga) for commercial purposes was formerly one of the main activities pursued by forest authorities in these regions. It is the timber species which attracts most attention for export and local joinery purposes (Groome 1966; Breithenach 1973). It has been managed under a crude selection system based on fixed diameter limits, representing between 5-10% of the total growing stock, but providing up to 60% of all sawlog yield (Parry 1966). Its large-scale artificial regeneration however, has confounded silviculturalists to date. Natural regeneration, in woodlands and on farms (Plate III), is encouraged by farmers and foresters alike. There is much concern however, about the age-class distribution of this species, with sawlog and pole-sized Mninga now becoming scarce in many areas. Its trade names include "mninga", or "muninga" (Tanzania), "mukwa" (Zambia), and "mulombwa" (Zimbabwe).

Conflicts in Miombo resource-use.

A range of woodland resource-use policies are implemented within the Miombo eco-zone. Some strategies aim to improve land productivity through conversion to an alternative vegetation or crop type. Other approaches attempt to protect and maintain the woodlands through reservation. In drier regions particularly, Miombo woodlands and surrounding savanna are designated as wildlife parks, ultimately boosting vital tourist industries. Local utilisation of the woodlands has historically been of a multi-purpose nature, and is still maintained on a small-scale throughout the area.

A matrix of Miombo Woodland Resource-Uses is presented in Figure 6. It has been prepared on the basis of a number of years spent by the main author in Miombo woodlands in Tanzania. There are 18 options presented in this matrix. Each option can be found within Iringa Region where Miombo is the dominant woody vegetation found. Although there is

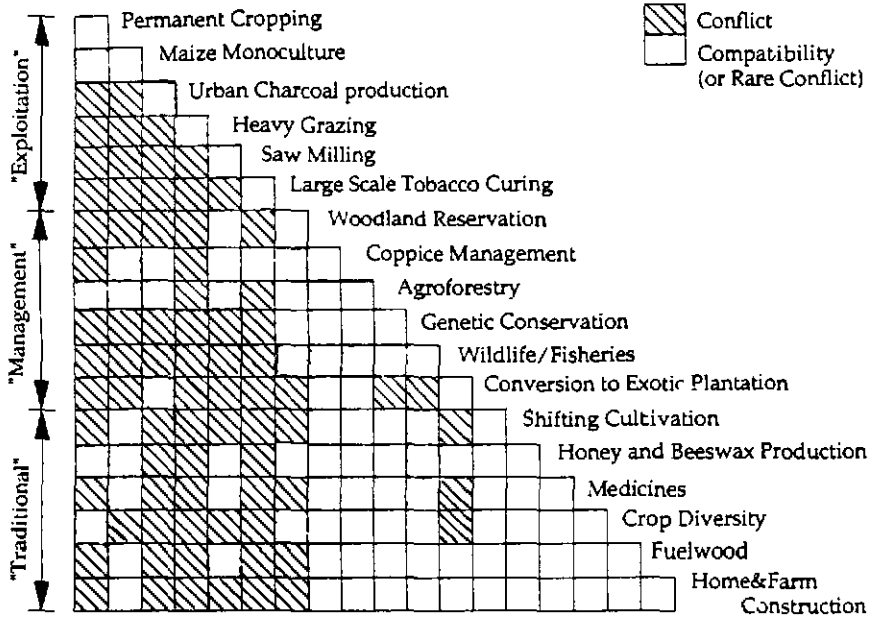

Figure 6: Possible Conflicts in Miombo Woodland Resource-Use.

a certain amount of subjectivity involved in defining conflict/compatibility, it is thought that useful insights may be gained from its inclusion. In the matrix, three groups of woodland resource-use strategies are presented, under the terms "exploitation", "management" and "traditional". Each strategy has been assigned six realistic options. "Exploitation" implies mismanagement, indiscriminate felling, no replacement, or conversion of woodland to other use. Saw-milling has been included due to the widespread depletion of Mninga stocks during such operations. The term "management" has been used to include a range of options which are viewed favorably by forest policy-makers. Options such as reserving woodland areas, coppice management, agroforestry, genetic conservation, wildlife/fisheries and conversion to exotic plantations have each been promoted in different areas. A "traditional" strategy on the other hand, reflects a more historical approach to resource-use in these areas. It also

implies a less intensive utilisation of the natural resource base, allowing for example, a restoration period (fallow) during food production through shifting cultivation, or encouraging mixtures rather than monocultures in cropping. The "traditional" approach is above all, based on a multi - purpose utilisation of woodlands and related resources.

A study of the matrix highlights a number of points. An "exploitation" strategy leads to extremely high rates of conflict. Heavy grazing, large-scale tobacco-curing and urban charcoal production are highly incompatible options. These three options are seen as the least compatible of all options in the matrix. The adoption of a "management" strategy on the other hand, reduces conflict considerably. Coppice management and agroforestry become the two most compatible of the options presented. Coppice management however, may not be compatible with permanent cropping (i.e. annual field crops), nor with heavy grazing. Agroforestry systems cannot support heavy grazing, nor can they be maintained in sites where large-scale indiscriminate felling is carried out. Both options however, can accomadate integrated systems for the production of charcoal. Agroforestry also has potential in areas where permanent cropping or maize monocultures are prominent. Conversion to exotic tree plantations and reservation of natural woodlands are the only two "management" options which conflict with those of a more "traditional" nature. Such options as shifting cultivation, honey harvesting, local fuelwood collection and the other "traditional" practices in the matrix, are compatible, both with each other, and with six of the eight "management" options presented. It is also suggested from the matrix that permanent cropping, maize monocultural practices and saw-milling, may be compatible with certain "traditional" options.

Discussion

Given the obvious potential conflict which results from the adoption of certain strategies, one must question why they are pursued? Due to the extent and speed with which land degradation and resource-use depletion occurs, it is hardly surprising that questions are now being asked about the sustainability of certain "exploitation" options. The suitability of certain woodland "management" options, such as reservation of woodland and exotic tree plantations, is less frequently questioned. As both options find wide favour within the areas in question, they are worthy of closer scrutiny. There is little doubt that both production and protection forestry each play vital roles in national economies. Large-scale plantations form a basis for wood raw material production and wood processing industries. Watershed management, wildlife management, genetic conservation and the promotion of tourism are facilitated through the gazetting of forest and woodland area. However, in the drier Miombo areas, plantation forestry

based on exotic species has met with little success. A MAR of 800mm or less is quite marginal for many of the fast-growing species which are popularly promoted, whilst rainfall variability tends to increase along drier margins. The nutritional poverty of soils in many parts of the ecozone is a second limiting factor (Allen 1986), as are the losses which may ensue following termite attack, or wildlife/livestock encroachment.

The socio-cultural aspects of woodland management have been largely omitted from forest resource development in eastern and southern Africa. Publicly owned tracts of land have provided sites for plantations and to a lesser extent, woodland reserves. Such land may have been formerly organised through the laws of traditional tenancy, where grazing, fuelwood collection, honey harvesting and shifting cultivation systems were maintained by groups and individuals. A replacement by forest plantations, (now administered by the Forest Authorities) does not meet the needs of local communities. The situation may be further exacerbated by a lack of consultation with the rural communities involved. Thus, encroachment and damage in young plantations may result.

In comparison, agroforestry and woodland coppicing systems have been highlighted as having potential in Miombo woodland management. The former system is being researched in Africa by ICRAF (International Council for Agroforestry Research), ILCA (International Livestock Centre for Africa) and ICRISAT (International Crops Research Institute for Semi-arid Tropics). As agro-forestry has been a security measure adopted by farmers in these areas for long periods of time, this research is highly appropriate and hence can be expected to meet with early successes. The potential for Miombo tree species in farming systems has not yet been taken on-board, despite the high level of natural regeneration of tree species in farmland (Tuite & Gardiner 1990b, unpubl.). Failure to give adequate attention to the pastoral communities and to the vital economic role played by the livestock sector would be a grave mistake. As noted above, excessive grazing conflicts with almost all other land-uses within a Miombo environment. It is possible however, that the live-stock carrying capacity of woodlands and savannas are exceeded because of the replacement of former rangelands by dispersed and inadequate alternatives.

The potential for improving Miombo woodland productivity through coppice management has not been documented. From a silvicultural point of view, Miombo tree species coppice prolifically. Local fuelwood harvesting relies on this property, yet there are no large-scale Miombo fuelwood projects based on coppice management! This system does not rely on high initial investment in growing stock, but it does require a management work plan. It is tempting to add that a Coppice with Standards system could also evolve, where certain trees are retained for sawlog and veneer purposes.

The two outstanding demands placed on contemporary Miombo arise

in the agricultural and energy sectors. Human population growth rate in sub-Saharan Africa is estimated at approximately 3% per annum (Harrison 1986). The rate of urban growth may be seen as one of the most significant of all demographic factors within the eastern and southern regions e.g. 7% in Zambia per annum, which is one of the highest in Africa. As this trend continues, so too does the pressure exerted on natural woody vegetation and its multiple uses and products. Within their eco-zone, Miombo woodlands are a very large part of the total resource base of seven developing countries. Policies which lead to conflict in the use of this resource result in widespread ecological problems. Such policies reflect also a lack of understanding of the role and functioning of the ecosystem itself, and an unwillingness to recognise the inherent value of more traditional and sustainable systems in the former use of this woodland type.

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Briefly . . .

Heat Pumps in Timber Drying

Traditionally, about two-thirds of timber drying in Ireland has been carried out in approximately a dozen larger sawmills using fuel-fired boilers.

However, in recent years drying by the dehumidification process using electrically driven heat pumps has become popular.

The main advantage of heat pump dehumidification drying lies in the fact that the latent heat of the moisture evaporated from the timber, is not expelled, but recovered and re-used for the drying process. In contrast the conventional 'heat and vent' kiln wastefully vents this heat in the stream of moisture-laden air, which is then replaced by ambient air of variable and uncontrolled quality and which, additionally, requires energy to raise it to the kilning temperature.

Results from a study of kilns fitted with heat pumps indicated that drying times were the same as those experienced in conventional 'heat and vent' kilns and target moisture contents were easily obtained even in thick section timbers.

Considerable savings in energy are possible with the heat pump drier system, varying from 73 per cent for the hardwood species to 85 per cent for the softwood.

The kilner can now increase this energy cost saving by wise selection of the optimum tariff, by maximising the use of cheap night rate electricity and in scheduling loads to avoid the maximum demand tariff.

Technology Ireland, June 1990.

A Possible Indicator of Shake in Oak

Shake in oak has been correlated with environmental factors, particularly the severe fluctuations in soil water availability that occur upon freely draining sites. However, scientists working at the Oxford Forestry Institute have found that certain individual trees possess inherent qualities that predispose them to this defect.

An investigation into the problem demonstrated that sessile and pedunculate oak, with larger than average sized earlywood vessels, are likely to have a greater predisposition to shake. Other wood characteristics such as ring width and width of earlywood appeared to have no influence.

External visible characters such as, branch angle, epicormics, buttressing, bark characteristics and time of flushing were looked at in relation to vessel size but only time of flushing had any relationship.

The reasons for the correlation are thought to be complex and are now the subject of further investigation. However the results from present research are encouraging and indicate that time of flushing can be a reliable indicator of vessel size for 85% of the trees investigated, and consequently of a predisposition to shake. It should therefore be possible to mark the latest flushing trees for removal in thinnings during the spring so that by the time the thinning stage is reached most shake-prone trees would be removed.

Forestry, Vol. 63, No. 4, 1990.

Predicting the Productivity of Sitka spruce

An understanding of the effects of climate and soil conditions on tree growth is an essential basis for predicting timber yields and planting limits. Prediction of the productivity of forest land has become increasingly important in various aspects of forest management, including land aquisition, investment decisions and choosing appropriate silvicultural practices.

Researchers working at Edinburgh University have developed statistical models that can predict general yield class for sites in Scotland. Using the models they have found that general yield class decreases by about 3-4m^3 per hectare per year for each 100m increase in elevation due to the effects of

increasingly adverse climatic and soil conditions. Yield class and elevation were found to be closely correlated at most sites but the relationship varied widely between sites. Values of general yield class at any specific elevation were higher on inland and southern sites than on coastal and northern sites. The elevation of the planting limit also varied between sites ranging from about 600m in the south and inland areas to 300-350m on coastal sites.

The geographical distribution of the variation in productivity is similar to the patterns of both growing season temperature (accumulated temperature) and windiness (tatter rate). These meteorological indices proved to be closely correlated with yield class and can also be used as a basis for predicting productivity.

Forestry, Vol. 63, No. 2, 1990.

Messy Loggers Welcome

Foresters in Oregon and Washington are trying something different: "new forestry." The principle is this: Instead of stripping harvested areas down to the bare ground (for easier replanting), a mess is left behind. Old standing trees, hollow sun-bleached trunks called "snags" and debris from undergrowth and fallen timber remain after the loggers leave. The old trees encourage genetic diversity by adding their own offspring to the new plantation; the snags offer hidey-holes for squirrels and owls; the ground litter in time decomposes and fertilises the whole process.

New forestry, a variation on techniques employed in Germany for two decades, has caught the attention of west coast foresters because of cuts in tree harvesting made to save the endangered northern spotted owl. The technique is seen by its advocates as a way to permit tree-cutting while not wiping out animal species. New forestry, they say, mimics the natural process that occurs when a forest regenerates after a storm or fire.

Perhaps. Test plots employing new forestry are under development on national forests in Oregon and Washington. But it will be ten years before its efficiency is known. Its detractors grouse that new forestry will reduce timber harvests and increase accidents.

Even new forestry's proponents concede that it will not be a panacea for an industry traumatised by a fierce new desire to preserve forests. But clear-cutting as it has been practised for the past 50 years has left many of the west coast's forests of fir, redwood and cedar ugly checkerboards of barren land that take years to turn green. Its side-effects – erosion, wind damage to adjacent stands, sun-warmed waters in salmon-spawning streams – make it difficult to justify the practice any longer.

The Economist, September 1990.

Forestry in the News

Six New Grant Schemes for Forestry

The Minister for Energy, Mr. Bobby Molloy T.D. has announced details of six new grant schemes to encourage expansion of Irish forestry.

The grants will cover the following areas:

- Afforestation;
- Improvement of Woodland;
- Reconstitution of Woodland;
- Forest Roads;
- Forest Harvesting;
- Back-up Measures.

The new grants are provided for in an operational programme for forestry which has now been approved by the European Commission under the Community Support Framework for Ireland.

The Commission has agreed to contribute 70% of the grant-aid paid by the Department under the operational programme. Total FEOGA funding over the period of the programme, which is 1989-1993, will amount to some £50 million.

The forestry operational programme sets out to:

- Exploit and utilise in a commercial manner the extensive area of land suitable for afforestation by doubling tree planting to 30,000 hectares per annum by 1993 as compared with 1988;

- Generate within the period of the plan some 2,000 jobs and additional jobs in the transport and forest processing sectors. Many of the jobs created will be in rural areas where alternative employment opportunities are scarce;

- Increase the annual supply of wood raw material for industry from 1.5 million cubic metres in 1989 to 2 million cubic metres in 1993;

- Contribute to the diversification of the rural economy;

- Make a positive contribution to the environment;

- Provide farmers with a profitable alternative line of production and thereby improve farm structure;

- Improve land usage by encouraging the transfer to forestry of 95,000 hectares of land, (almost 1½% of the total area of the country) which is of marginal agricultural use but highly productive for forestry.

The benefits of the programme will be dispersed throughout the country, thereby contributing to rural development.

New Grants

The highest afforestation grant available up to now was £800 per hectare under the Western Package Scheme. This grant was, however, confined to the designated disadvantaged areas. Outside of these, the grants ranged from £500 per hectare for conifers to £800 per hectare for broadleaves (*£850 per hectare in the case of full-time farmers). The new grants have been rationalised, and are available throughout the country and are a substantial improvement on forestry grant-aid previously available. Furthermore, farmers stand to benefit greatly because, not alone will they have improved grants but they also have available to them an annual forestry income for up to 20 years through the forest premium scheme launched earlier this year.

In all of the new planting schemes, farmers will qualify for the highest grant level, 85% of costs. By providing a strong incentive for farmers to diversify into forestry, the new schemes will make a major contribution to the important social aim of maintaining farmers on the land and providing them with an income-generating, alternative farm enterprise. Non-farmer applicants will receive grant-aid towards 70% of their costs. For the first time, these EC-assisted forestry development schemes will be available to Coillte Teo., the State forestry company. However, the company will only be eligible for a lower grant level of 65% of costs.

The six new schemes and the upper grant limits in each case are as follows:

1. Afforestation

The new afforestation grants are designed to encourage forestry development which improves the environment while, at the same time, discouraging less economic afforestation. This is to be achieved through a variation in the rates payable depending on the type of land on which the trees are planted.

The highest grant available will be £1,200 per hectare and this will be provided for the planting of broadleaved trees, which are being favoured for environmental reasons. This grant represents a 50% increase on the grants available for broadleaves up to now.

For conifers, the grant limit will vary depending on the type of land planted. In the case of land which was enclosed for agricultural purposes before being afforested, the maximum grant will be £900 per hectare.

Lands which were never enclosed by man-made boundaries for agricultural use, such as commonages or open mountain tops, are often of poor quality and are not very productive under forest. A lower grant of £800 per hectare will apply where such lands are planted with conifer trees.

2. Improvement of Woodland

This is a new grant scheme which was not previously available. The grants are directed mainly towards broadleaved woodland and are intended to encourage the conversion of neglected woodland to productive forest. The maximum grants are £900 per hectare for conifers and £1,200 per hectare for broadleaves.

3. Reconstitution of Woodland

Again, this is a new scheme which has not been available previously. The grants are designed to encourage the reconstitution of woodland which has suffered damage as a result of fire, storm or other natural causes. The highest grants will be £900 per hectare for conifers and £1,200 per hectare for broadleaves.

4. Forest Roads

Grant-aid for the construction or upgrading of forest roads has largely been confined to the disadvantaged areas up to now. The new forest road grants are a significant advance in that they are extended to all parts of the country. The grant level is 80% of costs for all applicants subject ot a limit of £12 per metre.

5. Forest Harvesting

New grants towards forest harvesting machinery represents another major milestone in the development of the forestry sector by the Department. These new grants are designed to improve efficiency and productivity by encouraging investments in machinery and facilities for forest harvesting and extraction of forest produce. The rate of grant will not exceed 45% of approved costs subject to upper limits to be set depending on the merits of each project.

6. Back-up Measures

A number of initiatives, which will act as a back-up for the main scheme, will also be funded. These include aid to associations, studies and pilot projects. In addition, publicity campaigns will be held by the Department to promote the programme.

Special Attention to the Environment

There is a growing awareness of the interaction between forestry and the environment. The harmony between the two, which must be maintained, is reflected in the particular duties placed on Coillte Teo., in the Forestry Act, 1988 to have due regard to the environmental and amenity consequences of its operations. It is also reflected in the operational programme which I am launching. This programme is committed to the development of forestry in harmony with environmental protection.

There are two special initiatives included in the programme for environmental reasons. Firstly, the planting of broadleaves is strongly favoured as these trees will enhance the environment, provide habitats for flora and fauna and also provide much needed quality hardwood timber. The grant level of £1,200 per hectare should encourage a substantial increase in the proportion of broadleaves planted.

Secondly, the grant rates for afforestation are designed to avoid pressure on unenclosed areas which can often have environmental value. Any unenclosed area which are approved for afforestation, following full investigation of and consultation on the environmental aspects, will only qualify for the lowest grants available.

This is a special feature of the programme designed to divert planting from such sites.

In addition, the Operational Programme contains strict guidelines for protecting the environment and the Government is committed to further strengthening these guidelines. Procedures have been instituted to protect Areas of Scientific Interest and other environmentally important sites. Furthermore, the Department will provide advice on environmental issues so that those afforesting land under the operational programme have the necessary knowledge to ensure that their work has a positive impact on the environment.

Leitrim Observer, 5th September 1990.

New Forestry Grant Welcomed with Caution by ICMSA

"The new forestry grant schemes announced by the Minister for Energy, Bobby Molloy, T.D., will provide much-needed income for farmers, both inside and outside the Disadvantaged Areas", said Mr. Dan McCarthy, chairman of the ICMSA Family Farm Committee.

Mr. McCarthy said that the operational programme for forestry is a lifeline which will help to maintain farming communities over the next twenty years.

"The forestry premium scheme means that farmers can plant marginal land and receive a realistic premium rate, which in addition to another enterprise will provide a continuity of income for the next two decades. This and the resulting jobs which will be created in the transport and forest processing sectors is good news for family farmers," said Mr. McCarthy.

However, he cautioned that the extension of the forestry scheme may have social repercussions if care is not taken by Coillte Teo to ensure that strict criteria is applied to planting so that rural dwellers are not planted out of existence.

Mayo Post, 30th August 1990.

Carrigallen Firm Links Up with Coillte Teo.

Crann, which was set up in 1986 to promote the planting of trees throughout Ireland and is based in Carrigallen, Co. Leitrim, has been invited by Coillte Teo. to assist in the planting of 110,000 oak trees in Co. Wicklow, next month. It is the first time that the two bodies have joined forces on such a venture. In all 65 acres will be planted over a fifteen month period.

When completed, it will be the biggest oak planting undertaking in the country for many years.

Mr. Kieran McGinley of Crann said that they were delighted to be involved in the project. In fact, it was Crann who brought the proposal to Coillte initially who encouraged them and Crann took if from there. They first began working on the idea fourteen months ago.

According to Kieran it is a major undertaking for his organisation but they are confident of doing a good job. Coillte has provided he 65 acres at Glencree, just outside Enniskerry, and they hope to complete the job by the end of 1991. If the project is a success they will be looking at other places in the coun-

Christmas Comes Early for Kilcommon and Rearcross

Minister Michael Smith, T.D., has announced that Kilcommon and Rearcross have been selected for the growth of Christmas Trees on specially selected farms. The Minister said he is hopeful that these farms, as the trees mature in 5 to 6 years, will produce an opportunity for a native industry with very considerable employment potential on a seasonal basis. The project is being undertaken by Coillte and it reflects the significant potential for the sale of high quality non-shedding Christmas trees in Ireland and abroad.

Nenagh Guardian, 8th September 1990.

try like Connemara, Cork and Monaghan to carry out similar work.

The whole project is being sponsored by The Body Shop Group.

Anglo Celt, 30th August 1990.

Strict Controls on Forests

Tough guidelines on planting forests are being drawn up by the Department of Energy to ensure that the environmental impact of thousands of extra trees is kept to a minimum.

Strict rules will govern preparation of the ground, use of fertilisers, planting methods, making of roads, timber extraction and other aspects which could harm water quality.

Similar rules covering issues such as archaeology and landscape are also in the pipeline, Minister for Energy Robert Molloy said when he opened a conference in the RDS on forestry and the environment yesterday.

Irish Independent, 18th October 1990.

Major Irish/Swedish Joint Venture

Coillte, the State forestry company, is to link up with Stora, Sweden, Europe's largest forest products company in a major joint venture. This involves the establishment of a joint forestry company to acquire land and establish new forests and also the setting up of a new £150m pulp industry.

According to Coillte Chief Executive, Martin D. Lowery, the joint forestry company will begin operations immediately in order to build up a secure long-term raw material base for the pulpmill. It is envisaged that the company will plant up to 2,000 ha. annually over the next 15 years.

The pulpmill is expected to be in operation by 1995. In its first phase the pulpmill will produce 100,000 tonnes of wood pulp annually. This pulp will be used in the manufacture of tissue and other absorbent hygiene products, liquid packaging and printing and writing paper. From the beginning, the industry will purchase timber chips from Irish sawmills and pulpwood from Irish forests – Coillte and private.

Announcing the project, Mr. Lowery said that the £150m investment will lead directly to 500-600 jobs – 150 in the pulpmill and 350-450 in timber harvesting, transport and ancillary activities. He also said that no decision has yet been taken on the location of the industry. "A feasibility study will be carried out beginning later this year and discussions will take place with the IDA, with the ESB in regard to electricity supply and the sawmills in regard to the availability of raw material, before any decision is taken in regard to location."

The Minister for Energy, Mr. Robert Molloy, T.D., welcomed the announcement by Coillte and stated that he had authorised Coillte to seek out a partner with technical capabilities and market outlets for pulpwood from Irish forests and residues from Irish sawmills.

Anglo Celt, 13th September 1990.

Society Warns of 'Destruction' of Rare Trees

Many rare and irreplaceable trees some unique to Ireland, face destruction due to the failure to catalogue them and enforce tree preservation orders. Speaking in Dublin this week, the chairman of the newly-launched Irish Tree Society, Thomas Pakenham, criticised the lack of public or private effort to preserve this "threatened heritage" of specimen trees.

"Ireland still has an amazing number of huge and ancient trees inherited from previous centuries. Probably the oldest and largest ash tree in Europe is somewhere in the Irish countryside. No-one knows, because on-one has bothered to look.

We may have the largest beech tree in the world. Again, no-one knows," said Mr. Pakenham.

The state-sponsored body for the promotion of forestry and protection of woodland, Coillte Teoranta, has no responsibility for the preservation of individual, free-standing trees. There has never been a body to catalogue specimen trees in Ireland and seek preservation orders for the most important. This has led to situations as at Shillelagh wood, Coolatin, County Wicklow, once the largest eighteenth century oak plantation in Ireland, where many tall, broad oaks were cut down before they could be measured.

These "specimen" trees are defined as "outstanding" both in isolation and in age, beauty, size or rarity of type. Among these are the two large Oregon Maples dominating Library Square in Trinity College Dublin, which were brought to Ireland in 1825. The largest of these is nearly 12 feet in circumference, and is growing at a rate of half an inch per year.

However, few trees have a lifespan of more than two hundred years, and most die or are destroyed in less than one hundred. The Irish Tree Society, while seeking new members and undertaking a comprehensive inventory of specimen trees, also intends to encourage people to plant trees to replace those being lost.

Sunday Tribune, 14th October 1990.

Call to Alter Forestry Plan

A major report, "Forestry in Ireland – Policy and Practice," was published yesterday by the environmental awareness group, An Taisce. The trust points out that an area the size of Co. Louth will be afforested every three years if the projected targets are achieved, making forestry the major agent of land-use change in the Irish countryside.

"Instead of the benefits that are claimed to accrue from forestry, large areas of the most acclaimed biotopes and landscapes in Europe risk being drained, ploughed and planted for industrial timber production by commercial interests", says the report, which was compiled by An Taisce's environmental officer, Mr. David Hickie.

"Our natural heritage is in retreat and other sectors of the economy which depend on a high quality environment for their viability, such as tourism and fisheries, are threatened", it declares, adding that the Government and the EC – which are providing substantial grants for afforestation – bear a "heavy responsibility" to ensure "sustainable development".

At yesterday's launch, Professor Frank Convery, director of the Environmental Institute at UCD, said the core concept running through An Taisce's report was that much environmental damage – especially on sites of low wood productivity but high environmental value – arose "because the Government, through its grant and tax incentives, stimulates the destruction".

The first priority, he declared, was to remove these "destructive incentives" by ensuring that commercial forestry is encouraged on cutaway bogs and "grass-rush sites", but discouraged on undisturbed peatland and the upper reaches of rivers supporting salmon and trout because of the risks of "acidification".

An Taisce strongly recommends that an economic evaluation of this policy should be undertaken, including the wider costs and benefits, to provide policy-makers with comprehensive information to make "correct decisions". If it was not reviewed urgently, afforestation would continue to consume unsuitable land in the short-term, "with serious environmental consequences".

An Taisce commends the Forestry Service of the Department of Energy for introducing more generous incentives for the planting of traditional broadleaved trees, suggesting that an opportunity now exists to develop an extensive broadleaved forest in the Midlands. It also welcomes the emphasis in "farm forestry", using marginal land.

Irish Times, 2nd October 1990.

Coillte Wins Woodlands Award

Coillte Teoranta has won the Royal Dublin Society's 1990 Irish Woodlands Award for Ravensdale Wood, Dundalk Forest. The prizewinning Woodland consists of 32 hectares of mixed conifers and hardwood from 25 to 60 years of age. Coillte are delighted to win the top award this year having received the Very Highly Commended Certificate last year for the same property. The award – an original piece of wood and silver sculpture by Eric Springbrunn, one of Ireland's top silversmiths, was presented to Tim McCarthy, Forester-in-Charge, Dundalk Forest by Ms. Mary Harney T.D., Minister for the Environment at a reception at the Royal Dublin Society on Friday October 19. Also present was the Chief Executive of Coillte Teoranta – Martin Lowery and Terry O'Reilly, Dundalk Forest.

The High Commendation Award went to Gerard Lalor, Fahy, Rhode, Co. Offaly.

The Award Scheme, sponsored by Irish Woodland Management Ltd. and the Irish Farmers' Journal in association with the Royal Dublin Society was designed to focus public attention on the Forestry Industry, recognise management achievements in timber production, encourage owners to consider landscape, conservation, recreation, public access and integration with other land use.

Coillte Teo. News Release, 19th October 1990.

Stora to Defer £150m Irish Pulp Paper Mill

The giant Swedish industrial group, Stora Kopparberg, is to defer a proposal to build a £150 million pulp paper mill in Ireland in conjunction with the State-owned forestry company, Coillte Teo. The chief executive of Coillte, Mr. Martin Lowery, said that the proposal had not been abandoned but that they would have to consider other partners besides Stora to build a paper mill in Ireland.

Stora announced yesterday that it would not proceed for the time being with a feasubility study on the Irish mill, which ws due to be completed late in 1991. Stora earlier this year paid over £1 billion for the German company, Feldmuehle Nobel. Mr. Lowery said Stora needed more time to digest the high financing costs associated with that acquisition.

However an associated joint forestry venture with Stora – with the much more modest capital commitment of £5m – was not necessarily affected. That would provide a further 350 to 450 jobs in forestry, harvesting and transport.

The Irish Times, 13th December 1990.

Coillte Land Policy Attacked

Coillte, the State forestry company, has been accused of being totally inflexible in its dealings with small farmers who wish to either buy land from, or swap land with the company in a bid to consolidate their holdings.

The accusation was made this week by Padraig Divilly, chairman of the IFA's western and less favoured areas committee. He pointed out that last year Coillte purchased almost 16,800 acres for forestry, some of which would be of agricultural use, but neighbouring farmers who had sought exchange or purchase agreements with the company in an attempt to bring disjointed farmland into a single manageable unit were turned down. He added that approaches made by the IFA at regional and national level had evoked a similar response.

Padraig Divilly appealed to the Minister for Energy, Bobby Molloy to intervene with Coillte to ensure that small farmers could have access to the fractions of land involved to help bring them up to an acceptable level of viability.

Farmers' Journal, 17th November 1990.

Loan for Forestry Development

Expansion of Ireland's forests is being supported by the European Investment Bank with a **48m ECU** (37 million Irish pounds) loan. The loan will be used to fund activities undertaken by Coillte Teoranta (Irish Forestry Board) and the Forestry Service of the Department of Energy for the private sector, including the planting of 32,000 ha, reafforestation of 4,900 ha and construction of 360km of forestry roads. The EIB will aid regional development and economic activity in areas of high unemployment and provide support for local wood-based industries.

Agence Europe,
17th December 1990.

£10 Million for Forestry

As part of an overall package of rural development measures proposed by the EEC £10m has been approved for forestry.

Minister for Energy, Robert Molloy T.D., said the money would go towards planned recreational forestry which will be geared towards attracting tourism, improving the environment and expanding wood production in rural areas:

– Co-operative farm forestry which will make available to farmers the necessary facilities for jointly investing in afforestation;

– Demonstration farm forests which will be established in association with Teagasc to give a practical educational experience of forestry to farmers;

– Farm business consultations and planning to ensure that farmers have the best available advice on all aspects of forestry investments;

– Investments in forest nurseries;

– Training programmes which will be run in association with Teagasc and Coillte Teo., the State Forestry Company to prepare people to take up jobs in forest establishment and harvesting and to ensure that all forestry operations are carried out safely and efficiently.

The Minister said that the Commission's approval of his proposals underlines the recognition which is now being given to the very important role which forestry plays in the balanced development of the rural economy, the diversification of farm enterprises and the improvement of the environment.

Galway Advertiser,
27th December 1990.

Obituary

THOMAS O'CARROLL

1914 - 1990

Tom O'Carroll, or Tomas Ua Cearbhaill as he was officially known from 1945, was buried under a warn September sun in Castlemacadam, a small graveyard near Avoca, Co. Wicklow. He had selected the place himself. It lies beside a wood and looks across the valley to Shelton Forest, Tom's base for many years. During the ceremony we heard chainsaws felling trees he had tended, and perhaps selected for planting. Forest production continues, indifferent to human vicissitudes, and the forest in its regeneration celebrates the forester.

Thomas O'Carroll was born in August 1914 in Arklow where his parents both taught school, and was educated locally and in Wicklow town. His father built a summer house near Avondale and it was there that the forestry connection began. This may have come in the person of Michael O'Beirne, Superintendent of Avondale Forestry School, who had been a contemporary of Tom's uncles in the former Royal College of Science for Ireland, later incorporated into U.C.D. (The College of Science building, incidentally, now houses the Department of the Taoiseach.) This contact led to an interest in forestry as a career, and, following his brother Joe, Tom qualified with a degree in forestry from U.C.D. in 1939.

His first appointment was as Temporary Assistant Junior Forestry Inspector in December 1939, and he was promoted to the rank of Assistant Junior Forestry Inspector (Unestablished) – those were the official titles – in May 1942. He served on District work in Clonmel, Portlaoise and Limerick before being appointed Superintendent of Avondale forestry School in October 1949. He transferred with the school to Shelton Abbey and later had responsibility for all internal education, including Kinnitty Castle. He retired in August 1979 as Senior Inspector responsible for Forest and Conservation research. He died on September 18th 1990.

During his years in Avondale and Shelton Tom was strongly committed to his teaching. He habitually "gutted" (his own word) forestry periodicals for items that would help him in imparting more and better forestry knowledge to

his students, that being always his first priority.

My own introduction to forestry came from Tom O'Carroll (We were first cousins). During a holiday in the summer house at Ballinaclash (Clash) in the summer of 1950 he brought me around Avondale. I clearly remember his obvious enthusiasm as we toured the plots and specimen trees of the big ride.

Tom was involved in one notable incident in the history of Irish forestry. On 19th November 1954 *The Irish Times* published a letter over the pseudonym *Rubus Strigosus.* In the circumstances of the time the publication of the letter caused quite a stir in some quarters, and was a *cause celebre* generally. It can now be recorded for the first time that the letter was written by Tom O'Carroll and his eldest brother, the late Michael, with help from another forester now enjoying his retirement. It could not be claimed that *Rubus Strigosus* achieved any tangible result, but it served as a valiant rallying call at a very difficult time for the forestry profession. The words *Rubus Strigosus* may be translated as "bristly raspberry".

Tom O'Carroll was a man of independent mind and had definite opinions on certain topics which he was quite prepared to defend, and to act on if he thought it appropriate. But anyone who knew him will know that he enjoyed forestry and enjoyed life. His friends were known to experience practical jokes and with considerable gusto he would occasionally dispatch by the post wittily annotated newspaper cuttings which were always apposite to some current topic, often not of a public nature. He was an enthusiastic forester and a good friend.

To his widow Lilian and to his sons and daughter we offer the sympathy of his friends and colleagues.

Niall O'Carroll

Society News

SOCIETY OF IRISH FORESTERS ANNUAL STUDY TOUR 1990 SOUTHERN SCOTLAND 15-19 MAY 1990

Day 1

The first day of the study tour began with a visit to the Forestry Commission Training Centre at Ae which was established in 1985 in response to increasing demand for properly trained machine operators. The Centre provides courses for operators, supervisors and service mechanics of forwarders, harvesters, processors and scarifiers.

Courses last for a period of 1 to 3 weeks depending on the machine and there is a follow-up training period of 1 week. It is considered important that the operator's first-line supervisor is also given a 2-3 day training course to give him an appreciation of the capabilities and limitations of the machines for which he is responsible. The value of comprehensive training courses is underlined by the fact that a poorly trained operator will only reach 65% of the output of a properly trained operator – this can have very practical implications when applied to machines costing £90,000-120,000.

Significant natural regeneration of Sitka spruce has occurred on clearfelled sites in the forest of Ae. Where 100% natural regeneration has occurred the cost of establishment (including drainage and respacing at 2m height) is reduced to £330/ha. The "normal" cost is £800/ha. To assess the economic potential of this form of regeneration, its occurrence has been monitored for the past 5 years. However, results to-date indicate that it is completely unpredictable as to when or where it will occur, and it is therefore not possible to rely on natural regeneration as a means of crop establishment.

A premature clearfell site was visited which had a windthrow hazard rating of 3 and was being clearfelled before it reached the critical top height. The crop had not been thinned and had a standing volume of 300m^3/ha with an average tree of 0.12m^3 – yielding 40% pallet, 30% pulp and 30% dead trees (due to suppression). The timber was harvested by a Kochums processor and extracted by a Brunnett forwarder for a total cost of £12/m^3. Prevailing timber prices were pallet (on roadside) £34.38/m^3 and pulp (delivered) £21/m^3. Thus the Forestry Commission was making a profit on the operation but the long term economics of this form of silviculture are extremely questionable.

The high priority attached to the visual impact of forestry on the landscape was highlighted at the final stop in Ae forest where a stand of Norway spruce (P/37) was being clearfelled as part of a national landscape plan. The replacement crop will be a mixture of Sitka spruce/Japanese larch and hardwoods. The mean tree size was 0.7m^3 (yielding 12% pulp and 88% sawlog) and harvesting costs were £7.25/m^3 on roadside (motor manual felling with extraction by Valmet 838 forwarder).

The day concluded with a visit to the estate of the Duke of Buccleuch near Castle Douglas. The estate is 40,000

ha in extent and contains 4,500 ha of woodlands which is 90% coniferous, with Sitka spruce the main species.

In marked contrast to the nearby Forestry Commission plantations, the estate foresters have not adopted a "no-thin" policy. Using a rack and selection thinning system they have carried out heavy first thinnings of Sitka spruce (P/64-67), removing approx 35% of the standing volume, and have not experienced any significant windthrow problems as a result. The thinnings were segregated into pallet and pulp which sell for £35/m^3 (on roadside) and £22/m^3 (delivered) respectively. The cost of harvesting and extraction was £16/m^3.

Pat O'Sullivan

Day 2

Day two of the tour was spent in the Castle Douglas Forest District area of Galloway Forest Park.

On a wet morning we departed from our headquarters in Dumfries and travelled west through the rich Galloway countryside of green farmland liberally interspersed with belts of broadleaved trees. Fortunately as we approached the day's first stop the rain eased off and the sun made an effort to shine. Thankfully it kept dry for the remainder of the day.

Our first stop was by peaceful Woodhall Loch, North-West of the town of Castle Douglas. Here, as the sound of the curlew and oyster catcher filled the air, Gordon Cowie (Forest Commission Conservator for South Scotland) introduced the group to District Manager Ernie Michie and his assistants Tony Burns and Roy Harvey.

Mr Michie welcomed us to the District and outlined the route for the day and topics to be discussed at each stop. Although a timber producing area, it was the recreation and conservation aspects which we were looking at and how these can be integrated into normal forest operations.

Along with three other districts, Castle Douglas forms a major part of the Galloway Forest Park. This was opened in 1943 and occupies an area of 66,000 hectares (250 square miles) of which 40,000 hectares are planted.

The whole area experiences a mild oceanic climate with annual rainfall ranging from 750mm on the coast to 1500mm on the northern hills. Peat is the major soil type throughout having formed on both shale and granite bedrock. These factors combined with high growth rates makes Sitka spruce the major species planted. There are also considerable areas of pine, Douglas fir and larch.

Small areas of broadleaves have been established on the fertile flood plains of the major river systems. Overall, approximately 5% of the annual planting programme is broadleaves, on selected sites using tree shelters. Providing the deer leave them alone, this will have a significant effect on the woodland character of the park in years to come.

Roy Harvey, whose duties include forest landscape design, spoke about the area west of the lake which is in the process of systematic clearfelling. Like many of the forest blocks in the park it can be seen from one or more of the public roads. As a result, design of forests has become a big issue. Landscape architects are employed to design and put on maps layouts of felling and

planting coups. These plans are made as practical as possible to fit in with normal production forestry. However, a certain amount of revenue loss has to be accepted. Once approved, these plans are made permanent and incorporated in future working programmes.

In these times of increased environmental awareness, it is important and very beneficial to keep the public informed about forest design plans. Articles are placed in local papers and displays put on in community centres. Meetings are also held with such bodies as County Councils and The Royal Society for the Protection of Birds to put across the plans and to get suggestions and exchange of views. Political support is very forthcoming for forestry, provided it conforms to sound environmental practices.

The rest of the morning consisted of stops along the ten mile 'Raider's Road' forest drive which was opened in 1976. It is open to the public from Easter to October carrying about 11,000 cars. There is a fee of £1.00 per car. Drivers obtain a ticket from a machine situated at either end of the drive. Surveys have revealed a 15% dishonesty factor. Most cars come from within a 70 mile radius. For the most of its route it follows the banks of the Black Water of Dee. In former days it formed part of an old drive road featured in 'The Raiders', a romance by Samuel Rutherford-Crockett. On it, the outlaws used to come down from their hideouts among the Galloway hills, raid farms on the Solway Coast and return to the hills with prize cattle. From this we get the name 'Raiders Road'.

First stop along the road was at Stroam Loch car park and picnic area. Here, beside the fine stone viaduct which carried the now closed Dumfires to Stranraer railway, Tony Burns gave us a further insight into the recreational uses of the Galloway Forest Park.

In comparison to the Lake District of England, the park is relatively underused. Amenity facilities are concentrated in certain areas, and include car parks, picnic sites and walking trails. The areas most frequently used are the woods close to the towns of Newton Stewart and Castle Douglas, known as 'town woods'. There are two caravan parks and two major centres where visitors can learn something of the balanced approach to the timber production, wildlife and amenity uses of the park.

For the more energetic a series of long trails, including the Southern Upland Way, cross the park. On these one can get away from it all and 'get lost' in the remote beauty of Galloway Forest Park. Walkers have the use of several bothys where basic facilities exist (shelter from the weather). Firewood is provided.

The central area of the park, devoid of trees is called a Wilderness area. There are no roads, thus little human disturbance. It is intended to keep it this way and let nature rule supreme.

A popular activity is fishing the lakes and rivers for which there is a charge of £2 per day for coarse fishing, £4 for trout, and £6 for salmon.

Throughout all this the aim is to have high quality amenity facilities with back-up maintenance. With an annual amenity budget of £80,000, there are plans now to charge for certain facilities, such as car parking and also for publications. However, the Commission do receive a subsidy for recreational works. The fee charged for the 'Raiders Road' goes to

its upkeep, and also the car parks and picnic areas along the route.

Further developments along the drive include a selective clearfell programme spanning 20 years, where small blocks of trees will be removed from the roadsides to create new views. It is also planned to retain groups of not so common trees for show. With the ever present problem of windthrow, size and shape of the felling coupes are carefully chosen and mapped out. In restocking of these coupes a policy of using 5% broadleaves is used as much as possible. The presence of deer is a problem however. Roadside operations have to be done between October and Easter.

Before leaving the drive we had a very pleasant ten minute stop-over at the 'Otter Pool', a popular spot with visitors. Here the Black Water of Dee flows over a rock outcrop with a maze of shallow pools. It is also the most scenic section of the drive.

A landscaped car park and toilet facilities are located among the trees. Close to the western entrance a path for the less able has been developed. North of the same entrance, on the public road is located The Galloway Deer Museum, one of two visitor centres in the park. With the aid of fine displays, visitors can learn about the Galloway red deer and other species of wildlife that find their home here. Adjacent to the building we ate our lunch, looking out over Clatteringshaws Loch.

Following lunch, we headed north into the hills towards Loch Dee stopping on route to the Commission's Clatheringshaws trout hatchery. We were introduced to Ian Murray who very enthusiastically showed us around. The nearby Loch Dee has a long tradition of tourist fishing. However, since the early seventies, the fishing was declining partly due to the increasing acidity of the water. Around this time the hatchery was set up to raise trout, thus getting them over the critical early years of their life. They are later released into the lake. Ian Murray explained that in October-November wild trout are caught in special traps. Females are 'stripped' of their eggs and sperm is taken from males. The eggs are taken to the hatchery where they overwinter in an insulated shed. Hatching occurs in February, in tanks fed by lime rich water. Once the fry have used up the contents of the egg sac, hand feeding begins using fish meal. As they develop, grading takes place whereby the bigger, healthier fish are retained. The others are released into the wild. From the hatchery the big fish are released into cages in Loch Dee, to be further fed until they are three years of age when they are finally released into the lake proper. Each fish carries a special mark, and with the co-operation of fishermen, Ian can trace their movements, life span and eating habits. Not all fish are used in local waters, some are sold to outside bodies, thus gaining revenue to fund the hatchery. We were very impressed with several fine specimans of trout on display for us in one of the big tanks.

Moving on up to Loch Dee, situated in the heart of the Galloway hills, Ernie Michie spoke of the Loch Dee Project set up in 1980 by the Forestry Commission in association with the Solway River Purification Board. The aim of this project is to monitor the causes, effects and treatments of the high acidity levels in the water.

The study has attracted considerable

interest being a major research project of national importance. The Scottish Development Department has given financial support for instrumentation and the employment of a full-time field technician. Loch Dee is a shallow lake covering an area of about 1 square km. It is fed by three main rivers flowing down from the granite hills. Water takes 28 days to pass through the loch. It has been found that the influence of winter storms carrying salt laden rain reduce pH levels considerably. Lorry loads of lime dumped into the rivers have increased the pH.

Leaving the wildness of Loch Dee, we retraced our course back to the A712, New Galloway to Newton Stewart road and drove south-west for our final three stops. Adjacent to this road is situated the Red deer range, set up by the Commission in 1977. Ranger Peter Kelly, met us on our arrival and outlined the operations of the range.

Covering approximately 200 hectares, the range contains about 70 deer made up of stags, hinds and calves. The aim of the range is to preserve the Galloway red deer and to give the public an opportunity to see them at close hand. As a result of Peter's feeding the deer have got very tame. The herd is free from tuberculosis, and despite the occasional poachers raid, numbers have built up. Surplus calves are sold to deer farms, and fetch high prices.

Further west along 'The Queen's Way', we stopped briefly to view the wild goat park. It was set up in 1970 and covers 60 hectares. The park shows feral goats to the public all year round in their natural habitats. Presently it contains about 50-60 animals. Research is being carried out in cross breeding these goats with certain breeds from overseas to produce a high quality cashmere.

Our final stop of the day was at Tulnotry campsite, one of two located within the forest park. In comparison to the site in Glen Trool, Tulnotry provides only basic facilities for caravans, and tents. It is a very pleasant site set among the trees on the banks of Palmure Burn. Very popular with visitors during the summer, it has reduced the incidence of 'wild' camping in the park. And so our day at Galloway Forest Park came to an end. The leader for the day Jim Neilan, thanked Gordon Cowie, Ernie Michie and everyone else involved in making our visit so interesting and enjoyable. A lot of enthusiastic effort went into the day, and was very evident at all of the stops.

Richard D. Jack.

Day 3
Eskdale Muir
Economic Forestry Group plc

We were met at the Eskdale Interpretation and Training Centre by Mr. David Woolfenden and Mr. Ronnie Rose.

Mr. David Woolfenden gave us a brief history of the development of private forestry in Scotland. Development began in the 1960's when full tax relief was available for forestry (at the time the top tax rate was 98%). Things went very well for private forestry in the early years. Then in 1978-79 the Green Lobby arrived on the scene and in particular attacked the practice of blanket afforestation with Sitka spruce. Foresters were not seen to be environmentally conscious and the campaign against forestry continued to gain momentum.

As a direct result of this campaign the tax relief on forestry was terminated in 1988. This was purely as a result of lobbying by environmentalists rather than any significant saving on behalf of the British Exchequer. The result of this has been that planting is now down by 75% from the mid 1980's.

The British Government now encourages afforestation with a grant of 615 per hectare under the new Woodland Grant Scheme, this however, has had only a limited effect on the amount of afforestation carried out.

Two interesting conditions of this Scheme are:

1. that the afforestation project does not have to be economic

2. that there is a minimum requirement for the planting of 5% broadleaves.

Having a Scheme approved for a grant is now a complicated process and can take up to 6 months and involves the employment of landscape architects. The complicated nature of this grant approval process can mean that an investor may have to spend up to £6,000 before a Scheme even reaches the approval stage.

Mr. Woolfenden finished off his talk by pointing out the contrast between Britain, where forestry, in general, has a poor public image (public and private forestry), and Ireland, where in general forestry has a good name and is certainly not subject to the same restrictions as those that apply in Britain. This he predicts will not remain the case in Ireland if foresters are not seen to respond effectively to the environmental issues raised.

Mr. Ronnie Rose, who is EFG Chief Wildlife Manager for South Scotland and Northern England, then gave us some "straight talking" as he described it himself, about wildlife. In summary, there are 200,000 deer in Scotland, and shooting and fencing are not sufficient to control this population. Planting started in Eskdale Muir about 20 years ago and there is now an area of 14,000 ha under forest. At the time that planting started, there were 10 deer in the area, there are now 3,000. The deer population is kept under control and there is practically no damage – the deer are looked on as an asset.

Young plantations provide ideal feeding ground for deer. One of the principles of deer management is the need to leave open spaces (approximately 15% of the total area). This is achieved by keeping back from the streams and rivers, which is good forestry practice anyway and leaves the deer areas to feed in. In Scotland the best areas to leave are wet flushes with mineral soil where the deer find their favourite food. Good areas to leave for deer are stream sides, it is important not to leave straight hard edges as these create wind tunnels that do not attract wildlife.

Mr. Ronnie Rose's staff of Wildlife Managers are managers and not just deer shooters. Wildlife management is something that can't be leased out to outside interests. This is because deer hunters as such, are primarily interested in trophies and do not effectively control the population. Shooting older stags only disrupts the deer population, where younger stags then try to establish territories. What is wanted is a stable predictable population.

All species of deer can be a problem. Red deer prefer grass and meadow plants, but when this is in short supply

they will eat trees. All deer have their food preferences, and if they are under pressure they will simply work down the list. It is not possible therefore to avoid damage simply by species selection. Red deer are not noted for bark stripping, but Sika deer are quite inclined to do this. Red Sika hybrids are the most destructive. Bark stripping by deer can be a major problem, if the population is not controlled.

At Eskdale Muir from the start foresters have tried to develop a natural ecosystem. This has been of enormous benefit to wildlife – at the time the development started there were 35 species of birds in the area, there are now 117, this is despite the fact that the main species used is Sitka spruce.

Voles can be a problem in Britain, where they strip the bark and kill young trees. Biological control is the only real answer, this is achieved by encouraging predators. Owls will keep the vole population under control. Carrion crows need to be kept under control as they feed on owl's eggs.

Later on we saw Eskdale Muir Forest itself and it was clear that the policies suggested by Mr. Ronnie Rose in relation to open spaces etc, were being implemented and in fact had been practised for many years, giving the plantation a varied and natural appearance.

We then went on to see an area of Sitka spruce which had been chemically thinned a number of years previously. The particular crop which we visited was chemically thinned at a time when there was a particularly poor market for thinnings. The thinning would have cost £5 per cubic metre if the trees had been harvested. The advantage of chemical thinning, is that it can be used on high windthrow hazard classification crops to maximise volume production without increasing the risk of wind damage. The EFG have used chemical thinning on quite a large scale. Two cc of Roundup squirted into an axe cut, results in a 75-100% death rate of the trees treated. The normal treatment used is to treat 50% of the crop. It was found to be cheapest to chainsaw brash the crop prior to treatment when the crop has reached a height of approximately 8 metres. The cost of this operation is £170 per hectare to the client, leaving 1,100 trees per hectare. The present policy is to plant mixtures on high windthrow hazard sites. Much of this forest area has a windthrow hazard class of 5-6 (on a scale of 1-6). Commonly used mixtures are Sitka spruce with lodgepole pine or larch.

The EFG looked after us very well, providing us with much appreciated refreshments on our arrival and again at lunch time. Kieran O'Brien, our driver for the trip, surprised everybody and treated us to a few tunes on the bag-pipes.

In the afternoon we visited the James Jones and Sons Ltd. Sawmills in Dumfries. James Jones & Sons Ltd are the largest sawmillers in Scotland and expect to produce 140,000 cubic metres of sawn timber this year. There are two mills in Dumfries, the Commercial Timber Mill and the Boxwood Mill. The two mills are approximately 1 mile apart.

On our arrival we were met by Mr. Brian J. Thompson, who is the overall manager for the two mills in Dumfries, and by Mr. Ian Gray, the manager for the Commercial Mill.

The Commercial Mill is built in a large aircraft hanger. Stocks in the yard are kept to a minimum and it is normal to have two to six weeks supply in the yard. The mill also has one months supply at the roadside in the forest.

The buttresses of the logs are trimmed before they enter the main mill, this reduces hold-up during sawing. The main species used are Norway and Sitka spruce. The mill has a normal production of 140-150 cubic metres per day of sawn material. James Jones & Sons, buy approximately 80% of their timber supply at the roadside and do approximately 20% of their own harvesting. Mr. Thompson was particularly critical of harvesting machines and he believes that a much higher recovery rate could be achieved in the mill, with more accurate selective cross cutting in the forest. In the Commercial Mill they normally achieve a recovery rate of 57%, (depending on the log size under bark).

James Jones & Sons Limited were typically paying £45-50 per cubic metre for sawlog at the roadside (March 1990). The average volume to weight ratio, for the year is 1.0 for Sitka spruce (measured in cubic metres per ton, under bark). In summer the volume to weight ratio varies from 1.1 to 1.15 and in winter the ratio is typically 0.85.

We were shown around the Boxwood Mill by Mr. Stuart Hastings. This is quite an old mill, which was refitted in July 1989. It produces mining and fencing material along with pallet boards. The mill currently has a production rate of 150 cubic metres per week and it is hoped eventually to produce 200 cubic metres per week. The Boxwood Mill has a conversion rate of 48-49%. The chips and sawdust are sold from both mills and the bark is sold to garden centres.

One problem encountered with Norway spruce in particular in the mill is butt rot *Heterobasidion annosum* (commonly known as *Fomes annosus*). This in many cases has entered the trees through blaze marks. After marking, the trees were then left unthinned for a number of months or even years. This practice allows an entry point for the disease and time for it to develop.

Participants:
Jack Barrett, Denis Beirne, John Brady, Maureen Cosgrave, Myles Cosgrave, Tony Crehan, Jim Crowley, Joe Doyle, Mathias Fogarty, Lily Furlong, George Hipwell, Dermot Houlihan, Richard Jack, Pat Kelleher, John Kelly, Larry Kelly, Pat Kelly, David Knox, Jimmy Lehart, Tom Luddy, Kevin McDonald, Tom McDonald, Michael McElroy, Arthur McGinley, Michael Mac Giolla Coda, Tony Mannion, Gerard Mawn, Donal Murphy, Padraig Naughton, Jimmy Neilan, Con Nyhan, Des O'Brien, Michael O'Brien, Con O'Driscoll, Paddy O'Kelly, Brendan O'Neill, Tim O'Regan, Pat O'Sullivan, Tom Purcell, Gerry Riordan, Noel Teague, Robert Tottenham, Arie van der Wel.

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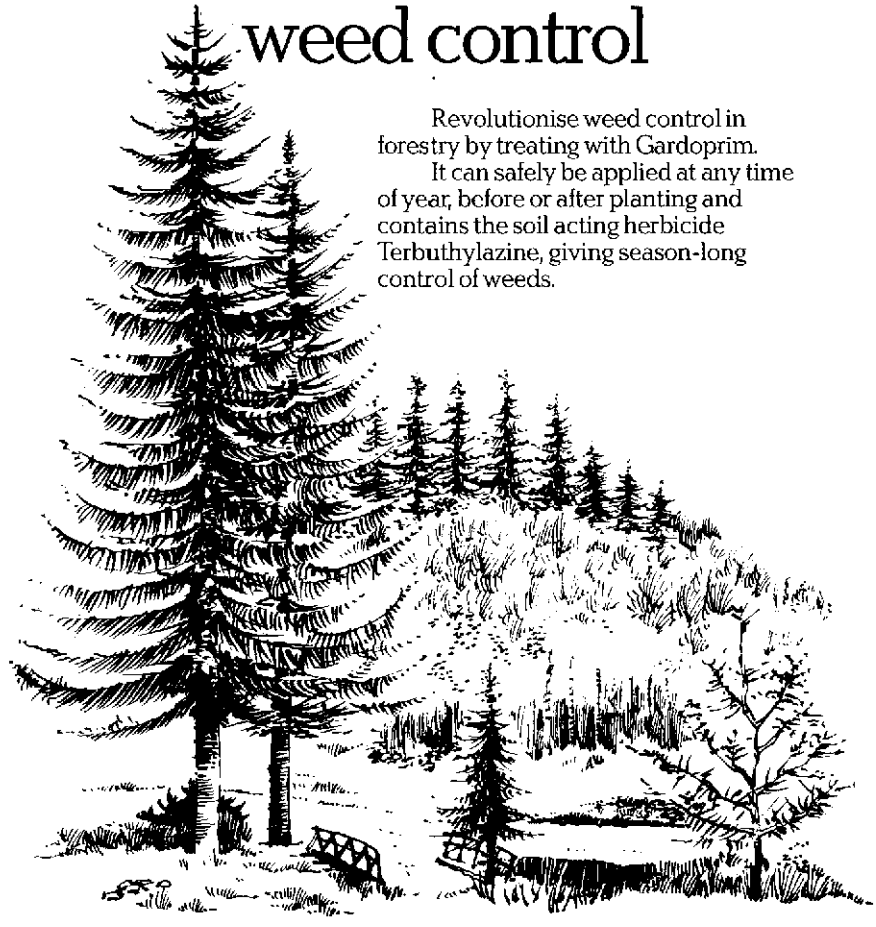

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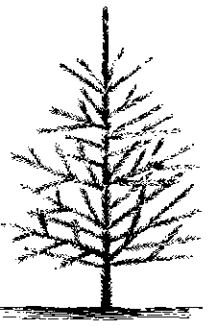

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Notes for the Assistance of Contributors

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.
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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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