Plantation Forestry on Cutaway Raised Bogs and Fen Peats in the Republic of Ireland

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ABSTRACT

Coniferous plantations have been established on sizeable areas of handcutaway raised bogs and modified fen peats in Ireland over the last thirty years. Whereas Scots pine and Norway spruce were used almost exclusively up to the mid 1960s, Sitka spruce has now become the dominant species because of its higher production potential ($20m^3/ha+$). Mixtures of Scots pine and Norway spruce were often used where competition from heather was envisaged on the handcutaway bogs.

Phosphorus and potassium application are essential on the handcutaway peat types in order to ensure good growth. There are increasing indications that copper application may also be necessary, particularly for pines and Sitka spruce. Potassium application alone is essential on the modified fen peats.

Although Scots pine grew well in the early years on many of the site types described there is increasing evidence of dieback at about 25 years of age on handcutaway sites, the causes of which are under investigation.

Machine cutaway bogs, both sod peat and milled peat, appear to have a high production potential for forestry ($22\text{-}24m^3/ha$). However, further research is necessary on milled peat bogs to ensure this potential is attained. The depth of peat left behind will be critical because of the highly calcareous nature of many of the underlying subsoils.

INTRODUCTION

Half of the forest estate in the Republic of Ireland, corresponding to an area of 170,000ha, is now on peatland. Although just over 80 per cent of this is on blanket bog, sizeable areas of cutaway* raised bogs and modified fen peats in midland areas have also been planted. These were acquired during the 1950s and 1960s before agricultural research showed that they had a high potential to

*The term 'cutaway' is used in this paper in preference to the term 'cutover', which is normally used in soil survey terminology to describe areas used for fuel production. This is to avoid confusion in forestry circles where 'cutover' has a different meaning.

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produce grass and certain horticultural crops, provided a proper reclamation scheme was executed. Consequently, farmer interest increased significantly in certain types of midland peat, particularly after EEC entry in 1973 when land prices rose significantly. Now, twelve years later, because of a surplus of many agricultural products within Europe the interest in peatland reclamation for agriculture is less than it was in the 1970s. Meanwhile, wood and wood products remain the second largest import after oil to the European Community, the current deficit being almost sixty million cubic metres/annum, or about fifty times that now being produced in Ireland.

Because of its moist temperate climate (unaffected by acid depositions now being increasingly linked with forest decline in Central Europe) and its substantial reserve of marginal land, Ireland is in a strong position to expand forest production in the years ahead. It is the purpose of this paper to review the experience acquired to date on the forestry production potential of cutaway raised bog and modified fen peats, two categories of sites where some of this expansion is likely to occur. Thus it is hoped to provide a more rational base for future land development.

SITE TYPES

Substantial areas of peatland in Ireland have been partially cutaway by hand for domestic fuel. The total area of cutaway raised bog comes to about 172,000ha (Hammond,1979). In addition to this about 65,000ha of raised bogs have been developed over the years by Bord na Mona for industrialised peat production.

Raised bogs are often found in close association with fen peats. Not only do the fen peats occur at the base of the raised bogs, they also occur extensively in river valleys and floodplains, poorly drained hollows and adjacent to raised bogs where the continued influence of groundwater prevented the accumulation of ombrotrophic peat. The relationship between raised bogs and fen peats is shown in Figure 1. Most fen peats can be classified as modified fens in that they have been considerably altered over the years by regional drainage schemes and reclamation.

1. *Hand Cutaway Raised Bog: Turbary Complex*

Hand cutaway raised bogs are a common occurrence in the Midlands and are referred to as the Turbary Complex. The profile consists of 30-200cm of highly acid peat materials, mainly *Sphagnum* (pH 3.5-3.8), removed from the original bog surface (strippings), resting on minerotrophic peat from the original profile. In extreme cases all of the original profile may have been removed leaving behind a variable depth of strippings from the bog surface.

Peat depths on cutaway raised bogs vary considerably depending on the original depth, the amount of peat removed and shrinkage which is influenced by drainage. Depths range between 1 and 4 metres, areas with less than 1 metre being unusual, except perhaps close to the boundary between the raised bogs and the surrounding more upland landscape (Figure 1). Frequently the microtopography is uneven. This results from the method of handcutting. Large peat blocks showing the original full bog profile occur next to deep bog holes separated by variable extents of flat areas used for handspreading.

The peat materials which remain on cutaway areas depend on the depth of peat remaining after cutting. Where it is shallow (less than about one metre) ombrotrophic peat materials are thin to non-existent and layers immediately underneath are of minerotrophic or fen origin. In the deeper peat areas the overlying peat materials consist of varying proportions of poorly humified and humified *Sphagnum*. Peat depth and drainage state are reflected in the surface vegetation but may be obscured if burning has been carried out in the recent past. However, a substantial part of typical areas tend to have *Calluna vulgaris* as the dominant species in the herb layer. Surface vegetation has been a traditional indicator for species selection in forestry in Britain and Ireland (Anderson, 1961). However, its usefulness as a tool for site assessment on cutaway raised bogs is limited. This is due to the extreme variation encountered in vegetation types and also because these may only reflect the nutritional status of the upper 30-50cm disturbed surface layers. Scrub layers where present can include *Betula* spp., *Sorbus, Salix, Ulex europaeus* and *Pinus sylvestris*. The herbaceous layer is influenced greatly by the nutrient status of the peat and drainage. Areas which tend to be dominated by *Calluna, Pteridium, Eriophorum or Sphagnum* and *Molinia* are dystrophic whilst *Phragmites, Juncus* and *Filipendula* spp. indicate more eutrophic conditions.

Because detailed soil surveys of forests have not been carried out it is not possible to give exact figures on the areas growing on Turbary Complex or indeed any of the other types described in this paper. However, it is estimated that some 7,000ha of plantations occur on the Turbary Complex comprised of many small blocks, about 10-20ha in area scattered throughout the Midlands. A typical afforested area stretches some 300-400m from close by the bog facebank/peat cutting edge to the boundary with the fen peats described in Figure 1 or occasionally beyond this to the boundary

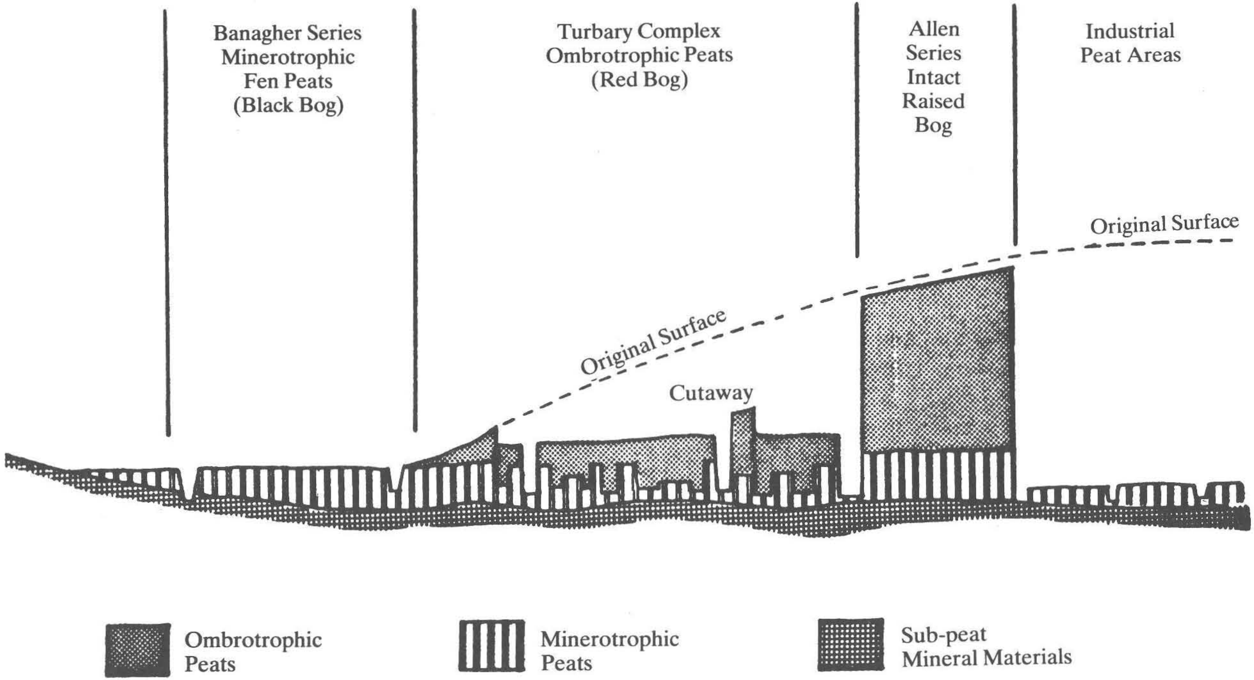

Fig 1 Schematic cross section of the typical Raised Bog landscape unit in the Midlands showing the field relationship between the drained Fen areas, hand cutaway, remnants of intact bog and the industrial peat areas.

with the mineral upland. Usually such areas were ploughed with a double mouldboard plough as an aid to tree establishment but currently mounding is being used more widely. This is likely to give better results provided the watertable is lowered through installation of main drains at some 20-30m. Mounding was successfully used on some of the wetter sites in the early 1950s where it was not possible to use heavy machinery. Midland peats are generally unsuitable for tunnel ploughing — with a few rare exceptions — a practice now recommended for some blanket peats (O Carroll *et all,* 1981).

Species Selection on Turbary Complex

In the 1950-1970 period, Norway spruce and Scots pine were the most commonly planted species on Midland peats, particularly on the Turbary Complex. Usually the species were mixed intimately or planted in alternate lines, the philosophy being that the pine would behave as a nurse species and protect the spruce from frost and at the same time help to surpress *Calluna vulgaris*. Susceptibility of the sites to late spring frosts was the main reason why Norway spruce and not Sitka spruce was planted. In recent years Sitka spruce has been planted more widely, partly because the incidence of late spring frost damage has declined but also because of its capacity to achieve higher levels of production than Norway spruce, even where it does sufer from occasional frost damage. Scots pine is seldom if ever planted nowadays, mainly because it has been replaced by the more vigorous and higher yielding Lodgepole pine, now the second most important forest tree species in the country (Carey and Hendrick, 1985). Whereas Scots pine appears capable of producing 12-14m^3/ha/annum, lodgepole pine is likely to achieve a Yield Class of at least 16-18.

Although Norway spruce has generally grown well in mixture with Scots pine, the production of the latter species and its quality has left a lot to be desired. This has resulted from a combination of poor provenance, squirrel damage and nutritional disorders.

Tree Nutrition on Turbary Complex

Phosphorus application is essential for at least the main coniferous species in order to ensure good establishment and growth on the Turbary Complex. This is illustrated by results from a trial laid down at Emo Forest in 1975 (Figure 2) which includes both Lodgepole pine and Sitka spruce. Projected yield classes for these species in this trial are extremely high. However, an interesting feature of the results is the decline in height growth at the higher rates of phosphorus applied. Foliage analysis of several of the Sitka spruce in the high phosphorus treatments which showed deformity, indicated that copper uptake was adversely influenced at the higher rates. In fact, part of this trial which had been split at age three years for copper sulphate application gave a significant response in height growth to copper sulphate applied at up to 20kg Cu/ha.

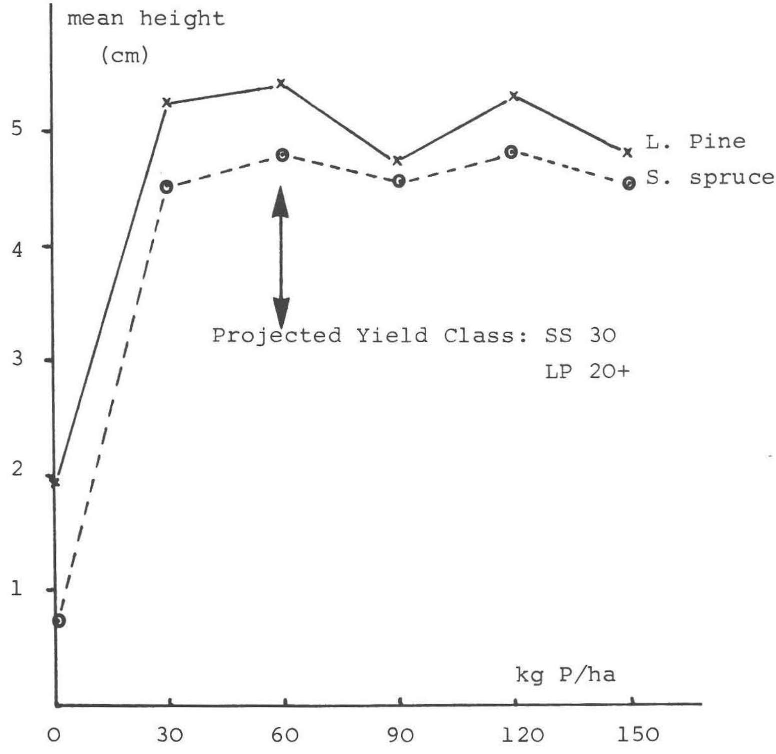

Fig 2 Emo 5/75. Effect of ground rock phosphate application on the height growth of Sitka spruce and Lodgepole pine on the Turbary Complex. Mean height age 9 years. (250kg muriate of potash applied to all treatments at planting).

Nitrogen deficiency occurs in some plantations of Sitka spruce on handcutaway bog but these are usually confined to localised areas where a deep layer of oligotrophic acid peat remains *in situ* below the disturbed and inverted original surface layer. It is often associated with the presence of *Calluna vulgaris*. The use of 2,4-D to control *Calluna* has resulted however in some side effects on the growth of trees. Its use in Athy Forest on a four year old Sitka spruce crop effectively controlled *Calluna* but resulted in severe distortion in 80% of the crop in the following year. This effect, it is postulated, is a consequence of copper deficiency induced by the short term release of nitrogen through *Calluna* kill accentuating an already chronic N:Cu ratio in the Sitka spruce crop. Subsequently the trees responded significantly in height growth to copper application, regained apical dominance but the crookedness resulting from the initial imbalance persists and will reduce considerably the commercial value of the lower 1.5 metres of the stem.

Although most midland peat soils are known to be deficient in copper for agriculture the experience so far in forestry is that this particular problem is mainly associated with the Turbary Complex. However, the problem is by no means widespread yet but there are indications that it may be more serious in the future, particularly on reforestation sites where the nitrogen:copper imbalance is likely to be greater as a result of mineralisation of organic matter and release of nitrogen following clearfelling of the first crop. Current research is aimed at achieving a better understanding of the problem and determining practical solutions. So far copper sulphate at rates of up to 60kg/ha and chelate-copper sprays (0.2-1.0kg Cu/ha) are giving promising results. Copper deficiency has also been observed in some thicket stage stands of south coastal lodgepole pine but the problem appears to be less common than in Sitka spruce.

Table 1 Effect of copper sulphate application at age 4 on the height growth of Sitka spruce. Mean height at age 6 (m).

kg Cu/ha			
0	**20**	**40**	**60**
2.56	2.90	2.69	2.69

Std. error	.09
LSD 5%	.21
Cu quad*	
Cu cub*	

Note: This is the same fertiliser trial referred to in Figure 2, the 60kg P and 150kg P/ha plots of which were split for copper sulphate application.
*Significant at 90%.

Although the input of potassium in rainfall in the Midlands is only in the region of 2kg/ha/annum (O Carroll and McCarthy, 1973) it is interesting that young plantations of spruce and pine on the Turbary Complex do not respond to potash application. This is in contrast to the situation on the modified fen type peats — see below — where large responses in tree growth have resulted from potash application (O Carroll, 1968). This difference may be due to the exhaustion of potassium reserves on the fen peats as a result of agricultural practices and/or the higher potassium levels associated with the upper layers of raised bogs, corresponding with the distrubed upper layer on the Turbary Complex (Walsh and Barry 1958). However, most recent observations suggest that potassium stress is likely to develop in plantations growing on the Turbary Complex in or around the time of canopy closure, corresponding with age 10-12 years.

Forest Production on Turbary Complex

Production (Yield Class), measured in terms of m^3/ha/annum, is known to vary considerably on the Turbary Complex depending on species, former cultural treatment and very likely peat depth. Although few data are available on the latter so far, the indications are that Sitka spruce grows better where the peat is shallow (less than 1 metre) but exceptions to this are likely to occer. The depth of strippings may also be important.

The oldest known stand of Norway spruce, clearfelled at age fifty four years in 1979 was at Kilyon property, Donadea forest (Figure 3). This attained a Yield Class of 16. Younger stands of Sitka spruce appear to be more productive and the indications are that a yield class of at least 20 is possible (Figure 2 suggests Yield Class 30!), provided nutritional and drainage requirements are satisfied. Lodegpole pine (coastal) also generally grows vigorously. However, its form is poor due to the relatively high incidence of basal sweep, pine shoot moth and increasing evidence of deformation due to copper deficiency.

Although there are some impressive stands of Scots pine on the Turbary Complex, its maximum production potential appears to be in the order of 12-14m^3/ha/annum. Many stands have a lower yield class than this and also are of very poor quality. There is also evidence of dieback in an increasing number of areas, probably associated with a nutrient disorder of some kind. This matter is currently under investigation. Scots pine is particularly interesting from an ecological viewpoint. It is known to have grown extensively in the Midlands over the past six thousand years when peat deposits were forming. Yet it is generally assumed to have become extinct

Fig 3 Norway spruce (*Picea abies*) on cutaway raised bog (Turbary Complex) at Kilyon property, Donadea forest. The photograph was taken in 1968 when the crop was 44 years of age. Yield class 16.

(Mitchell, 1976) at some point in time during the historic period and certainly prior to its re-introduction by man, some 300 years ago (McCracken, 1971).

2. *Machine Cutaway Raised Bog: Clonsast and Boora Complexes*

Because of the activities of Bord na Mona mainly, and a number of small private operators, large areas of peatland are in the process of being cutaway mechanically. The end product, sod or milled peat, is used for combustion in generating stations or for the manufacture of turf briquettes for domestic use. The total area involved is in the order of 65,000ha, most of which is on raised bogs in the Midlands. Because Bord na Mona account for over 95% of the total operation, the discussion here centres on the areas likely to result from their activities. However, it should be borne in mind that substantial progress has been made in recent years in the development of small tractor mounted peat harvesting machines. The ground condition remaining after these operations are completed will, it is thought, be considerably different to that resulting from Bord na Mona activities.

The two harvesting systems, sod and milled peat, now differ only in the way in which the peat is extracted but previously (before 1980) also in the form and nature of the residues left behind. The net result is that the major part of the peat profile is cutaway leaving only the basal layer or layers. However, the depth of organic matter that remains depends on the topography of the underlying bog floor. In all cases a variable thickness of the lowest peat layer remains but in some exceptionally deep peat areas it can be covered by a layer of the overlying humified acid peat. The *in situ* peat in both Clonsast and Boora complexes is essentially similar. However, in the production of sod peat a 50cm layer or so of poorly humified acid *Sphagnum* peat strippings is cut from the original surface and deposited over the spread grounds prepared for peat drying, leaving a bipartite profile, a situation not unlike that described for handcutaway areas. Because it is now Bord na Mona policy to harvest milled peat from bogs formerly exploited for sod peat this bipartite profile will be the exception in the future.

Forestry Potential of Machine Sod Peat Cutaway Raised Bogs (Clonsast Complex)

Because of the experience gained over the last 30 years at the Forest Experiment Area at Trench 14, Clonsast Bog, a considerable amount of information is now available on forestry production on machine sod peat cutaway bog. The site, with a total area of 12.9ha, is leased to the Forest and Wildlife Service by Bord na Mona. In 1955 it was considered representative of what the future situation would be like on machine sod peat bogs following completion of turf harvesting.

Site details for Trench 14 and the earlier results obtained on tree growth have been documented in previous papers (O Carroll, 1967; Carey and Barry, 1975). So far the results have been encouraging since it has been found that a wide range of conifers grow satisfactorily with a minimum of inputs. No ground cultivation is required and moderate applications of phosphorus and potassium ensure good establishment and growth. Future research may demonstrate a need for copper application for certain species. The leading species in terms of Yield Class are grand fir (24), Sitka spruce (18-24) and coastal lodgepole pine (18-20+). Other impressive species include western red cedar and western hemlock, both Yield Class 16, and Scots pine, Yield Class 14. Apart from a number of varieties of poplars that failed, the only other tested and very promising broadleaved species is the sessile oak; a small plot planted in 1971 has a projected Yield Class of 10. The best plots of douglas fir have a Yield Class of 14.

Peat depth varies from about 50cm to about 3 metres over the length of Trench 14 (1.6km) and is now known to have a considerable influence on tree growth for a number of species. Whereas Lodgepole pine grows vigorously, regardless of peat depth, the growth of species such as spruce, fir, hemlock and larch fall off dramatically where depths are in excess of about 1.20 metres (Table 2). However, a large part of this fall off can be attributed to the greater sensitivity of these species to competition from heather, which was a problem for a number of years. Research in recent years has shown that such problems are easily overcome for spruce by using fertiliser nitrogen (Carey & Griffin, 1981).

Table 2 Relationships between peat depth and Yield Class at age 16 for a range of species growing on machine sod peat cutaway bog at Trench 14, Clonsast Bog (m^3/ha/annum).

Average peat depth (m)	Western red cedar	Western hemlock	Grand fir	Sitka spruce	Japanese larch	Lodgepole pine	Douglas fir
0.18	13	16	16	21	10	18	13
1.00	16	16	16	20	10	18	12
1.60	—	10	—	10	4	16	—
2.31	—	10	—	10	6	16	10
3.01	—	10	—	8	—	16	—

— = Yield Class not determined due to slow development.

Forestry Potential of Milled Peat Cutaway Raised Bogs (Boora Complex)

Because of the results achieved at Trench 14, it is not surprising that afforestation has become an attractive economic proposition in terms of future land use on machine sod peat cutaway bogs (Gallagher & Gillespie, 1984). However, because of the differences that exist between sod peat bogs (Clonsast Complex) and milled peat bogs (Boora Complex), indeed within a particular bog unit, care must be exercised before extrapolating results from a small experiment area which, although it appeared to be representative in 1955, is in fact now quite different to what the situation may be like in the future on Bord na Mona cutaway areas. This is because Bord na Mona have changed over almost totally to milled peat from sod peat production. The two production systems also leave behind very different drainage intensities (250m as against 15m interval drains for sod and milled peat respectively), the significance of which for forestry has yet to be evaluated.

Whereas thirty years experience exists with regard to evaluating the forestry potential of machine sod peat bogs, the situation for milled peat is far less satisfactory. In order to fill this void and obtain information on the potential of milled peat cutaway bogs for afforestation, the Forest and Wildlife Service have leased a total of 77.5ha from Bord na Mona since 1983. Most of this land (66ha) is at Lullymore in Co. Kildare, the remainder being at Turraun Bog, part of the Boora Bog Complex, west of Tullamore. Although the areas have been planted 3 years, it is premature to comment on the results. However, the indications so far are that milled peat cutaway bogs may have rather different requirements to sod peat bogs in relation to afforestation. The basic soil profile is different to that at Trench 14 in that no stripping layer of dominantly *Sphagnum* peat exists at the surface and the peat layers which remain have been undisturbed for thousands of years. This is also in contrast to the modified fen peats described in the following section, the surface layers of which have been ripened or ameliorated gradually over centuries as a result of agricultural practices. Nevertheless, the forest production potential of the Boora Complex is expected to be high, provided nutritional requirements (phosphorus, potassium and very likely, copper) are satisfied and sufficient depth of peat is left behind. This will be particularly important where the underlying subsoils are unweathered and highly calcareous (Carey & Hammond, 1970). As yet there are no conclusive data on what depth should be left after harvesting to ensure satisfactory long term growth, but a minimum of at least 50cm would seem desirable. The critical depth is likely to vary with the nature of the subsoil and tree species. There are indications that some kind of surface cultivation may be desirable in order to minimise the effects of peat cracking, shrinkage and subsoil influence.

3. *Reclaimed Fen Peats: Banagher Series*

Fen peats, most of which have been partly drained and reclaimed in the past, occur extensively in the Midlands (over 90,000 ha) and on a smaller scale throughout the country and have been referred to as the Banagher Series by Conry *et al.* (1970) and Reedswamp peat by many people involved with forestry. Whereas both terms could be correctly applied to specific situations, neither is in fact satisfactory from the point of view of describing what is a more complex soil pattern. Typically the fen peats grew and accumulated in a relatively rich minerotrophic environment, often in river floodplains or in interdrumlin flats and in the immediate environs of raised bogs (Figure 1). The profile never included a layer of highly acid ombrotrophic peat at the surface, the upper layers usually having a pH of 5.0-5.5. The complexity arises in relation to the topographical position in which the peat formed. The lowermost areas usually developed from reedswamp overlying marl deposits whereas more upland areas formed wood or woody fen peats over less calcareous subsoils. Although such differences might appear to be of little consequence for land use, they do have a considerable influence on the moisture holding capacity of the peat, the woody types being far more susceptible to drying out than those derived from reedswamp plant communities. In areas with low rainfall, such as the Midlands, this may be of significance for species selection.

The overall hydrology situation on the fen peats has been altered greatly by drainage schemes, such as those carried out on the rivers Boyne, Blackwater and Barrow catchments. In addition the soils usually show evidence of previous localised drainage, cultivation, liming and fertiliser incorporation. Old field boundaries are often discernible. The surface horizons, often containing earthworms, are usually black in colour with a crumb-like structure. Fossil wood or reed remains are evident at 30-50cm. Surface vegetation usually features grasses such as *Festuca rubra* and *Anthoxanthum odoratum*.

FORESTRY POTENTIAL OF FEN PEATS

There are about 2,000ha of coniferous plantations growing on man-modified fen peats most of which were planted during the 1950-1970 period. Initially species selection was dominated by Norway spruce or Norway spruce/Scots pine mixtures, as on the Turbary Complex. More recently plantations have consisted almost exclusively of Sitka spruce because of its greater production potential. Many of the earlier plantations did not achieve their production potential because of severe potassium deficiency and large responses in growth have been found from potash application in Scots pine and Norway spruce (O Carroll, 1968) and more recently in Sitka spruce. An interesting feature of the results from one fertiliser experiment at Derryricket property, Edenderry Forest (Table 3), is the negative effect of phosphorus application on the growth of spruce, reason(s) for which is(are) uncertain. In practice, nowadays, Sitka spruce is normally planted on this site type following application of 125kg K/ha as muriate of potash, no phosphorus fertiliser being necessary. There are suggestions in Table 3 that higher rates of potassium may be desirable, perhaps as high as 200kg K/ha. Sites have usually been ploughed in the conventional manner (DMB) but less intensive drainage/cultivation systems would probably suffice, provided the waterable is lowered sufficiently.

Table 3 Effects of applied potassium and phosphorus on the growth of Sitka spruce and Norway spruce on the Banagher series (fen peat). Mean height age 9 (m).

		Sitka spruce		*Norway spruce*	
		P0	P87	P0	P87
K0		1.48	1.40	1.21	1.40
K100		2.37	2.36	2.36	1.93
K200		2.65	3.32	2.69	2.59
K300		3.28	2.64	2.66	2.74
Standard error	0.31				
LSD 5%	0.67				

Note: K applied as sulphate of potash, P as rock phosphate. Nutrients expressed as kg/ha.

Indications are that sites planted in the early 1970s with Sitka spruce will attain a Yield Class of 18-20 compared with a range of 12-16 for Norway spruce. The lower production potential of Sitka spruce relative to that suggested earlier for the Turbary complex is perhaps rather surprising. The reason(s) for this difference are unclear. Some stands of Norway spruce in Athy and Monasterevan forests have attained a Yield Class of 20. Scots pine on the other hand does not appear to grow as well on the Banagher Series as it does on the Turbary Complex and Yield Classes of 8-10 are commonly encountered. However, there is no evidence of the dieback being experienced on the Turbary Complex, except in situations where marl is within 30cm or so of the surface. So far there is no evidence of copper or nitrogen deficiency but severe symptoms of the former have been observed at one site near Clonavoe property, Edenderry Forest, in Japanese larch and Douglas fir (Figure 4), both of which are known to be particularly sensitive to low levels of available copper but are seldom planted on fen peats. There is evidence from one site in Donadea Forest of copper deficiency being a problem for second rotation crops of Sitka spruce following clearfelling of an unthrifty crop of Norway spruce and Scots pine.

Fig 4 Loss of apical dominance and crown deformation in Douglas fir (*Pseudotsuga menziesii*) on fen peat (Banagher Association) at Edenderry Forest due, very likely, to copper deficiency. Notice unaffected Norway spruce (*Picea abies*) in background.

Discussion and Conclusions

Cutaway raised bogs and modified fen peats have a considerable forestry potential. This stems not so much from the large areas of existing plantations but rather from the extensive areas of under-used peatlands throughout the country now becoming increasingly marginal for agriculture, and the areas likely to result from Bord na Mona operations. The potential also relates to the vigorous growth patterns being recorded for certain coniferous species on some of the site types described. However, this is not to state that problems will not arise. For instance, the fall off in growth and dieback of Scots pine at about age 20-25 years on the Turbary Complex is a cause for concern. (This is in contrast to the 30 year old Scots pine still growing well at Trench 14, Clonsast). There are also indications of growth disorders in Lodgepole pine on the Turbary Complex around the time of canopy closure and difficulties have been experienced locally in establishing second rotation crops of Sitka spruce on modified fen peats. Most of the experience to date has also been based on Scots pine and Norway spruce, neither of which feature significantly nowadays in planting programmes. Whereas the performance of Scots pine has been poor, Norway spruce has been growing satisfactorily on all of the site types described and some stands have gone through a full rotation on the Turbary Complex yielding at least $16m^3$/ha/annum. Somewhat higher Yield Classes have been recorded for the species on modified fen peats and it is seldom associated with copper deficiency.

Although Sitka spruce is now the preferred species on both cutaway raised bogs and modified fen peats, the oldest crops are now only about 15 years of age, apart from those planted at Trench 14, Clonsast Bog in 1955, a site type now considered quite unrepresentative of future industrial cutaway areas. Nevertheless, indications of its production potential so far are very encouraging with Yield Classes of 18-26 being recorded for younger stands. However, as these develop and grow on past canopy closure, there is no guarantee that the problems of dieback now being observed in Scots pine on the Turbary Complex will not also occur. For this reason it is important to obtain a greater insight into the reasons for the variation being encountered between sites and species in both their relative performance and production levels. This applies not only to handcutaway areas but also modified fen peats and the different types of milled peat cutaway bogs that will result from Bord na Mona operations. The degree to which these sites are likely to dry out after canopy closure in areas with relatively low rainfall (about 900mm) may ultimately be a cause for concern and justify change of species.

Although much information is available from forest inventory records on growth rates for Midland forests, this has so far not been related to site types; this paper is merely an overview of the experience to date. More detailed soil/growth relationships are required for the main tree species in order to provide a basis for meaningful site surveys. These in turn will allow better use of the valuable land resource that is likely to become increasingly available for forestry development.

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