Appendix G - Upland habitats

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Preamble

For the purposes of this document, the English Uplands refers to the area above approximately 250 metres in altitude and above the moorland wall. The altitudinal element is approximate as in some areas, open moorland can be found at slightly lower elevations but nonetheless, these areas are regarded as being upland in character, reflecting the habitats and species found within them and often their continuity with blocks of higher land.

The uplands comprise the largest area of semi-natural habitat found within England, but they are far from natural and have been strongly shaped by human activity. This activity includes agriculture, game management, mining, access and the generation of wind-power, with the impacts being apparent at a landscape scale.

The important habitats can be collected under the following headings:

- upland heaths
- upland grasslands
- upland fens and flushes and swamps
- blanket bog
- upland rock habitats
- upland woods and scrub
- tall herbs and yellow saxifrage bank

An important point to note is that although some upland habitats occur in relatively homogenous areas at a landscape scale e.g. blanket bog or upland heath, these habitats also occur in mosaics, often at a fine scale that can be measured in square metres. Through all of these habitats, in mosaics at various scales, freshwater habitats also occur: runnels, pools, streams, rivers, tarns and lakes (see Appendix B). At a large scale these mosaics are referred to as ‘upland massifs’.

The term ‘tree-line’ is used at various points in this appendix. This is a nominal altitudinal line above which environmental conditions are considered to be too hostile for tree establishment and survival. It is a controversial term since historical grazing pressure and related management has widely eliminated trees and scrub and their associated seedbank from the moorland landscape, such that the true (natural) limit of tree and scrub growth is unclear. What is clear is that the tree line will vary in altitude around England depending on climatic and soil conditions, being higher in the south west and lower in the north. At a small-scale it will also vary depending on the degree of exposure of individual land areas within the landscape, being higher in sheltered ghylls and other sheltered spots and lower in highly windswept areas. Estimates of where the tree-line is located in different parts of England are crude and influenced by both historical and contemporary land management activities.

The communities discussed are those listed in the National Vegetation Community (NVC) descriptions by Rodwell (1991a). It is also the case that most of these habitats have lowland counterparts e.g. heath, fens, woodlands etc. and that these communities can overlap along the upland/lowland interface so the reader should also look at other appendices to gain a holistic understanding of the inter-relationship between habitats.

The range of habitats occurring naturally in the uplands is very large and this appendix reflects that. It should be viewed as a high-level summary to allow a broad understanding of the habitats and the issues that relate to them. For more detailed site-based information people should contact Natural England area teams or specialists.

In general, the uplands are not subject to the same types of development pressures found in the lowlands. For example, it is rare that a new housing estate or by-pass is proposed for construction on upland habitats. The period of the 1950s -1970s saw extensive, Government backed initiatives aimed at draining large areas of blanket bog in an attempt to improve agricultural productivity. Whilst smaller-scale attempts at drainage continued after the 1970s the last decade or so has seen concerted efforts to block drainage channels and restore hydrological integrity to drained blanket bog. Good progress has been made but more work will be needed in the short-to-medium term. More common now are development proposals around tracks, grouse butts, shooting huts and associated drainage. Less common can be proposals for quarrying or wind-farms. Less common still are afforestation proposals but where they occur, they can involve important habitats such as blanket peat. The impact of all these types of development upon the environment depends upon the habitat they are carried out on and where in the landscape they are placed.

G1. Upland heaths

G1.1 Factors affecting ecological position in the landscape

The distribution of upland heath in England is dependent upon soil type, hydrology and altitude. The majority of communities in England are sub-alpine in their occurrence (H4, H8, H9, H10, H12, H16, H18, H21 and H22, see Annex G1 for the full names of communities). Wet heath occurs within the same zone but is found on shallow peat soils rather than mineral, the hydrology of which is an important factor in determining the vegetation communities (M15, M16). The spatial patterning of wet and dry heath is naturally dictated by the pathways that water takes through the landscape, with wet heath forming along those pathways and dry heath forming further away from them.

The Alpine heath communities (H13, H19, H22, U7, U10) in England are restricted to the North of England (Rodwell *et al.* 1991a, Averis *et al.* 2004).

G1.2 Ecological function and relationships

Up to the natural tree-line, extensive upland heath is largely the result of historic management through either grazing by livestock or rotational burning for agricultural or game management purposes. In the absence of intervention, the process of succession would lead to these areas becoming open woodland which would include smaller areas of heath created by glade formation and the grazing pressure of wild herbivores. In the montane zone, the harsh environmental conditions prevent the colonisation by trees and the heaths that are found in these areas are thought to be near-natural, climax communities (Averis *et al*. 2004, Rodwell 1991b).

Upland heath can visually dominate the landscape but natural variations in geology, soil and topography result in the development of a mosaic of habitats consisting of wet and dry heath, bog and open freshwaters (pools and streams), especially along flush and spring lines.

G1.3 Current level of natural function

Upland heath occurs in every upland area of England from Bodmin Moor in the south west to Cheviot in the north east. The heaths of the west and especially the south west appear to be more transitional from dry to wet heath(referred to as “humid heath”) in their composition compared to further north and this is considered to be the result of the more oceanic conditions found in the south west.

Changes in land use post-World War 2 and the early 1990s resulted in at least a 20% loss of upland heath to intensive conifer plantations in England and Wales (Thompson *et al*. 1995). In addition to this, areas were lost both through reclamation to improved grassland and through overgrazing as well as through the use of fertiliser/lime/basic slag application, so that many areas that were once heathland are now dominated by mat-grass *Nardus stricta,* bent (*Agrostis* sp.) or fescue (*Festuca* sp.) grasslands. Changes in livestock payments have by and large prevented further losses of heath and the judicious targeting of agri-environment payments have resulted in some improvements in some places, in the last 20 years. Drainage and rotational burning on wet heath is especially damaging and remains a particular problem especially where this has led to the domination of Purple Moor-grass *Molinia caerulea* at the expense of the heath plant community.

Atmospheric deposition of nitrogen in particular is a growing threat that may result in a shift towards a more graminoid dominated vegetation (Fagúndez 2012, Field *et al*. 2014). Climate change may have impacts through the establishment of longer growing seasons along with changes in micro-climate, especially at higher altitudes that may allow previously temperature-regulated species to spread uphill. The native heather beetle (*Lochmaea suturalis*) can also be responsible for significant damage to heather at a site level - the triggers for this damage are unclear (Gillingham *et al.* 2016).

Table G1. Indicative levels of natural function in the upland heath resource.

State of naturalness	Prevalence of state within the habitat resource				
	Hydrology	Nutrients	Soil/sediment	Vegetation control	Species composition
Good	Moderate	Low	Low?	Low?	High?
Intermediate	Moderate	Moderate	Moderate	Moderate	Low?
Poor	Moderate	High	Moderate	High?	Low?
Confidence	*High*	*Moderate*	*Moderate*	*High*	*?*
Comments	*Often affected by drainage which increases the extent of dry heath at the expense of wet heath. Drainage can also create heath artificially from natural bog, but such cases are not considered true heath – they are degraded bog and dealt with under Section G3 rather than here.*	*Atmospheric deposition on nitrogen is the main impact on the current resource*	*Soil processes are affected by drainage and atmospheric nitrogen possibly also grazing and burning*	*Grazing regimes often drive the development of grassland from dwarf shrubs characteristic of heath*	Phytophthora *can affect ericaceous plants of upland heath*

G1.4 Potential for restoration of natural function

The approach to restoration of heath will depend upon the specific conditions on a site. Where the long-term problem has been over-grazing or the wrong timing of grazing, and key plant species (especially dwarf shrubs) remain albeit at sub-optimal frequencies, then manipulation of the grazing regime may lead to restoration of the habitat. Where the characteristic species have been lost entirely, restoration is likely to require significant intervention using seed addition and machinery over a large area. In the uplands this has only been tried on a relatively small scale and the effectiveness of this approach is uncertain. The restoration of wet heath will also require the restoration of the hydrological regime on the site through drain-blocking and the cessation of burning that can lower the water table and negatively alter the vegetation composition, this further degrades the underlying peat.

Table G2. Desirability and scope for restoring more natural function in the upland heath resource.

	Hydrology	Nutrients	Soil/sediment	Vegetation control	Species composition
Desirability	Yes	Yes	Yes	Yes	Yes
Comments	Needed to restore wet heath in natural mosaics with dry heath and a range of wetland and freshwater habitat types, including springs, flushes and mires	Needed to restore natural diversity of vegetation.	Linked to restoration of natural hydrology and natural nutrient status	Reduced grazing pressure is needed in many areas to restore degraded heath.	Needed to protect key species (ericaceous plants) from non-native pathogens.
Biodiversity synergies/ conflicts	Strong synergies with restoration of wetland and open freshwater habitats.	Natural nutrient levels are generally a shared conservation goal across all habitats and species		No significant conflicts. Restored heath would replace acid grassland of generally low biodiversity value (unless important for birds or invertebrates).	No biodiversity conflicts.

G2. Upland grasslands

G2.1 Factors affecting ecological position in the landscape

Upland grasslands are found throughout the English uplands and are generally unenclosed and subjected to extensive livestock grazing. Underlying geology, soil type and historic land use are significant drivers of distribution. Acid grasslands (e.g. U2, U3, U4, U5, U6, and locally U1, U7, U10 and U13) dominate with smaller areas of calcareous grassland (e.g. CG9, CG10, CG11,) and Calaminarian grassland (OV37) on metalliferous substrates, being found particularly in the north of England.

Like its lowland counterpart, upland grassland is largely the result of human intervention through livestock grazing although the exceptions are those that occur at higher altitudes in the montane zone (these are grassland in terms of NVC code but are called heaths and are included within the heath section). These examples are regarded as being near-natural. In the absence of agricultural grazing areas of grassland below the natural tree-line would be greatly reduced, restricted to small patches within woodland and scrub where wind-throw of trees creates clearings.

G2.2 Ecological function and relationships

The large swathes of Mat-grass (*Nardus stricta*) or Purple Moor-grass (*Molinia coerulea*) grasslands that are familiar in areas such as the Lake District or South Pennines are generally the result of historic grazing pressure combined with rotational burning and in the South Pennines in particular, drainage and past atmospheric deposition. In the past, much of the Mat-grass area would have been dry heath whilst the Purple Moor-grass would have been wet heath or even blanket bog. Both these grasses occur naturally but would not be dominant at a landscape scale in the absence of the interventions already listed.

Smaller areas (that can be locally extensive) of calcareous grassland also occur, often on small outcrops surrounded by acidic based vegetation. In the North Pennines, these outcrops hold some of the rare plants such as those for which Teesdale is famous. Calcareous grassland in general is associated with a wider range of plants than acid grassland which is notoriously species-poor.

Higher up the slope are the montane grasslands which are very restricted in England and exist as small habitat patches within larger areas of heath. Restricted to the Pennines are the Calaminarian grasslands, which would have occurred on metalliferous soils created by outcropping geologies with high levels of metal ores. These natural examples no longer occur due to mining activity (although it is possible that there may be small patches that remain to be discovered) and have been replaced by examples on mining spoil, often washed into streams and rivers and deposited downstream in river shingles and alluvium (see also Appendix C).

G2.3 Current level of natural function

Some acid grasslands such as *Deschampsia flexuosa* (U2) and *Nardus Stricta - Galium saxatile* (U5) are widespread across the uplands whereas others like *Agrostis curtisii* (U3) are restricted to one particular area, in this case, south west England (Averis *et al. 2004,* Rodwell 1991a). The montane grasslands are restricted to the highest parts of the Lake District Fells and North Pennines.

The calcareous grasslands are restricted to the North of England, in particular the North Pennines and the central and eastern areas of the Lake District and Yorkshire Dales.

Drainage is commonplace is many areas, eliminating small-scale flushes and fens and other wetland types from the grassland habitat mosaic as well as being responsible for a switch from heath and mire to grassland. This has permitted more intensive grazing which has further reduced the condition of remaining habitat.

Montane grasslands have generally seen an improvement in condition in the last decade following intervention via agri-environment payments (Martin 2014). However, a sample survey of upland calcareous grassland recorded 0% in favourable condition (Critchley 2011), indicating that grazing pressures may still be inappropriate.

Calaminarian grasslands are naturally very restricted in extent. Natural examples have been replaced with artificially generated examples on riverine deposits, and these are at risk of progressive decline as a result of natural processes (reworking of sediments by dynamic rivers and leaching of metal content) and measures to improve river water quality (e.g. removal of contaminated sediments). They are also at risk by both over-grazing and under-grazing (see also Appendix C).

Table G3. Indicative levels of natural function in the upland grassland resource.

State of naturalness	Prevalence of state within the habitat resource				
	Hydrology	Nutrients	Soil/sediment	Vegetation control	Species composition
Good	Low?	Low	Low	Low	Moderate
Intermediate	Moderate	Moderate	Moderate	Moderate	Moderate
Poor	Moderate	Moderate	Moderate	High	Low
Confidence	*Low*	*Low*	*Low*	*Low*	*Low*
Comments	*Drainage*	*Atmospheric nitrogen. Fertiliser application in some cases?*	*Associated with drainage and nutrient enrichment*	*High grazing pressure*	

G2.4 Potential for restoration of natural function

The widespread acidic grasslands are a part of the natural vegetation of the uplands although their spatial extent is greatly increased by agricultural grazing. They hold relatively little botanic interest in their own right and habitat restoration will usually involve changing the vegetation to other communities altogether (e.g. mosaics of dry and wet heath). They do however hold particular species interest (see below) and the impact of restoration on this interest should be considered before any management is enacted.

There is limited information available about the restoration of unenclosed calcareous grassland but where attempts have taken place, manipulation of grazing levels and timing to allowing greater sward structure and flowering appears to have been the main approach.

The restoration of Calaminarian grassland is problematic since exposing the substrate to enable colonisation by plants will expose the wider environment to toxic substances. The actions for this habitat need careful consideration to avoid conflicts with the restoration of natural function of upland river ecosystems. It may be worth investigating whether there are small patches of natural habitat remaining, which would increase the apparent natural function of the habitat resource. See Appendix C for more explanation.

Table G4. Desirability and scope for restoring more natural function in the upland grassland resource.

	Hydrology	Nutrients	Soil/sediment	Vegetation control	Species composition
Desirability	Yes	Yes	Yes	Yes	Yes
Comments	Needed to restore wet heath and a range of wetland and freshwater habitat types, including springs, flushes and mires	Needed to restore natural diversity of vegetation.	Linked to restoration of natural hydrology and natural nutrient status. Strategic approach needed for calaminarian grassland (see Appendix C)	Reduced grazing pressure is needed in many areas to restore degraded heath. Wetland and freshwater habitats	
Biodiversity synergies/ conflicts	Strong synergies with restoration of heathland, wetland and open freshwater habitats.	Natural nutrient levels are generally a shared conservation goal across all habitats and species		No significant conflicts. Restored heath would replace acid grassland of low biodiversity value.	

G3. Upland fens and flushes and swamps

G3.1 Factors affecting ecological position in the landscape

Fens and flushes are found across the uplands with water pH, (as a result of differing geology) playing an important role in shaping the plant community. These features are usually small in scale and make up a small but important part of the upland landscape. Valley mires are peat-forming mires where water from the surrounding area moves through the feature. These mires can be much larger than typical fens and flushes.

G3.2 Ecological function and relationships

These habitats form part of the mosaic of upland plant communities. Though small in scale they contribute to the variation of habitats on any given site. Some are more closely related to acidic mires and occur in combination with blanket bog and wet heath whilst others are found in the upland heaths and grasslands. The northern bias for some communities is a reflection of altitude and extreme environmental conditions whereas in other communities, the key is the milder, oceanic climate.

As with blanket bog and wet heath, these are habitats that depend upon water and are an important part of what makes up the hydrological function of the uplands. These habitats also store peat and will contribute to carbon storage as well as water flow although they have not been studied in this respect.

G3.3 Current level of natural function

The natural character of these features is determined largely by water chemistry and topography. Alkaline fens and alpine flushes (M9a, M10, M11) have a distinct northern bias, following calcareous geology, whereas the Short-sedge acidic fens (M4, M5, M6) are generally more widespread, in association with more acidic geology. The upland soakway and sump type (M29) has an oceanic-related distribution and is largely confined to the south-west of England. The spring-head, rill and flush communities (M7, M8, M31, M32) are confined to the Lake District and North Pennines. In general, these are sites that are either very wet or occur at high altitudes – the latter being considered close to near-natural vegetation. The higher sites are subject to grazing and in some circumstances this could be beneficial in maintaining the open structure of the vegetation.

Upland fens, flushes and swamps are widely subject to artificial drainage, with the severity of this generally declining with altitude. The drainage is largely effected through straightening and deepening of natural channels, for example the excavation of linear ditch along the centre of a valley mire system, in place of the multiple sinuous flow tracks that would be present in a more natural situation. In addition to impacts on natural hydrological gradients, this modification also affects natural chemical gradients by removing or reducing the influence of certain water supplies, e.g. groundwater seepage, on surrounding land.

Upland wetlands are generally deficient in in tall-herb and woody species as a result of historic and current high stock grazing levels. In some situations, for example higher altitude, low-intensity grazing is likely to be beneficial in maintaining the open structure of the vegetation.

Although nutrient status of the uplands is relatively natural compared the lowlands, deposition of atmospheric nutrients remains a threat to natural function, with large areas of upland wetland receiving nitrogen concentrations exceeding critical loads.

Table G5. Indicative levels of natural function in the upland fen and flush and valley mire resource.

State of naturalness	Prevalence of state within the habitat resource				
	Hydrology	Nutrients	Soil/sediment	Vegetation control	Species composition
Good	Moderate	Moderate	Moderate	Low	Moderate
Intermediate	High	High	Moderate	Moderate	Moderate
Poor	Moderate	Low	Moderate	High	Low
Confidence	*Medium*	*Low*	*Low*	*Low*	*Low*
Comments	*Despite some highly natural areas, small-scale drainage is extremely widespread*	*Atmospheric deposition remains an issue over large areas.*	*Peat oxidation due to drainage. Flushing of soils by mineral-rich groundwater reduced by ditching/piping springs & seepages.*	*Heavy grazing limits the full development of biological potential, although in some places may maintain skeletal surfaces for some rare species. Burning may also result in damage and loss of species.*	*Non-native species e.g. Epilobium brunnescens, Mimulus spp. may competitively exclude native species in some upland fen types.*

G3.4 Potential for restoration of natural function

The relatively un-modified nutrient status of many upland landscapes creates significant opportunity for restoration of highly natural complexes of upland wetlands and surrounding habitats. Many of these sites can be very wet which can provide a degree of protection from grazing animals or management fires. Restoring hydrological function through blocking and in-filling of drains and other techniques to restore hydrology along with the establishment of an appropriate grazing regime (that ensures eutrophication from congregating livestock does not take place) should ensure that damaged sites are put on a trajectory for recovery. Sites that have not suffered any artificial drainage activity can be maintained by a suitable grazing regime. It should be noted however, that these sites may be vulnerable to climate change or seasonal shifts in rain-fall patterns that lead to the development of different plant communities that may in time alter the nature of these habitats.

Table G6. Desirability and scope for restoring more natural function in the upland fen and flush and valley mire resource.

	Hydrology	Nutrients	Soil/sediment	Vegetation control	Species composition
Desirability	Yes	Yes	Yes	Yes	Yes
Comments	Will require infilling and damming of drains	Needed to restore natural diversity of vegetation.	Linked to restoration of natural hydrology and natural nutrient status	Reduced grazing pressure is needed in many areas to restore structure and function in mires and native species recovery.	Removal/control of non-native species needed.
Biodiversity synergies/ conflicts	Supports restoration of associated upland habitats and habitats further down the catchment, including heaths, streams,	Natural nutrient levels are generally a shared conservation goal across all habitats	Supports restoration of associated upland habitats and habitats further down the catchment, including mires, streams, pools, rivers and lakes.	Supports restoration of associated upland habitats, including wet woodland and scrub, including juniper	No conflicts

G4. Blanket bog

G4.1 Factors affecting ecological position in the landscape

Blanket bog, ladder fen and quaking bog distribution is determined by a combination of geology, land-form, high rainfall and low evapotranspiration. In general, blanket bog occurs at a landscape scale with ladder fens (a rare type of nutrient-poor fen) and quaking bogs making up smaller features within the blanket bog landscape. These are acidic environments that are botanically relatively species-poor but these species are specialists that do not occur elsewhere.

G4.2 Ecological function and relationships

These are habitats that depend upon rainwater and an intact natural hydrology to permit the conditions that allow the setting down of peat. The distinctive micro-topography (that is largely absent from England) associated with blanket bog develops through varying ability of the different bryophyte species to compete with each other (Lindsay 2010). This creates a varied micro-habitat mosaic consisting of drier hummocks supporting ericaceous plant and wetter troughs in which wet peat and pools occur. All this provides niches for as wide variety of plants and animals. Whilst blanket bog cloaks the landscape (hence its name) fens and valley mires can be much smaller and may occur in situations where the surrounding habitat is not blanket bog. Blanket bog in good condition is regarded as a climax community and does not require management either through grazing or rotational burning. Habitat condition is therefore strongly associated with natural function.

G4.3 Current level of natural function

Whilst all the vegetation communities share the requirement for rainwater there are regional differences that relate to climate and past land use. The M1 community is confined to the western side of England as is largely M17. The M2, M3, and M4 communities are found across the range albeit with a slight northern bias. The M5, M8. M9b, M18, M19, M20 and S27 communities are confined to the north of England. By contrast, M21 occurs in clusters in the south-west, the North Pennines, West Cumbria and the Lake District.

These are all communities that are negatively impacted by heavy or even moderate livestock grazing, drainage and rotational burning. Atmospheric deposition (historically sulphur but more recently nitrogen) has also been believed to have had negative impacts upon the bryophytes that are key peat builders (Tallis 1964). There have been some losses to afforestation especially around the Border Mires.**Table G7. Indicative levels of natural function in the blanket bog resource.**

	Prevalence of state within the habitat resource				
State of naturalness	**Hydrology**	**Nutrients**	**Soil/sediment**	**Vegetation control**	**Species composition**
Good	Low	Low	Low	Low	Moderate
Intermediate	Moderate	Moderate	Moderate	Moderate	Moderate
Poor	Low	Moderate	Moderate	Moderate	Low
Confidence	*High*	*High*	*Moderate*	*High*	*Low*
Comments	*Blanket bog has been extensively drained by 'gripping', eliminating active peat formation and enabling grazing*	*Atmospheric nutrient deposition has impoverished the vegetation.*	*Loss of active peat formation on which the habitat depends*	*Sheep grazing and burning have had major impacts on peat integrity and characteristic vegetation.*	*Ericaceous plants within the blanket bog micro-habitat mosaic are affected by Phytophthora*

G4.4 Potential for restoration of natural function

Much of the blanket bog resource has been subject to extensive drainage works in the last century. Over the last two decades, a priority has been to block drainage channels to help restore the hydrological function of the blanket bog. Evidence to date indicates that this approach has had a positive impact. It is known that the vegetation plays a key part in establishing the functioning of blanket bog and work is now focusing more upon restoring the key peat-building vegetation. There also appears to be an improvement in air quality (the reduction of sulphur) that is being manifest in an apparent recovery across the uplands of bryophytes. This recovery has yet to be quantified but it suggests that restoration of blanket bog may take less time than was once thought.

The projected shift in climate and rainfall may have a marked affect upon blanket bog in England which is at its southern limit. What is not clear is whether this will lead to a loss of blanket bog through gradual erosion of the peat body or whether a shift in species composition making up the blanket bog will occur. The peat archive suggests that a shift in species composition is likely although it is not clear if this will be a rapid or slow response.

The restoration of natural function in blanket bog is not only critical for the bog itself but also for all wetland and freshwater habitats that the bog supplies with water. It helps store water to sustain supply to downstream habitats, and in favourable condition provides the high water quality required by the species of these habitats (e.g. Ramchunder *et al*. 2012).

Table G8. Desirability and scope for restoring more natural function in the blanket bog resource.

	Hydrology	Nutrients	Soil/sediment	Vegetation control	Species composition
Desirability	Yes	Yes	Yes	Yes	Yes
Comments	Essential for favourable condition of the habitat	Needed to restore natural diversity of vegetation.	Linked to restoration of natural hydrology and natural nutrient status	Reduced grazing pressure is needed in many areas to restore degraded heath.	Needed to protect key species (ericaceous plants) from non-native pathogens More sympathetic approach needed to native predators of conservation importance.
Biodiversity synergies/ conflicts	Supports restoration of associated upland habitats and habitats further down the catchment, including mires, streams, pools, rivers and lakes. Some species have exploited the drier conditions of degraded blanket bog, and would decline in number as a result of restoring more natural function.	Natural nutrient levels are generally a shared conservation goal across all habitats and species	Supports restoration of associated upland habitats and habitats further down the catchment, including mires, streams, pools, rivers and lakes.	Burning is associated with maintenance of moorland for red grouse, a native species which is managed for shooting. Restored blanket bog should still provide good habitat for the species, along with associated heathland.	No biodiversity conflicts.

G5. Upland rock habitats

G5.1 Factors affecting ecological position in the landscape

The natural distribution of these habitats is determined by geology, occurring on scree slopes and in natural crevices and faultlines. Their natural distribution has been extended by historical mine workings. Aside from Limestone Pavement, the rocky habitats of the uplands are amongst the most under-described of all upland habitats,

G5.2 Ecological function and relationships

These habitats vary naturally in scale in England from relatively extensive areas of limestone pavement to small outcrops. They can naturally occur in larger mosaics with any other type of upland habitat. Their botanical interest is dominated by species found on calcareous geology, which can provide important natural diversity in the habitat mosaic alongside more acidic habitats.

G5.3 Current level of natural function

All these habitats are naturally restricted by the occurrence of outcropping rock and are largely located in the North of England, in particular, the North and South Pennines, the Lake District and the area around Morecambe Bay. They are relatively immune from some impacts on natural function (e.g. hydrology), but can be subject to grazing pressure that is less or more than desirable for their full expression. In vegetative terms these habitats are generally regarded as open habitats but naturally would occur as a mixture of open, scrub and wooded habitats below the natural tree-line.

Table G9. Indicative levels of natural function in the upland rock habitat resource.

State of naturalness	Prevalence of state within the habitat resource				
	Hydrology	Nutrients	Soil/sediment	Vegetation control	Species composition
Good	High	Moderate	High	High	Low
Intermediate	Low	Low	Moderate	Low	Low
Poor	Low	Low	Low	Low	Low
Confidence	*Moderate*	*Low*	*Moderate*	*Moderate*	*Moderate*
Comments	*Relatively immune from hydrological impacts on natural function*	*May be some atmospheric nitrogen effects*	*Examples created by mine workings are unnatural*	*Natural sites are relatively immune from agricultural grazing*	*No known impacts from non-native species*

G5.4 Potential for restoration of natural function

Limestone pavement is the result of glacial processes that cannot be replicated. Damage to pavement is therefore permanent and much of the resource has been damaged or destroyed to supply the horticultural industry with limestone for gardens. The remaining resource is now protected which should prevent further loss. The focus for restoration and protection of pavement should be around managing the natural succession that takes place either mechanically or through livestock grazing.

The remaining habitats cover the spectrum of either out-of-reach of grazing animals (OV40) or being eliminated by overgrazing (OV38). Grazing may have a role in preventing succession to woodland (U21) that in turn will provide benefits for some important plant and invertebrate species.

Table G10. Desirability and scope for restoring more natural function in the upland rock habitat resource.

	Hydrology	Nutrients	Soil/sediment	Vegetation control	Species composition
Desirability	Not needed	Yes	Maybe	Yes	Not needed
Comments		Any risks from atmospheric nitrogen would addressed by its control	It is assumed that natural (inaccessible) sites are functioning properly.	Not an issue for natural (inaccessible sites) sites. Restoration of sites in accessible areas will need low intensity grazing regime	
Biodiversity synergies/ conflicts		None	Sites based on historical mine workings may need to be restored to other upland habitats, and this would reduce the extent of rock habitats. The importance of this will need local consideration.	None	

G6. Upland woods and scrub

G6.1 Factors affecting ecological position in the landscape

Woodland and scrub would naturally occur in the uplands below the natural tree-line where soil stability is sufficiently high and grazing pressure sufficiently low for their establishment. They will occur at higher altitudes where land areas are sheltered (such as in ghylls) and grazing pressure is naturally reduced by inaccessibility (steep slopes, as long as soils are sufficiently stable).

A variety of woodland types currently occur in the English uplands (Rodwell 1991b) with two that occur at high altitudes but only one of these matching the NVC description. These two high altitude habitats are extremely restricted within England being found in very small areas in the Lake District, North Pennines and Northumberland.

Individual trees in the landscape can be important in their own right, and scattered trees in 'wood-pasture' type situations can provide stepping stones and sources of shelter and pollination.

G6.2 Ecological function and relationships

In the past, all of the upland woodland and scrub habitats would have been more extensive than now and would have provided valuable structure, especially at higher altitudes amongst the heaths and grasslands. The remaining examples of high altitude woodland in Scandinavia host important invertebrate species (Averis *et al.* 2004) and this would probably have once been the case in England. Trees in the landscape, including woodland, hedges and small blocks of tree planting are known to provide an environment that is utilised by a range of species including mammals, birds and invertebrates. Their contribution to the ecological functioning of the English uplands is currently greatly constrained by their limited extent. Overgrazing has a massive impact on the extent and type of woodland found in the uplands. Scattered trees may be remnants of wood pasture systems.

G6.3 Current level of natural function

Downy birch (W4), Alder (W7), Ash (W9) and Oak (W11) woodlands are found across the English uplands with a bias towards the north of England. Juniper woodland (W19) is restricted to the Lake District, North Pennines and Northumberland. Some losses in the North Pennines have occurred recently as a result of the non-native fungal pathogen *Phytophthora austrocedri.*

In the Lake District, planting of Downy Willow Salix lapponum (W20) has taken place recently in an attempt to reinforce the existing population. The hope is to establish a wider scrub habitat on the site in question.

The main impact on natural function is loss of extent due to historical and contemporary grazing regimes. Drainage has also reduced the suitability of conditions for wetter woodland types, or for scattered trees of wetland character (such as alder and willow) along hydrological pathways. Upland ghylls below the natural tree line would naturally be expected to have good coverage of riparian trees, which are an essential component of the stream habitat mosaic and critical to ecological function (see Appendix B). They would also be expected to be an element of valley mires and around fens and flushes, providing important shelter and feeding opportunities for bird and invertebrate species.

Table G11. Indicative levels of natural function in the upland woodland and scrub resource.

State of naturalness	Prevalence of state within the habitat resource				
	Hydrology	Nutrients	Soil/sediment	Vegetation control	Species composition
Good	Low	Low	Moderate	Low	Low
Intermediate	Low	Moderate	Moderate	Low	Moderate
Poor	High	Moderate	Moderate	High	Moderate
Confidence	*Moderate*	*Low*	*Low*	*High*	*Low*
Comments	*Drainage impacts constrain the development of wet woodland and wetland trees and scrubs in the uplands*	*Little known about the effects of atmospheric nitrogen deposition on native woodland and scrub*	*Impacts on natural function here relate to hydrological impacts from drainage*	*High historical and contemporary grazing levels are suppressing woodland and scrub development in the uplands*	*A range of diseases are affecting native tree species that naturally occur in the uplands*

G6.4 Potential for restoration of natural function

The current *Phytophthora* threat has meant that there is renewed interest in restoring Juniper across its former range. Similarly, if the recent plantings of Downy Willow are successful, then attempts may be made to restore the habitat to other sites. One of the critical factors in restoring these habitats is the control of grazing. If this cannot be achieved then restoration is unlikely to be successful. There are relatively few examples in England of the restoration of transitions between woodland and other upland habitats. One example under development can be found on Ingleborough NNR.

Restoring genetic diversity of tree populations is a critical part of restoring the spatial extent of upland woodland/trees, to counter the effects of the various tree diseases that are devastating different species in England and elsewhere. There is a very depleted seedbank in the uplands, caused by intensive sheep grazing over many years, so the potential for natural regeneration is often poor. Natural regeneration has most potential in the moorland fringe where trees and scrub can be abundant immediately below the moorland wall.

Table G12. Desirability and scope for restoring more natural function in the upland woodland and scrub resource.

	Hydrology	Nutrients	Soil/sediment	Vegetation control	Species composition
Desirability	Yes	Yes	Yes	Yes	Yes
Comments	More natural function needed to provide the full range of woodland types and tree/scrub species that naturally occur in the uplands	Any risks from atmospheric nitrogen would addressed by its control	Linked to restoration of natural hydrology and natural nutrient status. Natural woodland development (leaf litter and fallen wood (will restore natural soil humus and microflora levels over time.	Reduced and grazing pressure and altered grazing regimes are needed to restore upland woodland and scrub habitats and trees as an integral part of the wider upland habitat mosaic.	Key mechanism is high genetic diversity in newly established trees. Natural regeneration where possible.
Biodiversity synergies/ conflicts	Strong synergies with restoration of wet heath, wetland and open freshwater habitats.			Need to target restoration of habitat at degraded open habitats with lowest biodiversity interest.	No biodiversity conflicts.

G7. Tall Herbs and Yellow Saxifrage Bank

G7.1 Factors affecting ecological position in the landscape

The Tall Herbs (U16, U17, U19) and Yellow Saxifrage Bank (U15) communities are typically confined to steep slopes that prevent grazing animals from accessing the vegetation. The assumption is that prior to the introduction of sheep, they would have been found across hillsides although some of these sites would probably have been woodland.

G7.2 Ecological function and relationships

These communities contain some of the rarest montane species and contribute to the overall interest and importance of other montane vegetation communities. These communities occur above 300 metres in altitude and occur on the thin soils on cliff edges, sheltered gullies and ravines. The U15 community is found in basic conditions; U16 and U19 occur on acid rock whilst U17 is mesotrophic. These communities seemingly play little role in terms of hydrological function in the uplands but in the absence of inappropriate grazing they would be a larger component of the upland mosaic and would contribute towards the maintenance of botanical and invertebrate diversity.

G7.3 Current level of natural function

The area of these communities totals no more than a few tens of hectares, the majority of which are in the Lake District with the remainder in the North Pennines. The condition of the habitat is determined by the level of sheep grazing with the more accessible areas subject to losses of individual species.

Table G13. Indicative levels of natural function in the tall herbs and yellow saxifrage bank resource.

State of naturalness	Prevalence of state within the habitat resource				
	Hydrology	Nutrients	Soil/sediment	Vegetation control	Species composition
Good	High	Moderate	High	High	High
Intermediate	Low	Low	Low	Low	Low
Poor	Low	Low	Moderate	Low	Low
Confidence	*High*	*Moderate*	*Moderate*	*Low*	*Low*
Comments	*Relatively immune from hydrological impacts on natural function*	*May be some atmospheric nitrogen impacts*		*Naturally inaccessible sites are immune from livestock grazing pressure.*	*No known problems with non-native species*

G7.4 Potential for restoration of natural function

In some areas, the communities exist in a natural state because they are on inaccessible cliffs or slopes. Restoration onto more accessible areas should be an objective – they would have existed naturally in such areas within a dynamic habitat mosaic created by natural variations in grazing pressure in the landscape.   This would require the removal of grazing in the first instance and then, once areas are restored, the careful control of re-introduced grazing. Less controlled grazing in these restoration areas, if adopted at sufficiently low grazing intensities over sufficiently large areas to generate sufficient variation in grazing pressure in the landscape, may regenerate the righ conditions for the dynamic presence of these communities. However, it may also result in the reversion of vegetation to scrub or woodland and result in lost opportunities for these rare vegetation types. It should be noted that these communities are extremely rare and localised within England, meaning that it is relatively easy to plan any restoration to ensure the right outcomes at site-level.

Table G14. Desirability and scope for restoring more natural function in the tall herb and saxifrage bank resource.

	Hydrology	Nutrients	Soil/sediment	Vegetation control	Species composition
Desirability	Not needed	Yes	Yes	Yes	Not needed?
Comments		Any risks from atmospheric nitrogen would addressed by its control	Inaccessible sites are assumed to be functioning naturally. Restoration of accessible sites is linked to soil nutrient status (see left)	Requires appropriate grazing regimes (low grazing pressure) in moorland areas that are accessible to livestock. Access may need careful control.	
Biodiversity synergies/ conflicts		Natural nutrient levels are generally a shared conservation goal across all habitats and species		Strong synergies if restoration is undertaken as part of a large-scale alteration of grazing regimes to generate low but variable grazing pressure with appropriate livestock types.	

G8. Provision of habitat for particular species

G8.1 Invertebrates

The principal upland assemblages are the montane and upland assemblage F221, and the more widespread F003 scrub-heath moorland assemblage. They are spatially separated, as much as they can be, by altitude, although one will find members of each assemblage in the other one. The F221 reaches is peak on the very highest of ridges and summits, and is dominated by beetles, spiders and flies. Moorhouse and Cross Fell SSSI holds this assemblage on the highest ridges and upper slopes. A typical description of the habitat supporting this assemblage is of mountain summits with rock outcrops and loose frost-shattered stones, grass tussocks and *Rhacomitrium* moss mats. The more upland sphagnum bog faunas have some similarities, and the Sphagnum mats support a number of important Linyphiid money spiders, most notably the S41 Cloud-living spider *Semljicola caliginosus*.

The F003 scrub-heath assemblage can occur on lowland wet heaths, but is possibly more widely found on the lower, humid soils of the uplands, and across wide swathes of poor peaty ground. It is again dominated by beetles, spiders and flies, but adds an important moth fauna as a component. The assemblage type is found on nutrient-poor, acid soils where herbaceous or dwarf shrub vegetation is dominant, although trees and taller shrubs can be an important component of the overall habitat when found in the lowlands. Most of the Cornish “uplands” support F003 in character.

In abundance terms, uplands faunas tend to be heavily dominated by a few species, and a few spiders species such *Pirata piraticus* and *Lepthyphantes zimmermanni* can dominate samples. The same can hold true for beetles, with Usher (1992) finding that 6,336 individuals of 54 species, over half were dominated by just five species. Usher & Thompson (1993) note that the following management practices seem key in conserving the upland fauna:

- (i) burning on blanket bog be minimised;
- (ii) variable burning cycles to improve habitat complexity be used;
- (iii) wet flushes be conserved;
- (iv) upland heathland margins be burnt less intensively; and
- (v) scattered mosaics of scrub and woodland be established.
- The mosaic structure of upland heathlands is critical for wildlife conservation. The invertebrate assemblages rely for their diversity on this mosaic structure.

A surprising amount of invertebrate activity takes places across burnt or cut areas, even from taxa with no particular business being there, if Gardener and Usher (1989) study on the North York moors holds true for other uplands. The risk of predation in such open areas remain, however high.

Heavy upland grazing is detrimental to many species, and can shift ground beetle communities from those with reliance on shade to more open ground species.

Being low productivity system, the invertebrates require quite a degree of effort to trap and record, and passive trapping techniques such as pitfalls traps are essential. The logistics and difficulty of vacuum sampling, and the frequent impracticality of using sweep nets do present challenges, as do weather conditions.

G8.2 Lower plants

The bryophyte flora of upland habitats tends to be richest on sheltered north or north-east facing slopes where the microclimate is shaded and humid, in comparison to south-facing slopes that are more prone to dessication. Within the uplands the characteristic bryophytes vary according to habitat.

Medium-altitude acidic heathland often supports mosses that are widespread in lowland heathland, such as *Hylocomium splendens, Hypnum jutlandicum, Pleurozium schreberi* and *Dicranum scoparium,* with liverworts such as *Diplophyllum albicans*. In grassier upland areas species such as *Rhytidiadelphus squarrosus* become more frequent. Rock outcrops in uplands usually increase the diversity of bryophytes, and such outcrops in upland heathland often support leafy liverworts such as the various *Barbilophozia* species. Blanket bog vegetation covers extensive areas of the wetter regions in the uplands. This vegetation is bryologically less diverse in flatter areas, but on steeper slopes crags of exposed rock may support large cushions of liverworts and *Sphagnum* species.

Acidic rocks in the uplands support frequent *Racomitrium lanuginosum*, also with *R. aquaticum* and *R. sudeticum*, plus the mosses *Kiaeria blyttii, Andreaea rupestris, Grimmia donniana* and *G. trichophylla*. Characteristic liverworts include various species of *Gymnomitrion* and *Marsupella*. Bryophytes occurring on the acidic upland tors of Dartmoor and Bodmin Moor include *Andreaea rothii, Polytrichum alpinum* and *Antitrichia curtipendula*.

A range of uncommon bryophytes occur on base-rich rock in the uplands, where the mosses *Amphidium mougeotii* and *Hymenostylium recurvirostrum* are frequent. The richest area for Arctic-alpine bryophytes in England occurs in the northern Pennines area of Upper Teesdale, where sugar limestone outcrops support many calcicolous upland bryophytes.

Small-sized scree is often too unstable to support many bryophytes, however stable scree with large rocks and boulders is often a good habitat, and species of *Andreaea, Racomitrium* and *Grimmia* may be frequent.

Only well-adapted bryophytes can survive in the harsh environment of the upland summits. *Racomitrium lanuginosum* is often frequent, being very resistant to dessication, but it is vulnerable to overgrazing by sheep and acidic deposition from air-borne pollution. Specialised tiny liverworts are able to colonise bare summit ground, including species of the genus *Marsupella*.

Upland flushes support an interesting bryophytes community, including *Scapania undulata*, *Philonotis fontana, Dicranella palustris, Calliergon sarmentosum* and various species of *Sphagnum*. *Scapania undulata* is also usually frequent in upland streams, with *Brachythecium plumosum, Nardia compressa* and *Hygrohypnum* species. *Racomitrium* species are often prominent on rocks in such streams, including *R. aciculare* and *R. faciculare*. The Section 41 moss *Splachnum vasculosum* occurs on animal dung in upland flushes and springs in boggy moorland.

Additional Section 41 bryophytes that occur in the uplands include Carrion Moss *Aplodon wormskoldii,* an unusual and Critically Endangered moss that grows on old carrion in boggy ground, Brown Grimmia *Grimmia elongata* found on acidic rock at high altitude, and Slender Yoke-moss *Zygodon gracilis*, a rare species that occurs on limestone drystone walls, now mostly in upland habitats.

The restoration of natural processes in the uplands is likely in most cases to be beneficial for bryophytes, by keeping the vegetation structure open, creating suitable microhabitats, and preventing bryophytes from being overwhelmed by taller vegetation and the build-up of litter. However damaging over-grazing needs to be avoided, and in the case of the rarer species, in particular those listed within Section 41, care will need to be taken within individual sites to ensure that large-scale management actions do not have a negative effect on species that may be restricted to very small areas of habitat.

G8.3 Birds

Many threatened and declining breeding birds are strongly associated with, or restricted to, upland habitats and associated upland farmland (Table G15). Many depend on extensive, open areas of blanket bog and upland heath for both nesting and foraging habitat. For example, upland blanket bogs with a good cover of dwarf shrubs support both breeding and non-breeding Red and Black Grouse and, during the summer, important numbers of breeding Curlews. Extensive areas of undisturbed bog also provide an important breeding habitat for Hen Harriers, although few areas are now occupied by this species because of historical and on-going persecution. Other species strongly associated with upland heath and bog include nesting Merlin, Short-eared Owl and Golden Plover.

Table G15. Section 41 bird species strongly associated with upland habitats. (B = breeding, NB = non-breeding)

Species	Breeding status	Upland habitat
Hen Harrier	B & NB	Upland blanket heath & bog
Black Grouse	B & NB	Upland heath & blanket bog, scrub
Red Grouse	B & NB	Upland heath & blanket bog
Grey Partridge	B & NB	In-bye farmland
Lapwing	B	In-bye farmland
Curlew	B	Upland heath & blanket bog, In-bye farmland
Cuckoo	B	Upland heath & blanket bog, In-bye farmland
Skylark	B & NB	Upland heath & blanket bog, In-bye farmland
Tree Pipit	B	Scrub, woodland edge
Yellow Wagtail	B	Hay meadows
Ring Ouzel	B	Upland heath, scrub, rough pasture
Twite	B	Upland heath, in-bye farmland
Reed bunting	B & NB	In-bye farmland

Some upland species depend on a combination of unenclosed habitats for nesting and adjacent farmland for foraging. Breeding Curlews and Golden Plovers, which nest on open habitats above the limits of enclosed land, often visit adjacent pastures to forage. Curlews also nest in rough pastures and hay meadows when there is sufficient cover of tall vegetation for nest and chick concealment.

Ring Ouzels and the severely threatened English population of Twite both nest in open upland habitats, the former often using rocky slopes with mature heather and the latter choosing tall heather or bracken for nest concealment. Both species utilise pastures for foraging, with Twite particularly dependent on flower-rich field margins with abundant seeds.

For other species, particularly waders, poorly-drained ground also provides essential foraging habitat, both on the unenclosed and enclosed land. Flushes, pools and wet grasslands all, provide essential invertebrate-rich areas for both adults birds and their chicks.

Although scarce in many upland landscapes, areas of open scrub and young trees are important for some upland species. Black Grouse favour scrubby birch growth for foraging, particularly in the winter and early spring, and Ring Ouzels depend on rowan berries after the breeding season and before they migrate to their wintering grounds. Tree pipits are also associated with scattered trees, generally on the transition from woodland to open upland.

Unsustainable practices which generally reduce the value of upland habitats to birds include peat-cutting, gripping (drainage) and intensive rotational burning of blanket bog or heath vegetation. These activities often diminish the area of habitat suitable for breeding Hen Harrier, Merlin, Red and Black Grouse, Curlew and other declining upland species.

Overgrazing has, both historically and currently, contributed to the loss of expanses of heather habitat to species-poor grassland, which has displaced Red Grouse in particular. Conversely, a lack of grazing in some areas has also reduced habitat suitability, often resulting in an increased density and cover vegetation. This is particularly the case in some rough pastures where, ultimately, increasingly rank vegetation makes the grassland unsuitable for many species, including nesting and foraging Curlews and Lapwings. Other changes in farming practices, particularly field drainage, re-seeding of pastures, the use of artificial fertilisers and the loss of traditional hay meadows to intensive silage management, have also reduced the availability of suitable habitat for many species, particularly Curlew, Lapwing, Yellow Wagtail and Twite.

The restoration of natural hydrological conditions and the return to less intensive upland management and farming practices, which together encourage the proliferation of wetland habitats and greater structural diversity of both unenclosed and enclosed farmland vegetation, will favour a higher diversity of breeding bird species. Similarly, allowing some natural regeneration of scrub and woodland cover, particularly on the upland fringe and along watercourses, will provide additional valuable cover and nesting and foraging habitat for some upland birds and their prey species.

G8.4 Mammals

The mountain hare is an arctic/subarctic species that is native to the UK but extinct in England except for a population in the Peak District (which was actually the result of an introduction between 1870-1882 for sporting purposes). The reasons for extinction are unknown, but are probably related to habitat change, competition with brown hares (Thulin 2003) and hunting pressures. The presence of the introduced population in the Peak District is considered to constitute restoration of part of the species' natural range and so is consistent with current conservation objectives for the species. Generally the mountain hare is found on ground above 130m from sea level primarily on *Calluna-Eriophorum* communities rather than grassland. They are rarely seen in bracken, and areas dominated by purple moor grass (*Molinia caerulea*) seem to be avoided entirely. Pioneer heather is the preferred grazing source followed by wild grass. Grazing by mountain hares declines on upland hill pastures with increased sheep grazing, therefore livestock grazing regimes need to be carefully managed. Overall, restoration of more natural vegetation controls, to provide greater amounts of heather and wild grasses, can be expected to improve the long-term habitat prospects of the species in the English uplands. The Peak District population is suspected to be increasing now, aided by mild winters and cessation of hunting with dogs.

The distribution of red squirrels has declined drastically in the last 60 years, primarily due to the range expansion of grey squirrels which spread disease and compete for food. They are now extinct in southern England except for a small population on the Isle of Wight and two small islands in Poole Harbour. Red squirrels are still widespread in the North of England, Scotland and Ireland, but even here their range is contracting and they are now largely confined to conifer forests in northern upland regions. Tree seeds are small in upland spruce forests and grey squirrels find it difficult to eat enough to satisfy their basic energy needs; however the smaller red squirrel is better able to survive on such a diet.

Creation of habitats favourable for only red squirrels within the upland habitat mosaic as well as exclusion of grey squirrels will help sustain red squirrel populations, however restoration of native woodland and scrub could encourage grey squirrels into the area.

The pine marten (*Martes martes*) is one of our rarest mammals in England due to habitat loss and past persecution. They are a woodland specialist, but loss of woodland led to a severe decline during the 19th century. By the early 1900s, pine martens were mainly restricted to rocky upland habitats such as the Lake District. Pine martens have survived here in largely treeless landscapes as mountains and rocky crags provided alternative refuges to their preferred woodland habitat. Persecution for protection of game birds have kept populations levels low.

Pine martens have begun to recover in Scotland in response to declining persecution and increasing woodland cover. However, records suggest that pine martens persist only in very low numbers in upland parts of northern England such as the Lake District, Cheviots and North York Moors. The long-term viability of these populations is considered to be highly vulnerable due to low density of populations and restricted distribution. There are currently a number of feasibility studies underway looking at the potential of a formal reintroduction of this species into England.

G9. Key messages

G9.1 Upland heath

- Upland heath has historically been greatly extended by agricultural grazing relative to its natural occurrence, but there has been considerable loss in area and quality of the habitat between 1945 and 1995.
- Upland heath is a habitat that requires active vegetation control to prevent wholesale succession to woodland. However, low intensity grazing regimes are required to restore the habitat, particularly if it is to be restored within more naturally functioning upland habitat mosaics.
- In general, these are habitats that have good potential for restoration of more natural function. Depending upon the circumstances, this may entail alteration of grazing regimes; introduction of lost native species; and restoration of natural hydrological function.
- Restoration of more natural function of upland heath has great potential for restoring diverse habitat mosaics, both within heathland habitat (more balanced mosaics of wet and dry heath) and between heath and other habitats such as scrub, woodland, bog and open freshwaters. This may involve some loss of extent of heathland to restore a more balanced mosaic – any such loss can be focused on areas that are currently degraded.
- Many areas of upland heath are of international importance for their associated bird species. Any restoration of more natural function needs to pay particular attention to the implications for these species.

G9.2 Upland grasslands

- The large areas of Mat-grass and Purple Moor-grass are largely the result of historic management and restoration can be challenging and expensive. Restoration of more natural function of these acid grassland types has great potential for restoring diverse upland habitat mosaics, including wet and dry heath, scrub, woodland, bog and open freshwaters. This would involve loss of extent of acid grassland to restore a more balanced mosaic. Targeting off effort is needed to focus on the areas with greatest opportunities. Restoration of relatively small areas should have large biodiversity benefits.
- Whilst these acid grasslands have relatively low botanical interest, they are important for upland breeding birds, many of which are priority species. Any restoration of more natural function needs to pay particular attention to the implications for these species.
- Upland calcareous grassland requires sensitive grazing to ensure the botanical interest can set seed.

G9.3 Upland fen and flush and valley mire

- These sites are damaged by artificial drainage and any drains should be blocked.
- These sites should not be subject to burning.
- Depending upon the type of feature, grazing can be harmful or beneficial. Intensive grazing is damaging.
- Where practicable, steps should be taken to reduce eutrophication and restore appropriate water chemistry.

G9.4 Blanket bog

- Restoring hydrological function through blocking of all drainage channels and the cessation of rotational burning are key actions.
- Activities that reduce hydrological function should be avoided.

- Areas of bare peat should be stabilised and then re-seeded with mire-species seed mixes – preferably without the addition of fertiliser.

G9.5 Upland rock habitat resource

- Aside from limestone pavement, these are habitats that are relatively under-studied and described.
- The sustainable management of those communities susceptible to overgrazing (this includes limestone pavement) depends upon the control of grazing animals and this can include deer.

G9.6 Upland woodland and scrub

- Upland woodland and scrub are restricted in distribution and have suffered major historic declines.
- Disease is a threat to Juniper woods.
- Rare upland types require careful grazing regimes in order to prevent loss and damage to individual plants.
- Use natural regeneration wherever possible (e.g. around the moorland wall) and elsewhere plant with local stock of high genetic diversity.

G9.7 Tall herbs and yellow saxifrage bank resource

- Examples of these communities on inaccessible land (steep slopes) are naturally protected against grazing pressure (although rock climbers present a disturbance risk).
- Restoration would ideally be undertaken through restoring naturally functioning habitat mosaics across large areas but can be achieved by more controlled grazing regimes on small areas.

G9.8 Overall messages for upland habitats

- The best biodiversity outcomes for upland habitats are generated by restoring natural function in a strategic and targeted way, working in synergy with sensitive agricultural grazing regimes that reflect natural vegetation controls.
- This generates diverse habitat mosaics at multiple spatial scales according to geology, soils and topography and the hydrological pathways that they generate. This in turn provides the niches required for characteristic species to fulfil their life cycles, moving between habitat patches according to weather patterns, feeding and breeding opportunities and life stage requirements.
- Changes in the balance of different habitat types will occur as a result of this restoration, but provide a better balance of opportunities for upland flora and fauna based on natural habitat niches.
- This approach is reflected in the concept of natural upland massifs, embedded in the guidelines for selection of biological SSSIs (JNCC undated).

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Annex - National Vegetation Community (NVC) names

Acid Grassland (Upland)

U2 *Deschampsia flexuosa* grassland
U3 *Agrostis curtisii* grassland
U4 *Festuca ovina - Agrostis capillaris - Galium saxatile* grassland
U5 *Nardus stricta - Galium saxatile* grassland
U6 *Juncus squarrosus - Festuca ovina* grassland

Calcareous grassland (upland)

- ***Alpine***

CG12 *Festuca ovina - Alchemilla alpina - Silene acaulis* dwarf-herb community
CG13 *Dryas octopetala - Carex flacca* heath
CG14 *Dryas octopetala - Silene acaulis* ledge community

- ***Other Calcareous grasslands***

CG9 *Sesleria albicans - Galium sterneri* grassland
CG10 *Festuca ovina - Agrostis capillaris - Thymus praecox* grassland

Calcareous rocky slope

OV39 *Asplenium trichomanes - Asplenium ruta-muraria* community
OV40 *Asplenium viride - Cystopteris fragilis* community

Calcareous scree

For calcareous and calcschist screes of the montane to alpine levels:

OV38 *Gymnocarpium robertianum - Arrhenatherum elatius* community.

For other calcareous scree:

OV39 *Asplenium trichomanes - Asplenium ruta-muraria* community.
OV40 *Asplenium viride - Cystopteris fragilis* community.
CG14 *Dryas octopetala - Silene acaulis* ledge community may occur in fragmentary form.

A variety of other NVC communities, or communities not described in the NVC, may occur in fragmentary form where the scree is more stable.

Alkaline fen (upland, excluding alpine flushes)

M9a *Carex rostrata - Calliergon cuspidatum / giganteum* mire, *Campylium stellatum - Scorpidium scorpioides* sub-community
M10 *Carex dioica - Pinguicula vulgaris* mire, but excluding high altitude stands containing arctic-alpine spp. which are included in Alpine Flush (see section 2.5).
M11 *Carex demissa - Saxifraga aizoides* mire, but excluding high altitude stands containing arctic-alpine spp. which are included in Alpine Flush (see section 2.5).
M13 *Schoenus nigricans - Juncus subnodulosus* mire, where this occurs in upland situations as part of discrete flush systems.

Alpine dwarf-shrub heath

H13 *Calluna vulgaris - Cladonia arbuscula* heath
H14 *Calluna vulgaris - Racomitrium lanuginosum* heath
H15 *Calluna vulgaris - Juniperus communis* ssp. *nana* heath
H17 *Calluna vulgaris - Arctostaphylos alpinus* heath
H19 *Vaccinium myrtillus - Cladonia arbuscula* heath
H20 *Vaccinium myrtillus - Racomitrium lanuginosum* heath

H22 *Vaccinium myrtillus - Rubus chamaemorus* heath (in part)

H22 crosses the boundary between alpine (montane) and subalpine (submontane) habitats. It may be assessed as either this feature type or as the subalpine dry dwarf-shrub (see section 2.23) heath depending upon the surrounding vegetation and topographic situation.

H10b - Also include *H10b Calluna vulgaris - Erica cinerea, Racomitrium lanuginosum* sub-community, when its location is closely associated with the previous NVC types and it is strongly wind-clipped in appearance, but not otherwise

Alpine flush

M10 *Carex dioica - Pinguicula vulgaris* mire, but only at high altitudes in which there is an arctic-alpine floral element.
M11 *Carex demissa - Saxifraga aizoides* mire (containing arctic-alpine spp.)
M12 *Carex saxatilis* mire
M34 *Carex demissa - Koenigia islandica* flush

Alpine summit communities of moss, sedge and three-leaved rush

U7 *Nardus stricta-Carex bigelowii* grass-heath
U8 *Carex bigelowii-Polytrichum alpinum* sedge-heath
U9 *Juncus trifidus-Racomitrium lanuginosum* rush-heath
U10 *Carex bigelowii-Racomitrium lanuginosum* moss-heath
U11 *Polytrichum sexangulare - Kiaeria starkei* snow-bed
U12 *Salix herbacea - Racomitrium heterostichum* snow-bed
U14 *Alchemilla alpina - Sibbaldia procumbens* dwarf-herb community

Blanket bog and valley bog (upland)

M1 *Sphagnum auriculatum* bog pool community
M2 *Sphagnum cuspidatum / recurvum* bog pool community
M3 *Eriophorum angustifolium* bog pool community
M17 *Scirpus cespitosus - Eriophorum vaginatum* blanket mire
M18 *Erica tetralix - Sphagnum papillosum* raised and blanket mire
M19 *Calluna vulgaris - Eriophorum vaginatum* blanket mire
M20 *Eriophorum vaginatum* blanket and raised mire
M21 *Narthecium ossifragum - Sphagnum papillosum* valley mire

Transition mire, ladder fen and quaking bog (upland)

M4 *Carex rostrata - Sphagnum recurvum* mire (in part, when not Short sedge fen)
M5 *Carex rostrata - Sphagnum squarrosum* mire
M8 *Carex rostrata - Sphagnum warnstorfii* mire
M9b *Carex rostrata - Calliergon cuspidatum / giganteum* mire, *Carex diandra - Calliergon giganteum* sub-community
S27 *Carex rostrata - Potentilla palustris* swamp

Wet heath (upland)

M15 *Scirpus cespitosus - Erica tetralix* wet heath
M16 *Erica tetralix - Sphagnum compactum* wet heath

The following two rare communities from the extreme south-west of the UK are included in the definition of Northern Atlantic wet heath with *Erica tetralix*.

H5 *Erica vagans - Schoenus nigricans* heath
M14 *Schoenus nigricans - Narthecium ossifragum* mire

Short sedge acidic fen (upland)

M4 *Carex rostrata - Sphagnum recurvum* mire (in part, see also Transition mire, ladder fen and quaking bog)
M5 *Carex rostrata - Sphagnum squarrosum* mire
M6 *Carex echinata - Sphagnum recurvum / auriculatum* mire

Calaminarian grassland and serpentine heath (upland)

OV37 *Festuca ovina* - *Minuartia verna* community
H5 *Erica vagans - Schoenus nigricans* heath
H6 *Erica vagans* - *Ulex europaeus* heath

(Serpentine heaths are not fully covered by NVC.)

A variety of other NVC types may occur over ultra-basic substrates. This feature type tends to be defined by substrate type as much as by vegetation type.

Juniper heath and scrub (upland)

The NVC communities corresponding to the European definition is W19 *Juniperus communis* spp. *communis – Oxalis acetosella* woodland.

Montane willow scrub

W20 *Salix lapponum - Luzula sylvatica* scrub.

The NVC only partially describes this type of vegetation. Any of the willow species may become constant and dominant and not just *S. lapponum*. Also, the willow species can occur in a wide range of upland grassland, mire and heath communities and these could develop into more extensive areas of sub-arctic willow scrub if protected from browsing.

Limestone pavement

The NVC does not include limestone pavement vegetation *per se* but a number of NVC types may be present, usually in fragmentary form. The most distinctive to this habitat is probably OV38 *Gymnocarpium robertianum - Arrhenatherum elatius* community.

Others may include:

OV39 *Asplenium trichomanes - A. ruta-muraria* community
OV40 *Asplenium viride - Cystopteris fragilis* community
CG9 *Sesleria albicans - Galium sterneri* grassland
CG10 *Festuca ovina - Agrostis capillaris - Thymus praecox* grassland
CG13 *Dryas octopetala - Carex flacca* heath
W9 *Fraxinus excelsior - Sorbus aucuparia - Mercurialis perennis* woodland

Mire grasslands and rush pastures (upland)

For this feature type use the **Lowland purple moor grass and rush pastures** in the ***Common Standards Monitoring Guidance for Lowland Grassland Habitats***, available on the JNCC website at http://www.jncc.gov.uk/page-2233.

Siliceous rocky slope

Not well covered by the NVC, but vegetation similar to U21 *Cryptogramma crispa - Deschampsia flexuosa* community may spread into this sort of situation in places.

Siliceous scree

U18 *Cryptogramma crispa - Athyrium distentifolium* snow-bed
U21 *Cryptogramma crispa - Deschampsia flexuosa* community.

A variety of other NVC communities may occur in fragmentary form where the scree is more stable. There may be other community types not described by the NVC.

Soakway and sump (upland)

M29 *Hypericum elodes - Potamogeton polygonifolius soakway.*

Spring-head, rill and flush (upland)

M7 *Carex curta - Sphagnum russowii* mire
M8 *Carex rostrata - Sphagnum warnstorfii* mire (when not part of the Natura type "Transition mires and quaking bogs" - see Transition mires, ladder fens and quaking bogs)
M31 *Anthelia julacea - Sphagnum auriculatum* spring
M32 *Philonotis fontana - Saxifraga stellaris* spring
M33 *Pohlia wahlenbergii* var. *glacialis* spring
M34 *Carex demissa - Koenigia islandica* flush (when not part of the Natura type "Alpine pioneer formations" - see Alpine flush)
M35 *Ranunculus omiophyllus - Montia fontana* rill
M37 *Cratoneuron commutatum - Festuca rubra* spring
M38 *Cratoneuron commutatum - Carex nigra* spring

Subalpine dry dwarf-shrub heath

H4 *Ulex gallii - Agrostis curtisii* heath,
H7 *Calluna vulgaris - Scilla verna* heath (in part, when not more appropriately treated under coastal or lowland categories)
H8 *Calluna vulgaris - Ulex gallii* heath,
H9 *Calluna vulgaris - Deschampsia flexuosa* heath,
H10 *Calluna vulgaris - Erica cinerea* heath,
H12 *Calluna vulgaris - Vaccinium myrtillus* heath,
H16 *Calluna vulgaris - Arctostaphylos uva-ursi* heath,
H18 *Vaccinium myrtillus – Deschampsia flexuosa* heath,
H21 *Calluna vulgaris - Vaccinium myrtillus - Sphagnum capillifolium* heath.
H22 *Vaccinium myrtillus - Rubus chamaemorus* heath (in part)

H7 *Calluna vulgaris - Scilla verna* heath is a coastal/maritime type of heath and so may sometimes fall within the lowland heath definition and sometimes the upland definition. The latter is most likely to occur in the extreme north and west.

H22 *Vaccinium myrtillus - Rubus chamaemorus* heath crosses the boundary between alpine (montane) and subalpine (submontane) habitats. It may be assessed as either this feature type or as the alpine dwarf-shrub heath depending upon the surrounding vegetation and topographic situation.

Tall herbs (upland)

U16 *Luzula sylvatica - Vaccinium myrtillus* tall herb community.
U17 *Luzula sylvatica - Geum rivale* tall herb community.
U19 *Thelypteris limbosperma* - *Blechnum spicant* community.

Woodland (Upland)

W3 *Salix pentandra – Carex rostrata* woodland
W4 *Betula pubescens – Molinia caerulea* woodland
W7 *Alnus glutinosa – Fraxinus excelsior – Lysimachia nemorum* woodland
W9 *Fraxinus excelsior – Sorbus aucuparia – Mercurialis perennis* woodland
W11 *Quercus petrae – Betula pubescens – Oxalis acetosella* woodland
W17 *Quercus petraea – Betula pubescens – Dicranum majus* woodland
W19 *Juniperus communis ssp. Communis – Oxalis acetosella* woodland
W23 *Ulex europaeus – Rubus fruticosus* scrub
W25 *Pteridium aquilinum – Rubus fruticosus* underscrub

Yellow saxifrage bank

U15 *Saxifraga aizoides - Alchemilla glabra* banks