Conservation of the Historic Environment in England's Uplands

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EXECUTIVE SUMMARY

Whilst the protection of the upland historic environment has been a focus of agri-environment schemes, a rigorous and comprehensive evidence base has not underpinned the management action taken. Much of the work has been guided by direct experience of heritage managers in the field with some scientific enquiry. In particular, there is limited information on the effects of scrub growth (including bracken) and the management and restoration of semi-natural communities across England's uplands on the historic environment. The present evidence indicates that these factors have multiple impacts including physical damage to archaeological sites and masking landscapes from view.

This project examined the available evidence for the effects of upland vegetation and its management on the historic environment through a literature review, an assessment of case studies and a survey of a selection of the main stakeholders. From this, gaps in knowledge and research needs were identified, and an initial management tool developed to guide land managers towards best practice in the upland historic environment.

Many vegetation types typically occurring in the English uplands will be beneficial to the historic environment, as they are relatively benign in terms of disturbance from rooting systems and they provide a protective cover against erosion. There is, however, some evidence of damage caused, particularly to underground historic interest, by the roots of trees, scrub and bracken. Although there is little evidence from national survey of an increase in overall scrub and bracken cover, it would appear that there are local and regional variations, as many of the stakeholders interviewed during the course of the project expressed concern at an increase in these types of vegetation.

The key factor in the conservation of the upland historic environment is the maintenance of a vegetation cover to prevent damaging erosion. It is vital, therefore, that vegetation management activities do not damage the protective cover. It is recognised that vegetation needs management to maintain habitat types and prevent the development of vegetation which might harm the historic environment. This harm may be through physical damage, a reduction in the visibility of the historic landscape or damage caused by fire.

Grazing by livestock can help maintain a range of upland heathlands and grasslands and prevent the establishment of trees and shrubs. However, high stocking rates can lead to the removal of vegetation cover and the resulting overgrazing can be damaging to archaeology. Recent changes in agricultural and environmental policy have resulted in a reduction in livestock in the uplands and therefore the risk of undergrazing, leading to the development of adverse vegetation cover, is now thought to be the more important issue.

Controlled burning is recognised as an important vegetation management tool in the uplands and can reduce the risk of fire and consequent erosion. On wet heath or blanket bog controlled burning can be detrimental both to habitat quality and the historic environment, and can increase the risk of erosion and peat degradation.

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Artificial drainage of blanket bog over past decades has degraded this important habitat and has caused a significant loss of peat, which is an important historic resource in its own right. Re-wetting of previously drained blanket bog or wet heath can be beneficial in preserving peat and re-establishing vegetation cover. However there are concerns that the methods used to block the drainage grips to achieve this can be damaging, particularly if peat is the blocking material. Machinery used in these operations can also damage the peat and natural environment.

Cutting can be used to manage vegetation, and can have relatively little effect on the historic environment, as long as disturbance by machinery is avoided. However, there are examples of damage where heavy machinery has been used in inappropriate conditions. Use of low ground pressure vehicles may offer a better solution, although such machines should not be used in the vicinity of fragile archaeological monuments.

Recommendations arising from the project include initial research to quantify the potential risk to the historic environment of vegetation and its management, so that priorities can be set. This could be done by a national sample survey of known archaeological sites to determine the association between archaeological features, vegetation type and management; the damage and benefits to historic features; and the awareness amongst land occupiers of the historic environment interest. There is a need for catchment scale studies, in the context of multiple management objectives, to analyse how priorities are set, the practices carried out and their impacts.

Bracken is damaging to the historic environment and locally is reported to be increasing in extent. There is a need for assessment of changes in bracken cover at such sites. Bracken control by crushing can be a useful alternative to chemical control, but is potentially damaging. Research to quantify the degree of disturbance and its relation with vegetation litter depth will help to identify where crushing might be a suitable management method.

There is a need to establish whether European gorse has increased on archaeological sites, and for research on the damage it causes and methods of control. Purple moor-grass has been reported as restricting visibility of and access to historic sites in the south-west of England, and this issue needs to be quantified. The comparative effects of heather burning and cutting on the historic environment needs to be assessed.

The lack of knowledge about the historic environment, and the lack of awareness of landowners and land managers about the archaeological interest of their land were identified as important issues. A factor in this is the lack of protective designations for historic landscapes: the Dartmoor National Park has a designation of Premier Archaeological Landscapes (PALs), where the conservation of the historic environment takes precedence over other management activities, and this serves as a good example that could be applied elsewhere.

1. INTRODUCTION

ADAS, in partnership with Oxford Archaeology North (OA North), were commissioned by Defra and Natural England to undertake a study of the Conservation of the Historic Environment in England's Uplands.

The study sought to establish what evidence exists on the impacts and effects of vegetation and vegetation management on the historic environment in the uplands. This was achieved by examining published and unpublished information and by talking to individuals and organisations actively involved in the management of the uplands.

The information collected was examined from the point of view of a land manager trying to decide on a management strategy for an area of upland. The purpose of this approach was to be able to identify gaps in knowledge which make informed decisions problematic. Where gaps were identified, recommendations for further research were developed.

There are many pressures for change in the uplands, many of them driven by EU and government policy e.g. CAP reform, the introduction of Single Farm Payments, Sustainable Development, Water Framework Directives. At the same time, conservation, farming and sporting interests may all have different views on the best way to manage moorland to meet their objectives. As a result, developing a management strategy for an upland area often results in some form of compromise between competing demands.

In considering these competing interests the historic environment is often ignored. A sound information base and a simple management tool could help land managers protect the historic environment by making informed decisions as they change the management of the uplands in response to policy initiatives.

Using the information collected, a simple management tool was developed to help land managers take full account of the impacts of vegetation and vegetation management on the upland historic environment. The tool was developed to highlight the risks associated with various management approaches in the uplands and their potential impacts on archaeology.

1.1. Aims and Objectives

The specific aims and objectives were:

a) to undertake a review of all relevant information on the physical impacts of upland vegetation, other associated effects, and the physical impacts of vegetation management (or lack of management), including by burning, on the historic environment, together with an assessment of key case studies;

b) to conduct interviews with a selection of the main stakeholders (in conjunction with a);

c) to identify gaps in knowledge and recommend appropriate field-based research, prioritised and with suggested general locations;

d) to develop an initial management tool, preferably risk-based, identifying best practice for the management of the upland historic environment.

1.2. Definitions

In undertaking a review of current knowledge on the physical impacts of upland vegetation and its management on the historic environment, it is considered helpful to set out the context and definitions of the main issues.

Historic Environment: the term 'historic environment' is a catch-all and includes all the material remains that man has created to form the landscapes of town and countryside. It incorporates all the material remains of human activity from the largest, such as towns, churches and roads, to the very smallest, such as signs, standing stones or artefacts, and below ground remains. Because of unrelenting human activity through the ages, all the rural and urban landscapes of England are a product of man and therefore form part of the historic environment.

Moorland Line: The Moorland Line encloses land within England which has been defined as predominantly semi-natural upland vegetation, or predominantly of rock outcrops and semi-natural vegetation, and these areas are primarily used for rough grazing. The Moorland Line encloses nearly 800,000 hectares of Less Favoured Area (LFA). LFAs are areas where the natural characteristics (geology, altitude, climate etc.) make it difficult to farm, and include all upland areas, as well some disadvantaged lower lying areas. The study was specifically concerned with the conservation of the historic environment found above the "Moorland Line", which is used primarily to differentiate levels of payment under agri-environment support schemes. The moorland line roughly follows the boundary between enclosed and unenclosed land and between semi-improved and unimproved land.

Vegetation Issues: the most vulnerable archaeological sites are those that have lost their protective vegetation cover. In these instances, the loss of the site can be very rapid. Even the most hostile vegetation cover tends to be preferable to none at all. Trees, though mostly detrimental to archaeological sites, can, in some instances, hold structures together and their removal would have a disadvantageous impact upon the survival of the archaeological site. The factors that result in loss or reduction of vegetation cover are investigated as part of the study.

Vegetation Management: there are a broad range of issues that have an impact upon upland vegetation and provide a context for strategies for upland management. These include: Wind action, which is only relevant when vegetation cover is reduced; Climate change, which will potentially have a direct impact on vegetation patterns over time; Pollution, which can reduce vegetation cover and therefore remove its protective cover; and Animal disturbance and grazing, which directly impacts on the level of vegetation cover and therefore the protection of archaeology.

Peatlands: peats, including blanket bog, upland heath (a peat-based vegetation), and upland valley and basin mires, are a significant part of the historic landscape because they can conceal an earlier buried archaeological landscape. The peat itself is a part of the archaeological record, as the stratigraphy of the peat body and the fossils preserved within it provide evidence of anthropogenic, climatic, and biogeographical change over many millennia and are often the only tangible evidence of prehistoric activity in the uplands. It is therefore extremely important that there is very sensitve management of these habitats as any damage to surface vegetation such as sheep scars, drainage, tracks and fire allow natural erosion to destroy the peat.

Grazing: the terms 'over' and 'under' grazing are referred to frequently in the results of the questionnaire and the discussion. In the context of this study over-grazing is defined as a level of grazing when the ecology and the historic landscape are damaged allowing the onset of erosion (LUAU 1994). Under-grazing is defined as a level of grazing that allows the build up of above-ground biomass, and changes in the character of the ecology, for example the apparent spread of gorse in the North West following a reduction in sheep numbers after the recent outbreak of foot and mouth (J. Quartermaine, pers. comm.).

Tree occurrence: although tree occurence is generally low in the uplands, and the issue of plantations was specifically excluded from the study, there is a case for considering the impact of trees in the upland zone for the following reasons:

- the growth of trees can be damaging to the historic environment and also obscure it;
- a reduction in grazing pressure may allow an increase in the number of trees;
- the move towards 're-wilding' the uplands is potentially very damaging, particularly if it includes tree planting which could damage surface vegetation (allowing erosion to develop) and would introduce long term impacts on underlying arachaeology.

Character of the archaeological resource: for the purposes of the study a management perspecitive was taken and a broad character of monument forms was defined. These are as follows:

- *Artefact Scatters:* a dispersal of often waste material from the production of tools, often found on minerals soils and invariably only revealed as a result of disturbance of the ground. Maintaining vegetation cover will afford protection but severely restrict site visibility;
- *Findspots:* the reporting of the discovery of finds or scatters. Often complete removal of the artefactual material has taken place, and the site may therefore be severely denuded or destroyed. In any case, the location of the site may be very inaccurate if the discovery was prior to the use of GPS, or were not surveyed properly, and the reported locations cannot be assumed to have a high accuracy.

- *Earthworks:* these reflect the earth-covered surface expression of a monument, and can be a collapsed stone structure that is now turf covered, or a monument formed by the movement of soil. As monuments weather and decay they converge towards their most stable form. For former standing stone structures, this is the earthwork (whereby the stone material has spread outwards and turf / soil has formed a bond maintaining the integrity of the collapsed structure). Prehistoric structural monuments that are visible on the surface most typically survive as earthworks because of the stability of the final form. From a management perspective, they reflect a monument in a relatively stable state and can be more resistant to change than other less stable monuments, such as walls. In an upland context topsoil cover can be extremely thin, so any disturbance of the protective turf or vegetation cover can have a severe impact upon the underlying resource.
- *Non-earthfast stone deposits:* in upland areas where there is a very slow build-up of topsoil, the stone mounds or the collapsed remains of stone structures can survive without turf cover. The stones are typically in a stable, collapsed state, but they are more vulnerable to erosion than their earthfast equivalents.
- *Walled Structures:* a walled structure, be it bonded or drystone, is an inherently unstable structure and over time will revert to a collapsed pile of stone. For this reason any substantial, standing walled structure is more likely to be of relatively recent date. They are fragile, vulnerable and require more managerial consideration to keep them standing.

1.3. Background

The English uplands have been exploited by man for around 8000 years; indeed man has, in conjunction with climatic changes, been responsible for creating the upland environment that we know today. Evidence of man's use is widespread, and much of this is found on land used for livestock grazing, sporting and leisure purposes. There has been much research effort, leading to the subsequent development and adoption of techniques, supported by government schemes, to preserve and enhance the upland habitats for biodiversity, but the protection of the archaeological resource has often been of only secondary importance.

The recent and continuing implementation of changes to the Common Agricultural Policy (CAP) means that subsidies are no longer dependent on livestock numbers, with funding directed more to environmental land management. This, together with the loss of livestock to foot and mouth disease in 2001 and reduced profitability of upland farming, is leading to changes in the impact of agriculture on the environment in the uplands. Biodiversity Action Plan targets and a Public Service Agreement (PSA) target to get 95% of SSSIs into Favourable or recovering condition by 2010, also influence the management of the upland vegetation.

Alongside the CAP reforms, European Directives, such as the Water Framework Directive, are influencing the prescriptions for upland management in water catchments managed by water companies. Other activities also have an impact on upland vegetation and the historic environment, for example the development of wind farms to meet renewable energy targets, and pedestrian and vehicular access, which can need careful management to prevent damaging erosion.

The uplands are thus important areas of resource for our cultural heritage, biodiversity, food production, water gathering, sport and leisure, but the differing management strategies to support these aspects can conflict. The study looks at the potential to redress any imbalance and to highlight the land management issues pertinent to the long term conservation of the upland historic environment.

2. METHODOLOGY

2.1. Literature Review

An initial search of the literature indicated that there were relatively few publications that directly addressed the effects of upland vegetation and its management on the historic environment. However, there were a number of management studies that were relevant, and the literature review was informed by these earlier studies. For example, there had been a study into the deteriorating condition of the Langdale axe factories and the impact of tourism and grazing practices upon them (LUAU, 1994). A more recent study by OA North (on behalf of English Heritage) had examined the survival, threats and management of the heritage environment within and beneath upland peats (OA North, 2009). A further study by Forest Enterprise had examined the effects of root disturbance on archaeological sites (Crow, 2004).

As a first stage, relevant known publications and reports on this subject were collated. A systematic review of the literature was then carried out to identify attributes of upland plant species (primarily rooting characteristics) and vegetation management outcomes that could impact on the historic environment. The outputs from this review were then assimilated and the potential effects on the historic environment of the plant attributes and management outcomes were assessed from expert knowledge. Sources that were consulted, but are not cited in the text, are listed at Appendix 3.

2.1.1. Upland Vegetation

A list was compiled of the 30 most commonly occurring species across the principal upland heath, mire and grassland plant communities of England, as described by Rodwell (1991, 1992). A further six tree and shrub species associated with upland habitats were also included, along with the climber, ivy (*Hedera helix*). Information on root depth and system (tap root, fibrous, adventitious) for each species was extracted from the Ecoflora database (http://www.ecoflora.co.uk/). This database is the most comprehensive single source of data on higher plants in the British Isles. Data are extracted primarily from the published literature and so are the most reliable source, albeit incomplete in some cases. These data were then assessed to determine the potential impact of broad plant types, individual species and rooting characteristics on the historic environment. A more detailed search was also carried out on species for which there was documented evidence of effects on the historic environment.

2.1.2. Management Practices

A systematic literature review was also carried out on management practices in the uplands and their effects on different vegetation types. The review focused on grazing, burning, water management, cutting, mechanical operations, livestock trampling, plant introductions, chemical inputs and abandonment. Ingenta, Science Direct and Scopus search engines and the internet in general was used to carry out searches on individual key words and combinations of key words (listed separately below). Relevant articles were either downloaded online or sought from the British Library. Papers and unpublished reports already held by consortium members were also used, and additional citations were followed up from papers, books and reports located during these searches. The outputs were then used to assess the potential impacts of these management practices on the historic environment.

Example keywords used in searches:

Subject	Keywords
Habitats	Upland, moorland, heathland, bog, mire, acid grassland
Vegetation types	Heather/*Calluna*, *Eriophorum*, *Pteridium*, *Sphagnum*, *Trichophorum*, *Molinia*, *Nardus*, *Agrostis-Festuca*
Management practices	Grazing (by sheep, cattle, deer, rabbit, other), burning, cutting, drainage, disturbance, fertiliser, herbicide, seed/brash
Authors	Various authors with an established track record on upland vegetation management.

2.2. Selection and Interview of Major Stakeholders

One key objective of the project was to conduct interviews with a selection of the main stakeholders in conjunction with the review of all relevant information on the physical impacts of upland vegetation, other associated effects and the physical impacts of vegetation management (or lack of management), including by burning, on the historic environment.

In identifying stakeholders that should be interviewed, it was important to involve a broad selection of people with an interest in upland management and the historic environment, to include land and agricultural managers as well as historic environment and ecology specialists. They were selected from a range of people known to the study team, and suggested by Natural England, to ensure good geographic coverage of the English upland areas, as well good coverage of the key areas of interest.

The interview process incorporated an explanation of the scope and objectives of the research, together with a questionnaire designed jointly by ADAS and OA North. It was considered to be important to understand the factors that can or could damage the vegetation. Consequently, the stakeholders were asked in the first instance about a number of factors relating to the historic upland environment, the impacts specific to their areas, the most vulnerable monuments in their areas, and any issues concerning the management of the vegetation.

They were interviewed in person or by telephone by Philip Bull and Sonia Brunton (ADAS) and Elizabeth Huckerby and Jamie Quartermaine (OA North). The majority of interviews were by telephone, although Jamie Quartermaine attended a meeting of the Northern National Park archaeologists (six of whom were present) who discussed the questions included in the questionnaire. Stakeholders were also given the opportunity to make comments to be included in the research.

The original survey information was compiled within a database, which incorporated all the comments, and was categorised by common themes identified during the interviews. This enabled an appropriate comparison of all comments from diverse sources that related to a particular subject (e.g. fire risk). The opinions expressed during the interviews were those of the interviewee and have not been verified nor has any attempt been made to quantify the survey which was set up on a qualitative basis. The stakeholders interviewed and their responses are shown in Appendices 1 and 2 and have been organised by region and by discipline.

2.3. Identification of Gaps in Knowledge and Further Research Needs

The study team looked critically at the findings of the first draft of the review. All findings were assessed from the point of view of a land manager making decisions on land management issues related to the conservation of the historic upland environment, including the archaeological record and the vegetation. The team sought to identify gaps in the information and made recommendations for future research.

2.4. Development of an Initial Risk-based Management Tool

One of the final objectives of the study was to develop a simple computerised risk-based decision-support tool, designed to be relevant to land managers to guide the management of sites. The tool was based on information currently available but is capable of being adapted, as more information becomes available. It was particularly important that the management tool emphasised the value of understanding the historical resource on-site. Where possible, the tool should also guide land managers to documents, legislation, and archaeological curators and consultants, and could be used to develop a management strategy for moorland.

Design and development coding of the decision-support tool followed on from the establishment of the content. The tool was developed as a simple, stand-alone software programme by ADAS for Natural England and as such, is separate from this report.

It is recommended that before the tool is finally published it should be evaluated by the stakeholders consulted, who will provide an ideal test group. It is also recommended that English Heritage, as the statutory adviser on the historic environment, should be invited to contribute to this evaluation. Modification of the tool may be required following stakeholder feedback.

3. RESULTS OF LITERATURE REVIEW

3.1. Physical Effects of Upland Vegetation

Published data on rooting characteristics were incomplete and some records might not be representative if they arose from a single study. In a small number of cases, data were ambiguous where results from different studies were not in agreement (Table 3.1). Information on 'relative root depth' has been included in the table to supplement root depth measurements noted in general literature as data were not available for all species. Collectively, however, the information allowed a general assessment of the probable effect of different types of vegetation cover on the historic environment. This is particularly important as deep rooted plants have the potential to damage the buried archaeology whereas shallow rooted ones are less damaging.

Table 3.1. Data on rooting characteristics for upland plant species. Species type: C = climber; D = dwarf /small shrub; F = forb; Fn = fern; G = graminoid; T = tree/large shrub. Rooting system: A = adventitious; F = fibrous; T = tap. ND = no data. Relative depth is root depth relative to height of stem. Data from the Ecoflora database (http://www.ecoflora.co.uk/).

Type	Species	Depth (mm)	System	Relative depth
G	*Agrostis canina*	ND	ND	shallow
G	*Agrostis capillaris*	500-1000	ND	ND
G	*Anthoxanthum odoratum*	500-1000	ND	ND
T	*Betula pendula*	ND	ND	ND
T	*Betula pubescens*	ND	T	ND
D	*Calluna vulgaris*	100-500	F, A, T	deep
G	*Carex nigra*	ND	ND	ND
G	*Carex panicea*	0-100	ND	ND
T	*Corylus avellana*	ND	ND	ND
G	*Deschampsia flexuosa*	500-1000	ND	shallow/deep
D	*Empetrum nigrum*	0-100	ND	shallow
D	*Erica cinerea*	0-100 or 100-500	A, T	ND
D	*Erica tetralix*	0-100 or 100-500	A, T	ND
G	*Eriophorum angustifolium*	ND	ND	shallow
G	*Eriophorum vaginatum*	500-1000	ND	deep
G	*Festuca ovina*	0-100	F	shallow
F	*Galium saxatile*	0-100 or 500-1000	F, T	ND
C	*Hedera helix*	ND	A	ND
T	*Ilex aquifolium*	ND	F	ND
G	*Juncus acutiflorus*	ND	ND	ND

Type	Species	Depth (mm)	System	Relative depth
G	*Juncus articulatus*	ND	ND	ND
G	*Juncus effusus*	100-500	ND	ND
G	*Juncus squarrosus*	0-100 or 100-500	ND	shallow
G	*Luzula multiflora*	500-1000	ND	ND
G	*Molinia caerulea*	100-500 or 500-1000	F	deep
D	*Myrica gale*	ND	ND	shallow
G	*Nardus stricta*	100-500	F	deep
F	*Narthecium ossifragum*	100-500	F	shallow
F	*Potentilla erecta*	0-100 or 500-1000	A, T	shallow
Fn	*Pteridium aquilinum*	ND	A	ND
T	*Quercus petraea*	100-500	T	deep
F	*Succisa pratensis*	ND	A, T	shallow
G	*Trichophorum cespitosum*	500-1000	A	deep
T	*Ulex europaeus*	ND	T	shallow
D	*Ulex gallii*	0-100	A, T	deep
D	*Vaccinium myrtillus*	0-100	F, A	ND
D	*Vaccinium vitis-idaea*	ND	ND	ND

3.1.1. Forbs, Graminoids and Dwarf Shrubs (Grass/ Heather)

Three of the four forb species illustrated in Table 3.1 have a tap root of varying length (to 1m) although they are shallow-rooted relative to the stem height. The graminoids have a similar range of rooting depths but without a tap root. Dwarf shrubs only develop a tap root during the seedling stage, after which the root system is not particularly deep (to 500mm in the case of *Erica* spp.). These species will therefore tend to stabilise the substrate and reduce the potential for erosion, which is of considerable importance for the retention of the thin upland soil deposits. However, as much of the soil cover over archaeological monuments (away from peatlands) is often less than 0.5m, dwarf shrub roots have the potential to impact on stratigraphy of the archaeological monuments, although no literature has been identified that specifically addresses the impact of heather on archaeological monuments.

3.1.2. Bracken

Bracken (*Pteridium aquilinum*) has stout rhizomes that spread over considerable distances and its impact on sensitive and shallow archaeological deposits is substantial. In studies by Historic Scotland, the rhizomes were found to be extensive and destructive across the earthfast, stone-constructed sites at Upper Tillygarmond, Aberdeenshire, and Lairg, Sutherland, and were present to a depth of 600mm, and can be as much as 1000mm, below the surface (Rees & Mills, 1999). The effect of bracken roots on soft sediments is often to homogenize them, reducing complex stratigraphic sequences to topsoil with artefacts (*ibid*). However, at Lairg it was found that the root disturbance did not prohibit the recognition of complex stratigraphy, although the condition of the sediments and their value for palaeoenvironmental research was compromised. This was particularly in areas of well-drained, soft sediments and fine stratigraphy.

It is difficult to identify the actual damage caused by bracken rhizomes in areas where bracken was widespread previously, but is now absent. At Upper Tillygarmond it was possible to identify partly decomposed rhizomes in the soil and subsoil indicating an earlier infestation, which is likely to have caused some degradation of the archaeology. However, any relict infestation is difficult to identify and therefore the extent of archaeological damage is unquantifiable. No research was found that dealt specifically with the potential archaeological damage caused by rhizome density and the ongoing effects over time.

Rhizomes can increase the size of voids between rubble components of features such as walls and ramparts, leading to instability and degradation. In a study on Dartmoor, the physical and chemical effects of bracken rhizomes on a prehistoric roundhouse were examined (Gerrard, 2002). It was observed that the species' preference for well-drained ground often coincided with the location of archaeological remains. Gerrard's excavations showed that up to 20% of the archaeological deposits had been displaced by rhizomes in an area that had been affected by infestation for 20 years. Bracken can also reduce the visibility of, and accessibility to, archaeological sites and therefore make them more susceptible to accidental damage (Natural England, 2008).

The area of Bracken Broad Habitat (defined as 95-100% bracken cover) declined in the UK by 17% between 1998 and 2007 (Carey *et al.*, 2008). This was attributable to a decline in bracken cover in existing stands, rather than a complete loss of bracken in these areas. A reduction in bracken cover which included a contraction in area covered would prevent any further damage to archaeology.

3.1.3. Gorse

European gorse (*Ulex europaeus*) root systems have been shown to impact on archaeological monuments. Stands of gorse tend to funnel livestock (and people if present) into particular routes, resulting in tracking and poaching. Dense stands of gorse might prevent access to certain areas or redirect movement away from sites, however erosion scars commonly occur next to impenetrable stands. Gorse stands generate leaf and branch litter which can contribute to the risk of fire (Grime *et al.*, 1988 - for the effects of fire see Section 3.2.2.), reduce site visibility and indirectly affect features by harbouring burrowing animals such as rabbits (Riley, 2006).

European gorse has a relatively shallow tap root (Gaynor & MacCarter, 1981) but in some situations this root could still potentially damage sites. Gorse tends to colonise disturbed areas (Grime *et al.*, 1988) and is therefore relatively restricted in its distribution on moorland in most areas. However, because of its preference for disturbed areas, it can have a preference for colonising archaeological sites. Where present, it might also be indicative of sites where damage has occurred as a result of more recent disturbance. This makes it difficult when trying to understand whether the gorse or other factors have caused, or are causing on going damage, to the historic environment.

Western gorse (*U. gallii*) can often be dominant in western heaths, and is locally distributed in south-west and western England, where it favours dry/ humid moorland soils. Elsewhere it tends to mainly occur on the fringes of the moor, for example alongside roads. It has a stronger root system comprising robust tap and lateral roots. The tap root can penetrate through soil to 100mm but it can reach twice this distance with laterals extending up to 183 cm (Stokes *et al*., 2003). This suggests a greater capability for causing damage to archaeological features than the European gorse.

As Eastern gorse potentially has less impact on underlying archaeology than Western gorse (and is less widely distributed), it may sometimes be included in discussions around increasing scrub habitat in the uplands. However, other potential impacts beyond rooting depth (as identified above) would need to be assessed in order to properly weigh up the benefits between nature conservation and the potential effect on the historic environment.

3.1.4. Trees and Shrubs

While woodlands are not now a primary habitat of upland areas, consideration should be given to the disturbance that can be caused by individual trees and large bushes. Little quantitative data were available in the Ecoflora database on rooting characteristics for other tree and shrub species but there is sufficient evidence documented elsewhere that they do damage the structure of standing monuments and buried remains due to their strong and extensive root systems.

The effects of tree root systems on archaeological deposits interact with factors such as soil type and the density and species of tree (Crow, 2004). Tree roots usually take the line of least resistance and will in general grow around an object rather than trying to go through it unless there are any easy points of access. In heavy waterlogged or compacted soils the rooting systems tend to be shallow, while in poor, loosely consolidated soils root systems could even inhibit other forms of erosion.

Crow (2004) also summarised the current knowledge of soil chemistry and the weathering of soil minerals as influenced by root exudates and associated microbial activity. Archaeologically, the effect of root systems has been noted as significant in two main ways: (i) via the introduction of non-native species of snail into medieval deposits at Boscombe Down, and (ii) via the displacement of artefacts, namely flints, which became engulfed by the root system at Grimes Graves, Norfolk, and Rock Common, Sussex. Although these examples are from the lowlands, root damage is likely to be similar in the uplands.

Damage to larger features and masonry is well documented, and there are numerous examples available from those working in the historic environment of trees undermining building foundations or growing out of wall fabric. However, immature tree growth is less of an issue as there is a natural tendency for root systems to grow around an obstruction along the path of least resistance, and they have in some cases, been seen to consolidate a ruinous feature. Removing the root system can cause problems as it can be extremely difficult to achieve without damaging the historic elements surrounding the root system (Crow, 2004). An example of this is the proximity of an established yew tree to a section of ruined wall at Waverley Abbey in Surrey. The increased height of the wall where it was affected by the tree might be a strong argument for the yew positively affecting its preservation, but should the tree be thrown in adverse weather, the wall would be destroyed (Beavan-Jones, cited in Crow, 2004). The most catastrophic impact of tree root systems on the historic environment is undoubtedly wind throw. Instances of wind throw are hugely detrimental to both upstanding monuments and sub-surface remains (Rimmington, 2004).

In a recent survey for the Heritage Council Ireland, scrub growth patterns were shown to coincide with the main distribution of archaeological sites (ERA-Maptec Ltd., 2006). The direct effects of scrub, in this case hazel (*Corylus avellana*), were identified as structural damage, sub-surface damage and loss of visibility and access. As well as these primary impacts, scrub can provide harbourage for burrowing animals, particularly rabbits and badgers, both of which can be destructive to archaeological sites (Rimmington, 2004). Ivy (*Hedera helix*) is often associated with stands of scrub and can damage walled structures and possibly standing stones.

3.1.5. Summary

With the exception of trees, scrub and bracken therefore, most of the vegetation types typically occurring in the English uplands and dominated by dwarf shrubs, graminoids and forbs will be beneficial to the historic environment, being relatively benign in terms of disturbance from rooting systems and providing stability of the substrate. Bryophytes, particularly *Sphagnum* species also have a beneficial stabilising effect on deep peat (O'Brien *et al.*, 2007). This function of upland vegetation will be dependent on maintaining intact vegetation cover, which will itself be partly dependent on the management regime imposed and the resistance of different species to physical disturbance.

3.2. Management Practices

Various vegetation management practices in the uplands can lead to increased risk of damage to the historic environment. Physical damage to sites and monuments can be caused by grazing, burning, water management, cutting, mechanical operations, livestock, plant introductions, chemical inputs and also through land being left abandoned (unmanaged).

The following literature review looks at current evidence available where the potential impact of vegetation management practices in the uplands is discussed in the context of the historic environment. At the end of the section Table 3.2 provides a summary of the main management practices in the uplands along with key vegetation characteristics and their combined potential to affect the historic environment.

3.2.1. Livestock

The effect of livestock grazing on upland habitats has been studied extensively but the outcomes are dependent on many factors including the stocking regime, vegetation type and spatial distribution, physical environment and timescales (Adamson & Critchley, 2007; Gordon & Prins, 2008). In general, however, grazing by livestock can help to maintain a range of upland heathlands and grasslands and prevent establishment of trees or tall shrubs.

Light or moderate grazing intensity by sheep (especially if confined to summer), will normally maintain dry heath or wet heath vegetation, which will be beneficial to the historic environment by maintaining stable vegetation cover without major risk of erosion, fire damage or loss of visibility. Heavier grazing by sheep, especially if this is over the winter, will tend to cause replacement of heathland by acid grassland. Reducing sheep grazing intensity can result in a range of grassland, heath or bog communities, depending on site-specific conditions (Marrs *et al.*, 1988; Hope *et al.*, 1996; Hulme *et al.*, 2002; Pakeman *et al.*, 2003; Milligan *et al.*, 2004; Albon *et al.*, 2007; Critchley *et al.*, 2008; Anderson *et al.*, 2009; Gardner *et al.*, 2009). Differences between hill sheep breeds in the amount of heather consumed will also have more subtle effects on vegetation (Fraser *et al*., 2009). Upland grasslands are maintained by sheep grazing (Hulme *et al.*, 1999; Davies *et al.*, 2007; Holland *et al.*, 2008; Gardner *et al.*, 2009) and can be beneficial to the historic environment, with good visibility and access and low risk of root

damage, as long as stocking levels are not so high as to remove vegetation cover or cause localised trampling, such as around supplementary feeding sites (Hetherington, 2000; ADAS, 2002). Light summer grazing by sheep on deep peat can also maintain blanket bog (Grant *et al.*, 1985) and its associated historic environment but high concentrations of sheep will carry increased risk of erosion and subsequent damage to the historic environment, as for example in Langdale (see case study; LUAU, 1994; Tallis *et al.*, 1994).

With cattle grazing, the risk of trampling damage and erosion to the historic environment is much greater than sheep grazing, and is especially so in winter or on wet heath, blanket bog and other wet areas (Welch & Scott, 1995). This can, however, be reduced by the stocking of smaller upland breeds of cattle. Grazing by horses or ponies also carries an increased risk of trampling damage. The grazing behaviour of cattle also differs from sheep, resulting in changes to vegetation composition. For example, cattle selectively graze purple moor-grass (*Molinia caerulea*), in contrast to sheep, which select finer-leaved grasses (Critchley *et al.*, 2008; Gardner *et al.*, 2009), although differences in diet selection between cattle breeds on heather moorland have not been confirmed (Fraser *et al*., 2009). The reduction of purple moor-grass litter (which is flammable) by summer grazing of cattle could reduce the risk of wildfire and improve visibility and access to sites where it has developed a dense, tussocky growth form. Cattle grazing in summer can also reduce mat-grass (Grant *et al.*, 1996) but where it is dominant the differences between sheep and cattle grazing are less marked (Davies *et al.*, 2007; Holland *et al.*, 2008).

Rimmington (2004) proposes two methods for the management of livestock on archaeological earthworks, these being livestock control or focus removal. Livestock control can be achieved by a simple restriction of winter grazing, which is often sufficient to protect the monument. Stocking densities can also be controlled or cattle excluded, either by fencing or in small areas by less substantial means such as brashings of tree branches, wooden hurdles or chain fences. Focus removal involves the removal or moving of a focal point such as shelter areas, feeding stations and rubbing posts.

Trials of trampling by cattle or horses have been undertaken as a restoration technique to create bare ground and enhance the establishment of heather in mat-grass grassland and purple moor-grass grassland (Mitchell *et al.*, 2008). In itself, the creation of bare ground presents a risk of erosion, although establishment of dwarf shrub heath in the longer term would in most cases not be detrimental to the historic environment. In this study, the purple moor-grass community appeared to be more resistant to trampling than the mat-grass community, which suggests that purple moor-grass might provide a more resilient vegetation cover that could protect archaeological features.

At a landscape scale, sheep were found to be most associated with trampling impacts on heather-dominated moorland when compared to cattle, deer and other herbivores (Albon *et al.*, 2007). At local scales, trampling damage is most likely to occur where there are large concentrations of sheep, such as around supplementary feeding sites (Hetherington, 2000; ADAS, 2002) or along regular sheep tracks, where it can lead to erosion (Evans, 1997) or soil compaction. Livestock trampling can, however, help to break down bracken litter (Pakeman *et al.*, 2000). Cattle trampling is potentially more severe (Welch & Scott, 1995) and can reduce heather cover by physical damage to mature heather stems (Critchley *et al.*, 2008). Cattle can be beneficial for managing certain upland vegetation types, for example bracken (Brook *et al.*, 2007), but need to be managed to avoid localised trampling damage to archaeological features, especially in sensitive areas such as boggy ground.

3.2.2. Burning

Controlled burning is commonly applied in the uplands to conserve heather for grouse production and to enhance forage quality for sheep. Burning management on ericaceous moorland in England has increased significantly since the 1970s, with approximately 4% burnt per annum overall and an average repeat time of 20 years (Yallop *et al.*, 2006). Burning encourages regeneration of heather and bilberry and alters the plant community structure of dry dwarf shrub heath, resulting in increased dominance of heather over a number of years (Gimingham, 1972; Cotton and Hale, 1994; Calvo *et al.*, 2002; Stewart *et al.*, 2005).

Controlled or managed burns should be “cool burns”, which aim to remove the leafy part of the dwarf shrubs leaving the bare stems (Defra, 2007). Occasionally it may be necessary to use back-burning, that is burning against the wind, which is slower and removes more of the vegetation, to make firebreaks and to clear the ground for re-seeding or tree planting. If controlled burning of dry heath is too frequent or intense it can cause replacement of dwarf shrubs by graminoids such as mat-grass (Anderson *et al.*, 2009; Yallop *et al.*, 2009). Although this represents habitat degradation, it is not necessarily detrimental to the historic environment as long as vegetation cover is maintained. For example in some cases there can be an immediate beneficial effect to the historic environment of any fire (notwithstanding any potentially damaging effects) in that previously unknown historic sites become visible, albeit for a short time only. The burning of bracken litter as part of restoration management to re-establish heathland or grassland vegetation can also be a beneficial management activity (Pakeman & Marrs, 1992). Although, if applied in the absence of additional restoration practices it could lead to further spread of bracken.

High temperatures on the other hand, can have the potential to cause cracking and damage to stones, remains of buildings, artefacts and other features of archaeological interest, particularly if they are on or near the surface. Key factors affecting the risk of damage are; temperature of the fire and the nature of the surrounding geology (e.g. some sandstones are particularly susceptible to fire damage). In the case of upland moorland the insulating qualities of turf means that the temperatures even just below the surface are generally considerably lower and buried stones (and consequently buried archaeology) are much less susceptible to fire damage. Unfortunately there is little available literature detailing research into the effect of fire on archaeological remains. What literature there is, mostly relates to North America, with a different vegetation structure (forests) and different ground cover and geology to the Great Britain.

The temperature required for most vegetation types to burn is 325°-480°C although the ease with which particular vegetation ignites is affected by a number of different factors such as moisture, temperature, weather, timing etc (Tucker, 2003; Scottish Executive, undated). After ignition, the temperature of the heather canopy can reach between 400° and 800°C, although nearer the ground it is usually much cooler and can be as low as 200°. The rise in soil temperature is minimal but does vary with soil type and moisture content. To date no detectable increase has been recorded at a depth of 0.04m in a lowland heathland fire (Tucker 2003; Glaves & Haycock, 2005). However, peat and humus layers can ignite resulting in prolonged intense fires, which spread laterally (Tucker, 2003). The heat distribution can be controlled by the method of burning, moisture content and speed of burning. Slower burns tend to be more damaging than fast burns. Burning in the winter months when conditions are wetter and temperatures are lower, minimises the risk of intense fires and damage. However fires (which may be caused accidentally, deliberately or on rare occasions, naturally) tend to occur in the late spring, summer and early autumn and fire temperatures can be higher (Tucker, 2003; Glaves & Haycock, 2005).

If burning is carried out on wet heath or blanket bog, the results can be detrimental to both habitat quality and the historic environment. On wet heath, heather can be replaced by purple moor-grass (Ross *et al.*, 2003; Anderson *et al.*, 2009). Bog vegetation is usually damaged by burning (Stewart *et al.*, 2004, 2005; Anderson *et al.*, 2009; Crowle & McCormack, 2009; Yallop *et al.*, 2009), with the typical bog-mosses and cotton-grasses being replaced by either heather or graminoids, depending on the severity of the fire and grazing intensity. An increase in heather can cause lowering of the water table and result in rotational burning management which perpetuates the heather dominance.

Burning of blanket bog can result in exposure of the bare peat substrate (Stewart *et al.*, 2005), which will increase the risk of erosion and ultimately, degradation of peat if the bog hydrology is damaged *(*Tallis *et al.*, 1994*).* However, if fire is appropriately managed (controlled), it is typically fast burning leading to the removal of above surface vegetation without killing the root mat or exposing the underlying peat (OA North, 2009). This type of fast burn should not damage the moss or leaf litter layers (Defra, 2007).

Controlled burning will reduce above-ground biomass and this decreases the available fuel in the event of accidental fire causing cooler and less damaging fires. A consequence of low levels of grazing or limited controlled burning is the build up of above-ground biomass, which will affect the heat of the fire in the event of an uncontrolled fire breaking out in the future. Moorland fires, whether deliberately or accidentally started, can develop into uncontrolled wildfire which can be highly destructive to the historic environment (Experience on Fylingdales and Anglezarke Moors. Howard-Davis, 1996; Vyner, 2005).

Wildfires can destroy large areas of vegetation and root mat and can set the peat itself on fire under drought conditions. This can result in exposure of large areas of bare ground, especially on blanket peat (McMorrow *et al.*, 2009). The development of wildfires depends on how dry the vegetation is and the amount and character of the vegetation that is available to burn. Areas that have not been grazed or been subject to controlled burning have a greater amount of fuel available for burning in a wild fire scenario. Controlled fires (particularly agricultural burns) may get out of control and lead to wildfires. The Upland Peat survey identified fire as one of the most serious threats to peat horizons (OA North, 2009), which can be critical to gaining a better understanding of the historic environment.

Sites that are not initially destroyed by the fire will be exposed to the actions of wind, water and frost erosion. Recent work on Barrow Fell in the Lake District, where more than 100ha were burnt in 2003, recorded and monitored soil erosion for two years following the fire (J. Warburton, pers. comm.). Erosion rates were elevated across the burnt area, although the stability of the slope and geometry of the fell, which was not conducive to concentrating runoff into hollows, were found to be a key factor in the lack of large-scale erosion. It was also noted that an extreme weather event two years later induced erosion rates that were identical to those during the winter immediately after the fire, highlighting the continued vulnerability of the area despite the fact that it was observed to have re-vegetated without active management.

Unfortunately, the number of uncontrolled moorland fires is increasing (OA North, 2009), exacerbated by higher visitor numbers and a reduction in active management. on Anglezarke Moor the level of management has already been reduced (Ian Harper *pers com*) and the incidence of fires has increased in a dry season. The Greater Manchester Fire Service recorded 11,500 moorland and grassland fires in 2003 alone, after an exceptionally dry winter and spring. Data from the Lancashire Fire Service suggests that there has been a rise in the number of grass and moorland fires between 2000 and 2003 (OA North, 2009). The Fylingdales survey concluded that the lack of management of the moor was a major factor in the severity of the fire (Vyner 2005). It is also predicted that the number of incidents will continue to grow as the mean summer temperatures rise and rainfall drops in response to climate change (Steve Heath & Steve Yearsley (Greater Manchester Fire Service), pers. comm. to OA North).

3.2.3. Cutting

Cutting can be used as a substitute for grazing in some places to amend the plant community structure of upland habitats. Experiments to control purple moor-grass by cutting have shown varying success; cutting on a wet heath community had little effect on purple moor-grass (Ross *et al.*, 2003) whereas repeated cutting on pure stands did successfully reduce its cover (Milligan *et al.*, 2004). Cutting a dwarf shrub heath community in Spain changed the species composition but did maintain dwarf shrub vegetation (Calvo *et al.*, 2002). Flailing of dwarf shrub heath can also regenerate heather, albeit more slowly than burning but with reduced wildfire risk (Cotton & Hale, 1994). Cutting of heathlands or grasslands can have relatively little effect on the historic environment as long as disturbance by machinery is minimised, and it could be beneficial if undesirable species such as purple moor-grass are reduced. However, in some instances the mechanical disturbance is considerable, resulting in substantial rutting to the ground surface which in areas of thin upland soils can increase erosion and have a direct impact on the historic environment (OA North, 2009).

Cutting can also be an effective means of controlling bracken (Lowday & Marrs, 1992a, b; Lee, 1995; White, 1995; Marrs *et al.*, 1998; Le Duc *et al.*, 2007; Måren *et al.*, 2008), with major benefits to the historic environment as long as machinery disturbance to archaeology does not occur.

3.2.4. Other Mechanical Operations/ Disturbance

Mechanical operations are sometimes advocated for removing extant plant material as a preliminary to habitat restoration in the uplands (Littlewood *et al.*, 2006). The most severe measure is turf removal, which has been used on acid grassland to increase heather and reduce dominance by wavy hair-grass (*Deschampsia flexuosa*) (Wilton-Jones & Ausden, 2005a). Ploughing also represents a severe form of disturbance, which can help to regenerate heather in dwarf shrub heath (Calvo *et al.*, 2002). Rotavation can also help to re-establish heather and other dwarf shrubs and reduce dominance of competitive grasses on mat-grass- or purple moor-grass-dominated grasslands, but the bare ground created can persist for two or more years after rotavation (Mitchell *et al.*, 2008). Hand-cutting and rolling back vegetation in dwarf shrub heath resulted in significant amounts of bare ground persisting after nine years (Cotton & Hale, 1994). Although the outcome of these various operations in the long-term might have some benefit to the historic environment in re-establishing benign vegetation cover, the severe physical disturbance is very detrimental and the persistence of bare ground will increase the risk of erosion. In lowland heathland, any form of mechanical disturbance used in habitat restoration could cause irreversible damage to archaeological features and therefore only non-disturbance methods are advocated (Hawley *et al.*, 2008); the same can be expected to apply in upland situations.

Raking of bracken litter has been shown to promote the establishment of sown grasses as part of bracken control measures (Pakeman & Marrs, 1992). Similarly, raking litter in stands of purple moor-grass can increase heather seedling densities in the short term (Marrs *et al.*, 2004). The use of mechanical flails on bracken, can also cause damage to earthworks and particularly to stone founded features (such as collapsed walls) which are susceptible to the dislodging of stones (Lee 1995; White 1995). If below-ground archaeology is present but not above-ground features, the raking of bracken litter as part of bracken control is advantageous by reducing potential damage from bracken rhizomes. However, if surface features are present, the risk of mechanised damage typically outweighs the advantages (OA North, 2009).

3.2.5. Plant Introductions

Establishment of heather in habitat restoration schemes can be accelerated by the addition of seed (Anderson *et al.*, 2009). This has been demonstrated in mat-grass grassland and purple moor-grass grassland (Mitchell *et al.*, 2008), lowland dwarf shrub heath (Wilton-Jones & Ausden, 2005b), stands of bracken (Pakeman *et al.*, 2000; Le Duc *et al.*, 2007) and acid grassland with bracken (Le Duc *et al.*, 2007), although the effects of seed addition are sometimes small or short-term (Marrs *et al.*, 2004; Milligan *et al.*, 2004). The establishment of grasses after bracken control can also be accelerated by seed addition (Pakeman & Marrs, 1992). The establishment of heathland or grassland, especially if replacing bracken, should be beneficial to the historic environment as long as disturbance is not used to create a suitable seed bed.

3.2.6. Chemical Inputs

Herbicides have been tested to control purple moor-grass on moorland dominated by the species (Milligan *et al.*, 2003, 2004; Marrs *et al.*, 2004) or co-dominant with heather (Ross *et al.*, 2003; Marrs *et al.*, 2004). Reductions in vegetation height and purple moor-grass and increased recruitment of heather seedlings or other graminoids can be achieved, but overall effects on the plant species composition are often relatively minor and short-lived. These treatments would have minimal positive effects on the historic environment and be dependent on avoiding disturbance by machinery, the creation of bare ground and any associated erosion. Non-selective herbicide applied to heather moorland can, however, be damaging to heather and other species (Milligan *et al.*, 2003) and might increase the risk of erosion if protective vegetation cover is reduced. Chemical control can successfully reduce bracken stands on heathland (Tong *et al.*, 2006) and can result in increased dominance by grasses such as wavy hair-grass (Pakeman *et al.*, 1997) or heathland species (Brook *et al.*, 2007). This replacement of bracken by herbaceous or dwarf shrub vegetation can be beneficial to the historic environment.

The addition of fertiliser can enhance re-vegetation of bare peat when seed is added during habitat restoration operations (Anderson *et al.*, 2009). Similarly, fertiliser can increase grass establishment after bracken litter reduction (Pakeman & Marrs, 1992), although the establishment of heather is not improved by such a technique (Pakeman *et al.*, 2000). However, the effect of nitrogen on established dwarf shrub heath interacts with grazing, with increased growth encouraging increased grazing (Hartley & Mitchell, 2005). Re-vegetation of bare peat is clearly important for conserving the historic environment and fertiliser application may therefore have a role in specific restoration schemes, as long as it does not change the chemical composition of the soil.

3.2.7. Abandonment

Complete abandonment will have major effects on upland vegetation, albeit over long timescales. However, cessation of grazing for example as part of a planned re-wilding scheme, can be used to restore heather moorlands and the resulting vegetation is usually more similar to the target vegetation than at sites restored by mechanical means (Littlewood *et al.*, 2006). Various grazing exclusion experiments have demonstrated that an immediate effect is an increase in cover or height of some of the dominant species.

More subtle changes in species composition have also been noted when grazing is stopped. A reduction in typical bog species occurred when sheep grazing was stopped on an ombrotrophic mire, being replaced by dry heathland species around the fringes of the bog (Smith *et al.*, 2003). In contrast, on degraded vegetation dominated by heath rush, blanket bog species and heather were replacing the heath rush (Marrs *et al.*, 1988). On degraded wet heath dominated by purple moor-grass, that species increased, but heather cover and seedling development were also enhanced, and other grasses declined (Mitchell *et al.*, 2008). Heather also increased in frequency on a degraded wet heath where it was already present (Hulme *et al.*, 2002). On dry dwarf shrub heath, heather cover and height increased whereas some graminoids declined (Pakeman *et al.*, 2003), and a similar effect was seen on heather-bilberry heathland (Hartley & Mitchell, 2005). Bilberry height also increased substantially when grazing was stopped on heathland where it was already dominant (Welch, 1998). Exclusion of sheep from bent-fescue acid grassland caused species more typical of heathland to increase (Hulme *et al.*, 1999), and removal of deer resulted in a reduction in species richness on this type of grassland (Virtanen *et al.*, 2002). In contrast, changes to mat-grass grassland occur much more slowly when stock are excluded (Mitchell *et al.*, 2008).

Changes in species composition are therefore highly dependent on the starting conditions but in most cases some form of heath, bog or grassland vegetation is likely to persist at least in the short term, with relatively little impact on the historic environment. Over longer timescales, however, the longer, unmanaged vegetation would carry the increased risk of damage should fire occur, loss of visibility and eventually, colonisation by trees or tall shrubs.

3.2.8. Water Management

Drainage of blanket bog affects its hydrology and reduces the range of plant species typically associated with it, particularly bog-mosses and cotton-grasses, often leading to heather or purple moor-grass dominance (Crowle & McCormack, 2009). This degradation of the blanket bog community might not in itself be detrimental to the historic environment. However, drainage also results in peat drying and decay (Anderson *et al.*, 2009); as an important historic resource in its own right, the loss of this peat can be very damaging. Re-wetting of previously drained blanket bog or wet heath, if successful, will therefore be beneficial in preserving peat and in re-establishing vegetation cover around areas disturbed by drainage operations, as long as it is done in a fashion that does not adversely impact the local peats. Replacement of heather by bog species on re-wetting will also result in less flammable vegetation and reduce the risk of fire damage.

3.2.9. Summary

In conclusion then, vegetation management is important for maintaining suitable conditions for conserving the historic environment and preventing the loss of, or damage to, historic features. In addition, lack of vegetation management can lead to reduced visibility and access, which in turn can be detrimental to our understanding and knowledge of the historic environment.

Factors such as topography and climate are however particularly key to influencing the extent, frequency or severity of any impact and mean that each locality will have its own characteristics that need to be understood.

Table 3.2 on the following page provides a summary of the main management practices in the uplands and key vegetation characteristics and their combined potential to affect the historic environment.

Table 3.2. Summary of the main management practices in the uplands and key vegetation characteristics and their combined potential to affect the historic environment. Risk of damage is reduced by +ve characteristics and increased by –ve characteristics.

Risk	+ve characteristics	-ve characteristics
Livestock	Where there is resilient vegetation and substrate, livestock are less likely to cause damage	Where there is sensitive vegetation and substrate livestock could directly damage sites through trampling and causing erosion
Grazing	Good grazing practices - maintenance of complete vegetation cover for heath, bog or grassland	Undergrazing leading to bracken, trees or scrub growth Overgrazing leading to bare substrate and subsequent erosion
Burning	Short vegetation providing better opportunity for control and lower temperature burns	Long, flammable vegetation leading to uncontrollable fires and high temperature burns
Cutting Vegetation	Maintenance of short vegetation ensuring retention of vegetation cover and reduction of scrub/ tree growth	Potential for increased erosion risk where vegetation dies back. Disturbance to underlying archaeology during cutting operation.
Mechanical Operations	Where there is resilient vegetation and substrate, operations have less potential to damage	Where there is sensitive vegetation and substrate operations could directly damage sites
Chemical Inputs	Application of chemicals to aid vegetation growth can help re-establishment of vegetation cover reducing the risk of erosion	Chemical inputs have the potential to change the nature of soil composition and thus the historical evidence base. Uncontrolled inputs can lead to an excess of vegetation growth encouraging woody plants and/ or vigorous roots.
Abandonment	For short periods cessation of vegetation management can be used to restore growth and increase cover preventing erosion	Over longer time periods unwanted vegetation growth (bracken/ scrub/ trees) will become a problem. Some wet heaths may dry out leading to peat desiccation if abandoned and not managed.
Plant Introductions	Positive change to vegetation with improved characteristics such as year round cover or shallower rooting systems	Change to native habitat leading to loss of vegetation cover and potential for introduction of alien species with more vigorous growth or longer root systems.
Water Management	In areas of wet habitat - maintenance of water levels keeping bog hydrology undisturbed	In areas wet habitat - draining of land leading to disrupted bog hydrology

4. RESULTS OF THE QUESTIONNAIRE

4.1. Introduction

Interviews were conducted with a broad selection of people who have an interest in upland management and the historic environment. The selection included land and agricultural managers as well as historic environment and ecology specialists. Individuals from the English National Parks, Natural England, County Councils and other interested bodies were approached and respondents included archaeologists, ecologists, academics and land managers, providing a wide geographic coverage of the English uplands.

The organisations and expertise of those interviewed are summarised in Table 4.1 and a full list of stakeholders interviewed for this project is in Appendix 1. The data have not been statistically analysed because the sample is small with only 51 respondents. However, of those interviewed, 43% were archaeologists, 27% ecologists, 22% land managers and 8% agricultural advisers (See Table 4.1).

Table 4.1: Respondents by discipline

	No.	**%**
Archaeologists/historical advisers	22	43
Ecologists and wildlife specialists	14	27
Agriculture advisors	4	8
Integrated land management	11	22
Total	**51**	**100**

In Table 4.2, these were further divided by function, for example an archaeologist or an ecologist could be an adviser or an academic. This breaks down to eighteen (35%) were agricultural, ecological or archaeological advisers, thirteen (25%) policy makers, eight (16%) private land estate managers, seven (14%) land/ estate managers from national or local government bodies, and five (10%) academics.

Table 4.2. Respondents by function

	No.	**%**
Private land estate managers	8	16
Land estate manager from national or local government bodies	7	14
Agricultural, Ecological and Archaeological Advisers	18	35
Policy makers	13	25
Academics	5	10

The interviewees were asked to state the main threats to the historic environment specific to their area and what, in their opinion, were the most vulnerable upland monument types. The information was collated on a spreadsheet (Appendix 2) and the results relating to vegetation issues and management practices that directly affect the conservation of the upland environment are presented below.

4.2. Stakeholder Vegetation Issues

4.2.1. Heather/ Grass

Issues raised by interviewees about the management of heather moorland highlights the importance of managing heather and other ericaceous plants as well as inhibiting the spread of shrubs and small trees. Lack of heather management in the Bowland Fells and on Anglezarke and Rivington Moors is a concern to those responsible for the management of the moors. Following an investigation into the feasibility of cutting firebreaks, United Utilities introduced a no burning policy on Anglezarke and Rivington Moors in order to minimise contamination of water supplies, preferring cutting as a method of vegetation management. Whilst the policy was introduced to reduce potential contamination from carbon particles arising from the burning, there was also concern over exposed peat deposits which could lead to water discolouration. However, they then discovered that some of their tenants were in Countryside Stewardship and this scheme would not support cutting. As a result, there has been no heather management on these moors for five years and one interviewee spoke about heather becoming leggy, and that the unmanaged moor might therefore (in their words), 'become a greater fire risk'.

It was recognised by 15 (29%) participants in the survey that carefully controlled burning was desirable for reducing the frequency of wildfires and subsequent damage to the historic environment. [Burning is discussed in more detail in Section 4.3]

Nine (18%) respondents said that heather was managed in their areas by cutting, although there were reservations about whether this could damage the moorland. In Shropshire, the National Trust found that older heather obscures some monuments that they would like their visitors to enjoy. Whilst in North Yorkshire there are some concerns that mechanical flails are causing disturbance to historic remains on or near the soil surface, through both physical damage and displacement. [Cutting is discussed further in Section 4.3]

One respondent had observed an expansion of purple moor-grass as grazing levels decline in their area. On Bodmin Moor this expansion was reported as becoming a serious issue as the grass can obscure archaeological sites and inhibit easy access to the moors. Four respondents mentioned that purple moor-grass was being managed and that the favoured control method was by burning or cattle grazing.

4.2.2. Bracken

The personal experience in practical land management activities of the stakeholders that were interviewed, led them to raise similar issues. It was therefore not surprising that bracken management in the uplands was a concern shared by archaeologists, ecologists, the RSPB, and land managers.

Bracken encroachment was thought to be a serious problem by 14 (27%) of those of interviewed. Although one interviewee suggested that in their view, 'bracken was expanding across the country', Natural England uplands specialists confirmed that whilst there may be local variations, there was currently no information to support a national increase in bracken. However, Natural England hold a view that bracken control should be targeted on heath and species-rich grassland. It was also noted that bracken control on historic features is a priority under Environmental Stewardship agreements.

According to many respondents, bracken encroachment was thought to be undesirable to the historic environment because:

- It obscures archaeological features and the wider historic landscape, and the roots can cause damage to the stratigraphy of the buried remains - particular concern was expressed in relation to prehistoric farmsteads.
- Dense vegetation cover (bracken or gorse) encourages the channelling of people and animals along limited corridors, thus increasing soil erosion along this line. It also provides cover for burrowing animals such as rabbits and badgers.

In Shropshire, the National Trust (NT) considers the control of bracken as a priority, although they recognised that there was a potential divergence of views between archaeologists and ecologists. From a general professional stand point, archaeologists would like complete removal of bracken and ecologists would prefer to protect some areas as habitat for the rare High Brown Fritillary butterfly. The dilemma for all involved is that areas of bracken that are left can provide a source point from where new bracken could spread into surrounding areas, potentially re-infesting historic sites. Concerns were also expressed that some control methods, notably the use of mechanical flails on bracken, can cause damage to earthworks and particularly to stone features.

With regard to different methods of bracken control, three interviewees suggested cutting, three mentioned chemical application, and one of those interviewed mentioned crushing bracken as a means of establishing control. Bracken control by spraying is carried out by Northumberland National Park, Peak District National Park and the National Trust. Where large stands of bracken are involved, the spraying is carried out by helicopter. The spraying is in bands across the slope so there are still barriers of vegetation across the slope to restrain water flow. There was no mention of the specific chemicals used in bracken control. One interviewee felt that bracken could be best controlled by heavy grazing and traditional farming methods. However, in this context it was also mentioned that the up-rooting of plants should not be used where historic sites exist, as this could cause disturbance to the underlying deposits.

4.2.3. Scrub

Scrub expansion in the uplands was mentioned by many of the interviewees. Dense vegetation cover (bracken or gorse) was said to encourage the channelling of people and animals along limited corridors (increasing soil erosion along this line) and provided cover for burrowing animals such as rabbits and badgers. Eleven (22%) of those interviewed identified that scrub encroachment is occurring at the present time in the uplands and is posing a threat to the historic landscape. Seven (14%) interviewees were concerned with the expansion of gorse and one mentioned the spread of Rhododendron (an amenity shrub).

There was a reported expansion at higher altitudes and a general increase in vigour of scrub in the uplands. This was thought to be related both to reductions in grazing levels (nine interviewees, 18%) and to an extended growing season as a result of warmer winters (one interviewee).

A stated example where scrub encroachment is becoming an issue is Castle Hill in Shropshire, where parts of the commons are no longer being grazed. The National Trust commented that they would like more stock on the commons although at the present time scrub on historic sites is being controlled by hand through the use of volunteers.

Beyond scrub in general, few of the respondents mentioned the control of gorse in particular. However it was specifically mentioned by four of those interviewed and one ecologist noted that Western Gorse (*Ulex gallii*), which occurs mainly in the South West, has a growth form comparable to heath and is distinct from Gorse (*Ulex europaeus*) scrub. One respondent said that he thought managed gorse can be good for sites as it can conceal vulnerable monuments, but recognised that site visibility is also reduced. General concerns were expressed about the potential impact of root action upon archaeological deposits and several respondents confirmed that they manage Western Gorse by burning it to reduce the potential for damage to historic sites.

Natural England upland ecologists mentioned that they were keen to encourage an increase in scrub on the fringe of moorland grazing units. They believe that this would provide a better transition from moorland to woodland, making good the effects of previous overgrazing. However, they also recognise that this approach needs to be planned and must take into account a range of interests, including the historic environment through schemes such as the Higher Level Stewardship scheme.

Specific mention was made of the visibility of archaeological sites, where scrub encroachment was said to potentially lead to physical and intellectual loss of historical knowledge. This lack of visibility was said to potentially create difficulties for the development of historic environment management plans. Excessive scrub growth, which is highly inflammable, was considered to be a potential fire hazard, especially gorse and there was also concern that areas for walkers in the uplands could be limited to narrow tracks between scrub thickets.

4.2.4. Woodland

Natural England ecologists indicated that an increase in woodland cover form part of the Upland Vision to provide less intensive but more sustainable management and to meet the Biodiversity Action Plan targets for upland oak woodland. The natural expansion of woodland was mentioned by one interviewee, who observed oak trees growing out of abandoned lime kilns and potentially causing structural damage. This was felt to be a particular issue on monuments not subject to statutory protection, as they are not normally monitored or subject to appropriate management.

It was stated that good management practice should lead to archaeological features being cleared of trees. However, in the absence of continuing management, The National Trust had observed the re-establishment of woodland on archaeological monuments and are concerned about the potential for root damage on vulnerable sites.

Another interviewee drew attention to a policy of planting trees as a wind breaks to protect monuments. He described how the Bleasdale Circle in Lancashire was now being damaged by the growth of the trees in the wind break and interrupting the connection between the monuments and the wider landscape.

4.2.5. Re-wilding

Three interviewees spoke about re-wilding in the uplands. Two of those interviewed, both palaeoecologists, felt that re-wilding could potentially cause extensive damage to the peat by causing water levels to drop. They also expressed a view that the vogue for planting native trees is encroaching on the drier slopes, again damaging the peat. However, one of those interviewed (archaeologist) was content to see small areas of planting in ravines in Cumbria. However, they did think that it should be discouraged over large areas.

4.3. Stakeholder View of Management Practices

4.3.1. Grazing

Grazing is an important element in the conservation management of vegetation in the upland environment. However, grazing levels and what constituted overgrazing, light grazing or reduced levels of grazing were not specifically defined in the responses to the questionnaire.

Three of those interviewed were concerned about what they described as over-grazing in the uplands. In general, it was felt that over-grazing in the uplands is becoming much less of a problem when compared to the past when it caused extensive damage to both peat and mineral soils.

One researcher had observed that there was increased run-off from erosion. Their view was that this could be caused by grazing, altering the sediment load of streams, and as a result could cause damage to archaeological monuments lower down the slope through increased erosive activity. Another respondent felt that cattle grazing can be detrimental to the historic environment, e.g. grazing being allowed on the site of a Roman fort in the winter months causing localised disturbance to the stratigraphy due to the cattle disturbing the upper layers of the soil.

Eleven (22%) of those interviewed expressed concern that reductions in the level of grazing were allowing encroachment of bracken, scrub and trees. This was identified as becoming a significant threat to the historic environment in the uplands, particularly on Dartmoor, Exmoor and Bodmin Moor. On the latter, the reduction in grazing was reported as allowing an expansion in the growth of *Molinia*, leading to tussocks, which makes access difficult and obscures the ancient field systems and the prehistoric and medieval farmsteads of the area. It was also noted that an expansion of bracken and scrub as a result of the reduction in grazing was potentially increasing the threat to the historic environment. It was also mentioned that as grazing reduced, heather and bilberry become “more leggy”, and the risk of fire damage increases.

One interviewee felt that reductions in grazing may be exacerbated by the single payment scheme, which does not encourage farmers to have higher stocking levels. One respondent expressed a view that the correct level of mixed grazing, in conjunction with good husbandry, is best for both the vegetation and the historic environment, buried and above ground. However, their concern was that, due to the way subsidies are paid, hill farmers are gradually loosing knowledge of the more traditional methods of mixed stocking regimes.

Although only five interviewees (10%) stated that the positioning of feeding troughs was a threat to the historic upland environment, supplementary feeding of livestock can be seen as a significant issue in heritage conservation. Historic sites in the uplands can often to be found on the drier raised ground making them favoured sites for feeding troughs. Animals are then concentrated on these areas and the necessary vehicular access to service the troughs causes an increase in erosion, thus damaging the monument. Several interviewees highlighted the need for feeders to be moved on a regular basis and stated that in their view feeding stations should not be located on archaeological sites.

Two interviewees mentioned fencing. One said that it should be used to protect monuments and the second, said that the actual fencing itself can cause damage to the historic environment. Their view was that fencing a monument could result in the growth of vegetation, which if not managed, may obscure a historic site and could increase the risk of damage from fire.

4.3.2. Burning

Burning is an important element in the management of vegetation and the subsequent conservation of the upland environment. Fourteen of those interviewed (27%) said that controlled burning was part of the vegetation management in the uplands. It was recognised by some as essential in reducing the likelihood of wildfires damaging the historic environment. Two respondents expressed their concern about the consequence of a reduction in the frequency of burning as a management tool. The view was that poor burning regimes could result in an increase in likelihood of wildfires. Two Natural England specialists commented on the potential impacts arising from burning over different soil types, and for example, did not advocate burning on peat. It was also noted that the updated Heather and Grass Burning Code and Regulations 2007 (Defra, 2007) provides for a ban on burning (except under licence) due to the potential risk of soil exposure and erosion.

It was reported that on Exmoor there is a rigorous annual policy of burning small areas of moorland to encourage grass and a closer sward. The general view of some respondents was that this type of policy may have a beneficial result for the historic environment as it increases the visibility of historic sites. Controlled burning also inhibits the growth of scrub on Exmoor. The National Park Authorities provide land managers with maps to identify areas where there are vulnerable monuments, such as standing stones. The land users are encouraged to cut firebreaks around the stones to prevent heat damage.

A reported downside of the controlled burning is the potential for fires to get out of control and the use of fire vehicles and mobilisation of personnel can lead to further damage of the historical environment. However, burning at appropriate times of the year should minimise the risk of fires burning out of control. In Shropshire, the National Trust has a policy of not burning on or near known historical sites as they believe that the fire could contaminate archaeological deposits. The National Trust in Devon undertakes fast burns of heather and gorse but avoids scheduled monuments and other significant sites.

Six (12%) interviewees identified uncontrolled fires as being one of the major problems for the historic upland environment. The interviewees thought that the frequencies of fires will increase with a reduction in grazing and intensity of land management and the predicted increase in spring and early summer droughts as a result of climate change.

4.3.3. Cutting

Cutting of vegetation is used extensively as a management tool in the uplands, with heather, grass, and bracken being cut the most. Fourteen (27%) interviewees said that the cutting of bracken, grass or heather was used as a management tool in their areas. One of them stated that cutting was undertaken by mechanical means and two said the vegetation was cut manually. Reservations were expressed about the extent of damage caused to vegetation and the historic environment by cutting heather mechanically, but two other respondents suggested that the use of low pressure equipment could reduce compaction from mechanical cutting.

Cutting was mentioned by three interviewees as a means of controlling bracken. The National Trust controls bracken across the Long Mynd by hand-cutting using scythes, brush cutters or strimmers over small areas; the bracken is then turned into peat-free compost. Bracken is also controlled by crushing. In addition scrub is cut in the South West.

4.3.4. Other Mechanical Operations/ Disturbance

Mechanical disturbance can be caused by a wide range of equipment, including agricultural, construction, military and recreational vehicles.

Six (12%) of the interviewees mentioned the use of inappropriate machinery as being the cause of significant damage to the historic environment in the uplands. Similarly, the use of machinery for grip blocking was cited as a cause of concern by both archaeologists and palaeoecologists. The machinery can cause damage to the peat, despite the fact that the blocking is intended to protect or restore previous damage.

Two of those interviewed mentioned that the use by farmers of quad bikes/ATVs to gain access to replenish feeding troughs and for stock control. If concentrated or incorrectly placed, these vehicles can damage the historic environment. Potential damage could be avoided or mitigated by varying the routes of quad bikes over the moors, and by moving the feeding troughs around, subject to advice from archaeological curators.

The problem of off-road vehicles was considered by 13 (25%) of those interviewed to be a serious cause of disturbance in many areas, and a number of individuals expressed their concern about the potential damage caused by 4x4 vehicles (9 respondents, 18%), off-road biking (3 respondents) and quad bikes (1 respondent). In general, the damage caused by 4x4 vehicles tends to be localised to the line of old routes, but some of these in the North West have already been extensively damaged. In Lancashire, the County Council is taking steps to repair them by floating new tracks over the damaged sections. In some instances, it was felt that it was difficult to police the traffic regulations on these old roads and off-road bikes are legally allowed to use some of those that are prohibited to 4x4 vehicles.

There is a separate issue of damage by 4x4 vehicles on the open moors when drivers use their vehicles off-road, as for example whilst following the hunt on Exmoor. The use of quad bikes for leisure activities and farming was also highlighted as a cause of erosion and in the case of Exmoor for causing actual damage to upstanding monuments, such as boundary stones and cairns.

One respondent raised a number of issues about motocross bikes. They are often used in areas close to large conurbations and can cause extensive damage, particularly to old quarries and mine workings, with their spoil heaps and tracks. Trial events, if official, can be acceptable as they are well marshalled, but the unofficial ones are not. Spectators follow the competitors over the open moors and can cause erosion damage, as there are no controls. One respondent mentioned an unusual cause of mechanical disturbance in the area that they manage; tanks on the military training grounds in the uplands.

4.3.5. Chemical Input

Chemical interventions by fertiliser/ herbicide were only mentioned as a means of managing the vegetation in the context of bracken control. Eight (16%) of those interviewed said that chemical spraying was the method they used, or was used in their areas, and it was considered the most effective means of destroying bracken. However, this was discouraged in some parts of the country by the water companies because of the risks to public health. Two respondents stated that bracken control by spraying was managed in bands across the slope so there were still barriers of vegetation across the slope to restrain water flow into the groundwater. Spraying was generally carried out with helicopters. Whilst extensive spraying by the National Trust is generally no longer carried out on the Long Mynd, knapsack spraying with a systemic herbicide like glyphosate is still used to control bracken over large areas.

4.3.6. Abandonment

Abandonment of land was not mentioned in any of the responses. However, there was frequent referral to a concern that a decrease in grazing would lead to an expansion of scrub and bracken. This in turn might lead to land being abandoned over the longer term.

4.3.7. Plant Introductions

There was no mention of plant introductions in the response to the questionnaire, except in the context of re-wilding (Section 4.2.5). However, it was reported by one respondent that the harvesting of heather for seed brash, (a technique used to restore areas of badly eroded moorland), may cause harm to the moorland.

4.3.8. Water Management

The responses to the questionnaire about water drainage and re-wetting in relation to the management of the vegetation included a range of concerns, particularly in relation to the methods by which re-wetting are achieved.

Natural drainage was mentioned by six (12%) interviewees, including both ecologists and land managers. Five (10%) interviewees said that water erosion caused by natural drainage quickly followed damage to the surface vegetation by livestock and walkers, putting the historic environment at risk. However, on Dartmoor, Exmoor and Bodmin Moor, it was thought to be only a localised problem. Localised damage to prehistoric farmsteads and field systems, caused by erosion channels, was mentioned by one respondent.

In the North of England, water erosion caused by natural drainage was more widespread and was of concern, especially following heavy rainfall. One respondent in Cumbria expressed concern about natural drainage and the destruction of streamside historic remains, for example the workings from old mines. Erosion of footpaths can rapidly escalate into large drainage channels. This was a particular issue on the major footpaths leading up to the Langdale Pikes, which extend through areas of Neolithic axe working (see case study in Section 5.3). Similarly, along the Hadrian's Wall Path National Trail, it has been noted that it only requires slight wear to the surface vegetation to allow small runnels to form, which in turn rapidly develop into gullies; however, this damage can be minimised by appropriate path repair. Footpath repair in the Lake District is concentrated on drainage control as well as the repair of footpath surfaces.

Conversely, poorly drained soils can become impacted by sheep and cattle. In Cumbria and Northumberland, poor grazing regimes, such as cattle grazing throughout the year on wet soils, are putting archaeological monuments at risk, notably at Hardknott Roman Fort in the Lake District National Park and on sections of the Hadrian's Wall Path National Trail.

In a peatland landscape, drainage was generally considered to be a very serious problem when the surface vegetation had become damaged by fire, walkers, grazing pressures or through the inappropriate use of vehicles. The width of existing gullies quickly increased following heavy rainfall or severe storms. One respondent mentioned that if the surface peat is damaged, the hydrology can be changed to such an extent that sections of peat can move downslope.

One interviewee mentioned the cutting of new grips for drainage and the damage this can cause to the historic environment. Damage takes place when the grip cutting goes into the mineral substrate, leading to the potential destruction of preserved buried archaeology. However, artificial drainage on the uplands was not generally reported as an issue at present.

Grip blocking as a management tool in the upland environment was mentioned by 15 (29%) of those interviewed. It was agreed that drainage of the uplands, especially in areas of peat, had been extremely damaging in the past. However, proposals to re-wet the moors by grip blocking and the techniques to do this were considered by four respondents to be one of the key management issues for the historic upland environment. Re-wetting of the moors was generally recognised as “a very good idea” which can benefit the ecological and historic interest, but the technique of grip blocking did not meet universal approval, because of the methods used to achieve it.

It was reported that whilst some restoration work can result in damage, it was possible to undertake the work sympathetically (using heather bales or Herdwick sheep fleeces laid with specialist machinery) in a way that is beneficial to the conservation of the historic environment.

4.4. Other Stakeholder Issues

Other important issues raised through the questionnaire that are not directly related to the management of the vegetation in the uplands were: climate change; wind erosion and soil loss; wild animals; access; archaeological sites; Grouse moors; agricultural change; and wind farms.

4.4.1. Climate change

Six (12%) interviewees mentioned climate change, both as an advantage and as a disadvantage. One major change predicted is an extended growing season, which was described as both advantageous and disadvantageous in the uplands. Firstly, some of the respondents thought that a longer growing season allowed damaged vegetation to recover along footpaths and after grazing. However, others noted that it might encourage the spread of bracken and scrub to higher levels due to conditions favouring more vigorous growth.

Three interviewees noted that the current prediction of an increase in the number of extreme climatic events, such as storms and spring and early-summer droughts, is likely to result in an increased threat to the upland historic environment. Storm events could lead to extreme water erosion resulting in land or peat slides, and droughts would lead to an increased risk of wildfires.

4.4.2. Wind Erosion

There was a single mention of wind erosion and soil loss. This related to the loss of the dried peat on Anglezarke Moor following fires, but there was also a general concern about wind erosion and peat loss in Lancashire. However, it would appear that this is a less important issue unless the vegetation or turf cover is lost as a result of wildfires.

4.4.3. Wild Animals

Ten (20%) interviewees (archaeologists, ecologists and land managers), identified rabbits as causing serious damage to the historic upland environment and to earthworks in particular. There were a number of examples where burrows had devastated earthworks almost beyond repair (Plate 1). Several of the archaeological curators felt that the rabbit population needed to be controlled by land managers. One respondent also thought that in some areas of the North, the control of predatory animals by gamekeepers allowed rabbits to flourish.

Three of those interviewed made reference to the potential threat that can be caused by badgers in the uplands. Along Hadrian's Wall, badger setts are causing damage and parts of the monuments have been directly affected. Surface scratching by badgers has removed vegetation from Milecastle 40, leading to erosion. Despite their potential for damage however, one respondent felt that their impact was localised and not a major concern for the maintenance of the National Trail.

There was only a single mention of deer in the responses to the questionnaire. This was from the South West, where it was said that the numbers of deer were increasing as they were no longer being managed.

4.4.4. Access

Access to England's uplands indirectly affects the conservation of the vegetation and management of the historic environment and is therefore included in this survey.

Open access in itself was not identified by respondents as damaging the historic environment. In fact some archaeologists were generally in favour of greater freedom to roam in the uplands as it has the potential to spread people out across the area rather than concentrated access along footpaths. Although increased access was not perceived as significantly adding to the erosion of archaeological landscapes, the archaeologists, ecologists and land managers interviewed as part of this project were generally concerned that walkers and climbers were a principal cause of footpath erosion and can be the cause of accidental fires.

Seven interviewees (14%) mentioned tourism in their responses and four thought that numbers were increasing. High visitor numbers in National Parks leading to increased impact on vegetation and subsequent erosion, was mentioned by five (10%) respondents.

There are specific public access, tourism and recreation issues associated with footpaths and tracks. Although these may indirectly affect the conservation and management of upland vegetation within the historic environment, they are included in this survey. A total of six (12%) interviewees felt that badly sited footpaths were an issue in the conservation of historic monuments. One interviewee in the Lake District National Park stated that there is a move to open up the fells to the disabled by creating surfaced paths and removing stiles to accommodate wheelchairs. Their view was that construction of these paths could involve ground disturbance and an impact on underground archaeology and could result in footpaths and tracks that are a visual intrusion. Another interviewee said that in the Yorkshire Dales National Park and the North Pennines AONB, there is erosion arising from the expansion of walkers tracks across the North Pennines. These access tracks are considered to be extremely detrimental to peat deposits as the resulting erosion can lead to increased drainage and desiccation.

The advantages of footpath and track maintenance on Hadrian's Wall National Trail and in Northumberland and Lake District National Parks, were identified by four of the interviewees. In Northumberland and Lake District National Parks, the park authorities are undertaking intensive narrowing of wide areas of wear by creating pitched paths. On the Langdale Pikes, massive footpath erosion scars across axe-factory working areas (Plate 2) have been filled and replaced with narrow pitched paths that are believed to have been successful in preventing erosion of the archaeological resource.

On Hadrian's Wall, permission for the National Trail was conditional on maintaining a green sward wherever possible along the route of the trail. To achieve this sward requires regular and intensive grass management. The line of the footpath is typically defined by mowing a narrow corridor, and this can be used to divert walkers away from eroded sections, allowing these to recover. The managers of the National Trail along Hadrian's Wall have also experimented using a number of different techniques to stabilise the erosion and encourage the regrowth of the sward (Plate 3). On selected areas of the Hadrians' Wall Path, artificial elements such as Golpla or Ritter, have been used to help the recovery of grass. Sand has also been used to dry the path, as wet mud spreads, killing the grass and increasing the likelihood of erosion scars developing. This over-arching approach to footpath maintenance has been successful and badly eroded sections of the Trail have recovered as a result, despite the increasing numbers of walkers along the Trail. However, the approach will require constant maintenance for the lifetime of the footpath.

4.4.5. Archaeological Sites

Seven of those interviewed (14%) were concerned that stones were being removed from prehistoric monuments and summit cairns. Three interviewees observed that stones from walls and other features were being removed to repair other walls or buildings. Although neither of these actions is associated with vegetation, the activity does have the potential to alter the character of the historic environment of the uplands.

One interviewee identified a problem whereby land managers were using stone from archaeological monuments as a source material to consolidate footpaths. Whilst this was identified as a particular problem in the North York Moors National Park, it has historically been an issue in the Lake District as well. There are examples of Bronze Age burial mounds on Town Bank, West Cumbria, that have been robbed to provide stone for tracks. Similarly, footpath repair in the Mickleden Valley, Great Langdale, incorporated substantial amounts of stone from adjacent clearance cairns. Increasingly, the National Trust and the Lake District National Park Authority are undertaking archaeological surveys in advance of path repair schemes to identify monuments that may be directly affected by the repair or by the winning of stone from borrow pits.

4.4.6. Grouse Moors

Six (12%) of the interviewees mentioned grouse moors in their responses. The view of many interviewees was epitomised by that of an estate owner: "*Management for grouse generally maintains heather cover, has a regular burning programme and low sheep stocking rate and thus tends to maintain the archaeological interest. It is of great economic importance in the uplands*".

However, three interviewees also highlighted the damage caused by the shooting industry, particularly in the North West. The main points raised were the damage created by the infrastructure of grouse moors, the construction of grouse butts in inappropriate places like mine shafts, and the robbing of monuments and the digging of borrow pits for their construction. Similarly, the establishment of shooting huts and roads on the moors is a significant issue in some areas.

One interviewee has observed an indirect change to the ecology of the uplands caused by the management of grouse moors, which is the removal of predatory animals by gamekeepers to protect the chicks. This leads to an expansion in the rabbit population, resulting in damage to earthworks through increased burrowing activity.

4.4.7. Agricultural Change

Five (10%) interviewees mentioned that the decline in traditional farming methods is already causing concern to archaeologists and that mixed grazing (two respondents) and traditional farming methods (three respondents) are important in the preservation of the historic landscape.

4.4.8. Wind Farms

Six (12%) of the interviewees expressed concern or reservation about the impact of the construction of wind farms. Firstly, damage caused by the footprint of the turbines can be significant, however access roads and construction work can result in more extensive damage to the historic environment. When surface vegetation is damaged, the natural drainage patterns are altered and this increases the risk of erosion and the potential loss of the archaeological record. Concern was expressed about the siting of wind farms on peatland landscapes in particular, as this can cause disturbance to the natural drainage.

One respondent also expressed concerns about the possible damage to the historic environment through cable laying and pipelines, and the lack of resources to properly control the activity. The archaeological curators in the South West are concerned that wind farms are being built around the edges of the moors and that these are affecting key views on Exmoor, Bodmin Moor and Dartmoor, and adversely impacting on the historic landscape character.

4.4.9. General Comments

The questionnaire (Appendix 2) allowed for further comments to be made by the interviewees. Many of these relate to education, policy-making and the general management of the uplands, and are summarised below.

One issue that was mentioned by six (12%) of the interviewees was the lack of awareness of the historic environment. Two of those interviewed felt that this could be improved by education, five (10%) by the prioritisation of historic landscapes (PALS - Section 5.4 e.g Dartmoor), and one by the integration of the historic environment into management plans. The designation of the historic environment and archaeological sites was thought by three respondents to have less strength than that for Sites of Special Scientific Interest (SSSIs) and this needed to be increased. One land manager cited the absence of good, easily accessible records as being a problem and another said that there needed to be better communication between agencies with regard the management of vegetation in the historic environment.

One respondent highlighted the need to remember that the uplands are a living landscape and that in some cases it is not always possible to avoid some damage to the historic environment. However, two interviewees thought that the historic environment and the palaeoecology needed to be well recorded where damage might occur. Finally, four respondents referred to the need for better funding to enable the safeguarding of sites and to encourage the conservation of the historic environment.

5. CASE STUDIES

Four areas were selected as case studies. The first was Fylingdales Moor, in the North York Moors National Park. This study was chosen as an example of the vulnerability of the historic upland landscape in an area of heathland with organic soils, an area subject to only minimal land management over many years. This lack of land management was thought to have contributed to the spread on an accidental fire, when gorse beside a lay-by caught fire, causing significant damage to historic sites on the moor. The sources for this study were Vyner (2005), Neil Redfern, of English Heritage, and Graham Lee and Rachel Pickering of the North York Moors National Park (Philip Bull, pers. comm.).

Anglezarke Moor, Lancashire, was selected as the second case study area in order to examine a more typical area of burnt moorland as Fylingdales Moor, is considered an exceptional case. The study encompasses an area of moorland that had been managed by United Utilities, and was the subject of both controlled burning and extensive wildfires. It is also an accessible area containing important archaeological resources (Howard-Davis, 1996). As part of this study, ADAS and OA North have relied extensively on the considerable knowledge and expertise of Ian Harper, the United Utilities Wildlife Warden for the moor.

The third case study was the Langdale Fells, in the Lake District National Park. Here the landscape is very varied, with steep craggy hillsides partially covered by thin mineral soils and a gently rolling, high, peat-covered plateau. Sheep intensively grazed the area before the outbreak of foot and mouth disease in 2001, and today there are very high visitor numbers of both walkers and climbers. A combination of sheep, people and heavy rainfall has led to severe erosion of both the mineral and peat soils in an area where the historic landscape is of international importance. The sources for this study were the Langdale Erosion Research Programme (LUAU, 1994), the Upland Peat Project (OA North 2009) and Jamie Quartermaine, OA North (pers. comm.).

The fourth and final area was the Dartmoor National Park, selected as an example of one direction that the conservation and management of the upland historic landscape could take. The sources for this study were the website for Dartmoor Vision, Debbie Griffiths of the Dartmoor National Park, Bob Middleton of Natural England, and Sandy Gerrard and Vanessa Straker of English Heritage.

5.1. Fylingdales Moor, North York Moors

In the late summer of 2003, an area of some 250ha of moorland on Fylingdales Moor, North Yorkshire, was affected by fire. The fire destroyed an unknown quantity of archaeological artefacts and information including organic remains, which are generally rare in the United Kingdom. However, the fire also revealed large numbers of previously unknown and unrecorded archaeological monuments.

This rich archaeological record encompassed all periods, from internationally important prehistoric rock art (Plate 4) and Bronze Age funerary monuments, to late twentieth-century geological boreholes, with the extracted cores lying alongside them. There was considerable evidence of military activity from the post-medieval period, including militia camps, Second World War dugouts, and spent ammunition, demonstrating that the area has been used as a military training ground for a considerable period. Some of the archaeological remains were more ephemeral, such as striations on the ground, which have been interpreted as the cut marks where the thin peat was removed for fuel, and also the associated wheel ruts (N Redfern, pers. comm.). Similar features have been identified from aerial photographs in the Upper Derwent Valley, Derbyshire (Ardron, 1999).

5.1.1. The causes of the fire

The fire was caused when someone set fire to rubbish in a lay-by in September 2003, which subsequently set light to gorse at the roadside. The severity of the fire was exacerbated by a strong wind, causing it to spread rapidly over the moorland, burning the stands of mature heather. Fylingdales Moor, unlike many moors in North Yorkshire, had not been managed for grouse shooting over the previous ten years, and had been left ungrazed since the Second World War (R Pickering, pers. comm.). This minimal management had resulted in a mature woody heather growth which, after a dry period, was easily ignited. At the same time it provided an abundant fuel which resulted in an intense fire. This resulted in the burning of not only the surface vegetation, but also the underlying organic soils and peats, thereby exposing archaeological remains.

5.1.2. Consequences of the fire

Once alight, the fire burnt for five days. It was gradually brought under control when helicopters were brought in on the third day, but some areas continued to smoulder fifteen days later. The shallow peat / thin organic soil was completely destroyed, leaving a layer of ash above the mineral substrate. Conversely, the wet valleys and areas of short heather remained unburnt, and on some localised areas of the moor there was a rapid regeneration of cotton grass only thirteen days after the fire. This suggests that, although the wind exacerbated the fire, it also prevented it from becoming too intense in some areas.

Following the fire, dust and ash was blown off, and the charcoal substrate was either blown or washed off rapidly (R Pickering, pers. comm.) (Plate 5). Within the first month, heather bales were placed in the gullies to stabilise them, and to try to relieve the threat of erosion. In the spring of 2004, following a rapid archaeological survey (Vyner, 2005), 60% of the most vulnerable burnt areas were re-seeded with nurse grasses, *Agrostis* (bent grasses), and *Lolium perenne* (rye grass), although the latter was not successful. In some areas of the moor, where the vegetation was completely destroyed, a hard crust developed as a result of bitumenisation of the surface, which is thought to have inhibited restoration work. Subsequently, heather brash has been used in these areas to help soften this and thereby aid germination. The National Park Authority has been surprised at the speed of natural regeneration of the heather in the less intensively burnt areas.

Unfortunately, the northern slopes and valleys of the affected area are still actively eroding, but in the long term, the ecologists are cautiously optimistic about the restoration of most of Fylingdales Moor. The archaeological remains though once exposed, were severely damaged by wind and water erosion, before the land was eventually stabilised. The impact on the historic environment was considerable, as archaeological remains are unique and irreplaceable and, once lost, cannot be recreated. In addition to damage to the physical survivals of the fire, an unknown quantity of archaeological artefacts and organic remains were destroyed. Although a rapid survey was carried out across the moor (Vymer, 2005) there was no more detailed assessment of the impact of the fire on the individual components of the historic environment.

5.1.3. Lessons learned

Although both the archaeologists and ecologists recognised that stabilising the landscape was the main priority following the fire, there were some factors where there was a conflict of interest. The need to record and map the archaeological record countered the need to stabilise the damaged landscape, which would have obscured the historic environment remains. The close working relationship and co-operation between the two disciplines resulted in an impressive recovery of large areas of the moor, whilst also enabling an archaeological survey. Following a fire, the North York Moors National Park Authority and English Heritage recommend the following:

- an immediate programme of aerial photography, incorporating both oblique and vertical images to record the surface remains of the historic environment
- a rapid field survey to record and verify features shown on the aerial photographs

At Fylingdales, the timing of the latter caused some concern to the ecologists, who could only put heather brash down between November and January. The archaeological survey was further constrained because seeding could only take place in April and May, and therefore all survey work needed to have been completed by then.

In retrospect, and accounting for the availability of modern technologies, it was recommended that in the event of a serious fire on this scale, an airborne high-resolution LiDAR survey be commissioned as a matter of urgency before the archaeological remains can erode.

The aftermath of the fire has demonstrated that ongoing consultation between all stakeholders, including, in this case, members of a Court Leet (or those that hold common rights), is essential for damage limitation and the restoration of the moor. One simple example of this is the necessity for other agencies to recognise that machinery not only causes extensive damage to the exposed fragile soil, but also to archaeological sites.

At Fylingdales, the various agencies joined together in helping to stabilise and restore the moorland environment as quickly as possible, thus preventing further damage to the archaeological record and the environment. Rachel Pickering, of the North York Moors National Park Authority, stated that they were only able to carry out such an extensive programme of re-seeding due to English Heritage, who donated more than half of the total cost. As a direct result of the fire, the North York Moors National Park entered into a Wildlife Enhancement Scheme with English Nature (now Natural England), for the whole area of Fylingdales Moor (2700ha). This will initiate a programme of preventative measures to help reduce the likelihood of a further major fire on the moor. This includes the creation of firebreaks, where the vegetation along a 30 metre wide corridor will be kept cut, and cutting of roadside verges. Natural England has bought a small fire tender to go on the back of a quad bike, which it is hoped in future will provide a rapid response to fire outbreaks. The catastrophic fire on Fylingdales Moor has brought together the National Park Authority, English Heritage and Natural England with a common purpose of restoring and protecting an area of moorland for future generations.

Perhaps one of the main lessons learnt is the possible consequence of leaving an area un-managed by either grazing or controlled burning. The impact of the fire could have been reduced, even under drought conditions, if there had not been an abundant fuel source. As a result the fire would not have been as intense and the archaeological remains would not have sustained as much damage.

5.2. Anglezarke Moor

5.2.1. Topography

Anglezarke Moor, along with the adjacent Rivington Moor, comprises an area of approximately 37km^2 of unimproved moorland, forming a substantial western outlier to the South Pennines. The area is largely at a lower elevation than the main bulk of the Pennine chain, with heights of between 200m and 380m AOD. The Anglezarke-Rivington outlier is well defined, bounded to the east by the South Pennines, and to the west by the low-lying Lancashire coastal plain. The urban conurbation of Greater Manchester is situated to the south, while the northern side is bounded by lower lying farmland and the industrial town of Blackburn.

Topography is a mixture of plateau moorland and stepped hillslopes, resulting from differential weathering of the interleaved soft shales and mudstones and harder sandstone. Unconsolidated Newer Drift Boulder Clays and blanket peat overlie these, and for the most part dictate the drainage of the upland plateau.

5.2.2. Causes of erosion on the moor

Anglezarke Moor is heavily eroded as the result of a succession of damaging fires, of which the first was documented in 1958 in the area of Stronstrey Bank. This was followed by a series of severe fires in the late 1970s and early 1980s, which prompted archaeological surveys of 1983 and 1985 (Howard-Davis, 1996). In 2003 there was a further major fire on the western slopes of Anglezarke Moor and another in 2007 (Ian Harper, pers. comm.). These two fires, both the result of deliberate uncontrolled burning, originated on the eastern side of the moor at Bromleys Heys (NGR SD 667178 centred) close to the A675 on the Belmont road North West of Bolton, Greater Manchester. Following on from the fires, the exposed ground has been subject to considerable water erosion and there are extensive areas of exposed mineral soil, where there has been little or no recovery of peat development or vegetation cover.

The area still continues to be particularly prone to uncontrolled fires, of which most are brought under control by the fire services. However, the small moorland fires rapidly become major fires and cause enormous damage to the landscape if the vegetation is unmanaged. Particularly if there are drought conditions and strong winds. The large numbers of moorland fires reflects that this moor and those around Manchester are in close proximity to urban centres, are subject to considerable visitor pressure, and in some instance the fires are a result of arson (Ian Harper, Steve Heath and Steve Yeardsley, Manchester Fire Service, pers. comm.).

In contrast, the higher areas of the moor with deeper peats were until recently managed as a grouse moor by controlled burning. This controlled burning was introduced in 1994/5 by United Utilities, the major land owner. In addition, the area has been subject to artificial drainage particularly feeding into Black Brook (Plate 6). These drainage channels have formed gullies on the lower slopes (Plate 7) and this erosion still continues to widen the drainage channels.

5.2.3. Archaeology

On Anglezarke little modern archaeological investigation had taken place prior to the survey conducted in 1983-5 by the Lancaster University Archaeological Unit (Howard-Davis, 1996), however like most of the Central Pennine Chain, it has been scoured by flint collectors. A wide-scale programme of flint collecting was undertaken by John Hallam, in conjunction with the Chorley and District Archaeological Society, during the 1950s and early 1960s (*op cit*, 138). This work examined areas of peat scarring from across the moor, and significant sites included an assemblage of 11 flakes of Mesolithic date from the eroded surface of the large Round Loaf mound (SD 637182), a glacially deposited drumlin.

The survey in 1983-5 found that the main sources of lithic material (Howard-Davis, 1996) were on Stronstrey Bank, and on the steep slopes of Black Brook. The lithic sites in the former area had been exposed as a result of a moorland peat fire in 1958, and surface collection was reinforced by a small excavation (SD 619178), producing an assemblage of 317 lithics ranging in date from the Mesolithic period to the Bronze Age (*op cit*, 143).

The Black Brook material was from a localised area of peat scars, adjacent to an offshoot gully feeding into Black Brook (*ibid*; Sites 36-8). The assemblage comprised 400 lithic artefacts that were all of Mesolithic date, and appeared to represent three small working floors.

A more recent transect survey in 2003 by OA North (OA North 2009) has identified new sites, again found in areas of erosion, and for the most part in the westernmost quarter of the transect, which had been affected by the 2003 fire. These areas were all on Stronstrey Bank, which is a flat-topped, generally well-drained natural bench, raised above the adjacent coastal plain. This type of landscape is commonly found to have been exploited in the uplands in the prehistoric period, notably in the western uplands of the Lake District, which are extensively covered with cairnfields (Quartermaine and Leech, forthcoming). On Anglezarke Moor the loss of peat cover caused by the various wildfire episodes has exposed a number of cairns, which are evidently part of one large, or even a number of smaller, cairnfields. This area of cairnfield, one of only two documented in Lancashire, is set in close association with a prominent elliptical kerbed cairn at Jepsons Gate at the southern end of Stronstrey Bank (Howard-Davis, 1996) and also a chambered round cairn (Site 40; *ibid*) at the northern end of Stronstrey Bank. Although much of the area is still covered by peat, it is evident that this is one of the more important prehistoric landscapes in the region.

Generally, the western part of the transect surveyed has suffered far greater erosion than the central and eastern parts, thus exposing more sites. The fact that lithic material was also recovered from the eastern part of the transect demonstrates prehistoric activity in the area, but as the erosion scars were scarcer, fewer sites were exposed. The finding of these new sites does not reflect previously lax investigation, as both the 1983 and 1985 surveys had independently and intensively examined the same area. That these sites were identified in 2003 indicates that they have subsequently become exposed as a result of fire episodes and on-going water erosion.

In effect, the finding of these new sites, which is almost half the number previously identified from the area, provides an indication of how much erosion has taken place since 1985, and hints at further exposure of archaeological remains if the erosion continues unabated. The 2003 survey also examined the previously identified resource and discovered that a number of sites recorded in 1985, have been lost to erosion. This includes elements of what was believed to be a medieval settlement, including long houses and enclosures, near Jepsons Gate, which had been constructed on the peat. The site has now been extensively degraded and although it was of stone construction, much of the stone has washed down the slope.

The significant archaeological remains are inevitably around the lower margins of the moor, where the land was historically of better agricultural quality than the higher land. Peat inception was often at a later date on the lower slopes, and so the peat cover is less by comparison with the higher moors. These areas are most vulnerable to impact by fire, because the sources of fire are invariably close to roads and access points around the margins, and the thinner depth of peat is more vulnerable to severe fire. It is an unfortunate reality that areas of greatest archaeological potential on Anglezarke Moor are where fires are likely to be a very significant issue.

5.2.4. Palaeoecological record

An integral part of the 2003 survey by the Upland Peat Project was a programme of coring, pollen analysis and radiocarbon dating. The evidence from this study, alongside the earlier work of Bain (1991) and Barnes (1996), suggests a number of episodes of human modification of the vegetation. The first of these became most marked after *c* 2850 BC, and coincides with deterioration in soil conditions, and the development of a woodland mor-humus on the central plateau of Anglezarke Moor. These three studies also recorded peat depths at a number of locations on the moor thus providing a known baseline for future studies.

Interestingly, radiocarbon dates from the surface of the peat (OA North 2009; Bain 1991) highlighted a number of points about the history of Anglezarke Moor. Firstly, up to 1000 years of palaeoecological history has been lost or failed to develop in the area of deep peat, which was probably a result of peat cutting. Secondly, it is also an area that has been subject to repeated 'controlled' heather burning. A recent study on carbon sequestration in a Pennine blanket bog (Garnett *et al.,* 2000) suggests that there is evidence for a net reduction in peat accumulation, caused by rotational burning. Unlike accidental fires (which can damage vast areas of the peat matrix itself), managed burning rarely removes all former vegetation (*ibid*).

The radiocarbon dates also showed that although the surface of the peat on the periphery of Anglezarke Moor appears slightly younger than that from the central plateau, a comparison of its depth and the date of peat inception implies that potentially over 1.50m of peat is missing, indicating a break in the environmental record of up to 4000 years. Whether this is due to former peat cutting, rather than water or wind erosion, is unclear. However, a consistent record of truncation and re-growth within the stratigraphy and pollen evidence is apparent. It is possible that the peripheral area of Anglezarke Moor has suffered a long history of severe peat loss, possibly originating in the medieval period. The documentary data also indicate that this peripheral area of the western part of Anglezarke Moor has been subjected to a number of uncontrolled fires, thus exacerbating an already dwindling resource (OA North 2009).

5.2.5. Management of the Moor

United Utilities, a major upland landowner in the North West, has produced guidelines for heather burning, after the spate of uncontrolled fires in the early spring of 2003 (United Utilities 2004). The code stresses that all heather and grass burning must comply with the *Heather and Grass Burning Code* (MAFF, 1994, Defra, 2007), and alongside the more obvious restrictions of dates, time and safety, the code requires permission from Natural England for burning on SSSIs, and that English Heritage must be notified if Scheduled Monuments are on the site or in the vicinity. United Utilities has also instigated additional requirements when burning is practised by their tenants. These requirements are stringent and are sensitive to many aspects of the upland environment, both physical and biological. Particular reference is made to firstly, burning along contour lines to help minimise erosion on slopes, and secondly, to avoid peat hags, blanket mire and bracken stands (burning of the latter tends to encourage its competitive regeneration to the detriment of other plants). Finally, they require that the wildlife warden keep a detailed record of any burning activity.

However, United Utilities subsequently revised their views on controlled burning because of concerns about contamination of water supplies, and in 2005/2006 introduced a policy of managing the heather by cutting (Ian Harper, pers. comm.). This is part of the Sustainable Catchment Management Programme (ScaMP) and endeavours to work with all interested parties in the way United Utilities manages the land that supplies water to the reservoirs in the North West. Unfortunately, this policy is proving difficult to implement as a number of the tenants have signed up to Countryside Stewardship schemes, which on Anglezarke Moor prevent the cutting of heather. Discussions between tenant farmers, Natural England and United Utilities should resolve this issue in due course.

Alongside the actual management of the moor, United Utilities has drawn up fire-fighting plans for a wide area, which includes the West Pennine Moors (United Utilities, 2004). This includes maps of individual sectors with access points, locked and unlocked gates, tracks and other fire related information that might be needed in the event of a fire. A generic plan for managing uncontrolled moorland fires is being produced (Ian Harper, pers. comm.). The awareness of how devastating uncontrolled moorland fires can be to the historic environment and the forward planning should help prevent further serious damage to Anglezarke Moor and the known and buried archaeological resource.

United Utilities has also introduced a policy of grip blocking on the moor to combat the enormous amount of erosion that has been, and is continuing to be, caused by the drainage channels. They use blocks of peat to block the grips and inhibit the flow of water, which are cut from the peat away from the grip. They only employ specialist contractors to carry out this work (Ian Harper, pers. comm.). On Anglezarke Moor this is considered to be the most efficient method of grip blocking. However elsewhere (South-West England in particular), there is concern that both the archaeological and palaeoecological record preserved in the peat is lost when this method is used (Vanessa Straker, pers. comm.).

The management of vegetation on Anglezarke Moor and the conservation of the historic environment are closely linked and United Utilities are faced with a balancing act between livestock levels, water quality, agricultural tenancy agreements and conservation requirements (Ian Harper, pers. comm.). It is further complicated by Anglezarke Moor being an access area with 53 access points and 50 Rights of Way, and lying within easy reach of a number of major towns in East Lancashire and Greater Manchester. United Utilities has already noticed that Open Access is leading to increased footpath erosion, surface erosion, the loss of surface vegetation. Other access issues include the abuse of the moorland by unauthorised motorcycle and mountain bike use, and an increase in accidental/ deliberate fires (Ian Harper, pers. comm.). With current rates of erosion and loss of surface vegetation, if continued, could lead to further exposure and damage to the historic environment in the uplands of East Lancashire.

Anglezarke Moor is an area which is primarily managed by United Utilities to ensure water quality, although their management strategy is also generally compatible with the preservation of the archaeological resource. However, despite this, the moor has been subject to a number of management issues in the past, which include forestry, direct visitor pressure, drainage, and fire. The one issue that poses the greatest concern for those managing the historic environment is the risk of fire. The complete prevention of moorland fires is in practical terms an unachievable goal given the location of the moor within easy access of several large towns, but preventing them from developing into wildfires is feasible. There are a number of strategies that can achieve this, by the creation of fire breaks, by reducing the amount of fuel (vegetation) available for burning, and by improving the responsiveness of the fire services. It is recognised by all the agencies that a combination of these techniques will be necessary to prevent further archaeological and environmental damage on the moor.

5.3. Langdale Fells, Lake District National Park

This study area lies in the Central Lake District where the landscape is very varied, with steep craggy hillsides covered by patchy thin mineral soils and a gently rolling, high plateau covered by peat. A combination of sheep, people and heavy rainfall has led to severe erosion of both the mineral and peat soils. The landscape is of international importance as it is the site of the Neolithic Axe factories. These axe factories have been found across the British Isles, indicating the significance of the industry during the Neolithic period and the importance of the axes as items of trade or status . This importance is directly related to the geology of the area, which is dominated by the igneous rocks of the Ordovician period (500 to 440 million years ago) and is known as the Borrowdale Volcanic Group. This Group comprises of a series of mainly volcanic rocks, including lava flows, tuffs and agglomerates (Taylor *et al.*, 1971). The hard form of this geology has contributed to the elevated and rugged character of the mountain landscapes in the central Lake District. It is also the source rock for axe manufacture, a fine-grained tuff of the Seathwaite Fell Tuffs, itself an upper band of the Borrowdale Volcanic Group (Claris and Quartermaine, 1989). Although originally laid down as a horizontal band, the strata now slopes down at 45^{o} to the north and outcrops mainly on the faces of Pike O'Stickle and Harrison Stickle in the Langdale area. The strata has been eroded by glacial action (detached blocks of the tuff being present within morainal mounds), and as a result of more recent frost fracturing, scattered within the scree across the northern slopes of the Great Langdale valley. The tuff, which has the same mechanical properties as flint, fractures conchoidally, and can be worked by hand in a regular and controlled manner and is therefore an ideal material for making sharp stone tools.

The doming of the Palaeozoic rocks of the central fells in the Tertiary period (Pennington, 1978) played a major role in the development of its radial drainage pattern, which was enhanced by subsequent glacial activity. This formed the major glacial lakes and valleys (including Langdale) that radiate out from the centre of the Lake District (Pennington 1978 and 2003). Due to the high relief and good drainage of the central fells, peat development has been hindered, and tends to occur mainly on the gentler slopes of the north and on the West Cumbrian coastal plain. It appears that peat development occurred in the central uplands on the flatter areas in the second half of the post-glacial period, but was initially confined to shallow basins and areas of impeded drainage (OA North, 2009). It is likely that this peat development was initiated during the long period of human activity on the central uplands and in Langdale during the Neolithic period, and was largely associated with axe production. The clearance of the trees in the uplands during the Mesolithic and Neolithic, which in Langdale is associated with the Neolithic axe factories led to an accumulation of acid humour or mor. The development of the mor-humus itself, plus the presence of an iron pan at the base of the peat would have inhibited vertical drainage and facilitated the development of blanket mire (Birks, 1988; OA North, 2009).

5.3.1. Causes of erosion

The whole of the upland landscape of the Langdale Fells is highly eroded, and footpath erosion has been recognised as a major problem with regards to the management of the peat and archaeological sites, although the mechanisms involved were little understood until the Upland Peat Project (OA North, 2009). The Langdale Fells are renowned by hillwalkers and the pathways taken by walkers are well mapped and tend to follow higher ground between the peaks, which, by their very nature, avoid areas of deep peat deposits. It is the footpaths that cross the valley in the southern part of the Langdale Fells, between Harrison Stickle and Pike O' Stickle (NY 277074) that have caused the most damage to the peats (Plate 8). The effect of footpath erosion alone is usually limited to the path itself, although in areas where footpaths cross areas of deep peat or drainage features, the damage can be extensive. The damage is especially marked in the relatively steep-sided valley between Pike O'Stickle and Harrison Stickle, and is also very prominent on the footpath north towards High Raise, where it crosses *c* 0.50m of peat. Many of these paths extend over axe-production sites, which are therefore subject to direct impact. Footpath maintenance has also had a considerable impact on the axe-working remains and has necessitated excavations in advance of footpath repairs, notably at Site 123 behind Loft Crag (OA North, 2004). However, the construction of a sacrificial pitched path, whilst affecting some archaeological sites, has had the considerable advantage of channelling visitor traffic along a defined route and prevented the spread of erosion. Similarly, on the southern shoulder of Harrison Stickle and the nearby Thorn Crag, the erosion scars prior to footpath repair had been up to *c* 20m across, which have now been narrowed to a constructed path that is less than 1m wide (LUAU, 1994). Both footpath schemes entailed archaeological excavation in advance of the repair works to record sites that would be destroyed by their construction.

Although the effects of footpath erosion and maintenance are apparent in Langdale Fells, it appears that other, much more widespread, processes are also serving to erode the peat. These processes were most marked where the deepest peat deposits were encountered, thus making the erosion scars more visible. The effects of what appears to be drainage erosion and natural wastage, though, are much more widespread. Peat hags of up to 2m deep have developed and have significant gullies. In a number of places, drainage channels have developed at the base of the peat, which has caused the surrounding deposits to slump. This type of drainage erosion is considered common in areas of peat, overlying drift-covered limestone, where natural sink-holes have developed. Although it is unknown how common the process is on other substrates (OA North, 2009). Towards the centre of the transect studied by the Upland Peat Project, just south-west of High Raise, the valley widens, and on the westerly-facing slope, the erosion pattern takes on a slightly different form, with many of the scars running along the slope (as opposed to up/down the slope as is common with gully erosion). It is possible that these scars developed as a result of peat slumping and subsequent erosion at the break of slope, although the process of peat cutting cannot be ruled out.

The Upland Peat Project was concerned with the Langdale peatlands (OA North, 2009) but the Langdale Erosion Research Programme (LUAU 1994) was established to research the causes of the severe erosion leading to slippage of the axe factory deposits on Top Buttress, on Pike O' Stickle, the largest surviving Neolithic axe factory. This programme highlighted the severe damage that intensive sheep grazing has had on the vegetation of the Langdale Fells on both the peat and mineral soils. The damage was most marked on the stands of heather and bilberry, as sheep tended to ignore the tough grasses and sedge now prevalent in the area. The effects of trampling and the creation of sheep paths (trods) were also seen as being causative factors in erosion processes. It is known from the pollen record that heather was much more widespread in the Langdale Fells at certain points in the past (Walker, 1965). Therefore, if heather has been specifically targeted by sheep on sites where suitable forage is limited, it is possible that periods of overgrazing have exposed both peat and mineral surfaces making them more susceptible to weathering and drainage erosion. As in the past, severe winter conditions and high rainfall in the fells may cause the loss of exposed archaeology.

South Scree, adjacent to Pike O' Stickle, was the largest of the axe factories and was well publicised from the time of its initial discovery (Bunch and Fell, 1949). It has been susceptible to considerable visitor pressure by people searching for rough-out axes and was also used as a rapid scree-run route down to the Mickleden Valley. These activities removed the protective vegetation cover and the area then became susceptible to flash floods. The floods caused significant damage to the axe-factory deposits in the 1950s (LUAU, 1994). Since then, continued pedestrian erosion and flooding has resulted in the complete destruction of the axe factory site (Plate 9). In part, the demise of the site reflects its distinctive topographical position, but nevertheless lessons need to be learnt from this instance to prevent further losses of important sites.

5.3.2. Erosion repair and prevention

The Langdale Erosion Research Programme (LUAU, 1994) also undertook an experiment to cover with turves part of a further axe-factory site on Harrison's Stickle, which was similar to that on Top Buttress. This proved to be successful and it was recommended that this technique be used as a basis of repair work on Top Buttress. However, bilberry rather than grass is the dominant species and further experimental work may be necessary to see if the technique can be applied successfully (Halliday, 1994). It was recommended that this repair work should be carried out with a reduction in grazing (with fencing) on a temporary basis and in the long-term, by a permanent reduction in stocking levels. The worst areas of sheep erosion were on the very steep ground of Top Buttress. However, Evans (1994) considered that this area was marginal for sheep grazing and that a reduction in sheep numbers on the fells would quickly favour the recovery of the grass. He thought that the introduction of the ESA schemes would lead to a reduction in sheep numbers. More recent changes to the Single Payment Scheme have encouraged the decrease and the foot and mouth disease outbreak in 2001 contributed to redressing the problems of overgrazing. The effect of this reduction in grazing pressure has been that grass is now growing over the Top Buttress sites, which are stabilising and thus protecting the archaeological resource.

5.4. Dartmoor National Park

The approach of Dartmoor National Park is perhaps an example of one potential strategy for the conservation of the upland historic landscape. Many of the threats identified as significant on Dartmoor are common to all upland areas. The issue of long-term viability of hill farming and the tourism impacts of the outbreak of foot and mouth disease, highlighted the importance of management maintaining a 'Sense of Place' unique to Dartmoor (Dartmoor National Park, 2007). The most significant impact of the changes to agriculture on Dartmoor has been the reduction in grazing pressure, as a result of cross compliance and agri-environment schemes. Overgrazing had a significant impact on the overall vegetation characteristics of the moor (Debbie Griffiths and Vanessa Straker, pers. comm.) and the increasing spread of scrub and bracken had the potential to cause significant damage to the historic environment.

The Dartmoor Vision project came about in response to these changes and aimed to establish a coherent and equitable vision for Dartmoor over 25 years. The vision stated the contribution of farming in achieving that goal sustainably. In particular, farming communities were keen to have a clear vision for the landscape to guide management in a coherent and focused manner. In particular, there was the wish that management goals should avoid conflict between differing priorities for the local environment. To achieve an integrated vision for Dartmoor, a range of statutory agencies came together to discuss how they would like the moorland to look in 25 years. The agencies involved were: English Nature (now Natural England), English Heritage, the Rural Development Service (now Natural England), the Environment Agency, Defence Estates, the Dartmoor National Park Authority and the Dartmoor Commoners' Council.

To overcome conflicting management priorities, landscapes were identified which best represented the character they wished to preserve. Premier Archaeological Landscapes (PALs) were identified as sites where the interests of the archaeological heritage were paramount (Dartmoor National Park Authority 2009). This meant that all other management considerations were secondary within these sites. This provided a clear focus to land managers who previously may have had conflicting goals for management. The Management Plan for Dartmoor (Dartmoor National Park Authority 2007) identifies that many of the sites chosen as PALs contained features of national or international importance. The range of PALs was intended to represent the range of current and past uses for the landscape which contribute to its unique nature and the sense of place it engenders in people who experience it.

PALs differ from other historical designations because the focus is on the landscape, preserving both the individual features and landscape within which they derive their context. They are a focus both for management and research encompassing the fourteen most significant archaeological sites within the Dartmoor National Park. The ambition for PALs is to bring the landscapes into active management, with criteria identified to inform condition assessments. Management plans dictate the appropriate management needed to bring each of these sites into good condition.

The most important feature of the Dartmoor project was the interaction with the wide range of stakeholder groups to identify priorities for management. In the interviews conducted for this project, several referred to the importance of identifying key focal points to guide specific management effort and to preserve landscapes, thus moving away from blanket preservation with generalised goals. This encourages archaeologists to identify discrete units and has the benefit of focusing effort and funding. However, it is recognised that often the designation as a PAL is insufficient to secure long-term management goals, and that archaeological priorities still struggle to maintain significance compared to the well-supported and documented ecological designations. In particular, it was felt that archaeology would benefit from similar European designations and national public service agreement targets (Debbie Griffiths, pers. comm.) as those for biodiversity interests.

In particular, it is recognised that while archaeology fails to attract legislation and designation, it also fails to attract sufficient funding. This is an ongoing threat where the lack of funding and the changes to agriculture are seen to lead to restricted management and in many areas the unchecked development of bracken and scrub.

6. DISCUSSION

The purpose of this section is to bring together the results of the literature search, the interviews and the questionnaire, and to identify knowledge gaps relating to the influence of vegetation and its management on the upland historic environment. Reference is also made to the management tool, which was designed by ADAS and OA North to advise land managers on the best practice for the conservation of the upland historic environment.

The main issues for the conservation of the upland historic environment are:

- Lack of information on the archaeological/historical resource in the landscape, which is exacerbated by an emphasis on individual sites and features, with insufficient consideration of their context and the value of the historical landscape as a whole.
- There is often a lack of dialogue between archaeologists and ecologists and archaeological issues are often not fully considered in preparing landscape management plans.
- There are gaps in our knowledge of the extent of some of the threats to the historic landscape, and the most appropriate way to manage these.

From the above issues, it is evident that there is a need for a much more integrated approach, which should give due weight to all aspects of the landscape. It is essential that we understand what is valued most and that conservation happens more often on the landscape scale and less often on the point scale. The benefit of this approach is that historical features are seen as part of the wider picture. This is important as the visible remains can be like icebergs, in that the visible element of a monument can be a relatively small part of a much bigger buried resource, and because there is a need to preserve the context for a monument as well as the observed physical remains.

There will only be effort to preserve the historical environment if the landscape is sufficiently valued. We therefore need to increase the baseline assessment of historical value (similar to the Baseline phase 1 data, the Land Cover Map and the Countryside Survey 2007 www.countyrsidesurvey.org.uk). There is a need to define areas (landscapes) of particular historical value, where the historical aspects would be important when considering land management, as is the case in the Premier Archaeological Landscapes (PALs) designated on Dartmoor (Dartmoor National Park Authority 2003).

The key issues arising from the interviews and the literature search are outlined below. One important point is that a single issue can seldom be viewed in isolation, as different management practices will interact with one another in impacting on both vegetation and the historic environment.

6.1. Vegetation Issues

6.1.1. Heather/ Grass

The literature search identified no studies specifically related to the growth and control of dwarf shrubs and its effect on the historic environment. Where dwarf shrub heathland was mentioned, the references indicated that it can help stabilise the underlying substrate and reduce the potential for erosion.

The results of the questionnaire have shown that the stakeholders had few concerns about the growth of heather damaging the historic environment. However, the management of heather was considered to be important in the conservation of the historic environment, in relation to excess growth providing a fuel source in the event of fire. These issues are discussed further under the various types of management regimes.

Upland grassland is generally beneficial to the historic environment. Providing a relatively stable cover is maintained, there should be minimal risk of direct damage from rooting systems.

The results of the questionnaire have shown that the stakeholders had few concerns about the growth of purple moor-grass directly damaging the historic environment. However, expansion of this species of grass has been observed when grazing levels are reduced. It was reported that the grass can obscure historical sites and make access difficult, although no documented evidence for this emerged from the literature review.

6.1.2. Bracken

The literature search identified two studies, which were specifically related to the growth and control of bracken and its effect on the historic environment. This research included data about the depth and lateral spread of the rhizome system and the potential disturbance to the underlying stratigraphy, which diminishes the value of the deposits for archaeological and palaeoenvironmental research. Damage is also caused to buried archaeology due to changes in soil chemistry.

Bracken encroachment was one of the greatest concerns of the stakeholders in the questionnaire. Bracken obscures and damages both the above and below ground archaeology. The dense ground cover formed by the bracken provides shelter for rabbits and channels people and animals, so causing erosion and damage to the historic environment. Methods used to control the spread of bracken included spraying (probably the most effective), cutting, burning and trampling by cattle.

6.1.3. Trees & Shrubs

The literature search identified few quantitative data about the rooting characteristics of tree and shrub species, but studies from Britain and Ireland have recorded the type of damage to both structural and buried archaeology that such vegetation can do. Whereas trees and shrubs might help to inhibit erosion and so stabilise unconsolidated soils, the roots can cause the disturbance of archaeological deposits and a displacement of artefacts.

Information specifically related to gorse species (primarily *Ulex europaeus*) highlighted various risks including damage from roots, fire breaking out in accumulated litter, lack of site visibility and increased erosion due to the funnelling of livestock and rabbit burrowing. It also highlighted that burning of trees and shrubs can extend down to the roots and result in contamination of archaeological deposits. These issues were also major concerns of the stakeholders interviewed.

The results of the questionnaire identified concerns about scrub encroachment, re-wilding and the deliberate planting of trees as windbreaks. Scrub encroachment and increased vigour of scrub in some areas was thought to be related to reduction in grazing levels and climate change. Grazing levels and re-wilding are discussed further under management practices.

6.2. Management Issues

6.2.1. Livestock

The literature survey identified relevant research on the effect of livestock grazing on upland vegetation. The effects of grazing upland vegetation are dependent on many factors including the stocking regime, vegetation type and spatial distribution, physical environment and timescales. The intensity of summer and winter grazing by both sheep and cattle have been studied and grazing does appear to help maintain a range of upland heathlands and grasslands and prevent the establishment of trees, scrub and bracken. In terms of the historic environment, grazing is considered acceptable as long as the levels are such that the vegetation cover is not completely removed, causing an increased risk of erosion.

Sheep grazing has been studied, and it appears that if grazing intensity is light or moderate, it will help to maintain dry or wet heath vegetation and other upland plant communities. Heavier grazing can cause modification of the vegetation structure and can lead to erosion, as illustrated in the Langdale Fells case study.

Studies of cattle grazing have shown that the risk of trampling damage and erosion is much greater than with sheep grazing, especially on wet heath, blanket bog and other wet areas. Trampling by cattle or horses is sometimes used as a restoration technique to create bare ground and enhance the establishment of heather. However, the bare ground created presents a risk of erosion (until the heather re-establishes), which could lead to damage to the historic environment. Livestock trampling can also be used to help break down bracken litter.

Questionnaire respondents expressed concern that inappropriate positioning of feeding troughs was damaging the historic environment of the uplands. Historic sites are often located on areas of drier raised ground, which are also preferred sites for supplementary feeding and this can lead to disturbance of the sites both by animals and machinery. The grazing behaviour of cattle and sheep also differs, resulting in changes to vegetation composition. For example cattle selectively graze purple moor grass and this could improve visibility and access to sites where it had previously developed a dense, tussocky growth form.

The results of the questionnaire identified the importance of a well-balanced grazing regime in the uplands, including the optimum stocking levels for either a mix of sheep and cattle, or sheep alone. Both undergrazing and overgrazing represent considerable threats to the historic environment, although the latter is now becoming less of an issue following the introduction of the Single Payment Scheme, the 2001 foot and mouth disease outbreak and the effects of agri-environment schemes.

Reduction of stock numbers can allow recovery of vegetation in some circumstances, for example as seen in the Langdale Fells case study. The experimental exclusion of animals demonstrated that a balanced grazing regime is desirable, and it is now thought inadvisable to fence off monuments. This is very evident from the Anglezarke Moor case study, where there is now dense vegetation over the fenced-off Pike Stones Scheduled Monument, which obscures it from visitors and makes it vulnerable to fire.

Before the start of this project, OA North had been of the opinion that the historic environment was most at risk from overgrazing rather than undergrazing, but there has been a recognition in the results of the questionnaire that a lack of grazing can significantly increase the risk of fire damage (see the Fylingdales Moor case study) and result in the expansion of destructive plant types such as scrub and bracken. Many of the interviewees were also concerned about the result of undergrazing which, together with changing climatic patterns, is a significant issue. It has been noted that if grazing is removed or dramatically reduced, bracken, scrub and purple moor-grass expand, the consequences of which are discussed above. In Cornwall, an Historic Environment Action Plan (HEAP) specifically for Bodmin Moor considers the impact that reductions in grazing regimes (to encourage diversification of habitats through agri-environment schemes), will have on the historic environment interests on Bodmin Moor.

6.2.2. Burning

Controlled burning is commonly applied in the uplands to conserve heather for grouse production and to enhance forage quality for sheep. However, burning too frequently can alter the species composition of the vegetation and can reduce the above-ground biomass.

The controlled burning of heather was thought by stakeholders to encourage grass, and a shorter sward is considered to be very beneficial for the historic environment as it increases site visibility through the removal of tree and shrub seedlings.

The burning of bracken litter is used in restoration management to re-establish heathland or grassland vegetation. Evidence from the literature review pointed to damage and changes to the species composition of wet heath or blanket bog. Additionally, the controlled burning of blanket bog can result in the exposure of bare peat, increasing the risk of erosion and affecting bog hydrology.

The questionnaire identified that controlled burning was used extensively as part of vegetation management in the uplands. Concern was expressed about the consequences of a reduction of such burning and this indeed was one of the major reasons for the damaging fire in the Fylingdales Moor case study.

The literature review also identified studies that described the dangers of wildfires, leading to the exposure of large areas of peat. This type of event can be severely damaging to the historic environment. In general, uncontrolled wildfire was identified in the questionnaire as being one of the major problems for the historic environment. It is thought likely that the risk of fire will increase with a reduction in grazing and the predicted increase in spring and early-summer droughts as a result of climate change. The stakeholders considered that, unlike controlled burning of moorland vegetation, fire (whether started deliberately or accidentally), can be highly destructive to the historic environment.

6.2.3. Cutting

The literature search suggested that the cutting of heathland, grassland or bracken is likely to do little damage to the historic environment as long as disturbance by machinery is minimised. However, there were instances where mechanical damage to both the vegetation and the historic environment was recorded.

Many of the stakeholders reported that the cutting of heather, bracken, scrub and grass (including purple moor-grass) in the uplands was used as a management tool in their areas. The respondents stated that cutting was undertaken either by hand or mechanically and that they had observed occasional damage to the historic sites as a result of mechanical cutting.

6.2.4. Other Mechanical Operations/ Disturbance

Mechanical operations are sometimes advocated for removing extant plant material or creating bare ground as preparation to restoring heather in the uplands. Although the outcome of these operations in the long-term might have some benefit to the historic environment in re-establishing benign vegetation cover, the physical disturbance involved is considered detrimental and the persistence of bare ground increases the risk of erosion. Raking to remove litter is less likely to be damaging as long as the level of mechanical disturbance is minimised.

The questionnaire identified the use of vehicles as another cause of damage to the historic environment in the uplands. Similarly, the use of machinery for grip blocking was frequently cited as a cause of concern by both the archaeologists and palaeoecologists. Vegetation management often requires use of quad bikes or All Terrain Vehicles (ATVs) to gain access to supplementary feeding areas and for stock control. If concentrated or incorrectly placed, this can cause considerable disturbance to historic sites. Disturbance could however, be mitigated in some cases by varying access route and by moving supplementary feeding sites around, subject to advice from archaeological advisers.

6.2.5. Plant Introductions

The literature review identified a number of studies relating to plant introductions in the uplands as part of habitat restoration schemes. These include many studies on seeding to accelerate the growth of new plants in different plant communities, although the effects of seed addition are sometimes small or short-term. The establishment of grasses after bracken control can also be accelerated by seed addition and will be very beneficial to the historic environment. However, only one incidence of re-seeding was reported as being of concern in the questionnaire, but this was related to the potential damage resulting from the harvesting of heather brash at the donor site. In contrast, a number of stakeholders believed that the present trend of re-wilding by plant introductions (especially trees) is to be discouraged as it damages the historic environment.

6.2.6. Chemical inputs

The literature review identified many studies about the use of herbicides in the uplands. Herbicides have been tested to control purple moor-grass on moorland but the effects are usually only short-term and likely to have only minimal positive effects on the historic environment. Herbicides have also been used successfully to reduce bracken stands. Replacement of bracken by grassland would be beneficial to the historic environment.

Several studies on fertiliser addition as part of upland vegetation restoration were also identified. Where re-vegetation of bare peat is enhanced, this should be beneficial in reducing erosion and in preserving archaeology.

There were no issues raised in the questionnaire relating to chemical interventions, except as a desirable method for the control of bracken.

6.2.7. Abandonment

The literature search identified studies of various grazing exclusion experiments, which have demonstrated the immediate effects of a reduction in grazing. These have shown that cessation of grazing can, in some circumstances; assist the restoration of heather moorland. Some form of heath, bog or grassland vegetation is likely to persist at least in the short-term, with relatively little impact on the historic environment but over longer timescales, unmanaged vegetation would carry the risk of fire and loss of visibility and, eventually, colonisation by trees or tall shrubs.

Abandonment of land was not specifically identified as a concern in the questionnaire, although reductions in grazing intensity are thought to be leading to an expansion of scrub and bracken and posing a fire risk from increase of above ground biomatter. This suggests that if abandonment took place, damage to the historic environment could occur. The stakeholders, however, did not agree about the merits of protecting monuments by fencing.

6.2.8. Water Management

The results of the questionnaire and the literature search indicated that conservation of the historic environment in the uplands was dependent on the maintenance of an intact vegetation cover and if this is damaged in any way it quickly leads to erosion, which presents a significant risk to the historic environment in the uplands. Where vegetation is damaged, for example as a result of farming practices or sporting interests, it is more vulnerable to the actions of water, wind and climate change.

The literature review indicated how drainage can alter the species composition of bogs and their hydrology. Hydrological changes can lead in extreme cases to loss of peat which, as an important historical resource in its own right, can be very damaging. Re-wetting of previously drained blanket bog or wet heath, if successful, will therefore be beneficial in preserving peat and in re-establishing vegetation cover around areas disturbed by drainage operations. The literature search did not identify any studies that looked into how natural drainage can modify the vegetation in the uplands.

The questionnaire identified that natural and artificial drainage was a major issue in the conservation of upland environment, although in the South West it was thought to be less of a threat than in the North. Although drainage problems caused by extreme climatic events are in general rare, they were in fact mentioned by archaeologists, geographers and ecologists as a potential worrying trend for the conservation of the upland landscape. If the predictions about climate change prove to be correct, then there may be an escalation of such events and an increase in their consequences. Water management in future will therefore need to take climate change predictions into account.

The questionnaire confirmed that grip blocking was used as a management tool in the upland environment. It was agreed that drainage of the uplands, especially in areas of peat, had been extremely damaging in the past, and that raising water levels was beneficial for habitats and the historic environment. However, grip blocking and the techniques to do this were considered by both archaeologists and palaeoecologists questioned, to be one of the most serious management issues to the historic upland environment. Particular concerns were the selection of appropriate materials for blocking the grips, and ensuring the use of specialist machinery and contractors to minimise damage to the peat.

The questionnaire also identified how water erosion caused by natural drainage, following damage to the surface vegetation by livestock or walkers, can quickly put the historic upland environment at risk. This was of particular concern in the North of England where destruction of streamside archaeology, for example the workings from old mines, was of particular concern following heavy rainfall.

Poorly drained soils can also become churned up by sheep and cattle. In Cumbria and Northumberland, poor grazing regimes such as cattle grazing throughout the year on wet soils, are putting archaeological monuments at risk, for example at Hardknott Roman Fort in the Lake District National Park and on sections of the Hadrian's Wall Path National Trail.

The questionnaire identified drainage to be a very serious problem in peat landscapes when the surface vegetation had become damaged by, for example, fire, walkers, grazing pressures and the inappropriate use of vehicles. The width of existing gullies quickly increased following heavy rainfall or severe storms and in rare cases the hydrology can be changed such that there could be a mass movement of peat downslope.

6.3. Gaps in Knowledge:

No.	Issue	Gap
1	Vegetation – Heather/ Grass	No conflicting evidence was apparent between the results of the literature search and the questionnaire. Although there was no evidence available that relevant and appropriate studies had been carried out into the growth and control of dwarf shrubs and their effect on the historic environment. The presence of a well-managed dwarf shrub heath was described as being optimum for the protection of the historic environment in the uplands. The expansion of purple moor-grass at archaeological sites needs to be verified and quantified as there is likely to be considerable variation from place to place. The extent of purple moor-grass encroachment and the effect this is having on site visibility in the historic environment is one area where further research is needed.
2	Vegetation - Bracken	Some stakeholders believe that bracken is expanding. However, as this is not supported by easily available survey data the claim needs to be verified and quantified, as there is likely to be considerable variation between different parts of the country. The extent and rate of bracken encroachment and the effect this is having on the historic environment is one area where further research is needed. The impact of bracken on the historic environment has been researched, but this study found little information available on the means of control. For example, it appears that there has been no specific monitoring of the benefits or damage to the historic environment of the different methods of control used.
3	Vegetation – Trees/ Shrubs	Some stakeholders believe that scrub is expanding. However, as this is not supported by nationally available survey data the claim needs to be verified and quantified, as there is likely to be considerable variation among different species and localities. The quantification of scrub encroachment, especially European gorse and the effect this is having on the historic environment is an area where further research is needed. For example, firm data about the fire hazard posed by gorse is lacking. There has also been no monitoring of the benefits or negative effects on the historic environment of the different methods used to control scrub, and therefore which remedial measures benefit the historic environment the most.
4	Management – Livestock	There is some evidence that cattle grazing is more damaging to the historical environment than sheep. However, further research on whether different breeds of cattle have a greater impact and what the most benign type of stocking management is, would be useful. Likewise, further research would be beneficial on the optimum grazing levels for both sheep and cattle under different ground conditions (as well as soil type, upland vegetation type and hydrological effects). The various stakeholders questioned believe that livestock trampling is damaging to the historic environment in the uplands. The relative depths to which the trampling extends on different soil types and soil conditions, and by various livestock types, needs to be researched, along with how this activity could potentially damage the historic environment.

No.	Issue	Gap
5	Management – Burning	There seems be considerable agreement between the archaeologists, ecologists and land managers as to the dangers of uncontrolled fires both in the literature and in the response to the questionnaire. All parties were aware of the consequences of fire in an upland environment and the need for a well-managed landscape, with either controlled burning or the cutting of heather and scrub, together with optimum stocking levels. The absence of any land management was thought to lead to excess growth of heather and other woody plants and, with the predicted increase in spring and early-summer droughts, was thought to make the uplands more vulnerable to fire damage.
6	Management – Cutting	There appears to be no research studies that corroborate whether cutting of vegetation is more damaging to the historical environment than burning and this perhaps needs to be addressed in a systematic way. If cutting was to replace burning as a management tool, its effects on the historic environment need to be monitored.
7	Management – Other Mechanical Operations	There are published studies that justify the use of machinery to manage upland vegetation in certain circumstances but the damage caused to the historic environment is undocumented. This is needs to be addressed and advice included in the management tool.
8	Management – Chemical Inputs	There are gaps in our knowledge of the use of chemical interventions in the uplands and the conservation of the historic environment. There has been no monitoring about how the application of fertiliser might affect site visibility.
9	Management – Abandonment	Abandonment was not a major issue with many of the stakeholders, so there was not a perception of its advantages or disadvantages with regard the historic environment. If the practice becomes more wide-spread, there is potential for an impact upon the surface and underlying archaeological resource. In this situation monitoring of the impacts of abandonment will be required.
10	Management – Plant Introductions	Supporting evidence is required on perceptions about damage to the historic environment by the present trend of re-wilding by plant introductions (especially trees). The potential damage caused by harvesting for brash is another area requiring further study.
11	Management – Water Management	The causes and effects of erosion are well understood, and the issues relating to reducing and managing erosion are covered under the various management topics. The comparative advantages and disadvantages of grip blocking in the context of the historic environment are however not well documented. This needs to be monitored and undertaken with tight controls to prevent further damage to the historic environment.

6.4. General Issues

6.4.1. Definition of Archaeological Landscapes

During the course of the research for this study it has become apparent that there is a lack of understanding about the conservation of the historic landscape due to archaeological data traditional being focused on single monuments (point based) rather than set within their landscape context. Archaeology has been interested in historic sites like the Stone Circle at Stonehenge or the Roman forts of Birdoswald and Housesteads rather than the wider landscape in which they are located. There perhaps needs to be a greater emphasis on the designation of entire archaeological landscapes where individual sites are grouped within an all-embracing ring-fenced designation. This would build on the current approach that is predominantly focused on the scheduling of individual monuments [National Sites and Monuments Record (NMR) and county Sites and Monuments Records (SMR)], whereby monuments are defined as localised entities. The Heritage Bill (2008) better recognises cultural landscapes and it is hoped in the future this will allow for greater use of historic landscape designation.

An integrated historic landscape approach was taken in the South West with Devon County Council publishing, "The Historic Environment Role and Action Plan"(HERAP) [Devon County Council 2003]. In Cornwall, an Historic Environment Action Plan (HEAP) specifically for Bodmin Moor considered the impact that reductions in grazing regimes would have on the historic environment interests on Bodmin Moor and how appropriate such changes would be (Herring, pers. comm.), the aim being to encourage diversification of habitats through agri-environment schemes. A further approach for protecting the historic environment has been the management plan for Dartmoor (2007-2012), where Premier Archaeological Landscapes (PALs) have been designated. In these areas, when land management is under consideration, the historical significance is recognised and respected. The management requirements of the historically important features, especially archaeology, take precedence over ecology. It is also recognised that PALs are managed in a way to ensure they can be appreciated in their entirety, and future land management will need to take the wider landscape into consideration.

6.4.2. The Management Tool

The results of the questionnaire identified that there was a conflict of interest between the needs of the historic environment, a healthy economic landscape and biodiversity. It was apparent that there still needs to be better informed decision making about vegetation management issues in the historic environment in the uplands. Some of the archaeological curators interviewed indicated that when they attended meetings they were sometimes outnumbered by other stakeholders. As a result, they felt that decisions tended to favour land management or ecological issues rather than the historic environment. This can lead to differences of opinion as to whether the landscape should be changed to accommodate new farming practices, the sporting industry, biodiversity or whether the status quo that has allowed the survival of the historic environment, should be maintained.

Where PALs (Premier Archaeological Landscapes) are being designated on Dartmoor, they are managed for their archaeological importance, alongside SSSIs, which are managed for their ecology, and this approach appears to provide clear objectives for their management. However, whilst this is the case, the fact remains that there is European legislation underpinning SSSIs (in the form of the Habitats Directive), and only domestic legislation for the historic environment. The delivery of the former is also linked to Public Service Agreement (PSA) targets, whereas there are none for the latter. This is an important consideration in trying to broker consensus at national, regional or even local levels.

A management tool is required to provide initial guidance for non-archaeological advisers on the management of the archaeological resource within the uplands and to sign post archaeological curators for more detailed consultation. The overall aim of the tool is to give guidance to the advisors about best practice for the conservation of the historic environment, taking into consideration the needs for the ecological and economic management of the landscape.

ADAS and OA North have endeavoured to construct a stand alone software tool that is simple to use, maintains the overarching principle of the protection of the historic environment, and respects the needs of the natural, economic and working environment of the uplands. For the purposes of the management tool, the historic environment is defined as anything over 50 years old, which is man-made. The tool is supplied separately to this report for the purposes of trialling its practicality.

It is hoped that the management tool will allow land management advisers to be more proactive in encouraging appropriate management of, and stimulating interest in, the historic environment. However, it is important for non-archaeological advisers, if at all uncertain, to seek the guidance of their local archaeological curators at National Park and county level. At times, it will be essential for them to seek appropriate professional archaeological advice and, in the case of work near Scheduled Monuments, they must also consult with English Heritage before any decisions/ action can be taken.

7. RECOMMENDATIONS FOR FURTHER RESEARCH

7.1. Survey of the Historic Environment in the Uplands

This review has identified a number of concerns regarding the effects of upland vegetation and its management on the historic environment. However, most of the evidence for this is anecdotal or based on individual case studies. Therefore, the first priority for research is to quantify the potential risk to archaeological features at a national scale, so that priorities can be set for raising awareness and for more specific research needs.

This could be done by a national sample survey of known archaeological sites using a combination of remote sensing and field survey, and would need to follow on from earlier surveys, such as the Monuments at Risk in Englands Wetlands (Van de Noort 2002) and the Upland Peats study (OA North 2009). Such a survey would determine:

- the extent to which archaeological features are associated with different types of vegetation;
- for each vegetation type, the extent to which archaeological features are associated with different vegetation management practices;
- the consequent nature and extent of damage and benefits to archaeological features;
- the level of awareness amongst land occupiers of the existence of archaeological features and the measures taken to protect them.
- A survey of a sample of upland farms would enable a judgement to be made about the extent and density of the unknown historical record, and would therefore better inform land management regimes.

7.2. Balancing Objectives at a Catchment Scale

Those involved in vegetation management in the uplands need to take multiple interests into account in addition to the historic environment, including biodiversity, agricultural production, water quality, carbon storage, game production and landscape quality. These requirements are best addressed at a catchment scale to encompass the range of vegetation types and take account of the multiple objectives. Therefore, there is a need for catchment-scale studies to analyse how priorities are set, what practices are carried out and what their impacts are on the range of interests, including the historic environment. This would identify whether optimum results are already being achieved and whether development of a decision support system at a catchment scale would be justified to improve the outcomes.

7.3. Vegetation and its Management

7.3.1. Vegetation

Bracken - There is good evidence that bracken is damaging to archaeological sites. National data on the Bracken Broad Habitat suggest a recent overall decline in bracken cover but this masks any local variation and conflicts with the views of some site managers who perceive that there has been an increase in bracken at their sites. There is therefore, a need to determine whether bracken is increasing at archaeological sites. This could be determined using recent and historical remote sensing data, including aerial photography. With regard to controlling bracken, crushing by machinery or livestock is an accepted method of control (especially where chemical control is might affect water quality), but is potentially damaging to the historic environment. In some situations bracken litter could provide a protective cushioning layer and reduce the risk of damage. Research is required on the amount and depth of disturbance attributable to crushing, and its relation with litter depth. This would help to identify where crushing might be an acceptable alternative to chemical control.

European Gorse – Some land managers believe that European gorse on archaeological sites is increasing. However, quantitative data on the extent of European gorse are currently lacking. Therefore, there is a need to determine whether it has in fact increased at archaeological sites, and if so by how much. As with bracken, this could be determined using recent and historical remote sensing data, including aerial photography. The extent and nature of damage to the historic environment by gorse species is uncertain, with no specific studies identified in the literature review for this project. European gorse can colonise disturbed sites and might therefore exacerbate any previous damage to the historic environment. Further research is therefore required on the damage caused by gorse, its relationship with other disturbances, and on methods of control and prevention.

Purple Moor-grass - Some consultees raised the issue of purple moor-grass restricting visibility of, and access to, archaeological sites, mainly in the south-west of England. This issue needs to be quantified and the question addressed of whether purple moor-grass is expanding at some sites. This would require targeted field assessments of a sample of sites.

7.3.2. Management

Heather Burning and Cutting - The comparative effects of heather burning and cutting on the historic environment need to be assessed, especially since some water authorities are increasingly favouring cutting. This would need a specific study to determine whether charcoal permeates into the peat layer, to what depth, and whether this destroys the archaeological record. A targeted study of disturbance caused by heather cutting is also required, both in the context of heather management and of supplying material for grip blocking.

Grip blocking - Grip blocking is a matter of some concern and there is a need to research ways that can effectively and economically block grips without damaging the archaeological environment in the process.

7.3.3. Other Issues

There is a need to:

- Further develop guidelines for the selection of Premier Archaeological Landscapes (PAL). This would be used as a basis for extending the PAL approach to overcoming conflicting management priorities to other upland areas of England.
- Research the impact on the historic environment of the use of vehicles such as quad bikes and 4x4s for land management.
- Increase awareness around the vulnerability of stone features such as walls and cairns and the need to conserve them, rather than view them as suitable material for footpath stabilisation.
- Ensure that there is sufficient information on the historic environment and that this is explained to land managers, in order to better manage the upland environment.

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The management tool was designed by ADAS in consultation with Elizabeth Huckerby and Jamie Quartermaine, both of OA North.

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PLATES

Plate 1: Rabbit disturbance to the rampart of the Castlesteads Iron Age Hillfort on the Feldom Ranges at Catterick, North Yorkshire (Copyright Phil Abramson - Defence Estates).

Plate 2: Harrison Path, Langdale, showing the major erosion scar up the hill-side before the site was repaired with a pitched path

Plate 3: Footpath erosion at Peel Crags, adjacent to Hadrian's Wall

Plate 4: Rock art exposed following the catastrophic wildfire at Fylingdales Moor

Plate 5: Run-off as a result of water erosion from Stoup Brow, Fylingdale Moor following the catastrophic fire (provided by North York Moors National Park Authority)

Plate 6: Artificial drainage on Anglezarke Moor, South Lancashire

Plate 7: Deep gullying as a result of the expansion of artificial drains by natural drainage

Plate 8: Areas of path erosion on the Langdale Combe

Plate 9: The now destroyed South Scree axe factory site following path erosion and flash floods

APPENDIX 1 - THE STAKEHOLDERS INTERVIEWED FOR THE PROJECT

Organisation	Interviewee	Subject/ Position
Natural Environment/ Protected Areas		
Natural England	Dr Jean Johnston	Natural England, Lake District Team
Natural England	Simon Lovell	Agri-environment Adviser
Natural England	Mervyn Edwards	Uplands agri-environment adviser
Natural England	Bob Middleton	Corporate Planning and Reporting Team
Natural England	Martin Furness	Assistant Site Manager North Pennine NNR
Natural England	Jon Hickling	North West
Natural England	Dave Glaves	National Upland Specialist
Natural England	Mick Rebane	National Upland Specialist
Lancashire County Council	Don McKay	Forest of Bowland AONB Officer
Cumbria County Council	Richard Newman	Environmental Planning Manager
Exmoor National Park, Mire Project	David Smith	Project Officer
Lake District National Park	Phil Clague	National Park Ranger
RSPB	David Morris	Agricultural Adviser North East England
RSPB Geltsdale Reserve	Stephen Westerberg	Farmland warden
United Utilities	Nigel Pilling	Countryside management
United Utilities	Ian Harper	Wildlife warden
The Heather Trust	Simon Thorp	Director
National Trust	Caroline Uff	Ecologist

Organisation	Interviewee	Subject/ Position
Historic Environment		
Natural England	Peter McCrone	Historic Environment Adviser based in Cheshire
Lancashire County Council	Peter Iles	County Archaeologist Specialist Adviser (Archaeology)
Cornwall County Council	Ann Reynolds	Historic Environment Countryside Adviser
Lake District National Park	John Hodgson	National Park Archaeologist
Dartmoor National Park	Debbie Griffiths	National Park Archaeologist
Exmoor National Park	Jessica Turner	National Park Archaeologist
Exmoor National Park	Robert Wilson-North	Historic Environment Manager
Northumberland National Park	Rob Young	Former National Park Archaeologist
North York Moors National Park	Graham Lee	National Park Archaeologist
North Yorkshire Moors National Park Authority	Matt Buckler	NPA Officer
Yorkshire Dales National Park	Miles Johnston	Countryside Archaeological Advisor
Yorkshire Dales National Park	Rob White	National Park Archaeologist
Peak District National Park	Ken Smith	National Park Archaeologist
English Heritage	Jacqui Huntley	Regional Scientific Advisor for the North East and Hadrian's Wall
English Heritage	Vanessa Straker	Regional Scientific Advisor for the South West
English Heritage	Sandy Gerrard	Heritage Protection Adviser - Western Team
English Heritage	Peter Herring	Characterisation Inspector
Oxford Archaeology North	Rachel Newman	Archaeological Consultant for the Hadrian's Wall Path National Trail

Organisation	Interviewee	Subject/ Position
Ministry of Defence	Phil Abramson	Historic Environment Adviser (Operation South) based at Catterick, North Yorks
Nidderdale AONB Heritage Strategy	Pippa Pemberton	Historic Environment Project Officer
National Trust	Jeremy Milln	Archaeologist
Farm/ Landowner		
Northumberland Estates	Mike Glossop	Farms Manager
Barningham Park	Sir Anthony Milbank	Landowner, Richmond, North Yorks
CLA	Angus Collingwood	North-east Regional Director
MOD Dartmoor	Lt Col Tony Clarke	Commandant, Dartmoor Training Area
Stratton and Holborow	Mr Dixon	Land Agent for Molland Estate
Farmer on Exmoor	Sir Roger Swinburn	Farmer
Academics		
University of the South West in Plymouth	Ralph Fyfe	Lecturer
University of Stirling	Richard Tipping	Senior Lecturer in Environmental Science
Ruskin Anglia University	Bob Evans	Researcher - Environmental Science
University of Exeter	Robert van de Noort	Professor - Wetland Archaeology
University of Durham	Jeff Warburton	Reader in Geography

APPENDIX 2 - QUESTIONS AND RESPONSES

See following pages.

Interviewee Specialism/ Region	What threats are specific to your area?	What are the most Vulnerable upland monument types?	How should upland archaeology be conserved?	What are the main Management & land use impacts?	Designated archaeology or nature conservation.	Who gives advice?	What does the advice cover?	What type of vegetation is on site?	What management do you do?	What impact does this management have on the site?	Comments
Natural Environment/ Protected Areas – North West	Drainage, Sheep grazing, Motor Cross, Localised access damage, Mineral collectors deposits	Summit cairns, Industrial units falling down, Damage to Peat Deposits	Reducing grazing, Hydrological restoration.	Grazing, Burning, Drainage, Localised Tourism	Mostly Nature Conservation interests. A lot of unknown archaeological sites.	Natural England Historic Environment, National Parks, English Natures Upland management handbook.	Mainly vegetation management. Monuments are covered under HLS agreements.	Blanket Bog, Woodland, Heather Moorland, Acid grassland	Grazing, Small amount of Burning, Grip Blocking	Over grazing is damaging particular sites and effecting drainage.	Would like to have more discussions at the strategic level to determine all the issues and not just from one perspective.
Natural Environment/ Protected Areas – North West	Mainly encroachment by bracken, gorse and scrub. Erosion by water, especially severe rainfall. Some farming activities by people unaware of historic environment.	Outlying farm buildings and walls and some industrial buildings. Some features surface and sub-surface potentially damaged by farming or bracken and scrub encroachment	Sites valued e.g. listed should be protected by recording and legal protection The cultural landscape should be conserved together with biodiversity. Grant aid and cross compliance can help with this. If sites can be used they are more likely to be protected. Financial incentives help.	Extensification of grazing- reducing cattle and sheep will allow encroachment by scrub and bracken, gorse is becoming a problem on Dartmoor. Unknowing use of site s for supplementary feeding can cause damage. Rabbits can burrow under features	Many sites are designated for both. Natural England advises on SSSI	Natural England has biodiversity and historic environment advisers in all regions	All aspects. Historic environment is covered under HLS agreements	All upland types	Advise on all aspects of management	Reduction in grazing is allowing scrub and bracken to develop. Care in use of machinery needed on or near historic sites.	Financial incentives help maintain sites and buildings. Upland livestock farming is not profitable enough to maintain items that do not have a use. Some unsympathetic repair or demolition of buildings takes place. Known and valued areas tend to be looked after, unknown sites are at greatest risk. Some 4x4 activity damages green lanes, usually greatest near urban areas.
Natural Environment/ Protected Areas – North West	Visitor Pressure, Grazing, Erosion by surface water run off	Summit Cairns, Iron age village sites, Peat Deposits	Don't know	Walking, Grazing	There are a lot of Archaeological sites not defined most are recognised nature conservation interest	English Heritage and National Park	Don't know	Short sward Acid grassland	Grazing		Feels he is not the right person to ask as he covers the coastal areas not upland.

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Natural Environment/ Protected Areas - North East	Lack of knowledge of sites allowing damage. Fires. Use of 4x4 vehicles Bracken. Burrowing animals, especially rabbits	Cairns, unrecorded sites	Knowing what is there, incentive schemes, education of land owners. Information to be included in ES ,especially HLS	Grazing. Debate about "re-wilding". Bracken control. Use of common rights, e.g. remove stones, peat cutting, grazing. Understanding of issues by land agents.	Both ,although more sites designated for biodiversity than archaeology	Natural England, English Heritage, County Archaeologist	Making safe historical sites, vegetation management,	Bracken, wet heath, dry heath. Most upland types	NE gives advice which is incorporated in HLS agreements	Once site is recognised and included in HLS site should be maintained or improved.	Fewer sites designated for archaeology than biodiversity. Ignorance is a great threat. Agricultural activity is potentially a threat .Cool managed burns considered to be good management for both archaeology and biodiversity. Rabbits a significant problem.
Natural Environment/ Protected Areas – North East	Erosion, Drainage, Grouse Moors access roads, Quad bikes, Footpath erosion, Fire, Climate change	Industrial building conversions, Summit Cairns, Historic routes, Peat Deposits	Grip blocking to help stop erosion of peat	Grouse shooting, Sheep grazing although it has reduced	A lot of Archaeology sites have not been recorded	Lancashire County Council Archaeology Department & Forestry commission		Heather, Bracken, Peaty acid grassland	Some Grip blocking(United Utilities Land), Burning on grouse moors, Some Bracken cutting, Grazing	Areas have been heavily overgrazed in the past but not so much now with new Stewardship Schemes	

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Natural Environment/ Protected Areas – North East	Threat of 'rewilding' policy, Ok in small ravines but bad in large areas. Ecologists are often lacking in knowledge of landscape history and assume no trees is post Elizabethan. They also have climate change lobby behind them. Rewetting projects need consultation between ecologists and archaeologists. Adaption to climate change may be a problem if Historic Environment not taken into account. Also fire may become more of a problem with drier conditions. Inappropriate grazing e.g. cattle on wet Roman fort in winter destroys stratigraphy to a depth of 3 feet. 4x4 a serious problem. Small streams and flash floods causing destruction of archaeology e.g. lead mines in the Pennines. Considers that the modern social attitude of doing what you want where and when is causing unnecessary damage.	Anything next to a stream. Cairns summit and other often by bracken growth. Drystone walls not understood, mapped or relationship to other walls plus removal of stone to repair other walls. Old routes being destroyed 4x4.	Upland archaeology often isolated and when abused difficult to monitor especially now when APs and satellite images used to monitor sites. They need to be regularly monitored immediately a potential problem is noted. Staffing levels in counties make this difficult but National Parks better placed for this type of work although have greater problems because of visitor pressure. Correct mixed grazing regimes reintroduction of highland cattle and Herdwick sheep. Managing the countryside to make it pay. Towns people having to pay to use the countryside. Damage done by 4x4 may decrease with expense of running such the vehicles become prohibitive.	Do stewardship schemes really made an impact? We don't know. Farmers are aware of ecology but often know little of the Historic Landscape even former use of tracks on their land and stone sitings of feeding troughs etc. Education therefore important as they are keen to learn. Traditional farming methods best National trust can help here	Information and knowledge needed.						Reintroduction of the Herdwick sheep as very adaptable encouraging the use of the fleeces for insulation rather than Rockwool or man made materials. In the case of stream side archaeology and walling it may not be possible to preserve them but necessary to record them. Felt that change in social attitude to the right to use the countryside was necessary. It should be a paying environment not a playground.

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Natural Environment/ Protected Areas - North East	Erosion caused by walkers, animals etc increasing risk from water erosion. Poor burning. Badly sited tracks and paths. Wildfire. Leggy heather, bracken and scrub. Burrowing animals, especially rabbits.	Limekilns because people think that they are common. lead mining works, rigg and furrow	Ensure that owners and managers know what is there through education. Ensure that features are covered with soil and suitable vegetation. Need to pay for county archaeologists information, can discourage people from asking.	Unsympathetic farming and access for shooting or walkers. Poor burning practice.	Many archaeological features not recorded or designated whereas many sites designated for biodiversity	Little advice needed for HLS ,usually from county archaeologist	Importance and maintenance of feature. Changing vegetation management may reveal features.	All types of upland vegetation dealt with during work.	Advise on veg. Management for birds and HLS	Sympathetic management should also conserve the archaeology	Awareness and education important. Sympathetic management needed. Vibration from wind farms may damage sites nearby-is there evidence for this? Provide fire breaks near features
Natural Environment/ Protected Areas – North	Reduction in Grazing, Sphagnum Moss becoming more established	Peat deposits.	Maintain grazing,	Grazing, Tourism,	Site designated SSSI for breeding birds	Work closely with Natural England & RSPB management team. Archaeological survey indicated sites previously unknown during HLS application.	Mainly vegetation management	Heather, Dry Heath, Molinia	Experimental burning, grazing, grip blocking, cutting	Not having any detrimental impact.	

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Natural Environment/ Protected Areas - North	Wild fires, bracken encroachment and some unauthorised use of vehicles. Occasionally supplementary feeding and machinery tracks cause problems but this is rare.	Industrial sites and historic grouse butts falling in to disrepair Industrial building conversions, Summit Cairns, Historic routes, Peat Deposits	People need to be aware and then sites are considered and cared for. Managers need to know which activities are potentially damaging fencing, tree planting, poor burning.	Water catchment generally sympathetic for most features. UU have policies to manage heritage features	Out of 10000ha estate 7000ha is SSSI but there are only 2 SM and 20-30 recorded before HLS surveys which revealed more.	Mainly from Lancs County Council Archaeologist and natural England HE adviser.	Mainly to avoid tree planting on sites. Encourage low level grazing.	Heather and "white moor" (grassland)	Grazing, controlled burning, cutting, grip blocking	Management designed to be positive for historic environment	Awareness of sites important for people managing land. An integrated plan covering all aspects and management (SCaMP-Sustainable catchment management plan) is helpful. Water catchment management is generally sympathetic to biodiversity and historic environment.
Natural Environment/ Protected Areas - North				Burning, water management, walkers shooting,	Both	Natural England (both Defra and English Nature, United Utilities, Local fire services	Vegetation and fire management, water quality	Blanket bog, heather moorland and Molinia grassland, plantation	Grazing, Cutting if allowed, historically burning, grip blocking, ScaMP projects	No burning or cutting is allowing the heather to become “leggy”	Would like to at least cut fire breaks. Open Access and the number of access points is a problem on Anglezarke and Rivingtong Moors, Greater Manchester and Lancashire

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Natural Environment/ Protected Areas – South West	Encroachment by bracken and gorse because of reduced grazing, unchecked leads to poaching by animals under the gorse .	In the South West prehistoric farmsteads and field systems often damaged by erosion channels	This is the responsibility of the archaeologists, who need to identify key priority areas rather than blanket preservation. There needs to be a clear selection process and it is necessary to specify how the sites should be conserved ie. Visible or concealed. Management of visitors, study and conservation of the historic environment.	Good shepherding and husbandry ensures the stock do not congregate in one area. Cairn cleared of heather in 1895 still clear with good stock control. Undergrazing becoming a real problem Controlled burning is advantageous for archaeology as it helps prevent "leggy" growth and increase risk of fire. Managed gorse can be good for sites as it can conceal vulnerable monuments. Upstanding monuments need extensive grazing to keep them clear but conversely in winter stock cause erosion.	In SW the sites are designated for both						The Dartmoor Moorland Vision and Dartmoor Hill Farming Project are examples of good practice. The Dartmoor National Park has a plan of land use, which was discussed with the farmers and landusers. Plans of this nature require a facilitator. The archaeologists were required to prioritise areas of greatest importance rather than the blanket conservation of all archaeology.

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Natural Environment/ Protected Areas – South West	Burning, intact peat column disturbance	Not sure	Through consultation with Natural England and National Park Archaeologist	Burning, Grazing, cutting	All the area is designated SSSI, ESA, and managed under natural England Guidance	Natural England, National Park Archaeologist	Description of features and management practices	Blanket bog, *Molinia*, heather	I am the conservation works manager/ ditching, channels being kept open	It could potentially damage archaeological features that may get exposed through moving the peat, but the blanket bogs could dry up if other works were not carried out	
Natural Environment/ Protected Areas - National	Burrowing Rabbits, Inappropriate Burning causing exposure, Over grazing, Installing new fence lines using machinery, Juniper growth	Charcoal Pits, Industrial monuments, Hut circles, Peat deposits	Vegetation management, repair to unsafe buildings, Grip blocking	Grazing, Tourism,	Both	Natural England, English Heritage, County Archaeologist	Making safe historical sites, vegetation management,	Hay meadows, Montane heath, Blanket Bogs, Heather, Juniper	Grazing, Burning, Cutting, Grip blocking	The management is having the desired effect. Possible slight over grazing.	
Natural Environment/ Protected Areas - National	Hydrological	Field systems, circles, peat bogs	Can only be conserved if known about	Sheep grazing, grouse shooting, water catchment	Mainly Nature conservation interests unless told of documented archaeological sites, Most are SSSI and under environmental schemes	Natural England with more consultation needed with the County Archaeologists	Vegetation management, stocking densities	Blanket Bog, with Heather, Bilberry and bracken on the slopes	Grip blocking and grazing, heather cutting	It maintains the water levels on the peat bogs reducing discolouration in direct water supplies	Further discussions about burning and cutting; he felt that cutting is more damaging to the moorland than controlled burning but fire breaks essential. Hummock and hollows being lost by cutting, felt research was needed to look into effects of cutting on the vegetation. Felt there was a need for a survey of heather condition on the moors.

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Natural Environment/ Protected Areas - National								Heather Scrub Bracken Heath Western gorse Purple moor-grass	Burning	Want less burning on peat and wet heathland – control risk by fire breaks and management. On drier heaths burning gives benefit of age structure. Keen to encourage scrub on moorland fringe to restore transition to adjacent woodland. Target control to heath and species rich grassland – steep slopes less important. Restoration can conflict with historic interest where involves disturbance e.g. ploughing. Prominent in SW. More heath like in structure than European gorse, less likely to cause damage. Often managed by burning.	Changes to Heather and Grass Burning Code in 2007 gives improved protection of sensitive areas. Need to take account of other interest including historic environment. Higher Level Stewardship schemes more targeted with site specific management than earlier schemes. Control on historic features priority under agri-environment schemes. Need to balance objectives.

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									Cutting Rewetting	Possible alternative to burning on peat, with fire breaks. Compaction – use low ground pressure vehicles. Good for habitat and historic interest if done appropriately.	

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Natural Environment/ Protected Areas - National								Heather	Burning Mowing Rewetting	Impacts depend on substrate – not advocated on peat Risk of compaction but use low pressure vehicles and route according to topography Constrains heather growth. Benefit to peat – grip blocking with peat on narrow grips gives limited disturbance; wooden/plastic better on wider grips	Bracken - no national data to support increase but local variations. Trees/shrubs – appropriately located increase contributes to Upland Vision and less intensive management

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Natural Environment/ Protected Areas - National	Encroachment by bracken and gorse because of reduced grazing. Access to prominent sites, such as hillforts Burrowing animals, especially rabbits .Possible damage from farming if people are unaware of sites	Hill forts and other sites at good view points because these are a focus for people when walking. Stone cairns especially at summits because stones are removed or added. Some trackways because of 4x4 use.	Ensure that people are aware of sites. Maintain low key management and vegetation cover over the uplands thus protecting both known and unknown sites. Once aware people generally value these things and are surprised at the number of sites in the uplands.	Biggest change is in grazing regimes, grazing of both sheep and cattle is decreasing. This will reduce any trampling but vegetation height will increase. Bracken gorse and scrub are spreading on sites e.g. Exmoor. Roots can damage subsurface remains and obscure above ground sites. The longer vegetation will be more susceptible to wildfires.	Sites designated for nature conservation tend to give more information. Historic sites often only listed with little information. Most landowners mention something when asked about archaeology	Amount of advice depends on how prominent site is. Usually from EH or county archaeologist. Most people are intrigued once they obtain more information. Normally little advice is received.	No specific comments, depends on the feature	Heather Trust covers all upland vegetation but the emphasis is on the management of heather moors	Advise on all aspects of management, including grip blocking	Generally positive. Poor grip blocking and unsympathetic use of machinery could damage sites.	The immense richness of archaeology in the uplands should be valued and integrated with other management. Knowledge and access and this integration should help conserve the upland historic environment
Natural Environment/ Protected Areas - National						National Trust	Management of vegetation around monuments to protect site visibility	Heather moorland, bracken and scrub	Heather controlled by burning but looking to phase it out, bracken control by spraying, burning and cutting, scrub cut and sprayed, gorse ten year burning cycle,	Preserves site visibility	

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Historic Environment – North West	4x4 on old routes, fires that smoulder then peat blows away and erosion sets in, motocross in old quarries, feeding troughs on cairns raised dry areas, windfarms, access routes and cable routes latter 2 cause erosion channels to form, bigger and heavy farm vehicles but more limited in upland, metal detectors and fossil hunters. Motor cross in old quarries round spoil heaps etc.B28	Farmsteads, old routes being destroyed, organics in the peat and peat itself drying out. All abandoned monuments whether recent or older. Water can damage industrial monuments if their water catchment systems are not conserved. Old industrial buildings crumbling e.g. engine house. Prehistoric monuments are at risk if reduction in grazing with resulting bracken and scrub growth.	Windfarms, access roads and cable routes need to be better policed. Are they putting in the clay bunds and culverts under roads to prevent drainage problems. Light grazing best for monuments, recording and conservation sometimes. More control by county archaeologist for the water companies of buildings on their land. Traffic management of old routes but sometimes bikes can still use them.	If grazing reduced vegetation can damage. Sometimes management itself causes problem e.g. Bleasdale Circle trees that were planted to protect are now damaging the circle. Peat drying out. Money	Sites are often poorly documented. Protection for nature conservation and AONBs rather than archaeology. Landscapes and birds more important.		If given yes. Often asked for with building restoration as people are applying for grants.				

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Historic Environment – North West	Fencing around monuments such as shafts is causing damage. Similarly sub soiling of paths, by robbing material from adjacent sites is an issue. Mineral extraction: small scale extraction of minerals by collectors is progressively becoming a semi commercial enterprise, by even resorting to the use of explosives to obtain access to mineral deposits. Very illegal, theft, trespass etc but still it occurs. Limited planting in gullies, etc but not on the scale of 'Wild Ennerdale', where there is considerable re-landscaping on a rich archaeological site.			Limited planting in gullies, etc but not on the scale of 'Wild Ennerdale', where there is considerable re-landscaping on a rich archaeological site. Miles without stiles: there is a move to open up the fells to disabled people. Creating heavily landscaped tracks and removing stiles. So far only in limited places - e.g. Blea Tarn. Very controversial.	There is a marked lack of cooperation between Natural England and archaeological curators; however, this was mainly an issue with old English Nature, However, to an extent the situation is much improved with Natural England. The main issue needed here is to change the mindsets within the ecological fraternity to take on board the issues of the archaeological fraternity. One major issue is that Archaeology is way behind ecology in terms of legislation. Most of the uplands are protected as SSSIs, whereas archaeology has only localised schedules and only now are we considering large scale statutory protection as a result of the Langdale Trial as part of the Heritage Protection Review, but even now this needs to be passed through parliament. However, it is a step in the right direction. Natural England is still doing their own thing despite a programme of consultation. Notably the targeting of HLS (High Level Schemes) are not						

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Historic Environment – North East	Removal of predatory animals by game keepers (grouse moors mainly) has resulted in a rapid expanse of rabbits and now there is a real problem of burrowing into monuments. This is also an issue elsewhere, but more so on grouse moors. Myxomatosis has little effect, keeping down the population for a year but then it is back in force. Scheduled monuments at risk from this issue. Water erosion is a problem and is exacerbated by the removal of bracken. Big issue are the military training areas where there is common abuse of monuments by uneducated Military personnel. There are now integrated land Management for historical monuments for each range and is available through Phil Abramson, Defence Estates	x	Footpath scheme: they are involved in repair work entailing intensive narrowing and creating stone sets as the path degrades. Therefore concentrating the scars into narrower ones and preventing wholesale expansion.						Bracken control by spraying is in bands across the slope so there are still barriers of vegetation across the slope to restrain water flow. Spraying done by helicopters to control whole sale spread.		

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Historic Environment – North East	Heather cutting with mechanical flails is causing considerable damage. Solution cut the high heather and then inspect for archaeology, followed by reduced level cutting. Casual cairn construction by walkers etc can result in robbing of monuments. Grouse Scrapes have a significant impact on archaeology were pertinent	Grouse Moor Management		Track consolidation- using archaeological monuments as source material							Fylingdales: there is a revised PD for methodology that has been produced from Fylingdales - need to get in touch with him.
Historic Environment – North East	Trampling from tourism, Building woks, Unauthorised fires, Upland management (heather cutting machinery damaging,) Weathering	Industrial monuments, summit cairns, exposed lithics being removed, Packhorse routes eroding from 4X4 usage, Peat deposits.		Tourism	All designated for conservation interests but all have Archaeological features associated with them.	National Park Archaeologists		Heather, Blanket Bog	Grip blocking, Cutting of Heather	Increasing vegetation on exposed peat but sometimes covering some archaeological features.	

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Historic Environment – North East	Coal Authority: Filling of shafts, capping of shafts and often without consultation. Recreational vehicles: Off-roading Bikes go everywhere and the indications can be seen elsewhere. 4x4s are only in localised places and only where they can get onto the moor, but there cause a huge amount of damage. Trial events are an issue. Legal ones can be ok, but then illegal usage of the moors subsequently by people following up on the trials causes a huge amount of damage. There is a distinction between trial bikes and trail bikes in terms of weight and therefore the amount of damage that they cause.										

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Historic Environment – North East	Infrastructure of grouse moors: Construction of grouse butts in inappropriate locations like shafts, robbing of monuments for their construction. Similarly borrow pits for their construction is a major issue. Similarly the establishment of shooting huts. Roads across the area are a big issue. North Pennines AONB have done a survey of tracks across the North Pennines, which includes old ones, new ones - This is a definitive indication of erosion from the expansion of the road system. The impact of roads also has an adverse affect on the peatland landscape from drainage.			A large area of YDNP has been affected by extensive plough damage to drain the moors and recreate a heather moor over a short period of time. This is called the black grouse moor restoration project, and therefore presented as an environmental project, but then entails a significant amount of damage to the archaeological landscape. Grip blocking: there is good blocking and bad blocking. Heather bails good, but using a machine to take material from adjacent scrapes and borrow pits is bad. North York Moors Nat Park has guidelines for appropriate measures to ensure that it is being done properly. There are large amounts of redundant fleeces and							

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Historic Environment – North	Trig Points are an issue as they provide a focus for visitors and cause erosion around them. They have been removed at Addleborough, and replaced with a big cairn elsewhere. Very controversial as the public like their trig points. Rhododendron vegetation is an issue, not just on land associated with parks - e.g. Stanton Moor and is difficult to deal with. Big historic issue was acid rain on the dark peak, but he has accepted that the sort of vegetation decline has decreased with the use of scrubbers.	Summit cairns are an issue as they are on the focal point of summits. They get eroded and robbed by visitors making smaller cairns.	Principle issue is that Land Agents need education both in terms of the archaeology on their land but also what archaeological landscapes are likely to be on their land and also what strategies are needed to deal with them. If this issue can be addressed we would be a long way further towards preserving the historic landscape.						Helicopter spraying of bracken is very localised and provides a means of dealing with bracken. Horse drawn rollers also break the storks of the bracken but don't actually do any further damage.		
Historic Environment – North	Burrowing animals, reworking industrial sites in the Yorkshire Dales, vulnerability of peat. Machinery used for grip blocking doing a great deal of harm. Grip cutting into mineral destroys preserved buried landscapes and then destroyed by JCBs. Farmers access if concentrated or incorrectly placed.	Hill forts with rabbit damage, industrial sites and peat.	Education of public, landowners, diversification by farmers. Publicity of the value of the environment. Bracken and gorse control.	Conflict of need for access by the landusers for stock management etc concentrating or spreading them out							Climate change may cause more drying out in summer. Natural destruction of pests no longer takes place if winters are warmer.

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Historic Environment – North	Climbers damaging the dry stone walls. Walkers going along the Clayton Wall where the ruinous remains of HW were faced by dry stone walling and capped with turf in the 19th century, if it wears it collapses catastrophically. Anything unscheduled of no importance to landowners. Stone removed and sold even advertised on E Bay. Horses and cattle damage the wall. Unmetalled historic routes are often damaged along the trail. Rabbits in earthworks, moles and badgers digging sets in Mile Castle 40. Sighting of feeding troughs often on driest points. Added pressure if ground under stress.	If HW is a mound or earthwork people do not respect it or equate it with the wall. The ground around the 'honey-pot' sites. Anything unscheduled is of no importance to landowners.	Path management essential. It is necessary to try and spread the people out along the path and to avoid bare wet areas, pitching path on the slopes correctly and regular maintenance of the path. Preserving a green sward with the right level of grazing.	The setting around the main sites on the wall e.g. Housesteads treated like a country park by visitors ignoring paths and rights of way for 2-3 miles around the site. Balancing difficult decisions between the different bodies at right levels not those that shout the loudest. Even in on a World Heritage Site and designated such because of its archaeology ecologists expect their concerns to take priority over those of the archaeologists whereas the National Park it is the landscape.	Main designation a World Heritage site but also a National Park with 2 areas are SSSIs.	Liaises with Mike Collins the English Heritage HW archaeologist and also gives advice.	Both the monument and the vegetation	Upland grassland, a managed landscape.	Regular maintenance, cutting and influencing walk line, managing nettles and bracken	Dramatic in parts but slopes still a problem. Aggregate paths can be re-grassed i.e. right size of stones, too big no hope, too small turn to concrete when wet.	A contentious issue but using artificial medium (Golpan or Ritter) to help path recover and grass to regrow. Also using sand to dry the path as wet mud spreads and does damage. The HW site is very lucky because they employ 2 fulltime men to look after it but in general money for capital grants but not for maintenance.

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Historic Environment – North	Lack of knowledge & gaps in Historical Environment Records	A range of industrial monument types, Rock Art, Lithics, Burial Grounds, Monks route	Don't know	Grouse Moors, Agri-environment Schemes	SSSI	Natural England, FWAG, Rural Archaeologist	Don't know	Heather,	Burning, Grazing that I know of	Don't know ask the Rural Archaeologist	
Historic Environment – South West	Ponies, motocross on mine sites and quarries. Molinia growth a serious issue, very tussocky, hiding sites and making access difficult. Rewetting very unsympathetic to archaeology. Scale on Exmoor huge, 300-500 dams heavy machinery serious engineering and removing the peat for blocking. China clay extraction and tipping on edge of Bodmin, out of use now some may be mothballed but could be restarted and the mining and tipping could be a problem. Giant windfarms off the moors but around them spoiling the vistas and sense of landscape.	Prehistoric field systems and settlements and also medieval. Reduced grazing, bracken and scrub and Molinia. May lead to poaching. Bracken bad visual and root damage. Substantial walls and stone features vulnerable. Prehistoric cairns being used to make smaller personal cairns.	Outside National Parks, as Bodmin is where it is controlled by 2 District Councils which makes it difficult to identify who is responsible for conservation. It is an ANOB but only part of Cornwall not on its own. Encouragement of shepherding perhaps appointing shepherds and wardens. May help if it can be financed. Mixed grazing and stock plan levels. Capital works such as burning and scrub clearance.	Under grazing and rapid regrowth of bracken gorse and Molinia.	On Bodmin Moor Northern area SSSI therefore PSA target legislation. Southern part of moor SSSI only a very small area. Much of Cornwall a World Heritage Mining Site	She does with EH and World Heritage team.		Re-introduced heathland. Mix of heather, both gorses and *Molinia* with bracken in some areas, which is sprayed	Small scale burning. Grazing stock levels too low.		Realistic schemes and payments to support things. High level schemes in the upland of no financial benefit to the farmers only very baseline. Ann made some suggestions re the management tool may go to. Scheduled monuments. Set proforma of high, medium and low interest. Generic suggestions, Images showing things in good condition. Concept of Historic Environment Action Plans for Bodmin Moor idea of Peter Herring. Enhance sites coherent landscape Bodmin Vision similar to Dartmoor one. PALS

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Historic Environment – South West	Undergrazing resulting in scrub, bracken and woodland particularly in unscheduled monuments. Upstanding monuments used as scratching posts. Military activity digging bivouacs, the leisure activity of letter boxing often hidden in archaeological monuments. Artefacts such as boundary stones and milestones being removed.	All sites under bracken exposed cairns, stone roads, upstanding monuments. Old farm and industrial buildings and boundary and milestones.	Education of public and the military. Bracken and gorse control. Consolidation of old buildings before they reach a critical point. Landowners have very few rights on the common land both wood and moorland. Co-operation between the ecologists and the archaeologists. Awareness of the Cultural Heritage since 1890s in SW. Microchipping boundary and milestones.	Reduction in grazing a real problem as this allows growth of scrub and bracken. Destruction of bracken extremely difficult due to nature of the plant. Just regrows if cut and Environment Agency loathe for chemicals to be used because of water quality.							PSA targets for ecologists but not for archaeologists. In SW PALS (Premier Archaeological Landscape Maps) where archaeology takes precedence over ecology. 14 areas now pre-managed on Dartmoor for their archaeology. However the reduction in grazing means these are not sustainable because of the problems of keeping the vegetation clear. Farmers complain of conflicting advice from the "ologists". Archaeology needs a European designation to increase the strength of the arch lobby. Tavistock Trust jointly funded by EH conservation of sites on the moor £5000-£6000 per annum a very useful scheme for example vegetation clearance.

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Historic Environment – South West	Hunting followers in 4x4 and quad bikes. Undergrazing, mire restoration a problem, cattle handling facilities unnecessary. Often the broader landscape is not considered. Grip blocking machinery can cause a lot of damage and peat can be used. Lack of swaling in the future may be a problem. ESA money now dried up and boundaries and beech hedges may not be maintained.	Standing stones, field systems and settlements e.g. hut circles. Very vulnerable indeed.	Traditional farming and a good level of grazing.	Because of lack of grazing bracken and scrub growth. No next generation of upland farmers.	SSSIs for nature conservation	She gives advice and English Heritage does as well.		Molinia, bracken, gorse and heath.	All those mentioned in the list.		PALs on Exmoor is a tricky one as not always easy to maintain because of reduction in grazing.
Historic Environment – South West	Uncontrolled fires, the use of vehicles and the mobilisation of personal can lead to damage of the historical environment. Increase in scrub growth with a reduction in grazing.	Standing stones		If fires get out of control fire control vehicles can damage more vulnerable monuments; increase in scrub growth with a reduction in grazing				Heather moorland	Controlled burning to encourage grass and a closer sward, cut fire breaks		

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Historic Environment – South West	Rewetting with peat being used to block grips, hunt followers (4x4s) on Exmoor. Decrease in grazing on both Dartmoor and Exmoor resulting in scrubbing and bracken growth with archaeology no longer visible and root/rhizome damage. Negligent owners using stone for other things. Setting of windfarms is an issue in the SW West.	Those mentioned in the questionnaires plus peat hags, where small areas (couple of metres) of vegetation are vulnerable to erosion climate change, often not protected and in last 5 years 2 sites were identified when hags destroyed.	The South West is a premier Archaeological area and it is essential to have give and take between the ecologists and the archaeologists. Education of the farmers showing them and explaining subtle features on their land thereby making them aware of the historic heritage in their care.								What is the damage of swaling is at depth?

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Historic Environment – South West	Encroachment by vegetation of standing buildings and settlement sites. Bracken seems to cause chemical alterations and is dissolving away the granite real threat below ground. Real threat undergrazing. Scrub and bracken prevent access to sites. Gorse and tree roots more destructive than rabbits often more damaging than bracken but smaller areas. If scrub and bracken get too dense this can make access difficult. Mining and spoil heaps can be in present and the past for legal and illegal dumping of spoil and hill wash burying monuments where stratigraphy is shallow.		Do the job properly if stable leave it alone. Avoid knee jerk reactions over a short period. Quantify current damage and quantify historic damage and then cost. Sympathetic ownership a real help.		Changing situation. Conflict of interest very real. At meetings often 1 archaeologist and 10 ecologists therefore they tend to sway the arguments.				Bracken control is very problematic as it is very resilient getting shorter and shorter so that it can not be cut, too low to roll and so is not inhibited. Cited measurements of bracken rhizomes where in an area 9m square, 7.5 kilometres of rhizomes.		Archaeology no resources in the last 25 years previously the reverse. Bracken rhizomes often a fossilised mat of rhizomes under the present surface.

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Historic Environment – National		Upland Industrial sites	Financing and repairs. Paying for grazing if reduced because changing payments to farmers i.e. no headage. Combining resources of ecology, landscape and historic environment together. Data into GIS and priority areas targeted e.g. Lake District, Pennine Moorlands and ANOBs. 80% of the budgets will be used in the targeted areas. Land owners with important scheduled monuments on their land but outside these areas to be asked if they wish to be included. Spoke about the blocking of grips/drains to slow down run off. Specialist firms being used.	Possibility of vegetation changes resulting from changing management regimes. Heather, scrub and bracken may expand as grazing is reduced. Ecologists also worried about this	Both and thought that this joint designation was increasing.	He does	Specifically on sites but sometimes on vegetation management			Very difficult to monitor and get results on how changing management may affect archaeology because length of time is inadequate to realistically measure it.	Higher level schemes to replace the ESAs (90% of Lake District used to be in these) more targeted and better results hopefully. A lower % in the Higher level schemes but hoped that these will deliver the most interest. Often SSSIs but hoping to be asked about best practice for the archaeology for example bracken and scrub control.

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Historic Environment – National	Bracken and scrub expansion may increase with longer growing seasons. More red deer around on the moors not managed. Orienteering and painting numbers on stones but improving now	The historic landscapes are not protected and become invisible if undergrazed. Abandoned prehistoric and post medieval settlements often obscured by gorse and bracken. Erosion round monuments and summit cairns because stones removed.	PALS should give historic environments priority rather than SSSIs. Historic Environment Action Plans as have been drawn up for Bodmin may be a way forward	Right to roam good as encourages people to value the historic landscape and want to conserve it. Water catchment now being talked about re run off. Heavier grazing and traditional farming methods being kept alive a good thing.							Renovation of industrial buildings in Cornwall less of a problem as World Heritage Site and therefore few demolished exception is dangerous mine shafts.

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Historic Environment – National	Military activity- shelling, troops digging in, burrowing animals (rabbits and moles) Fire. Badgers in one case. Bracken encroachment. Tractor, ATV and tank tracks. For instance, NAA surveyors at Otterburn considered that. The greatest and most widespread cause of damage was erosion resulting from sheep grazing, affecting a total of 100 sites (17%). Vernacular buildings may be pulled down if they have reached a point of deterioration where they are beyond repair. Otherwise we would try to convert them into 'stone tents' for soldiers, or use farm stewardship funding to conserve them. We have undertaken building surveys on some training areas to identify the condition of the buildings and costs of repair. Drystone walls that are in bad condition are sometimes pulled down and used a source of stone to repair other walls. Best practice is followed whereby the lower courses of the wall remain untouched that the route of the wall can remain visible	Features in military impact zones. Some inappropriate conversion of buildings. Locations the most important factor concerning threat. Cairns – due to 're-organisation' of the cairn structure to make defensive positions for soldiers. Earthworks – due to encroachment of bracken. Abandoned buildings/barns	Carry out baseline survey on all known sites and inspect every 5 years. Use Integrated land management Plan to list all issues, describe features and management which is linked to conservation, site operation and funding. Ensure tenants aware of sites and manage sympathetically. Good communication. Management plans which identify and locate the archaeology. Communication with landusers (military and farmers). MOD has put signs close around many sites. Identification of sites on range maps. Briefings to officers who use the ranges	Sites generally managed sympathetically and military personnel made aware of them and importance. Vegetation management designed to conserve sites.	Some sites designated for both. ILMP lists them and GIS also shows sites. We have numerous designated sites on MOD land (1054 Scheduled Monuments) and over 800 listed buildings. We also have lots of SSSI and other nature conservation designations (Ramsar, SPA, SACs).	Advice within MoD also English Heritage and Natural England. MOD/Defence Estates has an environmental support team within which there are subject matter experts in Historic Environment, Natural Environment, Environmental Planning, Sustainability and Public Access. As a part of the Historic Environment team I will give advice to colleagues – and at the same time I will sometimes seek advice on best practice from English Heritage, Management groups, Conservation groups etc	Advice usually on specific topics from national experts. I have access to foresters and natural environment colleagues who have similar problems regarding the use of the most appropriate chemicals and sprays, the time of year to do it, the number of revisits that might be necessary etc. I can use the advice that they give as a means of best protecting archaeological monuments	Most upland types. Heather, bracken, grasses, rushes. Bracken public enemy No 1	Most veg. Management done by farm tenants. Grazing, cutting and burning. Consultation on major works but not routine work.	Bad burning can be damaging. Artillery fire and can cause severe damage in small areas. Burning is generally ok. Grazing is fine as long as it is not over grazing and feeding stations are positioned away from archaeology.	If sites are to be damaged good recording before damaging activity is essential. Some "damage" is part of the continuous historic use of the site. Good records and good communication are essential. ILMP is a useful management tool. If people know something is there and valuable they will respect it.

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Historic Environment – National	Bracken growth and heather obscuring monuments, scrub encroachment on some monuments with gorse at higher levels			In Shropshire the National Trust view the control of bracken as a priority over heather control		National Trust, Natural England and English Heritage			Bracken control by hand cutting using scythe, brush cutter or strimmer over small areas; the bracken is then turned into peat free compost. They also control bracken by crushing		
Farm/ Landowner – North East	Some erosion by walkers and 4x4 vehicle but limited. Wildfire. Reduced grazing allowing scrub encroachment. Some poor farming practices e.g. supplementary feeding ,damage by tractors but very limited	No particular type identified	Knowing what is there and using sites in a sympathetic way such as grazing without damaging the surface	Many of the sites are SSSI so management is controlled by those requirements which are usually low level grazing, some heather burning and bracken control. Tenant farmers may manage differently to in-hand land.	Much of the upland estate designated SSSI. Many recorded and designated sites, especially cup-and-ring marked rocks.	Mainly Natural England, sometimes English heritage for scheduled sites	Vegetation management, specific biodiversity interest and access. If NE aware of historic site some advice on that.	The sites include heather some managed for grouse), "white moor", bracken, grass and scrub.	Burning, bracken crushing and spraying, grazing, grip blocking. In some areas attempting to regenerate heather.	Generally conserves sites and prevents scrub encroachment. Low intensity grazing keeps vegetation controlled without breaking the soil surface.	Need to be aware of sites; this has increased in last 20 years. Financial incentives help management and \SSSI have management plans which include historic sites. If restrictions are so draconian that it is no longer economic to use the sites management would stop. On site advice is useful.

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Farm/ Landowner – North East	Potential damage from increased visiting. Encroaching bracken or scrub. Inappropriate new paths and tracks. Over intensive management.	Removing stone from neolithic sites or other stone features. Too much rubbing of cup and ring marked rocks.	Awareness of its existence and sensitive management. Avoid forestry or other damaging development.	Possibly farming and sheep grazing and stock rubbing against a feature. Management for grouse increasing in importance of sheep. If done sensitively does not affect archaeology.	No biodiversity designation on moor. All archaeology sites (over 80) designated or recorded.	English Heritage and County Council archaeologists.	Management and maintenance of sites.	Mostly heather moor	Burning, grazing, grip blocking, bracken control by spraying	No detrimental effect on archaeology and may increase visibility of some sites.	Increasing awareness and interest in archaeology. Rabbits and badgers have potential to damage sites
Farm/ Landowner – North East	Wildfires. Inappropriate siting of new paths and tracks. Potential problems with winter feeding livestock ATV use	Not aware of any particular type more vulnerable than another	Treat carefully; ensure people know what is there. Sympathetic land use without too many restrictions	Tourism, especially use of vehicles. Bracken encroachment. Grazing pressure Fire	Members have designated sites	If site is scheduled members obtain advice. CLA does not advise specifically.	NA	Members have a whole range of upland vegetation types	Members do heather burning, some grip blocking, some bracken control.	They are careful with machinery access and it does not have any adverse impacts. There is no intensification such as gripping or tree planting.	Need to know existence of sites and then sympathetic management can be carried out.
Farm/ Landowner – South West	Mainly Erosion, wind and water. Bracken and burrowing animals. Walkers.	Peat Bogs, Monuments obscured by gorse and bracken	Integrated land management plans. Monitoring frequently for changes due to over or under grazing patterns.	Livestock grazing, Hikers. It was felt that live firing that caused craters in the moors was having an effect, but firing is now limited to small arms since 1998.	Areas under HLS and ESA agreements, archaeology seems to be brushed over; not all sites are mapped or managed for their archaeological status,	Defence training Estates, Natural England, National Parks	Vegetation management for conservation and Archaeology	blanket Bog, Molinia and Heather rich moorland, some area dominated by Gorse and Bracken	On the 1000ha the MOD owns we manage every aspect. N the 12,000ha under licence from landowners we are only responsible for the primary effects.	Some areas are not grazed enough and bracken is a problem,	A more targeted area management strategy for the commoners is needed.

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Farm/ Landowner – South West	Doesn't think there are any threats to the Molland Area of Exmoor	None are thought to be under threat in this area.	We have no choice than to follow guidelines from Natural England to receive the grant money for management	Grazing	SSSI, ESA scheme,	Natural England dictate	Grazing dates, burning times and areas,	Heather, Gorse, *Molinia*, Bracken	Burning, cutting manual and machine, chemical spraying, un blocking grips	Maintains the moor as its been for hundreds of years	
Farm/ Landowner – South West	Defra officialdom et al.	The whole of Exmoor		Grazing							
Academic – North East	Particularly interested in Erosion and the different types	Monuments, Peat Deposits	Conservation will depend on the site concerned and Geomorphology of the area concerned.	Main management impacts are draining, gripping and burning depending on the location of the site.	Both are mentioned but not all archaeological features are known.	County Archaeologists, National Parks Ecologist					Some interesting studies have been carried out including the Peat-scapes project and Moors for the Future.
Academic - North	Very concerned that natural drainage and extreme climate events/change are a major threat. Although forestry was specifically excluded from the brief, Richard is concerned that the vogue for planting native trees is encroaching on the drier slopes. Threat from the communication industry and windfarm access routes as there is no requirement for companies to investigate or preserve the peat. The ecologists having no sense of history.	In Scotland peat and field walls are the most vulnerable. Peat itself is very vulnerable and if removed the buried archaeology is exposed.	Not sure about this as most types of upland archaeology are not rare and not all need to be preserved.								Need for excavation of monuments that are not preserved and of environmental analysis of the sites.

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Academic - South West	The major threats to Upland Peat environments are rewetting cycles, water quality, and mass movement of peat following extreme storm events. Restoration projects often remove vast volumes of peat to block the grips. 'Rewilding' can cause extensive damage to the peat by causing water level drawdown. Bracken damage and gorse growth, the latter poses a fire hazard. Cut marked tree stumps exposed above a windfarm but no care taken of them and no recording.		Robust high quality databases fit for purpose. Key monuments known from survey. A programme of inspection for unscheduled monuments and ESA Agreements.								Changes in funding for moorland farmers. Rewarding for conservation of the Historic Environment with lower thresholds. Education of the wider community and Natural England (English Nature) is paramount. There is an ongoing PhD study on Dartmoor where Dipwells have been buried in the mires. Measuring drainage and a walkover survey of the Dartmoor National Park to monitor the state of the peat.
Academic – South West		Buried walls and lithic scatters thought not to be vulnerable but are.	More wetting.								Mentioned a case study in NE on military land and information Trent Peak Trust for South Peak District. Nothing more to contribute from author of Monuments at Risk in England's Wetlands.

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Academic - National	Once damaged peat erosion sets in. Over grazing can do enormous damage to the environment as can confining animals into a small area. Run off can increase after grazing and can therefore cause erosion, more input into streams and damage to monuments down slope.		Making sure that farmers know what is on their land. Giving them information. The public reporting incidences of damage to the Resource Payment Department. It is usually a question of the farmer's ignorance rather than deliberate malpractice. There are safeguards in place. Education of the farmers is very important. Today many upland farmers have no knowledge of cattle stocking and feeding as sheep had completely replaced them in the hills.	Diverse grazing better as sheep and cattle as there is differential use of vegetation by cattle and sheep. There are already regulations in place about positioning of feeding troughs. Better to allow small groups of cattle and sheep to wander rather than confining in a small area. Single payment will reduce levels of overgrazing. There is some recovery of peat growth if areas are fenced off for a number of years e.g. Kinder Scar.							Climate change with longer growing season in combination with reduced grazing is likely to improve matters. From 1945-1975 the growing season was shortened by 30 days and this coupled with overgrazing, because of subsidies, caused massive erosion problems.