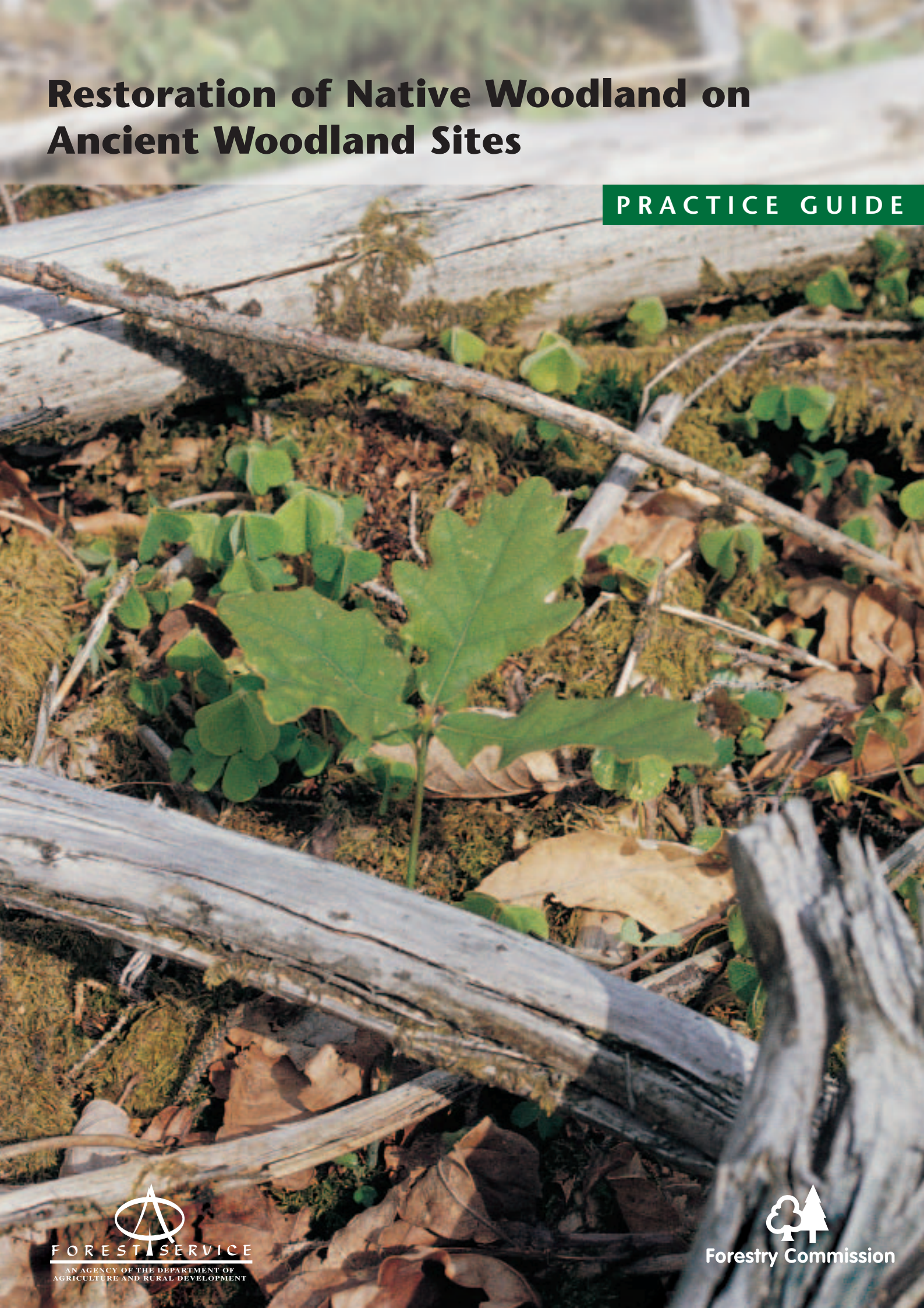
Restoration of Native Woodland on Ancient Woodland Sites

PRACTICE GUIDE



FOREST SERVICE
AN AGENCY OF THE DEPARTMENT OF AGRICULTURE AND RURAL DEVELOPMENT

Forestry Commission

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Practice Guide

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Contents

The structure of this Guide

A Site Assessment Guide is included with this publication. It is designed to assist the user in gathering the information needed to assess restoration potential and to identify appropriate restoration methods.

1. What is restoration?

Introduction

Ancient woodlands collectively form a highly prized and finite resource. However, the twentieth century saw major losses and changes to an already scarce and fragmented ancient woodland resource. Between the 1930s and the early 1980s nearly 40% of ancient semi-natural woodlands were converted into plantations, most of which were of non-native coniferous species. Other woodlands have been colonised by invasive non-native species such as rhododendron and sycamore.

The contribution that ancient semi-natural woodland (ASNW) makes to our natural and cultural heritage has been increasingly recognised. Interest in its conservation and restoration began in the early 1980s. Policies, best practice and programmes were developed through the 1980s and 1990s with *The policy for broadleaved woodland* in 1985[1], publication of the Practice Guides on *The management of semi-natural woodlands 1–8* (1994)[2] and *The UK Forestry Standard*[3] (1998). The *UK Biodiversity Action Plan* (UKBAP)[4] has further enhanced native woodland activity, through the native woodland Habitat Action Plans. These plans set targets for improving the condition of native woods, expanding their area, as well as for the restoration of planted ancient woodland sites to native woodland. The *UK Biodiversity Action Plan* includes targets to restore substantial areas of these Plantations on Ancient Woodland Sites (PAWS) back to native woodland by 2020. In addition, the *UK Woodland Assurance Standard*[5], a certification standard for woodland management, promotes restoration on a proportion of planted ancient woodland sites. It is important to identify and convert those woodlands which will deliver the greatest biodiversity benefits while taking into account the costs and feasibility of restoration.

Substantial programmes of restoration are now underway, with most activity so far being concentrated in former native pinewoods, upland oakwoods and lowland mixed broadleaved woods. Financial support such as European 'LIFE Nature' funding has contributed significantly to existing achievements.

The principles of restoration

Restoration involves re-establishing a functioning native woodland ecosystem by:

- Securing features from the former ancient semi-natural woodland.
- Removing introduced species of trees, shrubs, and other plants.
- Encouraging the re-establishment of native species.
- Initiating or enhancing ecological processes which may be absent or damaged (such as appropriate grazing regimes).

In most circumstances the aim of restoration will be to create the conditions needed to promote the development of native woodland over the longer term. Complete reinstatement of past conditions is not a realistic target. Usually, those conditions are not known and permanent changes will often have taken place, such as the introduction of the grey squirrel to the UK or changing climatic conditions.

Restoration is a long-term process. It is not simply a matter of removing non-native trees and shrubs. The initial aim should be to secure and enhance ancient woodland features. Successful native woodland development depends on there being sufficient sources of colonising flora and fauna. Success is also influenced by the method of restoration and the care taken in carrying out operations.

The scope of this Guide

The purpose of this Guide is to give advice to owners and managers on the restoration of those ancient woodland sites which were planted predominantly with non-native species since the 1930s. These 'non-native PAWS' form around 60% of the total PAWS resource which is 220 000 hectares. Ancient woodland sites are those included in the inventories of ancient woodland which were based on the oldest

Early stages of restoration. Ross Wood near Loch Lomond, Scotland.

reliable national information. In England and Wales this goes back to 1600; in Scotland to 1750. Northern Ireland does not currently have an ancient woodland inventory but work started in 2002. A provisional date of 1830 has been set (based on the earliest reliable national records: the first Ordnance Survey of Ireland). The Forestry Commission, Forest Service and conservation agencies can provide information on these various classifications.

Native species are defined here as those which are native to the locality and site, so that stands of species planted outside their native range (such as beech north of the English Midlands or Scots pine south of the Scottish Highlands) are classed as 'non-native' and could be considered for restoration work. Many of the principles in this Guide can also apply to ancient woodland sites which have been colonised naturally on a large scale by non-native species, such as sycamore and introduced conifers.

The emphasis of the Guide is on the potential contribution of restoration to biodiversity and the practical considerations for successful development of native woodland. The guidance aims to ensure that individual woods are considered within a landscape and regional context.

An assessment framework is included which enables owners/managers to rate the restoration potential of a site and rank the relative priority of a number of sites.

Methods are proposed for identifying where the greatest ecological gains can be achieved and where there may also be significant economic, visual and cultural opportunities. Approaches to management planning, harvesting and regeneration are provided, together with methods for setting targets and monitoring success. Complete restoration to site-native species may not always be possible or appropriate, therefore intermediate options are also discussed.

Many ASNWs do not reach their full ecological potential for reasons other than the effects of non-native tree and shrub species, for example, overgrazing or the cessation of traditional coppicing. While these may affect the choice of site and methods used for restoration, they are addressed primarily through advice provided in other Forestry Commission Practice Guides[2].

This Guide aims to give advice on good practice. Policies, programmes and mechanisms for restoration are developed at country level and readers should refer to Forestry Commission National Offices in England, Scotland and Wales, and Forest Service Headquarters in Northern Ireland for guidance (See Appendix 6).

2. Why should we consider restoration?

The value of ancient semi-natural woodland

Ancient semi-natural woodland (ASNW) contributes substantially to our natural and cultural heritage. Most of the UK was originally covered in woodland. Large scale conversion to other land-uses (e.g. agriculture and settlements) began in Neolithic times and has continued throughout history. Now only 1–2% of Britain's land area is occupied by ASNW. The special value of these woodlands is outlined in the Forestry Commission Practice Guides 1–8[2] and summarised in Box 2.1.

Clearance of ASNW for agriculture and development usually removed all evidence of previous woodland. However, many planted ancient woodland sites, having retained features of ecological and cultural interest, present us with valuable opportunities for restoration. Safeguarding and enhancing these sites will enrich our natural and cultural heritage, securing important components of our scarce and finite ancient woodland resource.

Rich ground flora and diverse structure typical of lowland mixed broadleaved ancient semi-natural woodland. Southeast Wales.

Box 2.1 The value of ancient semi-natural woodland

- Some ancient semi-natural woodlands have a continuity of woodland cover which may stretch back to the original post-glacial forests. More remote examples which have been less intensively managed are the nearest equivalent that we have in the UK to natural woodland.
- In more accessible examples, particularly in the lowlands, a long history of consistent management (for example, coppice with standards or wood pasture) has encouraged the development of a rich and distinctive flora and fauna.
- The continued survival of many rare and threatened species depends on the stable ecological conditions created by continuity of woodland cover, and by the presence of native tree and shrub species.
- ASNW are reservoirs of native genetic diversity; some tree populations show local adaptations to site and have a distinctive genetic make-up (e.g. the native pinewoods).
- ASNW soil profiles have established gradually and are invaluable as benchmarks for comparative study of soil development and as indicators of environmental change.
- Many ASNWs are highly valued by communities as landmarks, places of historical and archaeological significance within cultural landscapes, and as an economic and recreational resource.
- More recently developed semi-natural woodland can share many of the values of ASNW. This is particularly the case in the uplands, where woodland boundaries often change over time and species can survive in a range of non-woodland habitats, allowing new stands to quickly acquire a wide range of associated flora.

The ecological effects of plantations on ancient woodland sites

Recent research has identified the value of non-native plantations (both conifer and broad-leaved) as habitats for a wide range of woodland flora and fauna[6]. However, where they have been established on ancient woodland sites the loss of biodiversity characteristic of ancient semi-natural woodlands can be severe, particularly for many species of invertebrates and lichens which depend on native trees.

The ecological impacts of a plantation on an ancient woodland site are strongly influenced by:

- Tree species planted.
- Previous woodland type.
- Techniques employed to establish the plantation, i.e. treatment of mature semi-natural trees and ground preparation methods.
- Tending operations, i.e. intensity of 'cleaning' to remove natural regeneration and coppice re-growth.
- Thinning regime.

Research in the English lowlands[7] assessed the impact of planted mixtures of broadleaves and conifers on ancient woodland ground flora. The following results were obtained:

This Sitka spruce plantation has had a significant impact on the former upland oakwood. Few remnant native trees survive and ground flora is restricted to rides and streamsides.

- Surface soil acidification, increased litter depth and increased levels of soil organic carbon were found under Norway spruce and beech–pine mixtures. These conditions were associated with reductions in abundance and species richness of vascular plants.
- Increased soil acidity was associated with increased species richness, cover and abundance of mosses.
- Thinned stands had a more extensive and more species-rich ground flora than unthinned stands with a high density of stems of shade-casting species, such as Norway spruce, that have a particularly detrimental effect on the cover of vascular plants. This effect was reduced by early thinning and the use of at least 50% oak in the crop.
- Thinned stands containing pine tended to support a rich ground flora. Exclusive use of species with light-transmitting canopies (e.g. oak and pine) invariably led to the dominance of bramble at the expense of other ground flora species.

Streamsides often retain robust patches of ancient woodland flora.

- Few ancient woodland indicator species were found in the seedbank. This has implications for their survival if lost from the above ground vegetation due to ground disturbance, reduced light transmission following canopy closure and build up of litter.

Plantations can also affect the movement of species within the wider landscape. For many of the more mobile species, a well-managed plantation can contribute to a woodland habitat network[8], providing suitable conditions for colonisation and migration into adjoining habitats. However, for more exacting species, particularly those with slow recolonisation rates such as ancient woodland indicators, plantations on ancient woodland sites can act as a barrier and vital links may be lost.

Native woodlands Habitat Action Plans

The *UK Biodiversity Action Plan* (UKBAP)[4a] sets out programmes to meet the UK's international commitment to safeguarding and enhancing biodiversity. A key part of the UKBAP is the set of native woodlands Habitat Action Plans[4b], which identify targets for the conservation, restoration and expansion of semi-natural woodlands.

Six Habitat Action Plans were published between 1995 and 1998 and two more are being prepared at the time of going to press (February 2003)[4b] to ensure that all types of native woodland will be covered. The combined total restoration target for completion by 2015 is likely to be between 25 000 and 30 000 hectares. The action plans and their targets are described in the Forestry Commission Information Note: *Habitat action plans for UK priority woodland types* (in prep.)[9].

Restoration targets are restricted to PAWS stands or woods where the initial composition is mainly (over 50% canopy cover) non-native species. If the initial plantation canopy is mainly composed of native species, removal of non-native trees and other restoration work would contribute to targets for improving the condition of native woodlands.

There will be more opportunities for restoration in some regions than in others due to the network of existing native woodlands and distribution of woodland types. Regional targets for Great Britain are being compiled which will be available from the Forestry Commission National Offices. In many areas, local woodland Habitat Action Plans are being compiled. These identify the aspirations of communities and wildlife trusts, etc. and may describe action needed to safeguard vulnerable features. The plans should be available from local authority biodiversity officers.

The UKBAP also includes Species Action Plans (SAPs) a number of which are for species found in native woodland habitats. In many cases, simply restoring native woodland will contribute to the expansion of habitat for such species but there may also be scope for particular species-targeted management.

Forest certification

The *UK Woodland Assurance Standard*[5] provides a certification standard for sustainable forest management. It identifies options for managing planted ancient woodland sites which range from the maintenance of biodiversity within an otherwise conventionally managed plantation to full restoration to site-native species (see Appendix 5). This Guide is intended to be complementary to, but independent of, any certification standard.

3. What are the qualities of potential sites?

Gathering information

The process of deciding whether restoration is worthwhile, or which sites are priorities, requires an assessment of the potential value of the restored site and the practicalities of achieving the desired results. Assessment criteria are presented in Section 4. The initial step however, is to collect some basic information.

Background information is required to find out how important sites are in a national, regional and local context, and also to get an overview of the site at the landscape scale to assess its position in relation to existing native woodland and other semi-natural habitats. Site surveys should be undertaken to assess the ecological potential of the stand and any practical opportunities or constraints. The lists below identify many sources of information. The amount of detail needed will vary. In some cases the benefits of restoration will be obvious. For others, more information may be required (for example, where it is difficult to rank similar sites) and specialists may be needed to undertake recording of rare flora and fauna.

Much of the background information will be available from the Forestry Commission or Forest Service or from the conservation agencies (English Nature, Scottish Natural Heritage, Countryside Council for Wales or Environment and Heritage Service). This includes:

- The Ancient Woodland Inventories – which show the location of ancient semi-natural woodlands and plantations on ancient woodland sites.
- Any nature conservation and landscape designations for the sites or for adjoining areas.
- The regional targets for UK Habitat and Species Action Plans (HAPs and SAPs) – to indicate which woodland types are priorities and which rare species are known to occur within a region.
- Details of initiatives and grants and the criteria to qualify for financial assistance.

Other sources of information which may be useful include:

- Local Biodiversity Action Plans – to identify the potential for linkage with other habitat restoration schemes and to highlight local priorities for species conservation (local authority biodiversity officers).
- Records of archaeological sites from county archaeological trusts, council archaeologists and heritage agencies (e.g. English Heritage, Historic Scotland, Environment and Heritage Service or Cadw).
- Aerial photographs – to assess connectivity to existing native woodland and other semi-natural habitats.
- Records of rare species from local naturalists, conservation trusts and the relevant conservation agency.
- Any existing felling and restock plans for adjoining woodland.
- Records of previous management.

Site survey

The basic survey information required includes:

- Richness and condition of ancient woodland features (e.g. veteran trees, coppice stools).
- The number, species, condition (including seed-bearing potential) and distribution of native trees and shrubs.
- Patch size, distribution and species composition of remnant ground flora.
- Size, species, stability and quality of plantation trees.
- Presence of advanced regeneration (native and non-native species).

- Presence of invasive species within the site and in the adjoining landscape.
- Operational access.
- A broad assessment of the structural and species diversity within adjoining native woodlands.
- An assessment of weed growth and the amount (and cause) of browsing pressure.
- Information on public access and recreation usage.
- Where the ancient status of the site is in question, specialists may be required to identify ancient woodland indicator species and historic features such as woodbanks. Similarly archaeological field survey may be required to identify features associated with earlier activity.

Identifying the potential native woodland type

Additional survey work will be required to identify the potential woodland type(s) appropriate to the restoration site. Although woodlands are inherently variable, they can be classified into general categories which depend to a large extent on the climate, soil type and moisture characteristics of the site. A wide range of native woodland types occur within the UK[2,10]. Some types are internationally scarce, and the UK holds a high percentage of the total resource (e.g. upland oakwoods).

Identification of the potential woodland type will help make decisions about:

- **The selection of sites in relation to regional targets** – identification of local and regional priority woodland types, uncommon stand types etc.
- **The choice of silvicultural regime** – smaller gap sizes reduce weed competition in moist fertile site types and maintain moist micro-climates for woodland types where epiphytes are characteristic.
- **The use of natural regeneration or planting** – the range of native species that could be present and chances of successful natural regeneration given available seed sources.
- **The suitability of the adjoining semi-natural woodland as a source of colonisation**, e.g. the limited value of birch–purple moor grass woodland as a source of colonisation for an adjacent plantation on a former native pinewood site.

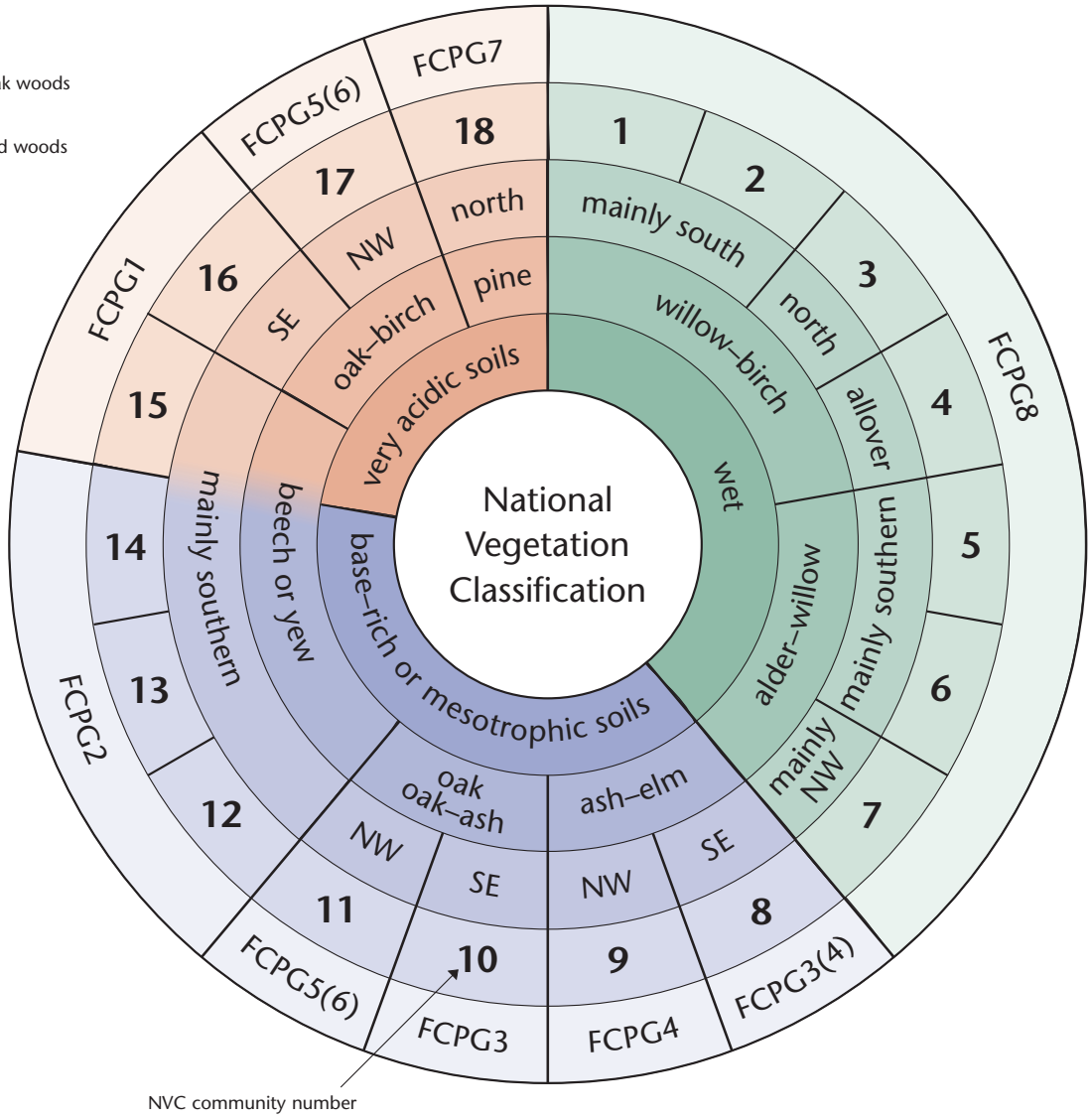
There are a number of different methods of woodland classification and at present National Vegetation Classification[10] (NVC) types are frequently used. These are more detailed than the broader Forestry Commission and Habitat Action Plan woodland types. Figure 3.1 gives an overview of the relationships between soil type, more general woodland classifications and the detailed NVC types in the different regions. The NVC is limited to Great Britain but most Northern Ireland vegetation communities can be related to NVC types. The potential native woodland type for the site may be identified by reference to some of the following:

- Flora and soils of the least disturbed parts of the existing stand.
- Vegetation on undisturbed rides and surrounding compartments.
- Records of the site's history, or local knowledge.
- The system of Ecological Site Classification (ESC)[11,12].
- The Native Woodland Model[13] (in Scotland only), used at a broader scale than ESC to give an indication of the potential woodland types at the regional level.

Mapping site types at 1:10 000 scale is useful in guiding species composition for replanting where this proves necessary. Forestry Commission Bulletin 112 *Creating new native woodlands*[14] provides lists of the main tree and shrub species suitable for each NVC type.

Figure 3.1 **National Vegetation Classification (NVC) communities and related Forestry Commission Practice Guides (FCPG1–8)** (adapted from Whitbread and Kirby[15])

FCPG1: Lowland acid beech and oak woods
FCPG2: Lowland beech–ash woods
FCPG3: Lowland mixed broadleaved woods
FCPG4: Upland mixed ashwoods
FCPG5: Upland oakwoods
FCPG6: Upland birchwoods
FCPG7: Native pinewoods
FCPG8: Wet woodlands



Characteristics of plantations on different woodland types

The climate and soils of a site determined the former native woodland type and often influenced the way in which plantations were established and managed. The following pages describe four contrasting examples of PAWS established on different former native woodland types, which present a range of typical opportunities and constraints. The emphasis is on differences between types rather than common problems (e.g. high browsing pressure from deer).

Plantations on native pinewood sites

National Vegetation Classification: W18 with pockets of W4, 11, 17 & 19

Large scale restoration of native pinewood. Glenmore, Scotland.

A capercaillie.

Opportunities

- Large scale: a strategic approach is possible.
- Often good sources of colonisation (e.g. some associated ground flora species also occur in adjacent heaths).
- Native pinewoods provide suitable habitat for SAP species in the following groups (numbers of species in brackets): vascular plants (2); fungi (1); lower plants (2); invertebrates (4); mammals (1); birds (4).
- A large proportion of planting took place in the 1960s and early 70s, so many plantations are still young, silvicultural manipulation is possible and features of interest remain.
- A range of disturbance and succession regimes (i.e. silvicultural systems) are appropriate.
- Weed competition is limited by the low fertility of the site.
- There is the potential to produce high quality joinery timber.

Constraints

- Remoteness for extraction.
- Fencing: woodland grouse fatalities.
- Mires damaged by intensive establishment regimes.

Management issues

- Fell to recycle (i.e. felling to waste): a cost effective option in young stands remote from forest roads.
- Deer control without fencing.
- Bog reinstatement.
- Larger coupes may be appropriate in some cases, mimicking natural stand dynamics in pinewoods which includes disturbance by wind and fire.

Plantations on upland oakwood sites

National Vegetation Classification: **W10e, 11 & 17** with pockets of W9 & 7

Clearance of inter-planted larch in an upland oakwood. Lochaber, Scotland.

Lungwort, an epiphyte of western oakwoods.

Opportunities

- Many sites were underplanted, so a significant proportion of oak canopies remain intact.
- Upland oakwoods provide suitable habitat for SAP species in the following groups (numbers of species in brackets): vascular plants (2); fungi (1); lower plants (8); invertebrates (9); birds (1).
- These sites have low to moderate fertility (therefore low weed competition).
- There are often good sources of colonisation, particularly in more northerly and westerly examples. (e.g. adjacent semi-natural vegetation containing species associated with upland oakwoods).
- Woodlands often contain deep gorges and rock outcrops which act as refugia for native species within plantations.
- Nature of the terrain means that less intensive establishment regimes were often employed.

Constraints

- Plantation species can be western hemlock: particularly invasive on acidic soils.
- Terrain is often steep and inaccessible.
- Rhododendron is often a problem.
- Bryophytes and lichens may be sensitive to desiccation if suddenly exposed.
- Oak is preferentially browsed and may not regenerate easily.

Management issues

- Chemical killing of small under-planted non-native trees.
- Rhododendron control.
- Birch regeneration may need to be enriched depending upon objectives.
- Maintenance of woodland condition for exposure-intolerant epiphytes.
- Maintenance of open habitats for SAP invertebrates.

Plantations on lowland mixed broadleaved sites (base–rich clays)

National Vegetation Classification: W8

Poorly established Douglas fir plantation with abundant young native trees.

Opportunities

- Plantation trees were often out-competed by coppice regrowth and natural regeneration of site-native species (e.g. ash). Therefore reasonable ground flora survives under native trees.
- This woodland type provides suitable habitat for SAP species in the following groups (numbers of species in brackets): lower plants (1); invertebrates (7); mammals (6); birds (1).
- Plantations of non-native conifers often grow poorly on these sites – in such cases, loss of future revenue is not a major consideration.
- Some sites regenerate well with native species if non-native trees are removed gradually and the woodland is protected from browsing.
- Potential to produce high quality timber from native species.

Constraints

- Competition from ground vegetation can be a serious issue if large canopy gaps are opened up over a short period. Ruderal species will compete with shade-tolerant woodland herbs and tree regeneration.
- Some woodlands are isolated with few external sources for colonisation of appropriate species.
- Ground flora typical of this woodland type may have depended on regular coppice cycles to maintain seed banks. Species surviving in refugia may be slow to spread.

Management issues

- Gradual conversion to native woodland is desirable, using silvicultural systems other than clearfell to control light levels and weed competition.
- Maintenance of woodland condition is important for species susceptible to disturbance and loss of woodland structure.
- Many beech plantations occur on this site type. These are often of low value for biodiversity and may produce poor timber crops. Conversion to site-native species may be more appropriate.

Wild garlic, a characteristic species found in this woodland type.

Plantations on lowland acid beech and oak sites

National Vegetation Classification: **W15 & 16**

Mature native trees and standing deadwood – remnants of a lowland acid oakwood within a pine plantation.

Opportunities

- Birch regenerates freely on these sites.
- There is low weed competition (with the possible exception of bracken).
- Often these PAWS are not isolated, occurring next to/within heathland and other woodland.
- This woodland type provides suitable habitat for SAP species in the following groups (numbers of species in brackets): lower plants (3); invertebrates (9); mammals (4); birds (2); fungi (1).

Constraints

- Plantations were frequently established successfully and, where plantation trees are shade casting, few niches for ground flora survive.

Lacon querceus, *a beetle dependant on the deadwood of veteran trees.*

Management issues

- Pollarding and gradual opening up of veteran trees in old pasture woodland.
- Clearance of larger coupes may be appropriate where shade-casting species dominate, favouring heath flora and fauna in the early stages of succession and encouraging the natural regeneration of light-demanding tree species such as oak and birch.

4. Whether and where to restore

Deciding whether to restore a site to native woodland will depend on a number of factors, not least of which will be the owner's objectives. For those with conservation objectives and adequate resources it may simply be a question of deciding where to start. Where a range of potential sites exist and resources are limited, a rigorous process of prioritisation will be needed to identify those which would deliver the greatest benefits to biodiversity.

This section provides a framework for selection and prioritisation (Figure 4.1). Firstly the ecological potential is assessed, then the various practical, economic and other factors are considered. Alternative options to full restoration are identified for lower priority sites.

Tables 4.1–4.4 summarise the ecological criteria and other factors indicating a qualitative range of values. Some of these may be complementary and some mutually exclusive. Using this approach an overall assessment of site potential can be made. Four worked examples are presented on pages 24–27.

Factors to consider

Ecological criteria

Plantations on ancient woodland sites can be prioritised for restoration on the basis of two related categories of ecological criteria:

- **Ecological importance**: the extent to which the restored site will contribute to biodiversity objectives.

- **Ecological development**: how successfully the native woodland habitat might be restored.

These should give an objective basis for identifying sites with high ecological potential.

Ecological importance

Designations (Table 4.1a)

Sites will have a high value if they are part of, or adjacent to, nationally and internationally important areas for native woodlands such as those designated as Special Areas of Conservation (SACs), Special Protection Areas (SPAs), National Nature Reserves (NNRs), Sites of Special Scientific Interest (SSSIs) or Areas of Special Scientific Interest (ASSIs) in Northern Ireland. A large proportion (85%) of semi-natural woodland is not designated in any way but may still have a high biodiversity value as highlighted by other criteria.

UKBAP habitat objectives (Table 4.1a)

The Forestry Commission and conservation agencies are preparing indicative figures for native woodland Habitat Action Plan restoration targets. The aim is to focus restoration efforts and to identify where opportunities exist for different native woodland types. Proposals will build on existing concepts and sources of information such as English Nature's preliminary nature conservation objectives for Natural Areas[16,17], Scottish Natural Heritage's Core Forest Areas[8], The Countryside Council for Wales' Regional Woodland Management Framework[18] and the Forestry Commission's Caledonian Pinewood Inventory[19].

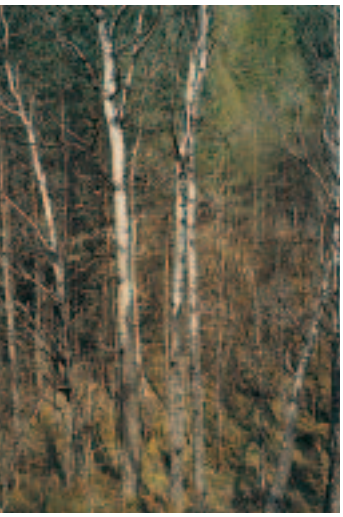
Forest habitat networks (Table 4.1a)

Restoring semi-natural woodland cover at the landscape scale is a priority for biodiversity. In some areas, particularly in Scotland, Forest Habitat Networks[8,20] are being developed. The creation of woodland habitat networks is considered to be beneficial to threatened species which depend on well-wooded landscapes and the presence of a variety of different habitats for their survival, e.g. the greater horseshoe bat. Sites will be of higher priority for restoration if they are part of a matrix of semi-natural woodland providing linkage between existing woods, other non-wooded semi-natural vegetation and planned new native woodland. Restoration will be particularly important where the plantation currently forms a barrier restricting the ecological functioning of a habitat network.

In some areas where patterns of land use have greatly reduced woodland cover, such as Northern Ireland, Norfolk and northeast Scotland, even isolated woodland fragments can have high conservation value relative to

their surroundings. Their restoration would contribute significantly to enhancing biological diversity. However, the fragmentation of habitat may limit the ability of organisms to disperse so these isolated woods may never attain their full potential for biodiversity.

Conserving populations of rare or threatened species (Table 4.1a)
There may be rare or threatened species on, or near the site which would benefit from restoration. Red Data Book[21] species or those which are covered by Species Action Plans are the priorities. Lists of forestry target species[22] are available from Forestry Commission National Offices. Examples might include the chequered skipper butterfly in upland oak–birch woods, or hedgehog fungus in lowland beechwoods. In exceptional circumstances, restoration may have a negative impact on species such as firecrests or red squirrel which make use of non-native conifer habitat. Similarly, recent research suggests that complete removal of non-native coniferous trees may be detrimental to dormice. Mature or veteran broadleaved trees of introduced species (such as sweet chestnut and sycamore), or of species which are native but planted outside their natural range (such as beech in northern England and Scotland), can have considerable value for wildlife.



Elspeth MacDonald

An example of a rare stand type: aspen within a planted ancient woodland site.

Sites with veteran trees such as this oak are likely to have high ecological restoration potential.

Rarity of the potential native woodland or stand type (Table 4.1a)
Some native woodland stand types are rarer than others and therefore have a higher conservation value. Lime stands in England and Wales, or stands of aspen in the Scottish Highlands are particular examples. These stand types are often associated with rare flora and fauna (e.g. *Hammerschmidtia ferruginea* – a hoverfly specific to aspen stands). Information on the local importance of particular stand types can be obtained from the conservation agencies. Guidance at the national and regional scale is available in Hall (1998)[23], which includes current best estimates of the extent and distribution of different NVC woodland types across Britain. A classification of stand types is also available in Peterken (1993)[24], and is related to the NVC in Hall and Kirby (1998)[25]. Nationally common native woodland types may be uncommon within a region due to climatic or geological factors (for example, extensive upland mixed ashwoods in west Mid Wales or upland oakwoods in southeast England). Restoration will help to maintain a representative distribution of woodland types across their former range.

Diversity of habitats (Table 4.1a)
There will be additional value from a restoration scheme if it includes a range of site and habitat types, such as areas of differing topography, a sequence of altitudinal zones, deadwood, streams, flushes, seepages, boggy pools, large boulders, shaded crags and cliffs. Patches of riparian woodland also greatly enhance biodiversity in adjacent freshwater habitats where leaf fall and deadwood can contribute to the provision of habitats for invertebrates and fish populations[26].

Size of site (Table 4.1a)
There is no minimum area for restoration as this will depend on the woodland type, and the habitat requirements of key species. Some woodland invertebrates are thought to require stands of at least 5 ha, whereas capercaillie need 100 ha or more of unfragmented old pinewood. In general terms, larger sites will be more robust and have greater potential for successful restoration.

Ecological development
These criteria suggest how successfully the basic building blocks of a woodland habitat – the tree canopy and ground flora – might be restored. The list is for guidance only. It is up to individual managers to decide which are of most relevance to their particular situation.

The remnant native trees and shrubs on site (Table 4.1b)
The higher the diversity of site-native tree and shrub species already on site the better. Sites with a high density of mature native trees (>20/ha), with large spreading crowns, provide for numerous species of forest animals, plants and fungi and may have retained remnants of epiphytic communities. The importance of deadwood for biodiversity is well known with larger diameter (>20 cm) fallen and standing deadwood being of higher value.

Most native woodlands were managed intensively in the past with useful species such as oak and hazel being favoured. This has resulted in a less diverse tree and shrub flora than might be expected under natural circumstances. Where locally uncommon trees and shrubs still occur more diverse native woodland development should be possible. A shortlist of scarce trees and shrubs to look out for in the different woodland types is given in Appendix 3.

Woodland ground flora (Table 4.1b)
Many planted ancient woodland sites still retain patches of ground flora, occasionally including species characteristic of ancient woodland such as herb paris or bluebell. Larger and more abundant patches of remnant vegetation provide a better starting point for successful restoration. The patches need to be robust enough (e.g. >0.5 m^2) to withstand damage from browsing or forestry operations. Where substantial gaps remain in the canopy more extensive patches may survive. In other sites, ancient woodland species may be restricted to forest rides and roadsides or around deciduous trees and other semi-shaded or open habitats (e.g. large boulders, cliffs). A gradual removal of canopy trees may be appropriate to retain the woodland conditions which favour these species.

Proximity to existing semi-natural woodland and other semi-natural habitats (Table 4.1b)
The closer the site is to sources of woodland species the easier it will be to encourage natural colonisation of the restored woodland. Migration rates of many specialist woodland species (such as the lichen lungwort), can be extremely slow. Restoration is more likely to be successful where the site is linked to a network of existing sources of species such as ancient semi-natural woodland, old hedgerows, riparian zones, rock outcrops or patches of moorland, grassland or wetland.

The type and condition of neighbouring woodland will also influence colonisation. If the wood is even-aged and structurally uniform with little deadwood or old trees, or of a significantly different type to that of the potential restored wood, then the prospects for successful restoration in the adjacent area will be lower. Conversely, restoration sites which are adjacent to high quality semi-natural woodland with structurally diverse stands, old trees and deadwood will have greater restoration potential. However, even in these circumstances a long-term view of colonisation will be needed.

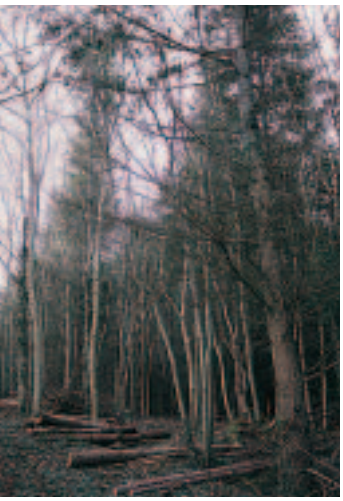
Within this landscape there is good connectivity between plantations, semi-natural woodlands and other semi-natural habitats. North York Moors, England.

Practical factors

Practical issues (Table 4.2) will need to be considered by anyone intending to restore a site, regardless of objectives. There will be sites where the ecological importance and development potential are high but where there are major practical constraints. Other sites may present opportunities for restoration, such as existing access, which will reduce the impact of operations and make restoration easier.

Operational access (Table 4.2)
Many sites with the best ecological potential for restoration have steep and inaccessible terrain or are within a matrix of other semi-natural habitats. These conditions make harvesting and extraction difficult. A list of possible solutions is given in section 5 (pages 30–40). If it is not possible to convert a plantation to native woodland without creating new access routes which would seriously damage ecological importance or development potential, the overall restoration potential of the site will be reduced.

Upland birchwoods, Loch Rannoch. The diversity of neighbouring semi-natural woodland will influence the range and abundance of colonising species. Richer sources are likely in the lower example.



This site contains abundant young native trees which can be developed through successive thinnings, allowing ancient woodland flora to persist.

Bramble is likely to dominate this site once browsing is controlled and canopy gaps are created.

Vegetation management (Table 4.2)
Management techniques are available to overcome most problems of vegetation competition and protection of regeneration. However, on moist fertile lowland sites, the response of vegetation to reduced browsing pressure and/or opening up the canopy, will be a practical concern. In such sites, the presence of young native trees within the canopy, or advanced regeneration under the canopy, will make restoration much easier.

Economic factors

The selection of sites will, in most cases, be obvious from the ecological assessment. But, where resources are limited and choices need to be made, economic considerations will play an important part in the decision making process. Both the value of the existing plantation and potential for future revenue should be considered.

The value of the existing plantation (Table 4.3)
It will not always be necessary to fell plantation trees before they reach maturity. Where features of ecological interest are at risk due to shading and root competition, targeted thinning or clearing around sensitive communities or species can maintain the ecological potential through the remainder of the rotation. However, where a site with high ecological potential for restoration is threatened by recently planted non-native trees, felling should ideally take place before canopy closure.

Litter input from native trees provides a food source for freshwater invertebrates, greatly improving habitat quality for fish. River Tweed, Scotland.

Thinning in oak. Restoration sites may be well suited to growing high quality timber from native trees.

Future Revenue (Table 4.3)
The loss of future revenue is a major consideration for woodland owners and managers whose main aim is to produce timber from high-yielding species. However, the economic penalties of restoration to native woodland can be lower than anticipated. In many cases, the sites with potential to deliver the highest ecological benefits are also less suited to growing non-native species. In some areas with base-rich soils, the costs of restocking plantations can be high due to competition from coppice re-growth and natural regeneration of native species. On sites with thin, chalky soils or base-rich clays, the introduced species may be growing relatively poorly. In remote upland areas typical of some former native pinewood and upland oakwood sites, the need for high capital investment in new roads, coupled with expensive secondary extraction on minor council roads, makes the economics of timber production less attractive.

On the other hand, the restored woodland may, in the future, provide some financial returns from native species timber, especially on fertile lowland sites – provided that grey squirrel

damage can be controlled – or from Scots pine on native pinewood sites. They can also be managed to enhance assets such as sporting woodlands or fisheries[26].

Other factors

Many people value ancient semi-natural woodlands as much for their visual and cultural qualities as for biodiversity. Ancient woodlands are typically located within National Parks, Areas of Outstanding Natural Beauty or National Scenic Areas. From a historic perspective, local historians often focus upon ancient woodland sites in studies of earlier human settlement and historic management practices. Such aspects can influence the decision of whether or where to restore (Table 4.4).

Visual (Table 4.4)

Restoration may provide an opportunity to improve the appearance of a woodland especially where harsh boundaries exist between evergreen and deciduous stands. The early stages of restoration can look unsightly especially where stands are clearfelled, with large numbers of dead, moribund and bent over native trees. Other silvicultural methods are available that limit the visual impacts. This aspect of restoration should rarely influence the choice of site except perhaps where large scale clearfelling is the only option within a highly visible landscape. Even in these cases, interpretation can be provided to explain the aims of the project and describe the short-term nature of the 'problem' and the positive longer term effects.

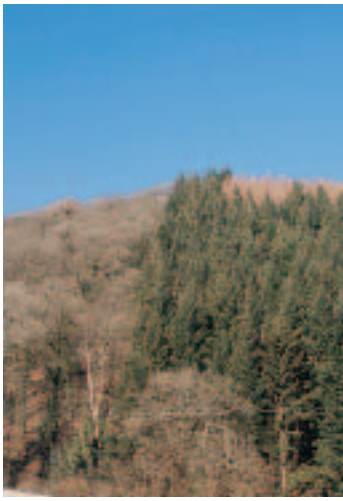
Cultural (Table 4.4)

The interests of the local and wider community should also be considered. Many ancient woodland sites are places of local folklore and tradition. Individual trees within such sites may be of great antiquity and many are well known as landmarks and sites of legendary events; the Major Oak in Sherwood Forest, for instance. Where features of historical interest remain, or where the site itself is of historical value, restoration may be of particular relevance to the local community.

On the other hand, non-native species, especially mature trees in designed landscapes, are often highly valued and such sites are unlikely to be candidates for complete restoration. Similarly, sweet chestnut coppice has high cultural values in some areas.

Archaeological (Table 4.4)

Ancient woodlands often contain archaeological remains. Many woods include earthworks and buried remains which may date back to early periods of human settlement. Traditional woodland management involved the construction of features which can still be found today, such as saw pits, charcoal hearths, woodbanks and ancient trackways. Ancient woodlands incorporated within the designed landscapes of the eighteenth and early nineteenth centuries may contain the remains of follies, gardens and carefully constructed pathways. Where such historic or archaeological features remain, their condition and context may benefit from restoration to native species. It may be appropriate to extend the restoration scheme to include features with historical associations. The possible negative impacts of harvesting, other operations and of future native vegetation should be taken into account. Where archaeological remains exist within a proposed restoration site, advice should be sought from the appropriate organisation.



Justin Church

Restoration may be appropriate where abrupt species boundaries cause visual problems.

Complete restoration to native species may be inappropriate where non-native trees are valued by the local and wider community.

Ancient woodland sites often contain archaeological remains such as this woodbank. The context of these features may be better understood in a native woodland setting.

Assessing restoration potential

The five steps set out below (and illustrated in Figure 4.1 opposite) provide a framework for assessing the overall restoration potential of a single site or number of sites. Tables 4.1–4.4 provide a checklist of criteria to help with the assessment process. Hypothetical examples of four different sites assessed against these criteria are provided on pages 24–27.

Where there are a number of potential sites the summary checklist (Table 4.5) on page 23 can be used to compare and rank results (completed here for hypothetical sites 1–4).

The Site Assessment Guide included with this publication is designed to assist the user in gathering information that will be used to assess the restoration potential of a site. It can be freely photocopied as a template so that information from a single site or number of sites can be recorded and summarised.

It is important to consider how urgently restoration needs to be carried out. Sites with fast-growing, shade-casting conifers which are about to close canopy may need prompt action to maintain semi-natural features or key species. In most cases important features can be maintained by thinning.

STEP 1 Assessing the Ecological Potential
(the potential gains for biodiversity and native woodland ecosystem development)

This is based on the Ecological importance and Ecological development criteria (Table 4.1a and b). In many cases simply adding up the High, Medium and Low values for each site should indicate the rating. However, this is not intended to be a quantitative exercise. The relative importance of the different criteria will vary according to local circumstances. There may be instances where sites rate highly for Ecological importance but low against Ecological development (or vice-versa). In these circumstances, decisions will have to be made locally on the balance for any given site. Where several sites are being considered, the Ecological Potential can be entered on the summary checklist for multiple sites (see Table 4.5 and page 5 of the Site Assessment Guide) to allow their ratings to be ranked.

STEP 2 Considering Practical Factors
(affecting the potential to achieve restoration)

Assess whether each factor has a positive, negative or neutral effect on the potential to achieve restoration. The overall assessment may be a simple average of individual values, but sometimes one factor will be critical. (See worked example for Site 3, page 26: Operational access.)

STEP 3 Assessing Restoration Potential
(the potential of a site taking into account Practical Factors)

Review and adjust, if necessary, the rating from STEP 1 in light of the Practical Factors considered in STEP 2. The Restoration Potential rating should only differ from the Ecological Potential rating where Practical Factors are very significant.

STEP 4 Considering Economic and Other Factors (the potential effects of restoration)

Assess each factor in terms of whether restoration would have a positive, negative or neutral effect. The overall assessment may be a simple average of individual values, but sometimes one factor will be critical.

STEP 5 Assessing Overall Site Rating
(the overall potential of a site taking into account Practical, Economic and Other Factors)

Review and adjust, if necessary, the rating from STEP 3 in light of the Economic and Other Factors considered in STEP 4. The Overall Site Rating should only differ from the Restoration Potential rating where the Economic and Other Factors are very significant.

Based on the Overall Site Rating obtained by working through STEPS 1–5, identify the degree to which the site should be restored; i.e. **Full** restoration, **Partial** restoration or **Maintenance** of existing biodiversity (see pages 28–29). Where Overall Site Rating is *High*, full restoration will normally be the most suitable choice (see section 5). The alternative options may be appropriate for sites with *Low* or *Medium* ratings.

It is important not to consider this framework as a prescriptive methodology; owners and managers should work with the Forestry Commission, Forest Service, conservation agencies and other organisations at a local level to develop and adapt the framework to suit their particular circumstances.

Figure 4.1 Flowchart to illustrate the site assessment process

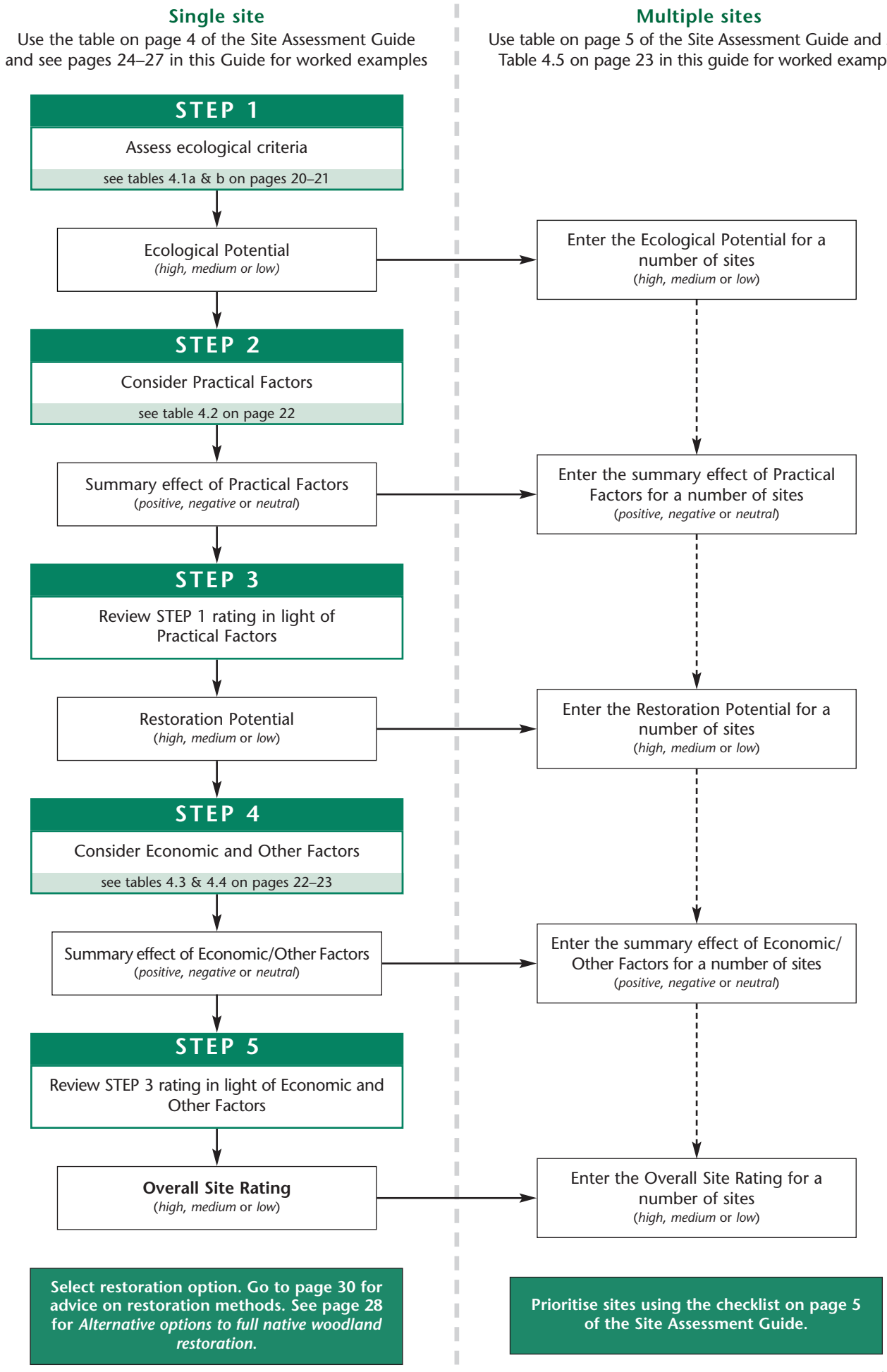


Table 4.1a Ecological Importance criteria

Criterion	Potential gains for biodiversity		
	High	Medium	Low
Designations (ASSI, SSSI, NNR, SAC, SPA)	• Site or adjoining area is designated for semi-natural woodland • Restoration will contribute significantly to safe-guarding and enhancing adjacent designated site	• Restoration site within close proximity to designated woodland • Restoration will make the management of adjacent designated site easier	• Site is not near to a designated woodland • Designated feature will not benefit from restoration • Designated feature will suffer from restoration
Potential contribution of site to UKBAP habitat strategies at local, regional and national levels	• Potential woodland types will contribute to area UKBAP targets for restoration	• Area UKBAP strategies not yet fully developed, but potential woodland type likely to be prioritised	• Potential woodland types not prioritised within area UKBAP strategies where the latter exist
Potential of site to contribute to a forest habitat network	• Restoration of the site will contribute significantly to the forest habitat network • If site is left unrestored, non-native trees will restrict the ecological functioning of the network	• Restoration will have a minimal or neutral impact on the forest habitat network	• Site is isolated and restoration will not improve connectivity
Potential contribution of site to conservation and enhancement of populations of SAP, Red Data Book (RDB) or other notable species	• Restoration will secure or benefit population of nationally scarce or threat-ened species (SAP or RDB) • Species is at the edge of its range	• Species is of local importance • Species already has extensive existing habitat • A viable population of the species can be maintained by partially restoring stand	• There are no scarce or threatened species likely to benefit from restoration • Nationally important species will suffer from restoration
Rarity of potential native woodland or stand type	• Nationally rare stand type (e.g. aspen stands) • Regionally rare woodland type (e.g. upland oakwood in SE England)	• Regionally rare stand type (e.g. slope alder woods; yew woods)	• Woodland type and stand type are common
Diversity of different habitats and features within the site	• A range of site types and habitat features exist	• Some variability in site and habitat diversity	• Uniform; mostly one site type, little habitat diversity
Size of site (relative to other woodland within the region).	• Large site	• Average sized site for region	• Small site for region

Table 4.1b Ecological Development criteria

Criterion	Potential for native woodland ecosystem development		
	High	Medium	Low
Number, condition and diversity of mature remnant semi-natural trees and shrubs on site	• High density of mature trees (>20/ha) • Some veteran trees • Good range of different native tree and shrub species (some locally or regionally scarce) • Remnants of epiphytic communities	• Remnant trees all of one species • Remnant trees at a low density (e.g. <5/ha) • No remnants of epiphytic communities • Limited range of native tree and shrub species	• No mature remnant native trees • Very limited range of native tree and shrub species
Presence of specialist woodland ground flora species on site	• High diversity of species in robust patches • Some locally or regionally scarce species	• A few patches • Small populations of one or two species	• No specialist species present
Adjacency of existing semi-natural woodland	• Restoration site completely surrounded by semi-natural woodland	• Semi-natural woodland adjacent to some parts of restoration site	• No semi-natural woodland adjacent to the restoration site
Quality and type of adjacent semi-natural woodland	• High structural diversity • Presence of old large trees and deadwood • Adjacent wood is of the same type to that of the potential restored wood	• Some structural diversity (e.g. two age-classes) • Some deadwood • Adjacent wood of similar type to that of the potential restored wood	• Even-aged stand • No deadwood, no old trees • Adjacent wood is of significantly different type to that of the potential restored wood
Adjacency of other non-wooded semi-natural habitats	• Adjacent semi-natural vegetation is closely related to the potential woodland type (e.g. calcicolous grassland adjacent to ash woodland)	• Adjacent semi-natural vegetation will facilitate the migration of some species into the restoration site	• No semi-natural vegetation adjacent to restoration site

Table 4.2 Practical factors

Factor	Effect on potential to achieve restoration		
	Positive (+)	Neutral (0)	Negative (–)
Operational access	• Good access exists and sensitive harvesting systems can minimise damage to the site and adjacent land • Tree size is small and felling to recycle is an acceptable option	• It is possible to create new access facilities which will not: - be prohibitively expensive - create a landscape problem - limit the ecological potential of the site	• Terrain is severe or site is isolated by nature of adjoining land use • Creation of adequate access would severely limit the ecological potential of the site • Tree size is large and felling to recycle would not be appropriate
Protection	• There is little browsing pressure within the vicinity of the site and any control that is necessary can be carried out safely and cost effectively	• Moderate browsing pressure exists: protection is possible	• The site is prone to severe pressure from browsing animals and control is difficult
Vegetation management	• The site is infertile and amounts of competitive vegetation that do occur are likely to be small • The site is fertile but vegetation is manageable using appropriate silviculture • No seed sources of invasive species exist within the vicinity of the site	• Weed growth is likely to be significant and regular weeding of planted or naturally regenerated site-native trees will be necessary • Invasive species exist adjacent to the site but the manager has control over their removal and is prepared to remove exotic species from the site when required	• The site is fertile, weed growth is likely to be luxuriant and intensive weeding is likely to be required for several seasons • Abundant seed sources of invasive species exist around the site, no influence over their management exists. Use of herbicides is restricted due to other constraints
Presence of young native trees and seed supply	• Young native trees are abundant • Good potential for production of seed from native species on site • Established advanced regeneration of site-native trees is well distributed, at a good density	• Young native trees are suppressed but they are likely to respond to thinning of plantation trees • Some potential for seed production from native species on or adjacent to the site • Limited amounts of advanced regeneration present	• Few young native trees exist and these are unlikely to develop satisfactorily after treatment • There is limited potential for seed production from native species • There is no advanced regeneration present

Table 4.3 Economic factors

Factor	The potential effects of restoration		
	Positive (+)	Neutral (0)	Negative (–)
Value of existing plantation	• Premature felling of plantation trees is not required • Features of semi-natural wood-land can be maintained and enhanced by targeted thinning	• The majority of features can be retained by thinning • A higher than optimum thinning intensity may be required	• Premature felling of high yield class stand would be required to safeguard features of value
Potential value of future rotations	• Site type is not suited to growing productive stands of non-native trees • High quality timber can be produced from native species • Site is commercially disadvantaged • Restoration will enhance value of non-timber interests	• Site is moderately productive • Some commercial disadvantages (e.g. permanently poor access) • Future losses in revenue can to some extent be offset by production of timber from native species and enhance-ment of non-timber assets	• Site is suited to growing productive stands of non-native trees • Restoration to native species would offer little opportunity to provide income, e.g. where growth or quality is poor or at risk from factors such as grey squirrel damage

Table 4.4 Other factors

Factor	The potential effects of restoration		
	Positive (+)	Neutral (0)	Negative (–)
Visual	• Restoration can be undertaken gradually using an alternative silvicultural system to clearfell, or clearfelling is necessary but the site is within a low sensitivity landscape • Opportunities exist to improve the appearance of a woodland where harsh species boundaries exist	• The site is within a moderately sensitive landscape, clearfelling is necessary but a reasonable density of mature native trees exists	• The site is within a highly sensitive landscape and clearfell is necessary. There is a low stocking of mature native trees, many of which are moribund
Cultural	• The site has a well documented history as ancient semi-natural woodland (ASNW) • Wide community support for restoration to site-native species	• The site would provide a minor increase in value or interest to the community if it was composed of site-native species	• The site is highly valued by the community for its non-native trees
Archaeological	• Conditions provided by the development of native woodland would be beneficial to archaeological conservation	• Restoration would bring neutral or minor benefits to archaeological features	• Archaeological features would suffer from development of native woodland

Table 4.5 Checklist to summarise the restoration potential of a number of sites (this table shows the results for sites 1–4 taken from the worked examples on the following pages)

	STEP 1 Ecological Potential			STEP 2 Practical Factors			STEP 3 Restoration Potential			STEP 4 Economic/Other Factors			STEP 5 Overall Site Rating			Restoration Option		
Site name	H	M	L	+	0	–	H	M	L	+	0	–	H	M	L	F	P	M
Site 1	✓			✓			✓			✓			✓			✓		
Site 2			✓			✓			✓		✓				✓			✓
Site 3		✓				✓*			✓		✓				✓		✓	
Site 4	✓				✓		✓				✓		✓			✓		

Notes

*No Access!

Checklist to assess restoration potential

Site name: ..I:..Sitka..spruce..plantation..on..upland..mixed..ashwood..site..

STEP 1: Ecological criteria	Notes	Rating
Ecological Importance: potential gains for biodiversity (see Table 4.1a)		H/M/L
Designations	Candidate SAC due to the quality of adjoining Tilio-Acerion woodland	High
Contribution to UKBAP habitat strategies	Regional restoration targets for this woodland type	High
Contribution to forest habitat network	Valuable links to areas of existing semi-natural woodland and other areas proposed for restoration	High
Potential to conserve endangered species	ASNW recognised for exceptional lichen communities and woodland invertebrates. This site contains remnant communities.	High
Rarity of native woodland type	Most woodland in this region is on acidic lithology: therefore upland mixed ashwoods are rare	High
Rarity of stand type	No stands of unusual species composition	Low
Diversity of habitats and features	Moderate range of habitats/features	Medium
Size of site	The site covers an extensive area	High
Ecological Development: potential for native woodland ecosystem development (see Table 4.1b)		H/M/L
Mature remnant semi-natural trees and shrubs	Frequent remnant semi-natural trees exist, good condition and surviving epiphytes	High
Specialist woodland ground flora	Scattered areas of dog's mercury	Medium
Adjacency of existing semi-natural woodland	Site enclosed by existing semi-natural woodland and other PAWS	High
Quality and type of adjacent semi-natural woodland	Adjacent woodland is very diverse: range of tree species, structural components and important flora and fauna.	High
Adjacency of other non-wooded semi-natural habitats	Base-rich small sedge mires above the upper boundary	Medium
	Ecological Potential (weight relative values)	High

STEP 2: Practical Factors (affecting the potential to achieve restoration (see Table 4.2))		Effect
		+/0/–
Operational access	Some existing access, opportunities to extract using cable-crane system	0
Protection	High deer pressure although control is feasible due to co-operation from neighbouring landowners	0
Vegetation management	Little competing vegetation	+
Presence of young native trees and seed supply	Abundant young native trees throughout. These are stable and some potential seed producers.	+
	Practical Factors (weight relative values)	+

STEP 3: Restoration Potential	Review rating from STEP 1 in light of Practical Factors? (H/M/L)	High

STEP 4: Economic and Other Factors (the potential effects of restoration)		Effect
Economic (see Table 4.3)		+/0/–
Value of existing plantation	Plantation is economically mature	+
Potential value of future rotations	Expensive extraction, YC 12 SS	0
Other (see Table 4.4)		+/0/–
Visual	Restoration would improve sensitive landscape	+
Cultural	N/A	+
Archaeological	Ruined dwellings associated with previous wood pasture management	+
	Economic and Other Factors (weight relative values)	+

STEP 5: Overall Site Rating	Review rating from STEP 3 in light of Economic and Other Factors? (H/M/L)	High

Restoration Option	Full	✓	Partial		Maintenance	

Checklist to assess restoration potential

Site name: 2: Corsican pine on lowland mixed broadleaf site

STEP 1: Ecological criteria	Notes	Rating
Ecological Importance: potential gains for biodiversity (see Table 4.1a)		H/M/L
Designations	No relevant designations	Low
Contribution to UKBAP habitat strategies	There are regional restoration targets for this woodland type	High
Contribution to forest habitat network	Neutral impact on the forest habitat network	Medium
Potential to conserve endangered species	No records of endangered species within or adjacent to the site	Low
Rarity of native woodland type	Woodland type is frequently encountered within the region	Low
Rarity of stand type	No stands of unusual species composition	Low
Diversity of habitats and features	Site is very uniform, no diversity of habitats	Low
Size of site	Small stand within an extensive area of semi-natural woodland	Low
Ecological Development: potential for native woodland ecosystem development (see Table 4.1b)		H/M/L
Mature remnant semi-natural trees and shrubs	Remnant semi-natural trees confined to the perimeters of the site	Low
Specialist woodland ground flora	Small patches of specialist woodland ground flora	Medium
Adjacency of existing semi-natural woodland	Extensive areas of semi-natural woodland enclose the site	High
Quality and type of adjacent semi-natural woodland	Adjacent woodland is very uniform, limited structural and tree species diversity	Low
Adjacency of other non-wooded semi-natural habitats	Not applicable	
	Ecological Potential (weight relative values)	Low

STEP 2: Practical Factors (affecting the potential to achieve restoration (see Table 4.2))		Effect
		+/0/–
Operational access	Access exists but ground is very wet and extraction will be limited to periods of dry weather	0
Protection	Very high pressure from fallow deer, can be controlled but only by fencing	0
Vegetation management	Growth of bramble currently kept down by heavy deer pressure. Vegetation competition likely to be excessive when fence erected.	-
Presence of young native trees and seed supply	Very limited advanced regeneration, restricted to one small patch	-
	Practical Factors (weight relative values)	-

STEP 3: Restoration Potential	Review rating from STEP 1 in light of Practical Factors? (H/M/L)	Low

STEP 4: Economic and Other Factors (the potential effects of restoration)		Effect
Economic (see Table 4.3)		+/0/–
Value of existing plantation	Plantation can be thinned to maintain ecological interest	0
Potential value of future rotations	Potential to grow productive native and non-native trees	0
Other (see Table 4.4)		+/0/–
Visual	Neutral	0
Cultural	Neutral	0
Archaeological	Woodbank in ASNW on western edge of site	0
	Economic and Other Factors (weight relative values)	0

STEP 5: Overall Site Rating	Review rating from STEP 3 in light of Economic and Other Factors? (H/M/L)	Low

Restoration Option	Full		Partial		Maintenance	✓

Checklist to assess restoration potential

Site name: 3: stands of JL, DF & SS on upland oakwood site

STEP 1: Ecological criteria	Notes	Rating
Ecological Importance: potential gains for biodiversity (see Table 4.1a)		H/M/L
Designations	No relevant designations	Low
Contribution to UKBAP habitat strategies	There are regional restoration targets for this woodland type	High
Contribution to forest habitat network	Would link two areas of existing ASNW within an agricultural landscape	High
Potential to conserve endangered species	No records of endangered species within or adjacent to site	Low
Rarity of native woodland type	Woodland type frequently encountered within region	Low
Rarity of stand type	No stands of unusual species composition within the site	Low
Diversity of habitats and features	Limited diversity with some wet flushes present	Medium
Size of site	Average size for upland oakwoods within the locality	Medium
Ecological Development: potential for native woodland ecosystem development (see Table 4.1b)		H/M/L
Mature remnant semi-natural trees and shrubs	Some remnant semi-natural trees across the site, many suppressed	Medium
Specialist woodland ground flora	Frequent patches of upland oakwood flora - can be maintained within an open non-native plantation	Medium
Adjacency of existing semi-natural woodland	A third of boundary has existing ASNW adjoining	Medium
Quality and type of adjacent semi-natural woodland	High structural and species diversity	Medium
Adjacency of other non-wooded semi-natural habitats	No other semi-natural habitats adjoining	Low
	Ecological Potential (weight relative values)	Medium

STEP 2: Practical Factors (affecting the potential to achieve restoration (see Table 4.2))		Effect
		+/0/–
Operational access	Very steep side slope, no access through fields or ASNW	- -
Protection	No significant protection problems	+
Vegetation management	Site has low fertility, vegetation competition is minimal	+
Presence of young native trees and seed supply	Abundant oak saplings under larch (approx. 1/3 of the area). Limited native regeneration under DF and SS	0
	Practical Factors (weight relative values)	- -

STEP 3: Restoration Potential	**Review rating from STEP 1 in light of Practical Factors?** (H/M/L)	Low*

STEP 4: Economic and Other Factors (the potential effects of restoration)		Effect
Economic (see Table 4.3)		+/0/–
Value of existing plantation	Remnant feature are not currently threatened by plantation trees	0
Potential value of future rotations	Poor access makes future timber production uneconomic	0
Other (see Table 4.4)		+/0/–
Visual	Abrupt species boundary visible from key viewpoint	+
Cultural	Used by local community - happy with current tree species	-
Archaeological	None	0
	Economic and Other Factors (weight relative values)	0

STEP 5: Overall Site Rating	**Review rating from STEP 3 in light of Economic and Other Factors?** (H/M/L)	Low

Restoration Option	Full		Partial	✓**	Maintenance	

* The Restoration Potential has reduced due to operational access constraints (*note the use of the two minus symbols to highlight the severity of this constraint*).
** Oak regeneration in larch stand will be successful if the site is protected. Some thinning to waste may improve landscape problems.

Checklist to assess restoration potential

Site name: 4: Norway spruce on lowland beech and yew site

STEP 1: Ecological criteria	Notes	Rating
Ecological Importance: potential gains for biodiversity (see Table 4.1a)		H/M/L
Designations	No relevant designations	Low
Contribution to UKBAP habitat strategies	This woodland type has not been prioritised in region's restoration strategies	Low
Contribution to forest habitat network	Restoration would provide good linkage to the existing FHN	High
Potential to conserve endangered species	Barbastelle bats, (Action Plan species) occur in ASNW, on the edge of this stand. Gradual restoration will greatly enhance the viability of population.	High
Rarity of native woodland type	Woodland type is not unusual within the region	Medium
Rarity of stand type	No stands of unusual species composition within the site	Low
Diversity of habitats and features	Site has moderate habitat diversity	Medium
Size of site	Small for the region	Low
Ecological Development: potential for native woodland ecosystem development (see Table 4.1b)		H/M/L
Mature remnant semi-natural trees and shrubs	Remnant semi-natural trees and shrubs at a moderate density few species are present	Medium
Specialist woodland ground flora	Only very limited ground flora, no specialist woodland species	Low
Adjacency of existing semi-natural woodland	A third of boundary has existing ASNW adjoining	Medium
Quality and type of adjacent semi-natural woodland	High structural and species diversity	High
Adjacency of other non-wooded semi-natural habitats	No other semi-natural habitats adjoining	Low
	Ecological Potential (weight relative values)	High*

STEP 2: Practical Factors (affecting the potential to achieve restoration (see Table 4.2))		Effect
		+/0/–
Operational access	Limited access	0
Protection	Increasing population of roe deer - fence needed for adequate control	0
Vegetation management	Vegetation competition likely to be moderate	0
Presence of young native trees and seed supply	Advanced regeneration of beech at low densities throughout	0
	Practical Factors (weight relative values)	0

STEP 3: Restoration Potential	Review rating from STEP 1 in light of Practical Factors? (H/M/L)	High

STEP 4: Economic and Other Factors (the potential effects of restoration)		Effect
Economic (see Table 4.3)		+/0/–
Value of existing plantation	Plantation can be thinned to maintain ecological interest	0
Potential value of future rotations	Site is moderately productive for non-native conifers	-
Other (see Table 4.4)		+/0/–
Visual	Neutral	0
Cultural	Used by local community - enthusiastic about conversion to native woods	+
Archaeological	None	0
	Economic and Other Factors (weight relative values)	0

STEP 5: Overall Site Rating	Review rating from STEP 3 in light of Economic and Other Factors? (H/M/L)	High

Restoration Option	Full	✓	Partial		Maintenance	

* In this example, the presence of a population of an endangered species (Barbastelle bat (*Barbastella barbastellus*)) on the edge of this stand overrides other ecological criteria to increase the Ecological Potential from *Low/Medium* to *High*.

Alternative options to full native woodland restoration

Where the decision to restore is not obvious from the process described on page 18, one of the alternative options outlined below may be appropriate.

Maintaining existing biodiversity

Where there would be very limited benefits from restoration (e.g. where few, if any, features of the former semi-natural woodland survive and there are no links to existing native woodland), the owner may decide to maintain a high percentage of non-native trees and manage stands for other objectives. In such cases, management should be undertaken to maintain what ecological values exist (e.g. favour native trees in thinning operations).

Partial restoration

Where there would not be high benefits from restoration partial restoration may be appropriate. This involves managing mixtures or mosaics of native and non-native trees as irregular or even-aged stands. Partial restoration can provide positive benefits for some species which utilise habitat provided by non-native coniferous trees (e.g. dormice which, current research suggests, obtain food and shelter from non-native conifers). The approach described is intended as a final goal (i.e. the continued presence of non-native trees to a greater or lesser extent) but would also allow for full restoration to be undertaken in the future. The following practices should be undertaken in stands being partially restored, to enhance ecological diversity.

A mature Douglas fir plantation with natural regeneration of native trees. Coed-y-Brenin, Wales.

- Use appropriate silvicultural systems to maintain woodland conditions.
- Retain veteran trees.
- Maintain an open canopy around native trees, particularly veterans, allowing light to filter through to lower branches and the bole of the tree to enhance populations of epiphytic lichens and ferns.
- Thin to enhance nationally uncommon or locally rare species of native trees and shrubs.
- Maintain habitats of priority species (e.g. maintain open space for known populations of Species Action Plan invertebrates such as heath fritillary or chequered skipper butterflies).
- Safeguard existing areas of ground flora and aim for their expansion by maintaining canopy gaps and protecting less robust vegetation on rides.
- Maintain a proportion of non-native trees to biological maturity, to provide large diameter deadwood (useful for bryophytes and fungi).
- Retain all standing and fallen deadwood.
- Extend the rotation length of even-aged stands. Within productive conifer stands, structural diversity typically begins to develop around the normal economic age of clearfelling. Diversity greatly increases with very long rotations as the ‘old growth’ stage is reached.
- Competitive processes between different tree species are complex. Intimate mixtures may require regular management to maintain a proportion of native trees and shrubs. Discreet groups of native and non-native trees are likely to require less frequent management (although early thinning would be beneficial to increase light levels. Additionally, consideration should be given to eventual extraction routes and vulnerability of adjoining habitats).

- Replace densely shading non-native species with lighter canopied species or manage densely shading species as discreet groups (see above).

- Within a site, favour the restoration of microhabitats which are likely to support higher levels of biodiversity (e.g. wet flushes, rock outcrops, base-rich areas in otherwise acidic woodland).

- Focus on the development of native trees with the potential to become veterans and standing deadwood in the longer term.

Where fully restored sites occur within a mosaic of non-native stands, a buffer zone may be useful to prevent re-colonisation of the site by non-native species. To act as buffer zones, partially restored plantations on ancient woodland sites should have the following characteristics:

- Any non-native species retained need to be of a non-invasive nature.

- Native planting stock should be of local or regional genotypes (whichever approach has been used in the restoration site).

- The partially restored site should be of sufficient size to act as an effective barrier to invasion of non-native species.

- Management to enhance any linking features (e.g. thinning to favour old hedgerow leading from restoration site around edge of buffer zone).

5. Restoration methods

Management planning

Long-term forest plans/ forest design plans

The prioritisation of areas for restoration should be considered within the wider context of woodland design. Wildlife networks linking permanent habitats together should form a framework within which more transient stands can be designed. Future changes to adjoining stands may affect the restoration site and coupe shape, species choice and the timing of felling should be altered accordingly. Neighbouring owners should be consulted to co-ordinate restoration efforts and limit constraints to restoration success (e.g. avoid selecting a site for restoration where a neighbour plans the long-term retention of an adjacent western hemlock stand).

The native woodland management plan

Once sites have been selected for full or partial restoration they should be included as part of a wider plan for native woodland management. The essential elements of management planning are outlined in *The UK Forestry Standard*[3] and Forestry Commission Practice Guides 1–8[2]. Here, those elements which need to be specifically tailored for restoration schemes are discussed in more detail.

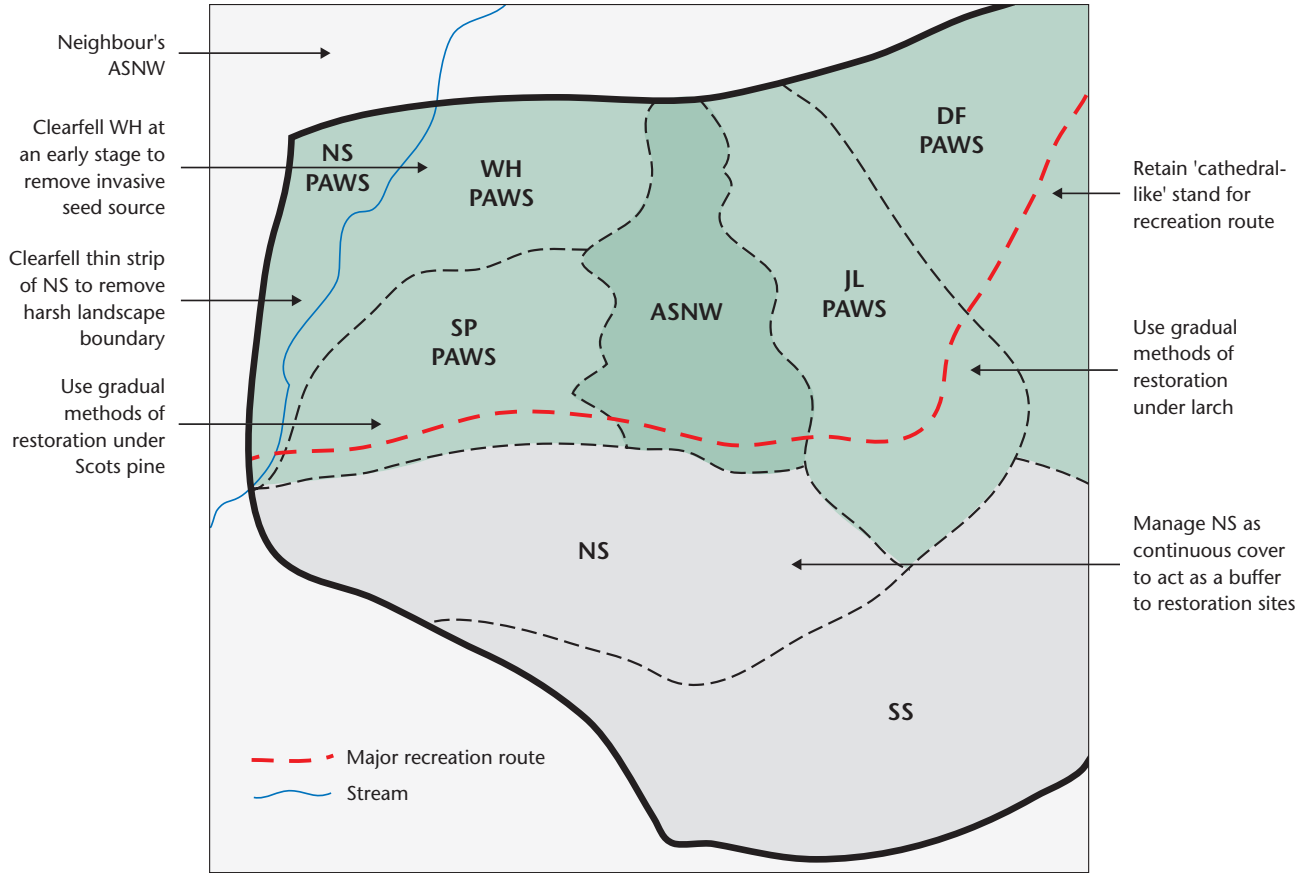
Management proposals should provide a rationale for:

- The selection of sites for full and partial restoration or maintenance of biodiversity.
- The choice of coupe boundaries and design of buffer zones.
- The silvicultural systems to be employed and the timing of operations.

Setting targets

Clear and realistic targets should be set. These should be reasonably open-ended allowing for

Figure 5.1 Hypothetical concept plan



natural dynamic processes such as natural regeneration and colonisation. Set targets for the development of the main ecosystem components (trees, shrubs, ground flora), as these are the most easily measured, and for any important ecological features. If appropriate, detailed targets can also be set for key species where these contribute to the value of a site. Specialised help may be required for monitoring key species.

Trees and shrubs

Where possible, establishment should be achieved by natural regeneration. Success will be influenced by:

- the age, density and health of surviving trees on and around the site;
- the fertility of the site;
- browsing pressure;
- the speed of canopy removal (available light and weed competition);
- the amount of ground disturbance.

Species such as goat willow and birch are well-suited to colonise disturbed, open ground. Where little canopy remains, late colonisers such as beech may be slow to regenerate until woodland conditions have been re-established.

An appropriate target for the first stage of restoration might be *to establish locally native tree species ecologically suited to the restoration site (in a given period)*. If rare or uncommon trees and shrubs were recorded in the initial survey then targets could be set for their establishment and spread. Where timber production is an objective then planting of timber species such as oak, ash or beech may need to be considered.

Structurally varied woodland provides a greater range of niches for wildlife. Song birds, for example, prefer a well-developed shrub layer. In many cases, the precise species composition is less important than the physical structure. It may be appropriate to set broad targets and artificially create structural diversity by felling small areas or thinning as necessary.

Ground flora

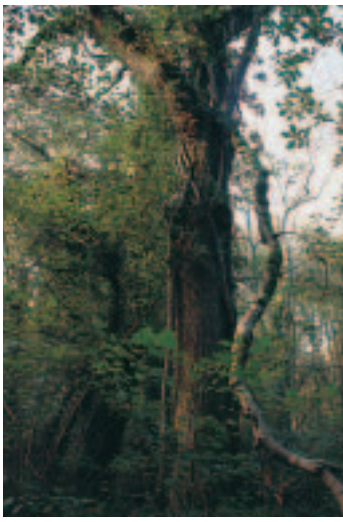
Restoring native woodland ground flora should be an objective of any restoration scheme. However, ground flora restoration is a long-term process. A simple target for upland sites might be *to re-establish some of the key species* (e.g. invertebrate food plants or species that define the woodland type[10]) *over half the site within 40 years*. In lowland sites, where species are generally less mobile and sites suffer more weed competition, an even longer timescale may be realistic. Where small populations of scarce ancient woodland indicator species still survive on site or in adjacent stands, targets could be set to maintain and increase these populations. However, colonisation rates can be very slow and the potential distribution limited by local soil and microclimate conditions.

Artificial techniques for the re-introduction of woodland ground flora are still being developed and are not likely to be appropriate in most restoration schemes. Resources would be needed to introduce and maintain plants and care taken to ensure that seed or plant origin is appropriate. The timing of introduction is critical to success as canopy establishment will help suppress faster-growing ground flora species.

Once objectives and targets have been set it will be important to identify how they are to be achieved. Each target should be considered in the five-year plan of operations with work plans drawn up and reviews undertaken.

Operational planning

The plan of operations should be divided into harvesting plans and regeneration plans which can be clearly interpreted in the field. Where operations are undertaken by different staff to those involved with planning, clear lines of communication are essential to safeguard features of value. Harvesting systems and the choice of extraction routes are particularly important. If tendering work to contractors, specify which harvesting system is required. In particularly sensitive cases it may be necessary to specify the type of equipment (i.e. mini or low ground pressure forwarder). Operational plans should be timed or adapted to minimise disturbance to rare and vulnerable species such as the honey buzzard or dormouse[27,28].



This structurally complex stand provides niches for a range of woodland flora and fauna.

Stand management

Choosing the appropriate silvicultural system

Restoration is often best achieved by a gradual removal of the introduced species providing a phased transition to native woodland. A range of silvicultural systems may be considered from those which produce regular stand structures (such as seed tree or uniform shelterwood), to those which create more irregular stand structures (such as group selection or irregular shelterwood). Such systems are generally covered by the term 'continuous cover' forestry[29]. By maintaining woodland conditions these systems provide the following advantages:

- A lack of sudden major disturbance to fauna (e.g. bats within mature semi-natural trees, wood ants on rides, retention of aerial route ways for dormice).
- Control of vegetation (particularly important on moist fertile sites) by using the remaining trees to influence light levels and soil water table.
- Retention of moist microclimates – important for woodlands with epiphytic communities and deadwood invertebrates.
- Gradual opening up of mature semi-natural trees, reducing problems with instability and epicormic growth.
- A gradual development of native tree regeneration, with a range of age classes and potentially, a wider range of species, including slower colonising species such as beech.
- Reduced visual impact and retention of woodland cover in areas of high landscape sensitivity and public access.

Gradual conversion to native species is simpler on freely-draining acid soils under light canopies.

Gradual conversion is difficult where regeneration of non-native species is likely to be prolific.

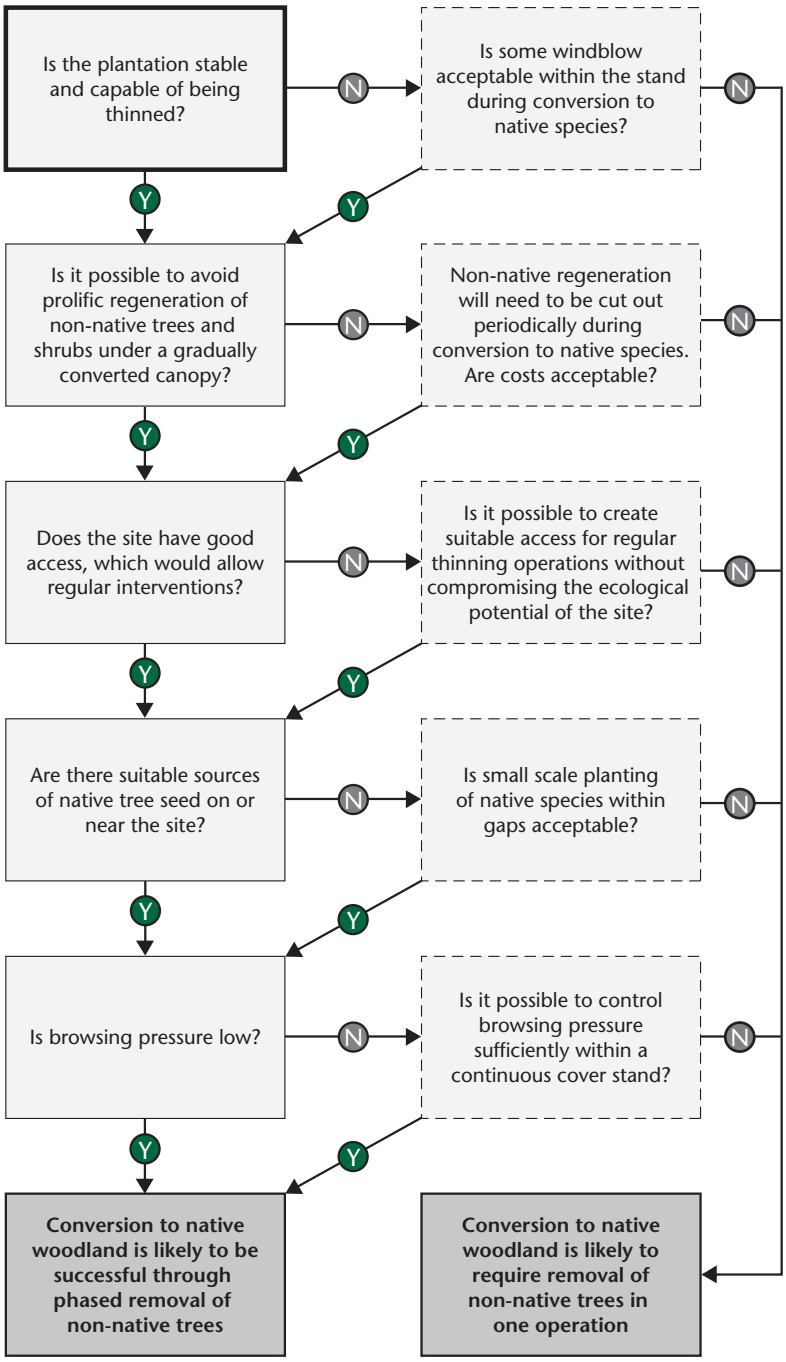
A gradual transition to native woodland would be particularly appropriate on moist and fertile sites, where species are sensitive to sudden changes in microclimate and structure, or where the site is prominent in a highly sensitive landscape.

For such systems to be practical and effective a range of conditions are necessary and a gradual transition may not always be possible. Where plantation trees are unstable, or where access and cost restricts the number of times that operations can be carried out, it may be more appropriate to clearfell stands of introduced species. Figure 5.2 can be used to suggest where clearfell or continuous cover systems are most appropriate.

Harvesting

Whether thinning or clearfelling, inappropriate techniques can lead to direct habitat loss or restrict the recovery of the woodland flora and fauna. Soil profiles and drainage patterns may

Figure 5.2 **Choosing an appropriate silvicultural system for the conversion of a plantation on ancient woodland site to native woodland**



also be very sensitive to disturbance. Conversely, carefully targeted interventions can be used to safeguard important features and encourage colonisation. The following sections identify methods to minimise disturbance to features of value and maximise opportunities for successful restoration.

Operational access

In many instances difficult access can be overcome and disturbance reduced by:

- Making sure that new facilities such as extraction tracks avoid damaging features such as rock outcrops with lower plant communities, large areas of remnant ground flora and mature native trees[30].

- Considering the choice of primary extraction routes. Select racks for skyline or high-lead extraction to avoid the need to remove mature native trees. Where such trees are very dense, it may be less damaging to put

Greg Vickers

Extraction equipment, such as this Alstor mini-forwarder, may be useful where there are sensitive ground conditions or narrow trackways.

in a new track and extract with a skidder, or to use alternative silvicultural systems.

- Using low impact, purpose-built harvesting equipment such as mini-forwarders. Horses are also being used where access is difficult and track creation or widening is inappropriate.

- Only carrying out harvesting and extraction on wet sites in dry periods.

- Felling to recycle.

Thinning and treatment of native trees

Less intensively managed plantations will often include a mixture of planted trees, mature semi-natural trees and native trees that arose from coppice re-growth or natural regeneration when the plantation was established. The latter can help speed up restoration. Young native trees should be favoured in any thinning operation and selectively thinned themselves to allow the development of crowns, improve stability, increase seed production and enhance epiphytic communities. Similarly, any areas of ground flora, particularly ancient woodland indicator species, should be given more light where they are getting shaded out. Thinning should be targeted around features which have potential to develop a more diverse and interesting flora (e.g. wet flushes, stream-sides and rock outcrops). Where invasive non-site native species form minor components, early felling will avoid prolific regeneration beneath canopy gaps or into adjacent stands with more favourable light regimes.

In this part of Sherwood Forest, glades have been created and progressively enlarged around veteran trees. Young native trees within the conifer matrix have been developed through a five-year thinning cycle.

Paul Barwick

Young native trees, which have been drawn up into the canopy, should be retained unless they interfere with the development of potential seed trees, present a safety hazard when felling planted trees, or restrict access for ground preparation machinery. On clearfelled sites, the visual appearance of unstable, bent over trees can be a problem. A suitable compromise may be to coppice or pollard young and unstable trees and retain larger, more open grown examples.

Veteran trees require particular care. The general recommendation is to gradually open up the stand around such trees while avoiding extraction damage. In some cases, re-pollarding some of the branches may help reduce the weight of the crown and encourage new growth. The management of veteran trees is a complex subject and where important examples exist within the restoration site further advice should be sought[31].

The impacts of brash

Where sites are clearfelled, the distribution of brash can have an impact on site recovery in five main ways:

- by casting shade;
- influencing the balance of nutrition;
- influencing the composition of vegetation;
- influencing browsing damage;
- providing support for machinery, thus limiting soil disturbance.

Table 5.1 provides a broad guide to the effects of different harvesting systems when clearfelling. Contrasting site types are used to illustrate the effect of soil moisture and nutrient regimes at either end of the spectrum. Recommendations for site-appropriate harvesting systems are summarised in Table 5.2.

Felling to recycle

In most cases, felling to recycle (i.e. felling to waste) will be unnecessary or will only be needed for a small element of the restoration scheme. However, in large remote schemes the cost of roading can make felling to recycle a cost-effective option. While trees are small, the operation can be carried out relatively cheaply and without major practical constraints. The residual effect from felled trees varies

Table 5.1 The effect of brash distribution on natural regeneration of trees and ground flora development

Brash distribution	Dry infertile site		Moist fertile site	
	Ground flora	Tree regeneration	Ground flora	Tree regeneration
Evenly spread over the whole site, shallow and at low density (i.e. 10–15 cm) (e.g. Skidder – whole-pole)	Remnant patches of woodland herbs and bryophytes sensitive to exposure may survive in shade and micro-climate provided by brash.	Good results if brash is sufficiently deep to reduce deer browsing and competition, but not too deep to significantly reduce light levels in gaps.	Ruderal species may quickly dominate brash although in places shade from brash may allow woodland herbs to survive. Extra ground disturbance due to lack of protection for machinery may result in germination of dormant seeds and invasion by ruderal species.	Initially good conditions but window soon lost due to competition. Success is most likely when advanced regeneration exists under the canopy before felling takes place. At the very least target felling to years when native trees produce abundant seed.
Dense brash mats and clear timber zones (e.g. Harvester/ Forwarder – shortwood	Recovery in brash rows will take a long time. Species sensitive to exposure may survive in the edge of the brash mat and light demanding species in seed bank (e.g. heather) may develop in timber zones.	Patchy density. No protection from deer browsing apart from on the edge of the brash mat.	Less ground disturbance, therefore less disturbance of seed bank, though timber zones may still re-vegetate rapidly. Brash rows may become dominated by species such as rose-bay willow-herb or bramble. Where possible, double drift brash.	Some limited opportunities for tree regeneration. Slow colonisation of old timber zones. Brash should be concentrated by double drifting, to give more open space and reduce ground disturbance.
Cleared site with possible brashed main routes and large brash piles at conversion bays. (e.g. Skidder – whole-tree or Skyline – whole-tree)	Apart from compacted areas and concentrated brash mats, removal of brash should provide good conditions for species such as heather from seed banks and remnant patches (e.g. bilberry (blaeberry)) tolerant of exposure.	Good for pioneer species, particularly where extraction has exposed mineral soils. Seedlings will be very vulnerable to browsing. Large seeds (e.g. acorns) will initially be exposed to predation unless ground is scarified. Brash piles may provide shelter for rabbits and weevils.	Skidder: Rapid re-vegetation with ruderal species due to ground disturbance and lack of competition. Skyline: Where resources permit, this system may help to limit the initial increase in soil fertility associated with clearfelling by removing brash while leaving soil relatively undisturbed.	Sites are normally very slow to regenerate. Some evidence that bramble can provide protection against browsing but light levels underneath are usually too low to allow trees to regenerate successfully. Where resources permit, skyline – whole-tree method may give better results. Brash piles will quickly become dominated by bramble and provide a home for rabbits and Muntjac deer.

Table 5.2 Recommendations for choice of harvesting system

System	Site type	
	Dry infertile site	Moist fertile site
Whole-pole (even brash distribution)	✓	✗
Shortwood (Lanes of brash with adjacent brash-free strips)	–	✓
Whole-tree – wheeled machines (brash-free site with concentrated brash piles at conversion points)	–	✗
Whole-tree – skyline (brash-free site with concentrated brash piles at conversion points)	–	–

✓ System recommended.

– System should provide satisfactory results but may not:

- be appropriate (e.g. whole-tree harvesting on infertile sites would affect site sustainability[32]);
- be a realistic option (e.g. skyline – whole-tree where forwarder could easily operate);
- provide optimum conditions (e.g. shelter for ground flora sensitive to exposure).

✗ System would cause damage to the site, reducing chances of successful tree regeneration and woodland ground flora development.

Chemical thinning, Blackwood of Rannoch, Scotland.

Felling to recycle, Blackwood of Rannoch, Scotland.

according to size and species of tree; pine rots down quicker than spruce, and small trees rot faster than larger ones. In well-stocked stands of large trees, felling to recycle is usually inappropriate. Felled trees are likely to lie across each other causing low light levels at the forest floor. Even when felled in an organised way, dense brash mats and large volumes of timber will form a barrier for tree regeneration and ground flora recovery.

Regeneration of restoration sites

Natural regeneration, where trees are established from seed without recourse to sowing or planting, is the preferred method and, along with coppice re-growth, should ideally be used to establish a substantial proportion of restoration sites.

Where natural regeneration is not likely to be successful (see Table 5.3) or where it will not achieve the required stocking density, species or speed of regeneration, planting may be a sensible option. Forestry Commission Bulletin 112 *Creating New Native Woodlands*[14], suggests planting patterns to mimic natural regeneration and to maintain species with different growth rates. Recommendations for major and minor tree and shrub species are also provided. Use of plants grown from seed of local provenance is preferable[33]. Nationally or locally scarce tree and shrub species (see Appendix 3) should only be planted in areas where they already naturally occur and on appropriate site types. Any planting of such species should be recorded and be of locally-derived stock. If the aim is to establish a productive timber stand then the use of plants raised from seed collected from registered seed stands may be appropriate. Box 5.2 compares some characteristics of natural regeneration with planting.

The appropriate regeneration method will depend on a number of factors including the owner's objectives and the initial site conditions. Restoration sites should be individually surveyed to assess where natural regeneration or planting is most appropriate. If natural regeneration meets management objectives, and the survey suggests that it is likely to be successful, an assessment should also be made of the preparatory management required and the appropriate timing of operations (see Table 5.3).

Planting native trees where line mixtures of Norway spruce have been removed. Natural regeneration is unlikely due to competition from vegetation.

Table 5.3 Questions to consider when deciding where natural regeneration is likely to be successful

Subject	Questions	More chance of successful natural regeneration	Less chance of successful natural regeneration
Objectives	• What are they? • Do they have any order of priority?	• All operations within the whole woodland aim at restoration by natural regeneration, recognising that this may take many years of careful, sensitive, management, but which may also need to be intensive on some sites	• Short term ill-considered interventions with the expectation of rapid success.
Native trees and shrubs	• What is the target woodland type and can it be achieved through species present on and around the site? • Where are they located? • How many are there? • What is their seed-bearing capacity? • How is their seed dispersed?	• Adequate numbers of large seed-bearing trees (with well-developed crowns) of suitable species, distributed either on or immediately adjacent to the site. • Regeneration of species depending on wind for seed dispersal likely to be more prolific and predictable	• Insufficient or poor seed-bearing trees of appropriate species either on or adjacent to the site
Soils	• Are these fertile/impoverished; heavy/well drained? • How will they influence tree and weed growth? • Is any manipulation desirable and how will it affect weed growth?	• Infertile sites with well-drained soils where growth of weeds is not excessive. • Ground preparation is used on sites with deep litter layer	• Fertile sites with heavy moisture retaining soils which can support a luxuriant growth of competitive weeds. Ground preparation likely to disturb seed banks and expose seed beds for rapid colonisation by weedy species
Climate	• Is it wet/dry; warm/cold? • How will it affect plant growth? • Will there be sufficient seed production?	• Areas with favourable climates that allow seed production and growth of tree seedlings	• Sites with extreme environments that restrict seed production and establishment of new trees
Felling regimes	• How much will the site conditions change under different treatments? • What will the consequences be for weed and tree growth?	• Carefully managed either to promote the growth of existing tree seedlings or develop conditions that favour the germination and establishment of others	• Uncontrolled felling in the absence of any existing seedlings with the hope that some will appear
Ground flora	• What species are present? • What changes will occur during restoration? • What weeds will become a problem? • How can competitive weeds be controlled?	• Where operations will not cause the development of a competitive ground flora • Seedlings/saplings already established before felling • Canopy cover can be maintained over several years by thinning	• Operations will stimulate the development of a vigorous, competitive weed flora that is difficult to control (e.g on heavy moisture-retaining soils, or by disturbing seed banks and exposing mineral soil)
Protection	• What animals and how many are present? • What is the likely damage? • What protective measures are needed?	• Browsing is restricted to levels that allow seedlings to establish	• Browsing is inadequately controlled, or tree seedlings given insufficient protection

Box 5.2 Some characteristics of natural regeneration and planting

Natural regeneration	Planting
• Maintains local genotypes by germination of seed *in situ*	• Where available, nursery stock grown from locally collected seed can be used to maintain local genotypes
• Matches species to microhabitats across the site	• Careful choice of planting site can approximately match species to appropriate microhabitat
• Produces more naturalistic woodland with greater structural diversity	• Well thought out planting designs can produce woodlands with diverse structure
• Success will be unpredictable on some sites	• Predictability of success generally high
• Managers and contractors often have little detailed knowledge or practical experience of the process	• Level of knowledge and experience generally high amongst all involved
• Flexible approach to management necessary at all stages	• Procedures can be more formalised but must still respond adequately to changing site conditions
• On some favourable sites may be cheaper than planting, but the costs of achieving success is initially unknown	• The cost of successful establishment can be predicted with reasonable accuracy before work begins
• The diversity and abundance of species that develop on the site are difficult to control and derive initially from those in the immediate locality	• The proportions of species planted can be clearly defined
• Can supplement planting	• Can be used to enrich natural regeneration

A site with heavy, fertile clays following clearfelling. Vegetation competition is severe and few native seed sources exist. Natural regeneration is unlikely in these circumstances (young trees are from coppice regrowth).

Freely draining infertile site. Given protection from browsing and sufficient seed sources, natural regeneration is usually successful on such sites.

Protection

Damage by mammals

Grazing is a natural process in woodland ecosystems, however, the levels of browsing by deer and rabbits is becoming a major constraint to woodland management[34,35]. Bark stripping by grey squirrels is also becoming widespread and serious[36]. Restoration may only be successful where appropriate steps are taken to prevent or reduce mammal damage. A low level of grazing (i.e. 1–5 deer/km^2) can promote greater diversity in vegetation structure and species composition than either over-grazing, or the absence of grazing brought about by fencing. Average densities of around 4–6 deer/km^2 represent a threshold in the uplands beyond which regeneration of broadleaves and Scots pine is unlikely to occur. In the lowlands thresholds may be higher because of the smaller deer size and more productive vegetation[37].

The main methods of deer control are culling and fencing. The advantages/disadvantages of each are summarised in Table 5.4. Whether browsing and grazing are due to deer, rabbits, sheep or other herbivores, it will be important to reduce pressure to an acceptable level early in the restoration process, particularly if the

Table 5.4 Advantages/disadvantages for methods of deer control

Control method	Advantages	Disadvantages
Culling	• Potential to reduce densities to desired levels and avoid complete removal of grazing (which is unnatural). • Most cost-effective method over large isolated landscape units and areas where neighbours have a co-operative deer management strategy. • Costs can be offset by sale of venison.	• Can be costly and difficult to achieve target densities in some areas (e.g. shooting within established woodland or close to areas of habitation and woods with public access). • Lack of co-operation between landowners reduces effectiveness.
Fencing	• Gives instant control (given sufficient control within the fence). • Can allow rapid growth of seedlings/saplings present before fencing.	• Can be impractical both aesthetically and logistically due to high costs, inaccessibility, snow damage, rocky terrain. • Grazing pressure can be increased in areas outside the fence. • Rapid development of field layer after fencing can arrest new tree seedling recruitment and reduce floristic diversity. • Bird strikes can be a problem (e.g. woodland grouse in the Scottish Highlands) but effective fence marking techniques are available.

aim is to use natural regeneration. Under a continuous cover system, advanced regeneration should be encouraged[38]. On clear fells (even on dry infertile sites) where there is continued grazing and browsing pressure, a grassy sward will often develop and the ideal conditions that existed originally for regeneration of poor competitors such as birch, will be lost.

Management of competing vegetation

Thought should be given to the vegetation changes that will occur after felling. The amount of vegetation management necessary will differ between sites and depend on a wide range of factors. The most significant of these will be the native woodland type, the shade casting characteristics of the plantation species (there may be existing weed problems under light canopies on more fertile sites) and the silvicultural system employed. Additional factors will include the initial site conditions, the impact of reduced browsing pressure and the presence of invasive species, such as rhododendron, in adjacent stands.

Hand-cutting of weeds is generally the least damaging to wildlife although it can cause moisture stress in tree seedlings. Herbicides are usually cheaper and more effective at reducing competition. Their use should be the minimum necessary for effective control and restricted to spot applications. In some instances weed control can benefit the development of less competitive woodland herbs, but care should be taken to avoid selective herbicides where they may harm non-target species (e.g. herbicides for bracken control in areas where there could be rare species of fern).

On some sites, managed grazing by domestic stock (preferably cattle) can be used to break up weedy swards creating niches for tree regeneration and maintaining floristic diversity[39].

Future management

The restoration process will involve some level of management once ancient woodland remnants have been secured and conversion to native species has been achieved[2]. This may be limited to maintaining fences and monitoring structural development, or more demanding where timber is an objective (e.g. enrichment, weeding, respacing and thinning). Possible operations for maintaining general woodland conditions include:

- Enrichment with late successional species (e.g. planting up gaps in birch regeneration with oak).
- Respacing and thinning native species for timber production.
- Respacing/thinning and removal of colonising non-native species.
- Maintenance of public rights of way.
- Protection (e.g. fence maintenance, deer culling).
- Removal of redundant fences.

Naturally regenerated ash on a restored ancient woodland site: respaced for timber production.

Additional work targeted at habitats for key species might include:

- Creation of deadwood or pollarding of veteran trees (e.g. for specialist invertebrates).
- Maintenance of open space (e.g. glades for pearl-bordered fritillary).
- Maintenance of coppice/scrub (e.g. for dormice, brown hairstreak).
- Blocking old drains to restore wet areas. (e.g. mires in native pinewoods).

Archaeological features should be maintained as agreed by an archaeological trust or agency.

Monitoring habitat development

Monitoring should measure progress towards key targets as set out in the management plan. The main focus should be on native tree, shrub and ground flora development and on the effectiveness of operations such as the removal of non-native trees and shrubs, control of conifer regeneration, and control of browsing.

Keep it as simple as possible and choose a methodology which will yield meaningful information. A good photographic record will be invaluable, either using fixed point techniques and/or taking general landscape shots. Assessing whether non-native trees and shrubs have been removed successfully can be done by simply walking through the site. Monitoring the regeneration of both native and non-native trees and vegetation requires a more structured approach, preferably using standardised procedures such as transect enumeration or the 'nearest neighbour' method[40]. Table 5.5 provides examples of the type of monitoring methods that could be used. Further advice on vegetation monitoring is available[41].

Other components of the system could also be monitored, such as the development of the epiphytic flora or colonisation by invertebrates or fungi. Advice should be sought from local ecologists and naturalists or from relevant publications and handbooks[42]. Advice on stocking density and mensuration is available if timber production is one of the objectives of restoration[43]. Whatever monitoring is carried out, keep accurate and properly archived records. This will help in applications for grant aid and for evaluating future developments.

Table 5.5 Examples of methods for monitoring habitat development on restoration sites

Objectives	Examples of typical targets in management plan	Monitoring method	Frequency of monitoring
Removal of non-native trees and shrubs	No mature non-native trees and shrubs remaining	Site visit	Once, after year one in clearfell or after planned phase of transition where a continuous cover management system has been used
Control of browsing	No significant damage to >50% of native tree seedlings	Damage to tree seedlings using standard methods[37]	Every two years for 10 years
Control of regeneration of non-native trees and shrubs	No non-native trees and shrubs present above 2m in height	Systematic or stratified random sampling	Every five years or as appropriate for risk of non-native regeneration
Establishment of native trees and shrubs	Canopy of site-native trees and shrubs established over 50% of site (by a given year).	Systematic or stratified random sampling	Monitor progress every five years
Establishment of typical components of the ground flora	Ground flora species present in 'robust' patches over 50% of site (by a given year)	Systematic or stratified random sampling	Every five years

6. Conclusions

This Guide provides a methodical approach for selecting and prioritising plantations on ancient woodland sites for restoration to native woodland and suggests appropriate management. Much of the advice is based on practical experience. A number of sites continue to be monitored to evaluate progress and advice may be modified as these sites develop. In summary, general recommendations for woodland owners considering restoration are as follows:

- Assess the attributes of all planted ancient woodland sites under consideration, recording information about their landscape setting as well as features within the site.
- Identify threats to biodiversity and prepare priorities for action.
- Identify plantations which are scheduled for thinning or felling. Assess opportunities to secure and enhance features from the former semi-natural woodland and developing components of native woodland.
- Identify other opportunities to improve biodiversity within planted ancient woodland sites.
- Target sites with a high overall potential. Where resources allow, include easily restorable examples of lower priority but not as substitutes for higher priority sites.
- Gain an understanding of the site type (i.e. some assessment of climate, soil nutrient and moisture availability) in order to anticipate how the site fits into area strategies, how it will respond to different forms of management and how it relates to adjacent habitats.
- Where possible maintain the woodland environment and encourage a gradual transition to native woodland.
- Ensure forest operations do not damage valued features or threaten biodiversity.
- Monitor native woodland development and carry out necessary operations to achieve milestones identified within the management plan.

Appendix 1
Glossary

Adjacent
The precise meaning will vary with different circumstances. Importance of proximity will depend upon the nature of the habitat, the mobility of species within it and the degree to which conditions are hostile to potential colonists between the existing semi-natural habitat and the restoration site. Adjoining sources of colonisation will always be preferable. Specialist advice may be needed to identify the probability of colonisation by species within the proximity of a potential restoration site.

Advanced regeneration
Naturally regenerated tree seedlings present under the canopy prior to any felling operations above normal thinning intensity.

Ancient woodland sites
Sites which have been continuously wooded since before 1600 AD in England and Wales, 1750 AD in Scotland and 1830 AD in Northern Ireland. Some of these woodlands may be primary (i.e. remnants of our prehistoric woodlands) and others will have arisen as secondary woodland on ground cleared sometime prior to dates given above. Ancient refers to the history of the *site* as woodland.

Ancient semi-natural woodland
An ancient woodland where the trees and shrubs are semi-natural, i.e. predominantly composed of trees and shrubs that are native to the site and are not obviously planted.

ASSI
Area of Special Scientific Interest (Northern Ireland)

Ancient woodland indicators
Species from various groups (typically flora and invertebrates) which are very slow colonists and/or rely on conditions found within ancient woodland. There is large regional variation, good indicators of ancient woodland in one region may not be so useful in other regions.

CCF
Continuous Cover Forestry[29].

Cleaning
Removal of non-crop trees, either natural regeneration or coppice regrowth, to maintain optimal growing conditions for target species, usually planted.

Conservation agency
Government agency responsible for the protection and conservation of the natural environment i.e. English Nature, Countryside Council for Wales, Scottish Natural Heritage and Environment and Heritage Service (in Northern Ireland).

Double drift (brash)
Also referred to as the Double Timber Zone method. In plantation conditions, this method involves harvesting seven to eight rows of trees within each drift (i.e. into one brash zone) giving more ground protection and greater areas of brash-free ground (12 to 15 m timber zones) see Forest Research Technical Note 18/98 '*Clearfell harvesting systems for purpose built and tracked harvesters*'.

Epiphyte
A plant that grows on the surface of another plant but it is not parasitic on it. Used in this Guide to describe plants growing on the trunks and branches of trees.

Habitat Action Plans
UK wide plans for priority habitats defined under the UK Biodiversity Action Plan. They contain quantitative targets for conserving, restoring and expanding the habitats

Lower plants
Mosses, liverworts, lichens and ferns.

Remnant natural tree
A tree surviving from the former semi-natural stand.

Native woodland
Woodlands composed of site-native and locally native tree and shrub species.

NNR
National Nature Reserve

Non-native species
Trees and shrubs which have been introduced to the UK by the activities of man. Also used to describe species not native to the site and locality.

Plantations on ancient woodland sites (PAWS)
Planted woodlands of any species on ancient woodland sites.

Red Data Book species
Species which are included on Red Data lists published by the Joint Nature Conservation Committee (JNCC). The lists are based on a global system developed by the International Union for Conservation of Nature and Natural Resources (IUCN) for classifying species according to their extinction risk (The World Conservation Union, 1994). The threat of extinction is measured by using quantitative criteria of decline, low numbers and limited occurrence. Red List species are classified as Extinct, Extinct in the Wild, Critically Endangered, Endangered or Vulnerable.

Refugia
Isolated locations where fragments of flora or fauna have survived within a modified environment due to favourable conditions within the immediate locality (e.g. more light, protection from browsing).

Ruderal
Species whose reproductive strategy is adapted to conditions of frequent and severe disturbance. Species are typically short-lived, have a high frequency of flowering, produce large quantities of seed and are rapid colonists of disturbed ground.

Special Area of Conservation (SAC)
A site designated by the UK government under EC Directive 92/43.

Species Action Plan (SAP)
A conservation plan under the UK Biodiversity Action Plan for species based upon knowledge of its ecological and other requirements, which identifies the action needed to stabilise and improve its status.

Semi-natural woodland
A woodland predominantly composed of trees and shrubs that are native to the site and are not obviously planted.

Shortwood
Conversion of trees into pre-determined lengths before timber has been extracted from the wood.

Site-native species
Species which are native to the UK and are present or could be present on sites within their accepted natural climatic and edaphic range.

Skidder whole-pole
A harvesting system where felled stems have their branches removed (snedded) on site and pulled out in the pole length to roadside by tractor and winch (therefore leaving the brash distributed over the site).

Skidder whole-tree
A harvesting system where trees (including their branches) are pulled out to roadside by tractor and winch, then snedded (sometimes by machine) at the point where they are converted into log lengths (therefore concentrating brash into localised piles).

Special Protection Area (SPA)
A site designated by the UK government under the EU Birds Directive.

SSSI
Site of Special Scientific Interest

UK Biodiversity Action Plan
The UK government response to the Convention on Biological Diversity at Rio de Janeiro: includes actions to safeguard key habitats and species.

Appendix 2a
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Appendix 2b
Useful sources of information

Forestry Commission Publications

Practice Guides

1 The management of semi-natural woodlands – Lowland Acid Beech and Oak Woods (2003).
2 The management of semi-natural woodlands – Lowland Beech-Ash Woods (2003).
3 The management of semi-natural woodlands – Lowland Mixed Broadleaved Woods (2003).
4 The management of semi-natural woodlands – Upland Mixed Ashwoods (2003).
5 The management of semi-natural woodlands – Upland Oakwoods (2003).
6 The management of semi-natural woodlands – Upland Birchwoods (2003).
7 The management of semi-natural woodlands – Native Pinewoods (2003).
8 The management of semi-natural woodlands – Wet Woodlands (2003).
Forest Design Planning (1998).
Hazards from trees: a general guide (2000).

Practice Notes

1 Nearest neighbour method for quantifying wildlife damage to trees in woodland (1998).
3 The prevention of mammal damage to trees in woodland (1998).
6 Managing deer in the countryside (1999).
9 Recommendations for fallow, roe and muntjac deer fencing: new proposals for temporary and reusable fencing (1999).

Bulletins

78 Natural regeneration of broadleaves (1988).
102 Forest fencing (1992).
115 Alternative silvicultural systems to clear cutting in Britain: a review (1995).
120 The potential for the natural regeneration of conifers in Britain (1999).
124 An ecological site classification for forestry in Great Britain (2001).

Information Notes

15 Creating new native woodlands: turning ideas into reality (1999).
23 Using natural colonisation to create or expand new woodlands (1999).

Handbooks

Trees and weeds (1993).
Growing broadleaves for timber (1994).

Field Book

8 The use of herbicides in the forest (1994).

Occasional Paper

31 Factors affecting the natural regeneration of oak in upland Britain.

Research Information Note

275 Natural regeneration of broadleaved trees (1995).

Technical Papers

26 Birch in spruce plantations (1998).
28 Herbicide update (1999).

For further information and details of new Forestry Commission publications visit: www.forestry.gov.uk/publications

Electronic (pdf) versions of many titles are available to download.

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Appendix 3
Scarce tree and shrub species

The table below lists the tree and shrub species which are nationally scarce, and/or have limited distributions, or are locally uncommon in the woodland types with which they are associated. Where these species occur on restoration sites, their survival and spread should be encouraged by natural regeneration.

New planting should only be considered when it is clear that the species is site-native and has not been previously planted. Any planting should be recorded and be of locally-derived material. See Soutar and Peterken (1989)[44] for more detailed guidance.

Tree/shrub species	Latin name	Habitat Action Plan Woodland type
Nationally scarce		
Black poplar	*Populus nigra*	Wet woodlands
Box	*Buxus sempervirens*	Lowland beech and yew woods
Large-leaved lime	*Tilia platyphyllos*	Lowland mixed deciduous woods
Midland hawthorn	*Crataegus laevigata*	Lowland mixed deciduous woods
Small-leaved lime	*Tilia cordata*	Lowland mixed deciduous woods
Wild pear	*Pyrus communis*	Lowland mixed deciduous woods
Locally uncommon		
Aspen	*Populus tremula*	All woodland types, excluding lowland beech and yew woods, and wet woodlands
Bird cherry	*Prunus padus*	All upland woodland types
Juniper	*Juniperus communis*	Native pinewoods, upland birchwoods
Whitebeam	*Sorbus aria sensu lato*	Upland mixed ashwoods
Wild service tree	*Sorbus torminalis*	Lowland mixed deciduous woods
Yew	*Taxus baccata*	Lowland beech and yew woods

Appendix 4
Control of rhododendron

Rhododendron control is best tackled at the landscape scale where it coincides with significant concentrations of native woodland. Rhododendron seed can disperse over several hundred metres or more so a local eradication policy will have to consider the range of land-use types in the area. Eradication is ideally targeted on isolated landscape units, such as peninsulas, islands, valleys or wooded estates surrounded by open land, starting from the windward side of any seed source. Co-operation between neighbours is essential.

Control options for restoration sites

There are a number of options for controlling rhododendron. Those recommended for restoration sites are:

- Herbicide applications to individual bushes below 1.3 m height, taking care to avoid unnecessary damage to ground flora or trees.

- Partial removal of tall and large groups of bushes, followed by herbicide applications to stumps to prevent re-growth, repeating as necessary. Alternatively, allow stumps to produce new shoot extensions prior to applying herbicide so that only live stumps are targeted. Partial plant removal without herbicide applications is ineffective.

- Remove small seedlings by hand but dispose of them off-site so that they are not left to re-establish. Where a seed source remains within dispersal distance of the clearance area, delay pulling until the main seed source is treated.

Technical information on herbicide choice, method and timing of application is available from publications listed within Appendix 2b.

Appendix 5
UK Woodland Assurance Standard*

Requirement

Plantations on ancient woodland sites (PAWS) are managed to ensure that they make a significant contribution to the conservation of biodiversity at the landscape scale, whilst at the same time reflecting the owners'/managers' objectives.

Owners/managers maintain the biodiversity and other environmental values of all the plantations on ancient woodland sites. Taking the certification area/forest management unit as a whole, they also achieve an overall enhancement of such values. This will often involve restoration of some areas to native woodland. This is achieved by:

- Appraising the value and management of the PAWS in the context of semi-natural woodland and other habitats in the landscape.
- Carrying out ecological surveys and assessments of all plantations on ancient woodland sites.
- Evaluating these sites in terms of their importance for biodiversity and their potential for restoration to native woodland in order to identify relative priorities between them.
- On the basis of the evaluation, deriving a strategy which forms an integral part of the management plan and which identifies opportunities and priorities and will achieve the maintenance, enhancement and restoration aims.
- Implementing this through suitable low impact silvicultural systems and sensitive forest operations.
- Monitoring and reviewing the outcomes to demonstrate that the strategy is being implemented and to assess how well the aims are being achieved.

Means of Verification

All woodlands:

- Management planning documentation.
- Field observations.
- Discussions with owner/manager.

Guidance

Surveying

The assessment could follow a hierarchical approach (for example the survey methodology developed for the Caledonian Partnership). The assessment may be a gradual process and need not always be a formal ecological survey or require the input of professional ecologists.

Evaluation

Criteria for evaluating ecological importance of individual PAWS include:

- Ecological context at a landscape level.
- Nature conservation designations (SSSI etc) including adjoining sites.
- Regional scarcity or importance of woodland type.
- Potential size of the restored woodland.
- Areas targeted in local plans and strategies (e.g. National Park).
- Importance for BAP species.

Criteria for evaluating ecological potential for restoration include:

- Presence of locally native trees and shrubs.
- Presence of characteristic native woodland flora (especially ancient woodland indicator species).
- Presence of old trees and deadwood.
- Potential for BAP priority species.

Other factors that will influence the strategy include:

- Cultural and historic interest.
- Scenic value and potential for landscape enhancement.

*Reproduced directly from UKWAS

- Amenity and recreational values.
- Economic considerations.
- Management of the remainder of the forest including creation of new native woodland.

Strategy

The owner/manager's strategy may identify three broad management categories (albeit recognising that there is a continuum between them) and will categorise stands according to the environmental priorities derived from the above evaluation:

- Areas where biodiversity interest will be maintained but will otherwise be managed as conventional plantations.

- Areas to be managed in a way that enhances their environmental values.

- Areas to be restored to native woodland (i.e. to tree and shrub species native to that site).

Restoration Targets

As a guide owners/managers should look to achieving restoration of at least 10% of the area of PAWS. This should be carried out during the first 10–15 years following certification. In determining any restoration targets the owner/manager should make reference to the UK Forestry Standard (SN5 & Annex 3), national HAP and local BAP targets and other relevant local strategies. Restoration should be concentrated on areas of highest priority for biodiversity enhancement.

Achieving these areas of restoration in the timescale suggested may not be possible where age structure makes this silviculturally inappropriate.

Furthermore, in situations where an owner/manager is already achieving significant enhancement of biodiversity in other ways this generic target may not be appropriate. Examples of such situations include:

- Where a significant proportion of the woodland/forest area (e.g. a third to a half) is semi-natural woodland managed in accordance with section 6.1.2 [of the Standard].

- A significant proportion of the woodland/forest area (e.g. a third to a half) is being actively managed with biodiversity as a primary objective.

- Where owners/managers can demonstrate that they have achieved such rates of restoration since the introduction of the Broadleaves Policy in 1985.

- Where comparable areas of forest are being restored to non-woodland habitat (see 3.5.1 [of the Standard]).

Appendix 6
Useful addresses

Forestry Commission
National Office for Scotland
231 Corstorphine Road
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EH12 7AR
Tel: 0131 334 0303
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Forestry Commission
National Office for England
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Forestry Commission
National Office for Wales
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