11th National Heathland Conference

18th to 20th March 2015 – Sunningdale Park, Berkshire

SURREY wildlife TRUST

Recommended citation: Alonso, I., Underhill-Day, J. & Lake, S. (eds.) 2015. *Proceedings of the 11th National Heathland Conference, 18-20 March 2015.* Sunningdale Park, Berkshire.

Foreword

After a gap of seven years (the 10th National Heathland Conference (NHC) took place in 2008), the Surrey Wildlife Trust coordinated the organisation of this year's conference. As the number of attendees over the three days demonstrates, this was a popular event, and is currently the only national gathering that brings together in one place site managers, practitioners, conservation and other government agencies staff, NGOs staff, consultants, contractors, academics and many others interested in heathland conservation. Attendees highly valued the opportunity to exchange information and to network among colleagues, and to visit and learn about heathland sites new to them.

Although the NHC aims to be a UK-wide event, a great majority of attendees were from England. Attracting more colleagues from Wales, Scotland and Northern Ireland is something that we should try and address in future events.

This document is a compilation of the papers produced by the speakers and the workshop leaders at the Conference. Unfortunately, we were not able to obtain papers for all the talks or workshops. The talks were edited for consistency and formatting and, where necessary, the authors were contacted for clarifications, but it should be noted that the papers have not been "peer-reviewed" in terms of their scientific quality. They are a record, sometimes with added background information, of the presentations and discussion at the conference.

We hope, nevertheless, that the readers find in this document new and detailed information and the means to contact the authors if they wish for further details. More collaborative work is necessary over the coming years to ensure that heathlands are managed and restored applying the most up-to-date evidence and techniques. Only then we will be able to ensure that they provide the resources that meet wildlife needs and a source of inspiration and enjoyment for generations to come.

The views expressed in the papers are the views of the authors, not necessarily of Natural England.

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November 2015

Contents

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Libby Ralph & Sarah Bunce (the A Team!)
Marcus Wehrle (for all things Techy and graphical)
Tunde Crowley & Laura Macleod (for all things financial)
Michelle Knight & Alex Learmont (for admin and stewarding on the day)
The North and Chobham team: Dave Boddy, Darren Brito, Vicky Russell, Jill Titlestad, John Wilsher and Gemma Hayes (for help all through the preparations, conference and site visits).
Mark Havler (for being the first person to believe)

Site visits
Alex Cruickshank, BBOWT
Matt Cusack, National Trust
James Giles & Graham Steven, Natural England
Mike Coates, RSPB

Rob Free, ARC
Fiona Haynes, Charlotte Williams and Scotty Dodd, SWT
Queenwood Golf Course

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Great thanks are also due to the team at the De Vere, Sunningdale Park who dealt with us with great patience and humour.

Presentations
Session 1: More than just heather

TALK 2: Comprehensive management of Common Land

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Summary

Commons may be complicated, and this may feel like a burden, but commons are places which are of immense value to everyone. What people value may differ but people are united by the strength of their concern, and it's this concern that helps to keep these places protected in the long term. This paper reviews why commons are important and the six-stage process which is the base for "Common Purpose".

Introduction

Firstly, I'd like to answer the obvious question "why is there a presentation about common land at a heathland conference?" A lot of heath is common land. That's because common land tended to be land which wasn't much good for cultivation, so it was used communally for things such as grazing, collecting firewood, gorse and bracken, peat for fuel, and others. Areas of heath also tend to be on land which isn't very suitable for intensive cultivation so it was not enclosed, and became protected as common land. Thirteen percent of Registered Common Land (RCL) is heath.

Some heathland is not RCL, but much of the following will still be useful for managers of those sites for the following reasons:

- Some commons were missed off the registers but may be added when the Commons Act 2006 is fully implemented
- Heaths all have public access rights under Countryside and Rights of Way Act 2000 (CRoW Act 2000)
- Quite a few of the laws mentioned here apply to sites other than commons

Importance of Commons in England

Although commons are only 3% of the area of England, they are proportionally more significant than ordinary farmland for delivering public goods. Fifty-five percent are Sites of

Special Scientific Interest, 48% by area are in National Parks, 31% by area are in Areas of Outstanding Natural Beauty, and 11% of Scheduled Ancient Monuments are on common land. Almost all common has access rights.

As so many commons are important because of their nature conservation, landscape and historic interest, they also receive considerable public funding - 72% of common land is in a Stewardship scheme, and 64% of common land is in the Higher Level Stewardship scheme.

Commons and Public Access

Almost all commons and heaths have public access, either because they had public access before the CRoW Act 2000 or because all RCL and heaths were in the categories of land that was mapped as access land by the CRoW Act 2000. Many commons are crossed by Public Rights of Way. There also tends to be *de facto* access, which may need to be managed - off-road cycling is a typical example.

Access rights are only one part of working out what people do when they are on a site. We also monitor what people do when they visit the natural environment. Natural England, together with Defra and the Forestry Commission, produce the annual Monitor of Engagement in the Natural Environment (MENE). MENE is an annual household survey of about 45,000 people that has been running for five years. It produces data on how often people visit the natural environment, where they go, how long they stay, how much they spend and many other factors.

Table 2.1: MENE provides us with information about how people use commons, compared to how they use the wider natural environment.

Activity	National Average (% of total)	Average on commons (% of total)
Walking without a dog (including short walks, rambling or hill walking)	27	39
Walking with a dog (including short walks, rambling or hill walking)	49	36
Playing with children	8	12
Off-road cycling or mountain biking	1	4
Running	3	5

On commons, people are more likely to go for a walk (without a dog), play with children, cycle off-road or run than they are on visits to the natural environment overall (Table 2.1). We do not yet know why, but will be exploring more of the data later this year.

Natural England's approach to management of Commons

In Natural England we have gradually been changing our approach to managing commons from where we were about 10 years ago. Natural England advocates that before changing management on a common, managers engage with communities. There is a guide to community engagement *A Common Purpose* (Natural England 2012)[1], which is endorsed by all the members of the National Common Land Stakeholder Group. If consent for works is required on a common, the Planning Inspectorate (PINS) guidance[2] also points applicants to use the process in *A Common Purpose.* We also recommend that managers take account of the public interest in determining management solutions, and NE commissioned the guide *Finding Common Ground*[3] (Ashbrook & Hodgson 2013) to help managers to do this.

Natural England runs a one–day course for advisers who work on commons. The course is about community engagement and it covers *A Common Purpose*. In the last two years we have trained just under 100 staff on engagement in relation to commons, so they are familiar with the principles for managing common land.

Principles for managing common land
Many people have a stake in common land, landowners, commoners, sporting interests, local communities, visitors, important for landscape, nature conservation, archaeology, and nearly all have public access. What people value may differ but people are united by the strength of their concern. **All interests on common land are legitimate and deserve recognition**: The various interests of the common should not be prioritised or viewed competitively, as if one consideration should prevail over another. All interests should be embraced with a single management framework. Progress is least likely when one interest in a common attempts to dieseline others or force change upon them. **Decisions affecting the future of commons should be determined through an inclusive decision-making process**: People with a significant interest in commons can contribute to decision on their future rather than be consulted once a decision has been made elsewhere.

A Common Purpose

A Common Purpose recommends a six-stage process to develop management options. The purpose of this paper is not to explain the stages in detail; instead it highlights the topics within the six-stage process where frequent issues arise in the management of commons. It also explains what you can do to avoid the most common problems.

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[1] http://publications.naturalengland.org.uk/publication/730889

[2] http://www.planningportal.gov.uk/uploads/pins/common_land/guidance/guidance_sheet_1a_procedural_issues.pdf

[3] http://www.oss.org.uk/wp-content/uploads/2009/02/Finding-common-ground-2A.pdf

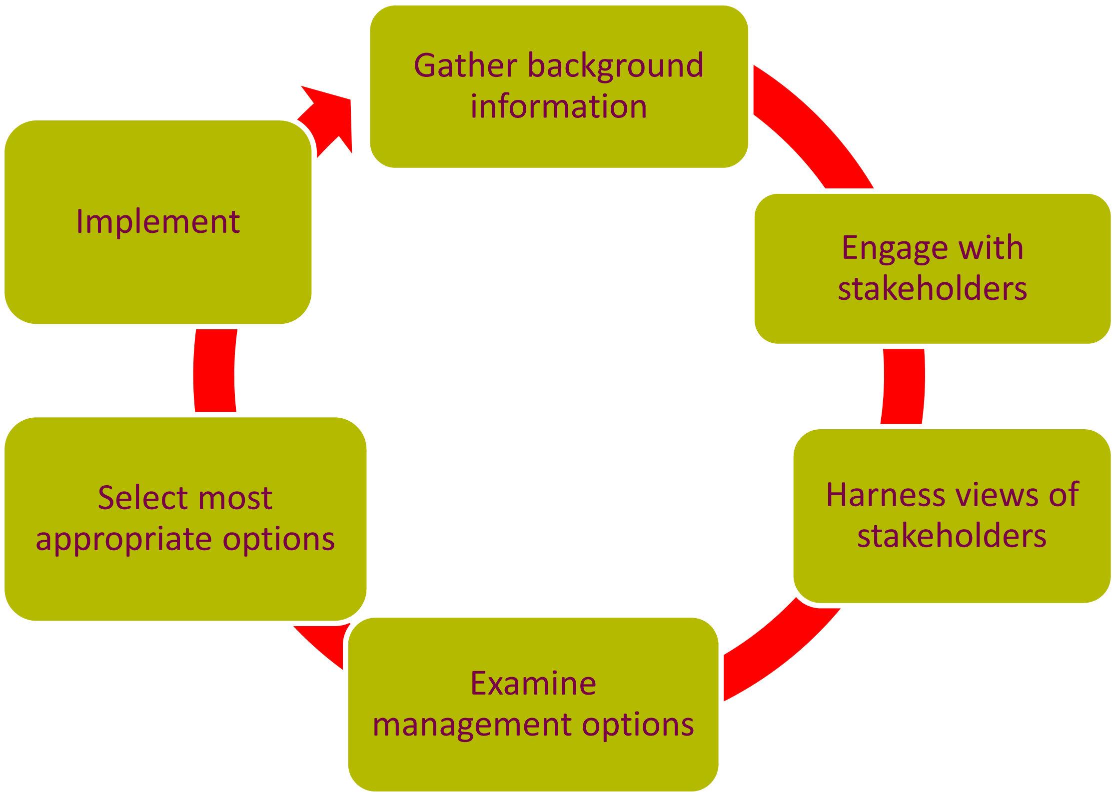

Figure 2.1. The six-step process of *A Common Purpose*

Gathering background information

From my experience this is the part of the process which is often overlooked, but it is necessary if problems later in the process are to be avoided.

- The legal position must be identified accurately – ownership, rights (of common and others), boundaries, statutory and other designations, relevant legislation, site specific Acts
- Evidence base must be sufficiently rigorous (and recorded) on which to base management prescriptions
- Managers must be familiar with the requirements for s38 or s16 Commons Act 2006 consent and associated Defra policy

Ownership must be checked including who owns what and where the boundaries are: it is really common for fences not to be on the boundary.

All common land is owned but it is land on which others have rights, most often this is a right to grazing but other rights might be to take wood, dig peat, take bracken and furze, fishing, or put pigs out. Common rights, recorded in the commons register, need to be checked. At a later stage if you want to change the management of the land by changing the grazing using different animals you will need to know if these grazing rights exist, or if the owner will allow alternative grazing animals within their rights to graze the surplus.

You need an accurate record of all the legislation that applies to your site, and the legal basis for its ownership. Don't forget that 55% of commons are SSSI, 48% by area are in national parks, 31% by area are in AONBs, and 11% of scheduled ancient monuments are on common land. Plus many commons are Country Parks, Local Nature Reserves, or National Nature Reserves. Local authorities are often owners of commons so the powers through which these sites were acquired may also have to be considered. This is often the Open Spaces Act 1906. It is necessary to check if the common has its own Act or Scheme of Management. If this is the case for your site you will need to be familiar with the detail, and you'll need a copy for reference.

The picture becomes more complex when we consider if subsidies or grants apply. Any land where there are claims for Single Payment or any Stewardship Scheme also has had to meet the requirement of Good Agricultural and Environmental Condition.

You will need to check the legal basis for access rights: for example, people on "urban" commons have a right to air and exercise on foot and on horseback, but not on a bicycle.

Getting the legal situation comprehensively stated will take a lot of time, but it is worth doing well, because it means plans are less likely to go awry later.

Finally managers should understand which operations would require a notice to PINS, consent, or deregistration of common land and the basis on which PINS will make a decision. This is explained in detail in the Defra guidance available online[4].

Engaging with stakeholders, harnessing the views of stakeholders

- Consultation should be done before the decision has been made, not afterwards
- Stakeholder views must be fully considered

Consultation with stakeholders needs to be carried out to find out what all the issues are that concern all stakeholders. An example of good practice is in Ashdown Forest where pre-consultation enabled Natural England to discuss with the managers prescriptions for different parts of the site and how they might achieve better outcomes.

Natural England is also aware that there is an issue of cattle and driver safety on roads crossing or near commons. There are many ways of mitigating the risks of livestock straying, perimeter fencing, invisible fencing, temporary enclosures are just a few. However we know that new fences require gates, but many horse riders do not like two-way self-closing gates. To try and find a better solution we have been working with the British Horse Society and there will be a trial of gates during the summer of 2015.

[4] http://www.planningportal.gov.uk/planning/countryside/commonland/commonland

Examining management options

- Explore the full range of management options and fine-tune proposals to meet stakeholder aspirations

After exploring what all the stakeholders want, which may be contradictory, you will need to explore the benefits of alternatives. Look to get win-wins whenever possible; for example, a fence might mean that a horse rider has to negotiate a gate, but it may also mean that if they fall off, their horse won't be able to stray onto a road.

Another example is better management of access: a good surfaced path may mean that people do not stray off the route looking for a dry path, which could reduce disturbance on a more sensitive part of the site.

Invisible fencing removes the need for gates – and it does not require consent from PINS.

Selecting the most appropriate options

Explain your reasoning – especially in your proposal to PINS. Lots of explanation about what was considered and the changes made to accommodate the needs of all the stakeholders may remove the need for a public inquiry. In addition you need to give evidence on how the management changes will deliver the outcomes that you have stated you are trying to achieve. This is where a good evidence base is essential part of your proposal.

Implementation

- Keep stakeholders informed
- Monitoring and review required

You will need to monitor the implementation of your management changes: is the cutting and grazing regime being implemented according to the plan, or is it more haphazard because of circumstances? What are the impacts on users? If there are problems, can you adapt the implementation to mitigate problems? Regular meetings with stakeholders can help identify adjustments that might reduce problems.

Two final points

Firstly, there are issues which come up regularly: boundaries, commoners exceeding their rights, the public exceeding their rights, and driving and parking vehicles on commons. If anyone has any questions about them or anything else I'd be happy to try to answer your questions.

Secondly, Commons may be complicated, and this may feel like a burden, but commons are places which are of immense value to everyone, what people value may differ but people are united by the strength of their concern, and it's this concern that helps to keep these places protected in the long term.

References

Ashbrook K & Hodgson N (2013) *Finding Common Ground. Integrating Local and National Interests on Commons: Guidance for Assessing the Community Value of Common Land.* Open Spaces Society.

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TALK 3: Mires

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Introduction

Of all the terrestrial habitats in the UK, peatlands are perhaps the most invisible. This invisibility is all the more remarkable when one considers that peatlands are the world's most extensive type of wetland, being found on all continents and ranging from the arctic to the tropics. So often they are defined as something other than peatland – usually dry heath, wet heath or moorland – but closer investigation, as was undertaken during negotiations by the former Nature Conservancy Council to purchase Fenn's and Whixall Moss on the Clwyd/Shropshire border, reveals that areas thought of as heathland on thin peat, or as dry moorland, are in fact damaged examples of very deep peat. Managing such areas as anything other than peatland is likely to be un-sustainable and lead to a steady degradation of all those ecosystems services which are provided by peatlands, such as long-term carbon storage, flood storage, water quality-control and a distinctive range of biodiversity.

Definition

Peat is the accumulated remains of partly-decomposed plant material laid down in situ, with waterlogging the responsible agent limiting the degree of decomposition. If a peatland is waterlogged it will tend to accumulate peat. If a peatland is no longer waterlogged, most commonly because of human action, it will tend to lose peat as the plant material oxidises and the stored carbon is thus returned back to the atmosphere as CO_2. Some peat deposits are more than 60-70 metres deep, but anything with at least 30 cm of peat can be classed as a peatland. Globally, there is at least 1760 Gt of carbon stored in the world's peatlands, which is around three times the amount stored in all the world's vegetation and one and a half times the amount of carbon in the atmosphere. Peatlands, and their continued maintenance as systems which store and sequester carbon for millennia, are therefore of considerable significance in terms of greenhouse gas budgets.

In the UK, the most extensive tracts of peatland are found in the uplands of England and Wales and in the north and west of Scotland. These are mostly blanket mire landscapes ('mire' is a wetland with at least some vegetation which is normally peat forming) often rather inaccurately or inadequately described as 'moorlands' – inadequate because the term embraces drier mineral ground as well, and 'moorland management' is generally geared to techniques appropriate for the areas of mineral soil yet is applied equally (and disastrously) to the often-extensive tracts of peatland within such landscapes. Peat is not just restricted to the uplands, however. There may once have been more than 1 million hectares of lowland peatland, embracing the vast East Anglian Fenlands, the Somerset Levels and the Lancashire lowland plain, but almost all of this resource has been converted to various forms of dry-land use, particularly traditional 'dry-land' farming. We have turned our back on the few remaining fragments of this habitat which survives in the lowlands, using them as dumping grounds or barriers to productive use and regarding them as 'waste' land.

Types of peatland

There are two fundamentally different types of peatland: fens and bogs. Fens, or 'minerotrophic mires', are waterlogged by groundwater or because they lie in an area of surface-water collection. Their characteristics and management requirements are very well covered in The Fen Management Handbook, published by Scottish Natural Heritage (McBride, A. *et al.* 2011). Essentially, fens can be characterized by their type of water supply and their associated landform morphology. Open-water transition mires are formed where a basin of water in-fills with peat-forming vegetation. Spring mires arise where groundwater emerges at the ground surface because of an impermeable layer, or because of artesian pressure. Valley mires are formed in valleys which are either flat-bottomed or which have become flat-bottomed because of peat accumulation. Water seeps into the valley from the head of the valley and from the valley sides, but never in sufficient quantity to create a river; a valley mire instead has a diffuse central water-track and may be so poor in dissolved ions that it resembles an acidic bog, but it is nonetheless a fen system. Consequently for this type of fen, and also for open-water transition fens, activities in the catchment can have a substantial impact, particularly in the form of diffuse of point-source pollution. Loss of the White-faced Darter dragonfly *Leuchorrhinia dubia* from Thursley NNR valley mire may be due to point-source pollution from a rumoured 'night-soil' field, or may be due to diffuse pollution resulting from dog-walking. Changes in water supply are also of major significance for these mires and for spring mires. Indeed the invisibility of the water supply for spring mires can disguise the fact that changes have occurred in the supply, leading site managers to look for more visible reasons to explain signs of change and ignore the more fundamental issue of water supply.

Perhaps surprisingly, one of the most serious threats to lowland fen system is *lack* of management. Many of the most biodiverse fen systems in the UK developed originally as a result of traditional fenland management which had operated over long periods of time - perhaps even millennia. Abandonment of such management traditions with the collapse of many rural economic practices has led to loss of substantial areas to wet woodland as a result of succession.

Burning is also an activity engaged in with some enthusiasm on peatlands of all types, both lowland and upland. Indeed there is considerable and heated debate at present between those who wish to manage our upland blanket mire landscapes as heathlands – and therefore burn them regularly – and those who wish to manage and restore our damaged blanket mires to a state of peat-forming vigour and resilience. Personally, the only justifiable and sustainable role for fire in relation to peatlands that I can see is for high-productivity fen vegetation from the lowlands to be used as a biofuel.

Another key form of peatland found in the lowlands is lowland raised bog, which forms over an in-filled open-water transition mire and then continues accumulating peat to rise in a low dome as much as 10 metres above the surrounding landscape because *Sphagnum* bog moss dominates the vegetation and is so remarkably good at retaining direct precipitation. Being raised above the underlying mineral ground-water table, bogs are wholly dependent upon direct precipitation inputs (unlike acidic valley mires and spring mires) and are thus termed ombrotrophic mires. As such, they are independent from the nature of the mineral ground-water table, but as they depend on this to act as the foundation for the perched bog water-table, if the groundwater is lowered then this can place significant hydrological stresses on the raised bog system. Raised bogs represent the densest concentrations of soil carbon in the lowland landscape, but we have dug them away for domestic fuel and to turn them into agricultural fields, we have mined them for horticultural growing media, and we have planted them with trees which cannot match the carbon density of the original bog. All-in-all this has pattern of land use has fallen some way short of being sustainable, with only around 6% of the area that was present in the 1840s still supporting a semi-natural bog vegetation today.

The most extensive form of lowland mire was once undoubtedly flood-plain fen, but this has suffered more dramatic losses than any other form of mire system, not just in the UK but across Europe. The once-extensive fens which dominated all wide river flood-plains have been almost universally converted to 'dry-land' agricultural production, or to urban development (many major cities sit on flood-plains). The consequences have been considerable, with the former wetland soils shrinking as they dry, being washed or blown away by wind and rain, and resulting in wholesale on-going subsidence of 1-2 cm per year. The Holme Fen Post in Cambridgeshire shows that the ground has subsided by around 4 metres in 150 years, and it continues to subside. The ground surface here is now more than 3 metres below sea level – a sobering thought given rising sea levels and the expected increase in storm surges.

Indeed across Europe, the growing costs of flood events involving former flood-plain fens is driving the insurance industry to question the wisdom and economic sustainability of continuing to support 'dry-land' activities on former flood-plain fens. There are increasingly widespread trials looking at 'new' ways to manage such land using old but long-abandoned ways of managing these areas as wetland, harvesting the fenland materials from these highly-productive ecosystems to create new products and new markets – the new mantra being 'sustainable management of our peatlands and peat soils'.

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Session 2: Grazing heathlands

TALK 4: A Different Field - Surrey Wildlife Trust's Farming Operation

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Introduction

Surrey Wildlife Trust (SWT) is the manager of an estate of 8,000 ha which includes significant areas of heathland. There has been an 85% loss in the heathland extent in Surrey during the last 200 years. The remaining heathland supports UK rarities, unique Thames Basin species and large numbers of heathland specialists. The county also has 1.3 million human inhabitants who have a variety of interests and uses of the Surrey countryside.

Heathland management involves a variety of methods including scrub clearance, bracken spraying and dwarf shrub maintenance. Grazing was the missing management technique on the Surrey heaths. There is a lack of conservation graziers with suitable livestock in the county. SWT had experimented with the few small local graziers but these sources could not guarantee stock numbers or timings. With the start of the new round of agri-environment funding in 2005 SWT decided to purchase its own herd of livestock.

SWT grazing operations

Belted Galloways were chosen for the cattle herd due to their visibility, placidity, naturally polled status and availability. Three were bought in December 2007. The herd was increased rapidly thereafter with the purchase of bulls and the start of in-house calving. The numbers in March 2015 are 287 cattle with 80 calves due later in the spring.

SWT have chosen to run two herds: a breeding herd (which operates on quieter or no public access sites) and a conservation herd (which grazes more intensely used areas). The breeding herd calves in the spring and cycles around appropriate sites before returning to the home farm for calving the following year. Sites for the conservation herd are grouped into risk categories depending on their public access and physical nature. The cattle work up through these categories as they gain experience. This system allows SWT to graze sites such as Petersham Meadows, a field of 8 ha in Richmond, which has over 250,000 visits a year by the public.

Results

SWT does not use its cattle herd for scrub control on its estate. The cattle are employed to create mosaics and warmer ground conditions in the grass sward on heathland sites. These effects are increasingly quantifiable as demonstrated by Surrey's only colony of Bog Hair Grass *Deschampsia setacea* which has increased from five plants in 2005 to nearly 50 following regular grazing. A trial site at the Folly Bog has shown significant beneficial effects on wet heath which are due to be published in the scientific literature in the near future.

Interesting behaviours by the cattle have been observed over the eight years of the grazing. Of particular value has been the use of GPS collars on the cattle during their extensive grazing. SWT believes that grazing is a sustainable and powerful tool which, if used sensitively, is a vital management technique.

SWT also runs a herd of Red Deer *Cervus elaphus* on one site and over 50 goats to manage scrub encroachment.

Challenges

As would be expected from a developing herd there have been a range of challenges to master over the lifetime of the farming operations. These have ranged from livestock escapes to extreme weather events and injuries. An experienced and calm grazing team and suitable livestock have been vital in overcoming these issues.

Future challenges involve sourcing enough layback land for overwintering, increasing sustainability via income streams (contract grazing, meat/live sales and hay production) and continuing to educate and inspire Surrey's growing population about how to interact with the livestock. SWT is creating a grazing system that will protect, enhance and support Surrey's countryside and its wildlife for generations to come.

TALK 5: Monitoring the effects of management on Chobham Common NNR

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Summary

A monitoring programme investigating the effects of management on Chobham Common NNR is being undertaken. Interim results have shown some clear indications of the effects of grazing on two contrasting heathland vegetation types (it should be noted that the final results may differ):

Dry heath samples show:
- A statistically significant reduction in the height of herb layer
- A statistically significant reduction in the mean dwarf shrub height
- An increased proportion of pioneer heather *Calluna vulgaris* but no change in heather cover
- No clear trend in cover of bare ground, purple Moor-grass *Molinia* cover or species richness.

Molinia mire samples show:
- A statistically significant reduction in herb and purple moor-grass tussock height
- An apparent reduction in purple moor-grass cover
- Some indication of an increase in species richness and bare ground cover

Ordination analysis (DCA) shows how grazing has changed the H2c *Calluna vulgaris-Ulex minor Molinia* sub-community) towards H3 *Ulex minor-Agrostis curtisii heath*/H4 *Ulex gallii-Agrostis curtisii* heath whilst control samples have remained little changed over the four years. Samples of M25 *Molinia caerulea-Potentilla erecta* mire have moved towards a M21 *Sphagnum papillosum-Narthecium ossifragum* mire/M25a *Erica tetralix* sub-community whilst control samples have again remained largely unaltered over the monitoring period.

Introduction

Chobham Common is managed by the Surrey Wildlife Trust as a National Nature Reserve. It is also notified as a Site of Special Scientific Interest (SSSI) and is a component of the Natura 2000 network, being classified as part of the Thames Basin Heaths Special Protection Area (SPA) and designated as part of the Thursley, Ash, Pirbright and Chobham Special Area of Conservation (SAC).

A monitoring programme was established on Chobham Common NNR in 2011 to demonstrate the effects of different management techniques on the heathland vegetation. This was undertaken to help guide future management of the nature reserve in the context of the results of a public consultation into restoration of grazing to the Common. To facilitate the monitoring of grazing effects an application was made to the planning Inspectorate for five temporary electric-fenced enclosures. Consent for these was subsequently granted in the summer of 2012.

The monitoring programme was initially established to assess the effects of five management treatments and controls:

1. Mowing
2. Turf stripping and bare ground creation
3. Controlled winter heather burning
4. Grazing
5. Experimental trial of herbicide-based techniques used in the uplands (non-sensitive location(s) to be approved by Natural England)
6. Controls

Following subsequent discussion with Natural England, the use of herbicide was discounted as a potential management method within the NNR.

Monitoring is being undertaken for five years following an initial baseline year giving a total of six years' data between 2011 and 2016. In this paper we provide initial results comparing the effects of grazing on two contrasting heathland vegetation types from four years of monitoring between 2011 and 2014.

Key vegetation types

H2 *Calluna vulgaris-Ulex minor* heath

H2 *Calluna vulgaris-Ulex minor* heath is generally a dry heathland vegetation type dominated by heather and with constant wavy hair-grass *Deschampsia flexuosa,* bell heather and dwarf gorse. It is a vegetation of predominantly free-draining soils in south east and central southern England. Traditional burning and grazing practices have a significant effect on its structural and floristic character (Rodwell, 1991) although neglect of these activities means that this kind of heath is often in various stages of succession to woodland or is found as small isolated remnants. With the decline of traditional management methods, surviving stands of this community often have a very leggy canopy in which heather is overwhelmingly dominant.

M25 *Molinia caerulea-Potentilla erecta* mire

M25 *Molinia caerulea-Potentilla erecta* mire is a community of moist, acid to neutral peats and peaty mineral soils. It is characterised by an abundance of purple moor-grass which in ungrazed situations can assume overwhelming dominance, forming large tussocks. In central southern and south-east England it can develop as a transitional vegetation community around the fringes of valley mires and in the New Forest is characterised by the presence of bog-myrtle *Myrica gale*. In the Thames Basin, vegetation that conforms to this community appears to displace wet heath and valley mire vegetation in the absence of traditional grazing practices and in response to hydro-geological damage to valley mire systems.

Methods

Selection of heathland vegetation types

A National Vegetation Classification (NVC) survey of the NNR undertaken in 2002 (Sanderson and Groome 2002) provided the basis for the selection of vegetation types to be monitored. Following discussion with Surrey Wildlife Trust and Natural England, a sample of five heathland vegetation types, listed below, were identified for monitoring the effects of the different management treatments. These represent a range of vegetation types ranging from dry to wet conditions with potentially contrasting responses to the different management techniques.

- *Calluna vulgaris* – *Ulex minor* Dry Heath (H2) – Annex I habitat type
- *Ulex minor- Agrostis curtisii* Dry Heath (H3) – Annex I habitat type
- *Molinia* dominated dry heath (H2/H3 + *Molinia*) – Not Annex I habitat type
- *Molinia* dominated Wet Heath/Mire (M25) – Not Annex I habitat type
- *Erica tetralix* – *Sphagnum compactum* Wet Heath (M16) – Annex I habitat type
- *Narthecium ossifragum* – *Sphagnum papillosum* Valley Mire (M21) mostly – Annex I habitat

Vegetation types listed on Annex I of the EU Habitats Directive that contribute to the SAC selection criteria are identified in the above list.

In this article, we present the results on *Calluna vulgaris* – *Ulex minor* Dry Heath (H2) and *Molinia* dominated Wet Heath/Mire (M25).

Quadrat location and distribution across vegetation and treatment types

Sample vegetation and management methods were monitored using random stratified fixed point quadrats. Using standard phase 2 survey methodology (Rodwell, 1991) a 4mx4m quadrat sample size was used for all samples. For most plots this was a square but for turf stripped plots a 2mx8m quadrat was used.

Areas of the target vegetation types were identified from the NVC survey of 2002 from both within the five grazing compartments and the surrounding heathland habitat. Changes in vegetation distribution since the 2002 NVC survey meant that it was necessary to re-map some areas of vegetation (using differential GPS) to record patches of the target vegetation types.

Due to difficulties in applying treatments to all vegetation types, it was agreed with Natural England that not all treatments would be applied to all vegetation types. For instance, it would have been inappropriate and indeed almost impossible to apply burning and mowing treatments to the wet and inaccessible mire vegetation. As a consequence, a sampling schedule was agreed with 250 quadrat samples distributed across the five vegetation types as shown in Table 5.1. The ten herbicide treatment plots were dropped from the monitoring schedule after the baseline year of 2011.

Table 5.1: Number of sample quadrats per treatment and vegetation type.

Treatment Type	Dry Heath (H2)	*Agrostis curtisii* heath (H3a)	*Molinia* dry heath (H2+ *Molinia*)	Wet Heath (M16)	*Molinia* Mire (M25)	*Sphagnum* Mire (M21)	Total
Grazing	10	10	10	10	10	10	60
Mowing	10	10	10	10			40
Burning	10	10	10	10			40
Turf stripping	10	10	10	10			40
Herbicide treatment			10				10
Control	10	10	10	10	10	10	60
Total	**50**	**50**	**60**	**50**	**30**	**20**	**250**

Sampling grids of 4mx4m were placed over mapped areas of the target heathland vegetation type using GIS. Central points were extracted from the grid, giving OS grid references for each 4mx4m square. Sample squares were then selected using random number tables to give grid references for each sample plot location. Sample plots were initially located in the field using a hand held GPS with an accuracy of ± 2 to 5m.

Plot locations were permanently marked with wooden pegs and buried metal pipe sections. Most pegs could be relocated between years but where these had been displaced, plot locations were re-found using a metal detector. All quadrats were aligned north-south using a compass.

Recording

Parameters to be recorded within each quadrat were agreed in advance with Natural England and Surrey Wildlife Trust. These were then incorporated into a standard quadrat recording form to be completed in the field, shown in Appendix I. Cover values for each plant species and feature were estimated in the field to give percentage cover values per quadrat. Vegetation heights were measured for cryptogams (liverworts, mosses and lichens), herbs (grasses, sedges, rushes and broadleaved herbaceous species), dwarf shrubs (heather *Calluna vulgaris,* bell heather *Erica cinerea,* cross-leaved heath *Erica tetralix* and dwarf gorse *Ulex minor*), purple moor-grass tussocks (where present) and shrubs, with five sample heights for each vegetation type being recorded per quadrat. In addition the percentage of each age class of heather was recorded (where present in the sample) using the four standard age class criteria after Gimingham (1975) (degenerate, mature, building, pioneer). A summary of cover of values for the groups (cryptogams, herbs, dwarf shrubs and shrubs) were also recorded.

At least three photographs were taken of each plot on each monitoring visit with oblique photographs taken from opposing quadrat corners and an overhead photograph taken against a 300mm rule.

Grazing management

Following a public inquiry, consent was granted for Surrey Wildlife Trust to erect a series of five temporarily fenced grazing enclosures in 2012. Belted Galloway cattle were introduced into these enclosures in the late summer of that year and were kept on site for two months until the end of October.

The number of cattle per enclosure was initially estimated to give a stocking rate of between 0.75 and 0.9 cattle/ha for the initial 2 month grazing period. Stocking rates were then re-calculated for 2013 grazing period using an analysis of forage values for the vegetation present within grazing compartments. This gave stocking rates of between 0.47-0.65 cattle/hectare for the six month grazing period between April and September as shown in Table .5.2

Table 5.2: Stocking rates in grazing enclosures 1-5. Grazing period was between April and September. Vegetation monitoring was undertaken using fixed point quadrats in compartments 1, 2, 3 and 5.

Compartment No.	Number of cattle	Compartment size (ha)	Stocking rate (cattle/ha)
1	6-10	11.0	0.52
2	8-12	15.7	0.47
3	5-9	9.8	0.58
4	4-7	8.3	0.60
5	3-6	7.2	0.65

Analysis

Data were normalised before analysis and back-transformed for final values. Differences between grazed and control plot were analysed using a 2-way ANOVA procedure and a

Tukey test for the overall pairwise comparison applied. This tested the differences between grazed and ungrazed plots at the end of the trial, not the differences in change over time between the two. Vegetation communities were assessed using Detrended Correspondence Analysis (DCA)(Hill and Gauch 1980) and the Modular Analysis of Vegetation and Interpretation System (MAVIS) developed by CEH which assigned communities to NVC types.

Results and Conclusions

The following results and analysis are based upon four years of monitoring. We have not attempted to undertake a discussion of the results at this stage of the project, with a further two years of monitoring still to be undertaken.

H2 Calluna vulgaris-Ulex minor *heath*

Results are presented in Figures 5.1 – 5.7, comparing control and grazed samples of H2 *Calluna vulgaris-Ulex minor* heath vegetation between 2011 and 2014 for the following parameters: bare ground cover, herb height, species richness, purple moor-grass cover, dwarf shrub height, heather cover and pioneer heather cover (as proportion of all heather age classes). Graphs show means ± 1 standard error.

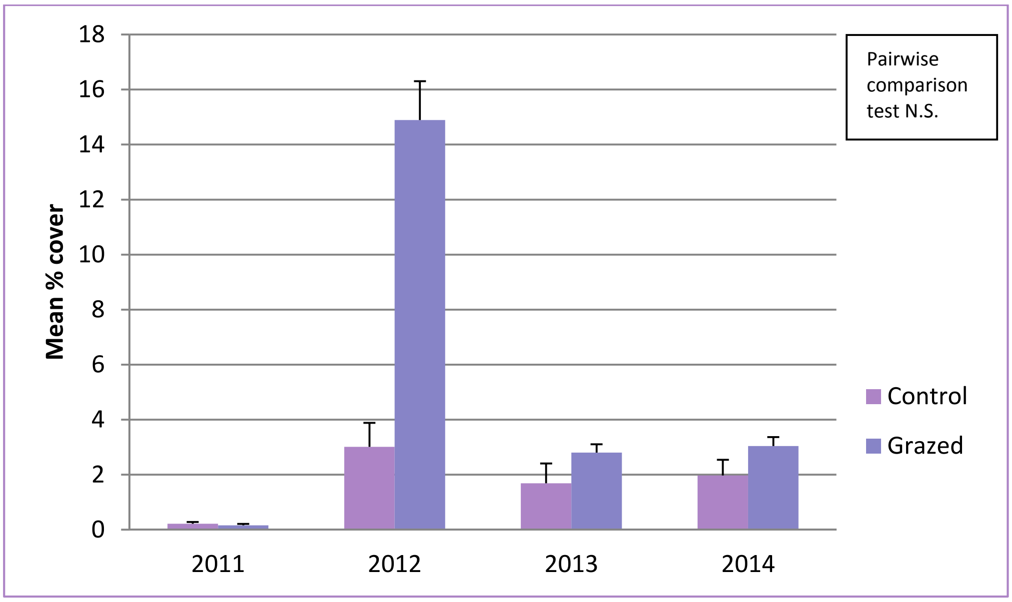

Figure 5.1: The percentage cover of bare ground within grazed and ungrazed H2 *Calluna vulgaris-Ulex minor* heath.

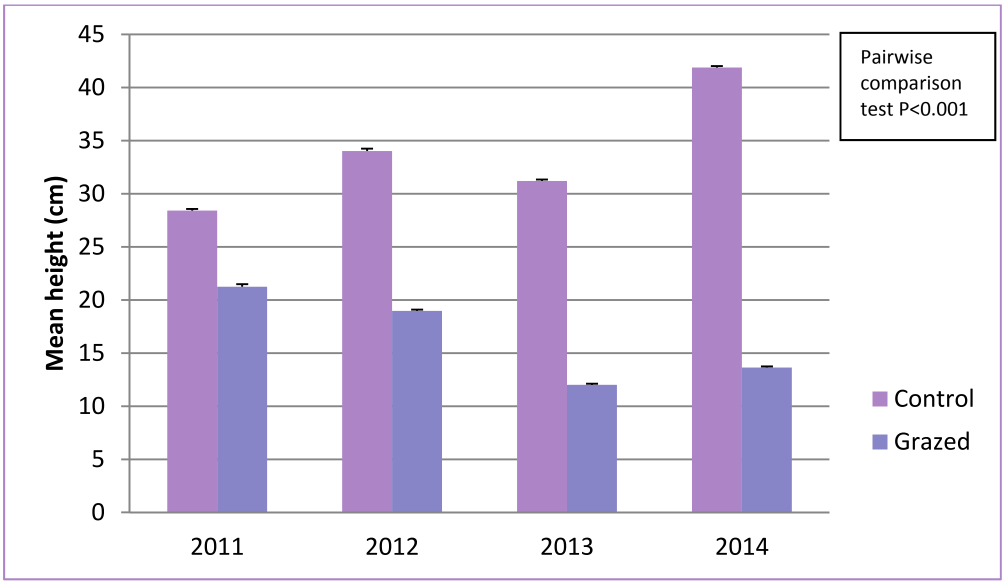

Figure 5.2: Herb height within grazed and ungrazed H2 *Calluna vulgaris-Ulex minor* heath.

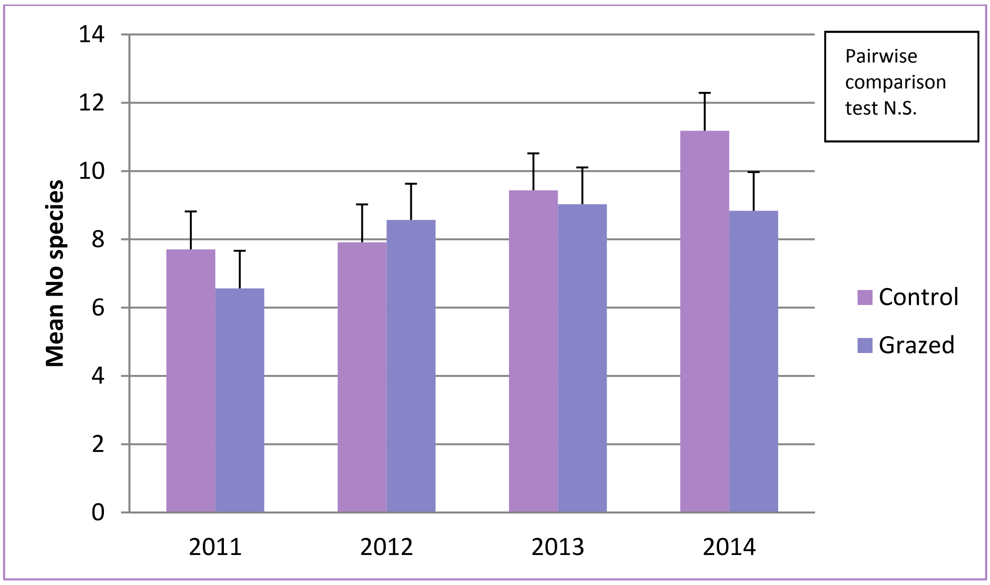

Figure 5.3: Species richness within grazed and ungrazed H2 *Calluna vulgaris-Ulex minor* heath.

Figure 5.4: Purple moor-grass cover within grazed and ungrazed *H2 Calluna vulgaris-Ulex minor* heath.

Figure 5.5: Dwarf-shrub height within grazed and ungrazed H2 *Calluna vulgaris-Ulex minor* heath.

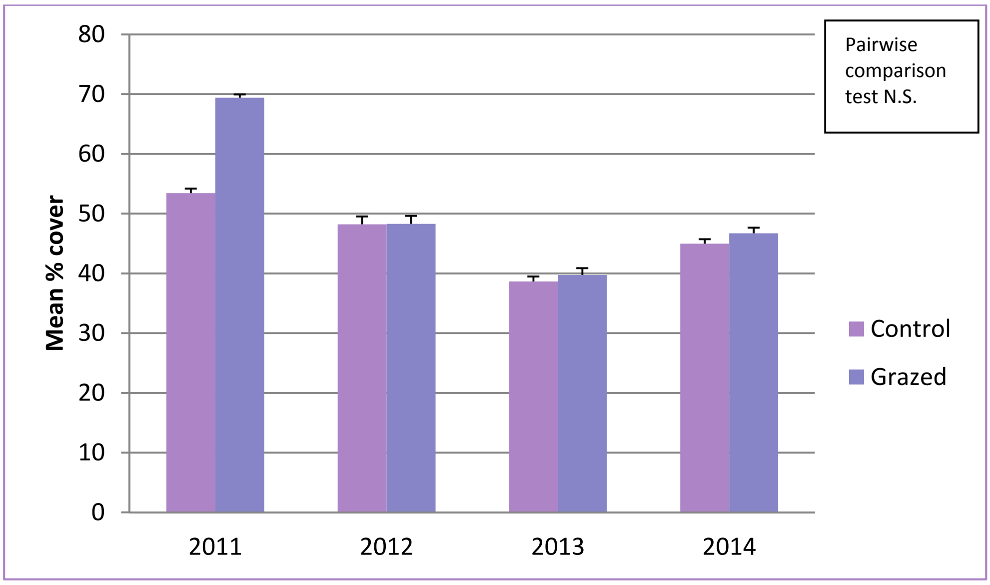

Figure 5.6: Heather cover within grazed and ungrazed *H2 Calluna vulgaris-Ulex minor* heath

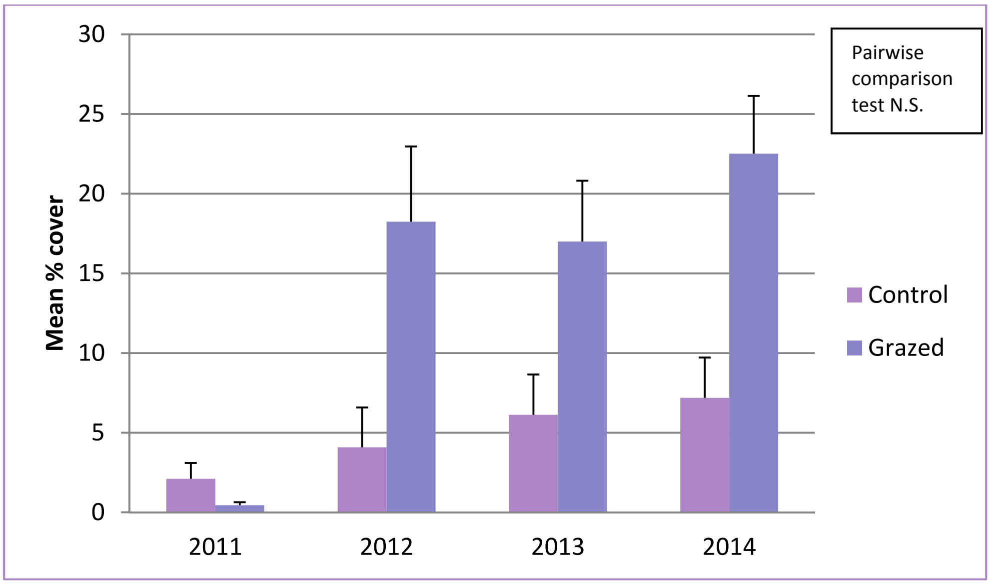

Figure 5.7: Pioneer heather *vulgaris* cover as proportion of four heather age classes within grazed and ungrazed *H2 Calluna vulgaris-Ulex minor* heath

Ordination analysis

Detrended Correspondence Analysis (DCA) (Hill and Gauch 1980) has the effect of grouping samples with similar characteristics. These are displayed graphically here using the axes that account for the most variation in the data. Median values for year groups were calculated to show average changes. Figure 5.8 shows the DCA plots for H2 *Calluna vulgaris – Ulex minor* heath over the four study years (2011-2014).

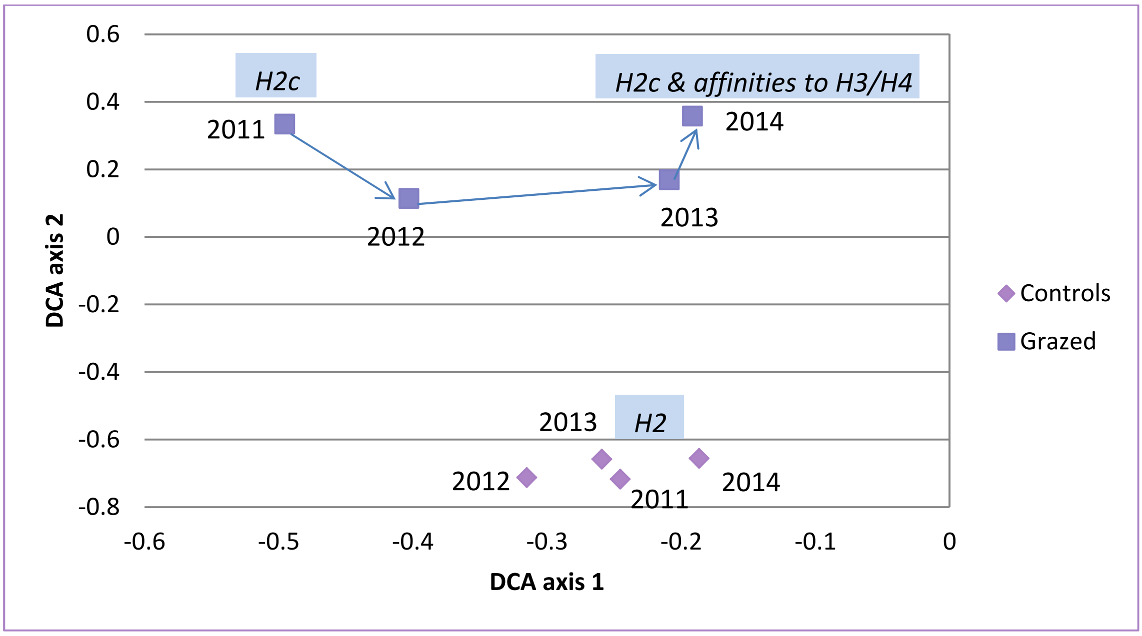

Figure 5.8: DCA Analysis of H2 *Calluna vulgaris-Ulex minor* heath samples

Herb height, bare ground, species richness and purple moor-grass cover

As might be expected, grazing has had the effect of reducing the height of the herb layer within the H2 plots. The pairwise comparison test shows a significant change (P<0.001) between grazed and sample plots over the four years of sampling with mean herb height in grazed plots declining from 21cm to 13cm and control plots increasing in mean height from 28cm to 42cm over the same period.

The amount of bare ground in the H2 plots increased in both the grazed and control plots over the sample period, but grazed plots showed a greater increase in the proportion of bare ground, rising from 0.16% to 9.0% whilst control plots increased from 0.22% to a maximum of 3.0% in the second year of sampling (differences in bare ground between grazed and ungrazed plots were not significant).

Species richness measured as mean number of species, did not change markedly over the period, and the pairwise comparison test did not show any significant change between the pairs over the sample period.

Initial indications are that grazing is reducing the height of the herbaceous elements of the H2 heath and creating some more bare ground. As yet, there is no clear indication of an increase in species richness as a consequence of these structural changes in the vegetation.

There is no obvious trend in the cover of purple moor-grass in the H2 samples with control samples showing consistently higher cover values and grazed samples consistently lower values. This reflects differences in the initial composition of the sample and grazed plots rather than any effect of grazing. The pairwise comparison test reflects this significant difference in the purple moor-grass cover in the two sets of samples.

Dwarf shrub height, *Calluna* cover and *Calluna* age structure

Grazing has had an impact on the mean height of dwarf shrubs in the H2 grazed plots with a reduction in mean height from 47.5cm to 29.6cm over the sampling period whilst control samples have varied between years but show no obvious trend. The pairwise comparison test shows a significant change (P=0.028) in dwarf shrub height between grazed and control samples over the sampling period reflecting the reduction in dwarf shrub height in the grazed plots.

The cover of heather over the sampling period shows no significant change between samples. Grazing is not resulting in a reduction of heather cover within the grazed plots. By contrast, there appears to be a much more pronounced change in the proportion of pioneer age class heather in the grazed plots, increasing from 0.45% to 22.5% over the four years. The control plots show only a small increase in the proportion of pioneer heather, rising from 2.1% to 7.2%, as illustrated in Figure 5.7. The pairwise comparison test shows no significant change in heather cover between grazed and ungrazed plots over the four year period.

Community composition

The DCA analysis shows some large differences in change between the grazed and control samples. Grazed samples move mainly along DCA Axis 1 between 2011 and 2014 as the relative importance of species in the community change. In this instance, species more typical of H3/H4, particularly bristle bent *Agrostis curtisii* and dwarf gorse, become more prominent. By contrast the control plots remain relatively clustered at the bottom of DCA Axis 2 and mid-way along DCA Axis 1 indicating little change in species composition.

M25 Molinia caerulea-Potentilla erecta mire

Results are presented in Figures 5.9 – 5.12, which compare control and grazed samples of M25 *Molinia caerulea-Potentilla erecta* mire vegetation between 2011 and 2014 for the following parameters: bare ground cover, herb height, species richness, purple moor-grass tussock height and cover.

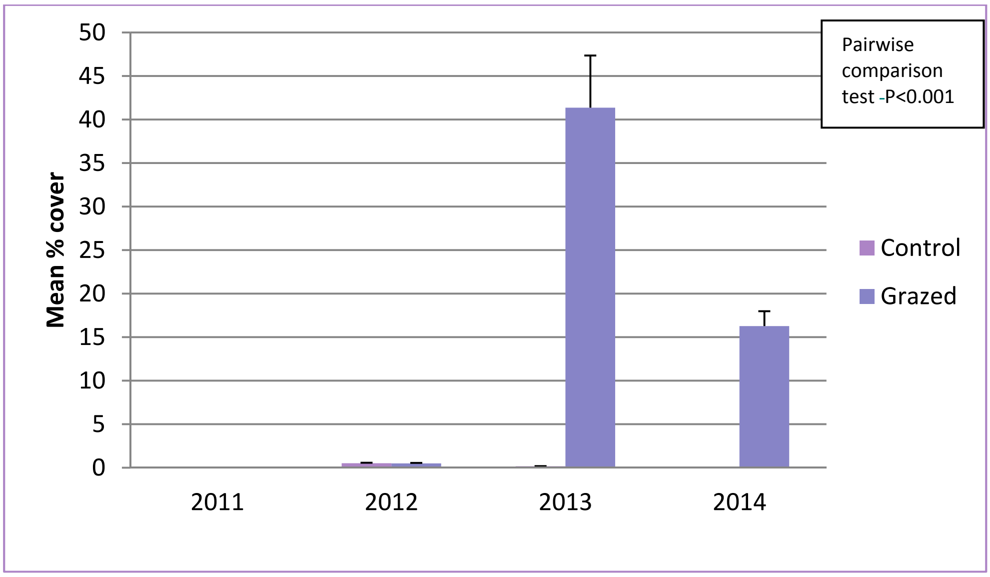

Figure 5.9: Bare ground cover within grazed and ungrazed M25 *Molinia caerulea – Potentilla erecta* mire.

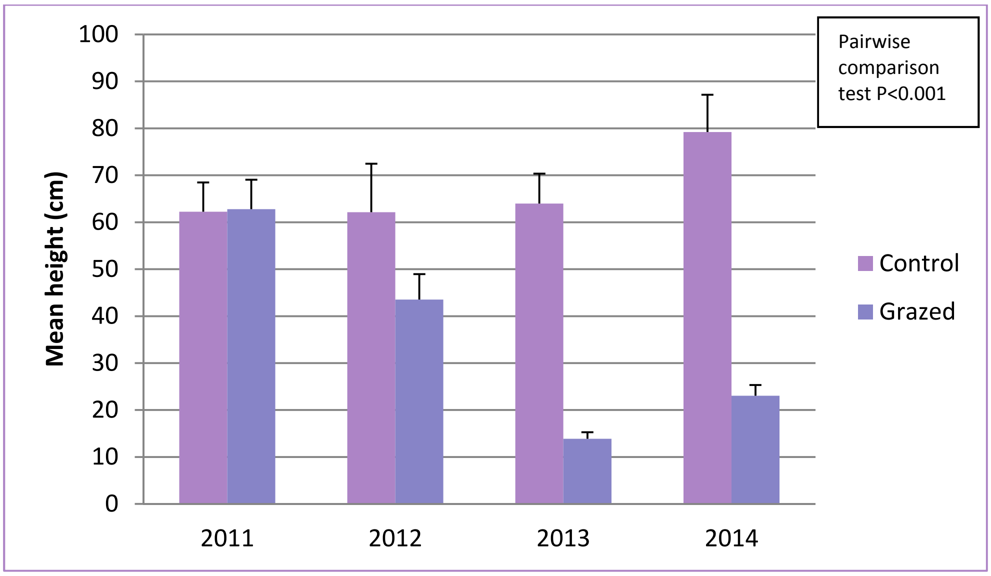

Figure 5.10: Herb height within grazed and ungrazed M25 *Molinia caerulea – Potentilla erecta* mire.

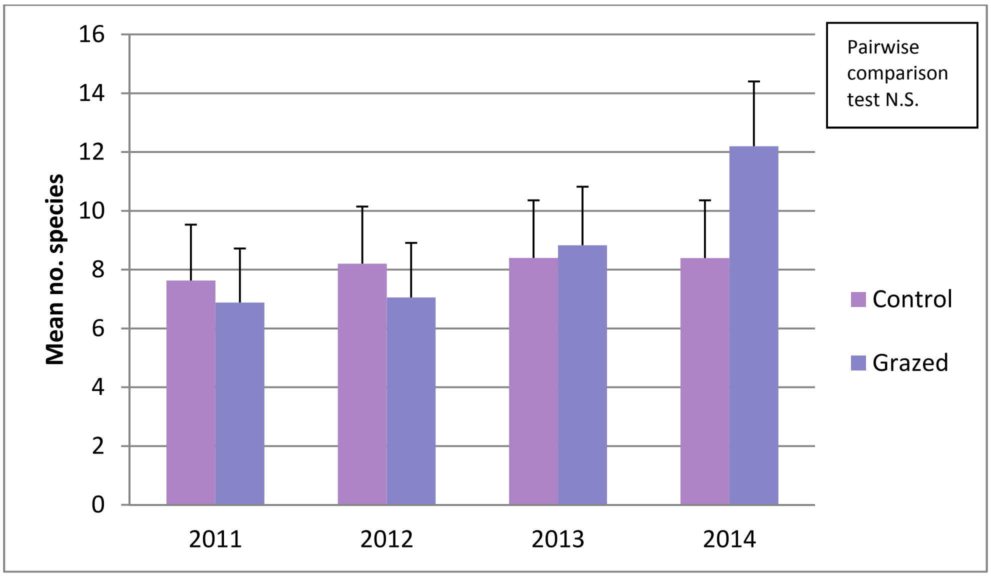

Figure 5.11: Species richness within grazed and ungrazed M25 *Molinia caerulea-Potentilla erecta* mire.

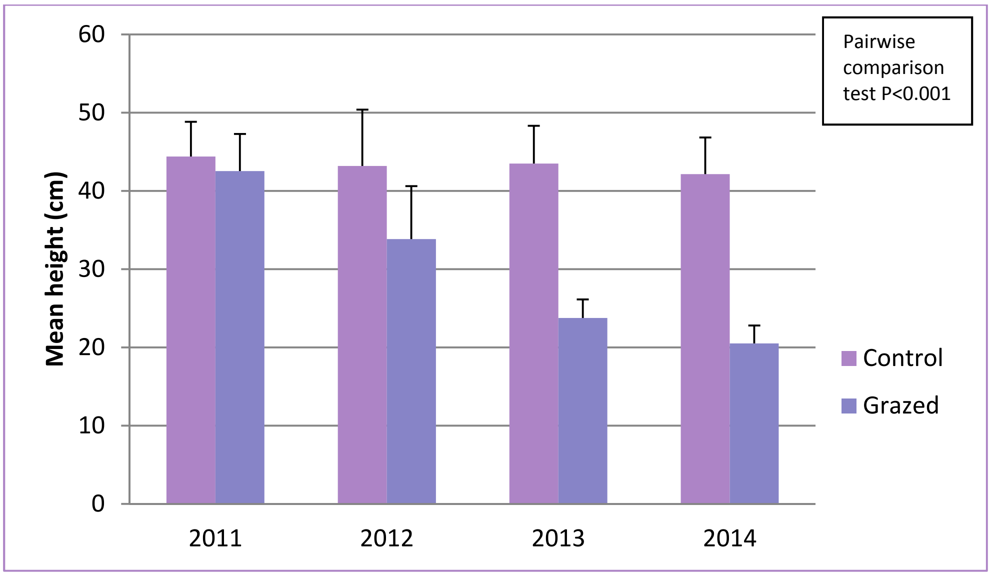

Figure 5.12: Purple moor-grass tussock height within grazed and ungrazed M25 *Molinia caerulea – Potentilla erecta* mire.

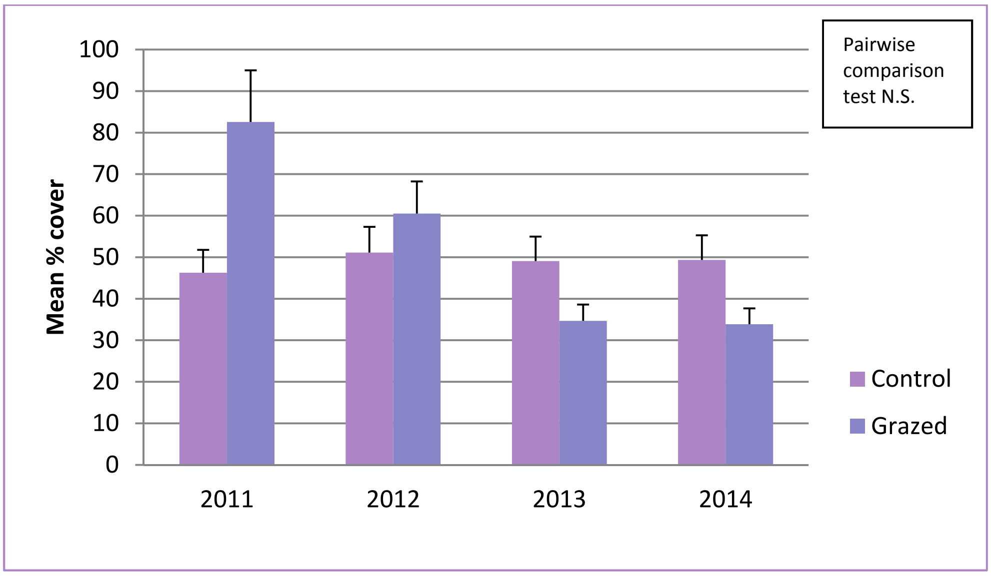

Figure 5.13: Purple moor-grass cover within grazed and ungrazed M25 *Molinia caerulea – Potentilla erecta* mire.

Figure 5.14 shows the DCA plots for M25 *Molinia caerulea-Potentilla erecta* mire over the four study years (2011-2014).

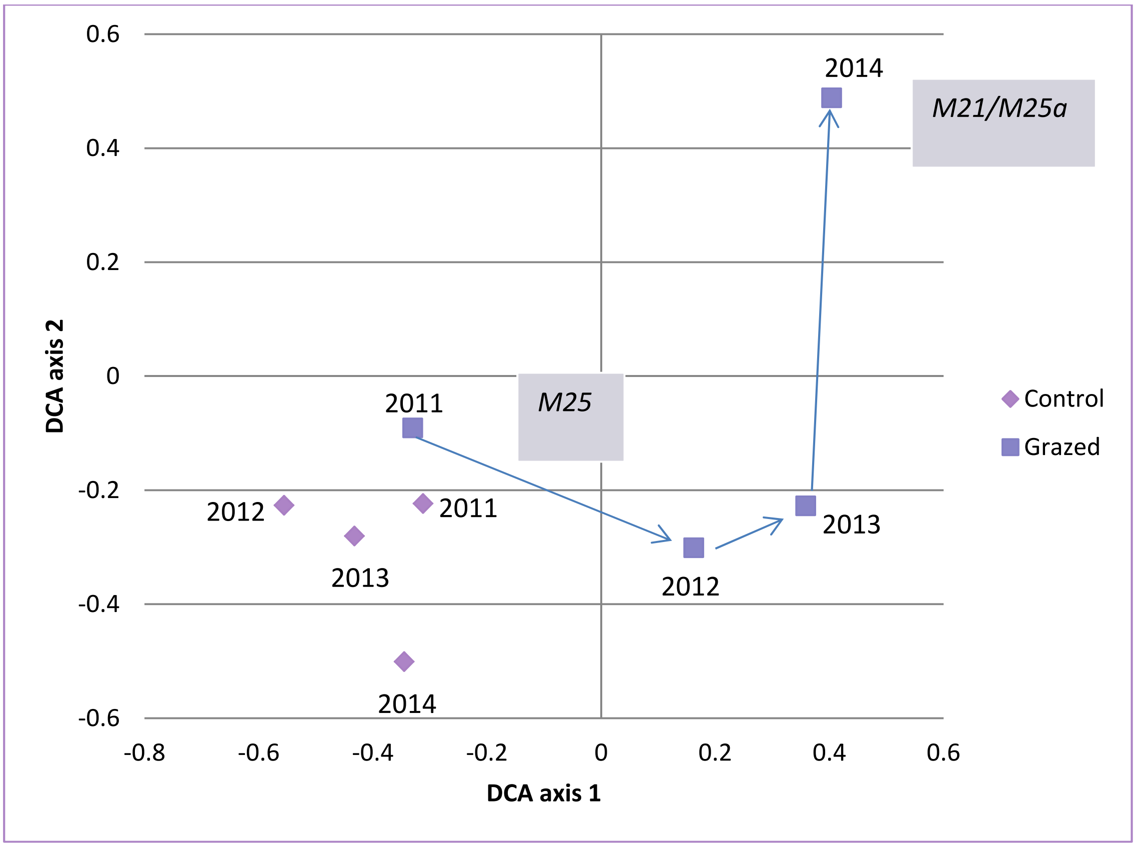

Figure 5.14: DCA Analysis of M25 *Molinia caerulea-Potentilla erecta* mire samples

Effects of grazing on M25 Molinia caerulea-Potentilla erecta mire samples

Herb height, species richness and bare ground

As with the H2 samples, grazing has had a marked effect on herb height with a significant change over the sample period. Grazed plots show a reduction in mean herb height from 62.7cm to a mean of 13.8 cm in 2013 followed by a slight increase to 23.04cm in 2014. By contrast, control plots show an increase in herb height from 62.3cm to 79.2cm over the four years.

Species richness increased in both the grazed and control plots over the sampling period but the increase in mean species richness in the grazed plots, rising from 6.8 to 12.2 species, is greater than in the control plots, rising from 7.6 species to 8.4 species over the four years, as illustrated in Figure 5.10. Despite the apparent greater increase in mean species diversity in the grazed plots the pairwise comparison test did not find any significant differences between the groups.

Purple moor-grass cover and tussocks height

Purple moor-grass is the principal component of the M25 mire vegetation, with mean cover values of over 80% at the start of the sampling period. The introduction of grazing has reduced the dominance of this species with mean cover values declining from 82.5% in 2011 to 33.8% in 2014. By comparison purple moor-grass cover in the control samples showed no trend and appears to remain relatively constant with mean cover values of between 46% and 51%. However, the pairwise comparison test did not show any significant differences between the groups, probably due to the large differences in purple moor-grass cover between the control and grazed plots prior to the start of grazing.

Grazing has reduced the height of purple moor-grass tussocks with mean tussock heights of over 42cm in 2011 in both control and grazed plots. Control plots remained at above 40cm in height over the four sample years with the grazed Molinia tussocks reducing in to a mean height of 20.5cm. The pairwise comparison test shows a significant difference between the groups of samples over the four years.

The decline in purple moor-grass cover and tussock height in the presence of grazing is likely to have resulted in the increase in bare ground and species richness seen in the grazed plots; increases that were not observed in the control plots.

Community composition

The DCA analysis shows grazing to be having an effect on the vegetation composition as grazed plots move away from the cluster of control plots over the four years. The grazed plots take on more of the character of the M21 *Sphagnum papillosum-Narthecium* *ossifragum* mire community and the more diverse M25a *Erica tetralix* sub-community. These changes are due to an increase in the abundance of characteristic species, particularly cross-leaved heath and common cottongrass *Eriophorum angustifolium,* which are common to both communities, and cow-horn bog-moss *Sphagnum denticulatum,* common haircap *Polytrichum commune* and sharp-flowered rush *Juncus acutiflorus* in the M25a and papillose bog-moss *papillosum* and heather in the M21.

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Sanderson NA & Groome G (2002) *Phase 2 NVC Habitat Survey- Chobham Common SSSI Thursley, Ash, Pirbright & Chobham SSSI*. Report by Ecological Planning and Research (EPR).

Appendix 1: Chobham Common Vegetation Monitoring Recording Card

Site Name……………………….…………..Date……….…….….……Habitat……………………

Quad No./Code					
Quad location: Northing					
Easting					
Photo number(s)					
Species/% cover					

Litter					
Bare					
Dung					
% Calluna age-class:					
Degenerate					
Mature					
Building/young					
Pioneer					
Veg ht: (5 samples/quadrat)					
Cryptogams					
Herb layer					
Dwarf shrubs					
Shrub layer					
% Cover:					
Cryptogams					
Herb layer					
Dwarf shrubs					
Shrub layer					

TALK 6: Grazing and sensitive species

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Summary

- Sensitive species may be negatively impacted by livestock grazing.
- Sensitive species are not necessarily confined to certain habitats – some have complex ecologies reliant on many features.
- Planning and assessment are essential when mitigating for the potential negative impacts of grazing on sensitive species.
- Site objectives must be achievable through grazing for it to be used
- "Less is more" is a good maxim.
- Timing of grazing is critical.
- Be as flexible as possible in your approach to each site.
- Monitoring is crucial to achieving success in mitigating any negative effects of grazing, as with any type of habitat management.
- A holistic approach to management is best, with grazing used as a part of a suite of management tools used.

What are sensitive species?

- Any species that relies on a well-structured habitat – for hibernation, feeding, temperature control
- Any species that relies on a certain habitat feature – for egg laying/ hibernation
- Any species that is relatively immobile – small territories or annual movements
- Any species that is easily disturbed

Nightjar *Caprimulgus europaeus* (Chris Dresh)

Adder *Vipera berus* (Chris Dresh)

Sensitive groups on heathland

In a heathland context, sensitive species may include:

- Reptiles and amphibians
- Invertebrates
- Ground nesting birds
- Small mammals
- Plants

Reptiles and Amphibians

Reptiles and amphibians need a well-structured habitat for thermoregulation, hibernation, feeding. Some species are reliant on particular habitat features for reproduction, for example, sand or ponds. Most species are relatively immobile and prone to disturbance.

Invertebrates and ground-nesting birds

Invertebrates and ground-nesting birds are reliant on habitat features for rearing young and feeding, such as sand and open areas. They may also be prone to disturbance.

Small Mammals

Small mammals need well-structured habitat for hibernation, feeding and predator avoidance.

Nightjar egg (Chris Dresh)

Harvest Mouse *Micromys minutus* (Peter Vaughan)

Flora

Plants are immobile and prone to trampling. Particular plant communities can be damaged by overgrazing and trampling, particularly where livestock congregate.

Valley mire vegetation can be vulnerable to livestock trampling (Chris Dresh).

A closer look at reptiles

General Ecology

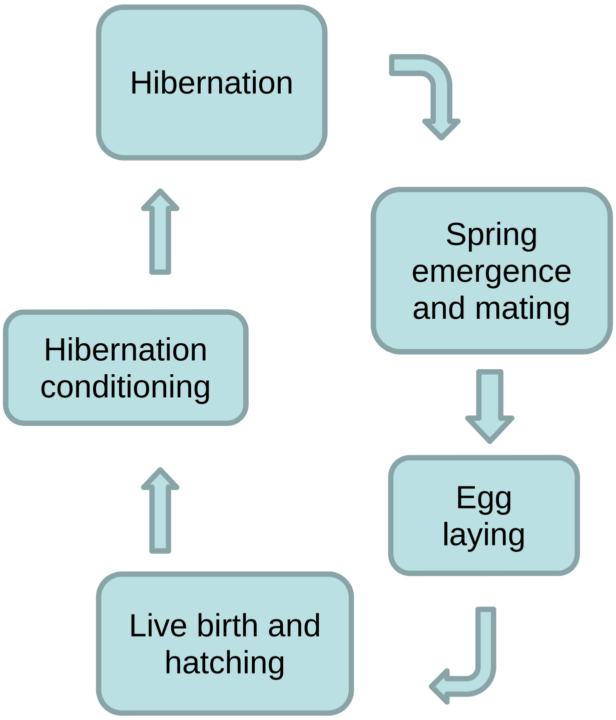
- Need for thermoregulation; both heating up and cooling down requires well-structured and diverse habitats
- Successful hibernation requires a stable environment
- Spring emergence is a time of low energy stores vs. high expenditure in mating.
- Live birth/ egg laying requires large amounts of energy and the use of open spaces.
- Change in prey items over lifetime requires well-structured habitat with many ecological niches.

In summary

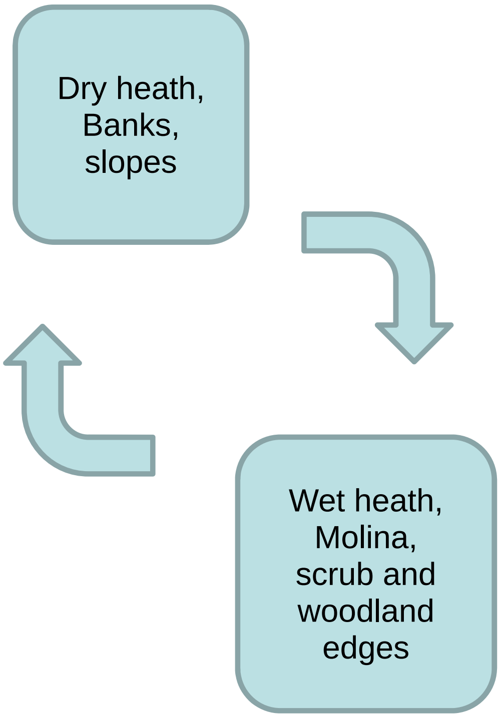
- Different reptile species have different levels of sensitivity to grazing pressure.
- Reptiles have a complex ecology requiring well-structured but differing habitats through the year and over a life time.
- Most reptile species will use a range of habitats available on heathland at any point during the year; with wet heath and Purple Moor-grass *Molinia caerulea* grasslands being particularly important over the summer for the majority of reptile species.
- Features important to reptiles can be created by and/or attractive to grazing livestock – bare sand, tracks, ponds, dry areas
- It is important to know which species are present to get the balance right between species and livestock grazing.
- Differing interactions between individual livestock and/or types/breeds and sensitive species
- Reptiles are potentially vulnerable to excessive habitat change and/or disturbance from winter into spring.

Figure 6.1: The reptile year

Animals have a yearly cycle with different habitat and physical requirements.



Heathlands contain diverse habitats with subtle interfaces between them, providing varied choice for reptiles.



Grazing

Grazing and habitat structure

Grazing can produce well-structured micro habitats, but it can also easily reduce structural diversity, especially in the grass component of heathland ecosystems. Seed dispersal by grazing livestock may also contribute to habitat change over time.

Grazed (left) and ungrazed (right) heathland (Paul Edgar)

Disturbance

Natural features and recreational activities (e.g. shelter, water, dog walking) can bring sensitive species and livestock together in areas of high risk. However, the impacts of direct disturbance by livestock will vary between species and over time. For example, reptiles are most vulnerable immediately post-hibernation in spring, while other species are more likely to be impacted in spring-summer, when disturbance may reduce breeding success.

Trampling

Trampling is probably a small risk to both animals and eggs. However, habitat and livestock management can result in animals and livestock concentrating in the same location. The behaviour of both livestock breeds and of individuals can be important. The greatest risk to flora and other site features is generally from livestock lying up.

Reptiles can potentially be crushed if livestock trample on artificial hibernacula such as this (Richard Sharp).

Management planning

The main elements of a grazing regime are considered here. The next section describes how Amphibian and Reptile Conservation are applying these principles to conservation grazing in Dorset.

Before instigating grazing, it is essential to consider fully what the objectives are for the site and what the alternatives are to grazing. It is worth carrying out a site audit, which should consider:

- Species and habitats present.
- Infrastructure present.
- Relationships with neighbours
- Public use of the site and their attitude to management.
- Whether grazing can be targeted
- Finances and resources available

Objectives set for the site must be achievable by grazing. Two common themes are the relative proportions of grass and dwarf shrubs, and the control of scrub and regenerating trees. The particular objectives will influence the choice of stock, timing of grazing and livestock numbers.

Whether to graze should be a long-term decision and the original set up will have implications into the future. This includes whether to use a grazier or an in-house herd and livestock type and numbers.

Grazier or in-house?

The use of a grazier:

- limits the choice of livestock type
- reduces control of timing
- reduces liability and costs

Conversely, in-house grazing:

- allows a greater choice of livestock type
- increases control of numbers and timing
- increases liability and costs

Livestock type

It is important to be able to match animal type to objectives - a poor match will lead to animals, sites or both being pushed past what is best

Numbers

Start small! Numbers can always be increased if objectives are not being met.

Timing

Timing is a complicated question and will be influenced by how the scheme is set up, objectives and the desired outcome for the livestock.

Monitoring

Monitoring is all important, both annually and long-term. This should look at habitat structure and changes as well as trends in reptile numbers.

Grazing our Dorset reserves

Amphibian and Reptile Conservation (ARC) grazes eight of its reserves in Dorset. Grazing was set up using graziers through private arrangements and the Dorset Urban Heaths Grazing Project. ARC recently developed a grazing plan to cover general grazing on Dorset reserves. ARC also use more targeted grazing outside of Dorset for specifically for Natterjack Toad *Epidalea calamita and* Pool Frog *Pelophylax lessonae.*

British White cattle grazing Purple Moor-grass dominated heath in Dorset (Richard Sharp).

With cattle being the only livestock easily available, ARC are working on the objective:

> *"Manipulation of grass beds and dwarf shrub species to increase structural diversity through the grazing, movement and lying up of animals."*

ARC are working to keep the number of animals on site close to 0.1 LU per ha (1 LU = 1 adult cow). This means a 100ha site would have 10 animals as a starting point for a year's grazing. Adjusting stocking density up or down relies on an assessment of the sites ability to support stable reptile populations, habitat types and present habitat structure.

Taking reptile conservation as the overriding parameter, ARC avoid late winter, spring and possibly early summer grazing. Late summer/autumn into early winter grazing is preferred. This means livestock come onto site post hatching/birth when all reptiles are mobile.

ARC is using two methods of monitoring:

- A simple grazed/un-grazed comparison survey to look at reptile numbers over time.
- A targeted risk assessment looking at actual grazing impacts on vegetation structure.

A closer look at ARC monitoring

Aims

- Monitoring any changes in heathland vegetation structure that happen as a result of grazing.
- Assessing if and how the quality of reptile habitat changes as a result of grazing.
- Improved our understanding of how cattle use a site during short periods of extensive grazing

Methodology

- A large number of monitoring sites – more than one per hectare
- Monitoring sites chosen using two assessment criteria - potential as reptile habitat and potential as grazing resource
- Standard recording - reptile habitat quality 1-5 (5 being highest quality), observed grazing impact 1-5 (5 being greatest impact)
- Before, during and after grazing assessments carried out

Risk index

A risk index is calculated as follows:

Mean grazing impact score x mean habitat quality score = Risk index (RI)

The potential maximum risk score is 25, highest quality reptile habitat showing the highest grazing impact.

Figure 6.2 shows the mean RI for each habitat type on a site over the grazing season. Although it experiences the highest grazing pressure, the enriched ground does not have a large RI due to its poor reptile habitat score. Conversely the dry heath transition has a very high reptile habitat score (5) so it only takes a medium grazing impact score (2.5) to take its risk index to 12.

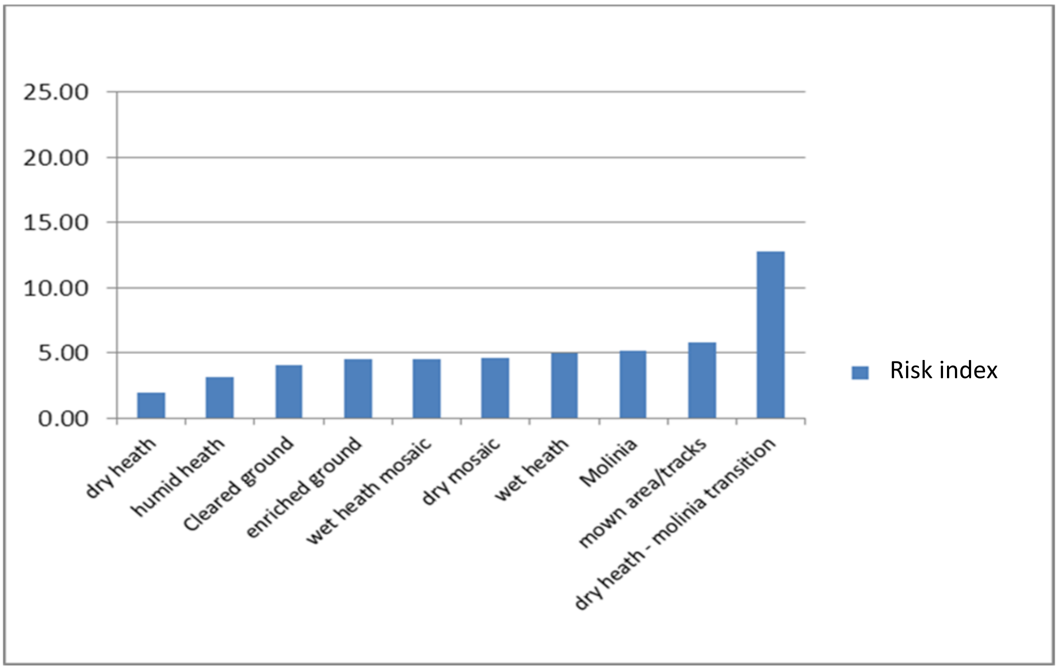


Figure 6.2: Risk index by habitat type

When managing for reptiles we would want the RI of any important feature to be under 10 and ideally below eight. The risk assessment summarised in Figure 6.2 would trigger a review of the grazing and a probable change in the regime or stocking density.

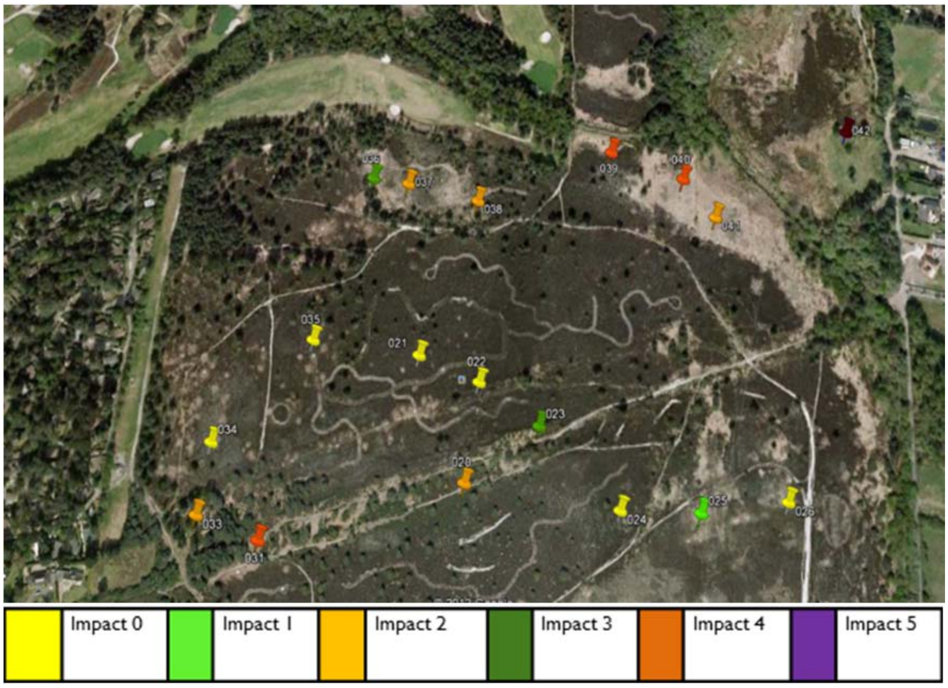


Figure 6.3: The location and category of assessment points on an ARC reserve.

Acknowledgements

Thanks to Gary Powell and Jon Crewe, also to Peter Vaughan, Paul Edgar and Chris Dresh for use of their images.

SESSION 3: INTERVENTION MANAGEMENT

TALK 7: "Robust" interventions: The re-creation of dry heathland and habitat for a nationally threatened butterfly at Prees Heath Common Reserve, Shropshire

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Summary

The Silver-studded blue butterfly (*Plebejus argus*) is a species of conservation priority in the UK as a result of severe declines over the past 100 years through loss of habitat extent and quality. Prees Heath Common in Shropshire has supported the last population of the butterfly in the English Midlands since the 1970s on small areas of relict heathland. Butterfly Conservation purchased part of the Common in 2006 to safeguard this population and to undertake a re-creation of lowland heathland in an attempt to ensure its persistence. Through major interventions to the soil profile and chemistry heathland vegetation has been established on sandy soil enriched by previous arable cultivations and associated uses. After 8 years the aim of greatly increasing the area of suitable habitat by creating dry dwarf shrub heathland and acid grassland mosaic communities is progressing well. The techniques used involved soil profile inversion through deep-ploughing, chemical acidification, and sowing by spreading recently harvested heather brash. Control of invasive plants such as Creeping Thistle (*Cirsium arvense*), Common Ragwort (*Senecio jacobaea*), Rosebay Willowherb (*Epilobium angustifolium*) and Silver Birch (*Betula pendula*) has been essential. Browsing by the large resident rabbit population was thought likely to have a severe negative impact but within three years an extensive cover of *Calluna vulgaris* had nevertheless become established and small stands of *Erica cinerea* are persisting. This has continued to develop and provide the principal larval food plants (*Erica cinerea* and *Calluna vulgaris*) for the butterfly and the habitat conditions needed by its obligate associate, the black ant (*Lasius niger*).

Introduction

In May 2006 the UK charity Butterfly Conservation (BC) purchased the western half of Prees Heath Common, located in north Shropshire, England. The purchase of these 60 ha of land, to establish a nature reserve, was the culmination of a campaign that started in the early 1990s. It allowed BC to start re-creating the lowland heathland and acid grassland vegetation communities lost over the latter part of the 20th century, and thus provide a greatly increased area of suitable habitat for the population of Silver-studded blue butterfly (*Plebejus argus*) persisting on this half of the Common. Most of the 126 ha common is thought to have been covered by grazed, lowland heathland in 1880, but by 2006 the majority had been converted to arable land on which crops of beans, wheat and potatoes were grown. Some areas had become woodland, scrub or coarse grassland and ruderal vegetation. During the 20th century the site had variously been part of a large WW1 army trench warfare training camp, and during WW2 supported an internment camp then an airfield. By the 1970s only sections of disused runway and other artefacts prevented the entire heathland area being converted to modern farming operations.

In 1991, 25 ha of the semi-natural vegetation surviving on the western half of the Common, including only 5 ha at most of recognisable heathland vegetation supporting the Silver-studded Blue, were notified as a Site of Special Scientific Interest (SSSI) in an attempt to protect this nationally significant population. Formerly a relatively widespread and locally common species in southern parts of the British Isles, the Silver-studded Blue underwent severe declines during the 20th Century caused by habitat loss, becoming extinct in Scotland and northern England and localised over the rest of its range by the 1990s (Asher et al., 2001). It is now considered nationally threatened and a Priority Species in the UK Biodiversity Action Plan. Reinforced by the butterfly's very sedentary behaviour it was recognised to have several distinctive habitat and range related forms, long considered to be separate 'races', but now regarded as 'eco-types'. The population on Prees Heath has been isolated for much of the 20th century and the large and bright colouration of its specimens has long made this site of interest to lepidopterists.

Lowland heathland is now the species' most widely used habitat in Britain, though significant populations also remain on calcareous grasslands in particular areas (e.g. Isle of Portland, Dorset, Pembrokeshire coastal grasslands and the Great Orme, North Wales) and major calcareous sand dune systems (e.g. N. Cornwall). In all such habitats the butterfly requires short or sparse vegetation, such as recently burnt or cut heathland, or thin, eroding soils (for example old quarries and coasts). In the far south of England it is less demanding and is often associated with shorter areas of wet heath dominated by Cross-leaved Heath (*Erica tetralix*). Even where these overall habitat types persist as large areas, natural vegetation succession and a lack of grazing or other suitable management as well as habitat fragmentation have been responsible for local extinctions.

A wide variety of ericaceous and leguminous larval foodplants are used in these habitats: on heathland Ling *Calluna vulgaris*, Bell Heather *Erica cinerea*, Cross-leaved Heath *E.tetralix*, gorses *Ulex* spp.; and on calcareous sites mainly Common Bird's-foot Trefoil *Lotus corniculatus*, Common Rock-rose *Helianthemum nummularium*, and Horseshoe Vetch *Hippocrepis comosa*. In all cases the butterfly's dependence on an association with Black Ants (*Lasius niger* on heathlands and *L. alienus* on calcareous grasslands) determines the vegetation micro-habitat occupied. On Prees Heath, Ling is the main larval foodplant, with Bird's-foot Trefoil used occasionally, and Bell Heather is an important nectar source for the adult stage.

Anthropogenic lowland heathland typically occurs on acidic infertile soils in the UK. In order to achieve UK Biodiversity Action Plan targets for this priority habitat, heathland recreation was included in agri-environment schemes available for agricultural land on former heathland (UK Biodiversity Steering Group, 1995). The difficulties of recreating heathland on arable land due to long-lasting chemical changes in soil properties are well known (Walker et al., 2004). Soil nutrient levels are also a major impediment to heathland regeneration and persistence (Pywell et al., 1994; De Graff et al., 1998). Even when acid amendments such as sulphur have been effective in reducing soil pH, establishment of heather vegetation can be poor. On this site the legacy of enrichment from previous arable uses together with the associated disposal of large quantities of chicken manure is exacerbated by high aerial nitrogen deposition levels in the area (NEGTAP 2001). The ambitious heathland re-creation scheme proposed by Butterfly Conservation therefore faced significant ecological challenges.

Materials and Methods

A baseline study of the existing soil profile in various parts of the reserve area was undertaken in October 2006 to determine the characteristics of the underlying subsoils and to examine the extent to which soil pH and the concentration of major soil nutrients changed with profile depth. This information subsequently informed the decision making about the optimum approach for the creation of new heathland habitat areas across the site. The decision to use deep ploughing, acidification and application of seed from heather brash was the conclusion of a review of options by Butterfly Conservation and research advisors. It was done with the knowledge that the underlying geology of the common comprises deep deposits of sand and gravel, post-glacial outwash having created a sandur around 17,000 years ago.

An area of 6.49 ha (Hangars Field) was selected to undertake the first phase of the heathland re-creation project. A Bovlund 64D plough was hired from Landlife at the National Wildflower Centre to invert the soil profile in the Hangars Field, as well as East of Runway Field 14.62 ha and Control Tower Field 4.57 ha.

Map 7.1: Prees Heath Common

Figure 7.1: Soil profile prior to deep ploughing revealing sand and gravel beneath approximately 300 mm of enriched topsoil.

Contractors commenced ploughing in March 2007 using a tracked Claas tractor (> 250hp) to invert up to 900 mm of the soil profile with this modified double mouldboard forestry plough (Figure 2). The surface was then rolled and later in July and October 2007 boom sprayed with glyphosate to control weeds emerging from buried roots, *Cirsium arvense* in particular. The objective was to bring the underlying glacial sands to the surface and bury the 300 mm thick, nutrient enriched topsoil layer. The inversion profile was not uniform: this new raw sand ground surface layer was of variable depth, with brown residual organic matter sometimes within 300 mm of the top or even visible on the surface. The surface also still had a more elevated pH (7.0) than considered suitable for successful heather establishment.

Figure 7.2: Deep ploughing to 900 mm and broadcasting heather brash containing seed.

Following the successful example of the RSPB at their Minsmere Reserve in Suffolk (Owen et al., 1999; Kemp, 2004), elemental sulphur was used to increase the acidity of the upper sand horizon, both in the short term, and to accelerate the weathering and leaching processes expected to eventually restore the sand's natural acidity levels. Pelletised sulphur ('Brimstone 90') was applied to the Hangars Field in August 2007 at a rate of 1.25 t ha-1. The surface was lightly disturbed with a chain harrow to assist shallow incorporation of the sulphur prills. Several samples of sand (0–75mm depth) were collected at various times between August 2007 and June 2014 and pH tested to follow this process.

Heather brash bearing ripe seed capsules harvested on a selected area of Cannock Chase AONB (Area of Outstanding Natural Beauty), Staffordshire was spread (Figure 2) on the Hangars Field using a muck spreader with a walking floor and twin vertical beaters, in November 2007. Approximately 100 tonnes of brash (159 bales averaging 0.63 t each) were spread over the 6.47 ha area. Capsule number per unit fresh weight, and seed number per capsule were assessed from several samples collected from three different bales. The seed number per capsule ranged from 0–12, but average number of seeds per capsule was 7.5 (sample size 200). If these samples are representative, about 37,000 seeds per square metre were spread. During the summer of 2008 and subsequently ruderal weeds such as *Senecio jacobaea* and *Cirsium arvense* emerging on the Hangars Field were hand-pulled and spot sprayed with glyphosate on three occasions to try and maintain a weed-free and bare sandy soil suitable for heathland plant seedlings.

The process of acidification with pelletised sulphur and heather brash spreading was then carried out on a 6.5 ha part of the deep ploughed East of Runway Field in 2008. In 2010 the Corner Field, which had not been farmed as intensively as the other areas, received the same treatment on 2.1 ha, approximately two-thirds of its total area.

The remaining 8.12 ha of the East of Runway field and the whole of the 4.57 ha Control Tower Field, both of which had been deep ploughed but had not been acidified, were sown with a species-rich wildflower mix harvested from local unimproved hay meadows in 2007 and 2008.

Seeds of *Erica cinerea*, harvested from Prees Heath in September 2007, were used by a local nursery to raise 20,000 plug plants. This process involved trialling known methods for breaking seed dormancy such as scarification and smoking. The plugs were subsequently planted out by volunteers in the Hangars Field and the heathland reversion part of the East of Runway Field between August and October 2009. To ascertain levels of rabbit browsing damage, twenty marked 2 m × 2 m plots were each planted with 24 *Erica cinerea* plugs. Some were protected with wire mesh and the remainder with just woody remains of the heather brash.

Seed of Wavy Hair-grass, *Deschampsia flexuosa*, was brush harvested on remnant heathland parts of the reserve during those first summers and broadcast on the three acidified heathland reversion areas.

Subsequent to the baseline survey of soil properties undertaken in October 2006, soil sampling of the top 100mm layer was repeated in November 2007, October 2008 and October 2009. Samples were taken from the Hangars Field, where sulphur had been applied, and the two other deep-ploughed areas where there had only been partial treatment with sulphur. These, together with soil sampling in the Corner Field, an area of sown agricultural grassland at the southern end of the site which had been outside of the intensive arable cultivations and was not deep ploughed until 2010, and part of the SSSI under semi-natural acidic grassland, provided a framework for comparison and control referencing.

Analysis of available soil chemical elements (NO3 –N, NH4 –N, P, K, Mg, Ca and soil organic matter) was undertaken by an accredited laboratory. Monitoring of plant colonisation using twenty four fixed rectangular 2 m x 1 m sampling quadrats in a grid pattern commenced in June 2008. This was repeated in October 2008, September 2009, July and September 2010 and August 2013, with the plots re-located using GPS.

Results

Fig. 3 shows the site mean pH values for each occasion that soil samples were collected on the Hangars Field. The data demonstrate that soil pH had declined progressively from the initial pre-ploughing value (7.0) to the typical pH range for heathland by June 2008, a period of 20 months. After this time pH fluctuated within a narrow range (3.4–4.1) from October 2008 to June 2014. Soil pH tends to fluctuate seasonally and these fluctuations probably reflected the seasonal variation. The effect of sulphur treatment in Hangars Field measured over a period of 3 years from August 2007 to August 2010 was to reduce soil pH by more than two units. This brought soil acidity close to the typical range of values found in many lowland heath soils in the UK (Owen & Marrs, 2000).

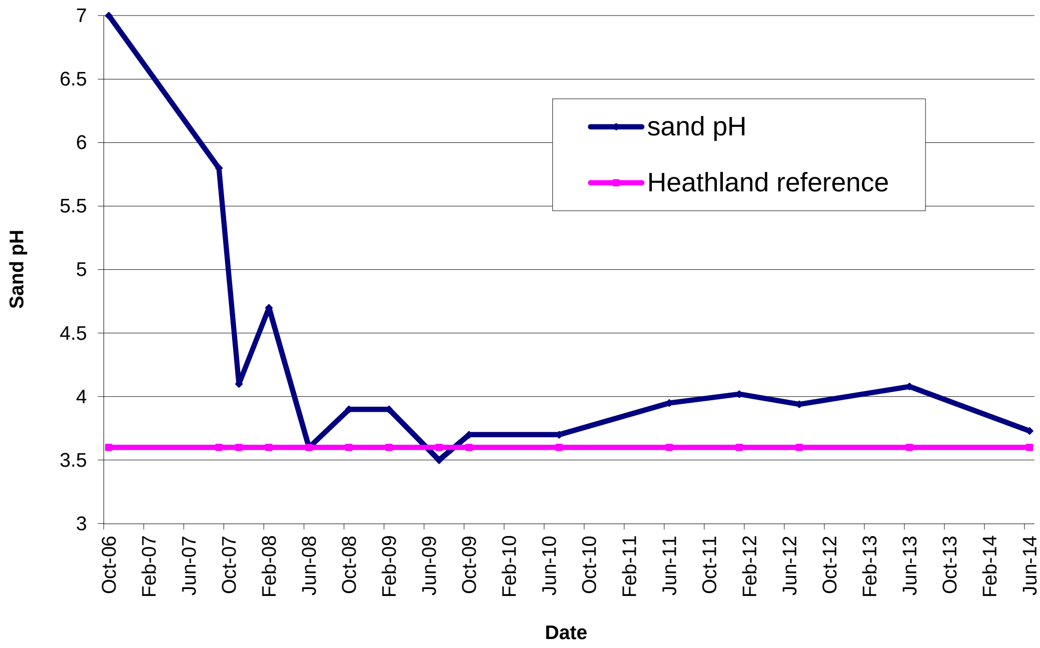

Figure 7.3: Progressive change in the mean substrate pH from October 2006 to June 2014 on the Hangars Field.

The local reference soil pH values provided by sampling a part of the site supporting acidic grassland revealed readings between 5.8 and 6.2 down through the profile to 80 cm, significantly higher than the UK reference levels and those achieved by the acidification. The disused runway supporting remnant heathland was not sampled as the runway sub-base of old concrete and building rubble is largely still in situ and not representative of local soil conditions.

By February 2009 the soil pH values recorded in parts of the deep ploughed areas that had not been acidified with sulphur had nevertheless dropped as low as 4.9. This considerable increase in acidity caused by natural processes of leaching base cations and replacing these with hydrogen ions carried in with rainfall occurred after just 20 months. However, the range of values, 4.9 to 6.3 indicated considerable patchiness in the increase in acidity.

Changes in extractable soil phosphorus, calcium (mg l-1) and ammonium nitrogen (mg kg-1) plus soil organic matter content for the Hangars Field, over a period of three years from October 2006 to October 2009 are shown in Table 1.

Table 7.1: Changes in the chemical properties of substrate in Hangars Field over a period of 3 years.

Soil parameters	Before ploughing, Oct 2006	3 months after ploughing, June 2007	31 months after ploughing, Oct 2009
Percentage organic matter	4.3	0.12	0.97
Phosphorus mg l^{-1}	58	11.8	23.3
Calcium mg l^{-1}	1588	118.5	32.7
Ammonium – nitrogen mg kg^{-1}	3.8	0.21	3.3

Deep ploughing had a dramatic effect on key soil chemical properties and soil organic matter (SOM) content over the three year period at Hangars Field (Table 1). Eight months after ploughing SOM was reduced to 0.12 % and both extractable phosphorus and calcium were reduced to concentrations consistent with undisturbed heathland (Pywell et al., 1994). However by October 2009 (31 months after ploughing) the mean concentration of phosphorus had risen to 23.3 mg l-1. This raised concentration of phosphorus may encourage successful establishment of *Betula pendula* seedlings and thus increase the requirement for ongoing intensive management. Although the concentrations of ammonium-nitrogen had increased by October 2009, it remained very low and therefore should not encourage invasion by trees or shrubs.

In October 2008 the mean density of *Calluna* plants in the Hangars Field was 24.9 m-2, although this masked a wide variation from 0–73.5 m-2 for winter/spring 2008 cohorts and 0–26 m-2 for the autumn 2008 seedling cohort. The maximum number in a single sample was 97 m-2. It is unusual for such a relatively high density of heather seedlings to become established during the first summer following spreading of heather brash in the previous autumn, but was very encouraging. There was a distinct spatial pattern to the establishment of heather seedlings which appear to have mostly grown in the shelter of slight linear depressions which may have been formed by the tractor tyres during and just after spreading the heather brash (see Fig. 2 and Fig. 4).

The results on the deep-ploughed and acidified part of the East of Runway Field that received heather brash from Cannock Chase in 2008 were not so successful. A substantial ruderal weed cover rapidly developed that required removal with a forage harvester, then boom spraying with glyphosate. The surface was then harrowed and re-seeded with further heather harvested from The Long Mynd (2009) and then Cannock Chase (2010). Weed control has had to continue but heather seedlings have since become established. 10,000 *Erica cinerea* plugs were also planted on this area. The deep ploughing, acidification and seeding treatments carried out in 2010 on the Corner Field, with additional seedings in 2013 and 2014, are just beginning to show significant heather establishment.

A flowery grassland sward has been established on the remaining deep ploughed but non-acidified parts of the East of Runway Field and the Control Tower Field. Control of Common Ragwort, *Senecio jacobaea*, remains a significant issue.

By July 2010, whilst neither the wire nor brash-only protection cover had prevented browsing of the *E. cinerea* plugs, survival levels were similar at > 50% on average. Though numerical survival levels were similar between plot types (insufficient samples to test significance) plants under wire mesh were larger and some were flowering unlike those only protected by brash. Seed of *E. cinerea* hand harvested on site and broadcast on the Hangars and East of Runway Fields has not germinated significantly. Germination of the *Deschampsia flexuosa* seed harvested on site and broadcast on these areas has been patchy.

Further vegetation surveys were carried out in 2014. On the Hangars Field the average percentage *Calluna vulgaris* cover was 52%, *Erica cinerea* cover was 2.2% and bare ground averaged 30%. On the northernmost area of the part of the East of Runway Field that was acidified and received heather brash C. vulgaris cover was 12.9%, *E. cinerea* cover was 6.6% and bare ground averaged 61%.

Figure 7.4: Hangars Field in 2009 two years after spreading (top), in 2010 (left) and in 2014 (right).

Figure 7.5: East of Runway Field in 2014 showing *Erica cinerea* in flower (left) and the Control Tower Field in 2014 (right).

Costs

Total costs for the soil inversion over 25.5 ha in 2007, including plough hire, supervision and repairs amounted to £954.50 ha-1. The heathland recreation costs of the Hangars Field area (6.5 ha, and the first and most successful area to date) from acidification in 2007 to weed control operations in 2009 (spot-spraying and pulling) equated to £2,166.13 ha-1. This excludes the costs of monitoring and BC staff costs, but does include minor incidental costs specific to the circumstances at this site. The total cost for the Hangars Field heathland including the soil inversion was thus around £3,100 ha-1. Almost a quarter of this amount comprised the purchase and delivery costs of the sulphur, which has since increased in price significantly.

Discussion

The long-term aim to re-create suitable heathland habitat for the Silver-studded blue butterfly and its associate black ant (*Lasius niger*) is progressing well on the Hangars Field part of the reserve. After 7 years an extensive cover of *Calluna vulgaris* has become established and some of the planted *Erica cinerea* has survived the vulnerable seedling stage. This should continue to develop and already appears to present the lowland heathland habitat required by the ant and butterfly, for which ongoing heather management will be required.

The Silver-studded Blue usually lays its eggs in short, sparse vegetation (< 10–15cm) and by the end of 2010 the structure of the vegetation on the Hangars Field appeared to already present suitable breeding habitat conditions. Surveys began in 2009 to detect colonisation by *Lasius niger* on the Hangars Field, with just 16 individual specimens being recorded. A further survey was conducted in 2014 which located a total of 46 *Lasius niger* nests on the Hangars Field, and during the course of this survey a Silver-studded Blue larva was found on top of one of the ants' nests, a significant event for the project.

The cover of *Calluna vulgaris* on approximately 1.5 ha of the Hangars Field had grown to 700mm tall by November 2014, too tall for successful colonisation by the Silver-studded Blue, and so this was mown, with the brash harvested and spread on the Corner Field.

The high rabbit population on the site resulted in severe browsing of the heather seedlings after their appearance in 2008. As protective fencing was impractical due to the size and the Common land status of the site, control by shooting was undertaken during 2009 but has not happened since. Now that heather has become well-established rabbit grazing may be beneficial in reducing heather height and creating bare patches.

The use of elemental sulphur in prill form to acidify the prepared soil surface was successful in achieving pH readings comparable to the UK reference within just over a year. The acidification of the exposed sandy surface by natural leaching observed over the first 20 months suggests that this process could also be used to achieve this modification. However the exposed raw sand surface is very prone to wind-blow and invasion by ruderal species if left un-vegetated. The scattered heather brash leaves woody remains on the surface for a number of years and this material can help attenuate wind-blow problems and is considered to have helped the heather seedling establishment by providing shelter and possibly some protection from rabbit browsing.

The poorer results of sowing in 2008 with heather brash on the deep ploughed and acidified part of the East of Runway Field is attributed to the lower quantities of viable seed present in those supplies and the higher levels of competition from ruderal species. Part of this area has a different land-use history in having been established pasture originating from 19th century or earlier enclosures of the heathland. These were levelled along with the pre-WWII heathland when the airfield was established and their presence cannot now be detected on the ground. Following ruderal weed control and re-seeding, however, more heather is now becoming established on this area.

The necessity of rapid acidification for the successful establishment of heather from a seed source cannot yet be concluded from the results to date, although it has produced the habitat conditions required on this site by the Silver-studded Blue. Further work and surveying on other parts of the reserve will continue to provide insights on these and other factors.

Figure 7.6: Silver-studded Blue larva (left) and emerging adult (right) attended by ants.

Acknowledgements

We are most grateful to all the volunteers who have contributed to the heathland re-creation project, and also to the small group of Prees Heath Commoners and their friends who give valuable support. We thank GrantScape, Natural England and Veolia Environmental Trust for project finance as well as for the enthusiastic work by Richard Scott and Landlife, Robert Lee from Forestart, and site works contractors including John Hopwood, Rob Bebbington (Fieldfare Farmers), Andrew Richards and Adrian Marsh. We also thank the following whose advice and encouragement helped identify the way forward: Richard Pywell (NERC Centre for Ecology & Hydrology) and John Bacon; Frances McCullagh, Chris Hogarth, David Ragbourne and Robin Gilbert (all Natural England), Jan McKelvey (Shropshire Wildlife Trust), Sue Sheppard (Staffordshire County Council, Cannock Chase), Caroline Uff (National Trust, The Long Mynd) and Mel Kemp (RSPB). Two MSc students assisted with survey work, Marion Cornforth (Birmingham University) and Natalie Kay (Harper Adams University).

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TALK 8: When to convert woodland to open habitat: sustainable delivery of government policy

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Summary

This outlines Government policy, as at the time of the conference, on how to decide when to convert woodland to open habitat in England and shows progress on key aspects since the policy was established in 2010. The text is based on the summary document produced by the Forestry Commission. To find out more, including the full policy document, go to www.forestry.gov.uk/england-openhabitats.

Aims

We, the Forestry Commission (FC), developed this policy working with Defra, Natural England and others, including many of the organisations and people attending the conference. Our ambition is to generate landscapes that provide benefits for people and wildlife for the 21st Century. We are achieving this through land-use change using conversion of woodland to open habitat in tandem with woodland creation.

The aims of this policy are to:

- generate biodiverse landscapes of open habitat and woodland that provide long-term benefits to people and wildlife;
- make sure that conversion of woodland results in more open habitat which makes a significant contribution to biodiversity objectives; and
- minimise any negative impacts on the ability of woodland and forestry to increasingly contribute towards a low-carbon economy.

Outcomes

The outcomes we want from the policy are:

- resilient ecological communities, where wildlife, including open habitat species, is able to cope with changes so that biodiversity is maintained and enhanced;
- woodland and forestry that make an increased contribution to reducing greenhouse gas emissions, through higher rates of woodland expansion and by maintaining the area of commercially productive woodland;

- land management which is financially viable in the long-term so that resilient biodiverse landscapes can be maintained and the call on public funding is within manageable limits; and
- people's engagement with the landscape they use, particularly their local landscape, is maintained or enhanced.

To make progress on all these aspects we are applying the following principles:

- **the right tree in the right place;**
- **the right habitat in the right place; and**
- **the right change at the right pace.**

Delivery

We deliver this policy using the following elements:

- **A framework** for site-by-site decision-making based on converting woodland to open habitat where it will consolidate current high quality habitat, or where it will significantly enhance key species and habitats.
- **A mechanism** for balancing woodland removal and woodland creation based on making reasonable progress on both enhancing open habitats to benefit wildlife and creating woodland to help reduce greenhouse gases.
    - In 2010, we estimated that the level of ambition for land-use change that would represent reasonable progress on both was a rate of conversion of woodland to open habitat of about 1,000 ha per year, if the rate of woodland expansion were to also accelerate. An increase in the rate of conversion of woodland to open habitat would therefore start slowly and progress towards 1,000 ha per year with an accelerating rate of woodland expansion.
    - The mechanism includes compensatory planting in certain circumstances, and maintaining the total area of commercially productive woodland, such as conifers.
- A process for ensuring local involvement in decision-making from the early stages of any proposals for conversion of woodland to open habitat.
- Standards for conversion and for managing habitats created or woodland retained to:
    - minimise negative impacts on aspects such as landscape, access, and soils;
    - minimise greenhouse gas emissions during conversion;
    - make sure woodland is managed so it can still be converted at a later date if needed; and
    - provide information on where to create permanent open habitat, and where more dynamic mosaics of woodland and open habitat are desirable.
- Evaluation of progress towards the outcomes we want. We do this with our stakeholders. We assess progress using indicators of outcomes such as the amount

of open habitat restored, or expanded, and changes in the area of productive woodland, see http://www.forestry.gov.uk/forestry/infd-8kmhu6.

In collaboration with Natural England and working with others, we are evolving the delivery mechanisms available to Government to implement the policy. Key delivery mechanisms are regulation, grants, and publicly owned land. A strategy for open habitats on the Public Forest Estate is at http://www.forestry.gov.uk/forestry/infd-7rufp5.

Progress since 2010

The policy was endorsed by Ministers in the forestry and woodland policy statement January 2013 in line with the recommendation by the Independent Panel on Forestry. This fulfils the commitment to review during the Parliament 2010 – 15.

The extent of conversion of woodland to open habitat and the nature of regulatory decisions made under the policy are set out in Figures 8.1 and 8.2.

For the balancing mechanism, in 2014/15 the point where we expect compensatory tree planting to be included in proposals to convert woodland to open habitat was set just below sites which are designated for their open habitat characteristics or non-designated sites of SSSI quality where removing the woodland will have significant biodiversity benefits. This is reviewed annually.

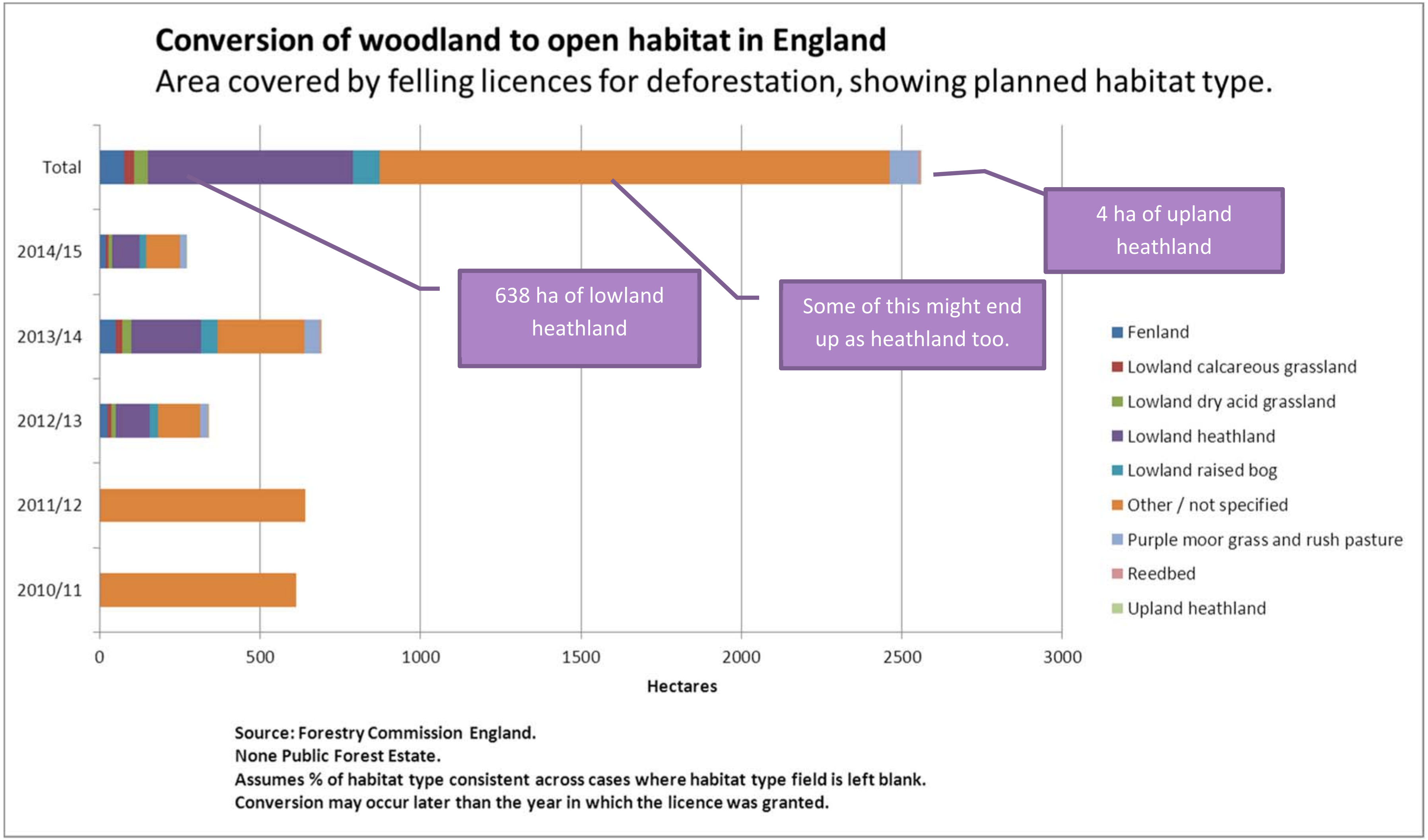

Figure 8.1: Conversion of woodland to open habitat in England – area covered by felling licences for deforestation, showing planned habitat type

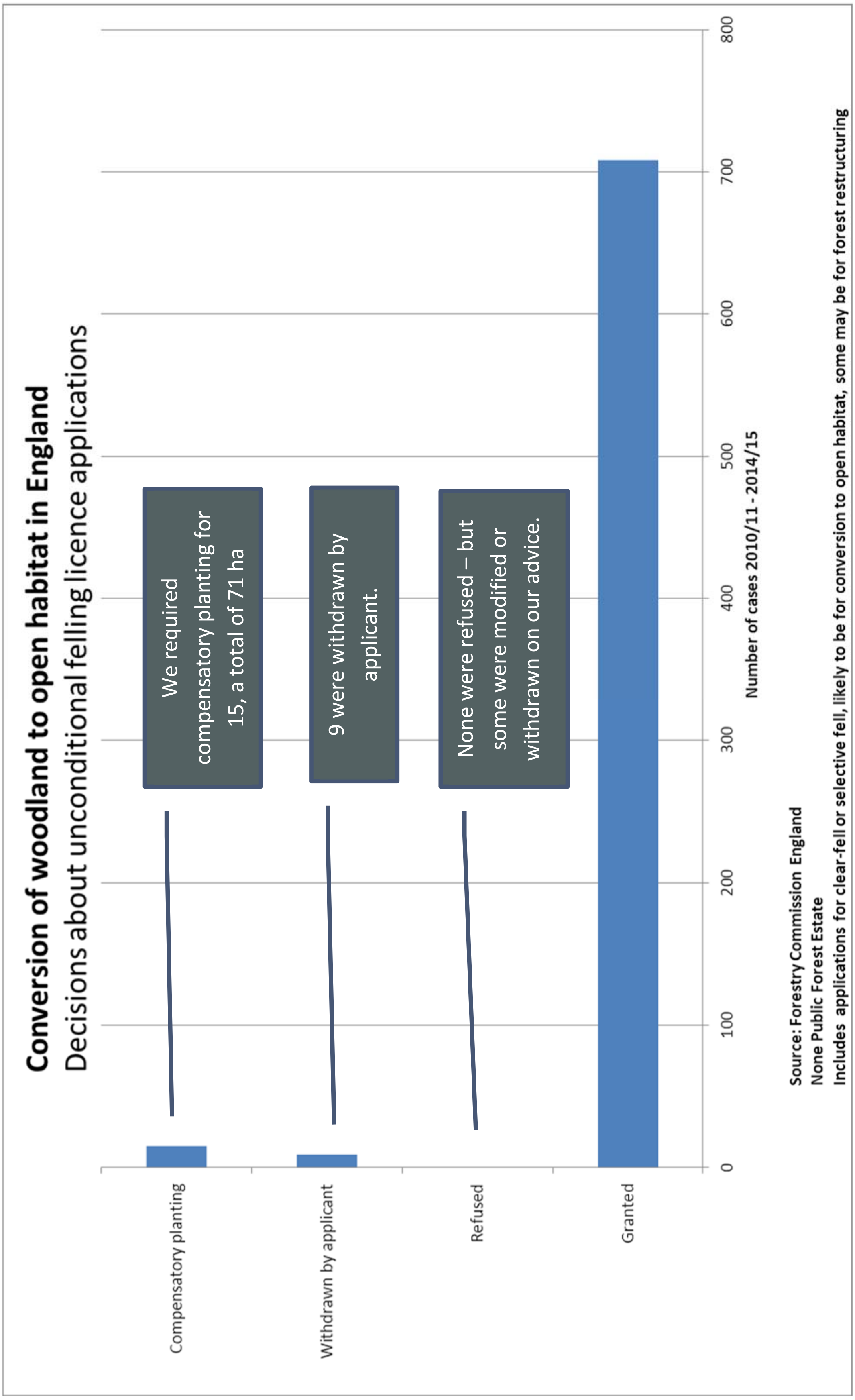

Figure 8.2: Conversion of woodland to open habitat in England – decisions about unconditional felling licence applications

Session 4: Let's innovate!

TALK 9: A renaissance in the chemical control of bracken?

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Summary

This paper discusses the problems associated with bracken in key habitats, especially lowland heath and dry upland heath, the current options for control and progress which is being made not only to identify potential alternative chemical control molecules but to re-evaluate the well-established, but currently banned, staple Asulox. It also considers some of the application problems and suggests ways forward.

Introduction and background

It is fully accepted that Bracken *Pteridium aquilinum* beds are an important component of heath, dry moorland and woodland areas and can have a valuable role in species conservation, e.g. butterflies. However large scale invasion and domination of these and other sensitive habitats has undesirable impacts on diversity, heritage features, landscape/access, water quality and supply, animal welfare and human health, not to mention grazing quality in improved grassland and adverse competition in woodland planting and natural regeneration. Our diverse heathlands, both fragmented and large, are particularly vulnerable and bracken control is an important management tool in long term conservation. Key habitats (identified under the original BAP notation) and features severely affected by bracken encroachment in the UK are listed in Table 9.1, which also indicates key habitats included in the current trial programme.

Table 9.1: Bracken control trials 2012 to 2018 - habitats and features impacted by bracken encroachment.

Feature	Impact Severity	Covered by trial sites to 2014	Scheduled for trial from 2015
BAP HABITATS			
Arable field margins	1		
Hedgerows	1		
Wood Pasture and Parkland	2	Yes	
Upland Oakwood			
Upland Birchwood	1		

Feature		Impact Severity	Covered by trial sites to 2014	Scheduled for trial from 2015
Lowland Dry Acid Grasslands		3	Yes	Yes
Lowland Calcareous Grasslands		1	Yes	
Lowland Meadows		1	Yes	
Upland Hay Meadows		1		
Coastal and Floodplain Grazing Marsh		1	Yes	
Lowland Heathland		3	Yes	Yes
Upland Heathland	**Dry**	3	Yes	
	Wet	3	Yes	Yes
Upland Flushes, Fens and Swamps		1	Yes	
Purple Moor Grass and Rush Pastures				
Lowland Fens		1		
Lowland Raised Bog		3	Yes	
Blanket Bog		2		Yes
Mountain Heaths and Willow Scrub				
Calaminarian Grassland		3		Yes
Limestone Pavement				
Maritime Cliffs and Slopes		2		Yes
Machair		1		Yes
Coastal Sand Dunes		2	Yes	
UPLAND GRASS ROUGH GRAZING		3	Yes	
HERITAGE FEATURES		3	Yes	
SEMI IMPROVED GRASSLAND	**Lowland**	3		
	Upland	3		
FORESTRY	**Planting**	2		
	Felled	2		Yes

Impact Severity: 1 = Moderate; 2 = Severe; 3 = Potential for total loss or denaturing. *It should be noted that the lack of a score does not mean bracken is not an extreme problem locally, but the scores are applied to habitats/features where at least 20% of the known UK extent is affected to the code level used.*

In summary, the reasons for controlling bracken may be identified as:

1. Habitat diversification, regeneration and conservation maintenance: mainly heathland, moorland, species rich grassland, maritime and some scrub environments.
2. Species, both plant and animal, conservation.
3. Historic/archaeological feature conservation. Utilisation of a combination of control methods to improve visibility and eradication on a local scale where rhizome and exudates are causing physical damage to features.
4. Landscape modification, improved access and ‘countryside experience’.
5. Reducing direct (eg Shikimic acid, Ptequilicides) and indirect (eg habitat for sheep ticks/tick borne diseases) human and animal health and welfare issues. This involves wild bird and mammals as well.
6. Temporary removal of competition for tree planting.
7. Improved grazing quality and stock management.

8. Water quality and quantity improvement.

Control Methods

In terms of delivering effective bracken control there are a number of options on any given area (Box 1) and a series of methods available (Brown and Robinson 1997). In one group physical control methods involve cutting, bruising/rolling, grazing/trampling/rooting out rhizomes using combinations of stock densities and species (sheep, cattle and pigs) and mechanical soil perturbation. The problem with physical measures is that they may result in surface damage and compromise of the habitat/feature which the control is attempting to conserve. Biological control options have been explored but for various reasons have a limited future. Chemical control, from the air using helicopters and from a variety of ground based application methods using both mechanised and hand held equipment is, in most cases, the mainstay for bracken control in the UK. In some situations there is a presumption against chemical control in general and aerial control in particular. Organic production units are heavily restricted in terms of chemical applications and there may be very sensitive species present in some areas. In many cases combinations of physical and chemical control are appropriate especially in small fragmented areas of high sensitivity but larger heath,

Bracken management options

1. **Leave.** On very steep slopes (>25%); where there is heavy grazing (>2.0 lu/ha), including rabbits (1 adult = 0.02lu/ha) and deer (Red stag = 0.07 lu/ha; Fallow Buck = 0.06 lu/ha) in some conditions ; ground cover is very limited (< 20%) and/or regeneration or introduction of alternative vegetation is difficult. These factors are often in combination. Other reasons for leaving include water supply security and erosion potential as well as species/habitat protection at a local level.
2. **Conservation Management.** Targeted control, e.g. clearing areas within a bracken bed for specific purposes such as butterfly conservation, maintaining visibility of archaeological features, natural tree regeneration or to encourage increased biodiversity. Areas may be larger, but are normally <0.5 ha and frequently just a few square metres. May involve leading edge control and path maintenance spraying.
3. **Control.** Extensive removal/reduction of bracken stands and limitation of spread at bed margins. Larger areas (generally 5 to 300 ha) cleared of frond growth and then managed to regenerate other cover, but not total destruction of all bracken within a unit. This is the main level of management and involves ongoing programmes of primary control and follow up, often over 10 years or more.
4. **Eradication.** The permanent removal of all bracken presence, including residual rhizomes, and replacement with alternative vegetation cover. Applies to specific and sometimes large beds in a long term control programme, but is neither realistic nor desirable on a landscape scale.

moor, woodland and grazing areas as well as archaeological features can often only be effectively and safely treated by aerial control.

In all cases the ability of bracken to regenerate from undamaged rhizome means that control has to be delivered over many years with follow up management after initial primary treatment by whatever means. It should be stressed that long term habitat restoration will also be dependent on factors such as stock management, locally available species to regenerate ground cover and intervention, such as heather reseeding.

The future of chemical control and ongoing trials

The primary molecule used in chemical control is Asulam [Methyl (4-aminonenzenesulphonyl) carbamate] which is presented as a solution Asulox for practical use. Due to various issues relating to European Registration requirements the use of Asulam was revoked in the EU after 2012 as there was insufficient information to support registration on the Approved Pesticides schedule. Since then it has been authorised for use for a 120 day period each year under the Emergency Authorisation procedure which individual national governments can invoke in their country's national interest (in this case the UK). The Authorisation is requested each year by the Bracken Control Group (BCG). The current owners, UPL Europe Ltd, are in the process of attempting to register Asulam, but unrestricted use for bracken control is not likely to be re-established until 2018 at the earliest.

Against this uncertainty a trial programme, involving the author (co-ordinator, manager and project leader), other professional colleagues, UPL Europe Ltd, Natural England (chair), Scottish Natural Heritage and Historic England has been developed. Other stakeholders in bracken management are expressing strong interest in joining. The trials provide an opportunity to collect more information on non-target species responses and the relative efficacy of aerial and ground based chemical application methods for both Asulox and the Sulphonyl Ureas (SUs). At the moment it is only the 2012 trial sites which have both aerial and ground based plots. Currently, Asulox is the only chemical which can be applied aerially (outside the trial framework) as well as on the ground.

The first trial plots were established in 2012 at Goathland on the North York Moors with further sites added in 2014 and more going in place in 2015 (Table 2). The programme will run to 2018 and has been established not only to evaluate efficacy and safety in bracken control terms but to investigate impact on as many non- target habitats and species as possible, to compare the impact of aerial as opposed to ground based application and to look at the residues from chemical applications in treated soil, including impact on some groups of soil mesofauna (Table 6). The work is being carried out to support the long term ability to maintain chemical control of bracken as a conservation management tool in the UK. It also comes at a time when some methods of ground based application are under scrutiny and have been restricted by the Health and Safety Executive (CRD).

Table 9.2: Bracken control trials 2012 -2018.

TRIAL SITES ESTABLISHED TO 2014	TRIAL SITES CONFIRMED FOR 2015 ESTABLISHMENT
1. Goathland. North York Moors. 4 full replicate blocks of aerial and ground based applications + Aerial wash out zone. Established in 2012. Wet and dry upland heath/moor, upland acid grassland, heritage features/landscape. (Natural England, National Park).	6. Grimes Graves. 3 Additional ground based replicate blocks to be determined 06/04/2015. To be used for early season spraying assessment and to bring in a scrub woodland and further heathland components. (Natural England/MoD)
2. Grimes Graves, Thetford, Norfolk. Stanta Firing Range. Currently three full ground based replicates. Established 2014. Lowland acid grassland, lowland heath and calcareous grassland. (Natural England/MoD)	7. Yarner Wood. 4 additional replicate ground based blocks to be determined on 09/02/2015. Early season assessment and bringing in two additional BAP categories, including upland birch. (Natural England)
3. Yarner Wood, East Dartmoor NNR, Devon. Currently 1 full ground based replicate. Established 2014. Western dry upland heath/moor. (Natural England)	8. Northumberland Heritage Sites (two ground based) and Dartmoor Heritage Sites (two ground based). Ground based. (Historic England/Natural England). Also BAP habitats involved.
4. Sandscale Hawes NNR, Cumbria. 5 full ground based replicate blocks + 1 unstable surface trial. Established 2014. Coastal dune and lowland heath habitats. (Natural England/National Trust)	9. Langholm. Hill area in South West Scotland. Moorland and acid grassland. Two ground based replicates. (SNH)
5. Beechgrove, Longbridge Muir SSSI , Solway Mosses SAC, Dumfries. 5 full ground based replicates. Established 2014. Lowland raised bog, felled forestry, wet heath and acid grassland. (SNH)	10. Laggan Estate on Islay, West Coast of Scotland. Blanket peat, coastal heath, machair. 3 Ground based replicates. (SNH)
	11. Glenample Estate, Central Hill area, Perthshire. Moor, upland wet heath, scrub and acid grassland. Three ground based replicates. (SNH)

The main 'on the ground' partners are indicated in brackets.

This paper reviews progress so far and identifies some of the key indications which will inform future bracken control work.

Methods

All field, laboratory, data collection and analysis work has been overseen and formally credited as GEP (Good Experimental Practice) by a qualified inspector.

Areas selected for trials are deliberately all designated SSSI, Natura 2000 and with some SAM areas as well as in National Parks (but not with water supply implications) to evaluate use in the most sensitive areas and to investigate efficacy and impact in the context of areas of very high conservation value. The location of Trial sites is summarised in Table 2.

The 2012 trials are located around Goathland Moor (NZ8202) in the North York Moors National Park and Four Trial Blocks were laid out and chemically treated in the summer of 2012. Two blocks are on areas which had dense bracken cover and two where there was little bracken, but consisted of Key Habitats and associated species in the moorland/upland heath and dry/wet heath phases. At each of the four sites there is a block with 6 aerial treatments, each treated plot 10 m x 50 m and 7 ground based treatments, each plot 6 m x 10 m. Aerial applications were carried out by a Robinson R44 helicopter with pencil drop nozzles applying 55 litres/ha total equivalent at 55 knots. The ground based treatments were by 3 m hand held boom giving a total application volume rate of 1.6 litres/ha per treatment plot.

In both aerial and ground based blocks there were Control, Asulam (Asulox), Amidosulfuron 1N, Metsulfuron methyl, Amidosulfuron 1N+Metsulfuron methyl 1N and Amidosulfuron 0.5N + Metsulfuron methyl 0.5N plots. There was also a glyphosate plot on the ground based replicates. The glyphosate is to provide a worst case scenario in terms of impact and recovery of non-target plant species after non selective chemical control. The 'N' values for the SUs are based on initial small scale trials and label values for Asulox and Glyphosate.

The main parameters being monitored on these and all subsequent trial plots are:

- Frond biometrics and stipe density
- Rhizome biometrics
- Non-target plant species response (cover, morphology and general condition)
- Soil invertebrate responses in the litter; 0-5 cm and 5.1 – 10 cm soil layers, including mites, collembola and various groups extracted using a modified Tullgren Funnel unit (Brown 1972)
- Chemical residues in the soil.

All blocks were fully scoped and described before spraying took place and the various parameters monitored then, 24 hours, 1 week, 1 month, 3 months, 6 months and at 1 year (complete re-assessment) after control in year one. In year 2 and subsequent years monitoring takes place in autumn, spring and mid-summer (July/August), which is the complete re-assessment point.

In order to assess a greater range of non-target species response 3 additional sites (Table 9.2) were established in 2014 and a further 5 sites are being added in 2015 to give a good habitat coverage across England and Scotland.

All of the additional sites focus on fully bracken encroached areas and the associated ground cover species. There are also additional non bracken areas and the two archaeological trial sites where specialist additional parameters are being monitored, e.g. the impact of physical control opposed to chemical control on delicate features such as steep lynchets and soft stone structures.

All 2014 trials onwards are ground based only and consist of five replicate rows with a control plot, Asulam (Asulox) N, Amidosulfuron1N and Amidosulfuron 0.5N plots as standard. On some sites Metsulfuron methyl1N has been used as an additional treatment outside the blocks on 'non biologically sensitive' features. The plots in each row are 6 x 10m with a 4m buffer between each plot and a 4m buffer between each row. Destructive rhizome sampling has been reduced to once a year as has sampling for chemical residues in the soil.

The 2014 onwards trials are all on bracken dominated sites with variable cover and density to give both high and low levels of exposure for non-target plant species over a wide range of habitats so that the non-target responses can be assessed in the context of normal bracken control practice.

The 2012 plots will be monitored with no follow up intervention after the initial 2012 spray and currently it is not planned to follow up on any other sites as the main purpose is to obtain information on non-target recovery after initial knockdown. However, it might be desirable to follow up on some of the later sites to obtain more information on control efficacy as well and the position will be reviewed for the 2014 plots in 2016 and the 2015 plots in 2017.

Results

Soil chemical residue and soil fauna responses are not discussed further here, but the 26 month chemical update is in the year 2 report and a separate document will be issued on each of these soil meso-fauna data sets in September 2015.

The interim results of the initial 2012 trials and previous micro trials on other historical plots suggest various responses and trends, which will be substantiated in the year 3 (2015) assessments. Interim results are discussed in a narrative relating to each treatment being applied and to the habitat and application methods used. The response of the bracken to ground based and aerial applications of different chemicals on the two bracken dominated blocks at Goathland is summarised in Table 3 and the response of dwarf shrub species on the wet and dry heath non target species blocks in Table 4. There is more comprehensive information in the 40 page summary of the trials results covering the period Summer 2012 (pre-spray) to Autumn 2014 (2 years post spray) which will be available electronically via the Bracken Control Group (BCG) website from 01 May 2015. This will be updated in November 2015 with the year 3 results.

Table 9.3: Bracken Responses to Chemical Treatments on the North York Moors 2012 Sites.

Chemicals and Parameters	2012	2013	2014
GLYPHOSATE			
Ground			
% cover	93	12	14
height in cm	153	52	38
stipe density	31	0.3	1.6
ASULOX			
Ground			
% cover	99	10	13
height in cm	137	43	29
stipe density	33	0.25	2.4
Aerial			
% cover	90	10	19
height in cm	151	40	40
stipe density	36	12	4.2
AMIDOSULFURON (0.5) + METSULFURON (0.5)			
Ground			
% cover	95	5	17
height in cm	157	14	37
stipe density	36	0.04	2.6
Aerial			
% cover	91	10	22
height in cm	137	34	42
stipe density	41	8	5.6
METSULFURON			
Ground			
% cover	85	10	9
height in cm	129	40	36
stipe density	34	0.1	1.4
Aerial			
% cover	93	10	10
height in cm	150	32	48
stipe density	37	12	6
AMIDOSULFURON (1N) + METSULFURON(1N)			
Ground			
% cover	82	5	14
height in cm	150	12	43
stipe density	32	0.05	1.3
Aerial			
% cover	82	10	20
height in cm	130	39	40
stipe density	37	8	3
AMIDOSULFURON			

Chemicals and Parameters	2012	2013	2014
Ground			
% cover	88	5	12
height in cm	150	14	33
stipe density	35	0.01	3.2
Aerial			
% cover	92	10	57
height in cm	154	32	52
stipe density	38	6	17
CONTROL			
Ground			
% cover	77	90	99
height in cm	128	119	146
stipe density	33	37	35
Aerial			
% cover	85	97	100
height in cm	120	123	147
stipe density	37	42	40

Table 9.4: Dwarf shrub non-target species responses to chemical Bracken control.

	STONY RIGG						ALLAN TOFTS			
	2013		2014		2015		2013		2014	
	Damg	Dead	Damg	Dead	Damg	Dead	Damg	Dead	Damg	Dead
Ground Based										
Vaccinium myrtilus										
Control *							36%	5%	15%	0%
Amidosulfuron							80%	0%	69%	6%
Asulox							73%	15%	14%	0%
Metsulfuron							3%	80%	36%	10%
Glyphosate							7%	88%	26%	44%
Amid/Metsulf 0.5N							3%	75%	26%	56%
Amid/Metsulf 1N							0%	58%	26%	28%
Aerial										
Vaccinium myrtilus										
Control *							43%	0%	21%	0%
Amidosulfuron							57%	0%	3%	0%
Asulox							44%	18%	23%	7%
Metsulfuron							14%	66%	24%	52%
Amid/Metsilf 0.5N							74%	2%	19%	2%
Amid/Metsulf 1N							65%	0%	34%	6%
Ground Based										
Calluna vulgaris										
Amidosulfuron	2%	0%	0%	0%						
Metsulfuron	44%	5%	28%	7%						
Asulox	7%	0%	8%	0%						
Glyphosate	0%	82%	8%	51%						
Amid/Metsulf 0.5N	10%	2%	11%	4%						
Amid/Metsulf 1N	17%	0%	20%	0%						
Control	0%	0%	0%	0%						
Erica tetralix										
Amidosulfuron	2%	0%	16%	0%						
Metsulfuron	3%	4%	4%	3%						
Asulox	5%	0%	2%	0%						
Glyphosate	0%	0%	6%	0%						
Amid/Metsulf 0.5N	2%	1%	5%	1%						
Amid/Metsulf 1N	3%	2%	4%	2%						
Control	5%	4%	4%	3%						
Aerial										
Calluna vulgaris										
Amidosulfuron	2%	0%	4%	1%						
Metsulfuron	8%	3%	20%	7%						
Amid/Metsulf 0.5N	9%	1%	19%	8%						

	STONY RIGG						ALLAN TOFTS			
	2013		2014		2015		2013		2014	
	Damg	Dead	Damg	Dead	Damg	Dead	Damg	Dead	Damg	Dead
Amid/Metsulf 1N	14%	5%	12%	18%						
Asulox	11%	0%	22%	2%						
Control	0%	0%	2%	0%						
Erica tetralix										
Amidosulfuron	0%	0%	0%	0%						
Metsulfuron	2%	1%	0%	0%						
Amid/Metsulf 0.5N	2%	0%	2%	0%						
Amid/Metsulf 1N	1%	0%	2%	2%						
Asulox	1%	1%	0%	0%						
Control	0%	0%	0%	0%						

* The damage (“Damg”) in the control sites is attributed to the impact of the severe 2013/13 winter on *Vaccinium myrtilus.*

Glyphosate (standard application rate)

Ground based application only on all four blocks. Appears to have had the lowest level of control on both the fronds and rhizome systems. In years 1 and 2 at least there was the greatest negative impact on non-target species with the bracken free non-target plots showing extensive damage after 26 months. Under dense bracken canopy areas the impact on non-target species is less marked and only marginally greater than some other treatments. Glyphosate was used in these trials purely to establish a ‘toxic standard’ and has not been used in any subsequent trials, but the 2012 treatments will be monitored to assess non-target species recovery from the severe initial impact and to chart bracken recovery for at least one more year.

Asulox (standard application rates)

The ground based applications have achieved a high level of bracken control and have had a very low initial impact on non-target species which also generally show rapid recovery within two years. Aerial control has resulted in a slightly lower efficacy of control (Table 3) but also a very low impact on non- target species (Table 4). These trials and work carried out by the author and a PhD student on the control of bracken using Asulox in wetland areas on the North York Moors (1995) have demonstrated that where the chemical is correctly applied there is a very high degree of efficacy and very little non target damage irrespective of aerial or ground based application. It is important to remember that in ground based control using asulox the peak tractor output involves 2.1ug/l active ingredient (ai). whereas the aerial output using Raindrop or pencil nozzles is 0.8ug/l. This variation in rates also applies to other chemicals.

Another important aspect to emerge from these trial blocks is that the impact on non-target species, for instance sedges, has been much less severe than indicated in the original assessments by May and Baker (1980) and The Bracken Management Handbook (1997) with recovery generally very rapid. This stresses the importance of good application methodology and long term thorough monitoring in a field situation.

The monitoring of the existing and new asulox trials will go on until 2017 and will help to inform the current registration process being undertaken by UPL Europe Ltd in relation to managing bracken encroached habitats within a structured control programme.

Amidosulfuron 1N (x 2 current standard approved maximum field dose in crops)

Ground based application gave strong bracken control in year 1 with little frond regrowth and severe damage to the rhizome system. Impact on non-target species on open and closed bracken canopy ground was very limited in year 1. This profile has persisted to year 2 generally, but on the wet heath area there is a suggestion that damage to some species may have increased slightly and therefore that there may be persistence of ai in the soil.

Aerial bracken control was very good in year 1 and overall non-target death/damage was low from both aerial and ground based application. The possible increase in damage recorded from the ground based plots has not been detected in the aerial sites. However, the second year assessment of the aerial plots recorded a much higher bracken re-growth rate than predicted. This is disappointing and it is possibly related to problems with the helicopter spray rig. The data from the 2015 season will hopefully give a clearer picture of what is happening.

In principle, for the moment, this treatment shadows Asulam closely for efficacy and being benign to non-targets.

Metsulfuron methyl 1N (approx. x2 current maximum approved rate in crops)

Ground based application achieved a good level of frond control in year 1, although rhizome damage was limited. Aerial application has been slightly less effective, but in both ground based and aerial the level of control has remained or even improved slightly in year 2. Ground based and aerial application has had a strong negative impact on non-targets and in year 2, whilst some species are recovering, others are still declining. The potential for continuing ai activity in the soil cannot be ruled out, although there was a large reduction in Uron presence once a three month peak had passed after application.

The impact on non-target species/habitats both on fully exposed ground and under bracken has been moderate to high. Where the bracken frond cover was more than 85% at the time of initial control the non-target damage is less pronounced.

Amidosulfuron 1N + Metsulfuron methyl 1N

This was a very heavy ai application rate. Ground based application gave moderate/ high level of control in year 1 in relation to both fronds and rhizome damage. Aerial application delivered moderate efficacy in bracken control but also moderate loss/damage to non-target species. Overall non target damage is marked and some species have recorded a strong and increasing negative response in year 2 although the level of bracken control has remained good as well. Clearly there is still activity as a result of residual chemical presence in the soil.

The level of ai involved in this treatment is high and there is no evidence of increased bracken control efficacy over Asulox or Amidosulfuron 1N. There is no justification for extending this treatment to other trial plots although responses on the 2012 Goathland plots will be monitored in 2015 and possibly until 2017.

Amidosulfuron 0.5N + Metsulfuron methyl 0.5N

Applied ground based the impact profile in year 1 is very similar to the 1N mixture. Aerially applied there is a moderate control effect on frond and rhizome activity. Aerial impact on non-target species under bracken canopy is slightly less than ground application over canopy. In year 2 the bracken control level (Table 3) has remained good and non-target species damage appears stable or improving rather than showing decline.

This treatment will not be considered in future trials, but as the two elements correspond to the current maximum rates for weed control in docks it is intended to trial the individually in two of the 2015-18 trials.

Control Plots

The untreated plots have been monitored to identify background trends which might distort the treated plot results. Between 2012, 2013 and 2014 there has been a year on year increase of vigour in the untreated bracken (eg greater mean frond height, frond density and quantity of intermediate rhizome). This trend has occurred widely over the UK.

There will be no intervention in bracken regrowth on any of the treated plots over the initial three years of post-spraying monitoring at Goathland, but this position will be reviewed in 2016.

Implications for the future

The need for the continued control of bracken is not in question. Indeed it has been adopted into the new RDP/Stewardship programmes of the UK as an important management tool for both habitat and heritage purposes. To deliver the control it is essential that both the chemicals and the methods of application are optimal and currently, with the restrictions on Asulox and on some ground based application methods this is not the case.

The ongoing and future work on application is addressing the continued availability of chemicals in the form of Asulam and possibly one of the Sulphonyl ureas, improving methods of application and insuring aerial application capability is maintained in the UK. It is accepted that physical means of control have an important role to play in appropriate circumstances and ground based chemical work is vital but aerial chemical application is being treated as the 'gold standard'. There are a number of reasons for this which are being developed in the ongoing research:

- Aerial application is the only realistic approach over large areas, especially if these are isolated/steep
- This is the key to tick 'hotspot' management
- There is a high level of precision with raindrop/pencil nozzles and GPS which helps to protect non target areas
- Health and Safety of personnel – operatives are not exposed to dangers of difficult terrain, potential reactions to chemicals and exposure to bracken irritants and toxins (not to mention sheep ticks and tick borne diseases)
- Cost effectiveness on large and difficult areas
- Targeted input – less risk of pollution
- More effective absorption through the abaxial cuticle due to perturbation of the canopy
- Non-invasive impact on sensitive ground (eg. very wet), Archaeological Remains or Historic Environments
- Survey and re-application easier and more accurate from an aerial platform
- Less chemical output than ground based application
- Peak aerial output on ground 0.8ug/l
- Peak tractor output on ground 2.1ug/l

Many of these points also apply to some ground based chemical work

The current research work is indicating that if chemical application is carried out in the right way very high levels of control with limited impact on non-target species can be achieved. From results so far Asulam appears to be more selective and non-target damage less extensive than earlier glass house as opposed to field studies suggest.

More work is needed on the impact of chemicals on sensitive/non-target species in a wide range of habitats and that is underway to be reported back formally between 2015 and 2018.

Evidence of control efficacy is being collected through the ongoing programme to help support the registration of asulam at levels which will reduce bracken domination in target areas. If appropriate label variations of other chemicals for restricted bracken control purposes will also be explored.

The possibility of lower ai levels of SUs achieving acceptable levels of bracken control is also being investigated over the next three years.

The main purpose of this work, apart from strengthening our technical knowledge and practical ability in terms of controlling bracken is to support and inform an integrated, long term approach to bracken management which can be supported by government conservation agencies, DEFRA and NGOs to insure there is an effective future in controlling this old and still rapidly spreading threat to our heaths, moors and pastures.

References

This paper is based on a project which is largely a work in progress. It is not set in the context of scientific precedence and consequently references are general and largely unpublished. As the first definitive year 3 results become available later in 2015 papers will be produced which slot into the normal peer reviewed scientific paper.

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TALK 11: The Heathlands Reunited project

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Heathland in the South Downs National Park – it's gone to the dogs!

- Only 1,544ha of lowland heathland remains in the South Downs National Park (1% of the total area)
- Ongoing loss of lowland heathland habitat and species
- Habitat loss, degradation and fragmentation
- Heavy recreational pressure (especially from dog walkers)
- Lack of appropriate management
- Insufficient economic incentives to manage heathland sites

Why focus on heathlands in the South Downs?

- Priority habitat, both nationally and regionally
- Heathland is sometimes regarded as a 'poor cousin' to the iconic chalk downland of the South Downs – heathland habitats don't always receive the recognition and resources they deserve
- Heathland habitats of the South Downs continue to decline in extent and quality
- However, they are highly valued for their biodiversity, cultural heritage, landscape value, access and recreation

The Heathlands Reunited Project

Aims

- Bigger: expanded areas of heathland
- Better: enhanced, sustainably managed heaths
- More and joined up heaths: improved connectivity
- Stronger links with local communities

Project partners

SDNPA is the lead body. The ten partners include: Amphibian and Reptile Conservation Trust, Defence Infrastructure Organisation (MOD), Forestry Commission, Hampshire County

Council, Hampshire and Isle of Wight Wildlife Trust, Natural England, National Trust, Royal Society for the Protection of Birds, Sussex Wildlife Trust and The Lynchmere Society.

The project area

Approx. 1600 ha of heathland, stretching from Bordon in the north-west to Pulborough in the east.

Application to HLF for project funding: Heritage Grants

Need to address 3 criteria: Conservation of the Heritage, People and Communities. Two stage process. Stage 1 application submitted in Nov 2013 (successful), leading to a Development Phase of 13 months (April 2014 – May 2015). Stage 2 application is due to be submitted in June 2015; if successful this will lead to a 5 year Delivery Phase (late 2015-2020).

Heathlands Reunited Project activities

HLF Development Phase work

1. Undertake further habitat survey work
2. Archaeological desk top assessment
3. Research potential for biomass fuel
4. Carry out audit of heathland interpretation
5. Site user survey
6. Develop methods of communicating with site users
7. Assessment of learning and participation needs
8. Develop a skills training programme

1. Further habitat survey work

- Extended Phase 1 survey of 14 sites
- Provides baseline for future monitoring
- Included habitat condition assessment
- Survey maps prepared from air photos & OS maps
- Standard recording forms developed
- Maps digitised using MapInfo Professional
- Habitat maps produced using modified Phase 1 classification

- Dry heath=H2a & H2b; wet heath=M16; 'humid heath'=H2c (where Molinia caerulea is abundant/dominant where under grazed)

2. Archaeological desk top assessment

- Phase 1- Creation of gazetteer for the designated areas
- Historic Environment Records
- Historic Landscape Character Assessment
- Historic maps, documents and photographs
- Surveys and reports
- Field work elements
- Phase 2 - Chronological account of cultural heritage of project area
- Phase 3 - Significance of heritage assets in the 14 heathland clusters
- Phase 4 - Assessment of impact of proposed works in the 14 heathland clusters

3. Research potential for biomass fuel from heathland

- Carried out a literature search and discussion with key contacts to determine what relevant information already exists
- Carried out an audit of the biomass potential from agreed heathland sites
- Identified area of material which could be harvested each year on a sustainable basis
- Identified and mapped current local & regional processors/suppliers as a potential market for wood fuel producers
- Developed an outline design for a 'heath to hearth' supply chain

4. Carry out audit of heathland interpretation

- Existing interpretation surveyed using staff/volunteers
- Target audiences identified
- Stakeholder workshop to develop key themes/messages
- Guidelines for interpretation
- Interpretation project proposals
- Monitoring and evaluation

5. Site user survey

- Fieldwork mapping car parks
- Counts of parked vehicles
- Counts of people
- 242 visitor interviews at 9 points
- Most were on short trip from home
- 78% were dog walkers
- 96% of dog walkers intended to let dogs off lead
- Mean route length was 2.19 km
- Most were not intending to leave the path/trail

6. Develop methods of communicating with site users

- Aim: to explore & address perceived problem of uncontrolled dogs on heathland

- Research carried out into current attitudes & site usage
- 'Influencing dog owners' workshop
- Key messages produced
- Links to case studies of successful projects

7. Assessment of learning and participation needs

- 3 types of public consultation: Pop-up engagement stalls, web questionnaires, reaching hard-to-reach groups
- Main activity: walking
- Barriers: access (including lack of transport), information, confidence
- 5 target audiences: specialists, recreational, families, dog walkers, local community (not in other 4)

8. Develop a skills training programme

- Audience: project staff, partners, volunteers, local communities
- Heritage - capital works & monitoring.
- People - developing skills
- Communities – aid local groups
- Additional ideas to Stage 1 bid, e.g. 'Hairy not scary' events, commons law, equestrian access

Delivery Phase Outputs

- Suite of interpretation materials developed
- A series of engaging events delivered
- Learning and outreach programmes carried out
- Workshops held on land management skills and crafts
- Training and guidance given to local volunteers/groups
- Extensive heathland restoration carried out
- Extensive grazing introduced
- Heathland sites expanded and linked
- Habitats managed for priority species e.g. sand lizard Lacerta agilis
- Rhododendron control carried out

Timescale and process for Heathlands Reunited Stage 2 bid

- Submit Stage 2 application by 08 June 2015
- HLF decision 22 September 2015
- Five year project, Dec 2015 - Nov 2020
- Grant requested will be approximately £1,471,600
- (circa 60% of total project value of £2,471,000)
- Partner 'cash' contribution is £440,650
- SDNPA contribution is £150,00

SESSION 5: MEETING 2020 BIODIVERSITY TARGETS

TALK 12: Where are we now and what is the gap?

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Introduction

Lowland heathland is a priority habitat for conservation in the UK. Although its current extent in England (about 50,000 ha) is not large when compared with upland heathland (>1.5 million ha) or even grasslands (~89,000 ha), lowland heathland is the priority habitat with the largest number of priority species associated with it (133) (Webb et al. 2010). Therefore, achieving favourable condition on most heathland sites will ensure that, not only is the habitat maintained in an appropriate status to meet national and international commitments, but also that the many rare species associated with it will also benefit.

Currently, the main strategy driving the progress on the improvement of the condition of habitats and species in England is "Biodiversity 2020: A strategy for England's wildlife and ecosystem services" (Defra 2013). The most relevant targets in relation with heathlands are:

> 1A. *Better* wildlife habitats with 90% of priority habitats in favourable or recovering condition and at least 50% of SSSIs in favourable condition, while maintaining at least 95% in favourable or recovering condition;
>
> 1B. *More, bigger and less fragmented* areas for wildlife, with no net loss of priority habitat and an increase in the overall extent of priority habitats by at least 200,000 ha (around 7,500 ha of lowland heathland);
>
> 3. By 2020, we will see an overall improvement in the status of our wildlife and will have prevented further human-induced extinctions of known threatened species.

Previously, the Lawton report (Lawton 2010) had also recommended focusing conservation efforts in improving the condition of existing sites ("better") and increasing the size and the linkages between sites ("bigger and less fragmented") as the way to ensure that priority habitats and species could be protected in the long term.

For lowland heathlands, achieving favourable condition has been defined by the Joint Nature Conservation Committee (JNCC 2009) as: no further reduction in their extent; there is a diverse vegetation composition and particularly structure, including bare ground, grassy areas and some trees and scrub; and the impact of negative indicators, such as native or exotic invasive species or undesirable disturbance is kept to a minimum.

Over the last two decades there have been various initiatives to fund heathland management in order to achieve favourable condition. This included The Lottery Fund (e.g. Tomorrow's Heathland Heritage), Aggregates Levy and Landfill Tax and European funds, for example, LIFE projects. However, the main source of funding for the maintenance and restoration of lowland heathland, both in terms of the reach and the achievements, has been agri-environment schemes.

Higher Level Stewardship for Lowland Heathlands

The Environmental Stewardship Scheme is now closed to new applications but it has been the main agri-environment scheme of the past 10 years. The main options of relevance here, within the Higher Level Stewardship (HLS), have been:

HO1 – Maintenance of lowland Heathland
HO2 – Restoration from neglected sites
HO3 – Restoration from forestry
HO4 – Creation from arable or improved grassland
HO5 – Creation on worked mineral sites

There were also supplementary payments for e.g. "LHX-Major preparatory work" or HR5-"Bracken control supplement", as well as for special projects.

The total number of agreements on heathlands over the life of the programme is only a small proportion of the total HLS number of agreements (about 700 agreements on heathland – counting only the main options HO1 to HO5) on over 46,500 ha, with a total expenditure of just under £60M (Table 1).

Table 12.1: Breakdown of HLS heathland options (2005-2015). Source; Natural England (NE).

OPTION	Agreements	Option area	Total costs
H01 – Maintenance of LH	226	8,767	£14M
H02 – Restoration of LH from neglect	523	35,726	£42M
H03 – Restoration of forestry areas to LH	107	1,741	£2.5M
H04 – Creation of LH from arable	29	294	£1.2M
H05 – Creation of LH on mineral sites	4	16	£21k
TOTAL	**692**	**46,544 ha**	**£60M**

The agreements are widely distributed geographically, as expected from the wide distribution of lowland heathlands in England. However, when considering the area affected and the funds invested, the main National Character Areas (NCA) in terms of the number of agreements by option have been:

- The New Forest: HO2, HO3
- Dorset Heaths: HO1, HO2, HO3, HO4
- Devon Redlands: HO1
- Breckland: HO1
- High Weald: HO2, HO3
- Wealden Greensands: HO1, HO2, HO3, HO4
- Thames Basin Heaths: HO1, HO2, HO3

Other heathland projects

On a smaller scale, management, restoration and expansion has taken place in other areas and with other funds, although they have not been consistently recorded. The best available records are from the Biodiversity Action Recording System (BARS). However, this recording system is not consistently used by most organisations and it provides only a partial record. It currently shows, however, that there are more than 600 ha of lowland heathland under management and restoration and over 200 ha of new heathland resource being created.

Results

The results presented in this paper cannot be taken as absolute figures. Rather, as we improve our inventories, we find that the figures fluctuate depending on the system used [e.g. Conservation Management System (CMSi)[5] –vs Priority Habitat Inventory[6] (PHI)] and the flexibility of the definition of heathland used. The latest versions of the PHI have removed significant amounts of heathland from the resource, based on high cover of trees, bracken or the definitions of other habitats or features. Some decisions taken to improve how we map the features in a consistent manner may also affect the final label attached to a particular land parcel.

In relation to Outcome 1A above, lowland heathlands in SSSIs haven't yet reached the 50% threshold of favourable condition; however, they are very near the 95% of the resource in favourable or unfavourable recovering condition (Figure 9.1).

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[5] Conservation Management System is owned by a non-profit consortium of conservation and land management organisations. CMS*i* is a software suite of tools enabling adaptive management on important conservation and amenity areas.

[6] *The Priority Habitats Inventory is* a spatial dataset that describes the geographic extent and location of Natural Environment and Rural Communities Act (2006) Section 41 habitats of principal importance

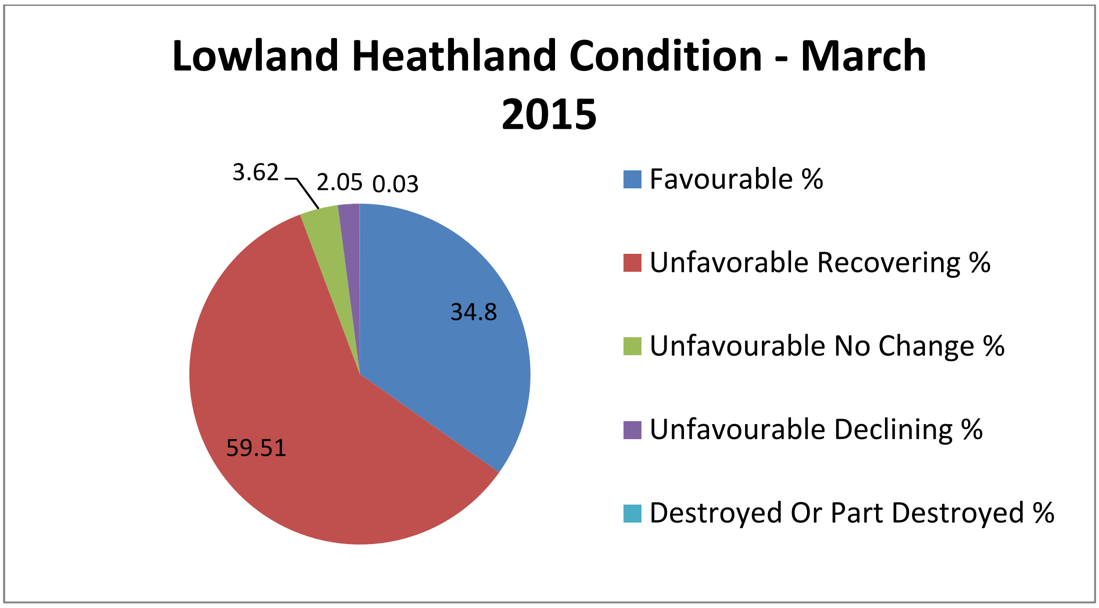

Figure 9.1: Percentage of total lowland heathland SSSI area in different conditions. (Source CMSi/NE).

We expect that many heathlands which are currently under agreements will achieve favourable condition. However, it is very difficult to provide a value as they are all at different stages, having also started from different original situations. Walker et al. (2004) found that the former land use was the most important determinant of re-creation success.

Table 9.2 shows the current performance against Outcomes 1A and 1B with most priority habitats taken together.

Table 9.2: Summary of current performance and achievability for all SSSIs against Outcomes 1A and 1B (The figures for heathlands in bold).

Outcome	Outcome 1A			Outcome 1B
	90% of priority habitats in favourable or unfavourable recovering condition	at least 50% of SSSIs in favourable condition	maintaining at least 95% in favourable or unfavourable recovering condition	increase in the overall extent of priority habitats by at least 200,000 ha
All SSSIs				
Current performance	62%	37.5%	96.1%	60,964 ha (30.5%)
Change since 1 April 2011	7.8%	0.9%	-0.5%	60,964 ha
Features assessed	40 terrestrial, freshwater and coastal habitats	All designated features within SSSIs.		24 priority habitats

Initial view on what might be achieved by 2020	72% (1,388,852 ha)	46% to 48% (498,224 ha to 519,886 ha)	95% maintained	147,651 ha (83%)
Confidence in achievability prognosis	MEDIUM/HIGH	MEDIUM	MEDIUM/HIGH	MEDIUM/HIGH
Heathland SSSIs				
Current gap to 2020	**26.4%**	**15.2%**	**0.7%**	**72% (5,400 ha)**

There is even less information available on the status of heathlands outside the designated sites series. The only survey that has been carried out (Hewins et al. 2007) found that none of the heathlands in a sample were in favourable condition, even those under agreements. Recent anecdotal information (from surveys prior to the designation of future heathland SSSIs) are still finding similar results, with most heathland features in unfavourable condition. Considering non-designated sites under agreement as being in recovering condition, our most up-to-date estimate is that about 84% of the heathland resource is meeting the Outcome 1A target.

Outcome 1B refers, as indicated above, to the increase of the extent of the priority habitat. Although the HLS options haven't been consistently applied, we can consider all sites under HO4 and HO5 to contribute towards this target, as well as some of the sites under HO3 (restoration from forestry) and HO2 when this options was used on sites not originally mapped as priority areas. For example, about 670 ha of sites mapped as woodland (conifer + deciduous) are under HO2 (source NE report on HLS options on non-priority habitat outwith SSSIs). We understand that this probably corresponds to woodland rides and openings which are being cleared or thinned to meet the heathland definition. Considering all the sites which may be in similar situation, about 1,734 ha have been created. Even when all sources are considered (e.g. BARS), there is a significant gap of over 5,400 ha of heathland to be created to meet the 7,500 ha expansion target by 2020 (Table 9.2).

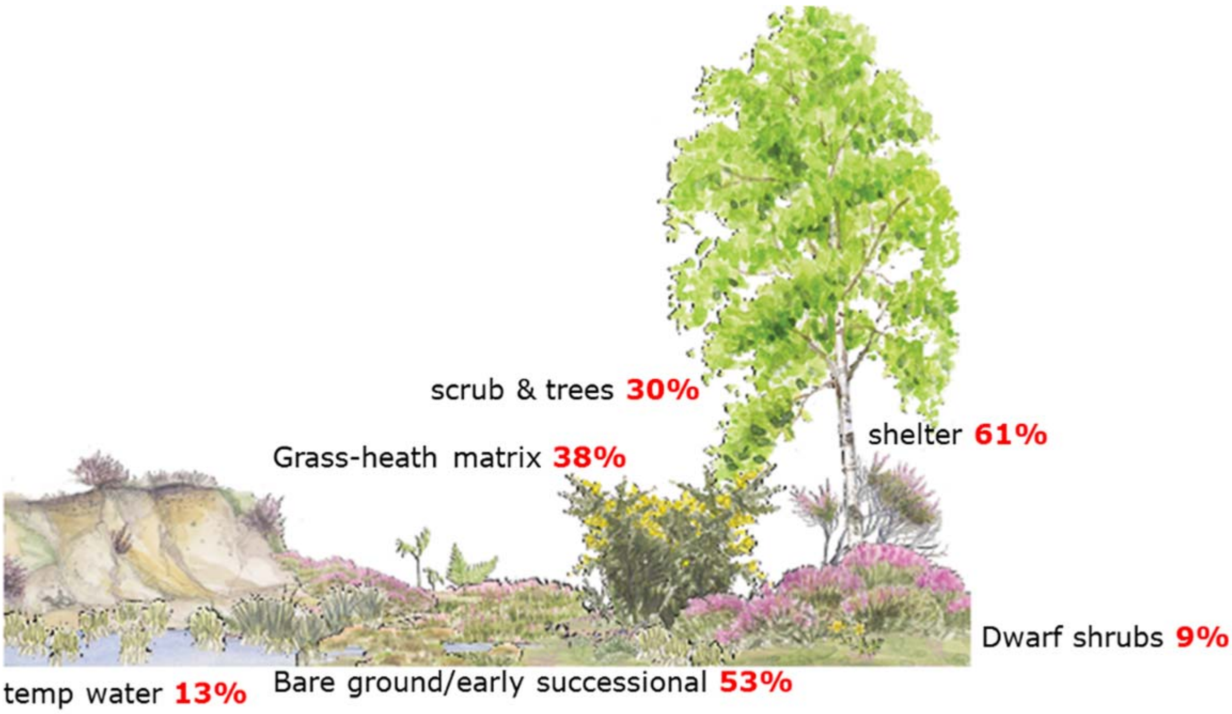

Figure 9.2: Percentage of priority species associated with various niches provided by lowland heathlands.

We do not have much information currently on the status of most of the priority species associated with lowland heathland. We know which niches they are associated with and in what proportion (Webb et al. 2010) (Figure 9.2), But there hasn't been a detailed study of the contribution of agri-environment schemes to the provision and quality of those features.

The constraints to delivery are many and of different natures:

1. Public attitudes (e.g. opposition to felling trees and grazing) can delay or stop restoration management or increase the costs significantly. Early engagement with the local communities can ensure that their opinions are taken on board and the projects run more smoothly.

2. Continuous development pressures can result in non-designated sites being damaged or deteriorating further. Excessive public pressure in all heathlands, e.g. through trampling or disturbance, may affect the breeding success of characteristic ground nesting birds and damage the vegetation. It can also result in further fragmentation of habitats within sites. External factors such as nitrogen deposition may have a significant impact, although there is not much that can be done at local level to control it, except perhaps intensifying the management to ensure that the vegetation continues to show a diverse structure.

3. Public and non-governmental organisations (NGOs) are working with diminishing resources, which will have an impact on the amount and quality of work that can be carried out.

4. Many sites have no clear conservation objective and funding strategies and therefore the maintenance or restoration management may not be focused enough or even appropriate.

5. There is not enough quality data being recorded on the effectiveness of the management of heathlands for different objectives and under different circumstances. This makes it difficult or impossible to exchange experience and best-practice across sites, and may lead to duplication of effort or waste of resources. In many cases, the results or progress is not reported centrally (e.g. through BARS), so the national overview may not be complete.

Conclusions

HLS has been the main funding source for heathland restoration and management in England in the last decade, and it is likely that the new scheme, Countryside Stewardship, will also be as important in the coming years. Building on the momentum of previous programmes since the late 1990s, there has been significant activity aiming to maintain, restore and recreate lowland heathlands in England. However and perhaps because the most significant sites, in terms of area, have already been dealt with, the number of agreements on lowland heathlands in the last few years has been lower as we enter a period of transition between the old Environmental Stewardship and the new Countryside Stewardship from 2016.

Particularly worrying is the significant gap to meet Outcome 1B, (heathland creation) which can only be realistically met by restoring more conifer plantations back to heathlands. The area of ex-arable land or improved grassland which can meet the conditions (e.g. nutrient levels) to be restored to heathland is likely to be small.

Next steps

Funding by Defra has been recently secured to look into the detail of what HLS has provided for lowland heathlands, both in terms of the habitat condition and the niches required by its characteristic species. This project will confirm whether agri-environment schemes are benefiting heathland species which are not being targeted directly.

Acknowledgements

This paper is based on reports produced by many colleagues in Natural England. Thanks are due to Jeff Edwards, Gavin Measures, David Hunt and Martin Ruddy, for their figures and clarifications. Any error of interpretation is mine.

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TALK 13: Brecks biodiversity audit and applications

Part 1: Methodology and applicability

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Summary

The Biodiversity Audit Approach uses a defined methodology to assess the biodiversity importance and input into habitat management options of a region. The approach was used on Breckland where species data was collated from a wide range of sources, including national and local recording centres, to total almost 1 million records. From the records, c. 2,000 species were identified which are priorities for conservation action. The ecological requirements of these priority species were then assessed, and from this information, species were grouped into cross-taxa management guilds. Using these guilds the relative importance of different heathland management options for priority species could be estimated. This approach has been refined in two further regions, with just under 4,000 of the c. 8,000 designated species in the UK now classified, and it would be valuable to apply this methodology to further areas.

Introduction to the approach

Conservation actions are often driven by top-down overarching objectives, such as the Biodiversity 2020 and UK National Ecosystem Assessment, which state actions for 'biodiversity'. However, biodiversity is rarely defined and, in reality, actions are often driven by a small number of species or focus on maintaining a habitat. Both species and habitat based approaches present problems with regards to management for biodiversity.

Species-based approaches can result in the setting of conservation objectives and consequent actions for a small and biased subset of species, which may or may not require similar management to the very large number of remaining species. Managing for multiple flagship species can result in conflicts between the actions required for different species, and there can be uncertainties in translating complex species requirements into management prescriptions.

Conversely, habitat-based approaches may be driven by national prescriptions, becoming generic and lacking detail and regional identity. Furthermore, broad habitat approaches may lack the detail of species requirements, such as specific micro-habitat conditions, particularly when there are a large number of species occurring at sites.

There is a need for greater cost-effectiveness within conservation management but this can only be achieved with a good understanding of species and their requirements. An effective regional conservation evidence base would answer key such questions as:

- What are the species? Which species are important for conservation?
- Where in the landscape are these species?
- What conditions do the species require?
- How can these be provided by management?
- How can we provide habitat connectivity?

Without a strong evidence base, management actions cannot be a targeted and prioritised to ensure maximum effectiveness for limited conservation spending. For example, there has been a recent emphasise on increasing connectivity in strategic conservation thinking (Lawton, 2010). However, such consideration of connectivity requires a good evidence base of the distribution of species, an understanding of their dispersal mechanisms and the habitat conditions they require.

The Biodiversity Audit Approach (Dolman et al., 2012) is a methodology developed to assist regional conservation in answering some of these fundamental questions. It is an innovative, new evidence based approach which considers a wide range of taxa. The Audit Approach has been implemented in three large regions in England to date, the Brecks, the Broads and the Fens.

Approach methodology

An important part of the approach has been the partnership of organisations involved. This was focused around the core commissioning group of key conservation management organisations, and local biodiversity partnerships. The involvement of other organisations is very important in the audit methodology. The partnership assists in engaging further with interested organisations, helps in providing direction and most importantly, can facilitate direct implementation of the recommendations from the audit. As partners have been involved from the start and have buy-in, uptake of the recommendations is much greater.

The first stage of the Biodiversity Audit methodology is to define the study area (Map1). In all audits to date we have considered 'natural' bio-geographic boundaries, rather than administrative areas. These often involve cross-county data collation and collaboration, but have greater ecological relevance to species, especially when defining regionally important or unique species. In the Breckland Audit, we considered the Environmentally Sensitive Area (ESA) together with the National Character Area, taking the combined extent of these and buffering by 1 km. The approach selected all 10 km squares within the chosen area and included those containing any part of the defined boundary.

All species records were then collated from these 10 km squares. These included records from a wide range of organisations and individuals. The primary source for records was the county Local Records Centres; Norfolk Biodiversity Information Service and the Suffolk Biological Records Centre provided approximately 65% of the total records. The county record centres are an important resource to provide good coverage, both spatially and taxonomically across the study area. Other county level recording schemes may operate independently of the county centre and must be approached for data. A large proportion of species records were also obtained from the National Biodiversity Network's (NBN) online databases. The NBN stores national databases for many organisations including for some Local Record Centres, taxa specific national recording schemes, natural history groups and other organisations. However, public access to records of sensitive species or sites on the NBN database can be restricted, so data requests directly to organisations are also needed to gain fuller data. Other notable organisations for specific taxa that do not contribute to the either the NBN or county centres must also be approached individually. It is also necessary to check that any other individuals or organisations collecting biological data have fed data into the main record centres. There may be a back log of biological data known to the Local Records Centre that is currently un-digitised, such as key reports, monitoring projects and university theses. Assisting the Local Records Centre to process these can provide important further records. It is also advisable to approach individual recorders to confirm records submitted are up to date and to start the process of involving local recorders at this stage.

In total, we collated c. 830,000 species records in the 23 10-km squares making up the Breckland audit area. This showed there was a huge resource available, much of which was collected by members of public. However, these species observations required processing before using in the audit. We used only records given to the species level; those given to a genus level were removed. Subspecies were considered as the parent species, unless the subspecies was of conservation concern. Species recorded at only the 10-km resolution were retained, as these were often old records which could be very useful for the historic perspective, especially in determining which species have become locally extinct. We applied a cut-off date to allow consideration of 'recent' records (post 1980) of species still present in the region compared to historic (pre 1980) species records.

We held a species workshop and invited individuals with expertise in the species and experience of recording in the region. Individuals were asked to identify species records which were probably incorrect (usually mis-identifications) and these records were removed from further analysis. We also asked for comment on whether species were now nationally or locally extinct.

This final list of species comprised 12,845 species and from this validated species list we determined the priorities for conservation. Important species were those with formal UK species designations (obtained from the JNCC). These designations included; all UK

Biodiversity Action Plan species, Global and UK Red Data Book, Nationally Rare/Scarce, Notable A/B, and Red and Amber bird list species. Additionally, we used provisional or informal status assessments (often based on expert opinion) for groups that were not evaluated or up to date in the JNCC lists.

Importantly, we also considered those species that are restricted to the region within the context of the UK or where the region forms an important stronghold for the species. This was evaluated by considering the distribution of individual species in the UK, and the proportion of the species distribution that is found in the region. Distribution maps for species were examined from atlases, species group websites or the NBN gateway. Local and national taxonomists were particularly important at this stage for suggesting candidate species at the species workshops and assisting to confirm the species distributions. Some of the species which were included on this list lacked any formal conservation designation but were highlighted as mostly restricted to the region. Therefore the management for these species is of particular importance, as the species only occurs in the region, and the region therefore has a national responsibility for their conservation. Furthermore, the identification of this select group of species helps to highlight, as new flagships, the contribution to national biodiversity provided by the region.

Guild process

The next stage was to collate information about the habitat and ecological requirements of all the species identified as conservation priorities. To do this we coded each species for their association with approximately 120 broad habitats, micro-habitats, structures and processes and management actions. This exercise helped inform guild classes, and was used if no further information other than habitat was known. It later informed a comparison of the habitat specificity of species, providing for the 40% of species not associated with a single habitat listed below. Species information was obtained from a wide range sources, including published national reviews, RDB accounts, the Invertebrate Site Register, atlases and other reports or specialist publications. Where information was particularly scarce, it was supplemented by knowledge from taxonomic experts.

We grouped species according to their coding into guilds, irrespective of habitat, and considering three key gradients: a hydrological gradient - from wet to dry; a canopy cover gradient – from open, unshaded conditions to closed canopy; and an approximate vegetation gradient from bare substrates to well vegetated, but allowing for some adjustments to relate these to management options. These guilds, have therefore been identified irrespective of habitats and other environmental factors (e.g. soil type), and are focused solely on hydrology and vegetation. Leaving aside habitat data was considered appropriate as, from our coding of species for their association with broad habitats, we found approximately 40% of species in Breckland were not associated with any a single habitat.

Using this guild classification we were able to calculate the number of species, taxonomic groups and designation groups (e.g. BAP or Notable) associated with each of the identified ecological gradients. The number of species from each of the guilds in each 1 km square across the region could then be mapped to examine the spatial distribution of species associated with certain conditions. Hotspot mapping, as shown in map 2, allows the distribution of species across the landscape to be visualised and potential ecological networks examined.

Feasibility of approach for other regions

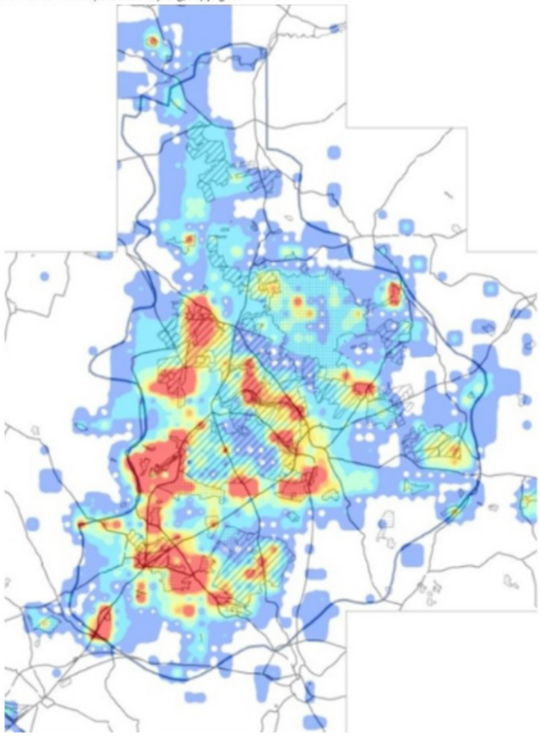
The Biodiversity Audit Approach has been very beneficial in assisting regional conservation as indicated in the second part of this paper. The approach follows a set methodology and is highly applicable to, and feasible in, other areas. Although using this approach is a significant undertaking and a time-consuming project, it is highly effective in answering important questions. The auditing makes use of the incredible resource of species' records, collated through citizen science. The audit has also proved a great way to involve members of the public, both directly with recorders and from reports of the project in the media. The biodiversity audits received national coverage, and each regional audit was featured in local TV news broadcasts.

By compiling guilds of species irrespective of habitat it was possible to emphasise the important vegetation structures and processes which should be key to conservation actions in the region. More crucially, this also served to identify which processing and management actions were missing in the landscape, following simple evaluation of the current status of conservation sites.

Conducting an audit identifies regionally important species and increases the recognition given to these species and their distinct contribution to regional identity. Some of these species are undesignated and prior to an audit their importance in the region is overlooked because of this. These species should be national priorities within the region, which is key to their survival in the UK. Examination of these species alone also helps to single out the ecological structures and processes that make the region biologically unique.

Map 1: Location of Breckland

Map 2: Hotspot mapping of Breckland specialist species.



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Part 2: Implications for heathland management

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Summary

The Breckland Biodiversity Audit was a highly innovative approach to assessing the biodiversity of an area; what species are present; where they are; and what management should be undertaken for them. It has provided a much more reliable evidence base from which to determine our conservation objectives and direct our implementation of management practices than was previously available.

Introduction

The heaths of Breckland are very different from those in other parts of the country. Breckland has a distinctive land use history, local climate and an array of rare and specialist species. The term ‘heath’ in Breckland is used to describe dry acid grassland and chalk grassland, as well as heather heath. The grassland communities are usually referred to as ‘grass heaths’ to distinguish them from those where heather is more dominant. Most Breckland heaths comprise a range of all these vegetation communities, often in intimate mosaics, reflecting both underlying soil type and prevailing management. Historically at least, the heaths featured extensive areas of early–successional vegetation, with bare ground and sparse vegetation created and maintained by rabbits, wind blow, occasional cultivation and other forms of physical disturbance. These supported important communities, including lichens, mosses and annual plant species. Dune vegetation (some 40 miles from the nearest coast) is a characteristic component of some of these heaths.

Like many natural areas in the UK, Breckland has experienced its share of depredations. During the 20th century, most of the heaths were lost to agriculture and afforestation. Modern farming techniques replaced low productivity systems and ‘brecks’[7], bringing more prosperity to an economically challenging area, but with significant consequences for biodiversity. The near total loss of rabbits through myxomatosis in the 1950s together with the decline of traditional sheep grazing led to the neglect of most of the heathlands and grasslands which remained.

Conservation effort through the latter part of the 20th Century focussed on re-introducing grazing and reversing the extent of secondary woodland, scrub and bracken. There were some targeted efforts for a relatively small number of notable species including some of the

[7] The medieval term ‘brecks’ (with a similar derivation to the word break or broken) refers to fields which were cultivated for a few years, often from reclaimed heathland, then abandoned to become fallow and usually revert back into heathland.

rare species for which Breckland is famous. These included spiked speedwell *Veronica spicata* and perennial knawel *Scleranthus perennis*, breeding stone curlew *Burhinus oedicnemus*, and latterly a few invertebrates such as lunar yellow underwing moth *Noctua orbona* and basil-thyme case-bearer moth *Coleophora tricolor*.

However, there was a growing feeling amongst some of those working in Breckland, across several organisations, that this was not enough. Even after nearly a century of ecological study and a good half century of conservation management, a full comprehension of Breckland was incomplete, nor was there understanding of how best to deploy our conservation resources. In particular, on the heaths there was an almost total reliance on livestock grazing alone to meet conservation objectives. Furthermore, the objectives themselves were often poorly defined, failing to recognise the ecological requirements of many of the specialist species present, as well as the dynamics of the vegetation types with which we were dealing. Although the importance of rabbits, and to some extent the role played by other kinds of physical disturbance, was understood, efforts to address the lack of them rarely featured in conservation management priorities.

As so often in conservation management, there was plenty of opinion on how best to manage the heaths and some good practices were being implemented, but there was little in the way of solid evidence. That was why the Breckland Biodiversity Audit was so significant: for the first time it identified the ecological processes required by *all* the priority species that make Breckland so important and distinctive, and quantified their relative importance[8].

The audit and implications for management

The audit identified 2,149 priority species in Breckland, and roughly a quarter of these are species that one might typically find on the open heaths. By grouping these into guilds of species requiring certain ecological processes, the audit clarified the emphasis we should place on different kinds of management regimes.

Table 13.1 shows the importance of physical disturbance of the soil and the use of grazing to deliver this for large numbers of rare species.

On the Breckland heaths, currently, livestock grazing is light on around half the total area, and even where well-grazed the heaths have closed swards, frequently with a significant accumulation of moss and vegetation litter. At both ends of the grazing spectrum, heavy and light, sward structures can be quite homogenous in structure, with livestock regimes quite static and little variation in intensity. Rabbits are absent or rare on at least 70% of the heaths, and other forms of physical disturbance such as tracks, pits, rotovations and turf

[8] The definition of priority species used in the audit is wider than that more typically used in conservation (Section 41/BAP species). It encompasses all species which have some kind of conservation designation (e.g. red list species, notable A/B, near rare/near scarce).

stripping cover less than 1%. On those heaths with a high proportion of heather, conservation management was frequently focussed on favouring the growth of heather (often in even aged mature stands) in mosaics of consequently long grass, rather than on producing more complex heathland communities.

Table 13.1: Species management requirements for priority species on the Breckland Heaths

Species management group **Species requiring:**	**Proportion of species**	**Number of priority species**
Physical disturbance and intensive grazing	27%	136
Sward mosaics and juxtaposition of bare ground and vegetation	23%	116
Grazing and no/ infrequent physical disturbance	16%	81
Light/no grazing and no physical disturbance	10%	53
Physical disturbance and grazing requirements unclear	15%	76
Scrub in open habitats	9%	46

Based on the figures above, the prevailing management on most of the heaths in Breckland was delivering the requirements of barely 40% of the species one might expect to find there. The audit demonstrates clearly that to sustain the 500+ species which are found on the heaths across Breckland a very different approach to management is needed.

Livestock, usually sheep but also cattle and ponies, will continue to be a principal component of heath management in Breckland. Heaths need to be hard-grazed at least over a significant area. However, at the same time complex, open sward mosaics need to be produced both spatially and temporally. Where this is delivered predominantly by livestock, it requires a much more directed approach to grazing management, with more varied and dynamic grazing regimes. But we are now better placed to understand exactly what we are aiming at, even if achieving it is likely to be challenging.

The audit highlighted just how essential rabbits are. They obviously produce short swards and soil disturbance, but just as important is what happens at the margins of the warrens. The wax and wane of rabbit populations produces mosaics of long and short vegetation, and bare areas which gradually recolonize in micro-succession to closed grassland and longer swards. Reducing their numbers is no problem, but increasing them is rather more difficult. Rudimentary attempts to encourage the spread of rabbits within heaths in the 1990s have now crystallised into a multi-partner project to trial and implement methods to enhance populations on heaths which still retain them, and introduce them to some which have lost them.

The importance of processes which create and maintain bare ground and early-successional communities has been brought sharply into focus, with key elements identified such as bare and blown sand, raw chalk surfaces and loose as well as firm, compacted ground. The general floristic character of the Breck heaths relies to some extent on a more dynamic approach to vegetation management, creating bare areas and allowing them to gradually vegetate. It is equally clear just how many priority species rely on this sort of process. In places where rabbits are absent, physical disturbance needs to be more widely deployed, to reduce accumulated nutrients and organic matter, or to create certain conditions for a particular identified population of a species.

There is a growing body of evidence to inform how valuable different soil disturbance techniques might be in achieving these objectives, and specialist surveys and simple observation are being supplemented with peer-reviewed studies which test different methods, and examine the response of groups of species. Rotovation, discing, ploughing, turf stripping and creation of sandy and chalky banks and have all been used, and we are slowly building both our evidence base in the application of different methods, and our confidence in using them. Most restoration management of Breckland heaths now includes some element of bare ground creation.

The approach to the management of heather heaths has also shifted. The principle of maintaining a varied structure of dwarf shrub growth is well established on heaths throughout the country, but in Breckland stands of heather have often been favoured over more open and disturbed conditions, and in particular over acid grass heath. However the audit shows that few invertebrate species rely solely on heather as a food plant, although many more will use it for shelter. Breckland largely lacks the many invertebrate species which need those denser, more mature heather stands found elsewhere in the country,. One entomologist observed that short dense cushions of heather in Breckland, close cropped by rabbits, were far more valuable as shelter for invertebrates than taller leggier stands. Also, of the few species which require it as a food plant, there is no evidence, at least in Breckland, that mature heather is any more valuable than pioneer heather in harder grazed situations. The majority of conditions required by priority species are delivered equally well in well-managed acid grassland – the addition of heather simply adds to the structural diversity and nectar source, where it can be an important component of the vegetation. This message has occasionally been misinterpreted as somehow ‘anti-heather’, but this is not the case. It is a matter of understanding more clearly the ecological role heather plays on the Breckland heaths, and managing accordingly.

The Breckland Biodiversity Audit significantly enhanced our understanding of the biodiversity value of the heaths in Breckland, and how best to manage them, but that was only part of its purpose. In undertaking an audit of the whole of the Breckland National Character Area, the intention was to inform our approach to landscape scale conservation. The knowledge we have gained has allowed us to consider how best to deploy all of the available conservation mechanisms to maximum effect.

Thetford Forest, the largest planted forest in lowland England covering over 18,000ha, was created predominantly in the 1920s–1930s, by planting on what was at the time economically marginal arable land and heath. However, maintained within its rides and other open spaces are traces of that former Breckland. Areas of grass and heather heath are present and woodlark and nightjar breed in the regular clear-felled forest compartments. At least 20 nationally rare and scarce plants and an assemblage of rare and scarce invertebrates are present within the forestry.

Using maps of the distribution of management groups identified in the audit, the Forestry Commission have developed an exciting, innovative plan to create a landscape- scale network of ecologically functional corridors throughout the Forest. The creation of this 278km network will be achieved by substantially widening parts of the existing ride network, creating open space alongside regular harvesting and thinning, and removing leaf litter, brash and tree stumps. Bare ground will be exposed, which will then be managed successionally, on a three to six year cycle, to maintain a continuity of bare, disturbed conditions with mosaics of vegetation at different stages of development. The audit has identified concentrations of relevant priority species which will be joined by suitably managed corridors providing links between hotspots through the Forest, and onto adjacent heaths. Instead of being a barrier to the movement of priority species Thetford Forest will become the hub of a landscape scale network of ecological corridors across Breckland.

In Breckland it has long been clear that some priority species do not survive well (if at all) in grazed situations. Some of the rare plants such as Breckland mugwort *Artemisia campestris* and fingered speedwell are vulnerable to grazing. In addition, a few rare invertebrates are known to need ruderal, food plants, rarely found on grazed heaths. Natural England had already begun to emphasise uncultivated margins as a key arable option in Environmental Stewardship agreements in Breckland, but the audit gave this further weight, detailing the numbers of species requiring these conditions. The number of priority species which require disturbed and un-grazed conditions, is roughly the same as the number requiring disturbed and grazed conditions. Furthermore mapping from the audit shows these species are present throughout the farmed landscape. Cultivated margins became the primary arable option promoted under Environmental Stewardship, and by the time the scheme closed in December 2014 320ha had been established across Breckland farmland forming a network of habitat around 515km long.

The audit has to a helped to take the guesswork out of the equation, giving us better evidence and more confidence that the decisions that we make about site management are the right ones. It has also enabled favourable condition to be defined in a way that encompasses as broad a range of priority species as possible.

The audit cannot answer every question; indeed it highlights as many gaps in our knowledge as it fills. Implementing management changes at different sites and across the landscape will continue to present challenges to our insight, inventiveness and resources. There will continue to be species which require special attention, and perhaps even those which we can't quite bring back from the brink, but we are better informed and maybe, with luck and hard work, the odds can be shifted in their favour.

NOTE

A summary of the audit and its principal findings is published in *British Wildlife*, Volume 22, No 4, April 2011.The full report and appendices, published as *Securing Biodiversity in Breckland: guidance for conservation and research*, can be downloaded at http://www.norfolkbiodiversity.org/reports/

More general information on biodiversity auditing can be found in a recent dedicated Parliamentary Office of Science and Technology report.

TALK 14: Living Landscapes – recreating Sherwood Forest's heathlands

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Summary

Landscape scale conservation can only be delivered through a shared vision, strong partnerships, engaged communities and access to significant funds, but through working together we are starting to achieve this in Sherwood Forest .Within NWT's Living Landscape area, we have achieved several notable successes, particularly through engaging with Harworth Estates to secure substantial heathland restoration at Rufford Colliery, but there is a great deal more still to be done and we are working against a background of significant constraints.

Introduction

This paper briefly describes the multifaceted areas of work that are required in order to create a Living Landscape that can deliver benefits for both wildlife and people. The focus is on the Nottinghamshire Wildlife Trust's Sherwood Forest Heathlands Living Landscape and covers the following aspects:

1. Sherwood Forest's heathlands
2. The Living Landscape approach
3. Delivering a Living Landscape in Sherwood Forest, with particular focus on the large scale re-creation of heathland at Rufford Colliery
4. Constraints to re-creating Sherwood Forest's heathlands

Sherwood Forest's Heathlands

Sherwood Forest developed on the acidic, free-draining soils that overlay the Sherwood sandstone. The Forest was managed as a mediaeval royal hunting forest which resulted in approximately 40,000 ha of oak-dominated wood pasture with a ground layer of acid grassland combined with open heathlands in a complex mosaic. The original vast tracts of heathland have been substantially eroded by commercial afforestation, intensive arable agriculture, coal-mining, quarrying for sand, and the expansion of settlements. There are several different estimates of the level of heathland loss, but general agreement is that it is between 80 and 90% since the early 1800s.

The current Sherwood Forest National Character Area (NCA[9]) covers 53, 456ha and despite the substantial historic habitat losses, important remnants of semi-natural habitats remain; predominantly consisting of a mosaic of sessile oak *Quercus petraea* and birch *Betula pendula* woodland, lowland heath and acid grassland. The area is particularly important for Annex 1 birds[10] Nightjar *Caprimulgus europaeus* and Woodlark *Lullula arborea*, heathland invertebrates, bats, and also the invertebrates of the ancient oak hulks and standing deadwood which have warranted the designation here of a Special Area for Conservation (SAC)[11].

Areas within the NCA which receive some form of protection through designation are:

- The Birklands and Bilhaugh SAC (270ha)
- Sherwood Forest National Nature Reserve (NNR-424ha)
- Sites of Special Scientific Interest (SSSIs) wholly or partly within the NCA (approximately Fourteen 1,757ha)
- And 220+ Local Wildlife Sites (LWS) covering approximately 7,133 ha (13 % of the Sherwood Forest NCA).

The NCA data (Natural England 2014) demonstrate that the majority of good Biodiversity Action Plan (BAP)/Section 41[12] habitat in Sherwood Forest is protected only precariously through the LWS system, with more than four times the area of habitat recognised as LWS compared to that designated as a SSSI.

In common with lowland heath elsewhere in the UK, many of the Sherwood heaths have been largely unmanaged until the last decade and were being invaded by scrub. The heather *Calluna vulgaris* was often found to be over-mature or geriatric with long woody stems and poor regeneration from the base. However, sterling work has been carried out over recent years on some of these heaths by the Nottinghamshire Wildlife Trust and a range of other partners including Nottinghamshire County Council, Newark and Sherwood District Council, Mansfield District Council, the Forestry Commission and Thoresby Estate on their land holdings in the area. Consequently there is now evidence of rejuvenation of significant areas of heath, which has been substantially supported on several SSSIs by Higher Level Stewardship (HLS) schemes. The dominant heathland type is National Vegetation

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[9] NCAs, devised by Natural England, divide England into 159 distinct natural areas. Each is defined by a unique combination of landscape, biodiversity, geodiversity, history, and cultural and economic activity. Their boundaries follow natural lines in the landscape rather than administrative boundaries

[10] Birds listed in Annex I of the European Birds Directive (2009/147/EC) which are subject to special conservation measures under European law.

[11] Special Areas of Conservation (SACs) are strictly protected sites designated under Article 3 of the EC Habitats Directive. This requires the establishment of a European network of important high-quality conservation sites that will make a significant contribution to conserving the habitat types and species identified in Annexes I and II of the Directive.

[12] Statutory lists of priority species and habitats in England, as required under Section 41 of the Natural Environment and Rural Communities Act 2006,

Classification (NVC) H1 Heather – Sheep's fescue (*Calluna vulgaris – Festuca ovina)* heath and the grassland is mainly U4 Common bent – Sheep's fescue – Heath bedstraw (*Agrostis capillaris-Festuca ovina-Gallium saxatile).*

The protection and enhancement of the heaths has been further promoted over the last decade after the publication of a Heathland Strategy for the area by the Sherwood Habitats Steering Group, a partnership with a wide range of conservation and land-owning organisations which aims to co-ordinate management and re-creation work in the NCA.

Sherwood Forest also has nationally important populations of Nightjar and Woodlark, with both populations exceeding the 1% national population criterion for SPA designation in the national survey reference years, of 2004 and 2006 (64 churning nightjar males and 39 occupied woodlark territories) respectively[13]. Unfortunately the delay in the SPA Review[14] has prevented designation of this important area and consequently its nightjar and woodlark populations remain vulnerable, particularly to pressure from built development and increased levels of recreation.

There is also a wide range of other characteristic heathland mosaic fauna in Sherwood, including common lizard *Lacerta agilis*, redstart *Phoenicurus phoenicurus*, tree pipit *Anthus trivialis*, Leisler's *Nyctalus leisleri* and Noctule *N. noctula* bats, fallow *Dama dama*, red *Cervus elaphus* and roe deer *Capreolus capreolus*, and dramatic assemblages of invertebrates, including tiger beetles, glow worms, hazel pot beetles and at least six nationally notable moths including the large red-belted clearwing *Synanthedon culiciformis* and white colon *Sideridis albicolon*[15].

The Living Landscape Approach

The 2009 Lawton Report (Lawton et al 2009) made explicit and evidenced what many of us had been practising for some years, i.e. that landscape scale conservation is essential in order to conserve our priority habitats and species and to ensure that our biodiversity is sustainable for the future. This approach was then formalised in policy through the Natural Environment White Paper (Defra 2011) which further reinforced the need for public bodies in particular, to adopt and a support a landscape-scale approach though their operations and functions.

In summary, in order to survive in the face of external pressures, including climate change, our habitats need to be:

- More – through creating new areas

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[13] A review of numbers of breeding nightjar and woodlark in the Sherwood Forest National Character Area (NCA), Nottinghamshire 2004 – 2006. NE Appendix 2 evidence to the Rufford Energy Recovery Facility Public Inquiry

[14] A review by Government of the SPA network

[15] Pers. comm. Dr Sheila Wright, County Moth Recorder for Nottinghamshire

- Bigger – adding buffer zones and increasing the size of existing patches
- Better – high quality habitats that are well managed to increase wildlife
- More connected – creating stepping stones and linkages through the wider landscape

The Wildlife Trusts have been championing Living Landscapes[16], their approach to landscape-scale conservation, since 2006, and in Nottinghamshire we had identified target areas based on clusters of Local Wildlife Sites as early as 2002. Living Landscapes encompass all of the approaches bulleted above but the Wildlife Trusts also recognise that engaging people in protecting and enhancing their landscapes is essential, so, in a Living Landscape:

".....wildlife is abundant and flourishing, both in the countryside and our towns and cities; .....whole landscapes and ecosystems have been restored;.....wildlife is able to move freely through these landscapes and adapt to the effects of climate change; .....communities are benefitting fully from the fundamental services that healthy ecosystems provide;.....everyone has access to wildlife-rich green spaces and can enjoy and be inspired by the natural world"

To achieve the above, each Living Landscape scheme covers a large area of land: usually a naturally functioning landscape (such as a river catchment) and often encompassing several Wildlife Trust nature reserves and other important wildlife areas including SSSIs and LWS. To deliver these schemes, Wildlife Trusts work with partners, landowners and local communities to restore a more natural landscape where feasible. These local schemes will combine to form the wider UK Living Landscape: a national network of high-quality natural areas for people and wildlife.

Each Living Landscape scheme consists of:

A. Core areas of high quality wildlife habitat

Often these will be protected areas, including nature reserves, SSSIs and LWS. In many landscapes, these areas are the "islands" of biodiversity from which flora and fauna will be able to colonise outwards into the wider landscape once it is restored. It is therefore essential that these remaining core areas are protected.

B. Connections between core areas

Continuous corridors of suitable habitat, such as river valleys or diverse hedgerows, may act as corridors that can enable species to disperse through the landscape to find suitable

[16] http://www.wildlifetrusts.org/living-landscape and http://www.wildlifetrusts.org/sites/wt-main.live.drupal.precedenthost.co.uk/files/files/TWT%20A%20Living%20Landscape%20vision%20FINAL.pdf

habitats for feeding and breeding. With the pressures of climate change on many species, particularly those already at the extreme point of their natural distribution, it is particularly important that as many routes of dispersal as possible are available. For some, more mobile, species, it may be sufficient for habitats to be connected by a series of stepping stones, rather than a large swathe of continuous habitat. Stepping stones are smaller, unconnected natural areas, providing pockets of protected habitat that can act as stop-off points for fauna that is trying to disperse. Critical distances between stepping stones can be immensely variable for different species.

C. Permeability across the whole landscape

Land between the core areas and connecting habitats needs be more accessible to wildlife. This does not necessarily require high quality diverse habitat but even minor changes in the management of land, particularly farmland, can make it easier for wildlife to move through and re-colonise the landscape. Agri-environment schemes have been of value in increasing this permeability, but much more is needed. More sustainable management of the wider countryside will also ensure that all can continue to benefit from the essential ecosystem services provided by the natural environment, such as clean air and water, healthy soils, food and flood management.

Delivering a Living Landscape in Sherwood Forest

In order to achieve “more, bigger, better, and more connected” across the remnant habitats of the Sherwood Forest landscape, the first task for the Nottinghamshire Wildlife Trust (NWT) was to identify important clusters of existing patches of habitat - Local Wildlife Sites and SSSIs. From those clusters we then focussed on an area where we saw the greatest potential for reconnection, where there were opportunities for large scale habitat re-creation, and where we knew that important Sherwood species were present. This area is shown in Figure1 and is 10,800ha in size.

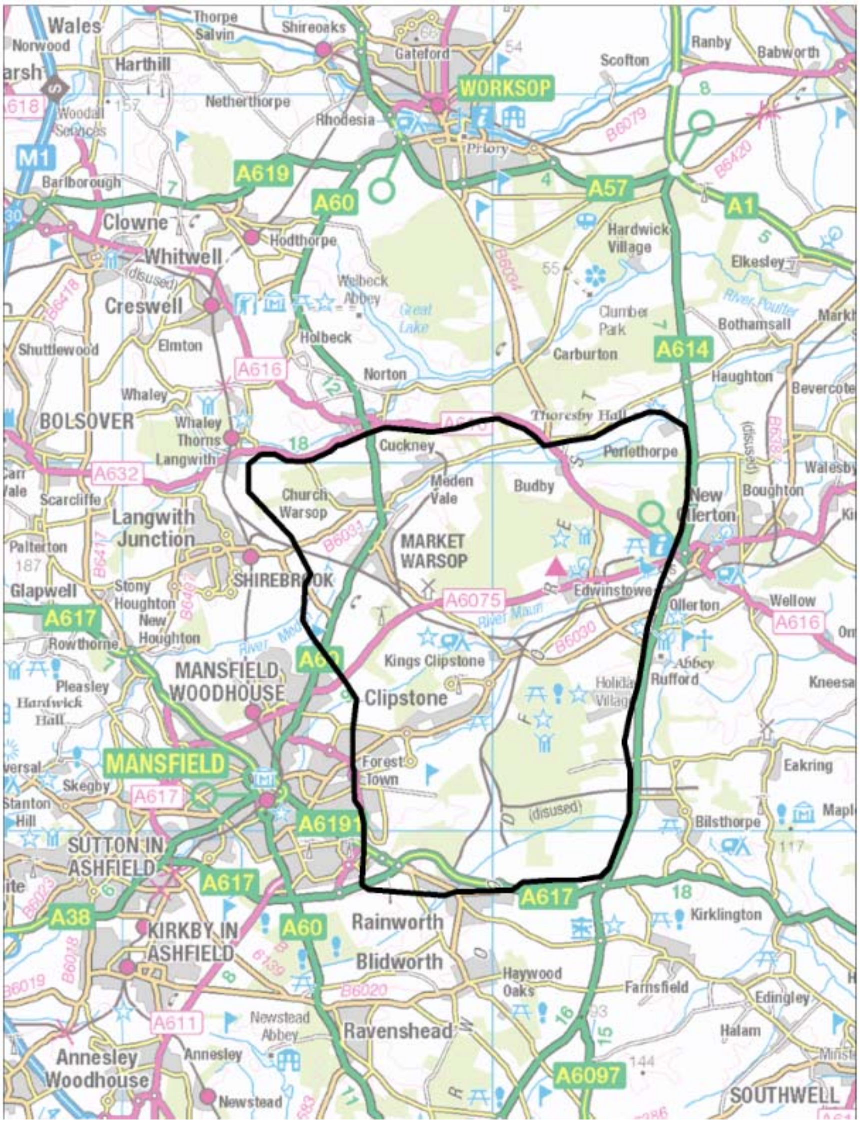

Figure 14.1: The Sherwood Forest Heathlands Living Landscape area

NWT's aim is to enhance, restore and re-create over 1000 ha of characteristic Sherwood habitats, in addition to those already present, by 2025 in the Living Landscape area.

In order to bring about substantive delivery of these aims, NWT identified all the possible mechanisms in this area, which could be used to secure large scale heathland restoration and re-creation:

- Managing our own nature reserves to achieve habitat protection, enhancement, restoration and re-creation.
- Providing advice and support for conservation land management to other landowners in the public and private sectors
- Using mineral planning to secure the large-scale re-creation of heathland (and other Sherwood habitats) on former colliery sites and sand quarries

- Influencing policy development and using development planning to protect existing habitats and species of value and to create new habitats and green infrastructure
- Engaging local people in caring for these habitats through conservation volunteering
- Working with local specialist recorders to learn more about important species and assemblages
- Liaising with NE on targeting of agri-environment schemes
- Delivering environmental education
- Working with partners to secure funds to deliver all of the above!

Figure 14.2 shows areas of existing heathland and acid grassland with a heathland element together with mineral and other development sites with restoration requirements to heathland or other Sherwood priority habitats. For many of the hatched areas, NWT (and the author in a previously capacity in RJB Mining UK Ltd) have been working since 1996 to secure the mineral planning outputs, reflecting the long term nature of mineral planning and the need for a strategic vision that can stay relevant for decades.

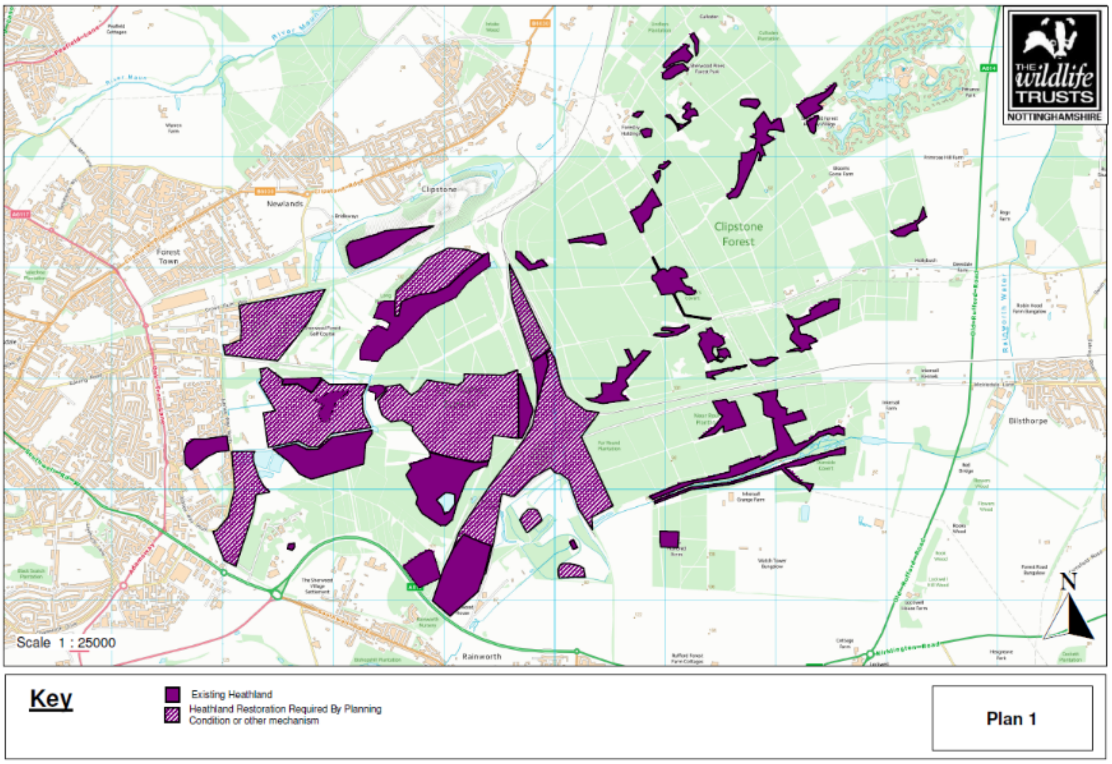

Figure 14.2: Key existing sites and planned restoration in the Living Landscape area. Areas of existing heathland and acid grassland with a heathland element (dark purple), mineral and other development where management planning has been used to secure restoration requirements to heathland or other priority habitats (hatched.)

Managing our own Nature Reserves to achieve habitat protection, enhancement, restoration and re-creation.

NWT manages Rainworth Heath and Strawberry Hill Heaths SSSIs, both of which are in HLS, and in our Living Landscape area. Within the Sherwood Forest NCA we also manage Fox Covert Plantation Nature Reserve, which represents a stepping stone site in the wider landscape. Over several years we have undertaken a range of management works, including selective scrub and tree removal, extensive grazing to manage broom, gorse and vigorous grasses, bracken management and the eradication of invasive non-native species. We have also undertaken heathland re-creation on an ex-woodland site, installed grazing exclosures to facilitate heathland re-creation and provide suitable areas for ground-nesting birds to breed and we have recently undertaken bank creation to benefit reptiles and invertebrates.

A small heathland re-creation exclosure on an area of former sycamore plantation.

A reptile and invertebrate bank, recently created on Rainworth Heath SSSI

An exclosure on Strawberry Hill Heath SSSI to prevent damage and disturbance by livestock to ground-nesting birds

Open habitat within the forest for breeding Nightjar

Providing advice and support for conservation land management to other landowners in the public and private sectors.

For several years NWT staff have provided conservation land management advice to farmers and other landowners in the Sherwood Forest area, including public sector landowners such as the District Councils and Forestry Commission. Through close working with FC, permanent and rotational areas of open habitat have been secured to provide breeding habitat for nightjar.

Farmers on the periphery of the Living Landscape area have been encouraged to undertake conservation measures on their land, including the provision of tree sparrow *Passer montanus* nestboxes and feed hoppers that are targeted at farmland red list Birds of Conservation Concern, including linnets *Carduelis cannabina*, tree sparrows, yellowhammers *Emberiza citrinella* and grey partridge *Perdix perdix* (that feed off the ground below the hoppers).

Part of NWT's Bed and Breakfast for Farmland Birds project.

Using mineral planning to secure the large-scale re-creation of heathland (and other Sherwood habitats) on former colliery sites and sand quarries.

This paper focuses on the Rufford Colliery complex, but the importance of securing heathland, acid grassland and other characteristic Sherwood habitats on other mineral and waste sites cannot be overestimated. To achieve this, Sherwood habitat restoration has also been secured at Ransom Wood Quarry and at the new Two Oaks Farm sand quarry. Although in the latter case, agreement for the complete restoration of the whole proposed quarry to Sherwood habitats was compromised at a late stage by an intervention by Natural England to restore best and most versatile soils to agriculture, resulting in an agreement to restore only 50% of the quarry to heathland and acid grassland. This is a worrying illustration of the improper application of conflicting central government policies. NWT remains optimistic that this may be revised in the future under the periodic 'Review of Mineral Permissions' process. Outside the Living Landscape area but within the wider NCA, restoration to Sherwood habitats has been secured at two further Quarry sites at Styrrup and Scrooby, and partially at Carlton Forest, and also at Dorket Head landfill site. In addition, restoration conditions to heathland and acid grassland have been secured for Harworth, Welbeck and Thoresby Collieries through consistent engagement by NWT in the mineral planning system for over a decade.

The area immediately around Rufford and Clipstone Collieries contains some of the most significant remnants of heath in forest at Rainworth Heath, Clipstone Heath, Oak Tree Heath, Strawberry Hill Heath and Sherwood Forest Golf Course SSSIs. These constitute an important reservoir of flora and fauna of local genetic origin and the Colliery Tips at Rufford and Clipstone are the geographical link between them.

A botanical survey of the tips in the mid-1990s revealed regeneration of heather on small areas which had been undisturbed for many years. Similarly, mounds of stored soils had regenerated into dense stands of Heather, some bell heather *Erica cinerea* and birch *Betula pendula*. Perhaps more surprisingly, areas previously restored with a ryegrass *Lolium perenne* dominated sward and overplanted with mixed native and exotic trees had (after around 10 years) started to develop a heathy ground flora. Prolifically flowering stands of common and bell heather amongst some of the plantations are now interspersed by red fescue *Festuca rubra*, sheep's fescue, Wavy hair grass *Deschampsia flexuosa*, common centaury *Centaurea erythraea*, common gorse *Ulex europaeus* and Broom *Cytisus scoparius*. On the Spring Hill stocking area, the long stored soil mounds had a dense cover of Gorse and Broom. Subsequent to this, approximately 30ha of heathland was re-created on Rufford and Clipstone Colliery Tips and on the Spring Hill coal-stocking are, using two trial methodologies; an acid grassland nurse sward with heather brash and the same sward with heather seed. These trials and the outcomes were reported at the 2002 National Heathland Conference (Bradley, J. & Lewis, N. 2009).

The experience from those early restoration schemes has been used for the last two years to deliver the next stage of the major restoration work for the Rufford Colliery complex. Changes in the mining scheme resulted in an application for the extraction of coal fines from former un-restored slurry lagoons. In order to secure permission, the Applicant (Harworth Estates) agreed to complete the extant restoration scheme, and also to bring former restored areas into good conservation management, as they had passed out of any statutory aftercare requirement several years previously. In addition, the working of the scheme was designed to ensure continuity of woodlark breeding habitat at all times within the Colliery complex.

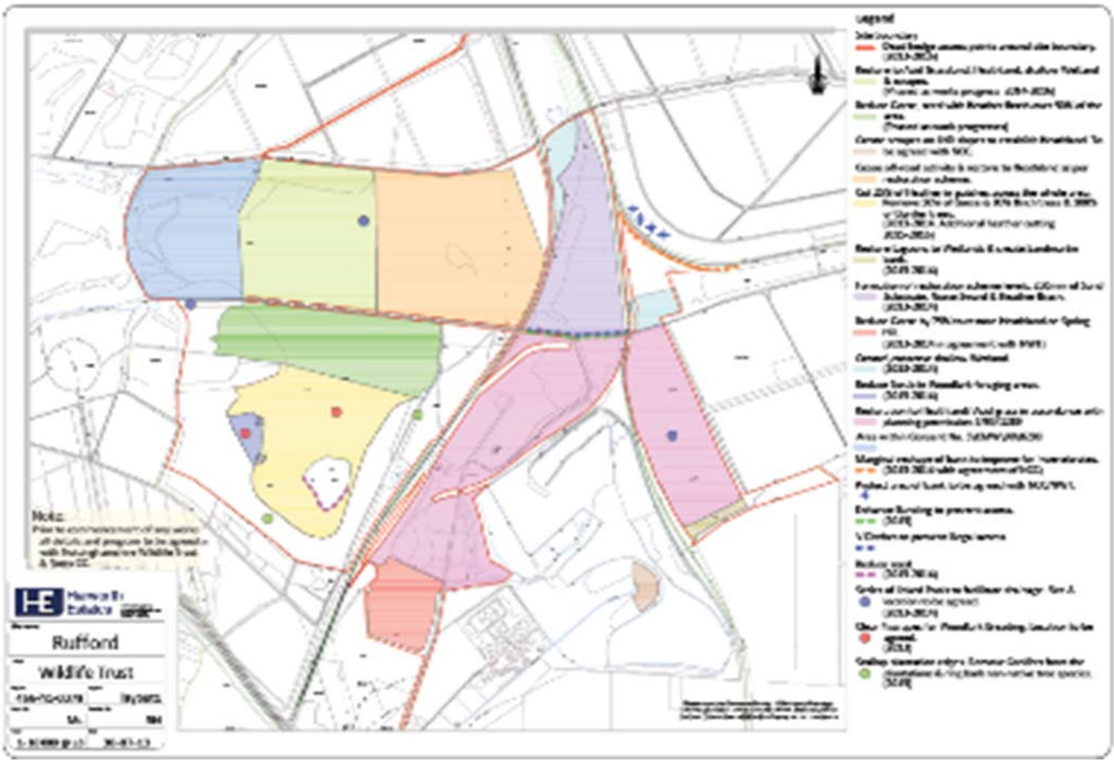

Figure 14.3: Restoration masterplan for the Rufford Colliery complex, incorporating restoration and re-creation areas and management and enhancement areas.

By the end of 2016 the following will have been delivered at the Rufford Colliery complex:

- All previously unrestored areas, restored to heathland, acid grassland and associated habitats, or encouraged to continue to naturally regenerate where high diversity has already developed.
- Wet heath created.
- All previously re-created heathland brought into good conservation management, so that it will become a diverse, well-structured heathland and acid grassland mosaic, with oak-birch woodland margins.
- Significant enhancement of existing woodlark and nightjar habitat
- Substantial new areas of new woodlark and nightjar breeding and foraging habitat.
- Creation of several new shallow wetlands and enhancement of existing wetlands.
- Enhancement of herptile habitat, including ponds, hibernacula and banks.

The above will result in an overall complex of 175ha+ of restored Sherwood habitats.

Based on the successes of the 1990s restoration scheme, the following methodology has been adopted for the most recent restoration work:

1. Blinding of the colliery spoil surface with 150-200mm of sand derived from the adjacent Sherwood sandstone quarry. This provides a more suitable physical-

chemical environment for heathland establishment, as un-ameliorated spoil can have extreme pH conditions, high salinity (conductivity), ultra- low nutrient status, and poor physical structure, resulting in a hard, hot crust forming in dry weather and a slurry-like consistency in wet weather.

Newly placed sand substrate over colliery spoil

2. Sowing of a basic acid-grassland nurse sward that will help to bind the newly placed substrate, and create a micro-climate to encourage the successful survival of young heather seedlings, in addition to providing the basis for a mosaic habitat. The mix used is:

- Common bent 50%
- Sheep's fescue 40%
- Wavy hair-grass 10%

3. Spreading with heather brash, sustainably harvested from the previously restored tip at Rufford, thereby guaranteeing local-origin material (the original restoration of Phase 1 of the tip used brash collected from Budby South SSSI). This has an additional benefit of helping to diversify the structure of the previously restored heathland.

The nurse sward was sown with a conventional tractor and broadcast seed spreader on the larger, flatter areas and an ATV for smaller, more confined or steeper areas

Loading of donor heathland plant material for transport to the restoration site

4. Rolling, to ensure good contact between seed and substrate and to help protect the area from erosion by wind and rain.

Spreading the locally collected heather brash

Rolling to create good contact between the brash/seed and the sand. Compaction of the substrate aids successful germination

Germination of heather in the first season after restoration.

New areas of restoration augmenting existing areas of natural plant colonisation, and protecting patches used by breeding woodlark whilst also creating future breeding habitat

Potential areas for the development of wet heath and mire; wet heath is one of the rarest habitats in Nottinghamshire

Previously restored wet areas have developed into this transitional mire habitat to date

A significant element of the restoration scheme has been managing the previously re-created habitats to bring them into good conservation condition. In the case of Spring Hill, this required restructuring some of the dense broom (*Cytisus scoparius*) and gorse to benefit reptiles, ground-nesting birds and botanical diversity. The initial cutting was with a flail, followed up in autumn with extensive grazing by Hebridean sheep to tackle broom re-growth.

Cutting broom and gorse with a flail

In the Rufford Colliery complex, there are a further 100 hectares to be restored in the next two years. Across the wider NCA there here are over 200 further hectares of colliery tips with extant restoration requirements.

Influencing policy development and using development planning to protect existing habitats and species of value and to create new habitats and Green infrastructure

NWT has engaged in the last 15 years with the development of every Local Plan, Regional Plan, Mineral Plan and Waste Plan that cover the Sherwood NCA, with the aim of ensuring the protection and conservation of Sherwood Forest's habitats and species. This has required a substantial effort, not least as the NCA includes 5 Local Planning Authorities in addition to the Mineral and Waste Planning Authority.

NWT has also screened every planning application that could affect habitats in the NCA for the last decade and sought to protect those habitats and species from development. This has resulted in notable successes, such as the refusal of permission for an Energy Recovery

Facility (incinerator) on the Rufford Colliery site, which was secured after a lengthy Public Inquiry, in which the protection of nightjar and woodlark was found to be paramount in the Inspector's conclusions. NWT has also secured refusals or protective conditions for a number of housing proposals in the NCA, but has also been unsuccessful in securing refusals in some cases, given current central Government imperatives for development even where Section 41 habitats and species would be affected.

Engaging local people in caring for these habitats through conservation volunteering

NWT has regular volunteer work parties on our Reserves in both the Living Landscape area and the NCA, but also supports and advises a number of Friends Groups who care for Local Nature reserves in the NCA owned by Local Authorities

Working with local specialist recorders to learn more about important species and assemblages

NWT has worked closely with the Birklands Ringing Group who are undertaking detailed research on nightjars in Sherwood Forest. An initial tagging scheme has been completed that tracks nightjar foraging behaviour, which has revealed surprising results [17] This will be expanded in 2015 to include tracking of migrating nightjar, which is being supported by the Heritage Lottery Fund (HLF).

A tracking device being fitted to a Sherwood nightjar

[17] Pers. Comm. Andrew Lowe, Birklands Ringing Group.

Liaising with NE on targeting of agri-environment schemes.

It is essential to increase the permeability of the landscape that surrounds our core areas of habitat, so that species can move and expand their populations. Agri-environment schemes are pivotal in achieving this, as are local conservation grant schemes. NWT and other partners have worked with NE to try to secure effective targeting of the new Countryside Stewardship Scheme so that it brings habitat benefits to Sherwood.

Delivering environmental education

NWT has worked with numerous schools in the Living Landscape area, particularly through the HLF funded Heathlands Education project which involved taking groups of children out to our Nature Reserves to learn about and experience heathlands at first hand.

Children carrying out a project on a heathland nature reserve

Constraints to re-creating Sherwood Forests' heathlands

Great progress in re-creating and restoring Sherwood's heathlands and protecting its scarce species has been made in recent years, but there are a number of significant constraints to further delivery:

- Development pressure
- Land values
- Value of timber
- Nutrient levels and pH in arable soils
- Nitrogen deposition
- Illegal off-road vehicle activity
- Wildlife crime
- Public sector funding cuts
- Lack of available funds

Working with partners to secure funds is essential to deliver all of the above.

There are a number of examples of recent partnership projects in Sherwood, which are helping to deliver our Living Landscape:

Biodiversity Opportunity Mapping

Through funds partially secured from NE, NWT and other partners have been able to undertake Biodiversity Opportunity Mapping (BOM) in the Sherwood NCA. The outputs are being used to develop a shared biodiversity vision for Sherwood, to raise funds and to inform the development of delivery plans for habitats and species. The BOM has provided a robust scientific basis for identifying the most important habitat networks and for focussing on particular areas to create linkages and stepping stones.

Tackling illegal off-road access

Access by off-road vehicles, both motorbikes and 4x4s is a significant problem in Sherwood Forest, leading to disturbance to sensitive wildlife, damage to habitats and danger to those with legitimate access, particularly walkers and horse riders. Consequently, NWT has convened a group of landowners, community representatives and the Police in the Living Landscape area to map all known access points; identify problem areas; and work together in a coordinated manner to consistently tackle the problem. This has resulted in better communication between neighbouring landowners and sharing of resources and best practice. Figure 4 summarises the main areas of problematic access.

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SESSION 6: KNOWLEDGE TRANSFER

TALK 15: Valuing Surrey's heathland

Sarah Jane Chimbwandira, Surrey Wildlife Trust
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Surrey Nature Partnership (SyNP) is one of 48 Local Nature Partnerships (LNP) nationally, mandated by Government in 2012 to provide a strategic co-ordinating role for all those with an interest in the natural environment in Surrey. We have a strategic remit for sustainable land management, supporting the economy and promoting health and well-being; LNPs were established to provide a source of expert advice to Local Enterprise Partnerships as they develop, and implement their economic development strategies.

Over the last two years we have focussed on delivering key projects one of which is Valuing Surrey; a Natural Capital Asset Check for Surrey. Natural Capital can be defined as the world's stock of natural assets from which we derive a wide range of benefits. The appropriate and sustainable use of these assets, and therefore the services which flow from it, underpins the SyNP approach.

The Valuing Surrey study produces an illustrative natural capital analysis for Surrey with the intention of illustrating how the principles, concepts and frameworks of natural capital analysis can be applied. The study focussed on two main aspects; developing a set of natural capital accounts for Surrey's woodland and two detailed 'asset check' case studies of key natural capital issues (flooding/catchment management and greenspace). These principles can be used to make a similar assessment of Surrey's heathlands. Work on developing our understanding of Surrey's natural capital will continue this year with further analysis, including an economic perspective on the value of achieving the Biodiversity 2020 outcomes for Surrey.

Workshops

Workshops were held on the following topics:

- Reintroductions (Leader: Jim Foster, Amphibian and Reptile Conservation ARC)
- Solving problems in managing commons (Matthew Boyer, solicitor)
- Access problems and solutions (Leader: Simon Thompson, Thames Basin Heaths SAMM)
- Dealing with aliens (Leader: Dr John Day, Footprint Ecology)
- Heathland arising – waste or biomass? (Leader: Crispin Scott, National Trust)
- Working with academia (Leader: Asst. Professor Nick Branch, Reading University)

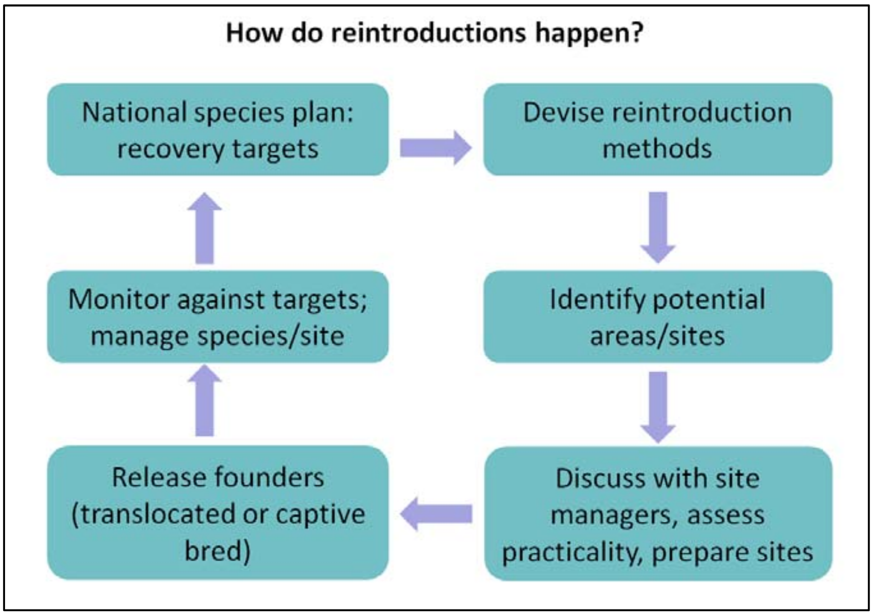
A written record was produced as an output for the first four of the conference workshop; these are presented here.

W1. Reintroductions

Leader: Jim Foster, ARC
jim.foster@arc-trust.org

1. Background

- Heathland has undergone massive loss, fragmentation and decline in quality over the last century.
- Methods for restoring and recreating heathland habitat are improving, with many successful examples.
- But what about the species that depend on species, and have also seen declines? Some will re-colonise naturally, but some groups would need deliberate (re-)introductions.
- Why reintroduce species?
  - Ethical/moral reasons
  - Legislative driver
  - To help another species, habitat, or ecosystem
  - As a scientific study
  - To meet a conservation need – more populations, increase range, climate?
- Which heathland taxa could benefit from reintroductions?
  - Some invertebrates, reptiles & amphibians are prime candidates, i.e. those with restricted range, low dispersal and long-term declines.
- Increasing range of guidance for reintroductions, especially the IUCN Reintroduction Guidelines (2013).
- Increasing evidence that carefully planned reintroductions can be successful in the long term, at least for some groups.
- Reintroduction can still be controversial though: there are risks to the reintroduced animals and the communities where releases occur (e.g. altering release site dynamics, disease transmission); they are resource-intensive and therefore compete for conservation funds.



2. Interactive session: Improving reintroduction practice

The participants were divided into six break-out groups, and asked the following:

> *Imagine you're a heathland site manager. Think of your favourite heathland site. Now, imagine that site has been identified as a candidate for reintroduction of species X.*
>
> *1) What barriers might there be to reintroducing a species at your site?*
>
> *2) How could these barriers be overcome?*
>
> *Choose top 3 barriers, and report back.*

The collated results are given in the table below, and as all groups clearly put much thought into this and listed more than 3, all points are included. The barriers have been ordered into categories after the event. Numbers in brackets indicate the number of times a broadly similar topic was selected.

Barrier	Solution
(A) Resourcing	
Resources to undertake habitat management in long term. (Note: government cuts exacerbating this funding constraint. Administrative costs increasing) (5)	Grants eg HLF; fund-raising.
Lack of resources for long-term monitoring of reintroduction. (3)	Grants; public appeals; fit in with Biodiversity 2020 targets so that funds more easily available.
Lack of resources for project officers or existing staff to allow effective co-ordination and consultation (3).	Grants; fund-raising.
(B) Reintroduction planning and implementation	
Poor planning of reintroduction or lack of long-term planning. (2)	Follow good practice. Good communication, especially with landowners and managers. Partnership work.
No long term plan for managing the target species at the release site (2)	Choose species that fit in with existing management methods or allow for minor tweaks. Link to other groups studying the species.
Conflict with other species already present at release site.	Good practice in planning reintroduction; aim for sustainable interactions between species in the long term.
Prioritisation: is species reintroduction the right activity to spend time on, compared to focusing on maintaining and improving existing interest features?	Investigate species-habitat relations, especially habitat specialists. Research into species presence in apparently marginal habitats.
Insufficient habitat extent or quality to allow reintroduction.	Use biodiversity opportunity mapping to highlight priority areas. Strategic habitat creation.
Bureaucracy holding up reintroductions, especially for multi-partner projects.	Build stronger relationships.

Barrier	Solution
Public perception and support: difficulty in gaining support for "uncharismatic" species (ants vs dormice!)	Education and awareness-raising. Publicity.
(C) Evidence base	
Knowledge of reasons for loss and species requirements; difference of opinions on these points. (5)	Encourage expert research, including into historical species status, historic land use and recent changes to management. Examine history of supporting or similar species. Intensive surveys to be sure of absence. Investigate genetic issues.
Uncertainty over whether the release site can sustain a population in the long term (e.g. Is it large enough? Lack of fragmentation?)	Ensure good choice of species. Research options. Reintroduction could be used to help make case for improving site condition.
(D) Risk of negative impacts on reintroduction sites	
People pressure, including "species tourists", leading to excessive trampling or disturbance (3).	Make site confidential, at least at first (species specific decision). Improve infrastructure. Open days, educational visits to reduce pressure of unsupervised access.
Climate change: query over future viability of populations. (2)	Land purchase and linkage to create habitat networks, corridors. Long term reintroduction programme and assessment of species viability.
(E) Potential conflict of objectives	
Habitat still under restoration, leading to queries over habitat suitability, conflict with management objectives. (2)	Peer review: is the site ready?
Poor location for species management (conflict with other species).	Good consultation in advance.
Conflict with other land uses among local community.	Discuss beforehand what is acceptable for all land users through extensive consultation. Find common ground.
Constraints imposed by reintroducing European Protected Species (legal implications – "regulatory top trumps"?)	Consultation; planning of species targets.
Archaeology as a constraint – not being sure of environmental historic significance.	Develop good relations with archaeologists, and undertake surveys in advance.
Landowners and developers concerned about increase in conservation value through reintroductions.	Public support. Reassurance re impacts on business. Add species to designations. Undertake reintroductions on existing designated sites, not unprotected ones.

Other comments brought up in discussion

- Rationale for undertaking reintroductions needs to be clearer: why, where and how many?
- Is reintroduction to isolated sites sensible, and if so when and why?

- Reintroductions and site designations: how do they fit with conservation objectives, Favourable Condition Tables?
- Convincing the public that reintroductions are worthwhile.
- Importance of developing partnerships.

W2. Solving problems in managing commons

Leader: Matthew Boyer, solicitor
boyer@matthew-boyer.co.uk

The Workshop addressed the main legal problems encountered when managing lowland heathland commons for conservation, covering in particular:

Commons Act 2006, Part 3, works needing the consent of the Secretary of State

- Definitions of "restricted works"
- The Works on Common Land (Exemptions) (England) Order 2007
- The Planning Inspectorate's Guidance Sheet 1b
- The Works on Common Land, etc. (Procedure) (England) Regulations 2007
- DEFRA: "Common Land Consents Policy Guidance"
- "A Common Purpose", revised 2012
- Natural England: "Common Land Toolkit"
- S. 39 Commons Act 2006:
    - The interests of persons having rights over the common
    - The interests of the neighbourhood
    - The public interest: nature conservation, landscape conservation, public rights of access, features of historical interest
    - Other relevant matters
- Partial, conditional or modified consent
- Cattle grids and bypasses
    - Section 82 and Schedule 10, Highways Act 1980
- Tips for a successful fencing application
- Evidence and procedure at public inquiries
- "Invisible fencing"

Commercial activity on commons

- By the owner or manager of the common
- By commoners
- By third parties
- Means of control:
    - Countryside and Rights of Way Act 2000
    - Wildlife and Countryside Act 1981
    - Law of Property Act 1925, s. 193

Dog Control

Liability for grazing animals

Abandoned ponies and trespass grazing

W3. Access problems and solutions

Leader: Simon Thompson, Thames Basin Heaths SAMM
simon.thompson@naturalengland.org.uk

What are the issues and possible causes of disturbance to heathland habitats and species?

Dogs:

- Causing disturbance/injury to birds, livestock, other people
- Adding nutrients to a nutrient-poor environment
- Added impacts from commercial dog walkers and dog training, e.g. gun dogs

Mountain bikes:

- Erosion
- Disturbance, collision, displacement of other users
- Rapid increase in numbers and cycling at night
- Do not keep to bridleways
- Particular impacts at popular destinations , near urban areas and from organised events

Horse Riders:

- Some issues similar to mountain bikes
- Path widening and riding off paths, can lead to damage to invertebrate and herptile habitat
- Problems with gates (e.g. for enclosing livestock)

Drones: (now used by a wide spectrum of individuals and agencies)

- Noise (and movement?) can impact on birds and livestock

Livestock: (belonging to owners or commoners)

- Can cause disturbance or injury to public
- Can be insurance issues

Other:

- Motor bikes
- Fires (accidental or arson)
- Presence of ordnance
- Fungi picking
- Metal detecting- Digging of holes, disturbing archaeology

Possible solutions

Dogs:

- Lessons from existing schemes e.g. Dorset Dogs
- Funding for initiatives, e.g. development mitigation (Thames Basin Heaths SAMMS project), NE access
- Some problems with this approach as funding to LAs not direct to countryside projects.
- Drip-feed funding needed over long period not large capital expenditure
- Wardening by dog wardens, site staff, volunteer ‘lookers’, self-policing and peer pressure
- On site contact needs consistent approach and continuing involvement as new residents move in
- Make people aware of the impacts of irresponsible behaviour, but accept that you won’t reach everyone
- Hold events for dogs and dog walkers, e.g. first aid for dogs. Some early morning when dog walkers are about
- Institute well marked zoning systems. Safe zones for dogs. Install dog proof barriers
- Good, well maintained signage with eye-catching information
- Website targeted at dog walkers
- SANGS for dogs?
- Allow time for a cultural changes to take root
- If Dog Control Orders are introduced they will need to be enforced

Mountain Bikes

- Provide specific routes away from sensitive sites
- Make routes more/less attractive for bikers
- Institute dual use tracks with room for different users
- Encourage the provision and use of skate parks for jumps (care over liabilities)
- Regular contact with event organisers, societies, clubs, shops
- Use social media to reach individuals, informal groups, forums
- Work with groups using softly, softly approach
- Provide more options and direct people where to go
- Difficult to anticipate new trends, bike design improvements allow increasing access
- Produce codes of conduct in association with bikers organisations

Horse riders

- Engage more closely with horse riders and their local and national organisations
- Encourage them to move around to allow damaged paths to recover and create new bare ground
- Produce codes of conduct in association with horse riders organisations
- Use websites to engage with horse riders

Drones

- Use web sites and social media to engage with users
- Do legal restrictions in urban areas encourage users into the countryside?

- Research needed into impacts of drones on wildlife

Livestock

- Use of docile breeds, care with bulls, stallions and cows with young calves
- Remove unruly animals promptly
- Good signage to advise when livestock on-site
- Livestock free areas always available

Other

- Engage and talk to motor cyclists
- Clear signage where motor bikes can/cannot go
- Legislation is clear-ask police to enforce (greater willingness than in the past)
- Write and implement fire plan-involve fire services as advisers
- Manage vegetation to reduce fire risk, create and maintain fire breaks
- Use drama sessions, courtroom scenario, videos in schools and other venues for young people
- Engage with young people and public to spot and report fires
- Use websites and social media to inform and engage with young people and public
- At critical times use patrols to detect fungi pickers.
- Signage in different languages
- Use of bylaws if available.
- Encourage responsible foraging e.g. by limiting weight of allowable crop
- Confiscate illegal or overweight harvest
- Encourage press stories on potential risk of poisoning

W4. Heathland Biomass

Leader: Crispin Scott, National Trust
crispin.scott@nationaltrust.org.uk

These were the points discussed:

1. We need to do more to make the economics stack up
2. What can we do about the poor quality of heathland biomass?
3. Briquettes for the log market – get some trials going
4. We need something along the lines of a "Biomass marketing board"
5. Resolved to form a working group to take this forward (in south east England)

W6. Dealing with aliens

Leader: Dr John Day, Footprint Ecology
john@footprint-ecology.co.uk

This account is based on a literature search prior to the conference and views and suggestions by participants at the workshop.

We asked ourselves the following questions:

What are the main species of invasive non-native plants of concern on lowland heathland?

- How should we decide on priorities for where eradication/control of these species should take place on any particular site (where there may be one or more NNS)?
- Define non-native invasive as: Any plant that is '**non-native**' has been brought in - or 'introduced'- either deliberately or accidentally. An **invasive** species is one that can cause economic, environmental and/or human, animal or plant health problems.
- Main invasive species on heathland: *Rhododendron ponticum*, Pirri-pirri bur *Acaena nova-zelandiae), Gaultheria shallon*, American rum cherry *Prunus serotina*, New Zealand pigmy weed *Crassula helmsii*, Parrot's feather *Myriophyllum aquaticum*.
- Species of possible concern more locally: Pampas grass *Cortaderia selloana*, cherry laurel, *Prunus* laurocerasus, American skunk cabbage *Lysichiton* americanus, Japanese rose *Rosa rugosa*, *Amelanchier ssp*., Sitka spruce *Picea* sitchensis, a moss *Campylopus introflexus*, Pitcher plant ssp?

What are the characteristics that led to these species being of particular concern?

- Good pioneer species
- Popular with gardeners
- Regenerates easily from seed/fragments
- Produces large quantities of seed which readily germinates
- Seed is long lived in soil
- Can produce new plants by layering or spreads by long stolons or rhizomes
- Can tolerate wide variety of pH, nutrient levels, soil condition, salinities, climate
- Can tolerate low winter temperatures, flooding or drought
- Seed or fragments spread by water/wind/birds/animals/people
- Winter green and grows at low temperatures
- Rapid growth outstripping competitors, casts dense shade or outcompetes on height
- Can tolerate shade or full sun
- Can colonise in or out of water, draw down zones

- Produces chemicals or has other leaf characteristics which make it resistant to grazing or attack by mammals or invertebrates
- Wide ecological amplitude
- Can alter local environments
- No natural predators
- Produces plant toxins in soil that deter plant competitors

What are Priorities for control:

- Do we leave, eradicate or control?
- Prioritise species which are having a negative impact on site designation, priority habitats or species
- Prioritise species which are spreading within the site or beyond its boundaries
- Consider practicalities, likely success and resources at an early stage
- Start control/elimination measure as soon as possible after INNS discovered on site
- Eliminate outlying plants first
- Prioritise control on transport routes, public areas, car parks etc.
- For aquatics and waterside prioritise upstream infestations, for some species top of catchment
- Introduce biosecurity measures at an early stage

What precautions should we take to protect our site from colonisation by invasive non-native plants?

- Understand how species could arrive e.g. vectors
- Check for presence of INNS in surrounding area (10kms?). Encourage neighbours to take action and offer advice and support. Liaise with other landowners.
- Check with Biological Records Centre and others about records of INNS in your area
- Check site and pathways every 12 months at least (pathways could be terrestrial e.g. transport routes, public rights of way, car parks, entrances on open access land or aquatic e.g. waterways, drainage discharges or pipes, run-off, etc.)
- Assess risks from boats, cyclists, horse riders, fishermen etc. and produce signs, leaflets, or other measures as necessary
- Make sure staff and volunteers can recognise potential INNS, with training if necessary, and that they are aware of the importance of immediate reporting of a potential sighting and there are clear procedures for doing this
- Check possible colonisation after winter floods, usually following spring or after any flood
- Check origin of contractor's vehicles and equipment coming on site and make sure it is clean and soil and debris washed off before arrival. On larger sites provide wash down facilities. Avoid caterpillar tracks if possible
- Check origin of livestock and check for burs etc. in fleeces, wash off feet of cattle
- Monitor sites used for fly tipping or garden waste disposal on a regular basis
- Provide wash down facilities for staff, volunteers/contractors
- Regularly check any disturbed ground, soil dumps or other earth works for INNS

- Regular check of pond dipping or other recreational/educational sites. Check equipment is clean and thoroughly dry after use
- Give careful consideration to routes used for the public, guided walks off public rights of way for example
- Put in place measures to reduce risks and formalise these in a biosecurity policy and circulated to staff, contractors, tenants and others

Additional Measures if INNS found on site:

- Carry out surveys to determine extent of infestation
- Assess likely source and route of infestation e.g. deliberate release, anglers, dog walkers, winter flooding, wild birds or mammals, contractors, livestock, educational activities, fly tipping etc.
- Put in place education and awareness strategy for staff/volunteers
- Cordon off high risk areas where INNS located and warn staff/ volunteers/contractors and others to stay out of area
- Put in place a public awareness strategy
- Make sure contractor vehicles do not spread propagules on site
- Avoid grazing contaminated areas unless INNS well established on dry ground and grazing is a control measure
- Clean off machinery, vehicles etc. leaving site
- Clean off animals leaving site for grazing elsewhere
- Put in place any necessary biosecurity measures such as footbaths, signs, limitations on routes or use of vehicles or other measures
- Fragments can be transported from elimination/control sites by people, animals or machines. Put measures in place to prevent this
- If dealing with water plants, put in barriers or screens to prevent movement of seeds or fragments to other parts of the system. Turn off pumps if they might transport propagules.
- Seek immediate advice

How do we decide on precise control measures:

These will depend on the biology of the target species. Does it spread by seed or vegetatively? Can we eliminate it by above ground cutting or do we need to remove roots or rhizomes? Is the seed short lived or does it survive in the soil for many years? Does the target species spread downstream in waterways? Is the target species vulnerable to drought, waterlogging, high salinities etc.

- For species with short lived seed, then further spread can be achieved by preventing it flowering while elimination of the plants is ongoing
- For species spreading downstream in water ways control measures need to start at the furthest upstream point at which the target species occurs
- If the target species occurs in a number of places, then outlying plants and clumps should be removed first to arrest further spread

- If cutting, mowing or grazing to control, continue throughout season to avoid late flowering plants being missed
- Avoid actions that spread seeds, fragments, roots, buds or contaminated soil. Do not use flails or strimmers but cut by hand or using reciprocal cutters. If mechanical methods used, carry out hand search for fragments afterwards
- For species which can spread from small fragments use only hand cutting or chemical or environmental controls
- Dispose of plant fragments with care. Composting is not effective for plants which can regenerate from fragments or long lived seed. Burying may be ineffective for deep rooted plants. Burning can be the safest method of disposal but can disperse light wind-blown seeds
- Re-invasion can take place from propagules brought in from outside, put in measures to prevent imports from people, vehicles, boats or animals

What advice might we need and who could provide it

- Advice on control or elimination measures from Plant Life, Local Authority, Environment Agency, Forestry Commission, Centre for Ecology and Hydrology, other?
- Advice on disposal of plant debris from control or elimination measures from Environment Agency or Local Authority e. g. "controlled waste" must be disposed of to a specially licensed facility-this includes Japanese knotweed.

Relevant legislation

Wildlife and Countryside Act 1981 section 14 and Part 2 of Schedule 9 (as amended 2010).

"*If any person plants or otherwise causes to grow in the wild any plant which is included in Part II of Schedule 9, he shall be guilty of an offence*"

For latest Schedule 9 see: Wildlife England and Wales: The Wildlife and Countryside Act 1982 (variation of Schedule 9) (England and Wales) Order 2010.

Schedule 9 includes: Japanese knotweed, Parrot's feather, Rhododendron, Japanese rose, New Zealand pigmyweed,.

Under a new section 14 of the W&C Act from April 1st 2014 it has been illegal to have for sale in England floating pennywort, water fern, water primrose, New Zealand pigmyweed and parrot's feather.

What steps should we take before considering control measures?

- Seek advice from others who have had the same problem as to how they dealt with it and what lessons were learnt from successor failures
- Decide whether the situation is best dealt with by elimination, control or monitoring. This decision will depend on the species, the extent of colonisation and the site
- Set out a strategy for control/elimination/monitoring

- Decide on control measures and whether these will be biological (e.g. grazing, control with approved invertebrate predator) environmental (e.g. shading, burying, infilling), mechanical (e.g. cutting, scraping, dredging) or chemical (e.g. herbicides).
- Make sure the resources of staff, volunteers, contractors and finance will be available from start to completion and that resources match chosen control measures
- Make sure that any permissions have been obtained (e.g. use of herbicides near waterways), and that management mechanisms are in place to complete the task (allow for staff changes, contractor changes, unexpected spread of INNS, other work planned on site, potential actions by neighbours etc. are covered by a contingency plan
- Decide how you will prevent re-invasion if elimination successful
- Decide what post elimination/control effects there will be and how you will deal with them (e.g. current shelter for deer removed, suitable conditions created for soil erosion or colonisation by another INNS, what vegetation will colonise cleared areas, will it provide a different management problem, will visitor behaviour change, how will it affect grazing practices etc.).
- Seek advice and make decisions on how cleared plant material will be disposed of.
- How will you know that elimination has been successful?

What monitoring should we put in place and when?

If the strategy is for monitoring only, decide how this is best done and at what intervals. Fixed point photographs may be useful or more intensive monitoring may be needed. Make sure that the methods chosen will not lead to the INNS spreading. If the strategy is for elimination, monitoring will only be effective if the target species is detectable at very low densities, otherwise it will be missed and re-invasion will follow

- Carry out a systematic search and record the locations of the INNS (this can be done with volunteers based on transects across the site and using GPS and or markers to locate plants.
- Keep a full record of all actions, what, when, where and how much and the results whether successful or failed and the costs
- Keep a full record of all plants removed and if relevant, whether or not they were in flower
- Keep a full record of the methods and results of disposal of plant material, e. g. burial, bonfires, composting
- Continue to carry out systematic searches throughout the control programme and afterwards for a period of years, where relevant, after last individual or flowering individual removed and recorded
- Concentrate monitoring for re-invasion on areas where vegetation has been cleared, areas of disturbed ground and disposal areas
- If the result exposes new methods, success or failures of relevance and value to others, consider how these lessons may be passed on to others
- Continue to monitor the presence of INNS in the neighbourhood and whether they are spreading.

References

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Agenda

11th National Heathland Conference 2015

	DAY 1 — 18th March
9 .00 - 10.45	**REGISTRATION**
11.00	**WELCOME** (Nigel Davenport, CEO Surrey Wildlife Trust)
11.15 - 12.45	**SESSION 1**: **MORE THAN JUST HEATHER!** (Chair: Dr David Bullock, NT)
	TALK 1: Bumps, Bombs & Birds: Heathland Restoration & The Historic Environment (Robin Standring, RSPB)
	TALK 2: Comprehensive management of Common Land (Pippa Langford, NE)
	TALK 3: **Mires** (Richard Lindsay, University of East London)
12.45 - 13.45	**LUNCH**
13.45 - 15.15	**SESSION 2**: **GRAZING HEATHLANDS** (Chair: Dr Sophie Lake, Footprint Ecology)
	TALK 4: Grazing in practice (James Adler, SWT)
	TALK 5: Monitoring The Effects of Management on Chobham Common NNR (Jonathan Cox and Dr Clive Bealy)
	TALK 6: Grazing And Sensitive Species (Richard Sharp, ARC)
15.15 - 15.45	**COFFEE BREAK**
15.45 - 16.45	**SESSION 3**: **INTERVENTION MANAGEMENT** (Chair: Dr John Day, Footprint Ecology)
	TALK 7: "Robust" interventions: Prees Heath (Stephen Lewis, Butterfly Conservation)
	TALK 8: When To Convert Woodland To Open Habitat: Sustainable Delivery Of Government Policy (Dominic Driver, Forestry Commission)
16.45 - 18.30	**WORKSHOPS** Reintroductions (Leader: Jim Foster, ARC) Solving Problems In Managing Commons (Leader: Matthew Boyer, solicitor), Access Problems And Solutions (Leader: Simon Thompson, Thames Basin Heaths SAMM), Heathland Arisings-Waste Or Biomass? (Leader: Crispin Scott, NT) Working with Academia (Leader: Asst Professor Nick Branch, Reading University), Dealing with Aliens (Leader: Dr John Day)
19.00 - 20.30	**DINNER**
21.00	**GOOD TO KNOW** (5-10 min sessions): Chair open mike session, Sue Everett

	DAY 2 — 19th March
8.00	**BREAKFAST**
9.00 - 12.15	**SITE VISITS** **Choice (limited by numbers) of:** - **Thursley NNR (NE)** with **Hindhead (NT)** - **Farnham Common (RSPB)** with **Royal & Bagmoor Commons (SWT)** - **Chobham Common NNR (SWT/SCC)** with **Sunningdale Golf Course (ARC/SHP)** - **Greenham Common (BBOWT)**
12.15 - 13.00	**LUNCH**
13.00 - 16.30	**SITE VISITS:** 2nd site of above pair
16.30 - 19.00	**CONCLUSIONS IN PLENARY** (Site visits and workshops)
19.30 - 20.30	**DINNER**
20.30	**After Dinner Speaker** (Professor Hugh Possingham)

	DAY 3 — 20th March
8.00	**BREAKFAST**
9.00 - 10.30	**SESSION 4: LET'S INNOVATE!** Chair: Nigel Symes, RSPB
	TALK 9: A Renaissance in the Chemical Control of Bracken (Professor Roy Brown)
	TALK 10: Invisible Fencing and Epping Forest (Dr Jeremy Dagley, Corporation of London)
	TALK 11: The Heathlands Reunited Project (Emily Brennan & Jonathan Mycock-South Downs National Park)
10.30 - 11.00	**COFFEE BREAK**
11.00 - 12.30	**SESSION 5: MEETING BIODIVERSITY 2020 TARGETS** (Chair: Alan Law, Natural England)
	TALK 12: Where Are We Now And What Is The Gap? (Dr Isabel Alonso, NE)
	TALK 13: Brecks Biodiversity Audit And Applications (Chris Panter, Footprint Ecology and Bev Nichols, NE)
	TALK 14: Living Landscapes - Recreating Sherwood Forest's Heathlands (Janice Bradley, Notts WT)
12.30 - 13.30	**LUNCH**
13.30 - 14.30	**SESSION 6**: **KNOWLEDGE TRANSFER** (Chair: Dr Anita Diaz, Bournemouth University)
	TALK 15: Valuing Surrey's Heathland (Sarah Jane Chimbwandira, SWT)
	TALK 16: Citizen Science (Dr Andrew Knight, Imperial College)
14.30 - 15.00	**SUMMING UP**
15.00 (EST)	**ENDS**

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ISBN 978-1-78354-286-4

Published on Natural England's Access to Evidence Catalogue January 2016