Forestry Commission

THE NATIONAL FOREST

Woodland Creation

Experience from the National Forest

Gary Kerr and Hugh V. Williams

Technical Paper 27

FORESTRY COMMISSION TECHNICAL PAPER 27

Woodland Creation: Experience from the National Forest

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FORESTRY COMMISSION, EDINBURGH

First published 1999

ISBN 0 85538 406 9
FDC 907.1:260:945.25:228.3:(410)

KEYWORDS: Amenity, Conservation, Establishment, Forestry, Native woodlands, Woodland management

The authors of this Technical Paper should be cited as:

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ACKNOWLEDGEMENTS

We are grateful to Ian Willoughby for help with Chapter 5, David Fourt for compiling Figure 3.1 and Plate 4, and Jenny Claridge for supervising the publication process. Cranfield University Soil Survey and Land Research Centre allowed us to use copyright data in the preparation of Plate 4. The Demonstration Woodland project has been funded by the Forestry Commission, Department of the Environment, Transport and the Regions and the National Forest Company. Ian Collier, Nigel Rylance and James Laing have been responsible for establishment and management of the woodlands.

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Front cover: The photographs were taken from the same place at Barton under Needwood Demonstration Woodland in January 1994 (inset) and March 1999 (main picture). In January 1994 the effects of pre-planting herbicide were visible; these were an essential element of the establishment package which produced the vigorous woodland 5 years later. [*Main picture: Forest Research Photographic Library 42173*]

Back cover: *left* Site interpretation board at main access point to Church Gresley Demonstration Woodland. *right* Provision of a raptor box for a kestrel at Church Gresley to help control populations of small mammals.

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Preface

The National Forest is one of the most ambitious environmental projects of this century. It is set to transform some 500 square kilometres (200 square miles) of the landscape in Leicestershire, Derbyshire and Staffordshire with a blend of wooded areas, open country, farmland and settlements. The intention is to create a very special multi-purpose Forest for the nation in the 21st century and beyond.

The idea for the Forest was pioneered by the Countryside Commission in 1987 in its policy document *Forestry in the countryside* (see Further reading). This advanced the case for multi-purpose forestry and proposed the creation of the National Forest as a demonstration of this concept. Backed by Government, the Countryside Commission appointed a development team in 1991 to work up a Forest Strategy and practical, costed plans for turning the concept into reality.

The Forest Strategy set out the wide ranging objectives of the Forest. These include:

- contributing to national timber supplies
- creating a major recreation and tourism resource
- enhancing landscapes and providing rich, new, wildlife habitats
- offering production alternatives for farmland
- helping to regenerate the local economy
- promoting community involvement and educational use of the Forest
- contributing to wider environmental objectives such as improving air quality.

In 1995 the Government announced the establishment of the National Forest Company to take forward the implementation of the Forest.

Prior to the formation of the National Forest less than 10 hectares of new woodlands were being created every year. Since 1991 over 2000 hectares of new woodland sites have been committed for planting. The National Forest Company aims to promote high standards of woodland creation using techniques which are appropriate to landowners' objectives and the site being planted. This publication provides guidance on the creation of new woodlands in the National Forest based upon the experience of planting three large Demonstration Woodlands within the Forest area.

Summary

This Technical Paper is a practical guide which explains how to create new woodlands in the National Forest. It is based on general principles, latest research findings and, importantly, experience of establishing three large Demonstration Woodlands in the National Forest. The Demonstration Woodlands at Barton under Needwood in Staffordshire, Church Gresley in Derbyshire and Desford Lakes in Leicestershire have much to offer everyone involved with woodland creation, from novices to professional foresters. A visit to at least one of them is encouraged to bring to life the points made in this guide.

Chapter 1

Introduction

In 1993 the then Department of the Environment (now the Department of the Environment, Transport and the Regions), the National Forest Development Team and the Forestry Commission recognised the value of initiating practical research into woodland establishment that demonstrates to landowners, both inside and outside the National Forest, the range of techniques available to create new woodlands. To meet this need, a project to establish three Demonstration Woodlands began with the following aims:

- to provide demonstrations of a range of woodland establishment techniques;
- to demonstrate how to create new woodlands on different types of sites;
- to carry out research into woodland creation techniques.

The main purpose of this Technical Paper is to introduce the subject of creating new woodlands in the National Forest using experience from the three Demonstration Woodlands. The guide is different from other tree planting guides because many of the points are supported by real examples of woodland creation which have been established specifically to help you. These Demonstration Woodlands are located at Barton under Needwood, Church Gresley and Desford Lakes (Figure 1.1). There is full public access to the woodlands. Information on how to find them and a brief introduction to what can be seen is presented in this guide; more detailed information is available on request from the National Forest Company (see Supporting information, page 29). The Demonstration Woodlands have much to offer everyone involved with woodland creation, from novices to professional foresters. A visit to at least one of them is encouraged to bring to life the points made in this guide.

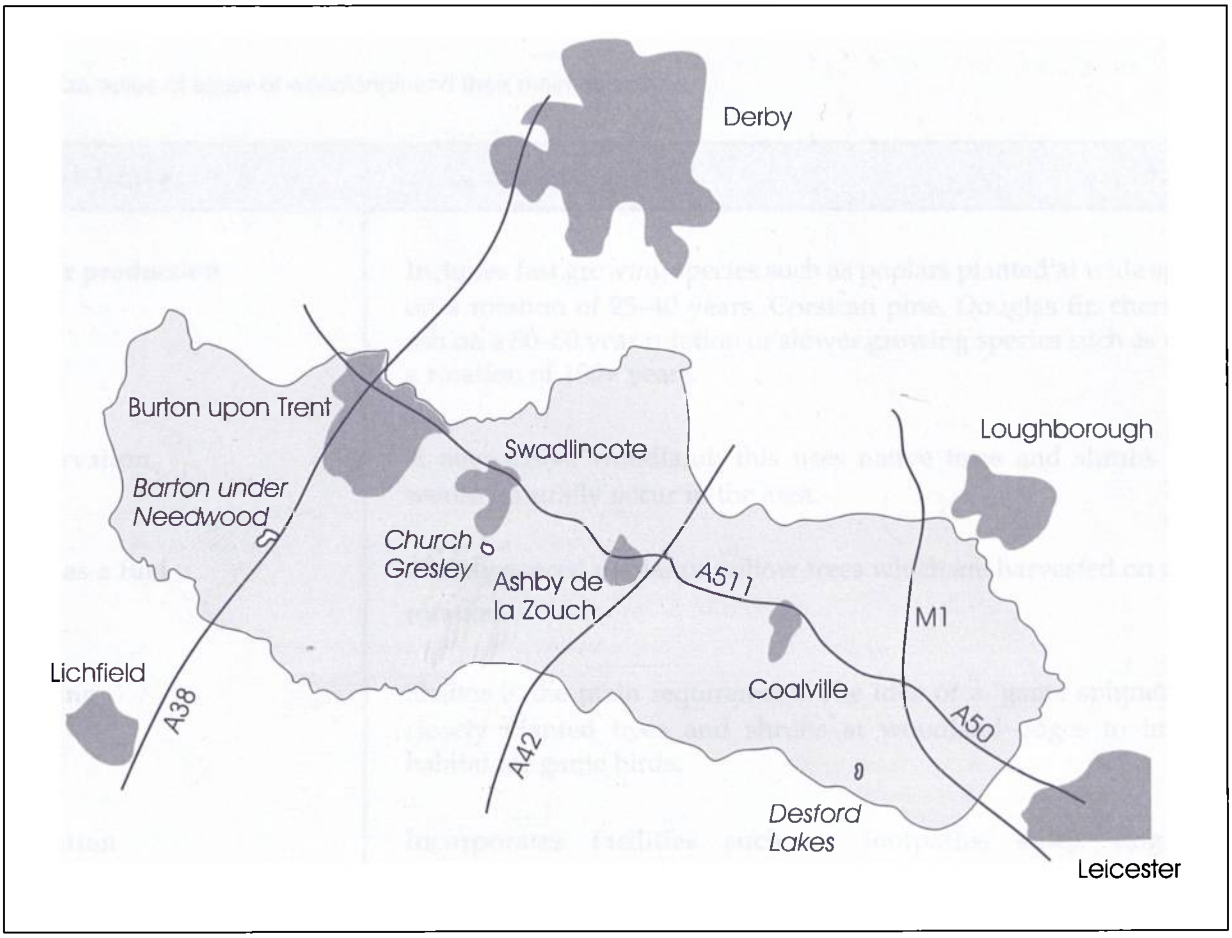


Figure 1.1 Location of the Demonstration Woodlands in the National Forest

Many factors influence a landowner in deciding to plant new woodlands although the decision is seldom attributable to any single aspect. Factors include the expectation of future income from timber, creation of new business opportunities, diversification, retirement, financial planning, a rationalisation of the existing land-use, issues related to planning, a need to reduce the day-to-day management of land and the desire to enhance and improve the environment. Current national policies promote the planting of new woodlands for multi-purpose objectives (see Plate 1). In the National Forest landowners planting new woodlands will be helping to meet the objectives of the Forest Strategy. The National Forest has a number of incentives to enable woodland creation, the most important mechanism being the National Forest Tender Scheme. The National Forest Company also acts as a source of advice to anyone who is thinking of planting trees in the Forest area.

The rest of this Technical Paper is divided into five main chapters, a short concluding chapter, and selected supporting information. Chapter 2 looks at essential first steps in creating a new woodland. In Chapter 3 guidance is given on site assessment. Chapters 4 and 5 describe tree establishment and weed control. Each of these chapters starts with a short list of key points which emphasise the essential features and outline the individual chapter contents. Chapter 6 introduces the three Demonstration Woodlands and describes what can be seen at each site. In conclusion, Chapter 7 provides a woodland creation checklist and the supporting information includes recommended publications and useful contact addresses.

Chapter 2

Essential first steps

- ▲ List your objectives and decide which are most important.
- ▲ Decide if you require the services of a woodland consultant.
- ▲ Make early contact with the National Forest Company and the Forestry Commission to find out details of grant-aid.

Objectives

Having decided that you want to create a new woodland it is fundamentally important to develop clear objectives. This will help to determine the type of woodland you create, and how it is designed and implemented. The most likely objectives for woodland creation include: timber production (Plate 2), conservation (Plate 5), landscape enhancement, recreation (Plate 3), shooting, shelter and screening. Any woodland can, of course, achieve more than one of these objectives but it is important to be clear about *your* main objective. If this is not clear, or you want a full appreciation of the range of options available, a visit to a Demonstration Woodland is recommended. Any of the three Demonstration Woodlands has a lot to offer but to help think through the links between objectives, type of woodland and methods of establishment, Barton under Needwood should be the first point of call.

Examples of the types of woodlands and their main objectives featured at the Demonstration Woodlands are shown in Box 1.

Access to expertise

At an early stage in planning your new woodland a decision should be made about whether or not to use an agent or adviser. There are many benefits to using a competent specialist but there will also be a cost.

Box 1 Examples of types of woodlands and their main objectives.

Main objective	Types of woodland
Timber production	Includes fast growing species such as poplars planted at wide spacing on a rotation of 25–40 years, Corsican pine, Douglas fir, cherry and ash on a 50–60 year rotation or slower growing species such as oak on a rotation of 100+ years.
Conservation	A new native woodland: this uses native trees and shrubs which would naturally occur in the area.
Wood as a fuel	Closely spaced poplar or willow trees which are harvested on a short rotation.
Shooting	Shelter is the main requirement. The idea of a 'game spinney' uses closely planted trees and shrubs at woodland edges to improve habitat for game birds.
Recreation	Incorporates facilities such as footpaths, stiles, dog-gates, waymarking, interpretation and car parking.

If you decide to use a consultant then this guide will enable you to discuss with him/her the necessary steps in planning and developing a new woodland.

Options for woodland creation

The main method of creating new woodlands in Britain is by planting young trees which have been raised in a nursery. However, two other methods deserve a mention: direct seeding and natural colonisation. With direct seeding, tree seed is sown so that it germinates and grows on the planting site. While this is an attractive idea its application is fraught with difficulties and is only recommended if specialist knowledge is available. Natural colonisation is based on the fact that any open ground, if protected from browsing mammals and left for long enough, would revert to woodland. The main disadvantage is that the method could take anything up to 30 years to establish trees on the area. The main use of natural colonisation is for the enlargement of an existing woodland where conservation of the local genotype is an important objective. Examples of direct seeding and natural colonisation can be seen in the Demonstration Woodlands at Barton under Needwood and Church Gresley respectively. Alternatively, if you want to keep things as simple as possible, with a high chance of success, it is recommended to plant young trees.

Grant-aid

In order to encourage the creation of new woodlands the Forestry Commission offers grants to landowners. Grant-aid is conditional on successful establishment and the provision of environmental and public benefits. It is therefore advisable to make early contact with the relevant authorities, directly or through your agent or adviser, to determine the current position. The main points of contact in the Forest area are the National Forest Company and the Forestry Commission. Addresses can be found in the Supporting information section, page 29.

Chapter 3

Assessment of the site

- ▲ Observe existing trees in nearby woodlands and hedgerows and use Figure 3.1 and Plate 4 to guide species choice.
- ▲ Dig holes to investigate the soil for potential problems such as depth and quality, compaction or waterlogging.
- ▲ Note the previous use of the land.

Before any site is planted it is worth while finding out as much as possible about it. If the site has been disturbed by mining activities or other industrial use then specialists must be consulted. Further information on such sites is available from the Land Regeneration Unit (LRU) and Bulletin 110 *Reclaiming disturbed land for forestry*, published by the Forestry Commission and available from The Stationery Office (see Supporting information, pages 28, 29 and 30). One of the Demonstration Woodlands, Desford Lakes, was established on disturbed land and woodland creation was not straight-forward (see Chapter 6). This guide mainly concerns ex-agricultural land, although many of the general principles apply to woodland creation on any site. The main things to investigate are:

- Observe the existing vegetation on the site and in adjacent hedges. This can be a good guide to the characteristics of the site, species choice and future weed problems.
- Determine if the site is (a) in a depression where frost may collect or soil may become seasonally waterlogged or (b) on a slope where frost is less likely to collect and drainage will be good.
- Check on soil type and evidence of impeded drainage and compaction by digging occasional soil pits.

Climate

The National Forest has a typical 'lowland' (altitude below 250 m above sea level) climate, being relatively warm and dry compared with the rest of Britain. The Charnwood (eastern) part of the National Forest area has higher rainfall, but this is not a significant factor in terms of tree survival and growth. Variation in climate over the Forest area does not significantly affect woodland creation, assuming tree species are selected from those listed in this guide. The most important factors are local exposure, unseasonal frosts and other micro-climatic effects which reflect conditions of local topography.

Soils

The soil type is an important guide to which tree species to plant and it is crucial to dig holes (up to 1 m deep) on site and observe basic soil characteristics. Particular features to look for are:

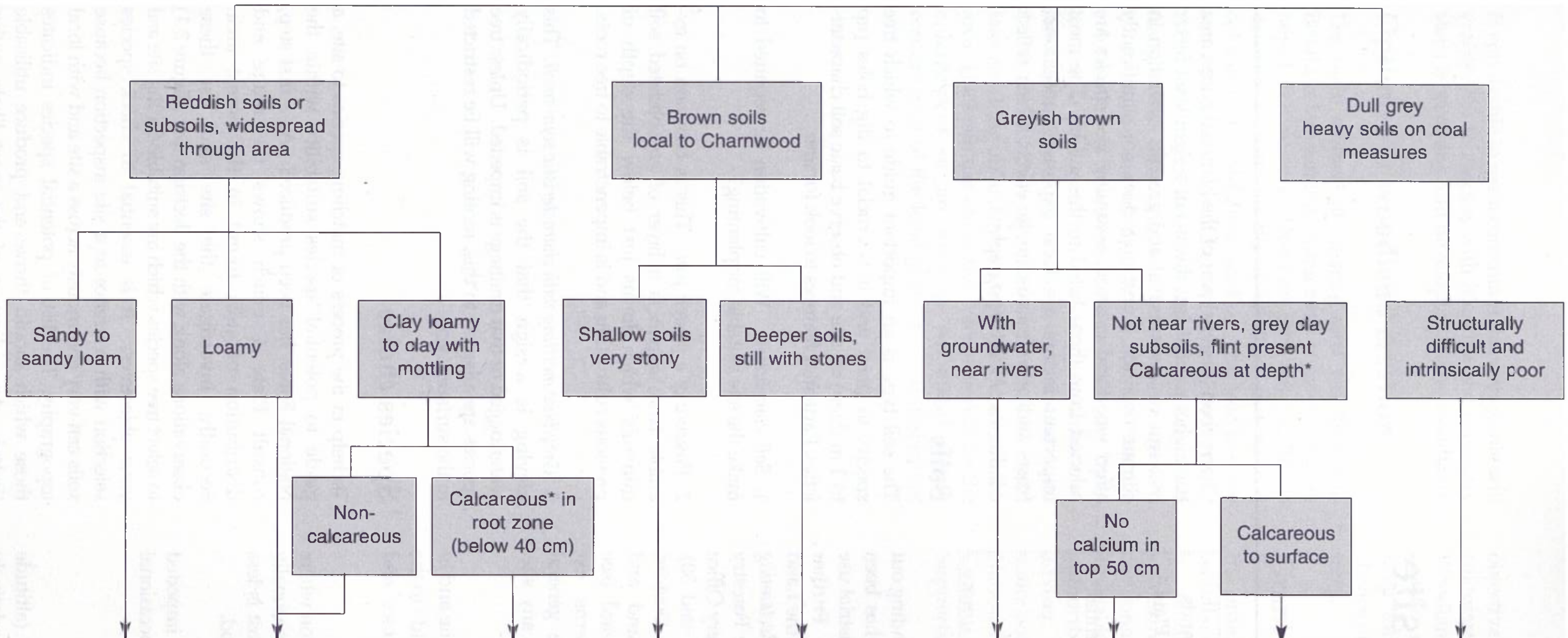
1. *Soil compaction.* Will cultivation be required to make the site suitable for planting?

2. *Presence of a plough pan.* This is common on ex-arable land; a pan is a layer of consolidated soil minerals which forms just below the depth of previous cultivation and is impenetrable to tree roots.

3. *Grey/blue mottling with characteristic sour smell.* This gleying is a sign that the soil is periodically waterlogged or that drainage is impeded. Unless tree species are adapted to this, rooting will be restricted to the surface layers.

Species choice

To help in the process of matching species to site, a guide to potential species suitability within the National Forest has been produced. As a first step, consult Plate 4 which shows the range and distribution of soils found in the Forest area. Secondly, investigate the site and use these observations along with the decision tree (Figure 3.1) to select tree species which are suitable for the site *and* your objectives. It is essential to check species selection with reference to a site inspection because soils can vary enormously across a site and with local topography. The list of potential species indicates those which should thrive and produce utilisable timber. An indication of the most likely native woodland type for the area is also shown.



Conifers	Corsican pine Scots pine Hybrid larch Douglas fir	Corsican pine Scots pine Hybrid larch Douglas fir	Corsican pine Scots pine Hybrid larch Douglas fir	Corsican pine Scots pine	Corsican pine Scots pine Hybrid larch Douglas fir		Corsican pine Scots pine	Corsican pine Scots pine	Corsican pine
Broadleaves	Oak Cherry Sweet chestnut Sycamore Birch	Oak Cherry Sycamore Ash Poplar Norway maple	Oak Cherry Sycamore Ash Italian alder Norway maple	Oak Birch	Oak Birch Cherry Sycamore Ash	Poplar Willow Italian alder Ash (locally with better drainage)	Oak Sycamore Ash Cherry	Sycamore Italian alder Norway maple	Oak Birch Italian alder
Native woodland type	W10	W10	W8	W10/W16	W10	W6 / W8	W10	W8	W10
Soil group in Plate 4	1	2	2	3	3	4	5	5	6

Fizz on addition of dilute hydrochloric acid.

Figure 3.1 Species decision tree based on soil and site factors

Plate 1 *A good example of a multi-purpose woodland. [19684]*

Plate 2 *Woodlands produce timber and can be a source of employment for the local community.[38577]*

Plate 3 *Providing a variety of opportunities for outdoor recreation is an important benefit of woodland creation.[Forest Life Picture Library: 1013994020]*

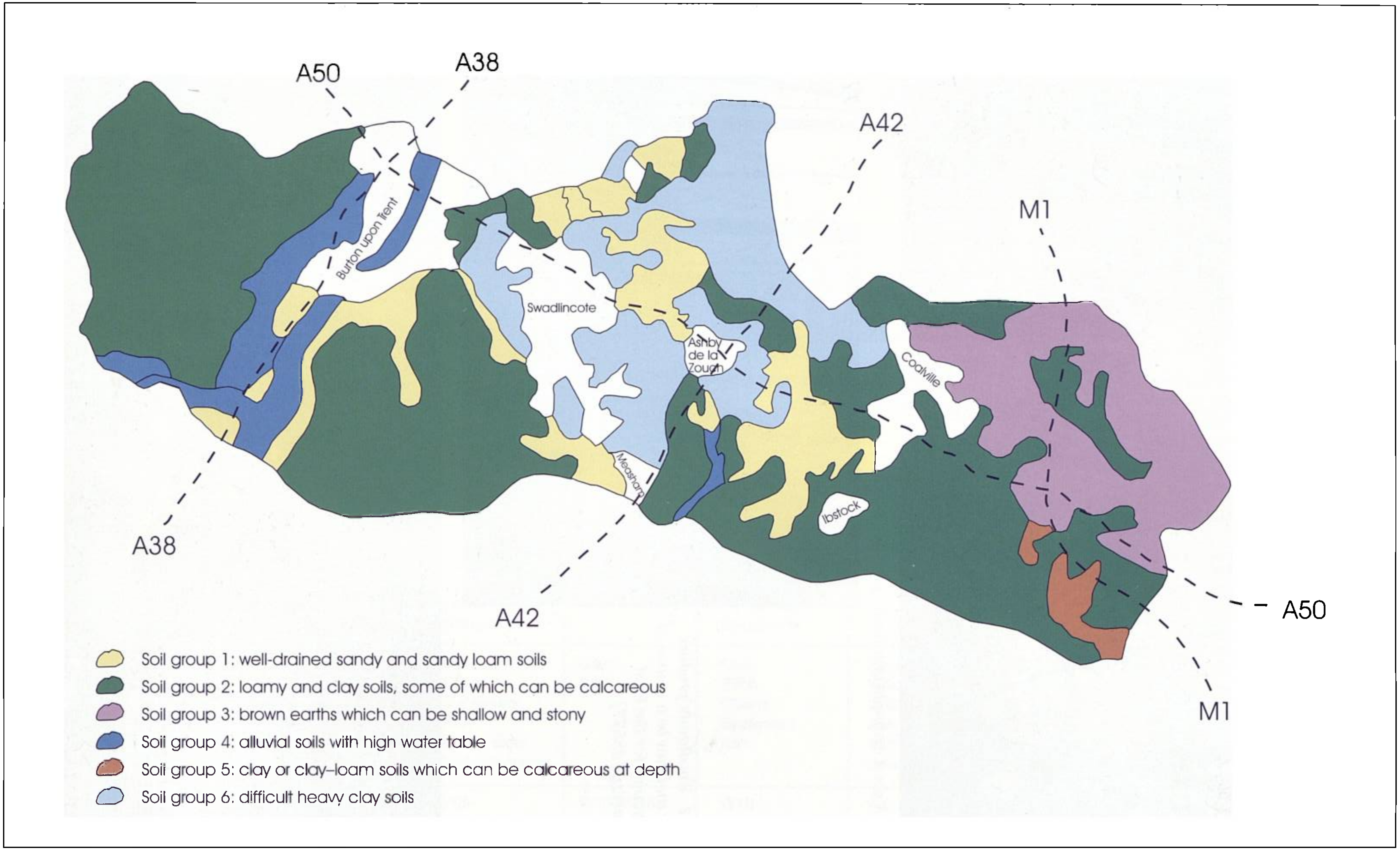


Plate 4 *Range and distribution of soils in the National Forest. Soils have been grouped into areas which have similar characteristics in terms of tree planting. Each soil group is numbered to cross reference with Figure 3.1.*

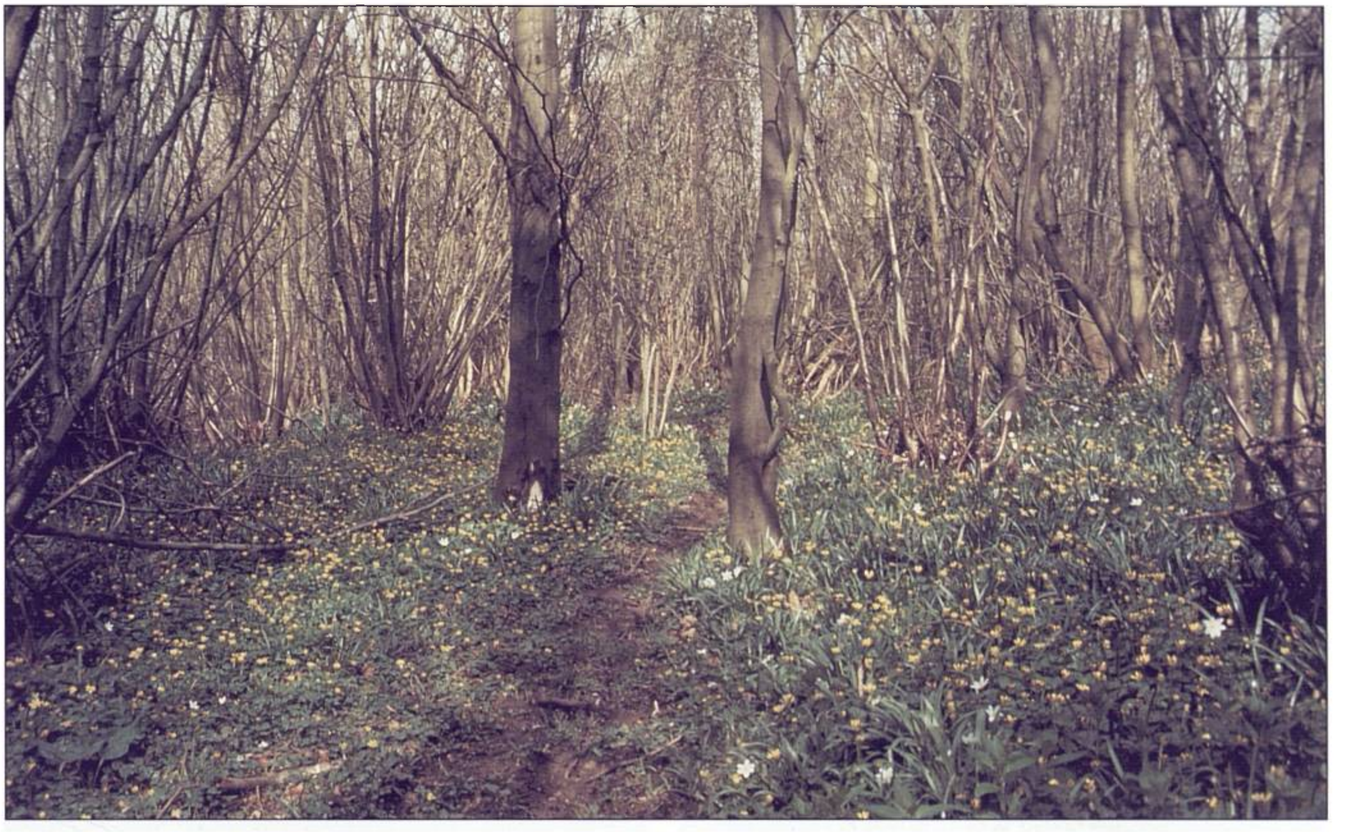


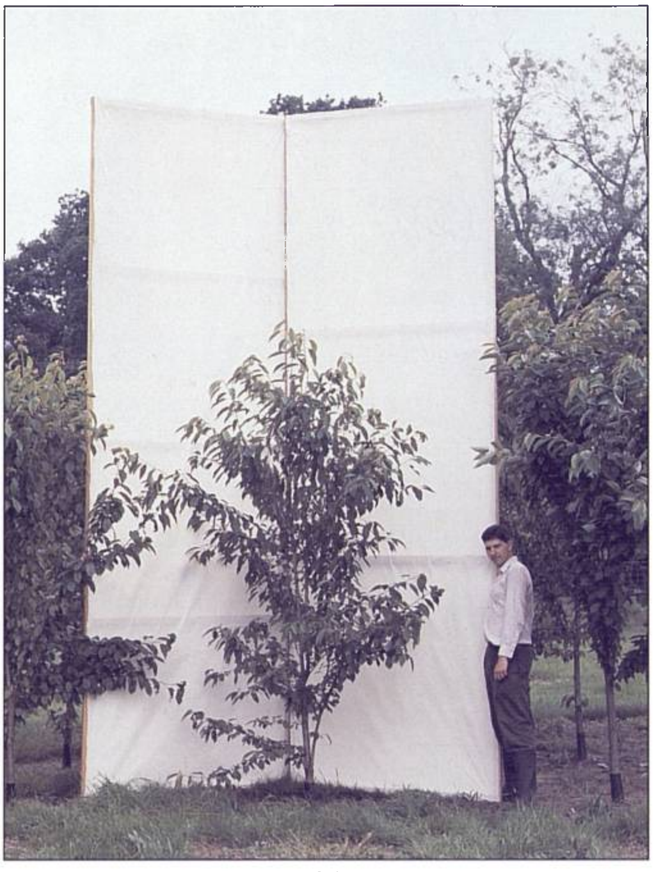
Plate 5 *Attractive spring flowers under ash coppice: a W8 type native woodland.[38625]*

Plate 6 *The two types of planting stock commonly used: (a) bare-rooted and (b) cell-grown.[40276 and 40274]*

(a)

(b)

(a)



(b)

Plate 7 *Effect of weeding on cherry: (a) no weeding, (b) 1 m² spots treated with herbicide.[40203 and 40201]*

Plate 8 *Herbicide application by directed spray around a treeshelter.[38880]*

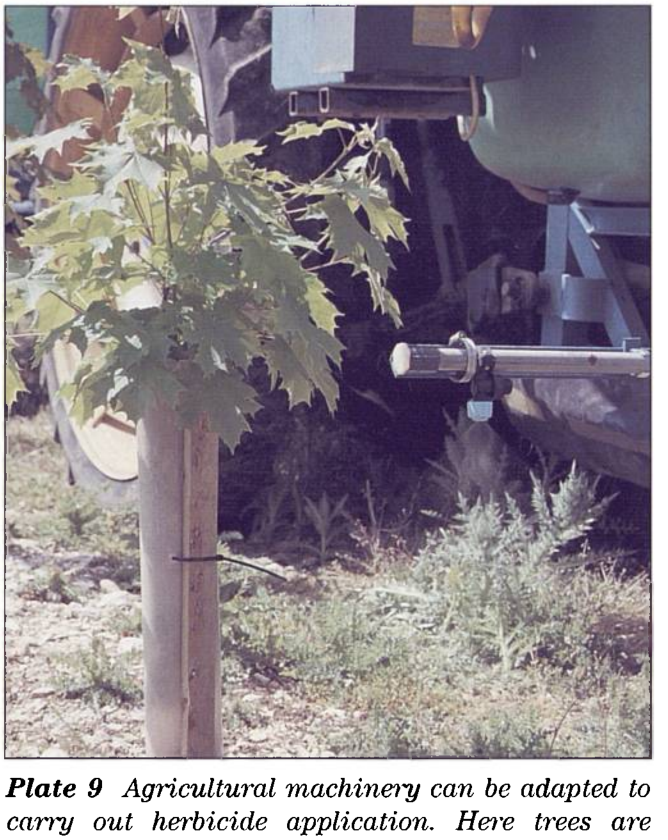


Plate 9 *Agricultural machinery can be adapted to carry out herbicide application. Here trees are protected by treeshelters and the aim is to keep a 1 m wide strip down the tree row weed free.[40157]*

Table 3.1 Trees and shrubs associated with main woodland types in the National Forest (adapted from Forestry Commission Bulletin 112: *Creating new native woodlands*)

	W6 Alder woodland with stinging nettle	W8 Ash, field maple with dog's mercury	W10 Oak with bramble and bracken	W16 Oak,birch and wavy hair grass
Major trees	Alder Crack willow	Ash Pedunculate oak Sessile oak Field maple	Pedunculate oak Sessile oak Silver birch	Pedunculate oak Sessile oak Silver birch
Minor trees	Downy birch Ash Pedunculate oak Holly Goat willow	Silver birch Holly Crab apple Rowan Wild cherry Aspen Grey sallow Common whitebeam	Holly Rowan Crab apple Aspen Wild cherry Hornbeam	Holly Rowan Aspen Common whitebeam
Major shrubs	Grey sallow Elder	Hazel Hawthorn	Hazel Hawthorn	Elder Alder buckthorn Common gorse
Minor shrubs	Hawthorn Guelder rose Blackthorn Alder buckthorn Purging buckthorn Almond willow Osier willow Purple willow	Blackthorn Elder Guelder rose Goat willow Spindle Dogwood Wayfaring tree Purging buckthorn	Blackthorn Elder Guelder rose Wayfaring tree Common gorse Broom	

This should be used with Table 3.1 to guide species choice if you aim to create a new native woodland. See Chapter 6 for examples of new native woodlands created at each of the three Demonstration Woodlands.

Previous use of land

The main factors to consider are whether past use was arable or grassland, and whether the site has an unusually high soil pH. Readily available soil testing kits are suitable for this purpose. The optimum pH for most tree species is surprisingly low, at about 4.5–5 (poplars are the main exception preferring pH 5.0 to 6.5), whereas the optimum pH for many agricultural crops is 6.5. However, in the Forest area some sites available for tree planting have a pH in excess of 7. This limits the tree species which can be grown successfully on such sites to a few tolerant species such as sycamore, Norway maple, Italian alder and Corsican pine. Decisions about establishment will depend on whether the site has been grassland or arable; these options are explained in Chapter 4.

Chapter 4

Tree establishment

- ▲ Use appropriate ground preparation to rectify any identified soil problems.
- ▲ Most conifers and broadleaves should be planted at a density of 2500 trees per hectare.
- ▲ Protecting trees from mammals is essential.
- ▲ Time spent ensuring the suitability and quality of planting stock is well invested.
- ▲ Bare-rooted stock or cell-grown stock should be notch planted in the dormant season.
- ▲ Few ex-agricultural sites in the National Forest will need fertiliser application.
- ▲ Weed control is essential (see Chapter 5).

Ground preparation

When planting trees on ex-agricultural land there are two main starting points: grassland or an arable stubble. Grassland is the easier of the two because grass is easy to control immediately around the trees, and the remaining sward will exclude noxious weeds such as creeping thistle and ragwort. Therefore the message is *do not plough*. Plant through the grass sward and then kill the grass at the base of the trees by using a mulch or a suitable herbicide (see Chapter 5). The grass between the weed-free areas (spots or strips) around the trees can be left to go rank or it can be mown to further discourage weed invasion. Occasionally soil below a grass sward is compacted. On these sites use subsoiling as a way of maintaining the grass sward. However, trees should be planted offset from the rip lines, because the cracks created by a subsoiler tine can open in dry weather and expose the roots.

For arable stubble, the most reliable option is to establish a grass sward in the year before planting, and then follow the advice above. If compaction or an iron pan is present then the ground needs to be prepared prior to planting. Where a grass sward is not established the stubble can be subsoiled to relieve compaction, but not ploughed, because undisturbed it will delay the development of weeds. Where weeds do invade after the trees have been planted, weed control is important. Control weeds around the trees with herbicides and mow the inter-row (the space between the tree rows) as necessary. Heavy soils beneath undisturbed stubble can be extremely hard and compacted, making it difficult to plant trees. In these conditions the site can be cultivated as though a winter cereal crop was to be sown and trees can then be planted into this cultivated ground. Where soil has been cultivated, however, weed invasion will usually be rapid and it is, therefore, essential to apply a suitable residual herbicide along the tree rows immediately after tree planting (see Chapter 5). The cheapest practical option is to maintain good weed control along the tree row with herbicides, and manage the weeds that appear in the inter-row by mowing. If mowing is carried out frequently enough to prevent annual weeds from seeding, a perennial grass/weed sward will be produced within two or three seasons.

Significant areas of the National Forest have poorly drained soils (Plate 4) which are most likely to be grassland or winter sown cereals. These agricultural soils have often been improved by pipe drainage which will also benefit tree establishment. If there is no evidence of pipe drainage then either mole drains can be put in or tree species chosen which can tolerate the wet site conditions.

Experience from the Demonstration Woodlands

At Barton under Needwood, one field (see area (a) in Plate 10) was found to have a well-developed plough pan which it was essential to break to allow tree roots to grow and expand to provide water, nutrients and anchorage (Plate 13). This was achieved using an agricultural subsoiler to a depth of 50 cm with 60 cm between the rip lines. Due to the timing of contract negotiations subsoiling did not take place until February when the soil was too wet for optimal effect. In the canal field (see area (c) in Plate 10) there were no compaction or pan problems and therefore ground preparation was unnecessary. It is recommended that ground preparation is carried out in the summer when the soil is dry, and maximum soil shattering and disturbance can occur.

At Church Gresley there was a grass sward over most of the site but on a large proportion of the area the soil had been compacted to such an extent that ground preparation was required to improve soil structure. This was achieved by ripping using an agricultural subsoiler to a depth of 50 cm with

125 cm between the rip lines. The presence of wings on the ripper tines meant that only 20 cm between the rip lines was uncultivated and disturbance of the grass sward was minimised. As at Barton, this did not take place until January when the soil was too wet for optimal effect.

Spacing

The number of trees planted has a significant effect on the cost of establishment and maintenance. Poplar can be planted at between 160 and 1100 trees per hectare. For all other species planting densities of 2500 trees per hectare (2 m x 2 m) are commonly used. If mechanical access is important then distances between rows and within rows may need to be varied, for example, 2.5 m between rows and 1.6 m within rows would still maintain 2500 trees per hectare. This density of trees combined with good silviculture will ensure the site is captured quickly to woodland conditions and should be universally used when establishing new woodlands on bare land. Close spacings result in suppression of side branches and hence a reduction in knot-size and an improvement in timber quality. In the special case of short rotation coppice, densities as high as 15 000 cuttings per hectare are required to maximise productivity. Grant conditions will normally specify a minimum number of trees per hectare (a) at planting and (b) surviving after 5 years.

Tree protection

Protection of newly planted trees from animal damage is vital, otherwise the investment in buying, planting and maintaining trees will be wasted if they are eaten or damaged. The risk of damage from deer, rabbits, hares and voles is high. Rabbit populations in some areas have returned to pre-myxomatosis levels, and roe, fallow and muntjac deer are all present in the National Forest area.

The main options for protection are fencing or individual tree protection, both of which should be used along with controlling populations of the animals in question (Table 4.1). Many landowners will be familiar with the requirements of stock fencing to British Standard 1722 Part 2; this standard applies to fencing to exclude deer and rabbits. Figure 4.1 shows suitable fencing for protection against rabbits and deer. When trees are protected by a fence, protection against vole damage is also advisable (see Plate 14). An added way of reducing vole damage is through good weed control, because voles tend not to cross ground where they are easily detected by predators.

Table 4.1 Protecting trees against mammals

Animal	Individual tree protection	Fencing	Notes
Cattle and horses	Generally not effective	Standard stock fence	A buffer zone is needed between stock fence and trees
Sheep	1.8 m high (if sheep are to have regular access, 2 tall stout stakes are needed)	Standard stock fence	
Deer: red, sika, fallow, roe,muntjac	 1.8 m high 1.2 m high	 2 m high 1.8 m high	
Hares	0.75 m high	1m high. Use rabbit netting with a line wire 10 cm above the netting	
Rabbits	0.6 m high	0.9 m high. 15 cm at base turned away from the area to be protected and secured by turves	Landowners are legally required to control rabbits if present Gassing from October to mid-March
Voles	Vole guards 20 cm tall; above height of vegetation. Buried at least 5 mm into soil (see Plate 14)	Supplementary vole guards are advisable in fenced areas if weed control is not meticulous	Good weed control will will reduce risk of damage Treeshelters will not protect against voles unless staked firmly and buried 5 mm into the soil

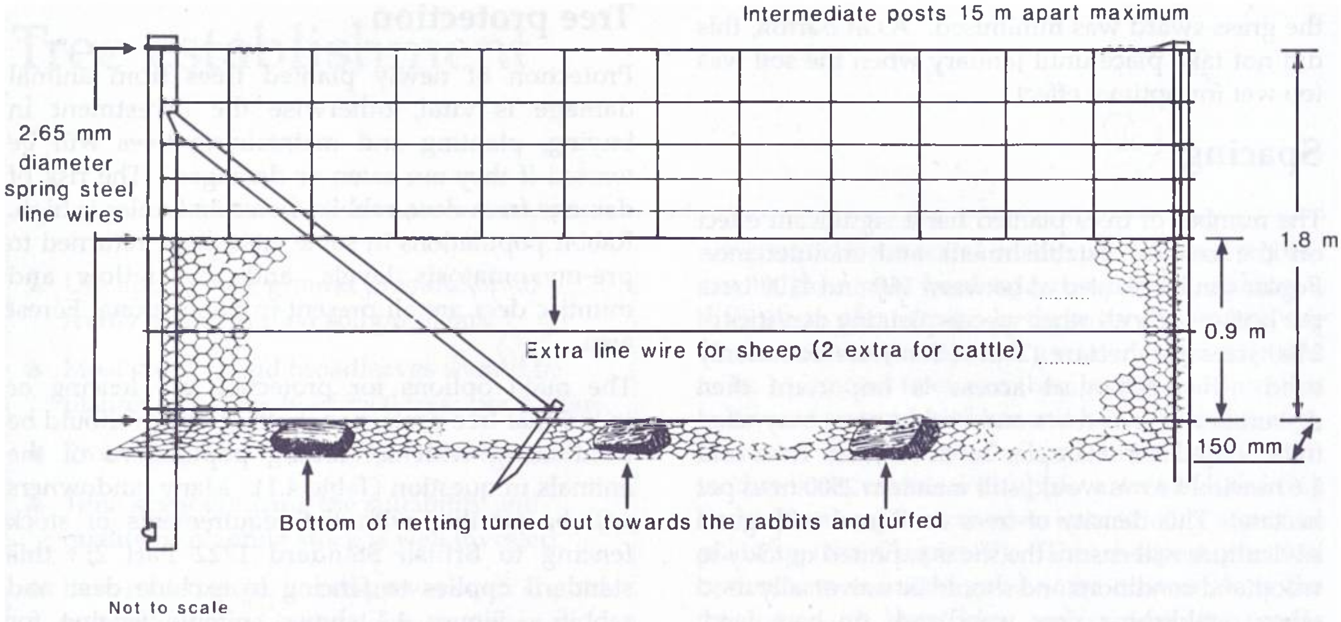


Figure 4.1 Specification for a deer and rabbit proof fence

Individual tree guards are made in a wide range of shapes, sizes and materials. The most popular type is the treeshelter, a plastic tube placed over a newly planted tree like a vertical cloche. It protects the tree from animal damage and provides a 'mini-greenhouse' environment around the tree for 5 to 10 years which aids tree survival and growth (Figure 4.2).

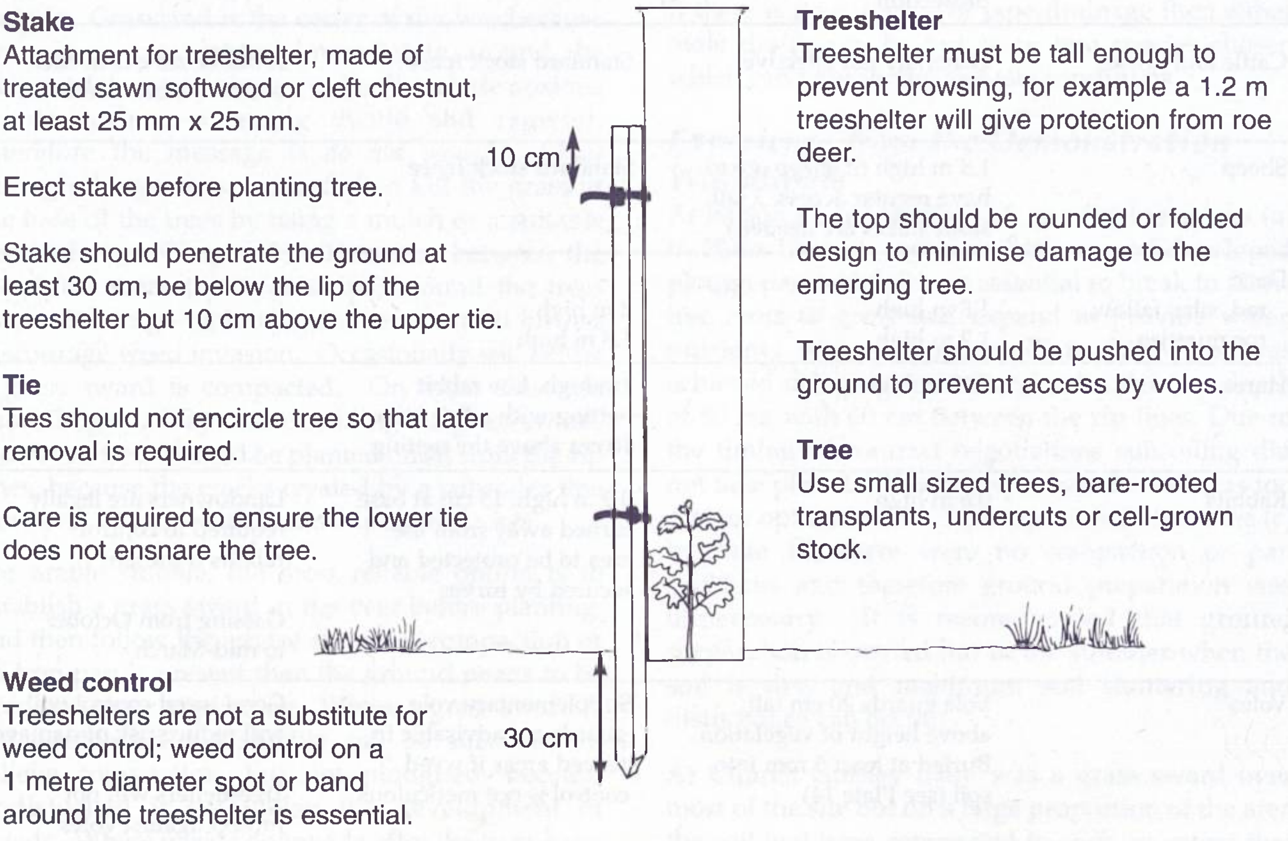


Figure 4.2 Recommended use of a treeshelter

As well as protecting trees from animals, treeshelters have additional benefits:

- They protect trees from foliar-acting herbicides, and so decrease the cost of weeding, especially if herbicides are applied by tractor.

- If a fence is breached, all trees are at risk to animal damage, whereas if a treeshelter is damaged only one tree is exposed.

- They can dramatically improve tree survival and height growth, as the sheltered, humid environment in the tube reduces moisture stress in the period after planting.

The main factor affecting the choice between fencing or individual tree protection is cost, which will vary depending on the area to be protected, its shape and the number of trees planted. Individual tree protection is usually more economical on areas of less than 2 hectares (5 acres), but it is always advisable to compare the cost of both methods for each area planted, paying particular attention to future maintenance, e.g. costs of disposing of or reusing treeshelters (Table 4.2).

Experience from the Demonstration Woodlands

The main need for protection in the Demonstration Woodlands was against rabbits. Deer were not considered a threat. Fencing was more economical than individual tree protection because of the size and shape of areas planted. All three sites, but particularly Barton under Needwood and Church Gresley, also provided good habitats for voles. Therefore vole guards were fitted as soon as there were signs that trees were being damaged. Weed control at all sites has been maintained to a high standard and this has helped reduce vole damage. In one field at Barton under Needwood the rabbit population was initially very high, and a fence was erected and all rabbits removed from inside the fence. However, it became apparent that the ditch on the outside of the fence housed an extensive warren and the fence was constantly breached. Despite control by gassing and shooting, rabbit damage persisted. To prevent further problems a decision was taken to use 0.6 m treeshelters inside the fence. This saved many of the trees which are now established and growing rapidly.

Planting stock

A key factor in successful woodland creation is the use of planting stock which is the correct size, and is healthy and vigorous.

There are two types of planting stock which are commonly used: bare-rooted and cell-grown (Plate 6 (a) and (b)). Bare-rooted trees are grown in an open nursery and are usually offered for sale when 1–3 years old. When ready for sale the trees are lifted, excess soil is removed from their roots and the trees are sold with the whole plant enclosed in specially designed plant bags.

Table 4.2 Calculating for cost-effective tree protection

	Site 1	Site 2	Site 3
Animal pests	Roe deer Rabbits	Roe deer Rabbits	Rabbits
The planting site			
Shape	Rectangular	Rectangular	Triangular
Dimension	100 m x 100 m	250 m x 75 m	200 m x 400 m x 450 m
Area	1 ha	1.9 ha	4 ha
Number of plants	1100	4750	4400
Fencing			
Fence length	400 m	650 m	1050 m
Fence cost per metre (£)	5.50 (for deer fencing)	5.50	2.37 (for rabbit fencing)
Total fencing cost (£)	**2200**	**3575**	**2488**
Individual tree protection			
Cost of treeshelter (£)	0.97 (for 1.2 m size)	0.97	0.56 (for 0.6 m size)
Total treeshelter (£)	**1067**	**4608**	**2464**
Most economical protection	Treeshelters	Fencing	Marginal decision

Cell-grown stock is usually less than 1 year old, having been grown under controlled conditions in polythene tunnels or glasshouses; the trees can be delivered in the containers or removed from them in a plug of soil, depending on the system used in the nursery. Both types of plant can be successfully used if handled carefully and planted properly in the dormant season (November to March). Bare-rooted stock is usually cheaper but cell-grown stock offers greater resistance to physical damage and can be planted in the growing season, although this is *not* recommended.

Some species such as poplar and willow root easily from cuttings. These species are usually established using unrooted cuttings (25 cm long, 1–2 cm diameter) which are simply inserted in the soil on suitable sites. The same species can also be planted as unrooted sets (up to 2 m long; 2–4 cm diameter). These will be more expensive to buy and plant but will give a useful growth advantage.

Catalogues from nurseries classify tree planting stock by method of production, species and size and use a notation which should be understood to ensure you get what you want. A '+' indicates a tree has been transplanted from a seed-bed into more spacious surroundings in the nursery. A 'u' indicates undercutting, when the lower parts of the root system are severed to promote a well-branched and fibrous root system. So a 1+1 has spent a year in the seed-bed before being transplanted to the nursery for a further year, after which it is sold; 1u1s are sown at wide spacing, spend 2 years in the seed-bed before sale, but are undercut in the second year. Most cell-grown stock is 1 year old and is commonly referred to as 1+0.

Experience from the Demonstration Woodlands

Most trees in the Demonstration Woodlands were 1+1 bare-rooted stock planted in the dormant season. When the schemes were costed, cell-grown stock was 20% more expensive than the bare-rooted stock.

Both types of poplar planting stock were used at the Barton under Needwood Demonstration Woodland. After 2 years, poplar cuttings were 2 m tall and the 2 m sets were 4 m tall.

Planting stock size

Large stock (whips, feathered and half standards) are generally more expensive compared with small stock (transplants, undercuts etc.) and are usually unsuitable for woodland creation. This is because when small trees are lifted in the nursery, much of their root system is left intact and when planted the roots are able to supply the water requirements of the plant. The root:shoot balance of larger stock is often not as good and as a result the survival rate can be lower and die-back is more common compared with smaller stock types.

The most important size parameter is the diameter of the stem where it meets the roots (root collar diameter). Trees with a sturdy stem generally have lots of roots which, if the tree has been treated well, will regenerate quickly when planted and supply the tree with the required water and nutrients from the soil. However, many nurseries grade stock according to height which in terms of transplanting is less useful. The information in Table 4.3 is from British Standard 3936: Part 4: 1984, and it is recommended that you specify that planting stock must meet these

Table 4.3 Minimum sizes for planting stock: based on British Standard 3936: Part 4:1984

	Minimum root collar diameter (mm)		
	Transplants Not less than 30 cm tall	**Undercuts** Not less than 40 cm tall	**Cell-grown stock**
Corsican pine	6.5	8.0	2.0
Scots pine	6.5	8.0	4.0
Douglas fir	4.0	5.0	3.0
Hybrid larch	4.0	5.0	[a]
Oak	6.5	8.0	6.0
Cherry	6.5	8.0	[a]
Sweet chestnut	6.5	8.0	6.0
Sycamore	4.5	5.0	6.0
Birch	4.0	4.5	6.0
Ash	6.5	8.0	6.0
Norway maple	4.5	5.0	6.0
Italian alder	4.5	5.0	6.0

[a] No information.

minimum requirements when ordering your plants. Even better, visit the nursery and inspect the stock you intend to buy. Check quality by appearance of shoots and buds, evidence of fungal growth or insect pests and scarred bark, all of which indicate poor quality and possible ill health.

Cell-grown plants grown under glass need a period of hardening off before being sold. Plants should be moved outdoors by late August at which time fertilising treatments should cease. Often cell-grown trees are moisture stressed during this period as part of the hardening-off process. Be wary of cell-grown plants that are still under glass in late summer. As with all nursery stock, it is generally not the lushest, darkest green, most rapid growing plants that will perform best after planting, but those plants that have been prepared for the shock of the transit and planting operations.

The following points will help ensure stock is in good condition before planting:

- Give the nursery advance notice of when you want your plants. Try to ensure trees are lifted only just before despatch, so that they are not left lying around in the nursery too long. If roots look dry and wiry it may be that they have been poorly cared for between lifting and despatch.
- Check all bags or trays of plants. Any suspect plant can be examined further by nicking the bark with a thumbnail: if green or greenish-white it is still alive; if creamy-white, brownish or brown it is dead or dying.
- If trees are of poor quality they should be sent back to the nursery; planting trees which are nearly dead or likely to die is a waste of time and money.

Nursery to site

Two requirements must be satisfied if plants are to be kept healthy for planting: roots must be kept moist (but not saturated), and plants must be handled with care. Bare-rooted trees and plugs should be sealed in special double-sided black/white planting bags when lifted.

Any exposure of roots to drying quickly kills the finer ones and can, in a few hours, kill the main roots as well. Bare-rooted plants should be kept in the shade at all times to avoid overheating in the bags and to keep the roots moist. Container stock should be kept in the shade and watered frequently.

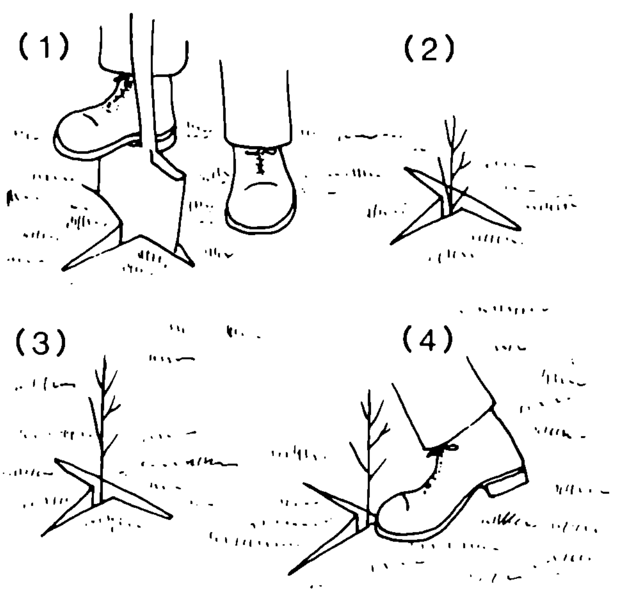
Rough handling reduces the survival and growth of the trees. It is essential not to drop plants or throw them about. They should be planted as soon as possible after delivery to avoid the potential for deterioration of tree quality between nursery and planting. Bare-rooted plants can be stored safely in their sealed bags for up to 2 weeks in a cool, frost-free shed during the winter. If planting is likely to be delayed for longer it may be worth considering cell-grown stock, particularly if the trees are near to starting their spring growth.

When to plant

All trees should be planted while still dormant. Although container stock can be planted in the growing season the risks of poor survival are greater than if planted in the dormant season. Planting is best carried out in November–December or from mid-February to the end of March into frost-free ground. Unless the weather is particularly mild, planting from Christmas to mid-February is best avoided.

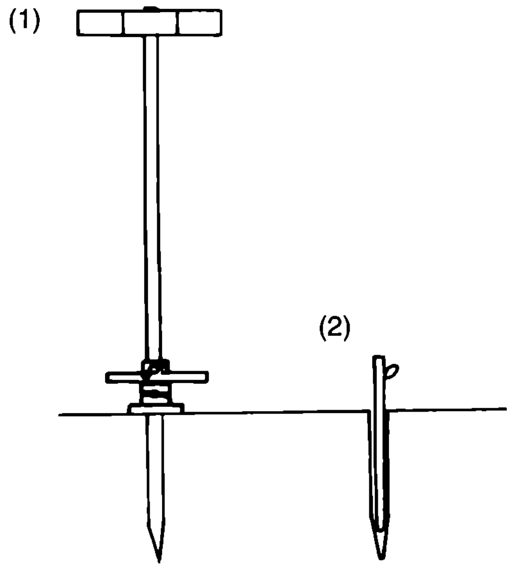
How to plant

The best method of planting bare-rooted and cell-grown stock is notch planting (Figure 4.3), whereas unrooted cuttings of poplar and willow should be planted into a hole made with a suitably sized bar (Figure 4.4).



1. Make plenty of room for the tree roots.
2. Ensure the tree roots are pushed as far down as possible.
3. Withdraw the transplant slightly to spread the roots.
4. Firm the ground gently with the ball of the foot to ensure good contact between the soil and the tree roots.

Figure 4.3 Planting techniques for transplants using the T-notch method



1. Using a suitable instrument, make a hole into which the cutting can be placed.
2. The cutting should be a snug fit in the hole with 2–3 cm above the soil surface to expose the uppermost bud.

Figure 4.4 Planting techniques for unrooted poplar or willow cuttings

Fertilisers

Generally on ex-agricultural sites in the National Forest fertilisers will not be required. Indeed, if weed control is not undertaken, fertiliser application can actually slow tree growth by stimulating weeds, thus intensifying moisture competition. Fertiliser in combination with weed control can marginally improve tree growth on some sites, but not often enough to justify the costs. In addition, fertiliser applied to bare ground can be rapidly leached.

Maintenance and inspection

Once the woodland is planted it is important to inspect it on a regular basis to assess the effectiveness of herbicide applications, to correct any problems with treeshelters and stakes, to ensure that fences are rabbit, deer and stock proof and, most importantly, to check that the trees are alive and growing well.

Chapter 5

Weed control

- ▲ Weed control is **the key** to successful tree establishment on ex-agricultural land.
- ▲ In most cases the most appropriate method of controlling weeds is by safe, judicious use of herbicides.

Weeds reduce the survival and growth of trees by competing for light, nutrients and, most important of all, moisture. This is critical in low rainfall areas such as the National Forest. The availability of water in the soil is lower for ground under weeds compared with under bare soil because vegetation can lose moisture more rapidly and for a longer time by transpiration. In comparison, relatively little moisture evaporates from bare soil before a layer of dry soil forms, which then restricts further moisture loss.

The majority of sites where trees are planted in the lowlands benefit from weed control during the establishment phase. However, regularly cutting or mowing weeds, especially grass, is of no value since it increases the rate of water use by maintaining active growth and competition for longer during the growing season. The most cost-effective method of weed control is through the use of herbicides.

Control of weeds need not extend over the whole site. Maintaining a weed-free area of at least $1m^2$ around the base of each tree or as a 1 m wide strip down the tree row will give satisfactory results. The latter allows mechanisation through the use of adapted agricultural spraying equipment (see Plate 9). Weed control is only essential during the establishment phase, normally for the first 3 or 4 years after planting.

Land managed for agricultural production usually has an enormous number of weed seeds in the soil. These are generally not apparent because, under pasture, grass prevents most weed species from becoming established, and under arable crops weeds are controlled initially by herbicides and later by the smothering effect of the crop. When agricultural soils are left unmanaged or efforts are made to maintain bare ground, a succession of weed species takes place, although not disturbing a cereal stubble may delay and reduce this influx to some extent. The process starts with a rapid invasion of volunteers from the previous crop and annual arable weeds. Gradually the annual weeds are replaced by perennials many of which are deep rooting and difficult to remove using herbicides. Examples are dandelion, docks, creeping thistle, perennial nettle and bramble. The best way to deal with these perennials is to prevent them from establishing in the first place. This can be done by using soil acting residual herbicides to prevent weed seed germination. If they do establish, they can be removed by repeated application of foliar acting herbicides, taking care to protect the trees.

Methods of weed control

Control of weeds by cultivation is not practical in most situations because it has to be repeated frequently during the growing season, leaves the loose soil subject to erosion and can cause serious damage to tree roots. The use of mulches, a layer of material around the base of the tree, is an alternative to using herbicides. The main types of material are plastic or composted bark; neither form a total barrier against weeds and are expensive, and therefore are not commonly used in woodland creation. *In most cases the most appropriate methods of controlling the weeds around young trees is through the use of herbicides* (Plate 7). Figure 5.1 illustrates the effects of different methods of weed control on the growth of cherry after three growing seasons.

Herbicides

The products can be divided into two broad groups:

1. *Soil acting residual herbicides.* These products act via the soil where they are taken up through the roots of weeds. It is important that these herbicides are applied to damp soil and that rain follows application to move them into the top 2–3 cm of the ground. If they are applied to dry soil and little or no rainfall follows application, weed control will be poor. Residual herbicides must be applied to a firm fine tilth; if large clods are present at the time of application these will weather and crumble,

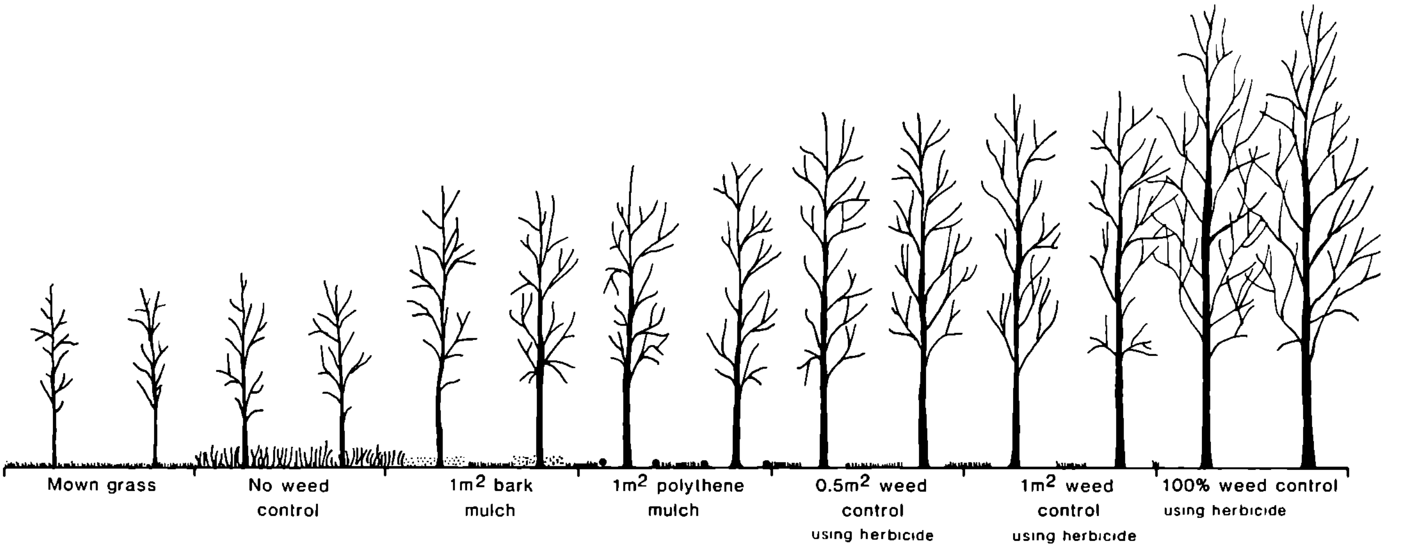


Figure 5.1 Effects of different types of weed control on cherry after 3 years

exposing untreated soil and allowing prolific weed growth. Similarly, if the site has not been cultivated it is necessary to accept slightly reduced herbicide efficacy.

2. *Foliar acting herbicides*. These are absorbed through the point of contact on the leaf and stem and are independent of the condition of the soil. The timing of application will be determined by the growth stage of the target weed. Foliar acting herbicides give best results when they are applied to actively growing weeds.

Depending on the susceptibility of the tree species, herbicides are applied as an overall spray (over the top of the trees and the weeds) or as a directed spray (placed to avoid contact with the trees; Plates 8 and 9). As a general rule, overall application of herbicides, particularly selective foliar acting herbicides, should be avoided during periods of bright sunlight or high temperatures as this can lead to scorching of tree foliage. If overall applications are needed in the summer then they should be made in the evening so that there is the maximum period between application and the occurrence of high temperatures. Never apply herbicides of any description to waterlogged ground or when trees are under stress from drought.

Herbicides can be used effectively before or after planting. There may be opportunities to control perennial weeds in the previous crop, e.g. use of selective herbicides in pasture or the use of glyphosate pre-harvest in cereals and other arable crops. These treatments can reduce the subsequent vigour of weeds such as creeping thistle or couch grass. Foliar acting herbicides can be used to clean up undisturbed stubble before planting.

Where long-term weed control is required after planting, the use of residual herbicides is the simplest and cheapest option. The principle here is to prevent weeds becoming a problem. Control of massive weed infestations is more difficult to carry out with foliar acting herbicides and is more likely to damage trees. The trees may also have been subject to many weeks of moisture competition before you can act with a foliar herbicide. It is vital to match the weed control spectrum of the herbicide to that of the weed species on the site. Many residual herbicides generally only control weeds pre-emergence and must therefore be applied to bare earth. If bare soil is to be maintained all year round, treatment may be repeated in the autumn and the spring. However, in practice, weeds resistant to residual herbicides begin to develop, and a mixed regime based on foliar acting and residual herbicides (sometimes applied as a tank mixture) is often needed. As an alternative to a year-round bare-soil system, some vegetation cover may be allowed to develop in the autumn and winter when it is not competitive and then be killed by a spring application of foliar acting herbicide; this will delay reinvasion of weeds.

Mulches

Applications of a thick layer of organic material such as wood chips or straw after planting can suppress weeds. However, such mulches are difficult to keep in place and their use may lead to a reduction in tree growth, since much available nitrogen is used for microbial breakdown of the mulches.

A better option is the various forms of synthetic mulch, including black polythene mulch mats (1 m x 1 m) and the same material applied as a 1 m wide strip.These impervious mulches have the advantage of retaining soil moisture normally lost by evaporation from bare soil and are particularly useful on very light soils. They may last for 3 to 4 years. Plastic film can be damaged by perennial weeds and birds. It can also provide sheltered conditions for voles which can then debark trees from beneath the mulch; and foxes will rip the plastic material when in pursuit of voles. The high cost of purchasing and laying mulches is a further disadvantage to their use.

Further guidance

This chapter is only a brief introduction to weed control on ex-agricultural sites. In order to plan a weed control programme using herbicides, more detailed information on their safe and judicious use must be referred to. This guidance is available in Field Book 8 *The use of herbicides in the forest* and its companion, Field Book 14 *Herbicides for farm woodlands and short rotation coppice,* published by the Forestry Commission and available from The Stationery Office (see Supporting information pages 28 and 30).

Experience from the Demonstration Woodlands

Experience from Barton under Needwood and Church Gresley demonstrates some of the main principles of weed control. At each site herbicides were used in a safe and judicious manner as described in Field Book 8; generally application was to 1 m diameter spots to minimise herbicide usage.

Barton under Needwood

This initially consisted of two different site types, ex-arable (see areas (a) and (b) in Plate 10), and ex-pasture (area (c) in Plate 10). In the two years after planting, the herbicides listed below were used on 1 m^2 spots on the two sites. An initial attempt to control weeds using only foliar acting herbicides was replaced by a combination of residual and foliar treatments.

On the ex-arable site:

Apr 1994	Glyphosate (foliar) as a guarded spray
Jun 1994	Glyphosate as a guarded spray
Dec 1994	Pendimethalin (residual) and propyzamide (residual) as a tank mixture
Nov 1995	Propyzamide
Jun 1996	Glyphosate as a guarded spray
Nov 1996	Propyzamide
Jun 1997	Glyphosate as a guarded spray
Dec 1997	Propyzamide / isoxaben
Jun 1998	Glyphosate as a guarded spray

The land was initially bare and glyphosate was used to control emerging weeds; two applications were necessary because of the flush of weeds. Ideally pendimethalin and propyzamide would have been applied in December 1993, reducing the need for two applications of glyphosate. However, subsoiling did not occur until February 1994 and propyzamide must be applied before the end of January (because it is activated by cold temperatures). The use of pendimethalin and propyzamide in December 1994 was so successful that an application of glyphosate was not needed in the 1995 growing season.

On the ex-pasture site:

Jan 1994	Pre-plant application of propyzamide (see Plate 12)
Jul 1994	Glyphosate as a guarded spray
Nov 1994	Propyzamide
Mar 1995	Pendimethalin
Nov 1995	Propyzamide
Jun 1996	Glyphosate as a guarded spray
Nov 1996	Propyzamide
Jun 1997	Glyphosate
Dec 1997	Propyzamide / isoxaben
Jun 1998	Glyphosate as a guarded spray

The site did not need cultivation. Propyzamide was applied to the grass sward in January 1994, followed by glyphosate in the 1994 growing season. Control after this was by residuals applied in the winter; pendimethalin was dropped as it was felt that the spectrum of vegetation present was adequately controlled by propyzamide.

Church Gresley

The site was ex-pasture and most of it was sub-soiled in January 1994. The following herbicides and timings, applied to 1 m^2 spots, have given good weed control.

Apr 1994	Glyphosate as a guarded spray
Jul 1994	Glyphosate as a guarded spray
Dec 1994	Propyzamide
Apr 1995	Glyphosate as a guarded spray
Nov 1995	Propyzamide
Jun 1996	Glyphosate as a guarded spray
Nov 1996	Propyzamide
Jun 1997	Glyphosate as a guarded spray
Dec 1997	Propyzamide
Jun 1998	Glyphosate as a guarded spray

The combination of glyphosate (foliar) applied in the growing season and propyzamide (residual) applied in November or December is widely used to good effect on grass swards.

Disclaimer

Advice regarding herbicides in this Technical Paper is not intended as endorsement or approval by the Forestry Commission of any product or service to the exclusion of others that may be available. The Forestry Commission can accept no responsibility for any loss or damage resulting from herbicide applications, or from following any advice given. Users must determine the approval status of herbicides and must **always read the product label** and comply with all conditions of use therein.

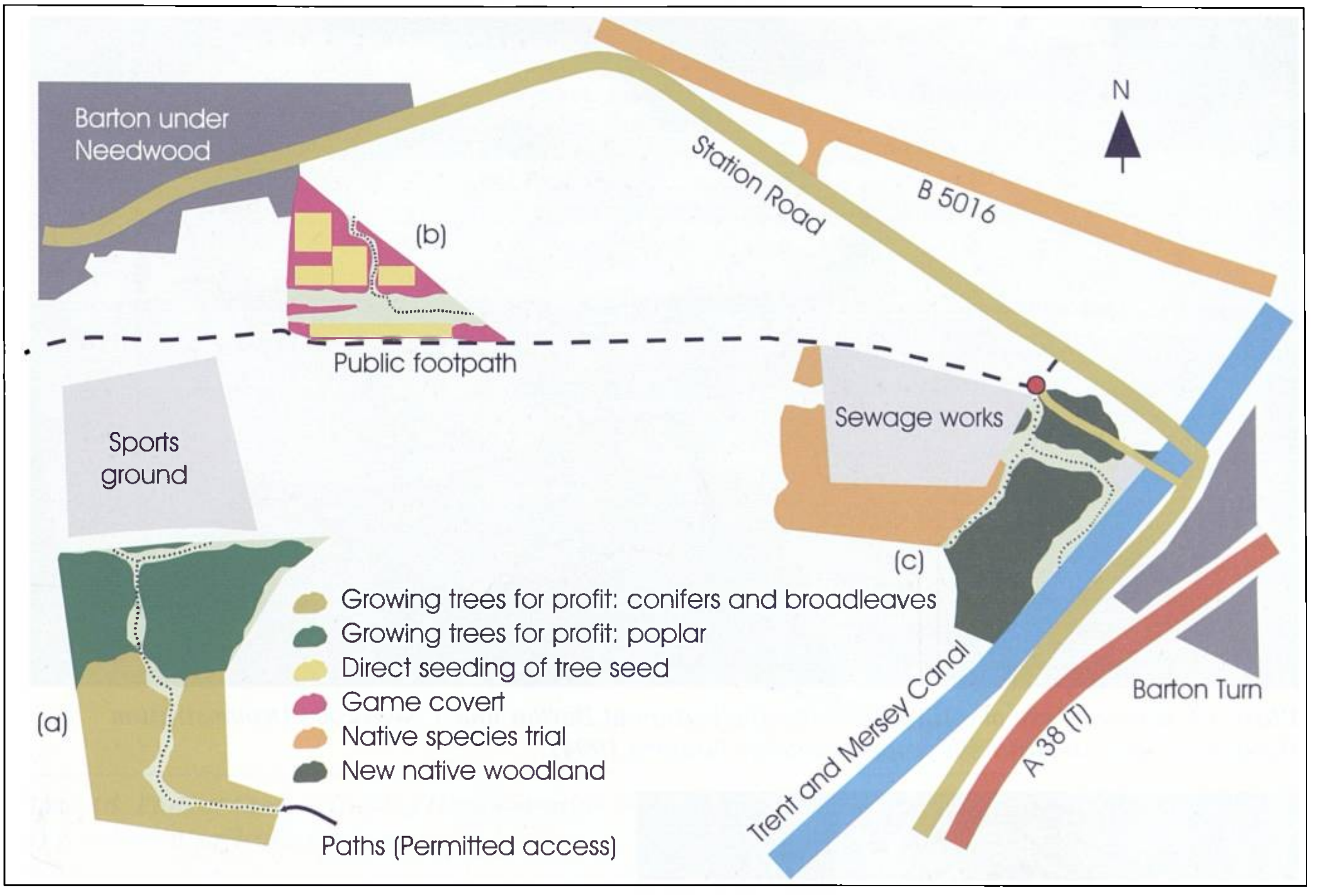


Plate 10 *Plan of Barton under Needwood Demonstration Woodland.(a) and (b) Ex-arable; (c) ex-pasture.*

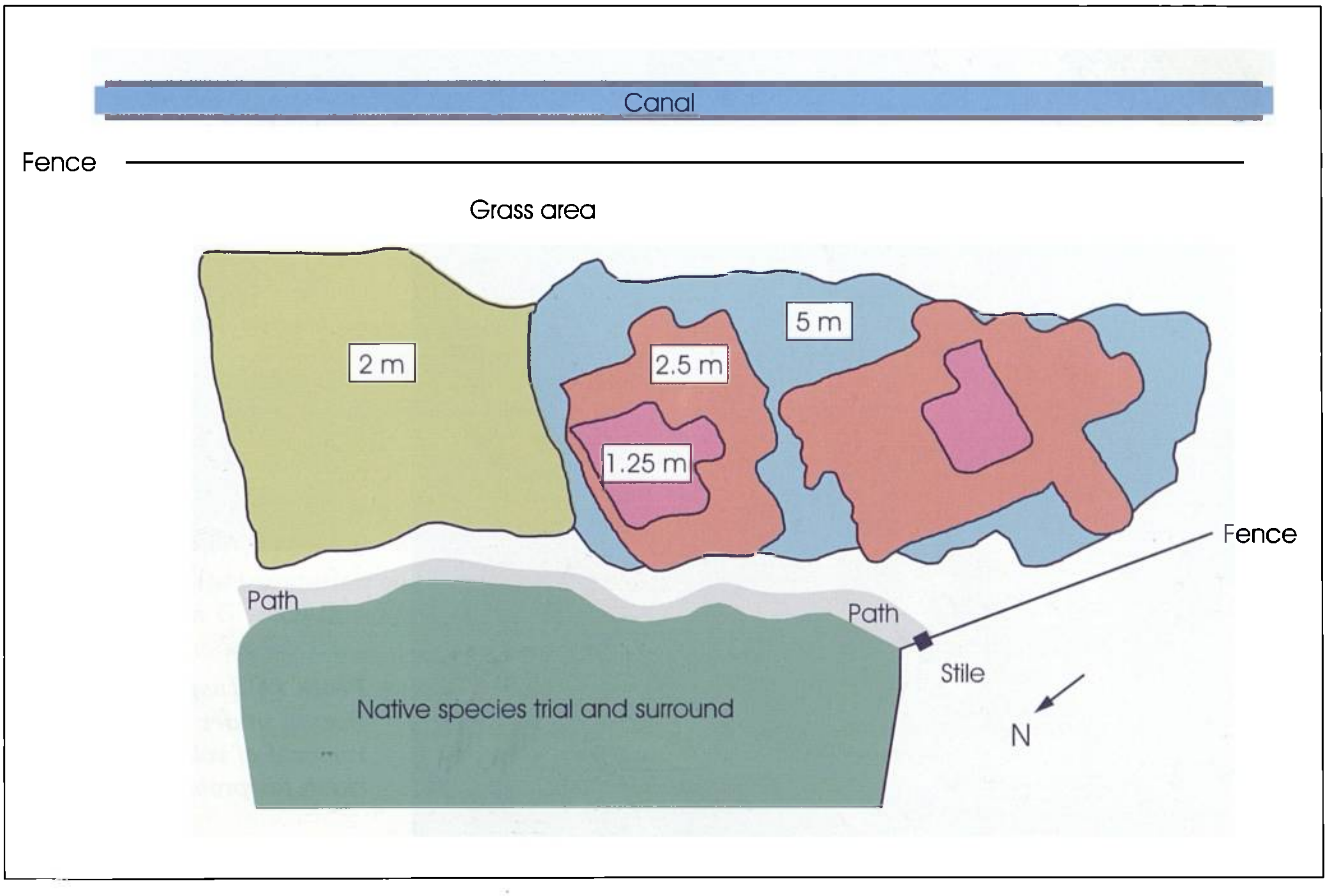


Plate 11 *Plan of new native woodland at Barton under Needwood. The site consists of two areas. At left, trees planted at uniform 2 m x 2 m spacing; at right, single species plots 5 m x 5 m square at 1.25, 2.5, 5 m spacing, giving 25, 9 and 4 trees per plot.*

Plate 12 *Effects of pre-planting herbicide application at Barton under Needwood Demonstration Woodland (spots treated with propyzamide in January 1994).*

Plate 13 *Soil profile at Barton under Needwood (area (a) in Plate 10) showing well-developed iron pan.*

Plate 14 *Inspection at Barton under Needwood: removal of vole guard to check for problems.[42174]*

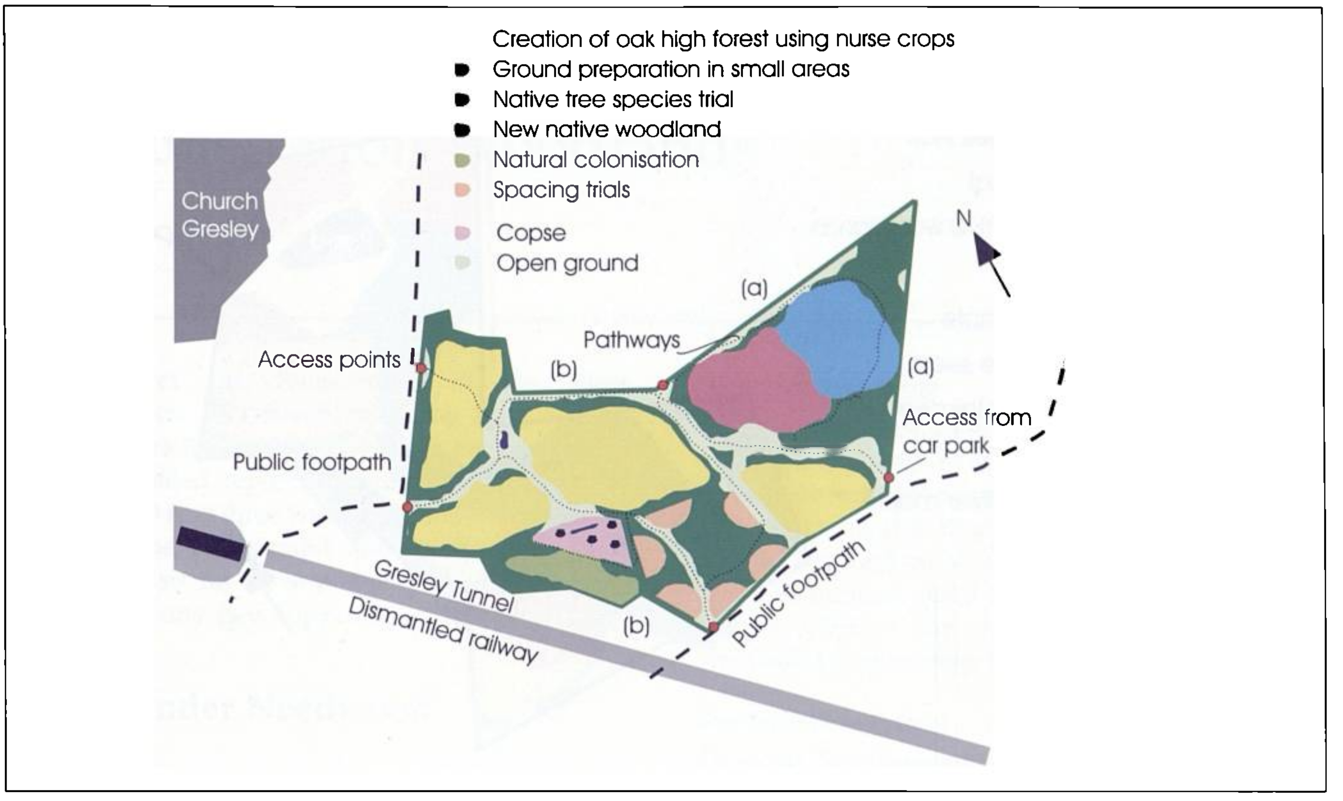


Plate 15 *Plan of Church Gresley Demonstration Woodland. (a) Previously china clay workings; (b) previously agricultural usage.*

Plate 16 *Site interpretation board at main access point to Church Gresley Demonstration Woodland.*

Plate 17 *Provision of raptor boxes (in this case for a kestrel at Church Gresley) can help to control populations of small mammals.*

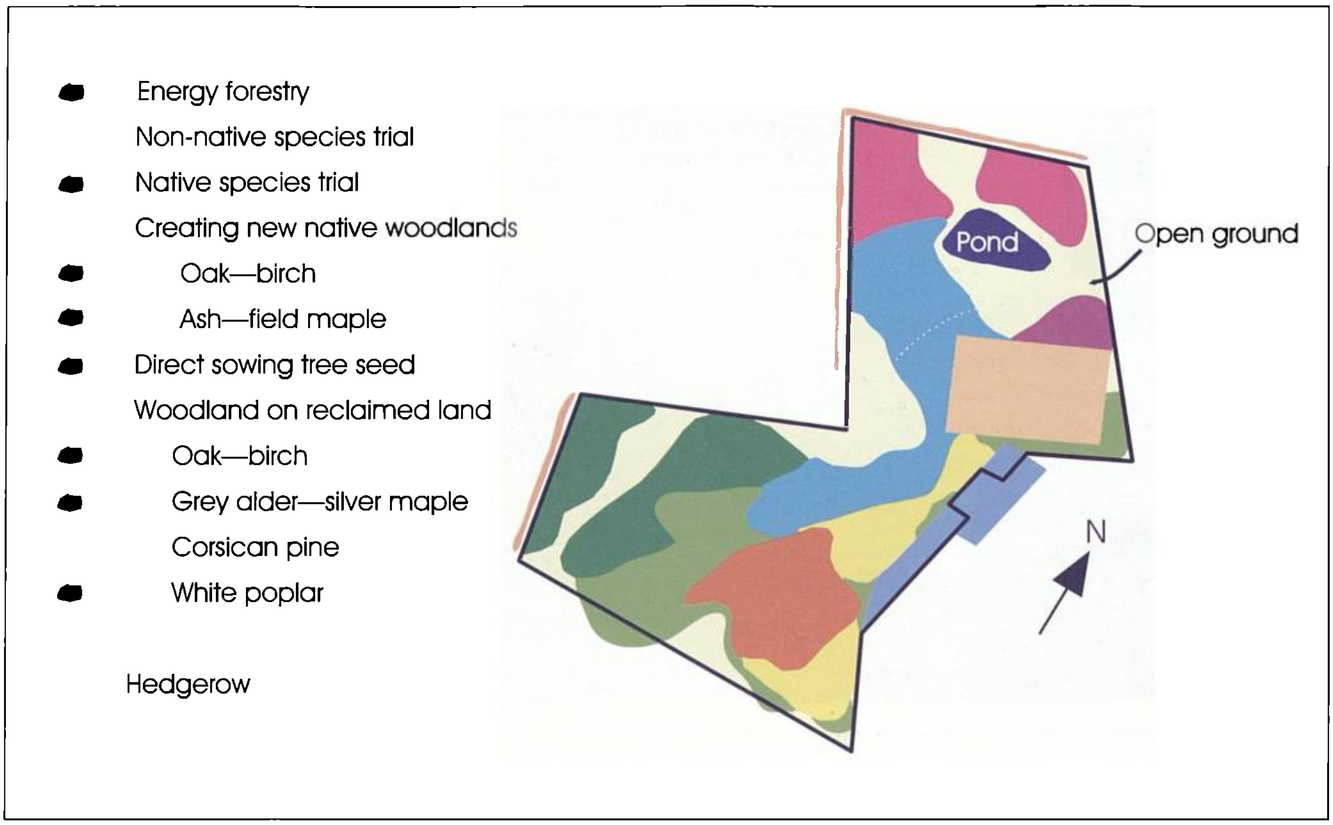


Plate 18 *Plan of Desford Lakes Demonstration Woodland.*

Plate 19 *Typical soil profile at Desford Lakes, showing thin layer of topsoil above compacted amorphous colliery spoil.*

Plate 20 *Ground preparation using contour ripping at Desford Lakes.*

Chapter 6

Demonstration Woodlands

This chapter introduces each of the three Demonstration Woodlands, explains how to find them, and briefly describes what can be seen at each site. A detailed report for each woodland which describes the first three years of establishment operations and the background and results of research undertaken so far is available from the National Forest Company (see Supporting information, page 29).

Barton under Needwood

Location

The site is located 1 km to the east of Barton under Needwood with the main access point at NGR SK201183 (Figure 6.1). It is bordered to the east by the A38 and the Trent and Mersey Canal, to the north by the B5016 and to the west by a school on the outskirts of the village.

Site description

The site comprises three separate areas (Plate 10) of which parts (a) and (b) are ex-arable and (c) is ex-pasture where remnant ridge and furrow formations can be seen. Lying at 52 m above sea level, it is generally flat and exposed on all sides. The soil is alluvial in origin, in parts (a) and (b) it is a fertile heavy clay and in (c) is a lighter clay : loam. Average soil pH is 6. The underlying geology is Triassic Keuper Marls.

Demonstrations

There are five demonstration areas (see Plate 10):

- Growing trees for profit
- Direct sowing of tree seed
- Game covert
- Native tree species trial
- Creating new native woodland

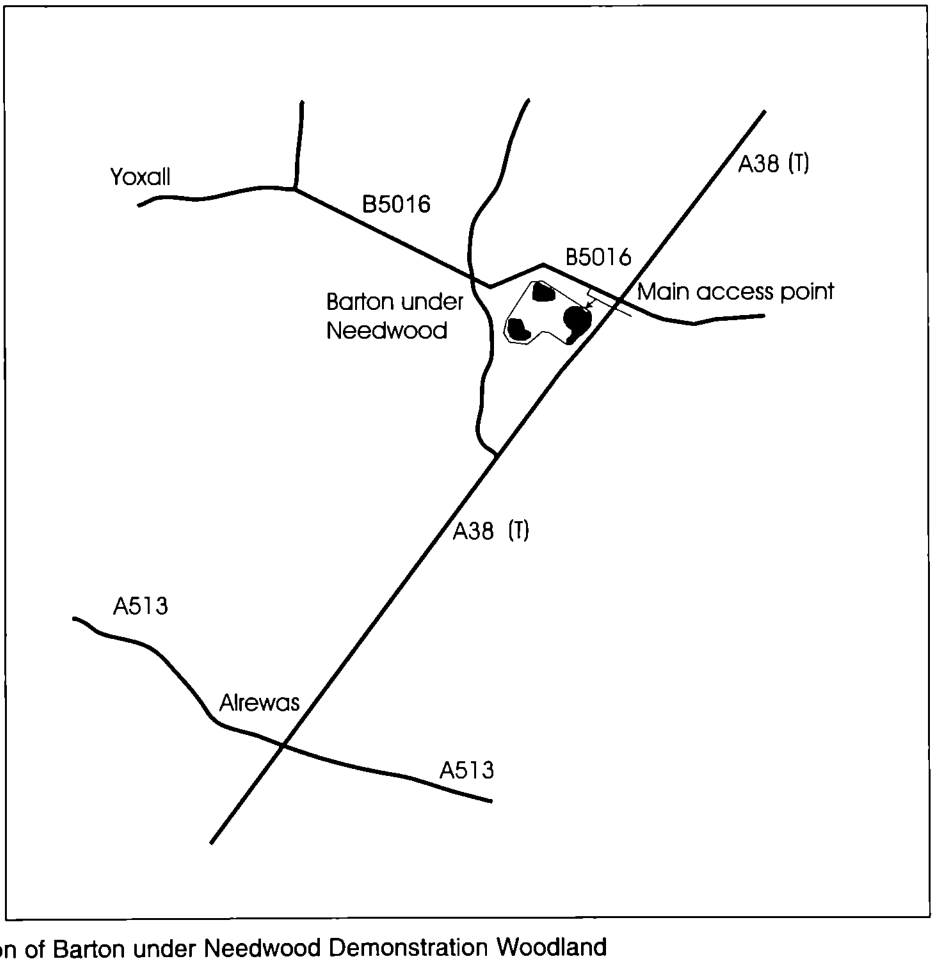


Figure 6.1 Location of Barton under Needwood Demonstration Woodland

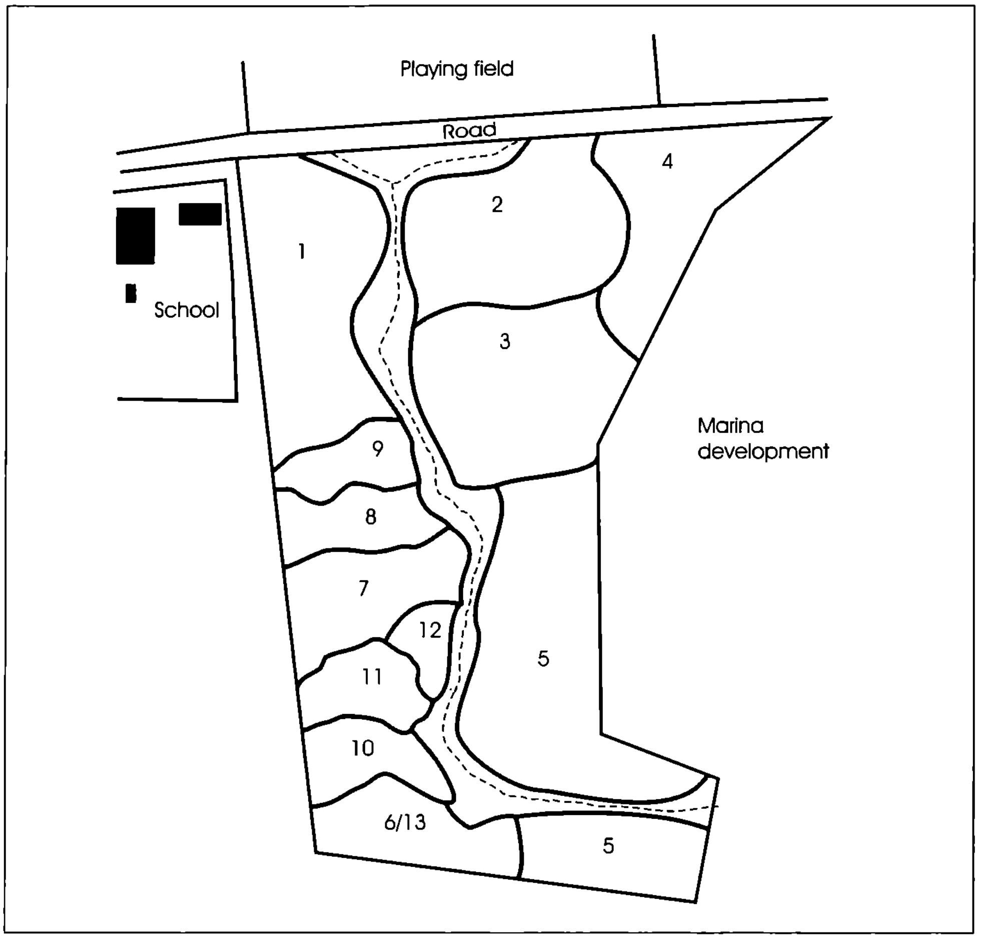


Figure 6.2 Plan of trees for profit area at Barton Demonstration Woodland. Numbers 1-13 refer to demonstrations described in the text

Growing trees for profit
This demonstration shows how to maximise financial return from environmentally sound forestry by careful species choice and management. The area was planted in Spring 1994 and comprises four methods of achieving this with poplars, which are fast growing broadleaved trees, and nine methods using pure and mixed broadleaved and conifer species.

Figure 6.2 shows the location of each element; the demonstrations numbered 1 to 4 all use the 'Beaupré' clone of poplar which is particularly fast growing.

1. Poplar: 25 cm cuttings planted at 3 m x 3 m spacing. This silvicultural regime allows for two future management regimes: (a) grow on a relatively short rotation (15 years) and harvest small diameter roundwood, or (b) thin trees at age 15 to 8 m x 8 m spacing for production of valuable large size timber.

2. Poplar: 2 m sets planted at 8 m x 8 m spacing (sets are complete young shoots from a coppice stool). The main objective of this regime is to grow valuable large size timber on short rotations (30–40 years) by concentrating volume increment on a small number of trees; thinning will not be required.

3. Poplar: 2 m sets planted at 8 m x 8 m spacing interplanted with common alder (*Alnus glutinosa*) at 3 m x 3 m spacing. This is similar to demonstration 2, but the incorporation of alder, which will form an understorey, will lead to a more diverse and sheltered woodland. This is likely to have environmental benefits and may increase the holding capacity for game birds.

4. Poplar: 25 cm cuttings planted at 1 m x 1 m spacing as short rotation coppice. The main objective of this regime is to maximise biomass production; harvesting would be on a short rotation (2–4 years) and the wood would be chipped for wood fuel.

Demonstrations 5 to 9 include areas of pure species planted with the objective of growing quality timber on short rotations while meeting the environmental conditions of grant-aid. Initial plant spacing is generally 2 m x 2 m over the whole of the site. The length of the rotation, which is dependent on species and the number of thinnings, will be in the range of 40 to 60 years.

5. Corsican pine (*Pinus nigra* var. *maritima*), likely rotation 55 years. A small area exists where 3 m x 3 m initial plant spacing has been used to allow comparison of the effects on tree form and possible timber quality.

6. Norway spruce (*Picea abies*), likely rotation 60 years.

7. Ash (*Fraxinus excelsior*), likely rotation 50 years.

8. Sycamore (*Acer pseudoplatanus*), likely rotation 45 years.

9. Wild cherry (*Prunus avium*), likely rotation 45 years.

Demonstrations 10 to13 show how ash and Norway spruce can be planted in mixture with the objective of growing a final crop of quality ash. The incorporation of a conifer nurse may aid the establishment of the ash and have other biodiversity benefits, but the main advantage is that the conifer will be removed as thinnings providing early financial returns.

10. A line mixture of 50% ash and 50% Norway spruce which is simple to manage but produces unattractive stripes; this is only a problem if the woodland is very visible.

11. A mixture of groups of 9 ash trees in a matrix of Norway spruce; a useful pattern to use in areas prominent in the landscape but more difficult to manage than a line mixture.

12. An intimate mixture of 50% Norway spruce and 50% ash which is very difficult to manage and most of the Norway spruce will need to be removed to prevent restriction of the growth of the ash before it has reached a marketable size.

13. An admixture of 93% Norway spruce, 5% ash and 2% walnut in which, unlike mixtures 10, 11 and 12, the objective is to grow a final crop mainly of Norway spruce. The broadleaved element is included to increase the amenity and conservation value of the stand with the possibility, especially with the walnut, that very high value timber will be an added bonus.

Direct sowing of tree seed

This area is a research experiment (incorporating many small treatment plots) which has investigated the direct sowing of seed of oak and Scots pine. As discussed in Chapter 2, direct seeding has three main problems : (a) unpredictable seed germination, (b) predation of seed by mammals, birds and mice, and (c) the control of competing vegetation. It is an option for woodland creation but is only recommended if you have access to specialist advice.

Game covert

Woodlands on farms can take many forms but those which can provide cover for game birds have a long history and can provide a valuable source of leisure and income. Guidelines for the establishment of game coverts can be found in Forestry Commission Bulletin 106: *Woodland management for pheasants*. This area demonstrates how to design a woodland which will provide a suitable habitat for game birds, the main requirement of which is shelter.

The covert was planted in spring 1995 and consists of three main areas: a *main crop area* planted at 3 m x 3 m spacing using oak, ash, larch, elder, privet, dogwood, hawthorn and hazel, surrounded by an *edge* of cherry, field maple, aspen, hazel, privet and dogwood planted at 2 m x 2 m spacing and a *hedge* of hawthorn, dogwood, privet, guelder rose, hazel and field maple planted at 0.5 m x 0.5 m.

Treeshelters were used to protect the main crop and edge species, and small treeguards known as quills were used to protect the hedge plants outside the fence.

Native tree species trial

In this area the survival and growth of 15 native trees and shrubs are being compared. The experiment has also been established at the two other Demonstration Woodlands, on low grade pasture at Church Gresley and on newly reclaimed colliery spoil at Desford Lakes.

The experiment is comparing the following species (one plot corner has been marked with a fence post to aid identification):

field maple	*Acer campestre*
common alder	*Alnus glutinosa*
silver birch	*Betula pendula*
dogwood	*Cornus sanguinea*
hazel	*Corylus avellana*
hawthorn	*Crataegus monogyna*
spindle	*Euonymous europaeus*
ash	*Fraxinus excelsior*
crab apple	*Malus sylvestris*
aspen	*Populus tremula*
wild cherry	*Prunus avium*
English oak	*Quercus robur*
buckthorn	*Rhamnus cathartica*
goat willow	*Salix caprea*
small leaved lime	*Tilia cordata*

Two non-native species were included for comparison:

silver maple *Acer saccharinum*
grey alder *Alnus incana*

Trees that died after planting have been replaced by *Acer campestre* to maintain full stocking and even competition throughout the sites while ensuring further assessments of the species under investigation are still valid.

Creating new native woodland
Establishing new plantations using traditional forestry practice can often lead to the formation of rather uninteresting woods with low species diversity which may show little resemblance to the classes of woodland described in the National Vegetation Classification (NVC). At present there is considerable interest in the establishment of new native woodlands in which species choice is determined by matching the soil and climatic factors of the site with similar areas of semi-natural woodland. This subject is described in detail in Forestry Commission Bulletin 112: *Creating new native woodlands*. However, much of the advice in this Bulletin is based on theoretical considerations and experimentation has largely concerned development of the ground flora. At present there is no evidence to show that the complex planting patterns suggested will produce more natural woods than well-planned and managed plantations using traditional designs with the same proportion of species. Several innovative designs are suggested in the Bulletin and this area compares the development of oak woodlands (approximating to NVC W10) established using variable spacing between trees and traditional uniform spacing but with a more imaginative use and distribution of species.

The soil in the canal field was suitable for establishing an oak woodland which approximated to NVC type W10 with the following species being planted in the percentages given: English oak (42%); silver birch (31%); hawthorn and hazel (5% each); hornbeam, gorse, rowan and holly (3% each); ash (2%); aspen, field maple and elder (1% each). The site was divided into two areas (Plate 11). One of these was planted with trees at uniform 2 m x 2 m spacing with variation being introduced by planting irregularly shaped groups of trees and shrubs located at random across the site when planting took place. In the second area trees were planted using single species plots, 5 m x 5 m square, that were located on a detailed planting plan. Spatial variation has been achieved by planting individual plots with trees at 1.25, 2.5 and 5 m spacing, giving 25, 9 or 4 trees in each plot.

Church Gresley

Location
The site is located 1 km to the south of Church Gresley with vehicle access from a minor road at NGR SK298174. The main access to the woodland is via a car park off this minor road (Figure 6.3, Plate 16). The woodland is bordered to the east by the B586, to the north by the A514 and to the west by the A444. The land immediately adjacent to the woodland in the south-west is raised ground under which there is a railway tunnel; to the north-west is an agricultural access track; and to the east is farmland.

Site description
Before establishment of the demonstration woodland the land was poor quality pasture. The eastern area ((a) in Plate 15) was disturbed ground having previously been subject to working for china clay while the western area ((b) in Plate 15) has a long history of agricultural usage. The site is gently sloping (<5°) with a south-east aspect and lies at 110 m above sea level. It is sheltered from the south-west by a woodland but is exposed on all other sides. The soil in area (a) is a heavy amorphous clay of pH 5.6 while in (b) it is generally a compacted brown earth with an average pH of 5.4. The underlying geology is Carboniferous shale with coal measures and beds of sandstone.

Demonstrations
There are six demonstrations (see Plate 15):

- Creation of oak high forest using nurse crops
- Ground preparation in small areas
- Native tree species trial
- Creating new native woodland
- Natural colonisation
- Spacing trials: the effect of tree spacing on tree form

Creation of oak high forest using nurse crops
The benefit of coniferous nurse species in the establishment of coniferous plantations in upland areas has been well demonstrated but the value of such nurses for the establishment of broadleaves, on lowland sites, is less clear. Experimental observations have shown that larch and pine can enhance early growth of some broadleaved species but previous experiments on lowland sites were of unsatisfactory design, allowing no sound conclusions to be made. Despite the lack of convincing positive growth or form benefits to the broadleaved element of a conifer:broadleaved mixture, they have often been used in the lowlands, mainly because the removal of the conifer provides early financial returns.

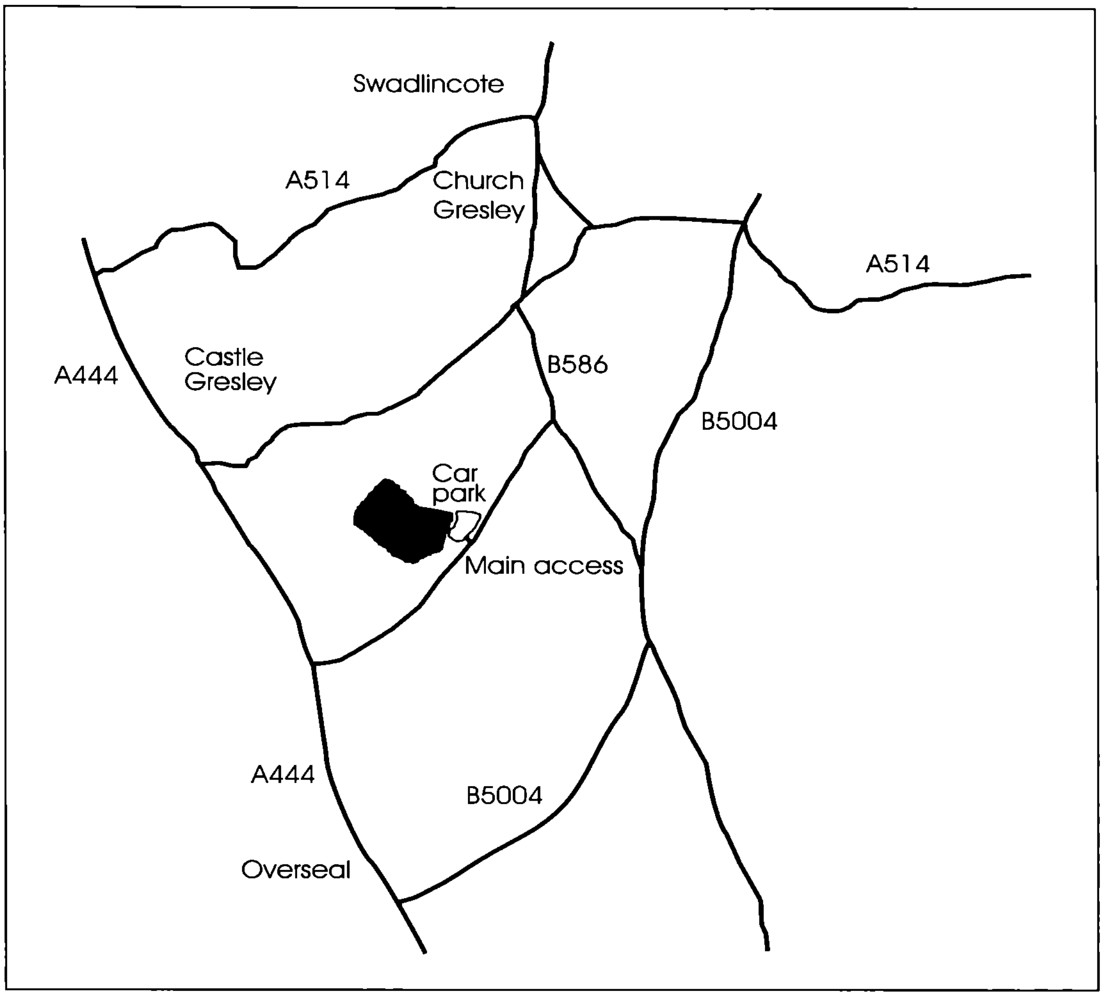


Figure 6.3 Location of Church Gresley Demonstration Woodland

It has also been suggested that nitrogen-fixing species, such as alder, may provide nutritional benefit to the nursed species.

These mixtures are usually planted as line mixtures with several rows of conifers alternating with rows of broadleaves, or in blocks with 16 or 25 trees of pure conifer or broadleaf mixed within a plantation. The line mixtures require careful management in order to ensure survival of a broadleaved crop whereas the block designs are more robust and can withstand more neglect. There are three experiments at Church Gresley, two of a block design which will quantify the nurse effect of either Corsican pine or Italian alder on the growth of oak, and the third of an intimate mixture of oak and green alder, which is a small, shrubby nitrogen-fixing tree which should self thin as the oaks grow.

Ground preparation in small areas

The importance of site conditions for successful tree establishment and growth is well established. Much research has focused on improving the effectiveness of site preparation on large areas of degraded land, especially minespoils. However, community and urban forest initiatives are highlighting the need to develop and test equipment for preparation of small areas with restricted access. Machinery must be manoeuvrable and yet rugged enough to cope with difficult compact sites. This experiment is evaluating the financial and biological aspects of six methods of ground preparation for restricted areas of derelict land.

A replicated experiment was set up to compare the performance of ash (*Fraxinus excelsior*) planted on sites prepared using six different cultivation techniques and an uncultivated control. The performance will be measured against the relative costs of the treatments and the effects on soil physical properties will be evaluated.

Native tree species trial

This demonstration is a replicate of one at Barton under Needwood and a description of it can be found on page 21.

Creating new native woodland

This concept is described on page 22 for a similar area at Barton under Needwood.

The soils at Church Gresley suggested that a woodland approximating to NVC W10, English oak–bracken–bramble, was the appropriate type.

The species mix planted comprised English oak (42%), silver birch (31%), hawthorn and hazel (5%), horn-beam, gorse, rowan and holly (3% each), ash (2%) and 1% each of aspen, field maple and elder. The planting was at 2 m x 2 m spacing with groups of each species located randomly when planting took place in 1994.

Natural colonisation

Alternative methods of establishing trees on former agricultural land are direct seeding and natural colonisation. The latter has received little attention by researchers mainly because natural colonisation has been perceived as unacceptably slow. However, there is now more interest in natural colonisation as a method of regenerating and extending semi-natural woodlands. This has stimulated a requirement for greater understanding of the factors involved in natural colonisation such as whether the rate or form of colonisation can be manipulated by low intensity ground preparation techniques, for example scarification, use of herbicides or ploughing. The objective of this experiment is to investigate natural colonisation of former agricultural grassland following the application of different ground preparation treatments.

The effect of tree spacing on tree form

In this area oak and ash trees have been planted so the effects of spacing on growth and timber quality can be assessed.

Desford Lakes

Site location

The site is located 3 km to the north-west of Desford and 1 km to the south-east of Bagworth. Vehicle access is from a minor road at NGR SK457068, the main access to the woodland being on the northern side of Desford Lakes some 150 m from the road (Figure 6.4). The site lies within the coalfield area of the National Forest which has been heavily mined in the past.

Site description

The demonstration woodland has been established on 13 hectares of restored spoil at the old Desford colliery; this forms part of a larger area which has been planted to form a new Forest Park. Although a large proportion of the 13 hectares was colliery spoil, other areas planted were a neglected field and land used as soil stores during the mining operation. The site on which the demonstration woodland has been planted is dome shaped with some steep slopes of between 10° and 15°. The top of the dome is about 170 m above sea level. The site is exposed on all sides with the prevailing winds from the south-west.

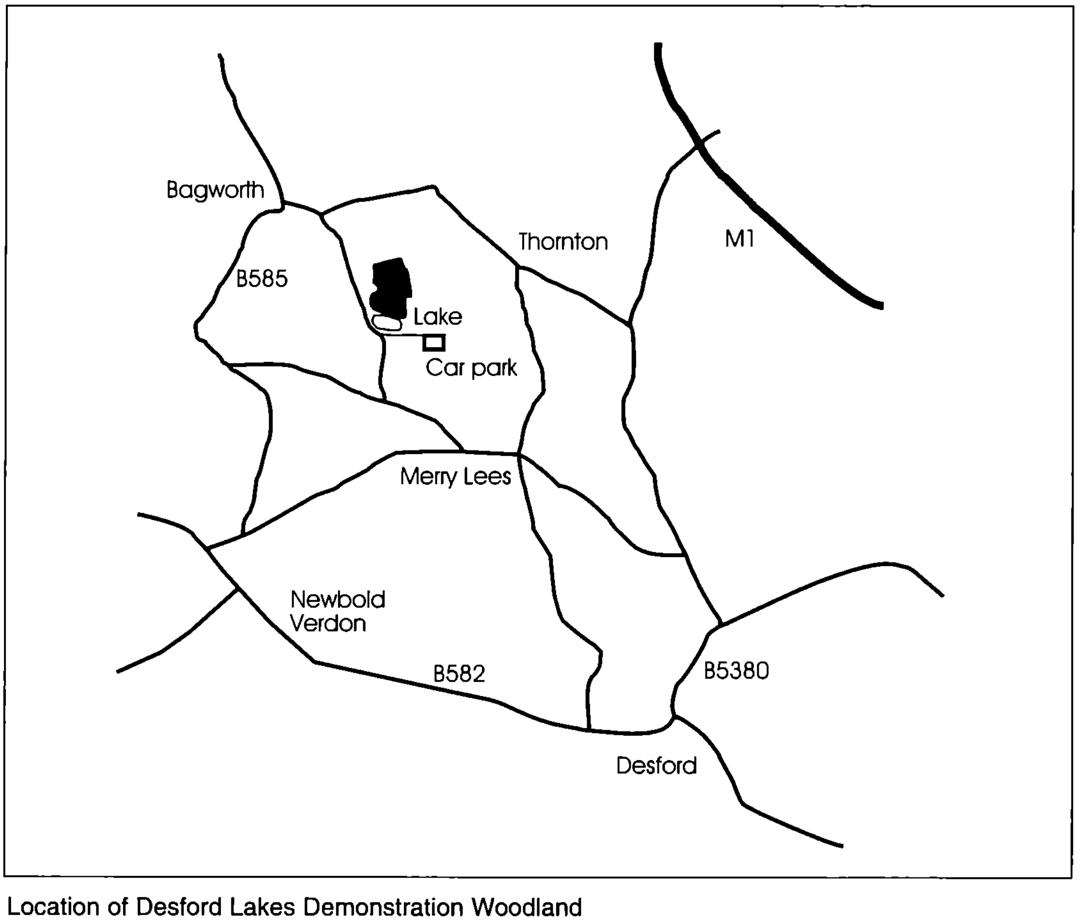


Figure 6.4 Location of Desford Lakes Demonstration Woodland

Establishment operations

When planning woodland creation on colliery spoil, or other disturbed sites, it is important to gather as much information as possible from the previous owner and by detailed site analysis. The following information relevant to woodland establishment at Desford lakes was drawn together:

1. Most of the colliery spoil was coal-washed (a process which recovers coal from the spoil to increase recovery rates) which resulted in a residue of compacted amorphous spoil (Plate 19).

2. The area was then covered by between 15 and 40 cm of top soil (pH 6.6) on which was sown a grass mixture of 40% strong creeping red fescue, 30% chewings fescue, 25% hard fescue and 5% brown top bent; this was combined with a small quantity of common wild flower seed such as oxe-eye daisy, sorrel and white campion.

3. The area was fertilised with 600 kg ha^{-1} of both NPK (nitrogen, phosphorus and potassium) and triple super phosphate.

4. The pH of the colliery spoil varied widely between 4.6 and 7.2, but more significantly a high level of iron pyrites was detected. If left unchecked, hydrolysis of the iron pyrites will release H^+ ions which will increase the acidity of the site.

A package of establishment operations was designed to take proper account of these factors, the main elements of which were:

- Contour ripping to alleviate compaction (Plate 20), mix topsoil and colliery spoil, and improve soil stability on slopes.

- Addition of coarse limestone at 12 tonnes per hectare to ensure controlled buffering of acidity.

- Effective weed control of grass and any invading arable weeds.

- Protecting the trees from browsing mammals.

Demonstrations

There are six demonstration areas (see Plate 18):

- Energy forestry
- Non-native species trial
- Native tree species trial
- Creating new native woodland
- Direct sowing of tree seed
- Woodland creation on reclaimed land

Energy forestry

In this experiment the yields of two clones of poplar 'Boelare' (*trichocarpa* x *deltoides*) and 'Gibecq' (*deltoides* x *nigra*) are being compared in five systems: (a) three short rotation coppice regimes, (b) coppice with standards, and (c) single stem energy forestry.

Non-native species trial

The Desford Lakes site is marginal for woodland establishment but is similar to many former mineral worked areas available for planting in the National Forest. Often there is a presumption that these areas should be planted with native tree species but this is not always possible or desirable. The species under investigation in this experiment can tolerate dry sites, acid sites, compacted sites or a combination of these unfavourable conditions.

The experiment was established in spring 1994 with the following species:

silver maple	*Acer saccharinum*
Tree of Heaven	*Ailanthus altissima*
Italian alder	*Alnus cordata*
grey alder	*Alnus incana*
western catalpa	*Catalpa speciosa*
Turkish hazel	*Corylus colurna*
Leyland cypress	x *Cupressocyparis leylandii* 'Leighton Green'
red ash	*Fraxinus pennsylvanica*
maidenhair tree	*Ginkgo biloba*
Scotch laburnum	*Laburnum alpinum*
Corsican pine	*Pinus nigra* var. *maritima*
London plane	*Platanus* x *acerifolia*
white poplar	*Populus alba* 'Racket'
red oak	*Quercus rubra*
Turner's oak	*Quercus* x *turneri*
false acacia	*Robinia pseudoacacia*

One native species (*Quercus robur*) was included for comparison. Trees that died after planting have been replaced by field maple (*Acer campestre*) to maintain full stocking and even competition throughout the site while ensuring that further assessments of the species under investigation are still valid.

Native tree species trial

In this area the survival and growth of 15 native trees and shrubs are being compared. The experiment has also been established at the two other Demonstration Woodlands, on low grade pasture at Church Gresley and on good quality agricultural land at Barton under Needwood. Of particular interest will be the survival and growth of native tree species on degraded sites, such as the colliery spoil at Desford Lakes.

The harsh conditions at such sites are often well suited to non-native species and two such species, silver maple and grey alder, have been included for comparison in all three trials.

Creating new native woodland

This concept was introduced earlier in the chapter on page 22. Two types of woodland were planted, one approximating to NVC type W8 (ash–field maple–dog's mercury) and one to W10 (English oak–bracken–bramble). The two woodland types were established next to each other but on soils with very different characteristics. The oakwood was planted on reclaimed land with poor soil and poor ground flora. In contrast, the ash-field maple wood was planted on old agricultural land which had been abandoned for many years and supported a lush herbaceous flora of rank grasses and weeds with a dense thatch of dead material covering the surface of the soil.

The mixture of species for the ash–field maple wood comprised 44% ash, 30% English oak, 10% field maple and 2% each of aspen, alder, goat willow, hazel, hawthorn, elder, sloe and privet. The oakwood was a simpler mixture consisting of 40% English oak, 30% silver birch, 10% mountain ash and 5% each of holly, gorse, hazel and hawthorn. The ash-field maple wood was planted in 1994 and the oakwood in 1995. Each site was divided into two areas. One of these was planted with trees at uniform 2 m x 2 m spacing with variation being introduced by planting irregularly shaped groups of trees and shrubs located at random across the site. In the second area trees were planted using single species plots 5 m x 5 m square that were located on a detailed planting plan; spatial variation was achieved by planting individual plots with trees at 1.25 m, 2.5 m and 5 m spacing, giving 25, 9 or 4 trees in each plot.

Direct sowing of tree seed

This is the same as the experiment described on page 21 for Barton under Needwood on a very different site.

Woodland creation on reclaimed land

Whatever the objectives for new woodland on degraded sites, a woodland environment must be created in order to achieve those objectives. This demonstration area shows how robust woodlands can be created by careful species choice and silviculture. By appropriate design, robust woodlands can achieve multi-purpose recreation, landscape, wildlife and wood production functions. This 3.9 ha area consists of four woodland types:

- Predominantly oak–birch on the north facing slopes where drought stress is likely to be less than in other areas. Close spacing, careful weed control, fertiliser application and an element of green alder will increase the robustness of this type.

- Predominantly grey alder-silver maple on the most drought-prone parts of the site. The character of the W10-W16 woodland type will be reflected in the presence of 5% silver birch, 5% rowan and 2% crab apple.

- Predominantly Corsican pine planting which will frame the creation of an amphitheatre-like open area below the planting. The 0.7 ha area was planted with 70% Corsican pine, 15% green alder as a tolerant shrub species and 5% each of silver birch, rowan and gorse to reflect the character of the W10-W16 woodland type.

- White poplar was planted pure on 0.5 ha of the north facing slope to balance the presence of the short rotation coppice area at the other end of the site and to create a visual contrast with the other woodland types. White poplar is a tough fast-growing species, but its striking appearance makes it inappropriate as a scattered element of a mixture, as it can look 'moth-eaten' from outside viewpoints. The species was established using rooted cuttings.

Chapter 7

Conclusions: woodland creation checklist

First steps

- ▲ List your objectives and decide which are most important
- ▲ Decide if you require the services of a woodland consultant
- ▲ Make early contact with the National Forest Company and the Forestry Commission to find out details of grant-aid

Site assessment

- ▲ Observe existing trees in nearby woodlands and hedgerows as a guide to species choice
- ▲ Dig holes to investigate the soil for potential problems such as depth and quality, compaction or waterlogging
- ▲ Note the previous use of the land

Tree establishment

- ▲ Use appropriate ground preparation to rectify any identified soil problems
- ▲ Most conifers and broadleaves should be planted at a density of 2500 trees per hectare
- ▲ Protecting trees from mammals is essential
- ▲ Time spent ensuring the suitability and quality of planting stock is well invested
- ▲ Bare-rooted or cell-grown stock should be notch planted in the dormant season
- ▲ Few ex-agricultural sites in the National Forest will need fertiliser application
- ▲ Weed control is essential

Weed control

- ▲ Weed control is **the key** to successful tree establishment on ex-agricultural land
- ▲ In most cases the most appropriate method of controlling weeds is by safe, judicious use of herbicides

Visit the Demonstration Woodlands

Barton under Needwood	Church Gresley	Desford Lakes
– Growing trees for profit – Direct sowing of tree seed – Game covert – Native tree species trial – Creating new native woodland	– Creation of oak high forest using nurse crops – Ground preparation in small areas – Native tree species trial – Creating new native woodland – Natural colonisation – The effect of tree spacing on tree form	– Energy forestry – Non-native species trial – Native tree species trial – Creating new native woodland – Direct sowing of tree seed – Woodland creation on reclaimed land

Supporting information

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Supporting information

Useful contact addesses

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The National Forest is set to transform large areas of landscape in Leicestershire, Derbyshire and Staffordshire with a blend of wooded areas, open country, farmland and settlements. The aim is to create a very special multi-purpose Forest for the nation in the 21st century and beyond.

This Technical Paper is a practical guide to creating new woodlands in the National Forest. It brings together general principles, latest research findings and, importantly, experience of establishing three large Demonstration Woodlands within the Forest area. They have much to offer everyone involved with woodland creation, from novices to professional foresters, and a visit to at least one of them will help to bring to life the points made in this guide.

Cover Designed and Produced by Colourgraphic Arts, Bordon, Hampshire.