The National Trust
for Scotland

MOORLAND MANAGEMENT GUIDELINES

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MOORLAND MANAGEMENT GUIDELINES

The guidelines below must be used on all Trust Properties that contain Moorland. In summary:

Land use change

- The Trust will conserve or enhance existing areas of Moorland. Decisions to convert moorland should be subject to a full conservation planning process.
- The role of moorland in the retention and accumulation of peat is crucial. Any change that is likely to result in a net release of greenhouse gasses should be avoided.
- Where a decision to allow land-use change has been taken, conversion through natural succession should be the preferred method

Grazing management

- Grazing, should be managed to achieve the land-use objectives. To conserve moorland herbivore densities should be no more than 15-20 deer per km^2 (or equivalent). It may be desirable to have much lower densities. Trampling must also be considered.
- On dry heath, the condition of the heather will be the main indicator of moorland condition, though other species may be more appropriate in wetter conditions.
- Monitoring procedures should be implemented to track the impacts of grazing pressure.
- The impact of grazing management on carbon balance will be kept under review.

Burning

- Muirburn should be avoided except in one or more of the following scenarios:
    - Likely significant net benefits for biodiversity;
    - Significant net benefit to a recognized cultural landscape
    - Significant net benefit to the economic viability of the hill farm or grouse shooting;
    - Significant likely long term benefit to carbon storage.
- Burning should only be allowed as part of the property management planning process or in consultation with relevant Trust specialists.
- Cutting should be considered as an alternative to burning.
- Where muirburn is adopted, it should be carried out in accordance with current Scottish Government guidance on best practice. Records should be kept.
- Fire risk assessments should be carried out on all properties with significant areas of heather moorland and Fire Contingency Plans (FCP) should be prepared.
- Fire preparedness and public education should be the main components of FCPs.
- Fire breaks should not normally be used except as temporary fire fighting measures.
- The use of prescribed burns to reduce fuel load is not recommended.

Tick/disease control

- Sheep should not be introduced solely for tick control, although treatment of existing sheep with acaricides is an accepted management practice.
- Information should be provided to all of the dangers of tick-borne disease

Drainage

- Moorland should be managed to encourage the retention and accumulation of peat.
- Drains should not be maintained, no new drains should be created and priority should be given to restoring the natural hydrology by the blocking of drains.

Tracks and vehicular use

- New vehicle tracks should not normally be constructed across moorland.
- Where they are no longer required, the Trust should consider the removal of tracks.
- The use of off-road vehicles on moorland should be minimized. Where they must be used, routes should be planned to reduce the extent of their impact.

The above guidelines are further supported by, and linked to, the Conservation, Wild Land and Unna Principles and the Trust's policies on Farmland &Deer Management, Woodland, Landscape and Peat, as well as the Grazing Working Party.

INTRODUCTION

Moorland is often regarded as synonymous with heather (mainly *Calluna vulgaris*) but in reality is a mosaic of unwooded, semi-natural vegetation, including heather moorland, wet heath, grass moor, blanket peat and montane heath. It is characteristic of much of the Scottish uplands. A number of other habitat types, notably rock, scree, water, woodland, montane scrub and Arctic-Alpine vegetation are also common in the Scottish uplands and make a significant contribution to the landscape character. Altitude, slope, aspect, climate, soil, grazing pressure and biogeographic history are all important in moulding the habitats present. The moorlands of the wet west coast are significantly different from those of the drier eastern hills and the fragile summit heath of the higher mountains bears little resemblance to lowland moors. Moorland sits within a matrix of these different habitat types, the issues facing each of which may be very different. The management of moorland must therefore be considered within the context of the surrounding habitat networks and the past and present influences shaping their development.

Moorland is conditioned by past human management as well as by natural features. The increased levels of sheep grazing, widespread in the late 20th Century, favoured a reduction in heather cover and the expansion of purple moor grass *Molinia caerulea*. Conversely, the extensive areas of uniform heather, common from the Borders to the Eastern Grampians, are partially the result of management for grouse, mainly by muirburn, and can therefore be considered a cultural landscape. The choice of which of these landscapes to favour, or whether to return to a more natural, varied mix of habitat types, is therefore a value judgement.

In addition to the landscape, biodiversity or cultural value, moorland also provides a number of ecosystem services, notably carbon sequestration and storage, flood management and influence on water quality. The value of these services has only been recently but now increasingly recognized and will play a new and growing role in guiding moorland management.

This document is intended to provide guidance on moorland management on Trust properties but also to guide response to national policy issues. Management objectives and priorities differ between properties, depending on environmental, socio-economic and cultural considerations. Uniform policies or management approaches are therefore unlikely to be appropriate and they will need to be tailored to individual NTS properties and individual sites within them. These guidelines highlight considerations that need to be applied under different circumstances. They outline the preferred option or default choice where other management objectives are not over-riding. Deciding on clear management objectives is therefore the key stage in managing the Trust's moorlands.

Moorland covers some 38% of Scotland which, together with Ireland, constitutes the centre of distribution of heather moorland within Europe. With its extensive tracts, the National Trust for Scotland has an important contribution to make to moorland conservation. The main properties containing moorland are shown in Table 1. It is estimated that the uplands cover over 63,000ha – around 80% of the Trust's landholding, though it is not known what percentage of NTS uplands constitutes moorland.

Much of the Trust's moorland is managed in-hand, although there are a variety of agricultural tenancy arrangements in force over extensive areas. Where an agricultural or crofting tenancy exists, the Trust's ability to influence the management is limited. Red deer, the major wild herbivore on most of the uplands, are wide ranging and their management commonly involves discussion with neighbouring landowners through Deer Management Groups.

Policy Context

A great number of the Trust's principles and policies potentially relate to the management of moorland. Some of the most relevant are highlighted in Annex 1.

These policies contain a wealth of sometimes conflicting advice on the management of what is the Trust's most extensive habitat type. This paper is designed to provide guidelines on how they can be applied on moorland at individual properties.

Many of the issues of moorland management have been pertinent for many years, but the issue of carbon storage and climate change mitigation have only recently emerged as important factors. The science underpinning this is in its early stages and is developing rapidly. An IUCN programme on peatlands was launched in 2010 to try to identify and fill gaps in the knowledge. It is likely that this policy will need to be reviewed within five years to take account of advances in scientific knowledge.

These guidelines were developed at the suggestion of the Countryside and Nature Conservation Advisory Panel by a working group comprising three members of the Panel and various staff drawn from some of the Trust's larger upland properties.

SIGNIFICANCE

The principal significance of moorland can be summarised as:

1 **Biodiversity** Dry heathland, wet heathland, blanket bog and montane heath are all habitats listed in Annex 1 of the EU Habitats Directive, and moorland hosts many birds listed in the EU Birds Directive, such as Hen Harrier, indicating that moorland is an internationally important feature. Although moorland is widespread in Scotland and can appear commonplace, a high percentage of the world's heather moorland is in Scotland which is the world centre for moorland plants such as ling, cross-leaved heath and bog asphodel. It has an international responsibility to conserve moorland and its associated wildlife.

2 **Carbon storage and climate change** The peat and organic soils that underlie most moorland store a huge amount of organic carbon. It has been estimated that Scotland's soils contain 2.7 billion tonnes of carbon - more than a quarter of the total quantity of carbon stored in all of the trees in Europe. Healthy bog vegetation can sequester carbon from the atmosphere at a rate of around 250 kg C/ha/yr but, more importantly, peat that is inappropriately managed can release its entire store of carbon very rapidly (SEERAD, 2007). The function provided by peaty soils in Scotland's moorlands is therefore critical in determining Scotland's contribution to global climate change and must be a major consideration in the management of NTS's upland estate.

3 **Landscape** Moorland is characteristic of much of upland Scotland and, in combination with the rugged topography, contributes to the classic landscape for which Scotland is internationally valued. In many cases it is the juxtaposition of the uplands with water, either freshwater lochs or the coast and islands of the west and north, that defines the landscape. Moorland results, at least in part, from human intervention in land management and is therefore also seen as a cultural landscape in many parts of Scotland, most notably the Borders and Grampians. Burning and grazing management are key forms of intervention.

4 **Wild Land** Almost all of Scotland's wild land is to be found in the uplands. Wild land quality has been identified as one of the most important features of several of our properties, notably Mar Lodge Estate, St Kilda, Kintail/West Affric, Torridon.

5 **Geology and geomorphology** The uplands of Scotland are the site of many of our most important earth science features. This is related to the fact that, as extensive landscapes, they encompass large-scale features, the steep topography facilitates viewing the underlying geology by maintaining large rock exposures and itself results from some of the more interesting geological features and processes. Periglacial and erosional features are particularly well developed in the uplands.

6 **Economic activity** Throughout much of Scotland, moorland provides rough grazing for sheep and cattle which constitutes the backbone of agricultural activity in upland areas. The value of this varies with the price of the commodities produced but, critically, with the agricultural subsidies available. Moorland is also extensively used for different forms of recreation, such as hillwalking, climbing and the shooting of deer or red grouse. These generate considerable sums of money for the Highland Economy (HIE, 1996).

7. **Environmental history** Heather moors and associated bogs can be rich in palaeoenvironmental deposits and archaeological sites. Scotland's moorlands were heavily populated and used by our ancestors, especially around 4000 years ago, when climatic conditions were more suitable for long-term, year-round settlement.

THREATS

Between 1940 and 1980, the area of heather moorland in Scotland declined by 23%. About half of this was lost as a result of afforestation with commercial conifers, facilitated by government subsidies (Moorland Working Group, 2002). Land use change to forestry has therefore been the greatest threat in recent years and continues to be so. The Scottish Forestry Strategy aims to increase overall forest cover from 17 to 25% and much of this is likely to be in the uplands.

Over-grazing has been the other major cause of loss of heather cover. The main grazers have been hill sheep, which increased by 32% between 1950 and 1990, though deer and other mammals, such as mountain hare, will have a lesser effect with occasional localised severe impacts (Moorland Working Group, 2002). Sheep numbers have largely been driven by agricultural subsidies and the change to the Single Farm Payment is likely to result in a decrease over the coming years, although deer numbers may rise where they were formerly in competition with sheep.

Agricultural intensification, largely in the form of drainage, has resulted in the loss of many of the wetter habitats, especially blanket bog and wet heath. The lowering of the water table, caused by drainage, can have an impact at a considerable distance from the drain itself. Drainage has a particularly severe impact on carbon storage as it may result in the rapid release of carbon in formerly waterlogged soils (SEERAD, 2007). (Note, drainage is also a feature of afforestation). Drains can precipitate gulley erosion, resulting in the widespread direct loss of peat. Drainage can also affect archaeological deposits, both by direct damage when cutting ditches and by lowering the water table. This promotes decomposition, thereby destroying pollen and other environmental evidence preserved in peat or wet conditions.

Inappropriate burning of heather, particularly in combination with high levels of grazing, can result in loss of heather to grassland. Burning can also result in the loss of several moorland species, particularly lichens (Davies and Legg, 2008). In contrast, well managed burning can preserve heather and diversify heather age structure. Some species, particularly reptiles, favour short heather and conversion to long heather may be detrimental to them. Burning can also exacerbate the loss of stored carbon: severe fires can burn into the peat and even less intense fires can promote cracking and drying of the surface which facilitates the release of carbon dioxide into the atmosphere and, in severe cases, erosion. Burning can also damage archaeological deposits and sites.

The spread of bracken can also result in the loss of heather. Bracken cover in Scotland increased by 79% between 1940 and 1980 and still appears to be continuing (Moorland Working Group, 2002). The spread of bracken is linked to a reduction in cattle numbers and the decline in frequency of spring frosts and is therefore likely to accelerate in future under the influence of climate change. Although swamping other vegetation types, including heather, bracken is an important habitat for a few species, such as pearl-bordered fritillary and may retain remnants of woodland ground flora. It impedes grazing and the movement of stock and can carry a very heavy load of ticks. Its rhizomes can damage archaeological remains. Intensive management (spraying with herbicide or repeated cutting) is usually needed to reduce bracken cover or prevent it spreading.

Climate change is likely to have a fundamental effect on moorland habitats, which are intimately linked with climatic conditions. Blanket bog, in particular, is the result of high rainfall and low temperatures which tend to inhibit the decomposition of organic material, resulting in the accumulation of peat. These are particularly widespread in western Scotland. In contrast, eastern Scotland tends to be dominated by dry heath, often grading into pine woodlands. Changes in temperature and rainfall will undoubtedly result in changes in the distribution of different moorland habitats. They will also affect the rate of loss or accumulation of carbon in peat soils. Climate change may also result in changing land management objectives for moorlands with unpredictable consequences.

Climate change may also affect the distribution of many typical moorland animal species. Changes in the timing of breeding of moorland birds have already been recorded and it is expected that some species adapted to high altitudes and low temperatures are likely to be lost.

One of the fastest growing types of development in moorland areas is the establishment of wind farms and the infrastructure (roads, pylons) needed to support these. Their greatest impact is on landscape and wild land quality because they tend to be large and in prominent, open locations. Although it is unlikely that large scale wind farms will be constructed on NTS property, the Trust is frequently asked to comment on wind farms on land nearby.

Moorland bird species are also affected by the loss of their typical habitats. The loss of heather, and occasionally increasing density or age of heather has been mirrored by a decline in species such as red grouse, stonechat, etc. Raptors, such as hen harrier, peregrine and golden eagle, have been lost as a result of direct persecution on some moorland (RSPB, 2008).

Grouse populations fluctuate on multi-annual cycles, partially driven by parasite loads but are threatened by the spread of ticks, which carry louping ill. Tick burdens have been increasing in recent years for reasons that are not clear, but may be associated with warming weather. Ticks also pose a threat to human health as they transmit Lyme disease.

MANAGEMENT PRACTICE

Land use change

The fundamental decision facing the Trust is whether to conserve existing areas of moorland or to allow them to change. The change may be planned (for instance the establishment of woodland) or by allowing plant communities within the moorland habitat mosaic to develop through natural succession without interference or priority being given to any particular one. In the past, major afforestation projects have been undertaken by NTS or previous owners at properties such as Ben Lawers, Torridon, Glencoe, Kintail and Mar Lodge. These were all designed to increase woodland cover at the expense of moorland, consistent with conservation priorities at the time. Provided some areas of moorland are retained nearby, woodland creation will result in a local net increase in biodiversity, but moorland species will inevitably decline in overall numbers and extent. Given the global importance of Scotland's moorland, this could be seen as deleterious. Conversely, it could be seen as reversing a past reduction in woodland cover caused in part by human action, combined with past climate change.

The impact of afforestation on landscape is also equivocal. On the one hand it can result in a more varied landscape but, on the other, it can restrict views and some of the former open landscape, typical of much of Scotland in recent centuries, will be lost. To the extent that moorland is a cultural landscape, albeit a relatively recent one, afforestation will result in the loss of cultural value too. Afforestation may also damage archaeological structures.

Afforestation also affects carbon balance. Tree roots tend to dry out soils and this will accelerate the rate of peat decomposition. However, the growth of trees itself results in sequestration of considerable quantities of carbon. Preliminary experiments indicate that afforestation with birch results in the loss of 20% of carbon compared with the pre-existing heather moorland; however more extensive research is ongoing. Moorland that is very wet also emits small amounts methane, which is many times worse than CO_2 as a greenhouse gas. The net effect of this is to counteract some or all of the carbon sequestered. The conversion of dry moorland to wet bog (e.g. by blocking drains or allowing them to deteriorate), in general, results in an increase in stored carbon.

The scientific understanding of the impact of moorland management and land-use change on carbon balance is evolving rapidly and this will demand an early review of these guidelines. A summary of the relevant factors in given in Table 2.

As with most complex management decisions, it is important to seek expert advice from specialists within and outwith the Trust in determining the preferred objectives.

Guidelines:

- **Moorland and its associated species are internationally important and there should be a presumption that the Trust will conserve or enhance existing areas. Decisions to convert moorland should be subject to a full conservation planning process, which may take into account factors such as the biodiversity or landscape value of the alternative land use (for example, native woodlands), and cultural or socio-economic factors.**
- **The role of moorland in the retention and accumulation of peat is crucial and it should be managed with this in mind. Any land-use change that is likely to result in a long-term net release of greenhouse gasses should be avoided.**
- **Where a decision to allow land-use change has been taken, conversion through natural succession should be the preferred method.**

Grazing management

Excessive levels of grazing can lead to a net loss of heather. These are normally associated with high densities of sheep or a combination of sheep and deer; they are probably no longer seen or are localized on Trust properties. Deer, on their own, rarely achieve sufficient density to result in other than very localised heather loss (Albon, et al., 2007).

There are many intermediate levels of grazing that can impact heather structure and biodiversity without resulting in a net loss in heather cover. A grazing density of around 20 deer per km^2 is probably sustainable in terms of maintaining heather area in dry conditions, but densities lower than 15 per km^2 are needed in blanket bog or in summit heath. Even moderate grazing levels result in a net loss in vegetation height and limit natural scrub and tree expansion. This can lead to a loss in habitat diversity.

The grazing density needed to allow trees to regenerate is much lower than that required for sustainable heather management, around 3 large animals per km^2. Deer on their own are capable of preventing tree regeneration and stringent deer control is needed to achieve this density. Feral goats could also have similar localised impacts as deer. At these densities, heather becomes taller and structural diversity is lost.

When heather has been lost through over-grazing, the moorland typically converts to *Molinia* grassland in wetter situations. This is resistant to grazing by sheep but its extent can be reduced by cattle grazing. In drier situations, the result is commonly an *Agrostis/Festuca* grassland which is palatable and sought by most herbivores.

Grazing ungulates can cause damage to vegetation through trampling. This is particularly important in wetter areas, where damage to *Sphagnum*-dominated communities can be significant. Trampling also opens up the sward and can facilitate the establishment of trees and other seedlings but can also result in loss of dwarf shrubs when severe.

The impact of grazing on carbon sequestration is as yet unclear, though trampling can certainly accelerate peat erosion. This topic will be kept under review.

Guidelines

- **Grazing, whether by livestock or wild herbivores, should be managed to achieve the land-use objectives decided through the conservation planning process (see previous section). Where moorland is to be conserved, herbivore densities should be no more than 15-20 deer per km^2 (or equivalent), depending on the ecological conditions. It may be desirable to have much lower densities, particularly if areas of taller heather are required. The impact of trampling must also be considered.**
- **On dry heath, the condition of the heather will be the main indicator of moorland condition, though other species, such as bog myrtle, may be more appropriate in wetter conditions.**

- **Appropriate monitoring procedures (for example Rapid Habitat Assessment) should be implemented to track the impacts of grazing pressure.**
- **The impact of grazing management on carbon balance will be kept under review.**

Burning

Seasonal burning of heather moorland maintains heather in its young, pioneer phase, which is more nutritious and productive both for sheep and grouse. It has been traditional for grouse since Victorian times and possibly longer for sheep. It is normally practised on a 10- to 15-year rotation, resulting in blocks of different-aged heather. This creates structural diversity, which favours some bird species living within it, allowing species such as red grouse to reach unnaturally high densities. It is likely that the current total area of heather moorland is partially the result of management by burning in the past, especially where it is almost a monoculture. Burning is not essential for the maintenance of heather as it will propagate itself by layering if allowed to grow long. Burning is also often used to manage *Molinia* grassland.

In contrast, burning practised badly can result in the complete loss of heather from an area and conversion to grassland, especially when combined with high sheep densities. It can also result in the loss of some components of biodiversity considered to have conservation value. McVean and Ratcliffe (1962) describe burnt heather moorland as impoverished and lacking in a large range of associated flowering plants. Lichen diversity declines after burning but can increase again after about 20 years, particularly those species growing on the ground. Rock-dwelling lichens have been found to decline following burning (Davies & Legg, 2008). Some habitat types, particularly hepatic mats and areas dominated by mosses, are very sensitive to burning. Burning, therefore, has mixed effects on biodiversity, largely negative, although some are positive and these need to be balanced against each other, depending on the strength of the effect and the importance of the species affected.

The Scottish Government has produced a Muirburn Code identifying which habitats are suitable for burning and which are not. The Code also contains advice on the timing of burning and measures to ensure that fires do not get out of control.

Burning creates a patchwork pattern, which has a major impact on the landscape over huge areas. While this can be viewed as a cultural tradition it can also be viewed as a detractor from wild land quality. It can also promote the spread of heather over other naturally occurring vegetation types, thereby creating an unnatural monoculture. Burning can make previous cultural landscapes more visible; however, more severe burning can damage archaeological sites and their underlying deposits.

Burning also affects the carbon balance of peat and peat-rich soils: by reducing the amount of accumulated vegetation it reduces long-term carbon storage. It also tends to increase the area of bare surface which accelerates peat decomposition and erosion (Yallop and Clutterbuck, 2009). In extreme cases, the fire burns into the peat, which results in a large loss of stored carbon. Cool fires may have positive effects on carbon storage by incorporating charcoal particles, but the dividing line between damaging, hot fires and beneficial, cool fires is so slim that a precautionary approach has caused Worral (2008) to advise against burning. Burning tends to maintain a monoculture of short heather and dries out the peat surface. Both of these factors increase the likelihood of fires causing damage. This has caused Natural England to recommend (Crowle, 2007) that burning should not be carried out on blanket peat, even as a fire control measure.

Burning is, of course, completely inimical to tree regeneration. In lowland heaths, burning is the main management method used to prevent colonisation by woodland. Burning can be used to reduce the thickness of ground vegetation and thereby accelerate seedling establishment; however its efficacy is less unless the moss layer is also burnt. Burning the moss layer carries the risk of igniting peat and causing extensive damage. Burning to accelerate woodland establishment can only be carried out once as seedlings and saplings would be destroyed by subsequent fires.

Cutting can be used on heather as an alternative to burning and may have a similar effect in maintaining a varied age structure or opening up the sward to promote seedling establishment. It is less damaging than burning in its impact on biodiversity, carbon storage and risk of uncontrolled fire but it can have significant

landscape impact. If cut material is left on the surface it can swamp the underlying vegetation and may increase the fire risk, but it is likely to increase the rate of carbon storage. The use of tractors and other machinery may damage the ground surface and their use of fuel impacts the overall carbon footprint.

A number of techniques have been used to lessen the risk of wild fires. These can be grouped into fire fighting preparedness, public education, the construction of fire breaks and measures to reduce fuel load. Fire fighting preparedness typically involves training staff, maintaining equipment (e.g. fire beaters, misting equipment) and providing facilities for professional firefighters (such as water-dipping points for helicopters). Public education includes general information on the need to avoid camp fires or discarding cigarettes, and specific information given at times of particularly high fire risk.

Firebreaks are strips of land cleared of vegetation designed to prevent fires from spreading. They are commonly used in managing controlled burns and, occasionally, in fighting wild fires. Wild fires are known to be able to jump over firebreaks for a distance of up to 3 times the flame height, or even further in strong winds. In order to be effective they therefore need to be 7-10m wide. Furthermore, they need to be continually maintained as they become increasingly ineffective if vegetation is allowed to build up, and are therefore unlikely to be acceptable on NTS properties as a permanent feature.

Fire risk is increased when the moisture content of the vegetation is lowest and also when vegetation density, and therefore fuel load, increases. Some practitioners recommend reducing fire risk by regular, prescribed burning to reduce fuel load. It should be noted that this does not totally protect against fire but merely reduces the intensity (heat) of the fire. This may reduce the impact on stored carbon and may make the fire easier to fight. However, because any burning accelerates carbon emissions (see above), the use of fire for this purpose is inadvisable.

Fire spreads most rapidly through areas of uniform vegetation, especially heather or *Molinia*. A landscape that is broken up, particularly by boggy areas, provides more protection.

Guidelines

- **There should be a presumption against the use of muirburn except where one or more of the following conditions apply:**
    - **Likely significant net benefits for biodiversity;**
    - **Significant net benefit to a recognized cultural landscape;**
    - **Significant net benefit to the economic viability of the hill farm or grouse shooting;**
    - **Significant likely long term benefit to carbon storage.**
- **Any decision to implement burning should be addressed explicitly through the property management planning process or in consultation with relevant Trust specialists.**
- **Cutting should be considered as an alternative to burning.**
- **Where muirburn is adopted, it should be carried out in accordance with current Scottish Government guidance on best practice. Records should be kept of the location and timing of all burning.**
- **Fire risk assessments should be carried out on all properties with significant areas of heather moorland and Fire Contingency Plans (FCP) should be prepared. These should consider the need for measures to reduce the spread of fires.**
- **Fire preparedness and public education should be the main components of FCPs.**
- **Fire breaks should not normally be used except as temporary measures in the fighting or control of fires.**
- **The use of prescribed burns to reduce fuel load is not recommended because of their impact on carbon storage.**

Tick/disease control

Tick abundance causes problems with the transmission of disease to both humans and wildlife, notably grouse. Louping ill causes large-scale mortality in grouse and is carried by mountain hares. The other major tick hosts are sheep and deer. Tick numbers have been building up in recent years, possibly driven by

increasing temperatures (milder winters) and the incidence of both louping ill and lyme disease has been increasing as well. One method of controlling ticks is by treating sheep with acaricides; the sheep then act as "mops", picking up ticks from the moorland and killing them. However, where sheep are not already present on moorland, this method would involve introducing new sheep and would therefore not be acceptable on most Trust properties where grazing control is an important objective. Where there is a significant population of deer, sheep treatment is less likely to be effective.

Guidelines

- **It would not normally be appropriate to introduce sheep solely for tick control, although treatment of existing sheep with acaricides is an accepted management practice.**
- **Information should be provided to staff and visitors of the dangers of tick-borne disease and the measures needed to guard against it.**

Drainage

Where moorland (particularly blanket bog) has been drained in the past ecological function declines and carbon stores tend to be lost both through drying and direct erosion. It may be possible to restore the water table by blocking the drains either with hard dams (normally corrugated plastic) or with straw or excavated peat. Some maintenance is required to prevent the dams from washing out as satisfactory restoration of the peat takes many years. Blocking drains not only restores wetland habitats but improves the functioning of the peat soils, slows the loss of stored carbon and provides some protection against wild fires.

Guidelines

- **Moorland should be managed to encourage the retention and accumulation of peat.**
- **Drains should not be maintained, no new drains should be created and priority should be given to restoring the natural hydrology by the blocking of drains.**

Tracks and vehicular use

The presence of tracks, either engineered or resulting from the use of off-road vehicles, can seriously detract from wild land value, both its landscape and by reducing travel times and therefore remoteness. However, tracks are also important for estate management, transporting materials, extracting venison, and access in the event of an emergency (mountain rescue or fire-fighting). Where they are no longer deemed necessary, the Trust can undertake the removal of tracks and their restoration to moorland.

The repeated use of off-road vehicles can cause landscape scars, damage to vegetation and, in extreme cases, increased erosion of peat. Good practice and careful choice of route can help to minimize these impacts. Repeated use of the same route can exacerbate the impact but can help to prevent more diffuse damage. Some vegetation types are more susceptible to damage, in ascending order from grass, through dwarf shrubs to bogs. High altitude vegetation is particularly susceptible and may take decades to recover after a single vehicle pass. The use of old roads and trackways may be advisable as they tend to avoid wet areas.

Guidelines

- **New vehicle tracks should not normally be constructed across moorland.**
- **Where they are no longer required, the Trust should consider the removal of tracks.**
- **The use of off-road vehicles on moorland should be minimized. Where they must be used, routes should be planned to reduce the extent of the impact on vegetation and landscape.**

Review

The understanding of moorland management, particularly the science of carbon balance, is advancing steadily.

- **These guidelines should be reviewed by 2015.**

Richard Luxmoore
May 2010

Approved by Leadership Team
August 2010

Table 1. NTS properties with moorland/upland

	Total area	Upland area	Notes/constraints
Balmacara	2748	1059	Crofting common grazings
Ben Lawers	4723	4401	Various agricultural tenants
Ben Lomond	2174	2079	Agricultural partnership
Blackhill	2	2	
Burg	569	569	Grazing lease
Canna	1317	1117	In hand livestock farm
Craigower	4	1	Small area within woodland
Culloden	63	50	In hand, battlefield area
Dollar Glen	22	3	Small area outwith woodland
Fair Isle	786	592	Crofting common grazings
Glencoe	5680	4930	In hand, some livestock
Goatfell	2285	2285	In hand, no livestock
Grey Mare's Tail	923	923	Agricultural tenant
Inverewe	863	450	Area leased to Tournaig Estate
Iona	848	400	Crofting common grazings
Kintail/W Affric	11093	10449	Agricultural tenancies
Leith Hall	112	2	
Mar Lodge	29380	27165	In hand; Grouse shooting interests
Mingulay	995	995	In hand, no livestock
St Abbs	170	10	Agricultural tenant
St Kilda	864	864	In hand, feral sheep
Staffa	42	42	In hand, no livestock
Torridon	5337	3591	1418ha of croft land
Unst	1550	1395	Crofting tenants
Total		63373	

Table 2 Factors affecting carbon storage and sequestration on moorland

Factor	Severity	Mitigation
Peat/organic content	Depth of peat or peat content of soil determines total carbon storage.	Avoid activities that might damage deep peat or peat-rich soils
Drainage – oxidation	Waterlogged peat is a stable, long term store of carbon, but carbon is lost through oxidation (as CO_2) when peat is allowed to dry out	Do not drain peat soils and try to restore hydrology in previously drained peats
Drainage – erosion	Particulate peat is lost through erosion as water is allowed to flow over exposed peat or through gullies/ditches.	Block up ditches, avoid creating areas of bare peat. Beware of new erosion channels developing as a result.
Climate change – temperature	Increased temperature favours drying and oxidation of peat	Maintain vegetation cover and waterlogged conditions
Climate change – rainfall	Increased rainfall promotes water-logging and slows oxidation but can increase gully erosion	Block up ditches, restore natural hydrology. Beware of new erosion channels developing as a result.
Vegetation type/productivity	Carbon sequestration depends on annual quantity of vegetation incorporated into peat/soil layer. *Sphagnum* is more completely incorporated than woody material.	Encourage return to *Sphagnum* cover or wet moorland
Muirburn – direct impacts	Burning releases carbon in standing vegetation into the air, though some particulate carbon may remain in soil after cool burns.	Avoid burning on peat. If burning is necessary on mineral soils, ensure burn is as cool as possible. Only burn

	Severe burns may ignite peat, causing loss of stored carbon and damage to archaeological remains.	when soil is wet. Consider cutting as an alternative.
Muirburn – indirect impacts	Burning tends to open vegetation structure which promotes drying, increases oxidation and may initiate erosion. Growth of new vegetation may increase grazing pressure.	As above. Avoid areas prone to erosion
Wild fires	Similar effects to muirburn, but tend to be over larger areas and more intense, especially where uniform heather and high fuel load.	Encourage mosaic of wet areas. Develop Fire Contingency Plans.
Grazing (both livestock and deer)	Grazing tends to remove standing biomass and may cause vegetation change. Both can reduce sequestration but effects are unclear.	Avoid overgrazing
Trampling	Tends to break up vegetation, especially *Sphagnum*, exposing peat to erosion	Avoid overstocking, particularly in wet areas and in winter
Cutting heather	Reduces standing biomass but dead material may be incorporated into peat. Litter left on surface may increase fire risk. Machinery may cause erosion.	Use appropriate machinery to reduce erosion. Avoid wet areas.
Afforestation	Tree growth increases carbon sequestration but this may be offset by losses of soil carbon in peaty soils.	Avoid planting trees on peat-rich soils
Tracks	Engineered tracks involve creating artificial drainage and disrupting hydrology of surrounding bog, leading to major loss of Carbon. Peat is also lost in construction process.	Avoid creating new tracks if possible. Essential tracks should follow mineral soils.

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Annex 1

NTS policies relevant to moorland and uplands

The **Conservation Principles** aim to protect cultural and natural diversity and local distinctiveness as features of national significance. "The Trust's properties celebrate the distinctiveness of Scotland's land and history, in the belief that Scotland's national identity is deeply rooted in its natural and cultural heritage."

The **Unna Principles** are taken to apply to all upland properties. They state that "sheep farming and cattle grazing may continue, but that deer stalking must cease, and no sport of any kind carried on or sporting rights sold or let; any use of the property for sport being wholly incompatible with the intention that the public should have unrestricted access and use". They recognise that deer management may be undertaken for conservation reasons. On Mar Lodge, the Unna Principles have been overridden by the wishes of the donor which require that the property be run as a traditional highland sporting estate. While championing public access, the Principles require that "the hills should not be made easier or safer to climb".

The **Farmland Management Policy** aims to establish farming practices which conserve and enhance the natural and cultural heritage of each holding. This aims to contribute to conserving and enhancing the natural heritage (including scenic beauty and biodiversity) and cultural heritage (including ..traditional farming practices) and the landscapes which result from the interaction of these factors.

The NTS **Grazing Working Party** Report (1992) recommended that the "NTS uses the status of heather at its moorland properties to make judgements about optimum grazing levels: if the heather is in decline then grazing levels are too high"

The **Wild Land Principles** (2002) define wild land as "relatively remote and inaccessible, not noticeably affected by contemporary human activity, and which offers high quality opportunities to escape from the pressures of everyday living". They are therefore principally concerned with the Trust's moorland and upland properties. They commit the Trust to manage areas with wild land quality appropriately so as to safeguard or, in some cases enhance, these qualities. Detractors of wild land quality include "recent signs of human activity, particularly 'man in charge of nature'".

The **Deer Management Policy** (2003) states that deer will be controlled in order to achieve landscape or nature conservation objectives. In order to identify these, the Trust will undertake a full assessment of each relevant Trust property to determine the status of the deer, the habitat and the aims and objectives for landscape, ecosystems and historic/archaeological remains. Where deer control is deemed necessary to achieve the required conservation objectives, this will be specified in the Property Management Plans or Property Statements.

The **Woodland Policy** (1994) aims to restore lost native woodland ecosystems in the wider countryside to satisfy the joint aims of nature and landscape conservation. Where woods are being created on open ground, native species should be chosen and natural regeneration should be the preferred restocking method. Reduction in grazing should always s be the first option; fencing should only be used where there is no alternative.

The **Landscape Policy** (2005) identifies landscape as the relationship between people and place and commits the Trust to championing the cause of improving, restoring and protecting Scotland's landscapes. Landscapes in our care will be managed to consistently high standards, making use of

theoretical tools in landscape evaluation and management. Landscapes are recognised as having environmental, social and economic values.

The **Peat Policy** commits the Trust to phasing out the use of peat in Trust gardens for all except essential purposes. . A very limited amount of peat use may continue at specific gardens in order to maintain a few key features of historical and horticultural sign