Forestry Commission

Practice Guide

Managing open habitats in upland forests

FOREST SERVICE

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Contents

Introduction

Many habitats important for biodiversity in the UK have become reduced and fragmented and are now in need of protection, restoration and expansion. Priorities for conservation are habitats that have the potential to provide the richest and most varied components of biological diversity. These include habitats that support species subject to EU Directives or that are priorities of biodiversity strategies in England, Scotland, Wales and Northern Ireland. The conservation of woodland biodiversity and the enhancement of forest and woodland habitats are key environmental principles of sustainable forest management and requirements of The UK Forestry Standard (UKFS). The UKFS also requires that we restore important semi-natural habitats where practicable. Beside native and semi-natural woodland, important habitats include the open ground that is associated with forests and woodlands.

Scope

The UKFS Guidelines on *Forests and biodiversity* set out the factors that contribute to sustainable forest management and biodiversity in the UK, including principles related to the treatment of open, scrub and edge habitats. However, the Guidelines do not give detailed practical guidance on how to create, restore or manage these 'non-wooded' habitats. This Practice Guide has been produced to provide landowners and forest and woodland managers with the information and practical guidance they need to understand open habitats and identify appropriate options for managing them; it suggests sources of more detailed information and includes case studies that illustrate good practice across the UK.

The Guide focuses on **upland** forests, particularly those which are planted, commercially-managed and composed of non-native conifers (Figure 1). Complementary guidance for **lowland** forests is available in the Forestry Commission Bulletin *Managing rides, roadsides and edge habitats in lowland forests*. The techniques suggested in this Guide are based on ecological principles rather than exhaustive trials and are recommended to be used in an adaptive management approach.

Figure 1 Upland conifer forests such as this example in the Trossachs in Scotland, contain open habitats which provide a range of benefits if managed appropriately.

What are open habitats?

In a forestry context, 'open space' is defined as areas with less than 20% canopy cover of trees and shrubs.

The term 'open' is used here to mean unwooded. Open habitats are the habitats on open ground plus the aquatic habitats of open water. Virtually all open ground is habitat for some plants and animals, and several distinct habitat types are recognised. These are defined by combinations of characteristic plant communities and soil or other environmental factors. Limestone pavement (Figure 2) and montane scrub (Figure 3) are examples of open habitat.

Open ground associated with forests can take many forms and be spread throughout the wooded areas. Road and stream corridors, turning areas, wayleaves, rides, quarries, deer glades and areas of failed trees make up an internal network of small and linear open areas. Clearfelled coupes, and those recently restocked, add larger patches but are only temporarily open. More extensive unplanted areas include land above the commercial planting limit, moorland, blanket bog and other open habitats protected for nature conservation. There may also be areas left unplanted for archaeology or landscape design. Lastly, the external edges – any unplanted ground between the outer trees and the land boundary – add to the overall area of open ground in a forest.

Open ground does not have to be treeless to provide valuable habitats that complement those found in closed-canopy woodland; a sufficiently low density of trees growing on an open habitat can add valuable microhabitats. However, their benefits must be balanced against any detrimental effects, such as the potential for invasion by regenerating trees. Wood pasture and bog woodland (Figure 4a) are just two examples of highly valued open habitats with trees. Other sparsely treed areas that can provide valuable semi-open habitats, particularly for invertebrates and their many predators, include mosaics with dense patches of scrub interspersed with more or less treeless patches of low vegetation and areas with a low density of trees or shrubs that are more evenly scattered.

Figure 2 Juniper and birch growing on a limestone pavement, a rare type of open habitat in the UK.

Figure 3 This willow treeline scrub is a valuable habitat, which is now rare due to upland grazing and burning.

Aquatic habitats such as streams, rivers, lochs, lakes and ponds (Figure 4b) greatly add to overall forest biodiversity but are easily affected by activities in the catchment – especially near the water's edge. Their habitat condition needs to be protected and can be improved by positive management where it has been degraded in the past. Further guidance on management relating to aquatic habitats in the UK can be found in the UKFS Guidelines on *Forests and water* and in *Restoring and managing riparian woodlands* published by Scottish Native Woods.

Springs and flushes (Figure 4c) are important habitats for 'dwarf' plants. They will often have been planted over when forests were established in the past, but they should often be restorable. These areas are easy to recognise and are worth incorporating into the open ground network when designing new forests, restructuring existing forests or revising forest management plans.

Rocky habitats (Figure 4d) include cliffs and crags, scree patches and boulder fields, ravines, gorges, streamside gravel deposits, and man-made road cuttings and quarries. In some situations they are valuable habitats for dwarf plant communities, ferns, mosses and lichens. Some are valuable habitats for invertebrates or nesting sites for birds.

The area of open ground on the public forest estate in the uplands amounts to around 34% of the landholding but this includes some extensive open areas outside forests. Integral open ground occupies around 12% of land in upland forests managed by the Forestry Commission (in Wales now Natural Resources Wales); the corresponding figure for forests in other ownerships is around 13%. In many forests, the proportion of open space is increasing as forests are restructured and management plans are implemented. In some cases it may well reach 25% or more by the time current management plans are put into place.

Figure 4 Examples of the different types of open habitat associated with forests: (a) sparsely wooded bog; (b) pond; (c) spring and flush; and (d) a rocky habitat provided by an old quarry.

The value of open habitats

Habitat diversity can be low in commercial forests composed of even-aged, single-species stands. Such stands may still provide valuable habitats for many woodland species, including rare birds such as the capercaillie and goshawk, but practices such as restructuring, long-term retention, deadwood management and conversion to continuous cover forestry can all increase habitat diversity and benefit a wider range of species. The addition of open and semi-open habitats complements wooded habitats to increase overall biodiversity.

Open ground and woodland edges provide quite different habitats from those within tree stands and thus support a different range of species. A number of plants and animals native to the British Isles is adapted to these habitats and so forest open ground has the potential to support many of these species. In some regions agricultural improvement in the uplands has been so thorough that unimproved grasslands are uncommon outside forests. Pockets of such land may have the potential to support some species not favoured by upland farming.

Open habitats provide other important ecosystem services in addition to their value in supporting biodiversity. They contribute to attractive, diverse landscapes, play a role in maintaining views (e.g. from footpaths or important viewpoints) and provide visitors with the opportunity to see wildlife. In addition, bogs play a role in regulating water supplies while, in common with fens, they actively accumulate carbon and at the same time protect the enormous carbon stores already laid down as peat.

Why manage open habitats?

In natural ecosystems, habitat diversity is maintained by natural disturbances. However, many of the disturbances that would operate in the uplands of Britain are now controlled to prevent adverse impacts on land management activities. For example, the risk of forest fire or windthrow is reduced by using short rotations; deer populations are managed to limit browsing on young trees; and grazing is controlled by excluding cattle and sheep – inadvertently limiting grazing on forest open ground at the same time. Without positive management to emulate natural disturbance, the condition of many open habitats in the forest would deteriorate.

A low-disturbance regime, and especially a lack of grazing, allows the fastest-growing plant species to become dominant. These shade out smaller and slower-growing species, resulting in a loss of species diversity. Shade from adjacent trees encourages some plants but constrains the range of light-demanding plants that can grow on rides and narrow road and stream corridors. Some species may grow but be unable to flower. Appropriate re-design and management can reduce these limitations.

Climate change is altering the available 'climate space' for many animals and plants. They are tending to lose climate space in the south and at low altitude and gain it in the north and at higher altitude. The capacity for these species to maintain a viable population will rely on there being sufficient suitable habitat available in areas where their climate space has extended and on the species being able to reach and colonise those habitats. Well-managed open space in forests and woodlands can add to the supply of suitable habitat. Open ground in forests that is ecologically connected to other open ground, both internally and externally, may be particularly valuable for species movement in the drive to colonise new habitats. However, open ground networks may also favour the spread of invasive non-native species, so this needs to be carefully considered.

Which areas are important?

Important areas to consider for conserving or restoring open habitats include sites which are designated for open habitat features or species (Figure 5) and sites with habitat types that support species which are conservation priorities (Figure 6). Conservation status will have a strong influence on the management priority for a particular area of open habitat (see Prioritising open habitats for management on page 7).

Appendix 1 lists the main types of conservation designation in the UK that may be relevant for upland habitats and species in upland forests. The most important designations are those for Natura 2000 sites which were selected to meet European Union (EU) Directives for habitats and species and for wild birds. These Directives also listed habitats and species which are priorities across the EU.

Between 1995 and 2007, lists of UK priority habitats and species were drawn up for use under the UK Biodiversity Action Plan (UKBAP). Examples of upland priority habitats are shown opposite. The UKBAP no longer exists, and each UK country now has statutory lists of habitats and species of importance, which include relevant parts of the UK lists plus some more which are specific to each country. For more information, see the JNCC (Joint Nature Conservation Committee) website at http://jncc.defra.gov.uk.

Some regional biodiversity groups and nature partnerships include other locally important habitats that are not on the national lists. Their local status should also be considered when deciding priorities for action.

The size of an area of open habitat also has a bearing on its priority for management. All other things being equal, there is greater biodiversity gain from managing a large patch of habitat than a small patch of the same type, and economies of scale can also be achieved. Importantly though, some types of habitat are only found in small patches, as are most habitats in areas of complex topography, and this should not diminish priority for management.

Priority open habitat types often associated with upland forests include:

- Upland heathland
- Blanket bog
- Upland hay meadows
- Upland calcareous grassland
- Limestone pavements
- Mesotrophic lakes
- Oligotrophic and dystrophic lakes
- Wood pasture and parkland
- Ponds
- Inland rock outcrop and scree habitats
- Upland flushes, fens and swamps
- Mountain heaths and willow scrub

Figure 5 Although not priority habitat types in themselves, forest rides, glades and other open habitats benefit priority species such as the pearl bordered fritillary (*Boloria euphrosyne*).

Figure 6 Black grouse (*Tetrao tetrix*) are a protected species which use open ground such as moorland or farmland in association with nearby forests and woodlands or scattered trees.

Getting the information you need

The management of open habitats in upland forests requires information for three distinct purposes. Firstly, knowing what priority habitats and species are present on a particular site. Ideally, maps showing discreet patches of habitats of different types are needed for this purpose, including those habitats known to be used by important priority species. Secondly, details are needed about the habitat patches that will help prioritise sites for management. These include information on current condition and ecological value, trends in condition and value under the current management regime. They should also include possible management options with likely impact on future condition and initial and long-term maintenance costs. Thirdly, further information will be needed when it comes to planning the management operations in detail.

Information about habitats

The **National Vegetation Classification (NVC)** is a comprehensive classification and description of the plant communities of Britain used by the nature conservation agencies to describe and assist in the evaluation of habitats. Find out more at **http://jncc.defra.gov.uk**

For statutory designated sites (SSSI, ASSI, SPA, SAC, NNR, Ramsar – see Appendix 1), it is normally possible to find out what habitats are present by obtaining copies of habitat and/or vegetation maps from the relevant national nature conservation agency. Most designated sites (Figure 7) will have had a habitat survey done, using the broad-brush 'NCC Phase 1' methodology and/or a more detailed National Vegetation Classification (NVC) survey. Phase 1 classes and NVC communities corresponding to the priority open habitats likely to be found in upland forests are shown in Appendix 2.

For land not subject to statutory designation, habitat or vegetation maps may not be available – in which case a survey will be required. NCC Phase 1 is a well-used survey methodology and experienced contractors are likely to be available to carry out the survey work. However, the Phase 1 survey does not unambiguously identify priority habitat types (see Appendix 2) and it is probably better to specify a survey protocol specifically for this purpose.

Figure 7 Good information on priority habitats is usually available for designated sites, such as this SSSI at Strathrory in Easter Ross.

A survey will typically focus on a single forest management unit, i.e. the area covered by a single forest management plan or proposal). It is useful to extend the survey beyond the forest boundary to cover the local landscape so that ecological connectivity with habitat patches outside the forest can be considered. This will require prior identification of areas outside the forest potentially containing priority open habitats, perhaps by using aerial photographs, web-based satellite imagery such as Google Earth, or land cover maps.

Information about priority species

There is no infallible method of finding out what priority species are present in, or use, a particular area. Existing records can be useful but recording intensity varies with geographical area and taxonomic group so these will, at best, provide only partial coverage of the priority species in your area.

The National Biodiversity Network (NBN) Gateway (www.searchnbn.net) provides access to a wide range of species records and is the best place to start looking. It holds records contributed by many professional and amateur naturalists and nature organisations and is searchable by geographical area. Data from surveys of individual priority species are particularly useful. Users can register to obtain access to restricted records not available to the general public. The Centre for Environmental Data and Recording (www.habitas.org.uk) is an additional useful source of species records for Northern Ireland.

Local knowledge can be a useful source of information on the presence of priority species. Forest rangers, gamekeepers, farmers, local naturalists and other local residents may know what bird and mammal species are present in an area. Anglers may know the fish species present. Local naturalists may also know about some of the less well-known groups, such as plants and invertebrates, and may have contributed their records to the NBN. Members of specialist botanical or other natural history societies may have recorded in an area – active engagement with these groups is a good way to access this information.

Field surveys can be conducted to complement existing records and knowledge but should be focused on species thought likely to be present. Surveys to cover priority species in general are expensive because of the wide range of specialist expertise and identification skills required.

Prioritising open habitats for management

Table 1 provides an example of an initial order of prioritisation for managing open habitats according to their nature conservation status. Management of open habitats as a conservation measure for priority species has not been included but should be prioritised on the merits of each case. Information from the priority habitats survey will tell you whether habitats are of a priority type. The boundaries of statutory designated sites will already be known. Notified interest features of SSSIs are available from the statutory nature conservation agencies and, for those in England and Scotland, are given on the relevant agency website (see Further reading and useful sources of information on page 34).

Information on condition trends for habitat patches is helpful when it comes to prioritising among habitat patches. Stable and improving sites may be lower priority than deteriorating sites but all sites will require judgement as to their potential. Some deteriorating sites may be judged to have little potential and so will automatically be low priorities for management.

Table 1 Suggested order of priority for managing open habitats according to their nature conservation status (see Appendix 1 for further explanation of conservation designations).

Order	Conservation status of open habitat
1	Notified interest feature of an Site of Special Scientific Interest (SSSI) in Great Britain or Area of Special Scientific Interest (ASSI) in Northern Ireland.
2	Priority habitat type within, but not a notified interest feature of, an SSSI or ASSI.
3	Non-priority habitat type within, but not a notified interest feature of, an SSSI or ASSI.
4	Priority habitat type not in an SSSI or ASSI but within a non-statutory nature conservation site.
5	Priority habitat type not in an SSSI or ASSI and not within a non-statutory nature conservation site.
6	Non-priority habitat type not in an SSSI or ASSI but within a non-statutory nature conservation site or of an LBAP or country biodiversity list habitat type.
7	Non-priority habitat type not in an SSSI or ASSI nor within a non-statutory nature conservation site or of an LBAP or country biodiversity list habitat type.

Condition of SSSI/ASSI interest features and, in most cases, trends in their condition can be obtained from the national nature conservation agencies, who set condition targets and monitor them using Common Standards methodology (see 'Habitat condition monitoring' on page 26). For other sites, the landowner or manager would need to assess the condition of habitats being considered for management and it will be helpful if this also indicates whether condition is deteriorating, stable or improving. This assessment need not be complex: for example, a non-designated area of upland heathland in a forest with no known priority species may simply be assessed for tree canopy cover and the structural diversity of vegetation or extent of old, layering heather (see the section on Habitat-specific guidance on page 18).

Prioritising open habitats for management might also be influenced by how well candidate habitat patches are ecologically connected to networks of the relevant habitat type. Information about the cover of the intervening land is helpful for considering ecological connectivity among open habitats (see 'Maintaining open habitat networks' on page 13). If the information is not already available (e.g. in the form of stock or sub-compartment maps or datasets) it could be gathered in addition to the priority habitats survey. Aerial and satellite imagery can be useful sources of information.

Tree stands of different type and age class would need to be mapped, as would open ground corridors and other open areas. Ideally, ecological connectivity to priority habitats outside the forest should also be considered – requiring information on, for example, the location of streams, roads, other linear features, moorland, other areas of semi-natural vegetation, fields and shelterbelts. Existing data sets (e.g. LCS88 in Scotland, LCM2000, LCM2007) should be commercially available. In some cases, local NCC Phase 1 survey data may be available. A broad-brush survey could be commissioned as a last resort.

Open habitats in forest design

Creating open habitats in existing forests and planning open habitats in new forests can make a significant difference to their value in terms of biodiversity benefits and general amenity. To those who visit upland forests and woodlands their visual appearance as 'natural' landscapes is often as important as their appreciation for their nature conservation value. This section provides guidance on what types of open habitats are most beneficial, where they are best located and what issues need to be considered in their design.

The design of open ground in forests and forest and woodland margins should comply with the UKFS Guidelines on *Forests and landscape*. Detailed guidance on aspects of visual design can be found in a number of key texts (see Further reading and useful sources of information). As a general principle it is important to avoid creating regular, geometric shapes in the landscape and instead ensure that the edges of habitat patches relate to their natural boundaries.

Planning open habitats in new forests

Even without special planning there will be some open areas created in new forests for operational reasons, e.g. rides, road edges, streamsides and deer glades. There is scope to increase biodiversity and amenity value by modifying the design of such spaces to provide wildlife habitats or corridors and open areas for other purposes.

Linear open habitats

Linear open ground can provide valuable internal edge habitats for a range of species. There is scope to improve the value of linear features such as rides and road corridors by modifying their design at the planning stage. Sunny edges are the most beneficial and are found on sufficiently wide rides and other open corridors that are aligned east to west – or within 30° of this. Narrow rides become shaded as adjacent trees grow and ultimately are of limited habitat

Box 2 – Designing a range of habitat and microhabitat types

Every habitat type supports some unique species. These 'habitat specialists' are sensitive to land-use change and will disappear from an area if their habitats are not retained. The varied, small-scale features of habitats (i.e. microhabitats) are also important, particularly for invertebrate species, as they are used for different purposes at different stages of their life cycle. Habitat patches containing a range of microhabitats can support more species than very uniform patches lacking in diversity. However, some upland habitat types such as blanket bog and upland heathland are valuable for biodiversity despite appearing to lack much microhabitat variety.

Incorporating a range of habitat types into a new forest should help maintain biodiversity, provided that they are managed appropriately over the long term. Care is needed if planning the creation of new habitats; appropriateness to the particular situation and environmental character of the site need to be carefully considered. Avoid artificially creating habitats that will require intensive management – these are unlikely to be sustainable in the long term. However, re-creating habitats that would once have been present is usually appropriate. These will often be habitats associated with former disturbance regimes, such as grazed grasslands and burnt heathlands. Habitats that could never have occurred naturally, such as a calcareous grassland in an area with acidic rocks and soils, are inappropriate. Examples of the latter are sometimes seen on road verges where calcareous road-stone has been brought in for forest roads. This can increase biodiversity but detracts from the natural integrity or character of an area.

River and streamsides and loch and lake shores are required to have a riparian buffer area of at least 10 m. The buffer should be a mixture of open and lightly-wooded habitats consisting of native vegetation. See the **UKFS Guidelines on Forests and water** for more details.

value; many species will only use these linear spaces if they are at least 15 m wide and, where possible, this should be the minimum design width. Designing wider and more varied spaces with edges that are graded in density and height increases the habitat value substantially while only adding 1–2% to the overall proportion of integral open ground. Not much is known about how corridor effects work, but shelter from strong winds is probably important for many invertebrates. Curved or convoluted corridors or those with constrictions at intervals are probably more useful than straight corridors of uniform width. Also, if such corridor variations are designed with respect to the local landform they will achieve an appropriate fit with the character of the local landscape.

Box 3 – Designing large habitat patches

The larger an area or patch of habitat, the more species it is likely to support. This applies particularly to larger open areas and less to the network of linear open ground which is valued more for its edges and as corridors. At least two different effects account for this. Firstly, any species inhabiting a patch will have a minimum viable population size, below which the species is vulnerable to extinction; the larger the patch, the greater the number of species the patch can support. Second, in general, the larger the patch the greater the diversity of microhabitats it is likely to contain (Figure 8).

How can large habitat patches be designed?

Some habitat types (e.g. springs) are inherently limited in extent. Even with a buffer area to prevent shading, they may occupy as little as 0.1 hectare. Extensive habitat types, such as heaths and blanket bogs, can occupy large areas. It can be appropriate in forests to retain or restore patches of these types as large as 100 hectares (1 km^2) or even larger. Neighbours should be involved if the habitat could be extended onto adjoining land. Where there is a choice, it is generally better to have one large patch of a habitat type than several separate small ones, except where the requirements of particular species preferring smaller openings – such as nightjar or dragonflies – override this. Such a choice may present itself when designing a new forest on an extensive area of heathland or when redesigning an existing forest on a former heathland or blanket bog.

Figure 8 Large habitat patches such as this blanket bog at Altnaharra in the north of Scotland contain a range of microhabitats which support distinct species groups.

Discrete habitat patches

When designing a forest around habitats that occupy a discrete topographic position, such as bogs and wetlands, keep the tree stands clear of the entire habitat patch – including the outer edges where soil conditions are transitional with those of adjoining ground. A further buffer zone, at least 30 m wide, should be left to prevent the transition zone or 'ecotone' from becoming unduly shaded as the trees grow. For water-based habitats, leave the lower 50 m of input slopes clear of trees to buffer the habitat against changes in the amount and quality of water it receives. Again, good design of the margins and transition edge detail will mean that the conserved habitat interlocks with the adjacent forest and the wider landscape.

Open habitats used by priority species

While new forests provide new habitat opportunities for wildlife, as the trees become established there will be some displacement of wildlife that used the open land before. Despite this trade-off, it is important not to endanger priority species using the land. To avoid this, open habitats used by priority species should be identified, retained and managed as open habitats within the new forest. For example, a wetland area used as a hunting ground by hen harriers should be retained, as should an area of moorland with juniper bushes. Pearl-bordered fritillary butterflies inhabiting bracken patches should benefit from tree planting around the edges but the bracken areas should be left open. All these habitat areas for priority species should be identified at the survey stage and incorporated into the design. These patches should become an essential part of a wider network of spaces and corridors throughout the forest, designed to be appropriate for the development of habitat networks and to the local landscape character.

Quiet open habitats

By considering which areas of the new forest are least likely to have significant levels of human activity and noise, such as those associated with forestry operations, recreational activities or events, it should be possible to design secluded open habitats where nesting birds and other wildlife will not be unduly disturbed. These should be designed as integral areas of the wider forest and with the appropriate selection of tree species and silvicultural system that will conserve the essential quiet nature of the open ground and discourage public access.

How much open ground

Increasing the area occupied by large open spaces in planted forests can have a positive impact on their biodiversity. A key consideration when planning and designing a new forest is how much open ground to retain. Several factors should influence this decision:

- The proportion of open space required by the *UK Forestry Standard* (10% of the forest management unit.
- The presence of priority open habitats (see http://jncc.defra.gov.uk).
- The need for visual and ecological balance in the landscape.
- The potential to create priority native woodland habitats.
- The forest type and overall management objectives.
- The specifications of any relevant grant or certification scheme.
- The size of the forest. In very small forests it can be more beneficial to leave a good margin of open ground between the trees and the outer boundary than to break a small block up into even smaller units.

Distribution of open ground

Open areas should be distributed so that individual patches are large enough to retain their interest features. They should be designed so that they are ecologically connected to others in the area and will remain so in the future. The locations of most valuable open habitats are determined by site characteristics and therefore are fixed. The forest should ideally be designed around the valuable open habitats, rather than the other way around. Remember that this includes non-priority habitats used by priority species.

Open buffer zones are needed around the outside of open habitat patches to prevent them from becoming shaded, protect them from fertiliser drift and to allow diverse natural ecotones to develop. Open ground corridors are beneficial between the open habitat areas, including links to patches outside the planned forest. Some priority species have particular design considerations: for example, open ground adjoining moorland is of high value to black grouse.

Areas not currently supporting valuable habitats but with the potential to do so should also be considered. Some habitat types not regarded as priorities can still be extremely valuable for biodiversity and some examples are worth retaining and managing – especially if in good condition or with potential to be improved. Upland acid grassland and upland neutral grassland fall into this category.

Future management

Consideration needs to be given to the future management of open habitat patches and of the interlinking network. Access or even the infrastructure needed to allow appropriate management (e.g. livestock fences, gates and watering places) should be incorporated into the forest design. In some cases, non-intervention may be judged appropriate (e.g. in the case of acid grasslands likely to undergo succession to heath or scrub); in others, pro-active management will be needed; for example, most grasslands need to be grazed or subjected to an equivalent form of management to retain their biodiversity. Such areas therefore need to have an access route suitable for driving livestock along or suitable for a tractor and mower. There is little point in retaining patches if the appropriate management cannot be incorporated.

Balancing open ground with other objectives

Open ground and valuable open habitats may occupy a surprisingly large proportion of a new forest. The desire to retain these may sometimes conflict with other goals, particularly those of timber production, carbon sequestration and creating new native woodland. In some cases, compromise may be required in reaching agreement on a final design, while adhering to UKFS requirements. Prioritising different open habitats may be the only means of substantially reducing the proportion of the area designed as open ground.

Some open ground habitat types (such as dwarf shrub heath and grasses) have a higher wildfire risk than others, especially during spring and summer or after long dry spells. This risk should be assessed during planning and control measures implemented in areas at high risk. More information can be found in the Forestry Commission Practice Guide Building wildfire resilience into forest management planning.

Creating open habitats in existing forests

When opportunities arise, the design of existing forests should be altered to enhance and better connect existing patches of open habitats, allow former open habitats to be restored, and create new habitats. Many existing patches will not have been designed to maximise habitat value and in some cases the original open areas may have been partly planted over or are so small that a large proportion is subject to shading by adjacent trees. Changes in management, such as abandoning grazing, will potentially reduce habitat value. The potential of existing open areas should be assessed and the practicality of getting them into good condition considered. Undesignated and biodiversity-poor habitat patches without a specific purpose or much potential for improvement could be earmarked for planting to create new native woodland. However, such decisions need great care and a long-term outlook; it may take years for a new woodland habitat to provide benefits equivalent to those of long-established open habitat.

Restoration of former open habitats

Re-creation or restoration of former open habitats can substantially increase landscape-scale biodiversity. However, permanent forest clearance for habitat restoration will be subject to Environmental Impact Assessment (EIA) Regulations and open habitat and woodland removal policies. A felling licence from the Forestry Commission is required to fell trees in Great Britain, except where the felling is specifically included in planning permission.

Maintaining open habitat networks

The aim of open habitat networks should always be to ensure that patches of a habitat type are ecologically connected. To benefit the species that use a particular type, patches should be enlarged and, where possible, joined up with nearby patches of the same type. Land in between patches should be managed in a way that makes it easy for species to move between them. This may involve reducing the size of patches of other habitat types, particularly if they are wooded, and this will impact on species of those habitats. An obvious conflict of interest arises between favouring woodland species and those of open habitats. In the end, it may come down to prioritising habitat types and favouring the higher priority type if this conflict occurs.

Box 4 – Designing habitat networks

Plant and animal species that can disperse over long distances (e.g. hare's-tail cottongrass or nightjar) can eventually reach most patches of suitable habitat. Species only able to disperse short distances may not be able to reach isolated habitat patches, however suitable. To provide for the less mobile species, patches of a particular habitat type need to be contiguous or ecologically connected. Where possible, habitat networks representing the various open and wooded habitats present at a site should be considered at the landscape scale, and not just for individual forests. This will entail working with neighbours and perhaps local authorities. Where this is not possible, and you are designing a habitat network for a particular forest, consider habitats outside the forest. Try to ensure that, for any particular habitat type, the network in the forest is ecologically connected to nearby patches outside.

Creating or restoring new habitat patches can ease movement of species between existing patches of the same habitat type. Small or relatively poor quality habitat patches that meet only some of the needs of a species can still be valuable as 'stepping stones'. The network of roads, rides, streams and wayleaves in forests is crucial for the dispersal of species that cannot inhabit or move through or over tree stands. With appropriate design and management, and consideration of any potential negative impacts that might occur due to the spread of invasive non-native species, these linear open areas can be useful as 'corridors' linking habitat patches. To design linkages to open habitats in new forests, identify the easiest routes for species to get from external habitat patches to the forest edge. This may be along the edges of a stream, shelterbelt or hedge, a roadside, railway line or field margin or over moorland. Linkages from open habitat patches in the forest should be designed so that they join up with external linkages at the forest edge.

Managing open habitats

Purposeful progress can be made when managing open habitats for biodiversity once the objectives are set and a vision of the outcome is formed. Some general principles will benefit most open habitats – for example, keeping the habitat open, aiming for an appropriate level of vegetation disturbance, encouraging the development of ecotones and avoiding unsustainable management objectives. An understanding of each particular habitat will help in planning effective management. This section deals with the management process and provides guidance on the basics of managing the different habitat types.

Setting objectives

As with any other forest operation, decisions on management of open ground should be geared toward achieving one or more stated objectives. *The upland management handbook* (see Further reading and useful sources of information) explains how to set habitat management objectives based on evaluation of sites and identification of trends in habitat condition or in the population of species of particular interest. If the main conservation interest is in vegetation that is currently in unfavourable condition and not recovering, or in a species population currently in decline, these may be the target for a change in management. Favourable or recovering vegetation and stable or increasing species populations may require the continuation of current management.

The scale at which management is planned will determine the size of the open areas for which separate objectives need to be set. Large open areas should normally be given specific objectives whereas the ride network within a forest might be dealt with as a single entity. In very large forests, the ride network could be subdivided on the basis of altitude, lithology, vegetation or soil type. Roads and streams are likely to need separate sets of objectives from those of the ride network. Road corridors have a wider range of microhabitats (i.e. road surface, road edge, verge, ditch, bank, roadside and forest edge). Other management purposes, particularly vehicle access, are important here.

Stream corridors have a different range of microhabitats (i.e. stream, stream edge, bank, streamside and forest edge). Safeguarding water quality will be a major objective for riparian open areas, as will providing good quality aquatic habitat in terms of the balance of light and shade and the inputs of invertebrates and leaf litter that fish and other stream-dwelling creatures feed on. Information for forest managers on protecting the freshwater environment is given in the UKFS Guidelines on *Forests and water*.

When setting objectives it is important to be realistic about what can be achieved. Consider how important biodiversity conservation is among other management objectives for the forest in question. Take account of the likely budget, not just in the short term but also in the much longer term and compare this with an estimate of the ongoing 'maintenance' cost of the management. Initial enthusiasm for the activity can help find ways to make a successful start but objectives must be realistic so that the ongoing maintenance can be met.

It is difficult to estimate costs of management options as they are often very site-specific. The most useful cost information usually comes from other site managers who have experience of the options under consideration. In the case of bogs and fens, websites such as www.peatlands.org.uk exist as a forum for exchanging information gained from experience of managing and restoring these habitats.

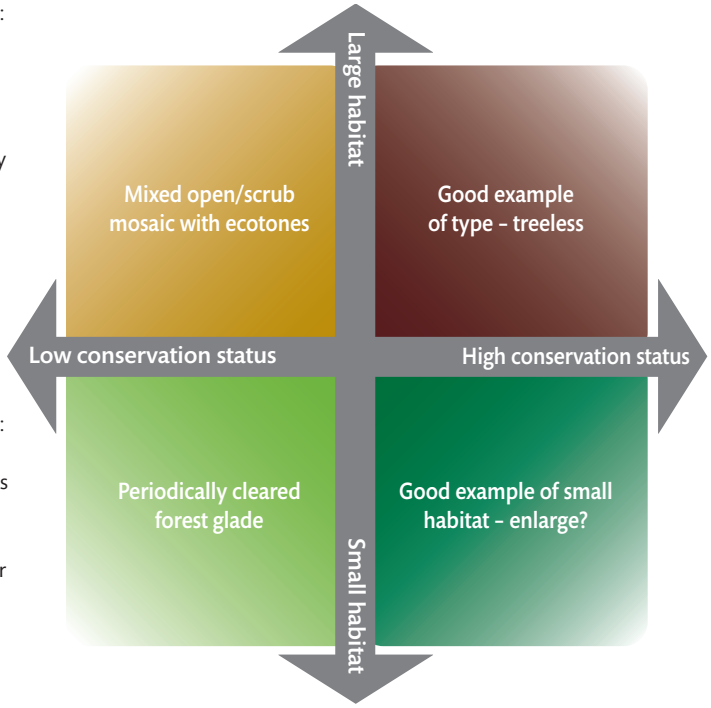
Setting target conditions

Assessing the size and conservation status of a habitat and using this information to influence the desired end point is one approach to setting a target condition for an open habitat. This allows biodiversity benefits from all open habitats while ensuring that sufficient effort goes into managing the more important sites. The matrix shown in Figure 9 suggests target conditions for a range of sites, from small to large and of low and high conservation value. A target condition can be specified in broad terms, but it can also be tailored for specific sites. This could include specifying a structure in terms of trees, shrubs, field layer and sward height, and maintenance and enhancement or limitation of any particular species populations present.

Figure 9 Matrix to show target conditions for a range of sites.

Large, less important open habitat: there is scope for setting a target condition more in keeping with the wooded landscape context – a mixed open/scrub mosaic with ecotones can have high biodiversity value and is less exacting in its management requirements than the textbook condition. An appropriate level of grazing may be the most cost-effective form of management for these sites.

Small, less important open habitat: this may have more limited biodiversity potential – potential as forest glades may be easily achieved simply by periodic clearance of self-seeded trees. Deer control and, where practicable, light grazing could be beneficial.



Large patches of open habitat in areas of high conservation value (including statutory designated sites) – target condition will have been set by the relevant statutory conservation agency and will usually be treeless – close to a textbook ideal – for the habitat type. It may require intensive and ongoing management to achieve this.

Small but important patches usually have a fairly precise target condition set by the relevant statutory conservation agency. Size limitations may make grazing impractical, necessitating mechanical treatment on some sites. There may be opportunities to increase the benefits of managing these by enlarging them.

General principles

This section sets out general principles that apply to most habitat types. The next section builds on this and provides guidance for specific habitats.

Keeping open habitats open

Habitats prone to succession need management to keep them open and the condition of nearly all open habitats can benefit from some level of vegetation disturbance. Management of non-successional habitats can include minimal or non-intervention with monitoring where such a regime is likely to meet objectives for the habitat.

Open habitat types tending to undergo succession to scrub or woodland will eventually be lost unless the process is interrupted. Grasslands, heathlands, fens, marshes and degraded bogs may need management if retention of existing habitat is an objective. Depending on how far succession has progressed, this might involve felling, mulching, brush-cutting, grazing or, where practicable,

burning. In some instances it may be necessary to resort to the use of herbicides, in which case good practice must be followed to avoid damaging the desired habitat or the environment.

An alternative approach for successional habitats is to create a dynamic mosaic, allowing succession to proceed while from time to time creating new early-successional habitats elsewhere in the forest. This is not always advisable because it may mean the loss of the oldest and best developed open habitats, which are often the most valuable for specialist flora and fauna. In addition, species with a poor dispersal ability may not be able to move to the new areas when their existing habitats become wooded. However, it may be a valuable approach for landscape-scale management and more sustainable in the long term on grounds of cost and management intensity.

Creating vegetation disturbance

Open habitats in upland forests tend to be protected against vegetation disturbance. Most areas are never affected by fire or livestock grazing and are only subject to a low intensity of grazing by wild animals (particularly deer). The resulting low disturbance regimes can maintain favourable (i.e. good) conditions in some habitat types but lead to undesirable changes in others. For example, plant litter can build up leaving few places for annual plants to grow – leading to less-competitive plant species being lost as a few competitive species become dominant.

Where habitat condition is unfavourable or deteriorating due to insufficient disturbance, the levels of vegetation disturbance should be increased. Ungrazed grasslands will benefit from increased vegetation disturbance unless the level of wild grazing is sufficient to maintain their condition. Undamaged bogs and nutrient-poor fens are unlikely to need increased vegetation disturbance because nutrient limitation should prevent their condition from deteriorating.

Where environmentally acceptable, restoration of natural processes (e.g. grazing, browsing, fire, river channel movement) can be very beneficial. These processes create microhabitats, to which native species are adapted, that are rare or absent in heavily managed landscapes. Mimicking natural processes can be a more practical option than restoring them and can provide many of the benefits. For example, cutting heather and removing the cut material has many ecological effects in common with wildfire.

It will often be most practical to increase vegetation disturbance by using livestock grazing, at an appropriate stocking level, or a mechanical means, such as mowing, flailing or swiping. Appropriate livestock stocking rates for different habitat types are given in *The upland management handbook* and in *Conservation grazing of semi-natural habitats*. Bear in mind that inappropriate grazing, particularly overgrazing by sheep and deer, can degrade upland habitats. If using a mechanical means of disturbing vegetation, divide the habitat patch up into a number of sections and treat them on a rotational basis so that only a small proportion of the patch is disturbed in any one year. Leave a section permanently untreated.

Avoid causing disturbances that result in unacceptable environmental damage. For example, fire on upland blanket bog can cause irreversible vegetation loss and severe peat erosion; vegetation management during spring and summer can destroy birds' nests; and operations leading to erosion of the headwater catchments of salmon spawning streams can damage spawning beds. It is an offence to cause disturbance to European protected species; to avoid breaking the law you must, before undertaking a potentially damaging operation or planning routes for access or recreation, take reasonable steps to ascertain whether such species are present (this might range from seeking expert advice to undertaking a specific survey). It is not

sufficient to plead ignorance about the presence of an European protected species in an area. Guidance on safeguarding European protected species can be found at www.forestry.gov.uk/eps.

Avoiding fertilising and drainage

Many plants have adapted to grow on inhospitable sites. They are able to overcome problems such as infertile or waterlogged soil that prevent other plants from growing there. These 'stress-tolerators' add much to Britain's biodiversity but many are now declining or rare because their habitats have been reduced and degraded during the past 300 years of land improvement. Fertilising and liming soils has relieved soil infertility and land drainage has reduced the extent of waterlogged soils. Both activities encourage vegetation to grow taller and become less species-rich.

It is crucial to avoid applying fertiliser onto open ground when fertilising tree crops. Where this has happened already, cutting and removing the vegetation regularly can gradually deplete the nutrient capital but it may take many years to get back to the original fertility level. Drainage of open ground should be avoided or, if required for access routes, minimised. Infilling or blocking existing unneeded drains can help restore soil waterlogging and can reduce erosion of upland mineral soils and peat.

Developing ecotones

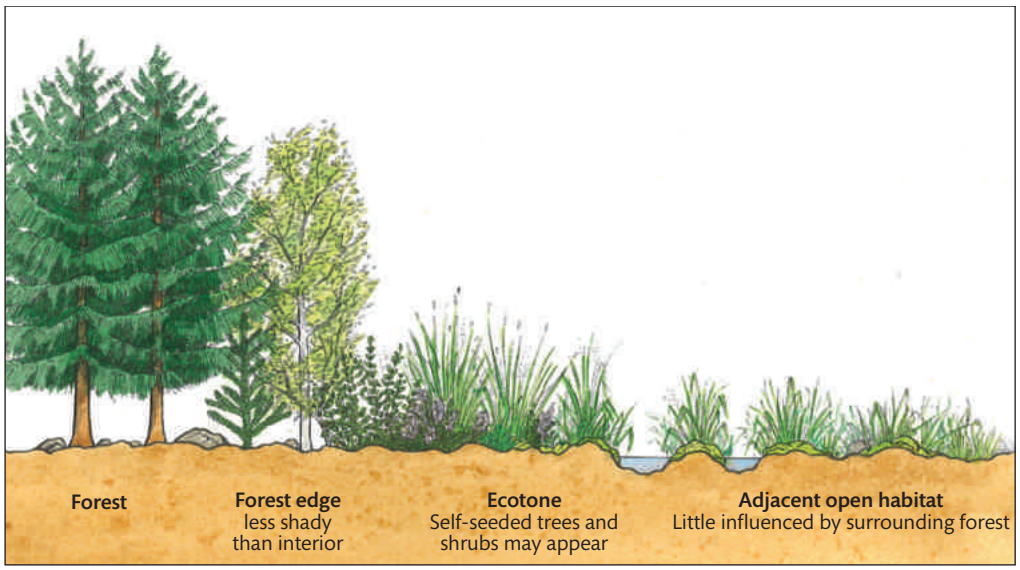
Ecotones are transition zones between different vegetation types (Figure 10). They contribute to increased habitat diversity by providing habitats different from, and intermediate between, the types on either side. They are often species-rich because they support many of the species from both vegetation types and may also support specialist species unique to edge habitats. Internal and external forest edges are well suited for developing ecotones. Well-developed forest edge ecotones include the outer part of the tree stand, in which there is more light than in the interior so that understorey trees or shrubs and field-layer vegetation can grow. Such ecotones can also include a zone adjacent to the trees that is more sheltered than further out on the open ground and, depending on the orientation of the edge, perhaps also more shaded. Seed rain is greater near the trees than at a distance because the trees deposit more seed at the edge and birds contribute seeds in their droppings.

European protected species (EPS) that may be found in upland woodland and associated open habitats in the British Isles include:

Animals
- Bats (all 17 species)
- Wild cat
- Otter
- Dormouse
- Great crested newt
- Smooth snake
- Sand lizard

Plants
- Killarney fern
- Early gentian
- Lady's-slipper orchid
- Yellow marsh saxifrage

Figure 10 Ecotones between forest and open habitats can be particularly valuable for heat- and light-demanding species, including many invertebrates.



Habitat-specific guidance

This section provides guidance that is specific to particular habitat types and builds on the general management principles set out above. These form the basis for a range of management options, which are introduced in the next section.

Heathland

Upland heathlands (Figure 11) are valued for their invertebrate communities – particularly moths and beetles – bird and reptile assemblages, and various unique dwarf shrub vegetation types. Except for certain montane and coastal cliff-top types, heathlands are successional habitats and require management intervention if their gradual change to scrub or woodland is to be prevented. In areas with plenty of heathland and potential heathland (i.e. former heathland now under forest but with a seedbank of heathland species that favours their potential for restoration), forest managers can choose between two approaches. The first is to maintain the existing heaths by preventing succession. The second is to allow succession but, at the same time, create new areas of heath elsewhere by deforestation.

The former approach is usually preferable because existing heaths will support well-developed floral and faunal communities, whereas newly-restored heaths will, at best, only initially support species-poor communities. The second approach, which should only be used where a large area is managed under a single management plan and restoration success can be demonstrated, has the advantage of increasing habitat and microhabitat variety by providing both completely open and partially-wooded heaths.

For general biodiversity objectives, structural variety in vegetation should be the target. Conversely, objectives geared towards particular individual species or taxonomic groups may require management to maintain large areas of vegetation at a particular height. Old heather that has gone 40 years or more without burning or other disturbance is valuable to certain uncommon liverworts and invertebrates that require humid, sheltered conditions. Such stands should be maintained by non-intervention, especially by protection from burning. More information is available in the Scottish Natural Heritage Information and Advisory Note *Heather layering and its management implications*.

Figure 11 Upland heath, such as this example at Dartmoor, is important for many species assemblages.

Grazing can help prevent succession and diversify vegetation structure. The carrying capacity of heathland is often low because heaths generally occur on poor soils and produce relatively little biomass per unit area per year, compared with ecosystems on more nutrient-rich soils. Livestock stocking levels need to be very low to prevent overgrazing, soil damage and compaction, consequent loss of dwarf shrubs and eventual conversion to acid grassland. Sites dominated by rank heather due to undergrazing may need an initial intense burst of grazing or some cutting or burning to open up the heather canopy. Heaths that have become dominated by grass due to overgrazing may recover if grazing is relaxed or removed but some may require scarifying to activate the buried seeds of dwarf shrub species.

Burning has traditionally been the main practice to prevent succession of heathlands. Patch burning is a very good way of maintaining vegetation structural diversity. However, burning can be severely damaging if undertaken too frequently, too extensively, or without being properly controlled. Burning is controlled by legislation, confined to a legal burning season and should conform to the appropriate code of good practice. For Scotland, this is available in the Muirburn Code and supplementary guidance. For England and Wales, in the Heather and Grass Burning Code. In Northern Ireland, the 1951 Game Law Amendment Act restricts upland burning to between 1 September and 14 April.

There are obvious risks in undertaking burning of heathland within forests. The risks can be controlled but it will often be preferable to cut heath vegetation instead of burning it. Like burning, cutting encourages heather shoot regeneration but cutting is less effective in stimulating seed germination. Cut material should be removed to favour regeneration of dwarf shrubs but this is not necessary if the cuttings are sufficiently finely chopped and thinly spread.

Where the wetter areas on heathland have been drained, blocking the drains should help re-wet these, providing an improved supply of invertebrates as food for moorland breeding birds.

Trees and scrub add structural variety to heathland at the expense of extensive open habitat. Many invertebrates benefit from the sheltered microhabitats provided by scrub. Some birds, notably golden plover, will only use extensive open areas without scrub whereas black grouse and some insects prefer some scrub. In black grouse areas, gradual forest/heathland transitions should be created by feathering the first 50–100 m of the forest and by allowing scattered trees to grow on the heathland near the forest edge. Heathland with extensive scrub may eventually need action to prevent succession to woodland. Where forest land extends above the upper altitudinal planting limit, open heathland on higher ground may have the potential to support valuable montane scrub habitats. Grazing pressure needs to be very low to allow these to develop.

Grassland

Grasslands, like heathlands, are successional habitats. They have traditionally been maintained by grazing or in the case of meadows, mowing combined with grazing. Both produce shorter and less dense vegetation than would develop in the absence of these practices. Grazing helps to maintain a varied structure, species-rich composition and prevent scrub development (Figure 12). Short, grass-dominated vegetation can support a great variety of herb species and a host of associated invertebrates and birds. Without grazing (or, in the case of meadows, without mowing), the taller and leafier grasses become dominant and most of the smaller grasses and herbs are eventually lost.

Agricultural improvement involving fertilising and re-seeding with species-poor grass seed mixtures has led to reduced species diversity in pastureland fringing the uplands. In some

Figure 12 Grazing has maintained the species-rich composition on this upland calcareous grassland.

regions this activity has been so widespread that the only unimproved grasslands left are those in forests. Unimproved grassland is very valuable for nature conservation. Where its use as pasture has ceased, it is likely to have lost species. Re-starting traditional grazing management of former pastures or, in the case of meadows, annual hay cutting with spring and aftermath grazing, will help reverse the losses but this will not always be practicable. A management regime mimicking the effects of the traditional practice may be easier to implement.

Acid grassland dominated by mat-grass (*Nardus stricta*), purple moor-grass (*Molinia caerulea*) or heath rush (*Juncus squarrosus*) may have developed from overgrazed heathlands. These types are often species-poor and could have greater habitat value if restored to heath. Removing grazing for several years may allow spontaneous recovery of dwarf shrubs and a reversion to heath vegetation. Where there is a seedbank of viable dwarf shrub seed in the soil, scarification is a good means of activating some of the buried seeds.

Bogs

Bogs are valued for their range of specialist bog plants (Figure 13) and dependent invertebrates, amphibians, reptiles and birds. Although not a particularly species-rich type of habitat, many of the species are unique to bogs. Some of these are now rare or threatened due to extensive habitat loss and damage. Bogs are also valued for their ability to sequester carbon.

Maintaining nutrient-poor conditions is the first key to maintaining the species assemblage of bog vegetation. Bogs are inherently nutrient-poor. Accumulation of peat has produced a raised surface that has become isolated from the mineral soil underneath and on the surrounding land. Because the roots of plants growing on bogs cannot reach down far enough to obtain mineral nutrients, the vegetation consists of stress-tolerant species that can either survive on the low concentrations of minerals found in rainwater or can trap and digest insects. Bogs are particularly vulnerable to enrichment by fertiliser application or even unintentional drift from operations nearby.

The second key to conserving bogs is to keep them wet or make them wetter. Peat accumulation is favoured by a high soil water table, which prevents complete decomposition of plant litter. The peat itself is almost impermeable and holds the water table up near the

surface. Peat tends to decompose and can release nutrients if the water table has been lowered by drainage or peat cutting – thus drying and enrichment tend to go hand in hand on drained or cutaway bogs. Blocking or infilling drains that already exist and avoiding undertaking any new drainage or ploughing can assist in achieving suitable wetness.

Once drained, bogs become subject to succession. A slight lowering of the water table and associated release of nutrients alters the delicate ecological balance to favour the establishment of birch, willow, pine and even spruce. Unless the water table can be raised sufficiently to tip the balance the other way again, continued management will be needed to prevent succession. Cutting and/or herbicides are normally used.

In their natural state, bogs are too unproductive and too wet to sustain anything more than very light grazing, over and above background levels of wild grazing. Livestock grazing is not required to maintain habitat condition. The degree of drying or nutrient enrichment will dictate whether a damaged bog is suitable for grazing. Grazing can restore some structural and compositional variety when the vegetation has become too tall, heathy or grassy. It can also counteract the tendency for damaged bogs and bogs undergoing restoration to scrub over with birch, provided the grazing animals are introduced when the seedlings are still small and low enough to be browsed. However, bogs are easily damaged by trampling and overgrazing.

Bogs are sensitive to burning. The dominant species recover – heather by resprouting from the stem base or by germination of seeds in the soil seedbank, hare's-tail cottongrass and purple moor grass by regrowing from protected parts. Fire-sensitive species, such as the bog mosses *Sphagnum austinii* and *Sphagnum magellanicum*, and those that are very slow re-colonisers may be lost, especially from sites that are burnt frequently. Hot fires – those that occur in summer or at other times when the vegetation and upper peat are relatively dry – can be severely damaging. Such fires can burn down into the peat, killing the underground parts from which the plants normally regenerate, and releasing large quantities of carbon dioxide. These peat fires are very difficult to put out and can smoulder and periodically re-ignite for months. In montane habitats, post-fire vegetation regrowth is prevented by the severe climate, especially the effects of wind and frost, and the fire-bared surface becomes subject to peat erosion. Guidance published in *Conserving bogs – the management handbook* and *The upland management handbook* generally recommends against burning on bogs.

Figure 13 Plant species growing on bogs, such as this sundew, are often unique to this habitat type.

Fens

Fens are inherently wet. They are usually found where peat has accumulated but, unlike bogs, fens have not yet become raised and their surface is not isolated from the groundwater that contains minerals. Fens are valued for a range of specialist plants and associated invertebrates and birds (Figure 14). Some types are particularly important for rare molluscs. Fen soil water is less acidic (pH>6) than that of bogs and can range from rich to poor, in terms of the major plant nutrients. It is their particular combination of mineral ions that makes the various different types of fen unique. Management should aim to keep fens wet or make them wetter; water chemistry must not be substantially altered or, if it already has been, should be restored to its former composition.

Fens are successional habitats, prone to the development of willow, birch and alder woodland or 'carr'. The wet woodland types that develop are valued as habitats in their own right so deciding on management may involve careful weighing up of the potential values of the open and wooded habitat types in the local context. Arresting succession by rotational coppicing of the scrub can be a good compromise.

Figure 14 Fens are peat-forming habitats with a range of specialist species of plants and animals.

Crags and rocks

Crags are special because parts of them are inaccessible to both herbivores and terrestrial predators (Figure 15). Their inaccessibility makes for good bird nesting and roosting habitats, particularly for raptors. They are also exposed and can suffer extremes in terms of wetness, dryness, sun and wind. Severely limited soil depth may add to their droughtiness. The combination of extremes makes them strongholds for stress-tolerant plants. Crags and rock outcrops can provide habitats for plants not favoured by the surrounding soil, especially where limestone outcrops occur among acid soils.

Maintenance of the local microclimate is important for the communities of stress-tolerant plants adapted to the particular conditions. Open crags may be threatened with increased shelter and shade from trees planted too close or allowed to grow too tall. Flight lines to nesting sites can also be threatened by tree growth and need to be maintained. Wooded crags

Figure 15 Crags and rocky habitats can support special vegetation communities. This outcrop of serpentine in Grampian is rich in toxic heavy metals and has calminarian grassland priority habitat.

or crags already colonised by semi-natural woodland or scrub will support species that benefit from some shelter and shade so this should be largely maintained.
Ravines and gorges are generally highly humid habitats. They are inaccessible to grazers and are often heavily shaded by steep sides, gorge woodland or both. They can support interesting plant communities with some rare lower plants adapted to tolerate shade but sensitive to drying out. The key here is to maintain humidity and shade conditions. Avoid opening sites up by clearing woodland from the steep sides or from ground above. At the same time, avoid increasing shade beyond the level in which the community has developed.

Screes and boulderfields are dynamic, successional habitats. The lack of soil makes them drought-prone, difficult places for plants to establish themselves. Stress-tolerant plants, especially lichens and bryophytes, find a niche here. Accumulations of larger rocks provide a subterranean world of linked holes that can be good habitats for reptiles. Management should be geared towards maintaining the microclimate and allowing continuation of the erosion producing the rock debris. In particular, avoid sheltering the actively eroding places.

Quarries, although man-made, can contain various types of valuable microhabitat similar to natural types, e.g. cliffs and crags, rock accumulations similar to boulderfields or streamside gravel deposits, and pools similar to ox-bow lakes. All are early successional habitats and thus temporary if succession is not managed. Their initial habitat value is mainly for lower and other stress-tolerant plants, such as club mosses and some fungi. The early stages of succession can benefit wildlife, e.g. by developing a food source for seed-eating birds, but the lower plant interest will be lost if the vegetation becomes too tall or dense.

Caves and man-made structures such as buildings, mines, dry stone walls and bridges are used by bats for roosting and breeding as well as trees. Such structures can also support rare mosses. Avoid making alterations that would restrict access or affect conditions of temperature, humidity, shade or shelter, as such actions are potentially illegal. Where such structures are known not to be used by bats, consider if they could be made more bat-friendly by, for example, creating access holes and covering roofless structures. More information can be found in the Forestry Commission partnership leaflet *Woodland management for bats*.

Management options

Table 2 lists management options available for the various valuable habitat types. It links each option to a particular objective that might be adopted for a habitat patch, depending on its importance and current condition. The table is intended to be exemplary rather than prescriptive, and it does not go into detail on methods or machinery. The list is based on a review of relevant literature and is not comprehensive – other management options may be available.

Table 2 Management options for open habitats.

Habitat	Management option	Objective
Heathland	Burning	Diversify structure of heath and create new growth to benefit birds and insects. Prevent succession.
	Grazing[1]	Increase microhabitat diversity.
	Excluding grazing	Reverse effects of overgrazing. Encourage scrub/open woodland development.
	Excluding grazing at high altitude	Allow montane scrub growth.
	Cutting	Diversify vegetation structure.
	Blocking or infilling drains	Increase microhabitat diversity.
	Controlling deer population	Prevent overgrazing. Encourage scrub.
	Scraping off vegetation	Create bare ground invertebrate and bird habitats.
	Controlling foxes and crows	Favour ground-nesting birds.
	Rotational cutting of scrub	Maintain a variety of habitats ranging in vegetation structure from open to wooded.
Grassland	Grazing[1]	Prevent succession. Maintain or increase structural, species and microhabitat diversity.
	Reduce grazing	Allow recovery of dwarf shrubs where acid grass-land has resulted from overgrazing of heathland.
	Mowing	Prevent succession. Maintain or increase species diversity in meadows or pastures not being grazed.
Bog	Blocking or infilling drains	Raise water table to re-wet the ground.
	Pulling or cutting tree seedlings	Prevent succession on damaged bogs.
	Grazing[1]	Prevent succession on dried bogs.
	Controlling foxes and crows	Favour ground-nesting birds.
	Preventing turf cutting on intact bogs	Avoid damage.
Fen	Blocking or infilling drains	Raise water level to re-wet site.
	Influence incoming water quality	Maintain or restore former water chemistry.
	Cutting	Prevent succession.
	Grazing[1]	Prevent succession.
	Non-intervention	Allow succession to scrub or carr.
	Coppicing of scrub	Maintain a range of successional stages.
Crags and rocks	Fencing ground below crags	Encourage spread of grazing-sensitive plant species.
	Cutting shrubs and trees	Slow down succession.
	Bulldozing in quarries	Renew succession.
Non-specific	Cutting back forest edge	Prevent too much shading. Discourage tree natural regeneration.
	Controlling bracken	Prevent loss of valued habitat to bracken.
	Planting broadleaved trees on forest edge	Enhance habitat for key invertebrates and birds.
	Planting birch, larch, hawthorn and rowan along internal edges	Provides additional food sources for black grouse.

Further, more detailed guidance on habitat management, including detailed information on appropriate grazing regimes, is contained in *The upland management handbook* published by English Nature (Natural England), and in agri-environment scheme prescriptions. The Further reading and useful sources of information section on page 34 of this Guide, also contains references to useful information on managing open habitats.

	Comments
	Often impractical in forests. Damaging unless very infrequent, restricted to part of habitat patch and well managed.
	Sustainable only if stocking density low. Sometimes impractical.
	Ideally a temporary measure. May lead to succession and/or deterioration and need for cutting.
	Must collect cuttings unless very fine.
	May conflict with maintenance of access and forest management.
	Only necessary in extreme cases.
	Small scale only (a few square metres). Most useful on south-facing banks/slopes.
	May need a concerted effort at landscape scale to be effective.
	Only appropriate where scrub develops naturally.
	Livestock prefer calcareous grassland to other vegetation types and this can lead to overgrazing.
	Hay meadows require grazing in May and after cutting (from mid-July until late autumn).
	On acid grassland stocking levels must be low to avoid damage to the nests and eggs of waders.
	Cut material should be removed. Hay meadows are best cut around mid-July.
	May constrain access and affect forest management. Various techniques available.
	Unsustainable in the long term or at least expensive unless trees removed on a regular basis when small.
	Very low stocking level required.
	May need a concerted effort at landscape scale to be effective.
	Where cutting rights exist, it may be possible to transfer these to areas of degraded bog.
	Check for possible impact on priority species, e.g. water vole.
	May require co-operation of neighbours.
	Low stocking level for short periods only to avoid excessive poaching.
	Likely to lead to complete loss of open fen.
	May require cutting. Avoid disturbing nesting birds[2].
	Avoid disturbing nesting birds[2].
	Quarry working may achieve this. Avoid disturbing nesting birds[2].
	Most effective on north-facing edges.
	Bracken can itself be a habitat for rare ferns and butterflies.
	Species selection dependent on detailed objectives.
	Appropriate if black grouse conservation is an objective. May compromise open corridor width.

Table notes

1 Stocking rates and other recommendations concerning grazing regimes are given in section 6.6.1 of *The upland management handbook* published by English Nature (Natural England), and Scottish Agricultural College Technical Note 586 *Conservation grazing of semi-natural habitats.*

2 Further information on preventing disturbance of nesting birds is given in Forestry Commission Scotland Guidance Note 31 *Forest operations and wildlife protection.*

Habitat condition monitoring

Monitoring is needed to detect changes to vegetation or wildlife resulting from management activities. The results of monitoring will tell the manager whether the regime in use has led to, or is likely to lead to, the achievement of the stated objectives for the site. This will allow adjustment of the regime or re-appraisal of the objectives.

A well-designed monitoring programme is cost-efficient because it gathers only the information needed for adaptive management. JNCC Common Standards Monitoring methodology (see Further reading and useful sources of information) is suitable for monitoring the condition of priority open habitats within statutory designated sites (i.e. priority 1 or 2 in Table 1) and open habitats important for priority species. Less sophisticated monitoring is more appropriate for most open habitats not in SSSIs/ASSIs. It should be based on the same principle of deciding wherein the ecological value lies, setting a target condition (can be broad-brush for low conservation status sites) and regularly checking if it is being achieved. For non-priority habitat types, monitoring should be simple and easily replicated. Fixed-point photography is useful for monitoring vegetation and may be adequate for some non-priority habitat types. The cost of monitoring can be substantial, depending on how precise the objectives, how easy it is to monitor the target species or habitat attributes and on how well the programme is designed.

It could be cost-effective to assess condition during the priority habitat survey. For this to be feasible, background work to identify any priority species present would have to have been done first. The surveyors would have to be given a set of standard target conditions for the likely types of open habitat, including examples with and without the various priority species present. They would assess whether current condition is satisfactory or otherwise against the appropriate target and report on signs of deterioration or improvement in condition.

Box 5 – Habitat condition monitoring

The statutory nature conservation agencies in the UK have a duty to monitor the condition of notified interest features on SSSIs, ASSIs, SACs, SPAs and Ramsar sites. Together with the Joint Nature Conservation Committee, they have developed 'Common standards monitoring'. There is a separate method for each habitat type and they are intended to be simple and quick.

How are Common standards monitoring methods used?
Each method involves assessing a few key attributes of the habitat, such as its extent, species composition, vegetation structure and physical characteristics. A desired target condition for each attribute is set for the site in question. Habitat condition is then gauged by whether the attributes meet the target condition and assigned to one of seven conditions:

- Favourable maintained
- Favourable recovered
- Unfavourable recovering
- Unfavourable no change
- Unfavourable declining
- Destroyed partially
- Destroyed completely

As well as being used to report on how the state of designated sites is changing over time, the condition classes help guide the management of individual sites. If the condition of the habitat is 'Favourable' or 'Unfavourable recovering', recent management is continued. If it is deemed 'Unfavourable no change' or 'Unfavourable declining' then changes in management to bring the site into at least 'Unfavourable recovering' condition are encouraged.

Case studies

The principles in this guide have been developed in parallel with practice in managing open habitats. The practice side has developed locally in forests all over the UK with many foresters, rangers and other practitioners contributing ideas. Usually there will have been an element of trial and error in the process so it may help others if lessons learnt can be passed on. Case studies 1–6 give examples of good practice for sites across England, Scotland and Wales.

- Case study 1: Blanket bog at North Alwen Forest in Wales
- Case study 2: Limestone grasslands at Whitbarrow Scar in Cumbria, England
- Case study 3: Heath and bog at Cladich Forest in Argyll, Scotland
- Case study 4: Bogs at Kielder Forest in Northumberland, England
- Case study 5: Springs and flushes at North York Moors in England
- Case study 6: Moorland enclaves at Minard Forest in Argyll, Scotland

Case study 1: Blanket bog at North Alwen Forest in Wales

In this partnership project, Forestry Commission Wales and the Countryside Council for Wales (CCW) – now both Natural Resources Wales (NRW) – worked to restore blanket bog at Gors Goch in North Alwen Forest. Gors Goch lies adjacent to Hafod Elwy National Nature Reserve, which is managed by NRW.

An area of around 35 hectares of blanket bog that had been planted with conifers in the 1960s was clearfelled in 1996. Manual felling and forwarder extraction were used and at least 50% of the brash went into creating a thatching track for the main extraction route. The smaller drainage ditches were dammed using plywood sheets. The larger drains were blocked with peat using an excavator. Soon after the forest was cleared, numerous tree seedlings appeared, mostly lodgepole pine. Although these were cut, some regenerated and several clearance programmes were needed to reach the current situation where, with a well-established cover of ground vegetation and virtually no remaining tree seed source, regeneration is not such a problem.

Forestry Commission Wales and CCW reached a joint management agreement for Gors Goch. The National Nature Reserve boundary was not extended but the boundary fence between the two sites was moved back so that grazing on Gors Goch came under the CCW tenancy agreement with a neighbouring farmer. Sheep now graze the entire area and the tenancy includes season and stocking density conditions so that the areas are not at risk from overgrazing. The sheep help to suppress tree regeneration by nibbling off the new growth. The dammed-up drainage ditches are potentially hazardous for livestock but the sheep were used to avoiding drains on the open hill and soon got to know their way around the site. The site is developing into a mosaic of habitats with several botanically important species. It also complements black grouse habitat management in the area and meets some of the requirements of this bird.

CCW completed a hydrological survey to inform the partnership about where to target future hydrological management. It is hoped to repeat the survey in future to monitor the change to the water table resulting from ditch blocking. The project was funded within existing operations budgets by both Forestry Commission Wales and CCW. This meant that the restoration and management work has proceeded gradually and was still in progress 13 years after the former forest was felled.

Case study 2: Limestone grasslands at Whitbarrow Scar in Cumbria, England

Farrer's Allotment, above Whitbarrow Scar in Cumbria, was afforested in 1965. The land was part of an Site of Special Scientific Interest (SSSI) designated the same year for its calcareous grassland and associated limestone pavements and juniper scrub.

Forestry Commission England took into account visual landscaping considerations as well as habitat restoration potential and earmarked the area for deforestation to restore the former habitats. The trees were felled during 1998–2000 and most of the brash was bailed and sold.

Calcareous grassland vegetation returned to the site but it became clear that the habitat condition would remain below the target 'favourable' unless the site could be grazed. A local grazier specialising in conservation grazing was contracted to provide this service. In 2005 cattle were introduced in September and the herd size was increased over the autumn as cattle returned from summer grazing at higher upland sites.

Other habitats at the site are being restored too. Juniper seedlings were produced under contract by a specialist nursery using seed collected on site. These have been planted in treeshelters in groups on the site, contributing to the Cumbria Local Biodiversity Action Plan target of increasing the area of juniper scrub in the county.

Besides improving the condition of the grassland, the cattle are expected to improve bracken habitats important for the rare high brown and pearl-bordered fritillary butterflies. By trampling through it, they should open up the bracken canopy sufficiently to favour the violets that are the larval food plant for these butterflies.

Plans are in place to restore an additional area of limestone grassland nearby and to build a collecting pond to create a drinking place for cattle there. A stock-handling corral and barn have been built at a strategic point near the two sites to support the future management of the herd.

Case study 3: Heath and bog at Cladich Forest in Argyll, Scotland

The Upper Sonachan section of Cladich Forest was planted in 1982 on moorland used for extensive grazing and grouse-moor. By the late 1990s, the forest still held some small areas of heather moorland and cottongrass bog and a remnant population of black grouse.

Managers of the forest, UPM-Tilhill, recognised that nearby areas of poorly grown and checked trees presented an opportunity to expand and enhance the remnant open habitats. This would also benefit the black grouse population. UPM undertook an ecological audit of the forest and took expert advice on black grouse management. Recommendations were to survey the status and distribution of black grouse within Upper Sonachan, maximise internal open space, particularly where heather and blaeberry are present, and link up all the suitable black grouse habitats in the forest to heather moorland outside it.

Habitat management work was carried out over the next five years. This was supported by funds from Forestry Commission Scotland after an initial survey funded by Scottish Natural Heritage (SNH) had confirmed the continuing presence of black grouse in the forest.

Work included complete removal of conifers from the deep peat area and damming of drains there to improve the hydrological integrity of the mire system. Adjacent areas were 85% felled to create open heath and mire with scattered trees and the forest up to 100 m beyond that was respaced to grade into the moorland habitat areas. Operations were timed to avoid causing disturbance during the black grouse breeding period. The treated areas were designated as the Black Grouse Management Area and thus integrated into forest operations planning. Annual black grouse surveys were conducted to monitor the population.

Although black grouse conservation was an important objective, it was recognised that factors other than habitat suitability could be contributing to their decline in Argyll and it was important that the work should have other objectives too. Restoring and improving the condition of heathland and mire habitats was the other main objective of this work. A baseline for monitoring this was established using fixed-point photography.

Case study 4: Bogs at Kielder Forest in Northumberland, England

Kielder Forest was planted moorland on which formerly supported vegetation communities of raised bogs, intermediate bogs and blanket bog.

As planting progressed, local naturalist Angus Lunn recognised that some of England's best areas of bog habitat would be lost if they were not protected. Some had already been partly drained or planted up. These were valued for their distinctive plant communities that included many specialist species.

The Northumberland and Durham Naturalists' Trust (now the Northumberland Wildlife Trust) initiated conservation activity and, from 1970, leased a selection of the sites not yet planted. In 1987 the Border Mires Management Committee was formed. Led by Forestry Commission England, it included the Wildlife Trust, Nature Conservancy Council (now Natural England), Northumberland National Park, University of Newcastle and RAF Spadeadam. These organisations all had an interest in the mires and their combined expertise made for an effective consortium. The committee managed a programme of restoring the better surviving bogs by damming drains and removing conifer stands planted on the outer margins.

The programme has continued for 20 years and opportunities have been taken to reassess the objectives. A 1993 survey by Steve Lowe to determine the original hydrological units of the mires identified 58 sites in various states of intactness, including a set of 'shadow mires' that had been completely planted over. The sites were prioritised for conservation action using a best-first to worst-last approach. Three Sites of Special Scientific Interest (SSSIs) containing 28 of the mires are now designated as a Special Area of Conservation (SAC) under the EU Habitats Directive.

Progress towards achieving overall goals was slow before a successful bid was made for EU LIFE-Nature funding. As the LIFE Border Mires Active Blanket Bog Rehabilitation Project, a dedicated team used a purpose-bought tractor and chipper to clear large areas of forest from the SAC bogs. This allowed enormous progress to be made over the three years of the project.

Case study 5: Springs and flushes at North York Moors in England

Natural springs that emerge at the base of limestone at Dalby Forest in the North York Moors are valued both for their geological and biological interest. Some are tufa-forming and others support rare species, such as the soldier fly *Odontomyia hydroleon* which requires some trampling to maintain suitable breeding habitat.

Appropriate management to improve these habitats has involved clearing the conifer woodland around them, introducing grazing where appropriate and managing vegetation to prevent succession to woodland where this would be inappropriate.

Targeted management of these recognised special springs led to the development of a District-wide policy of not replanting around springs and flushes after harvesting – including the acidic flushes that occur in the upland parts of the forests. Instead they are treated as part of the riparian zone and managed in a naturalised way.

Advice on appropriate management is obtained from a network of local expert naturalists and geologists and from Natural England. Where conservation grazing is appropriate but not easily arranged, its introduction becomes a long-term objective.

Formal monitoring is generally only undertaken on designated sites but others are subject to informal monitoring by local groups and individuals.

Case study 6: Moorland enclaves at Minard Forest in Argyll, Scotland

Extensive unplanted hill and moorland areas at Minard were formerly grazed by sheep before being surrounded by conifer forest. For the last 30 years, only deer, hare and grouse have grazed them. Their vegetation, which includes dry heath and a mosaic of bog, wet heath and grassy flushes, is tall and rather species poor. Black grouse inhabit the forest nearby but do not use these enclaves, although in many respects they are potentially ideal for them.

The long-term lack of grazing has probably reduced the contribution these areas make to the overall biodiversity of the forest and reduced their quality as black grouse habitats. Flailing was seen as one option but this is costly and unsustainable. Grazing was preferred as a more sustainable option in the long term and one potentially benefiting the local economy.

Cattle were brought in to graze these areas, diversify the structure of some of the heather patches and reduce the height of the flush vegetation. It should also create useful microhabitats in the form of trampled bare soil and dung pats. Black grouse should be better able to rear chicks as the cattle open up the vegetation, making it easier to move through and forage in. Before cattle could be brought in, funds had to be found to fence the areas with suitable hard-standing ground developed for cattle handling. Forestry Commission Scotland funds were supplemented by a Scottish Natural Heritage contribution towards experimental aspects of the trial, in addition to awards from various environmental charitable trusts. The grazing leases were advertised locally, initially for a minimal rent but with the prospect of worthwhile income being generated in future as the grazing condition of the sites improves.

Monitoring of black grouse habitat quality is underway, with fenced exclosures providing a no-grazing comparison. There are signs that the habitat quality is improving. More broken-up vegetation should make for easier foraging by black grouse chicks and an increased variety of plant species may increase food availability for adults and older chicks.

Improved habitat quality, combined with control of crows, is paying off. Within three years of the start of grazing a number of blackcock are lekking on the sites.

Further reading and useful sources of information

Forestry Commission publications

www.forestry.gov.uk/publications

- The UK Forestry Standard (FCFC001)
- UKFS Guidelines on Forests and biodiversity (FCGL001)
- UKFS Guidelines on Forests and climate change (FCGL002)
- UKFS Guidelines on Forests and landscape (FCGL004)
- UKFS Guidelines on Forests and soil (FCGL006)
- UKFS Guidelines on Forests and water (FCGL007)

Guidance and good practice

- Managing rides, roadsides and edge habitats in lowland forests (FCBU123)
- Forest fencing (FCTG002)
- The identification of soils for forest management (FCFG001)

Research

- Deforesting and restoring peat bogs: a review (FCTP032)
- Domestic stock grazing to enhance woodland biodiversity (FCIN028)
- Evaluating biodiversity in fragmented landscapes: principles (FCIN073)
- Evaluating biodiversity in fragmented landscapes: applications of landscape ecology tools (FCIN085)
- Evaluating biodiversity in fragmented landscapes: the use of focal species (FCIN089)
- Restoring afforested peat bogs: results of current research (FCRN006)
- Biodiversity in fragmented landscapes: reviewing evidence on the effects of landscape features on species movement (FCRN010)

Other publications

- Conservation grazing of semi-natural habitats. Technical Note 586 (Scottish Agricultural College)
- Habitat management for conservation (Oxford University Press)
- Habitat management for invertebrates: a practical handbook (RSPB)
- Handbook for Phase 1 habitat survey - a technique for environmental audit. NVC Users Handbook (Joint Nature Conservation Committee)
- Heather layering and its management implications. Information and Advisory Note 35 (Scottish Natural Heritage)
- Managing habitats for conservation (Cambridge University Press)
- Restoring and managing riparian woodlands. Scottish Native Woods (2000).
- The design of forest landscapes (Oxford University Press)
- The importance of livestock grazing for wildlife conservation (Natural England)
- The upland management handbook (Natural England)
- Upland habitats (Routledge)

Websites

UK forestry

- Forest Research – www.forestry.gov.uk/fr/openhabitats
- Felling licences (Great Britain) – www.forestry.gov.uk/felling
- Felling licences (Northern Ireland) – www.dardni.gov.uk/forestry
- Environmental Impact Assessment – www.forestry.gov.uk/eia
- European Protected Species – www.forestry.gov.uk/eps
- Northern Ireland Forest Service – www.forestserviceni.gov.uk

UK environment

- Convention on Biological Diversity handbook – www.biodiv.org/handbook
- European Union LIFE funding – http://ec.europa.eu/environment/life
- Common Standards Monitoring – www.jncc.gov.uk
- National Biodiversity Network species records - http://data.nbn.org.uk

In England

- Natural England – www.naturalengland.org.uk
- Heather and Grass Burning Code – www.defra.gov.uk

In Scotland

- Scottish Natural Heritage – www.snh.gov.uk
- Scottish Biodiversity List – www.biodiversityscotland.gov.uk
- The Muirburn Code – www.scotland.gov.uk/publications

In Wales

- Natural Resources Wales – www.naturalresourceswales.gov.uk

In Northern Ireland

- Northern Ireland Environment Agency – www.ni-environment.gov.uk
- Department of Agriculture and Rural Development (Environmental Impact Assessments) – www.dardni.gov.uk/environmental-impact-assessments
- Centre for Environmental Data and Recording (Northern Ireland) species records - www.habitas.org.uk

Other

- Conservation machinery – www.contak.org.uk
- Grazing animals project (GAP) – www.grazinganimalsproject.org.uk
- Grazing services – www.ecolots.co.uk
- Heathland management forum – http://tech.groups.yahoo.com/group/heathnet_uk
- The Peat Compendium – www.peatlands.org.uk

Appendix 1: Conservation designations

Site designations

SAC: Special Area of Conservation

Site designated under European Union legislation as being of European Community importance for the conservation of natural habitats and/or species listed in the 'Habitats Directive' and forming part of the Natura 2000 site network.

SPA: Special Protection Area

Site designated under European Union legislation as being of importance for endangered, rare or vulnerable wild bird species listed in Annex I of the 'Birds Directive' and forming part of the Natura 2000 site network.

ASSI: Area of Special Scientific Interest

Site in Northern Ireland designated under Northern Ireland legislation for the protection of sensitive wildlife habitats or geological environments.

SSSI: Site of Special Scientific Interest

Site in Great Britain designated under UK legislation for the protection of sensitive wildlife habitats or geological environments.

NNR: National Nature Reserve

Areas of national importance for wildlife or geology, often representing the best examples of particular habitat types or geological formations. NNRs, excepting some in Northern Ireland, are designated SSSI or ASSI and protected under that legislation.

Ramsar site

A wetland site designated as being of international importance, especially as waterfowl habitat. A wetland is regarded as internationally important if it regularly supports 20,000 waterfowl or 1% of a species, or sub-species of waterfowl. Ramsar sites are designated SSSI and protected under that and other UK legislation.

Non-statutory nature conservation sites

These are regional or local designations and the terminology varies in different parts of the UK. They include SINC, COWS, SNCI, ANCI, SCWI, LNCS, RIGS, and many others. Most receive some protection against development through the planning system.

Habitat designations

Habitats Directive Annex 1 habitat

A habitat of one of the types listed in the EU 'Habitats Directive' as being of Community interest whose conservation requires the designation of SACs. Under the Directive, the UK must aim to achieve and maintain Annex 1 habitats in 'Favourable Conservation Status' across the resource as a whole, not just in SACs. Further information on Annex 1 habitats can be found on the SAC selection section of the JNCC website (www.jncc.gov.uk).

Country Biodiversity List habitat

A habitat of one of the types on the list of flora, fauna and habitats considered of principal importance for biodiversity conservation in each country.

LBAP (Local biodiversity action plan) habitat

A habitat of a locally important type selected for local conservation action.

Species designations requiring habitat conservation

Habitats Directive Annex II species

Plant or animal species listed in Annex II of the EU Habitats Directive as being of Community interest due to their being endangered, rare or vulnerable. Habitats of these species have equivalent conservation status to Annex I habitat types in the Directive.

Birds Directive Annex I species

Endangered, rare or vulnerable bird species listed in Annex I of the EU Birds Directive. Habitats of these species have equivalent conservation status to habitats of the Annex I types in the Habitats Directive.

European protected species

These species, which are listed in Box 9, are protected by law against disturbance. Guidance on complying with this legislation can be found on the Forestry Commission website, including information about the issue of licenses for work undertaken to conserve populations of these species.

Country Biodiversity List species

An animal or plant species on the list of flora, fauna and habitats considered to be of principal importance for biodiversity conservation in each country. Separate lists exist for Northern Ireland, Wales, England and Scotland and they are intended to guide public bodies in fulfilling their duty to conserve biodiversity.

LBAP (Local biodiversity action plan) species

A species deemed to be of local conservation importance and selected for local conservation action under the relevant Local Biodiversity Action Plan.

Appendix 2: Priority habitat types

Priority habitats associated with upland forests and corresponding Phase 1 and National Vegetation Classification (NVC) classes.

Priority habitat type	JNCC Phase 1 habitat survey	Main NVC communities
Upland heathland	D1, D2, D5, D6 Dry and wet dwarf shrub heaths and their mosaics with acid grassland	H4, H8, H9, H10, H12, H16, H18, H21, M15, M16
Blanket bog	E1.1 Blanket bog	M1–M3, M15, M17–M20, M25
Upland hay meadows	B2 Neutral grassland	MG3
Upland calcareous grassland	B3 Calcareous grassland	CG9–CG14
Limestone pavements	I1.3 Limestone pavement	Not known
Mesotrophic lakes	G1.2 Mesotrophic open water	Not known
Oligotrophic and dystrophic lakes	G1.3 Oligotrophic, G1.4 Dystrophic open water	A7, A9, A13–A14, A22–A24, S4, S8–S11, S19b
Wood pasture and parkland	A3 Parkland/scattered trees	W10–W11, W14–W17
Ponds	G1 Standing water	OV28-OV35
Inland rock outcrop and scree	I1.1 Inland cliff, I1.2 Scree	U16–U18, U21, OV38–OV40
Upland flushes, fens and swamps	E2 Flush/spring, E3 Fen, F1 Swamp	M4–M12, M21, M23a, M25c, M27–M29, M31–M35, M37–M38, S9–S11, S19, S27
Mountain heaths and willow scrub	D3 Lichen/bryophyte heath, D4 Montane heath, A2 Scrub	H13–H15, H17–H20, H22, U7–U15, U18, W20

Note: The correspondences are inexact. Each priority habitat type may include other Phase 1 classes and NVC communities as minor components. The Phase 1 and NVC classes listed may include habitats or vegetation that does not fall within the priority habitat definition.

Glossary

Adaptive management A systematic process for continually improving management policies and practices by learning from the outcomes of operational programmes.

Aftermath grazing Grazing on the vegetation that grows after a site has been mown or cut for hay.

Carr Wet woodland of willow, sallow, birch or alder that can establish and grow naturally on fens.

Carrying capacity The maximum stocking rate of a given type of grazing animal that a particular environment can sustain. It implies a continuous yield without environmental damage.

Corridor Route by which a species may move from one habitat patch to another.

Cultural habitats Habitats of types that are only there because of human influence on the land and that would disappear without man's intervention.

Dynamic mosaic approach A management approach that allows succession to progress in some patches but maintains the overall habitat resource by restoring or creating new habitat patches elsewhere in the forest.

Ecological connectivity Habitat patches between which animal and plant species can move freely. Such patches may be physically joined up or they may be separated by land through which the species or their seeds can move.

Ecotone Transitions from one habitat type to another, often having soil properties intermediate between the two types and exhibiting some of the ecological characteristics of both.

Ecosystem services The benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as regulation of floods, drought, and disease; supporting services such as soil formation and nutrient cycling; and cultural services such as recreational, spiritual, religious and other non-material benefits.

Habitat A place or type of site where an organism or population naturally occurs (Convention on Biological Diversity, 1992), characterised by its physical and/or biotic properties.

Input slope Slope forming part of the water catchment of a bog or wetland habitat.

Invasive non-native species Plant or animal species which are not native or locally native that spread rapidly to the exclusion of other species.

Lithology Underlying rock type.

Lowland Land below the local upper altitudinal limit of enclosed agricultural land.

Microhabitat A feature with distinct environmental conditions within a habitat patch (e.g. a wet hollow or Sphagnum hummock in a bog).

Montane scrub High-altitude scrub on upper forest edges or in montane zone composed of bushy, stunted trees (Scots pine, downy birch and rowan) and/or specialist shrubs (willows, juniper and dwarf birch) able to survive near and above the altitudinal treeline.

Open ground/space Areas within a forest without trees, such as glades, stream sides, grass or heath land, water bodies, rocky areas, roads and rides.

Open habitat Land occupied mainly by bare ground or low semi-natural vegetation, not by tall shrubs or trees.

Priority habitat or species Habitats and species that have been listed as priorities for conservation action.

Ride Open ground used to separate forest areas and provide an access route.

Rotational management A system of subdividing a habitat patch to apply management operations to separate parts in separate years so that the whole patch is not disturbed at the same time.

Succession The natural process by which a plant (or animal) community successively gives way to another until a stable climax is reached.

UKWAS United Kingdom Woodland Assurance Standard. One of the standards used in certifying products from sustainably managed woodlands.

Upland Land above the local upper altitudinal limit of enclosed agricultural land.

The proportion of open space in many forests and woodlands is increasing as forest management plans are implemented and forests are restructured. Landowners and forest managers are increasingly being encouraged to manage this ground for biodiversity objectives but in some situations the management of open ground may be more complex and challenging than the management of the forests themselves. This Practice Guide provides information and guidance to forest managers on managing open ground in upland forests. The guidance covers planning open habitats in new forests, creating open habitats in existing forests and maintaining open habitat networks. The Guide sets out both general principles and guidance for specific habitats together with advice on monitoring.

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