



FIRES

Interdisciplinary Research
on Ecosystem Services:
Fire and Climate Change
in UK Moorlands and Heaths

Seminar 1

The Role of Managed Fire
in Ecosystem Services of
UK Moorlands and Heathlands

The University of Edinburgh
31 March - 1 April 2008

Programme and Abstracts



FIRES

Interdisciplinary Research on Ecosystem Services: Fire and Climate Change in UK Moorlands and Heaths

FIRES is a series of four seminars and workshops on the effects of moorland and heathland wildfires and managed fires on ecosystem services that will be held during 2008-2009. The series is funded by the ERSC/NERC Transdisciplinary Seminar Series on Ecosystem Services. The objective of this scheme is to support the development of trans-disciplinary research across the social and natural sciences under the theme of sustaining future ecosystem services. It will bring together economists, social and environmental scientists, other experts and stakeholders to explore and develop ecosystems services approaches and help to build research capacity for future interdisciplinary research in this field. The particular focus from ESRC/NERC is in advancing research and enhancing knowledge transfer with non academic users and/or the inclusion of international academics at events.

Context

Moorland and heathland ecosystems in the UK both sustain human use and are sustained by it. Fire plays a key but equivocal role, raising many controversies for management and policy making, especially under the anticipated threat of climate change.

The diverse environmental, social and cultural ecosystem services provided by moorlands and heathlands include carbon storage, biodiversity, water provision, flood protection, aesthetic/recreational value, and economic value from tourism, sporting enterprises and grazing.

Managed fire has traditionally played an important role in maintaining the landscape and biodiversity. For instance, rotational burning is used to maintain heather moors for grouse and grazing animals and contributes to floristic diversity.

In contrast, accidental or malicious wildfires increasingly threaten moorland and heathland ecosystem services and are likely to become more frequent and severe with climate change.

Managed fires and wildfires are linked. Managed fires can reduce wildfire risk by reducing fuel load and creating firebreaks, but, if poorly controlled, can result in wildfires themselves. Research on wildfires in UK moorlands and heathlands is in its infancy and lacks co-ordination. This seminar series seeks to contribute to effective management of wildfire risk by identifying policy implications and developing a joined-up research agenda for the UK.

Aims

The aims of the four workshops in the seminar series are:

1. to build capacity for inter-disciplinary research on fire and its impacts on ecosystem services of UK heaths and moorlands;
2. to establish a cross-cutting interdisciplinary research agenda on the relationships between ecosystem services, managed fire and wildfire in UK heaths and moorlands, especially implications of increased wildfire risk under climate change scenarios;
3. to incorporate the needs of policy makers, moorland managers and other stakeholders, facilitate knowledge transfer to policy makers and contribute to adaptive management response.

Specific Objectives

The objectives of the seminar series are:

- to facilitate dialogue between participants on three levels: socio-economic, environmental and physical scientists; researchers, international and UK academics and postgraduate students; and, especially, researchers, stakeholders and policy-makers;
- to identify the ecosystem services of UK heaths and moorlands, assess the role of managed fire in maintaining them and the costs and benefits of reductions in prescribed burning;
- to assess the threats to these ecosystem services posed by wildfire, including an anticipated increased threat from climate change;
- to evaluate the suitability for the UK of three broad categories of modelling tools designed to minimise damage to people and the ecosystem: forecasting the timing and severity of wildfire risk; modelling the behaviour of active fires and their ecological impact; and spatially modelling their cause and distribution (including evaluating alternative conceptual and methodological approaches, identifying data needs and implications for policy);
- to identify alternative strategies for managing wildfire risk (now and in the future from climate change), discuss their relative costs and benefits for ecosystem services, and identify the political and institutional policy drivers;
- to disseminate findings and define an agenda for further cross-disciplinary research.

Funding

In addition to the core funding from the ERSC/NERC Transdisciplinary Seminar Series on Ecosystem Services, the FIRES Seminars are sponsored by Scottish Natural Heritage, the Game and Wildlife Conservation Trust, the University of Manchester School of Mathematics and the University of Manchester President's Fund. Support in-kind is provided by the institutions of the grant-holders and steering group; the University of Manchester, the University of Edinburgh, Moors for the Future Partnership, the University of Leeds, the Chief Fire Officers' Association, and the Heather Trust.

FIRES Steering Group

Julia McMorrow	University of Manchester;
Colin Legg	University of Edinburgh;
Jonathan Ayles	University of Manchester;
Jon Walker	Moors for the Future;
Klaus Hubacek	University of Leeds, Sustainability Research Institute;
Claire Quinn	University of Leeds, Sustainability Research Institute;
Simon Thorp	Heather Trust;
Mark Jones	Chief Fire Officers' Association;
Gina Cavan	University of Manchester.

Coordinated by: University of Manchester.

FIRES Series Programme

Seminar One

The role of managed fire in ecosystem services of UK moorlands and heathlands. Edinburgh, 31 March – 1 April 2008

Seminar Two

The impact of wildfire on ecosystem services: relationships between wildfire, climate change and people. Manchester 24 June 2008

Seminar Three

Forecasting and modelling wildfire risk for UK moorlands and heaths. Manchester, Easter 2009

Seminar Four

Adaptive Management to Wildfire Risk: implications for ecosystem services of UK moorlands and heaths. Peak District National Park, June 2009

Further details of the Seminar Series are available from:

<http://www.FIRES-Seminars.org.uk>

Seminar One

The Role of Managed Fire in Ecosystem Services of UK Moorlands and Heathlands

Edinburgh, 31 March – 1 April 2008

The seminar will review how fire has been used historically, and the role of managed burning today. We will identify the ecosystem services provided by UK moorlands and heathlands, including: biodiversity; carbon budget; water provision; rural livelihoods; landscape quality and recreational use. The focus for debate will be the extent to which managed fires contribute to the maintenance of these ecosystem services or pose threats to them, especially with changes in policy.

Programme - Monday 31 March

Playfair Library, Old College,
South Bridge, Edinburgh

For those staying overnight transport will be provided to the Old College leaving Holland House at 10.15 a.m.

10.30 Coffee and Registration

11.00 **Julia McMorro** (University of Manchester) Introduction to the Series

Session Chair Julia McMorro (University of Manchester)

11.20 **Charles Gimingham** (Aberdeen) Introduction: our heaths and moorlands - values and criteria for management

11.35 **Colin Legg and Matt Davies** (University of Edinburgh) Managed fire and fire regimes

12.00 **Althea Davies** (University of Stirling) Where do we set the baselines? A long-term perspective on fire management on moorlands

12.25 Panel discussion

12.40 Posters

1.00 Lunch

Session Chair Jonathan Ayle (University of Manchester)

2.15 **Stefanie O'Gorman** (Jacobs Babbie, Edinburgh) Ecosystem services in the uplands (Title TBC)

2.45 **Klaus Hubacek, Mark Reed and Claire Quinn** (University of Leeds) The Upland Economy, Ecosystems Services and Rural Livelihoods

3.15 Tea

Session Chair Simon Thorp (Heather Trust)

3.35 **Fred Worrall** (University of Durham) The consequence managed burning for carbon storage and sequestration in upland peat soils

4.00 **Adam Smith** (The Game and Wildlife Conservation Trust) Why is muirburn a hot topic for grouse-moor managers?

4.25 Discussion

4.50 **Martyn Howat** (Natural England) Roundup

5.00 Depart

For those staying for Day 2 of the seminar there will be a Conference Dinner at 7.00 p.m. followed by informal discussion in the Raeburn Room of Old College, the University of Edinburgh. A bar will be open in the Raeburn Room from 5.00 p.m.

Evening transport to Holland House will be provided as required.

Programme - Tuesday 1 April

Discussion Seminar By invitation

The Crew Building
The University of Edinburgh, King's Buildings

Transport will be provided to the King's Buildings leaving Holland House at 8.40 a.m.

The theme will be implications for ecosystem services of changes to the managed fire regime.

Session Chair Matt Davies (University of Edinburgh)

9.10 **Andrew Walker** (Yorkshire Water) Implications for water (Title TBC)

9.40 **Graham Sullivan** (SNH) Implications for biodiversity and conservation of changes in managed fire regimes

10.10 **Simon Thorp** (Heather Trust) Changes to the managed fire regime: implications for sport and agriculture

10.40 Coffee

Session Chair Alistair Hamilton (Scottish Agricultural College)

11.10 **Claire Quinn, Mark Reed and Klaus Hubacek** (University of Leeds) Rural livelihoods and managed burning

11.40 **Roger Sidaway** (University of Edinburgh) The role of managed fire on ecosystem services of UK moorlands and heathlands: the impacts on recreation and tourism

12.10 **Michael Bruce** (Firebreak Services) International context of managed fires (Title TBC)

12.30 Lunch

Session Chair Colin Legg (University of Edinburgh)

1.30 Break-out groups

2.45 Tea and coffee

3.00 Reporting back

3.25 **Rob Marrs** (University of Liverpool) Summing up

3.30 Depart

Transport will be provided to Waverly Station at 3.45 p.m.

List of delegates

Russell Anderson	Forest Research, russell.anderson@forestry.gsi.gov.uk
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George Winn-Darley	Moorland Association, gwd@gmvw.fsnet.co.uk
Fred Worrall	University of Durham, fred.worrall@durham.ac.uk

INTRODUCTION: Our Heaths and Moors – their Values, and the Criteria for Good Management

Charles Gimingham

University of Aberdeen (retired)

To introduce this Symposium I will touch on the origins of lowland and mid-altitude heathlands and moorlands in Britain and W. Europe, which explain how the values we have come to place upon them have emerged. I then comment on the role of ecological research during the past hundred years in understanding human impacts on these ecosystems, and its bearing on criteria for good management.

It is now clear that in most cases our heaths and moors were derived from former forest or woodland at various times from the Neolithic period onwards, and that this was associated with their use by the domestic animals of the growing human populations. These areas were evidently valued as grazing land, notably for sheep, cattle and ponies - a value which still holds in many places today. The heaths, which developed on acidic, freely drained soils, were largely dominated by heather (*Calluna vulgaris*) and this plant had additional values, for example as a source of thatch, fuel, foundations for tracks, honey for bees, dyes for fabrics, etc. Much more recently, expansion of heather areas led to increases in the populations of grouse and deer for which it is a major food source. With the rise in demand for sport shooting and stalking, a new source of value was opened to landowners. Heathlands and moorlands are valued, too, for landscape quality and for their contribution to the conservation of biodiversity in these habitats.

Heather, however, is a woody perennial of limited lifespan, and unless managed by removal of ageing woody biomass is readily replaced by competitor species (e.g. grasses, bracken) or the return of trees. Carefully controlled grazing or cutting may delay this succession, but it was soon apparent that fire was a convenient tool for this purpose and burning management became the norm. When properly controlled, fires will promote quick regeneration of heather, either vegetatively or from a seed bank.

However, by the 1950s it was evident that both herbivore production and grouse populations were in decline, leading to alarm that overgrazing and fire were depleting the ecosystems of nutrients. This was a time when studies on production ecology and nutrient budgets were in vogue. From these programmes much valuable research on heathland ecosystems was initiated, including some of the first work on nutrient inputs in rainfall. This enabled some of the concerns over possible progressive depletion of the nutrient funds to be allayed, while more recent studies on the ecological effects of management by fire have been very productive in helping to promote good practice.

Although perhaps less evident in N. Britain than elsewhere, during the past hundred years various influences have led to widespread and continuing losses of heath and moorland in W. Europe. This emphasises the need for careful management if they are to survive. Where this involves the use of fire, guidelines for good burning management are now well established and must be followed to keep heather stands in good health and minimise the risk of wildfires. This is not to advocate the creation of extensive, monotonous tracts of dominant even-aged heather, but rather to promote mosaics of patches of varying age.

Managed Fire and Fire Regimes

Colin Legg and Matt Davies
The University of Edinburgh

Managed fire is deliberately set and controlled in order to achieve particular management objectives while wildfires are uncontrolled fires that are outside management plans and these can have impacts on ecosystems that are very different from managed fires. Prescribed burning is used extensively in upland Britain for habitat management for red grouse on heather moorland. Fire is also used extensively to regenerate heather moorland and grassland (principally where dominated by purple moor grass, *Molinia caerulea*) for cattle, sheep and deer. Other less frequent uses include control of gorse, promotion or prevention of tree regeneration, reducing fuel load and wildfire hazard, and manipulation of vegetation structure and composition for conservation purposes.

The impact of fire on ecosystems and ecosystem services can vary enormously from superficial grass fires that remove dry surface litter, but are virtually undetectable in a few weeks, to peat fires that may burn for months and cause major and effectively irreversible changes to the ecosystem. The difference between managed fires and wildfires, and between mild and severe fires, is all to do with fire regime.

The fire regime at a particular site may loosely be defined by the frequency, intensity or severity, size and season of the burning. In this talk we will highlight the factors that determine the fire regime of managed sites and explore some of the reasons why ecosystem impacts vary so much with different fire regimes.

There are three determinants of fire regime: 1/ weather conditions set limits on when vegetation will burn and when it will not, and also influence the intensity of the fire; 2/ it is the ecology of the vegetation and dominant species that determines what fuel is available to burn and this interacts with weather to determine fire behaviour; and finally, 3/ virtually all fires in the UK are anthropogenic and it is human behaviour that determines where and when fires will be lit and whether they will be controlled.

To understand the effects of fire we need to consider a wide range of different spatial and temporal scales. For example, the immediate effects are to kill some animals and (parts of) plants; to shift material to the atmosphere as gases (e.g. carbon dioxide) and smoke, and to expose the ground surface. In the intermediate-term, however, new habitats are created for species that could not exist in the unburnt vegetation, plant growth is stimulated and the rate of carbon sequestration may be increased. In the long term, viewed over several fire cycles, impacts depend on fire history: where there has been a long history of fire then the system may be maintained in a more-or-less stable state by continuation of the fire regime, but where fire is a recent introduction, or where historic fire frequency is altered, there will be progressive changes of the ecosystem characteristics towards a new equilibrium. In the long term fire determines the main vegetation type, land use and landscape characteristics. Whether or not these changes are desirable depends largely on management objectives.

Where do we set the Baselines?

A Long-term Perspective on Fire Management on Moorlands

Althea Davies

School of Biological & Environmental Sciences, University of Stirling

Fire is considered an integral aspect of management in many heath- and moorland habitats, but the extent to which it is essential for their dynamics and diversity is in review, particularly with changes in upland farming and the growing concern over carbon management. Taking a step back to view these current issues in a longer-term context can help stimulate debate over how and where baselines and targets are set.

This presentation summarises the longer-term evidence (for the Holocene, but focussing on recent centuries) and research gaps on the following issues relating to ecosystem services, with a focus on Scottish uplands:

1. *The history of burning*: just how ‘natural’ or ‘traditional’ a part of moorland dynamics is burning? A brief summary is presented of the history of burning, both natural (climatic) and deliberate, including the aims of historic management fires, i.e. the extent to which maintaining heather was always the aim of burning. This longer-term perspective provides a rather different view on setting appropriate baselines when compared with recent work by Yallop *et al.* (2006) on burning in English moors.

2. *Biodiversity*: how much is known about the long-term impacts of burning on heath- and moorland diversity? How much did grazing interact with burning to determine diversity? Pollen records can provide a proxy for long-term diversity, in the sense of taxonomic richness and vegetation evenness or heterogeneity. Recent palaeoenvironmental and documentary studies are used to examine how burning management has shaped current upland values, including concerns over the loss of heather. More such detailed and statistical analyses are needed to understand the dynamics and fire impacts over the full range of heath- and moorland communities, since most work relates to blanket peats, with a little data from dry grass heaths.

3. *Rural livelihoods*: how have changing patterns of upland management affected the quality and appearance of upland hills and moors, and how did the establishment of grouse moors and extensive hill sheep farming affect a ‘tradition’ of burning? This is relevant to the increasing shift from production to conservation and environmental stewardship, since many land managers feel that agriculture is being pushed aside in favour of conservation and understanding diversity benefits from agricultural methods are thus useful for shaping agri-environmental policy. In addition, examining how millennia of land-use have shaped our moors provides a very necessary context for any debate over ‘naturalness’, ‘re-wilding’ and landscape values.

4. *Carbon budgets*: a few years ago carbon was barely mentioned in policy or agency documents, but habitat management for C storage is now an increasing concern. This is also, however, a major gap in present research knowledge since very little long-term data are available to help understand the interactions between climate, burning, grazing and C accumulation/erosion. The evidence is summarised and the management implications considered. This is an area very much in need of more research to improve and reconcile macro- and micro-level understanding of processes and ‘good practice’ for ensuring long-term C sequestration, especially in conjunction with ‘favourable condition’ and habitat restoration.

Ecosystem services in the Uplands (Title TBC)

Stefanie O’Gorman

Jacobs Bابتie

The Upland Economy, Ecosystems Services and Rural Livelihoods

Klaus Hubacek, Mark Reed and Claire Quinn

The University of Leeds

Upland regions in the UK and Europe are often plagued by very similar issues: most are economically marginal and tend to be environmentally sensitive, and generally they face rapid socio-economic changes that are often driven by national and international policies. These are themselves responses to a range of pressures that include demographic shifts, economic development and environmental changes such as climate change, pollution, and the loss of biodiversity. Sustainability in such contexts is often only referred to in environmental terms but social, cultural and economic aspects need to be considered and carefully balanced.

Upland areas are often recognized for their outstanding beauty and for their provision of ecosystems services. This often includes lowland beneficiaries. This can lead to a mismatch of costs incurred by those who provide for ecosystems services and those who enjoy their benefits. Policies directed to sustaining the long term functioning of ecosystems services and at the same time providing for a vibrant rural community therefore need to fully recognize and appreciate the inseparable interaction between the bio-physical environment and economic activities taking place in the area.

Managed burning as a land management tool has to be analysed within this context. Managed burning and sheep grazing are widely perceived to play a key role in maintaining upland dwarf shrub and blanket bog habitats, providing agricultural outputs as well as the aesthetics that local residents, recreationalists and tourists value. This form of land management is therefore often seen as an important contributor to the local economy through jobs and income created through hunting and tourism. These economies have often moved beyond the mere production of food and fibre and have developed into complex economies in which the agricultural sector has seemingly lost its importance. But other ecosystems services such as water provision, flood prevention, biodiversity, and carbon sequestration are important functions that land managers provide as by-products of their activities, often without remuneration.

Thus it is necessary to find out how burning affects these ecosystems services: are there trade-offs between grouse production, biodiversity and clean water or is it possible to manage them synergistically; and how can institutions be designed to incentivise land managers to optimally provide these services but also feed back some of the benefits to help maintain vibrant rural communities?

The consequence managed burning for carbon storage and sequestration in upland peat soils

Fred Worrall

Department of Earth Sciences, University of Durham

Managed burning is a common management practice for vegetation control in the British uplands, however the extent of research on the consequences for soil and water quality and subsequently for carbon sequestration is very limited. The research reported here has used the Hard Hill plots within the Moor House Environmental Change Network site that have been under controlled management since 1954. The burn treatments include plots undergoing 10 and 20 year burns in a complete replicated factorial design with sheep enclosure and unburnt controls. In April 2005 replicated plots for each treatment and control were instrumented with triplicate piezometers, in October 2006 this instrumentation was augmented with triplicate runoff traps and gas collars. This meant that monitoring could include the following range of carbon species: DOC in both runoff and soil water; soil respiration of CO₂; uptake of CO₂ by primary productivity and dissolved CO₂ content of soil water. All sampling was supported by monitoring of water table depth and climatic conditions. The monitoring was maintained on at least a monthly basis and the 10-year burn plots were burnt in February 2007 which means that data was available for at least a year before and after the controlled burn. In addition soil cores were taken from all plots before the burning in 2007. The data from the field site has been supported by laboratory burning experiments and computer modelling. The study has shown that:

- i) Water tables were consistently higher on burn plots than on unburnt plots which is consistent with the changes in water balance due to taller vegetation on the unburnt plots; it is not necessarily an effect of burning itself.
- ii) It is not possible to distinguish whether change in carbon uptake and release pathways are due to loss of vegetation or whether the effect is unique to burning.
- iii) A computer model has been developed to study peat and carbon accumulation under fire management, the model is calibrated with results from laboratory experiments.

The results from the study show that burning under controlled conditions is not a universal bad with regard to soil and water quality, and that under some conditions it might be possible that burning leads to increased carbon sequestration. However, the risk associated with this management is not known and it is clear that fires that are “hot” rather “cool” do lead to overall carbon loss. The experimentation is continuing on the consequences of fire by examining cut sites and wildfire sites.

Why Muirburn is a Hot Topic for those Managing Moorland for Sport

Adam Smith

Game & Wildlife Conservation Trust, Drumochter Lodge, Dalwhinnie

Research has shown that the suite of management activities undertaken to sustain a sporting interest in red grouse is likely to be associated with retention of heather moorland, a series of habitats of international conservation importance. One of these management activities is the burning of heather (*Calluna vulgaris*) by gamekeepers in strips over a rotation of 10-20 years to provide a mosaic of different ages and structures that favour both foraging and cover for red grouse (*Lagopus lagopus scoticus*) and red deer. The need for this management is indicated in research which suggests that there are some positive relationships between muirburn and red grouse populations and the use of heather and grass mosaics by red deer and mountain hares.

Despite this, inappropriate rotational burning, together with overgrazing by sheep and deer, is cited as one of the two primary reasons for many upland SSSIs in England and Scotland being deemed to be in unfavourable condition. There has also been a considerable debate between moorland managers and statutory conservation bodies on the potential impact of heather burning on carbon sequestration and breeding birds, notably direct effects on the protection of ground nesting species in relation to postulated advances in the commencement of breeding associated with climate warming.

Reducing or restricting muirburn has been suggested as a way of mitigating the concerns identified above. However, these proposals could have a range of unintended consequences which could lead to reduced conservation value in the uplands. Apparently limited restrictions on timing of burning may affect the ability to conduct any muirburn. The ability to manage the impact of heather beetle may be more restricted than they are already. Changes in the grazing stock densities of upland areas may also require muirburn in order to mitigate possible loss of habitat quality and wildfire risk. Finally reduced or restricted burning patterns may negatively affect some moorland bird populations.

It is possible therefore that there could be potential for two European designations for the same piece of ground, an SAC designation (Special Area of Conservation) for the quality of moorland habitats, and an SPA designation (Special Protection Area) for supporting internationally important populations of breeding birds to be at odds.

DAY 2 : Invited discussion seminar

Implications for ecosystem services of changes in managed fire regimes

Implications for Water

Andrew Walker

Yorkshire Water

The Implications for Biodiversity and Conservation of Changes in Managed Fire Regimes

Graham Sullivan

Scottish Natural Heritage

In addition to direct effects on individual organisms, fire has impacts on a wide range of ecological factors and processes. Among the most significant ways in which these affect biodiversity are their influence on vegetation structure and species composition of habitats, and the suitability of these habitats in providing feeding, prey, nest sites and shelter for fauna.

The impacts of managed (or indeed unmanaged) fire on biodiversity vary not just according to the characteristics of individual fires and the fire regime but also with the way in which these impacts are assessed. For example an area of rotationally burnt dry heath will generally support fewer species than the same area were it allowed to succeed to woodland, but when considered at the habitat level dry heath forms a valuable component of biodiversity. It should also be noted that consensus does not exist among all interested parties over the benefits and disbenefits of managed fire in a range of circumstances.

Location, extent, scale, frequency, intensity and timing of fire can vary, either spatially, temporally, or both, and existing managed fire regimes can differ enormously. Many of the factors which may drive change in these regimes, and thus changes in their impacts on biodiversity and conservation, are the same factors that currently operate. These include:

- land management objectives;
- effort and resources available;
- traditions, experiences, and views of practitioners;
- legislation, policy, and incentives;
- direct and indirect effects of climate change.

There is a need to assess how changes in these factors will alter fire regimes, and thus impacts on biodiversity in the future. Much is known about the effect of fire on some elements of biodiversity, and this provides a useful basis on which to build, but for some others information is lacking. Filling gaps in this knowledge, and considering it in the context of what changes are likely in fire regimes, should inform assessment of the likely impact of such changes on biodiversity. In turn this should allow determination of whether and how the factors that influence fire regimes might be modified or responded to for the benefit of biodiversity and conservation.

Changes to the Managed Fire Regime: Implications for Sport & Agriculture: Introduction to the Discussion

Simon Thorp
The Heather Trust

1 Why burn heather?

- 1.1 The benefits and risks from burning associated with sporting and agricultural uses of moorland will be considered.
- 1.2 A comparison will also be made with the perceived benefits and risks from a conservation viewpoint.

2 The risks to ecosystem services from burning heather

- 2.1 The principal risks associated with burning heather and the potential impact on ecosystem services will be summarised.

3 The possible impact of changes to the prescribed burning regime

- 3.1 Changes to the prescribed burning regime, whether these are introduced as a result of climate change or by revised legislation, will result in changes to the balance between different vegetation species and the condition of the moorland.
- 3.2 The possible changes introduced under different scenarios will be summarised.

4 Summary

- 4.1 It will be suggested that “good burning is good for moorland, but that bad burning can be very bad”.
- 4.2 It will be suggested that the main drivers of change are climate change and the possibility of introducing more restrictive legislation with a view to ‘protecting’ moorland areas.

5 Questions for discussion

- 5.1 A series of questions will be posed to trigger discussion.
- 5.2 The aim will be to draw some conclusions from the discussion before the end of the time allocated.

Rural Livelihoods and Managed Burning

Claire Quinn, Klaus Hubacek and Mark Reed
Sustainability Research Institute, University of Leeds

Local rural livelihoods are linked to the bio-physical conditions in uplands in the UK. It can be argued that many of the ecosystem services currently provided by uplands are the result of long term management for grouse and sheep. However, there are now competing demands on upland landscapes, for agricultural/grouse production, and for services such as biodiversity, water and carbon storage that benefit wider society. Managing those competing demands is vital to the future sustainability of UK uplands.

Points for discussion:

1. Diverse conflicting objectives on different scales – zoning for ecosystem services

Questions:

Can we balance the needs of local economy, society and traditions against the demands of the wider society for services from the uplands?

Is there the potential for win-win outcomes?

Different places have different and often competing objectives for uplands. There will be the need for trade-offs between priorities but also the opportunity for win-win situations. Private ownership will come under pressure from regulation (removing rights) or through the buy-out of rights (subsidies or beneficiary pays). However, it may not be politically feasible to remove rights from a well organized, highly influential, homogenous group of stakeholders.

2. New roles of upland managers

Questions:

How can we compensate land managers for costs incurred for ecosystem services?

Would upland farmers want to become ‘landscape gardeners’ managing for ecosystem services rather than food?

Most farmers in uplands are aware that they could not survive without subsidies. We therefore need to think about whether mechanisms that pay land managers for ecosystem services are the way to promote sustainability in uplands. However, if zoning is considered then there may be differential payments and regulations depending on location and the priorities attached to those locations.

3. Potential drivers of change and implications for upland management

Questions:

How will population growth, doubling of world grain prices and increasing demand for biofuels influence upland systems?

How would managing for carbon and water change the uplands?

New changes in the agricultural sector are already taking effect. Bluetongue and Foot and Mouth have had a serious impact on sheep farming this year – average price of upland lamb is £10. Feed prices have increased due to increases in grain prices on world markets. Fertiliser prices have doubled this year because of rising oil prices and many upland farmers are considering not using fertiliser this year. Ultimately upland areas are marginal for farming, so opportunities in the arable, biofuels and intensive agriculture sectors will not be available to all upland farmers.

The Role of Managed Fire on Ecosystem Services of UK Moorlands and Heathlands: the Impacts on Recreation and Tourism

Roger Sidaway

The University of Edinburgh

Aims and Approach

This presentation outlines the main issues in the context of recreation and tourism, including both short term visual impacts and long term effects on the landscape, with the aim of identifying priorities for future work. As the literature concentrates on the impacts of wild fire, the reduction of risk and temporary restrictions on recreational access for safety, this presentation draws on my previous work on 'wildland' and landscape seen from a recreation perspective.

The Wildland Debate in Scotland

It is widely recognised that there is no 'pristine wilderness' in Britain and that landscapes perceived as 'natural' are heavily influenced by previous or current human activity. This has led to the use of the term 'wildland' being attached to remote areas in Scotland; where the landscapes have an ecological and spiritual dimension and human intervention is thought to be minimal.

My earlier synthesis of visitors' expectations of artefacts in the landscape identified the following dimensions:

- location: remote areas are associated with naturalness;
- incongruity: impacts of pastoral and recreational activities pass unnoticed, industrial activities are incongruous;
- venerability and habitat recovery are acceptable; and that
- awareness of impacts is low as long as their scale and frequency is low.

Features seen as 'visual detractors' in the landscape include: new buildings, tracks, concrete and metal structures (notably pylons); intensive agriculture and afforestation (notably sitka spruce plantations); and the intrusion of tourists (People not like Us) and their noise and clutter, such as ski tows, motor sports and possibly mountain bikes. Older structures (even mine workings) become part of heritage and are revered. 'People like Us' and the trampling damage they inflict on tracks are generally accepted. So too is the rural way of life, recognising that ordinary people have to make a living and farming, grazing and herding sheep with dogs are part of the rural scene. Significantly controlled burning and its effects are notably absent from this literature and in areas such as the North Pennines, it is accepted that landscape quality may depend on the variety of colours and textures provided by controlled burning and recovery of heather. The literature on tourism reveals a similar picture.

Topics for consideration

This brief review calls into question whether dependence of moorland on the burning regime is understood by most visitors and whether controlled burning is perceived as a management practice or an act of God. It may be that moorland management is widely accepted as part of the rural way of life, particularly if it is recognised as a temporary transitional phase. Arguably the burning of lowland heathland may be perceived differently because of its greater accessibility and proximity to urban areas.

International Context of Managed Fires

Michael Bruce
Firebreak Services Ltd

Poster Abstracts

The Classification of Heather Canopies on Upland Moors by Optical Methods

Alasdair A. Mac Arthur¹ & Tim J. Malthus²

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Upland moors are utilised for agricultural, sporting and recreational activities and are of international importance for biodiversity conservation. However, as the substrata are predominantly peat, these upland areas are of global significance as a store of carbon which, if released, would enter the carbon cycle and could contribute to climate change. As Earth surface flora can be used as ecological indicators, the spatial extent and health and vigour of heather, the dominant surface flora on many upland areas could be used to indicate underlying strata type and ecological condition and, hence, over time, be used to indicate the rate and direction of environmental change.

Remote Sensing (RS) offers an approach that is objective, replicable and practical in covering extensive areas. Nevertheless, acquiring an adequate level of detail and classification accuracy with RS has proved problematic. An objective and replicable non destructive method to classify heather canopies would greatly assist in the survey and monitoring of these extensive uplands areas. The UK now has high spatial resolution digital aerial photographic coverage of extensive areas of uplands and advances in image analysis methods may enable these images to be used to quantify and classify heather cover.

This poster reports on progress to quantify and classify heather using object based image analysis. Results presented demonstrate that heather can be classified, the spatial extent of each class mapped and percentage of ground cover of each class ascertained. In addition, the optimum time of year for aerial photographic surveys is recommended. Further, an optical non destructive ground survey method has been developed to classify heather canopies and results show that this can be used to quantify and classify heather canopies and validate image analysis products.

These objective and replicable survey and analysis methods will enable inventories of heather cover to be established and change to this cover quantified and monitored over time. In addition, data acquired by these methods can be used to compute canopy biomass per unit area and serve as input to grazing ecology models used to assist moorland management.

Optical Instruments to Assist FIRES Research

Alasdair A. Mac Arthur¹, Chris MacLellan¹ & Tim J. Malthus²

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The NERC Field Spectroscopy Facility (FSF) is a world class facility supporting Earth System Science. It comprises of a pool of high quality field spectroradiometers with associated calibration and support equipment and is based in the School of GeoSciences, University of Edinburgh. The Facility supports research projects of relevance to the broad range of NERC's Strategic Priority areas including ecological science. Instruments are available free of charge to the UK research community through the FSF Steering Committee expert peer review process. User training, on a one-to-one basis, is offered to all new users. Refresher training courses can also be arranged if required. In addition, a three day 'Introduction to Field Spectroscopy' course is held annually.

The Facility holds a range of high resolution, field portable and environmentally rugged instrumentation for use in remote locations worldwide. This includes: a number of spectroradiometers for the measurement of optical properties over the 400-2500 nm wavelength range and a FTIR for measurements in the thermal infrared wavelength range. In addition, the Facility has a number of hand-held sunphotometers for the determination of aerosol optical thickness, ozone, water vapour to aid the atmospheric correction of aerial images or for atmospheric aerosols research.

The Facility's instruments can be used to calibrate and validate aerial acquired data products of upland areas. These instruments can be used in the field or in the laboratory to measure the impact that change to upland ecosystem component state variables has on component optical properties. Further, the Facility's instruments can be used to measure gaseous emissions from Earth surfaces and from fires.

All FSF instruments are regularly calibrated to national standards. In addition, the Facility offers a service to calibrate third party spectroradiometers and reference panels to the UK academic research community.

Fire experiments for *Calluna* heathland conservation in NW Italy

Daide Ascoli and Giovanni Bovio

University of Torino

In Italy *Calluna vulgaris* heathlands are rare ecosystems mainly located in isolated protected areas of the NW plain. Among the urban growth these biotopes represent an important shelter for several endangered plant and animal species. Rotational fire and grazing by local farmers were dominant features in heathland management of NW Italy. As a consequence of the changes in rural practices, they have been gradually abandoned during the last 50 years. Changes in fire regime and reduced grazing pressure are probably major responsible for *Populus tremula* and *Molinia arundinacea* encroachment and subsequent ecologically adverse shifts in composition, structure and diversity of heathlands. This raises a serious conservation concern: heathlands are changing to woodlands and grasslands, with the risk that their natural, landscape and historical values will be lost. Like Muirburning in the UK, prescribed fire could be a suitable management tool in NW Italy. A long term fire experiment, started in 2004 at the Managed Nature Reserve of Vauda, Regione Piemonte, was designed to test the effect of fire frequency, backfire and headfire treatments on tree mortality and *Calluna* regeneration. The microplot scale analysis of fire behaviour enabled to cope with fire heterogeneity quantifying fine fuel consumption, rate of spread, flame residence time and fireline intensity with spatial and temporal resolution. *Calluna* showed a better regeneration after high intensity (3556 kW/m) quick moving fire fronts (12 m/min) with low flame residence time (15 sec). *Populus tremula* showed a dramatic resprouts capability which recovered up to 70% of pre-burn canopy cover. On the basis of short-term monitoring of vegetation responses to fire treatments a set of preliminary prescriptions for heathland conservation management by prescribed fire was established. Selective grazing after fire for limiting tree abundance is a necessary consequence.

Perceptions of Landscape and the Use of Fire as a Management Tool

Teresa Valor Ivars, G. Matt Davies and Colin Legg
The University of Edinburgh

See pdf of poster

This project examined perceptions of landscape and the use of fire as a management tool (muirburn) amongst stakeholders and visitors in the Cairngorms National Park. Muirburn is controversial, both within the Cairngorms and in the UK as a whole. Within the Park heather burning is widely used for game management and there are potential conflicts with other landuse interests. This provides an interesting context to carry out the research.

Key stakeholders, representing conservation, forestry, the National Park Authority and sporting interests, were sought using snowball sampling and 10 semi-structured interviews were arranged. Data were analysed using qualitative and semi-quantitative methods to gain an understanding of the different perspectives of stakeholders. This reveals opposing perceptions and understanding amongst different sectors. It is clear that there is little agreement between the different stakeholder groups over the meaning of terms like 'moorland in good condition' and that care must be taken to avoid misunderstanding in dialogue between the different groups. The diversity of views is unlikely to be resolved easily so there must be space for a diversity of management practices.

The perceptions of visitors to the Cairngorms were obtained using a questionnaire-based interview. One hundred and two questionnaires about fire and moorland landscapes were completed by visitors at three different sites. Data were analysed using both qualitative and quantitative methods. This identified three main sets of contrasting opinions amongst the respondents which relate to: 1/ frequent visitors with a good knowledge of moorland management practices *versus* those with little knowledge, but who think moorland management is for conservation of moorland birds; 2/ those with an interest in practical land management and forestry contrast with those who consider access and leisure issues more important; and 3/ those who would like to see moorlands changed to improve access, conservation and forestry contrasted with those with little knowledge but who think the Cairngorm moorlands are primarily managed for sheep (and had come to the Cairngorms primarily to visit family!).

The Effects of Increased Atmospheric Nitrogen on Ombrotrophic Bog Vegetation.

I. D. Leith*, L. J. Sheppard, N. van Dijk, J. N. Cape & M. A. Sutton
Centre for Ecology and Hydrology - Edinburgh,

See pdf of poster

The main anthropogenic sources of atmospheric nitrogen deposition are reduced NH_x from agriculture and oxidised (NO_y) from industry and vehicle emissions. Enhanced inputs of atmospheric nitrogen are a threat to nutrient sensitive habitats. In many of the areas of Europe with internationally important bog habitats, the Critical Load ($5\text{-}10 \text{ kg N ha}^{-1} \text{ y}^{-1}$) is currently being exceeded. Bryophytes (especially *Sphagnum* species) and lichens are important keystone species of bogs and are known to be susceptible to increased inputs of N. However, our understanding of the main drivers and the roles of the different N forms in these N responses has not been widely investigated.

The effects of the different nitrogen forms: gaseous ammonia (simulating an agricultural point source) or wet ammonium (NH_4^+) or nitrate (NO_3^-) in precipitation and increased N deposition have been studied on an ombrotrophic bog (NVC M19: *Calluna vulgaris*–*Eriophorum vaginatum* bog) at a N manipulation field facility in south-east Scotland since 2002. This unique long-term N manipulation study simulates 'real world' field conditions with the N treatment inputs coupled directly to the prevailing meteorology.

The changes in biodiversity, species cover, visible injury, foliar chemistry and increased susceptibility to secondary stresses such as frost, drought and fungal pathogens will be reported for the keystone species.

Dry deposition (ammonia) on a per unit nitrogen basis was found to be more damaging to *Calluna vulgaris*, *Sphagnum* spp. and lichens than wet deposition applied as either ammonium or nitrate.

Developing Wildfire Management through Fire Groups in Northern England

Ethan Bigelow

Rural Development Initiatives, Cockle Park, Morpeth

This poster will introduce those groups that make up the Northumberland Fire Group. Group members range from organisations like the Forestry Commission and the Northumberland Fire and Rescue Services to Natural England and private land owners and managers. The group aims to combine the resources and interests of these bodies into one cohesive strategy for the development of wildfire management in Northumberland. The poster will also introduce the developing Cumbria Wildfire Group and the future goals for wildfire groups in the UK.

Should Prescribed Fire be Used on UK Peatlands?

Alan Gray

Centre for Ecology & Hydrology - Edinburgh

Climate change (warmer and drier summers in the UK) is leading to increased fire frequency¹. Land use change, e.g. reduction in grazing and management fires, has also resulted in an increased fire hazard. Particularly problematic in peatlands are large intense fires which ignite the peat. Management by frequent small-scale prescribed fires reduces fuel load and hence the risk of damaging wildfires². Concern over the environmental impact of changes to fire regimes (i.e. frequency, intensity, size, season) is, compounded by a lack of data on the impacts of fire regime on biodiversity, soil erosion, water quality, carbon sequestration and other ecosystem services in peatlands. Given this, should prescribed fire be used on UK peatlands to manage fire risk?

The 'traditional' perception of a peatland is of a fire-free wet *Sphagnum* dominated area, however in the UK, many deep peat areas are covered by dense canopies of *Calluna vulgaris*. Climate change may increase this vegetation which in turn may also increase peatland fire risk. Prescribed fire can be used to alter vegetation composition and thus manage fuel loads. With a lower fuel load the risk of damaging intense fires may be lessened. Peatland patterning (e.g. hummocks hollows and pools) appears to involve many processes³ (e.g. climate and hydrology), however, fire has rarely been considered as a contributory factor; it may be that a differential response to fire is also crucial.

Fire has the potential to affect all aspects of the peatland carbon cycle and undoubtedly leads to initial losses of carbon. However, does post fire vegetation fix carbon at a higher or lower rate than pre-fire vegetation? How long does this persist? Fire may also lead to an increase in methane flux. The mechanisms for this rise are unknown but may include alterations to the microbial community, nutrient inputs and vegetation composition. At present, the debate surrounding fire and the peatland carbon cycle remains hypothetical, as applied research is lacking.

The use of prescribed fire is currently discouraged on UK peatlands⁴ but there is an urgent need for applied research to inform management practice and policy, particularly in the light of climate change and the present lack of data. Research on prescribed fires in peatlands might include such questions as:

1. When, and at what frequency, is prescribed fire good and when is it better to risk accidental wildfire?
2. What are the effects of using prescribed fire on UK peatland biodiversity?
3. How are other ecosystem services affected by the use of prescribed fire?
4. How does the interaction between prescribed fire and grazing impact on peatlands?
5. How does fire affect microbial activity and community composition?
6. What are the long and short term implications for the use of fire on peatland carbon cycle processes?
7. What are the social consequences of either using or not using prescribed fire in peatlands?

References: (1) IPCC, (2007). *Climate Change 2007: Impacts, Adaptation and Vulnerability*. CUP, Cambridge, UK. (2) Goldammer, J.G., et al., (2007). *The Eurasian Fire in Nature Conservation Network*: <http://www.fire.uni-freiburg.de/sevilla-2007/contributions/index.htm>. (3) Rydin H and Jeglum J.K., (2006) *The Biology of Peatlands*. OUP, Oxford UK. (4) Anon (2001). *The Muirburn Code*. Scottish Executive.

FireBeaters: Understanding Fire Behaviour in *Calluna*-Dominated Fuels

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²The Game and Wildlife Conservation Trust

³Scottish Natural Heritage

Background: Climatic and environmental change over the next few decades are likely to have a significant impact on fire regimes in the UK. In this context a robust fire danger rating system would be extremely valuable. A good understanding of fire behaviour and robust fire behaviour models are a central plank of any fire danger rating system and essential for the safe use of prescribed burning.

Methods: We burnt 27 fires in three different fuel categories under a wide range of weather conditions. Fuel structure, fuel moisture, weather conditions and fire behaviour characteristics such as rate of spread and fireline intensity were all recorded.

Additional small ignition tests have been used to investigate the effect of fuel moisture on flammability.

Results: The ignition tests to date suggest that a critical moisture threshold of 65% exists for sustaining fires. Redundancy Analysis was used to analyse the effects of all control variables on fire behaviour. This showed that more intense fire behaviour was associated with lower moisture content, increased wind speed and stand age, and reduced bulk density and low fuel heterogeneity. Such general findings are useful but mask significant complexity in fire behaviour: for instance fires showed a non-linear response to wind speed. Fires in older “High” fuel loads respond more strongly than younger, more uniform *Calluna* stands.

We tested a range of existing models and found that the Canadian FWI that underlies the Met Office Fire Severity Index does not reflect the behaviour of heather fires. Regression models we developed based on wind speed and fuel height perform well for other researchers’ data but do not account for the role of fuel moisture.

Conclusions: With the data collected to date we are able to develop robust predictions of behaviour of management-sized fire. Current work will focus on further ignition experiments to examine the role of fuel moisture and relating ignition potential to fire danger indices. We will also attempt to upscale our fire behaviour data to wildfires. A concerted effort is now required to adapt existing fire danger rating systems for UK fuel types.

Developing a Fire Danger Forecast for the UK

Colin Legg and G. Matt Davies

The University of Edinburgh, School of GeoSciences

The Met Office Fire Severity Index (MOFSI) was published by the Met Office in 2005 in response to the Countryside and Rights of Way (CROW) Act. It provides a valuable warning when weather conditions are exceptional and any fires will be difficult to extinguish and likely to cause significant environmental damage. Relevant authorities can close 'Open Access Land' to the public when there is an 'Extreme' fire risk. MOFSI was extended to Scotland in 2007: <http://firebeaters.org.uk>.

Does MOFSI predict the occurrence of wildfires in Scotland?

The Fire & Rescue Services have provided records for several thousand outdoor fires. We have calculated the MOFSI for each of these fires. Most fires occur when the MOFSI fire danger rating is 'Very Low'. When MOFSI is Moderate or High then most fires are bad ones. Exceptional conditions rarely occur in Scotland.

Alternatives to MOFSI

MOFSI is based on the Canadian Fire Weather Index. This also provides an index of the moisture content of fine fuels called the Fine Fuel Moisture Code. This is a better predictor of Scottish wildfires. Both MOFSI and FFMC could be greatly improved with better fuel moisture models. Further fire behaviour research will allow us to forecast conditions when fires can propagate, identify areas at risk from wildfires and understand the effects of climate change.

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Effects of fire on peatland C stocks and dynamics

**Frank Verheijen¹, Rebekka R.E. Artz², Laura Shotbolt¹,
Andrew Baird¹ and Lisa Belyea¹**

1 Department of Geography, Queen Mary University London
2 Soils Group, The Macaulay Institute, Aberdeen

Between 15 and 17 April 2007, a human-induced fire disturbed around 55 km² of the Galloway Forest Park in south-west Scotland. The burn area included the Silver Flowe National Nature Reserve, a large blanket bog which has a great diversity of vegetation and microtopographic patterning. This event provided an unprecedented opportunity to investigate factors influencing fire impact and post-fire recovery on peat physical characteristics, water chemistry, vegetation and microbial composition and peatland functioning in terms of C turnover. Our poster introduces ongoing work within a NERC-funded Urgency grant.

Summary of discussion sessions

An after-dinner discussion

Scenarios for Changes in Fire Regime

(Rapporteur: Alastair Hamilton)

Six main themes were discussed: economic change, social issues, biodiversity, climate change, carbon issues, and landuse options in general. From the discussions and notes produced, some over-riding issues seemed to emerge. They were:

- 1) the issue of declining rural population and loss of practical skills, even in the face of some rural areas having an influx of people;
- 2) the fact that there are new or increasingly important priorities for moorland management (such as carbon retention/sequestration, visitor pressure, cultural values);
- 3) flexibility and adaptability (in terms of understanding/working with others and other priorities, in terms of fire use and fire regime, and perhaps in terms of legislation) to incorporate these new priorities will be required;
- 4) we need more information/understanding to be able to adapt fire regimes as required;
- 5) bearing in mind climate change predictions and issues following from points above, we may expect more (and more severe) summer/late summer wildfires, fewer winter burning days (but also more less intense burns).

Break-out Groups

Breakout Group 1:

How do we transfer resources (money) from beneficiaries of ecosystem services to producers?

Rapporteur: Pat Thompson

What ecosystem services are we talking about in uplands?

Carbon storage and sequestration
Water provision
Water flows and flood alleviation
Recreation
Landscape
Production (both livestock and game)

How are these services currently provided and supported (paid for)?

Carbon storage and sequestration

By default

Soils policy, regulation (e.g. GAEC)

On back of biodiversity work (e.g. Favourable condition). But problems with whole carbon story (CO₂ emissions, CH₄ emissions)

Water provision

70-90% of water gathered in uplands. 55% of UK pop get water from a peat-covered catchment. Water companies. Collection, distribution and treatment costs. Consumer payment. Great conceptual link between an upland ecosystem service and the downstream user

Water flows & flood alleviation

Limited evidence. But benefits more likely to be felt downstream. Possible link with restoring hydrology in upland catchments and downstream community. Possible links with biodiversity (e.g. grip-blocking). Some benefits on back of other land-uses e.g. woodland/forest expansion, riparian woodland management

Recreation

Variety of ways in which access/recreation facilitated and supported

In English uplands, major link with National Parks and AONBs

Links with physical and mental well-being

Landscape

Largely a product of different land uses - therefore largely delivered on back of other interests

Production (livestock & game)

Livestock - public support (SPS, agri-env) and market

Game - mixture of private, public (agri-env, SPS) and market

Problems

Given lack of evidence, difficult to determine how best to transfer resources to producers of key services.

Production (livestock) - using a better combination of regulation, markets (e.g. local branding, labelling etc) and public support, might be possible to reward land managers (e.g. farmers) for delivery of key environmental outcomes (not just biodiversity). Re-profile current support! But also need new support.

Next steps

Do we need an upland forum? What does Defra's Upland Land Manager Advisory Panel do?

Need a major piece of work to collate research (what is known), tease out knowledge gaps, inform best practice (e.g. knowledge transfer) based on best available evidence and new work to measure value (in space and time) each of the key upland ecosystem services

Breakout Group 2: Spatial Zoning & Integration of Land Uses

Rapporteur: Ethan Bigelow, Projects Officer, Rural Development Initiatives

I. Categories of Land Use

- Forests
- Water Catchments
- MOD
- Recreation
- Sporting
- Industry
- Archeological
- Scientific Research
- etc...

II. Definition of a “Zone”

Potential zones would be created using river basin/watershed areas as the potential borders of a given zone. Each zone will have a varied level of integration among land uses. Competing interests with a legitimate claim in each zone will be considered and applied to the action plan for each individual zone. None of the land uses were determined to be mutually exclusive.

III. A Collaborative Effort

There is a definite need for collaboration among the organisations with a vested interest. There must be a vehicle to bring the group together to negotiate the priorities of each zone in order to optimize the use of the land.

IV. Potential Vehicles for the implementation of a zoning strategy

- The National Park
- Water Catchments Management Plan (Water Framework Directive)
- Forestry Commission Panel
 - Forest Design Plan w/local access forums

V. No integrated vehicle exists

The group concluded that a zoning strategy could be a workable strategy, but that at present no vehicle exists with the mechanisms to combine the expanse of potential organizations that would have to be included in such a project.

A stress was placed on the need to bring all groups with a vested interest together around one table. The possibility of having an independent third party administer a steering group for the planning of each zone was proposed.

Breakout Group 3: The Evolution of Land Management Priorities

Rapporteur: Alan Gray

Andrew Coupar, Charles Gimingham, Rob Marrs, Simon Thorp, Matt Davies and Alan Gray

This breakout session was organised around four main questions:

- What are the priorities for UK moorland and heathland management?
- What flexibility is available for moorland managers?
- What knowledge gaps exist and how do we fill the gaps?
- What skills currently exist and/or are lacking within moorland and heathland management in the UK?

1. Priorities	<p>Carbon, Climate change, Water Framework Directive (cost if don't comply - key driver), keeping the traditional aspect of burning and grazing, consequences of future changes to agriculture and sport, keeping designated sites in favourable condition, the retention of local communities and a viable rural economy.</p> <p>Access – Increasing pressure. Should this be free or can land owners charge? How will access change with climate change - more visits? A cultural divide in the use of the countryside still exists It is partially addressed by certain initiatives but Field Studies Council properties, for example, are limited therefore a possible education/awareness raising opportunity for land mangers exists. However, there is an urgent need to rationalise health and safety requirements.</p> <p>Rural support mechanisms – SRDP replacing Rural Stewardship Scheme etc.</p> <p>Renewable Energy – wind farm expansion includes threats and opportunities.</p>
2. Flexibility	<p>New local industries bringing greater need for farmers etc. to link business interests and utilise assets more effectively through e.g. farmers markets, sharing transport costs and cooperative establishments - local produce for local people. May lead to a rejuvenation of local slaughterhouses.</p> <p>Whisky industry may be a good marketing model for agriculture.</p>
3. Knowledge	<p>Better estimates for example, stock densities and area of burnt land are required getting information is still difficult.</p> <p>Solutions - remote sensing, land cover map, meta-estate burning plans, need for central collation of data</p> <p>Carbon research still limited by site dependency and short time series, variability according to land management needs defining – more research required.</p>
4. Skills	<p>Presently land managers policy officers all too specialised - there is a need for a broad, holistic and diverse management approach. For example, some game keepers may recycle bad practice in house, NGO's usually graduates and lack practical land management skills. Both groups need to exchange skills and need better communication. Adaptability is key.</p> <p>Demonstration Moor Days good knowledge dispensary and way of showing good practice – need to be wary of preaching to the converted. The challenge is to attract those who really need to be there.</p> <p>New blood seen as a way to revitalise communities but need income therefore a valuation tool for ecosystem services may be a necessity.</p>

Checklist of ecosystem services for consideration under different options for managed burning

Category	Baseline / Do nothing - Current fire regime	Option 1	Option 2	Option 3
Provisioning services				
Food				
Fibre and Fuel				
Genetic resources				
Biochemicals, natural medicines, pharmaceuticals				
Ornamental resources				
Fresh water				
Regulating services				
Air-quality regulation				
Climate regulation				
Water regulation				
Natural hazard regulation				
Pest regulation				
Disease regulation				
Erosion regulation				
Water purification & treatment				
Pollination				
Cultural services				
Cultural heritage				
Recreation & tourism				
Aesthetic value				
Supporting Services				
Soil formation				
Primary production				
Nutrient cycling				
Water cycling				
Photosynthesis				

Score and assessment of effect

++ Potential significant positive effect
- Potential negative effect

+ Potential positive effect
-- Potential significant negative effect

0 Negligible effect
? Gaps in evidence

Based on: Defra (2007) An introductory guide to valuing ecosystem services, Table 3.1, p24. http://www.defra.gov.uk/wildlife-countryside/natres/pdf/eco_valuing.pdf