That's Life - Restorating the Humberhead Peatlands

LIFE+ Project LIFE13NAT/UK/000451

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27 September 2016

Mid-Term Workshop Report

Natural England
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Introduction

The Making Moor Space workshop held 27 September 2016 brought together 68 people from 30 organisations and local residents. The aim of the workshop was to share experiences, to learn from one another and discuss good practice. The aim was set against a backdrop of the techniques being used by Natural England and its partners to restore the Humberhead Peatlands National Nature Reserve (NNR).

The workshop was structured around facilitated onsite workshops held on Thorne Moors, to allow delegates to enter into discussion. Input from the keynote speaker, Dr Roger Meade, set the context for the workshop by plotting the history of the Humberhead Peatlands from its designation as a SSSI in 1970 to the present day. The workshop was a key activity for the Humberhead Peatlands LIFE+ Project as part of its public awareness and dissemination.

Feedback from the workshop was positive and delegates saw value in networking with people from other organisations and finding out about current practices in peatland restoration.

This report provides an overview of the event, background information and objectives, a summary of the onsite workshops and discussions.

Humberhead Peatlands NNR – Thorne and Hatfield Moors

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Overview

The Humberhead Peatland NNR is located in the north of England, comprising Thorne, Goole, Crowle and Hatfield Moors. The 2287 ha, Peatland represents the largest area of lowland raised mire in Britain.

Lowland raised mire is one of western Europe's rarest and most threatened habitat. Around 94% of this unique habitat has been destroyed or damaged in the UK. The Humberhead Peatlands is a Special Area of Conservation (SAC) for its habitat and a Special Protection Area (SPA) for its breeding population of nightjar.

The Humberhead Peatlands are a remnant of a large wetland that occupied the floodplain of the Humberhead Levels thousands of years ago. They have been worked for peat throughout recorded history. The impact of this working has been to leave the remaining area with too varied a water table to allow peat formation.

The Humberhead Peatlands were heavily exploited for peat over many centuries. During the 20th centrury the integrity of the mire and its unique biodiversity were severely threatened by mechanised peat extraction and associated drainage. These activities finally ended in 2004 and provided the opportunity to restore the UK's largest area of degraded lowland raised mire.

To restore the Peatlands and return them to favourable condition, Nature England and the Doncaster East Internal Drainage Board (IDB) are undertaking extensive restoration works on Thorne and Hatfield Moors. The project is supported by LIFE+ Nature, which is a financial instrument of the European Union.

The Life+ Project

In 2014 Natural England was successful in securing funding from the European Union's LIFE+ programme to help the restoration of the Humberhead Peatlands. This was matched with a contribution of finance and staff time from Natural England and £1.9 million from the Environment Agency, channelled through Doncaster East sIDB, who are delivering complimentary works on Thorne Moors through the Thorne Water Level Management Plan (WLMP).

That's LIFE - Restoring the Humberhead Peatlands (LIFE13NAT/UK/000451) was launched in July 2014 and will continue to at least June 2017. The Project will extend the area of peatbog habitat under active restoration and will help provide a long-term future for the rare plants, birds and insects.

The completion of the Project will leave a lasting legacy for UK's largest lowland raised bogs.

Workshop Objectives

The objectives of the workshop were to bring environmental conservation practitioners together from across the UK, to:

- Develop knowledge and understanding of the techniques being used by Natural England and its partners to restore the Humberhead Peatlands NNR back to favourable conditions for peat re-formation.
- Discuss the project actions being carried out, the lessons learned and the results so far from viewing the practical works on Thorne Moors SAC.
- Share good practice from their own experiences and learn from one another on the techniques that they are using.
- Encourage delegates to share knowledge, collaborate and develop networks between individuals and participating organisations.

The workshop focussed on four core thmes to restore lowland raised bogs back to favourable conditions:

- Monitoring and tracking nightjars
- Evapotranspiration reduction (scrub control) techniques on degraded lowland raised bog
- Catering for insect and spider assemblages in lowland raised bog restoration
- Managing water levels to aid restoration of the mire communities.

"Really interesting to hear about problems and reasoning behind decisions"

Delegate feedback (anonymous)

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Workshop Summary

Tuesday 27 September 2016

Keynote Speaker

Dr Roger Meade, an expert in the restoration of damaged peat bogs, drew on his experience of working with specialists in several countries such as the Baltic States, Germany, The Netherlands, Siberia and New Zealand. To deliver his presentation entitled 'Climbing Everest', he outlined the recent history of Thorne and Hatfield Moors, spanning its designation as a SSSI in 1970 to the eventual purchase of the site in 2004, its designation as a National Nature Reserve and the long road to recovery leading to the LIFE+ Project in 2014.

"Roger Meade's presentation was good – great for someone who didn't know the full background information to NE's involvement at the site"

Practical Onsite Workshops

Delegates took part in four onsite workshops rotating from one session to the next. Each workshop was delivered by the people undertaking the work on the ground.

The workshops covered the aforementioned four core themes explaining the methods being used to restore the Humberhead Peatlands back to favourable conditions.

Monitoring and tracking our nocturnal Nightjars

Presenters

Lucy Ryan, PhD student, University of York
Bryan Wainwright, Reserve Manager, Humberhead Peatlands NNR, Natural England

Abstract

The European nightjar is a migratory, sparsely-distributed bird, breeding in the UK, with quite specific habitat requirements for nesting. This is one of the few peatland sites in the UK to be designated an SPA because of its nightjar population, with around an estimated 80 churring males (Middleton, 2016). Habitat manipulation on-site for active mire restoration has implications for the nightjar population and detailed monitoring is necessary for future management. Monitoring methods include surveys for presence of breeding territories, nest searching for breeding locations and tracking with the latest GPS tag technology to understand their foraging movements both on and off site.

Topics covered

- Breeding nightjar surveys
- Nesting habitat requirements & breeding success monitoring
- Tracking technology and procedures, data processing, analysis and use

"Fascinating. Loved how it made clear the need for a delicate balance of wet and dry habitat, on the needs of the hydrology workshop"

Managing water levels to recolonise bare peat and cleared areas

Presenters

Tim Kohler, Senior Reserve Manager, Humberhead Peatlands NNR, Natural England

Abstract

The Thorne Water Level Management Plan (WLMP) develops work previously carried out on the Humberhead Peatlands NNR. The aim is to maintain water levels across a topologically varied site at or around the level of the peat surface. A mixture of surface bunds, fixed plastic pile weirs, controllable dams and a new pumping station are being installed to achieve this.

Topics covered

- Pumping station
- Use of contour bunds to reduce flows
- Use of dams and sluices on internal ditches and drains, and tilting weirs on principal drains
- Telemetry control

"Tim Kohler – what can I say, Tim always has plenty to say that's interesting, provides insight into a subject matter, often amusing and delivers the information at speed so as to provide the recipient with a mine of information in a short space of time"

Evapotranspiration reduction (Scrub Control) techniques on degraded lowland raised bog

Presenters

Ed Brightman, LIFE+ Project Assistant Project Manager, Natural England

Lukas Rowe, LIFE+ Estate Worker, Natural England

Abstract

The LIFE+ project aims are to clear 572ha of scrub, comprising 234ha on Hatfield Moors, 338ha on Thorne Moors, including 200ha Rhododendron elimination. The scrub on site varies in density from total cover mature rhododendron, rhododendron under birch scrub to scattered small birch and willow. This is to be cleared through the use of a combination of contract works and an in-house estate team. Methods ranged from motor manual cutting, mechanised flailing and chemical treatment.

Topics covered

- Machinery operations used
- Motor manual (chainsaw/chipper)
- Immediate results and finish
- Follow up works required

"Watching the machinery in action, and seeing the changes it made, and the peat drilling scars at that exact spot as well, made the peatland restoration processes visible and tangible"

Catering for insect and spider assemblages in lowland raised bog restoration

Presenters

Dr Richard Smith, LIFE+ Project Monitoring Officer, Natural England

Claire Hayden, Apprentice, Humberhead Peatlands NNR, Natural England

Abstract

Invertebrates contribute the greatest number of species to peatland faunas. However, invertebrates are only considered infrequently in restoration projects. The invertebrate assemblages of Thorne and Hatfield Moors were studied in relation to rewetting and scrub clearance. Sampling focused on the standardised techniques of pitfall and pan trapping, to obtain baseline assessments of beetles, spiders and flies. Results will be analysed in relation to defined acid mire assemblages, using PANTHEON, a new web-based tool for conservation practitioners. The trade-off between effort and resource requirements in invertebrate monitoring was discussed.

Topics covered

- Habitat requirements of peatland faunas.
- Monitoring invertebrate assemblages: which ones do you choose?
- Vegetation descriptions as surrogates for invertebrate sampling.
- Flagship invertebrates in peatland restoration.

"Interesting to hear about solutions and problems"

The day ended with Robert Burnett, Manager, Yorkshire and Northern Lincolnshire Area Team, Natural England, summarising the day.

Robert thanked all the speakers, workshop presenters and delegates for their contributions to an excellent and informative day of discussions. He said that he had only been able to witness a quarter of the conversations but from what he had heard and seen, he felt it had been an excellent event. He highlighted the key themes as:

- Dr Roger Meade's keynote presentation, quoting his adage "you only truly know where you are heading to if you understand where you have come from". Roger gave an important insight into the history of the Humberhead Peatlands designation, land acquisition and why things are what and where they are. Robert commented that we need to ensure that we retain this background information as part of our long term planning and management.

- Tim Kohler's hydrology workshop, where Tim said "we don't deal with the perfect", and went onto explain how the landform has been significantly affected by peat extraction, which requires innovative solutions and careful, pragmatic decision - making to restore the sites.

- Lucy Ryan's nightjar workshop and her use of detailed monitoring information on nightjar foraging behaviour. Robert said, how we had heard fascinating discussions on what good looks like and the importance of seeing NNR's in the wider landscape contexts to conserve the species.

- Dr Richard Smith's invertebrate monitoring workshop, with good conversations on invertebrate sampling structures, techniques and the value of overall habitat quality and health.

- Ed Brightman passion and enthusiasm for the scrub ckearance programme along with the practical on site demonstration of the machinery was absorbing and thought provoking and enjoyed by all.

Robert encouraged delegates to keep these rich conservations going, explaining that the 'End of Project Conference' would follow-up from today's workshop discussions, focusing on the lessons learned from the restoration techniques used, the findings from the European nightjar and invertebrate monitoring, the degraded lowland raised bog's hydrological and ecological response to the works, impact on carbon sequestration and how the good practice could be incorporated into future environmental incentives.

He ended the workshop by thanking delegates for their participation and wished everyone a safe journey home.

"Fantastic mix of people (delegates) and everyone was passionate about their topic. Great day, thanks!"

Workshop Questions and Answers

Workshop One:

Monitoring and tracking our nocturnal nightjars

Question	Answer
Were nightjars on the Humberhead Peatlands when the moors were wet?	Yes. They were first recorded in 1821, on drier areas.
Where are the other nightjar areas in the UK?	Widespread in mostly heath and scrub in England but up into southern Scotland too.
What is the earliest occurrence of nightjars on the moors?	Earliest recorded was on the 10th May (2009) and the latest was on the 25th September (1990). The written record was in 1821.
Where do the birds go to Africa and what's it like where they go to?	They go to Western Sahel and Southern Eastern Africa where they inhabit grasslands, forests, woodlands and wetlands.
What size of area do the birds need to breed and forage?	At least 2 football pitches. In the north of the site is a large breeding area. We are looking at the optimum carrying capacity of Thorne Moors for the birds. This depends on food availability and amount of suitable nest habitat, in our area they are at a lower density, rquiring about 2 hectares of defended territory.
How close are the birds nesting?	On our site 1 in every 5 hectare. This depends on the territory shape, nests can be quite close together but birds forage in different directions, and this can be as close as 200m but more commonly 500m or more.
What are the distances between nest sites, foraging/feeding sites are they longer in the south compared to northern Britain?	There are papers that relate to research carried out in Suffolk/Norfolk foraging with normal range of 1km but in some places 3-4 kms. Distances are less in the South mainly because of better habitat, this can be as little as 1km or here up to 4km.
Do nightjars stay in a tight area?	Usually yes. Once chicks hatch and fledge they go slightly further afield but when the chick has fledged they will move about more.
How do you manage the scrub for the nightjars	We manage the scrub in strips rather than Blocks. We manage the scrub by keeping it at a low density in open drier (heather dominated) areas; typically at 10% in small clumps. Nightjars like to nest on bare areas near the edge of these clumps or on woodland edge, often near fallen trees.

Question	Answer
How long before they fledge?	Two and half weeks.
How many churring males do you have?	There are 33 - 34 on Thorne Moors. 81 for the whole reserve. Around 2% of the UK population. An area with over 1% of any species (breading or not) can qualify as a SPA.
What moths/insects do they eat?	Part of the project is to identify what the birds are eating. Other studies have found they mainly feed on night flying insects such as moths mostly but also many beetles and some flies. The present study aims to find out more specific information.
What's the reason for using tags when you have to re-catch the birds to get the data back?	The tags give us a wealth of data. The weight of these GPS tags is minimal but hopefully technology will have advanced soon to be able to use lighter tags that download the data automatically. The tags do not transmit data if they would be too heavy for the birds. Weights for attachments are set nationally at 2% of the birds' body weight. Technology may become advanced quickly making transmitting tags both lighter and cheaper.
How much do you pay for the nightjar tags?	£300 each but we don't manage to get them all back
Have there been comparable studies in the UK and EU on nightjars?	In Norfolk, Nottinghamshire and Dorset they are running 3-5 year studies. However, they have been using VHF radio tracking not GPS. Other studies in the EU are using radio tracking geo-locations, tracking the birds to Africa, as far as Angola and further south.
How do you attach the tags?	Double side tape, super glue and tied on with dental floss, to a central tail feather.
Do you know why the nightjars go to the colliery site (this was related to the discussion on the nightjars foraging movements)?	The security lights around the area attract moths, and this in turn attracts the nightjars.
What other species do you find in these cleared birch/rhododendron areas?	Stonechats, adders, woodcock, whinchat pass through but don't breed.
Do you get nightingales here?	In the past they've breed on Thorne Moors but nothing recorded since 2010. Nightingales use a different habitat to nightjars, preferring denser willow scrub and woodland edge with some water close by.
How many Marsh Harriers do you have on site?	Up to 3 pairs have attempted to breed with some success in the 3 years. 7 or more may come to roost area outside the breeding season.

Workshop Two:

Evapotranspiration reduction (scrub control) techniques on degraded lowland raised bog

Question	Answer
How are you controlling the rhododendron regrowth?	Cut rhododendron stumps are treated with 20% solution of Roundup Proactive™ ■ Mulched stumps are left to regrow. ■ Any regeneration is treated with a 4% solution of Roundup Proactive™ (glyplosate herbicide) in following summer. ■ May require second or third treatment for fullest coverage/kill.
What do you do if you have Phragmites?	They will be left and these areas are for the NNR to manage. We are currently working ahead of the Water Level Management Plan due to project staff not being in post until 6 months after the project started.
Does the sphagnum grow on chipping arising's?	It will do over time. This method is working in Cumbria who are following a similar technique.
What's the long term impact of leaving mulch?	Cumbria and ourselves are finding mulch can be beneficial in suppressing birch and rhododendron regrowth and keeping understory wet.
Will the oaks and pine trees on the reserve remain?	Yes, as diversity and interest. Our target is the rhododendron and birch, retaining lines and boundary trees.
How much area is the Bobcat mulcher able to cover through heavy rhododendron?	Quarter of a hectare a day.
And through silver birch?	2-4 hectares a day.
What's the maximum diameter tree that can be cut with machine?	5"
Do you leave a control area?	1 area left unintentionally due to very wet area
What is the ground pressure for the Bobcat mulcher?	Approximately 4.4 PSI
How often are the blades on the machinery sharpened?	We get them sharpened every 3 months but the blades will continue to cut after this period
What is the ground pressure of the all-terrain vehicle?	2 tonnes on the front and 2.5 tonnes on the back end.

Workshop Three:

Catering for insect and spider assemblages in lowland raised bog restoration

Question	Answer
Who else is working on wetland peatlands at the moment?	Many peatland restoration porjects in Britain are monitoring vegetation and hydrology, but it is less clear how many are studying invertebrates, other than the recording that takes place on their sites. The Delamere's Dragons project, carried out in the Delamere Forest by the Cheshire Wildlife Trust, is restoring lowland raised bog using the white-faced darter dragonfly, *Leuccorrhinia dubla,* as a flagship species. Another lowland raised bog site complex, the Fenns, Whixal & Bettisfield Mosses NNR, has experience of providing source populations of white-faced darter for re-introduction projects. Recent work in the upland, border mires of the North Pennines has studied the UK endemic, cloud living spider, *Semljicola Caliginosus;* though strictly not a peatland species, it may serve as an indicator of climate warming. Similarly, the muscid fly, *Phaonia jaroschewskii* (the 'Hairy canary') is regarded as an indicator of ideal raised bog conditions in the Humberhead Peatlands.
Are you satisfied with only identifying samples to the taxonomic level of genus?	For the LIFE invertebrate monitoring programme, we are identifying seleceted taxonomic groups to specis level (beetles, flies and solitary bees and wasps, plus some flagship species in other taxa). All other sample material will be kept and , where possible, identified to species too, although the information might not be available within the life of the project. We will depend on expert entomologists to identify this additional material voluntarily, so cannot guarantee deadlines for identification. It would be desirable to only identify indicator invertebrates to a coarse taxonomic resolution, such as genus, if that made monitoring quicker and cheaper. An example might be the genus of wolf spiders (Lycosidae), Pirata, which lives in wetlands and appear in our pitfall traps. We have about five species on the Humberland Peatlands, though some are better indicators of raised bog than others. Theredon't seem to be any obvious candidates among other readily recorded taxa.

Question	Answer
How often do you sample invertebrates?	Invertebrates have been sampled twice per year, in July and September in 2015 and in May and July in 2016, for two weeks on each occasion. Traps are deployed for two weeks because invertebrates can be less abundant on bogs compared to other habitats, due to lower productivity.
What are the trapping seasons?	Ideally monitoring would use just a single sampling session, because it is time consuming and expensive to both deploy traps and identify samples. The July samples should be directly comparable between years, while the May and September samples will help us identify particular invertebrates that occur early or late in the season. Invertebrates would normally be sampled on numerous occasions between May and September, if carrying out site inventories of invertebrates. But for monitoring, it is about gathering the most useful information for least effort. So you may not possess comprehensive information, but have sufficient to measure changes of interest.
What type of invertebrate traps do you use?	Two types: pitfall traps (plastic coffee cups, 1/3 filled with preservative, 100% propylene glycol) for ground active invertebrates, particularly beetles and spiders but also some flies; and water traps (white plastic bulb planters, containing 1 litre of 30:70 propylene glycol:water) for flying insects, mainly flies, solitary bees and wasps plus some spiders, butterflies and moths. At any location, 9 pitfall traps is a standard sampling effort adopted by many studies, so we used these in a grid, or in a line where the habitat was more linear. It is important that the traps are 2-3m apart from one another, so they are not sampling the same piece of ground. Similarly, we deployed 3 water traps at each sampling location, to provide replication, and these were wider apart. As we are exploring the effects of water level change and tree clearance, at each of 8 sampling sites we had paired locations, one among trees and one in open habitat (acting as a control for the tree clearance that took place in the following season).

Question	Answer
How much does it cost to identify the samples?	This depends on how many taxonomic groups are identified to species, which requires expert assistance. The services of 3 invertebrate consultants, some charging at 'conservation' rather than fully 'commercial' rates, cost a total of £5,000 - £10,000 in 2015, to identify pre-sorted samples from pitfall and water traps. That is why monitoring projects have to consider very carefully what invertebrate groups to study, what methods to use and how often to sample. In addition to those costs were about 2 weeks, per sampling session, for deploying and then collecting traps across 8 sites (i.e. 4 weeks per year); then about 130 hours of sorting samples into broad taxonomic groups, 'in house'.
Is there any crossover between invertebrate and nightjar monitoring?	Only indirectly. The University of York PhD student, Lucy Ryan, has been trapping moths, the main nightjar prey, with light traps to understand more about the quality of foraging habitats. Our pitfall and water traps do not sample moths effectively. If light traps are placed in contrasting habitats, e.g. restored peat and drier birch woodland, they may detect differences in the moth faunas, which can be related to the food plants their caterpillars feed on. However, moths can also fly between habitats.
Do you have white-faced darter dragonfly on the site?	There is evidence that it occurred on Thorne Moors more than 100 years ago, but the pools where it is believed to have existed were lost. There are plans by the NNR reserve staff to reintroduce this species to Thorne (see below).

Question	Answer
Are you planning to re-introduce any species?	Unlike other restoration projects, we do not plan to reintroduce Sphagnum mosses because initial restoration on Thorne and Hatfield Moors, since the early 2000s, shows they have recolonized by themselves (especially S. cuspidatum, S. fallax and S. fimbriatum). Chris Meredith, of the Delamere Dragon's restoration project, has visited Thorne Moors and identified extensive habitat that would be suitable for re-introducing the white-faced darter dragonfly. We believe that the site is big enough, and sufficiently stable, for the dragonfly to persist. This is compared to smaller, isolated sites that might require a set of 'stepping stones' to aid colonisation through the landscape. Restoration (more stable water levels at or near the ground surface) should only mean that the extent of suitable habitat increases over time. As the white-faced darter existed previously on Thorne Moors, we do not expect its re-introduction would harm any other species.
Would it not be better to restore the habitat and wait for the white-faced darter to recolonise the Humberhead Peatlands, rather than expending scarce resources on species re-introduction?	This is a very valid point regarding priorities over using resources, although the White-faced darter does not occur in eastern England and so natural colonisation is impossible. It is conceivable that someone could make an unauthorised introduction, as has happened with other insects at the Humberhead Peatlands NNR. We would strongly discourage such an approach, as it could unintentionally introduce other species or diseases. It would also render monitoring and evaluating the re-introduction process difficult. Conservation managers need to consider very carefully re-introductions in relation to other priorities, because they could divert money and staff time from more urgent tasks, e.g. appropriate habitat management or surveillance to prevent the loss of species from a site. On the other hand, a species re-introduction project could produce a 'good news' story and raise the profile of a nature reserve in the local community; harness the effort of volunteers and attract funding that was otherwise unavailable.

Workshop Four:

Managing water levels to recolonise bare peat and cleared areas

Question	Answer
How much for the Water Level Management Plan?	£2.9 million over 5 years, part of which used as match funding to support the LIFE project. Life project then used for other projects
What happens when money runs out at the end of phase?	At end of the plan – all structures will belong to Natural England. But should this should leave us in a good place to run and better control water levels.
What was the peat used for?	Fuel, bedding but more recently for gardens and compost
What depth would it have been cut to?	Not entirely sure – 2m – 4m. Therefore up to 2m of peat taken off.
How does the bund work?	It slows water levels down but will not stop it altogether and it maintains wetter conditions that the vegetation likes. We dig down to a good trench of humidified peat and put poor peat to one side. We use a borrow pit to get at and put on trench. The poor peat is put back on top off the bund to protect the bund surface. We have used some plastic piles in places.
How do you determine how high to make peat bunds?	Raise level of water too much and vegetation drowns, too little and unwanted vegetation grows
How wide are the cuttings?	20-25 ft wide but can be variable
What difficulties do you encounter with piles into bog wood?	Metal piles not too much of a problem, but probing prior to installation was the method used
How flexible are the dams for lowering?	Lot of the larger dams have tilting mechanism on them to give us some flexibility on water levels
During a very wet winter do you have to pump off in a certain amount of time?	Explanation given how water feed in to the River Ouse and how water levels work in terms of high rainfall events. Tim explained how he's been given assurance that the new pumping station has a similar capacity to pump as the old pump. He explained that the pump has a lag period of 1 to 2 weeks on site and that the pump can be set to run at a slower rate so that more water is kept on site rather than being fed in to the River Ouse.
Are you keeping reservoirs?	We've passed the need to do that on Thorne Moors. Hatfield Moors still needs some to some extent.
Have you had any community engagement issues – they have at the Cumbria Life project?	We have had a few adverse comments made on Facebook about the condition of the tracks after contractors have been working otherwise no we have had nobody turn up at events to protest about the works.

Conclusions

The workshop enabled delegates from a variety of organisations and backgrounds to understand aspects of how the LIFE+ Project work is being carried out, helping to bring the lowland raised bog of the Humberhead Peatlands back to favourable conditions.

Perhaps more importantly delegates had the opportunity to ask questions, discuss the techniques being used and share their own experiences with one another.

A range of points emerged from the workshops, which can be summarised under the following groupings:

- Various techniques of scrub control are available from hand cutting through to mechanised flailing; each area requires its own solution dependent on water levels and accessibility. Costs vary accordingly.

- To enable restoration, water levels need to be kept within ±10cm of the peat surface. Water has to be pumped off to avoid excess water but also retained on the site to keep levels within the desired range. Thus the large Archimedes pump, tilting weirs, plastic pile dams and bunding are being used to achieve this objective.

- Nightjars use various habitats on the site, but generally avoid large areas of bare peat and also use some of the surrounding landscape. Studying them is labour and time-intensive.

- Invertebrate monitoring is an important aspect of the project and some standard techniques are available.

Next steps

As always, the key is in the follow-up programme. A number of practical steps are in place to keep delegates, colleagues and practitioners up to date on the techniques and lessons being learned from the work emerging from the LIFE+ Project, including:

- Dissemination of the workshop report

- Bi-annual updates in our scientific newsletter, BogLIFE (a joint publication with our sister LIFE+ Project in Cumbria)

- LIFE+ progress reports and features in our quarterly community newsletter, Moor Space (a joint publication for the Humberhead Peatlands National Nature Reserve)

- Access to essential information on the LIFE+ Project via our website www.humberheadpeatlands.org.uk

- An 'End of Project' Conference, covering the themes:
  - Restoration techniques, including scrub removal, the control of invasive Rhododendron, rewetting and revegetation
  - Response of European nightjars and key invertebrate communities to peatland restoration
  - A degraded lowland raised bogs response to hydrological and ecological responses to the works undertaken
  - The potential impacts on restoring the degraded peat bog on carbon sequestration
  - Incorporating good practice into future environmental incentives

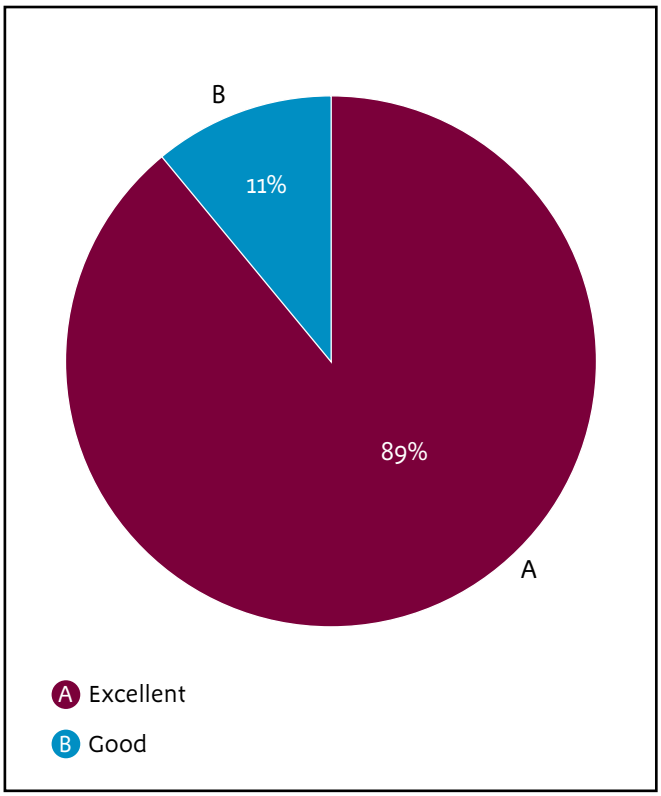
Appendices

Workshop Evaluation

The main reason that people said they came to the Mid-Term workshop was to:

- Find out about current practices in peatland restoration
- Attend workshops that were relevant to their area of work and network with practitioners in the field
- Find out more about the LIFE+ Project.

Delegates rated their overall experience of the workshop with 89% stating it was excellent and 11% good.



General comments left by delegates:

"THANK YOU! As a member of the public, I greatly appreciate this opportunity to learn more about the environment immediately around me. Thank you for making it free, providing lunch and transport, and allowing me opportunities to network and increase my knowledge. Would love to come back for the next one! Thanks!!"

"I'd like to give everyone a round of applause for yesterday – it was so well organised and fabulously interesting"

"One of the most well organised events I've been to. Covered a large amount of information in a very short time"

"An excellent day, very thought provoking and extremely useful. Thanks to all"

"Overall I thought it was a brilliant event and thoroughly enjoyed it. I really hope I can attend the conference next year. It was fascinating to see the site, particularly being able to hear from people who had known it during the early stages of the restoration who were able to describe how it had looked in contrast to how it looks now"

Workshop Programme

Tuesday 27 September 2016

Programme		
Thorne Rugby Club		
09:00 - 10:00	Arrival, registration and Humberhead Peatlands marketplace	An opportunity to browse the marketplace, to meet researchers and local amateurs who have shaped the Humberhead Peatlands, and to discuss with them their work and results. The marketplace will feature a display of the LIFE+ Project. Staff from the Project and National Nature Reserve will be on hand to answer questions ahead of the onsite workshops.
10:00 - 10:15	Welcome and introductions	Paul Duncan, Humber Team Leader, Natural England.
10:15 - 10:40	Opening plenary ■ History (setting project in context) ■ LIFE+ Project	Dr Roger Meade, former Senior Peatland Adviser, English Nature
10:50	Board mini bus to Thorne Moors SAC	
Thorne Moors SAC		
11:15	Arrive at Thorne Moors SAC	Site Guides will accompany delegates throughout the day and guide them to each onsite workshop. A lunch break of 30 mins is scheduled during the day.
Delegates will attend each of the four workshops, covering Scrub Control, Hydrology, Invertebrates and Nightjars. Each workshop lasts approximately 45 minutes.		

Workshop 1		Workshop 2	
Title	Getting to grips with nightjar - Monitoring and tracking nightjars.	**Title**	Don't forget Cinderella! Catering for insect and spider assemblages in lowland raised bog restoration.
Objective	The European nightjar is a sparsely distributed ground nesting bird, with quite specific habitat requirements for nesting. The Humberhead Peatlands is one of the few peatland sites in the country to be designated an SPA because of its nightjar population. This workshop will discuss methods for monitoring these birds during the breeding season and tracking their foraging movements.	**Objective**	Invertebrates contribute the greatest number of species to peatland faunas. They form the foundations of food webs and also provide flagship species to help communicate restoration messages. However, invertebrates are only considered infrequently in restoration projects. This session will explain how to measure the responses of invertebrates during restoration and discuss how their needs can be met.
Topics covered	■ Breeding nightjar surveys ■ Nesting habitat requirements & breeding success monitoring ■ Tracking technology and procedures, data processing, analysis and use	**Topics covered**	■ Habitat requirements of peatland faunas. ■ Monitoring invertebrate assemblages: which ones do you choose? ■ Vegetation descriptions as surrogates for invertebrate sampling. ■ Flagship invertebrates in peatland restoration.
Presenter	Lucy Ryan, doctoral student, York University	**Presenter**	Research and Monitoring Officer, Dr Richard Smith

Workshop 3		Workshop 4	
Title	Evapotranspiration reduction (Scrub Control) on degraded lowland raised bog	**Title**	Managing the water levels to recolonise the bare peat and the cleared areas.
Objective	Learn about the different methods of scrub clearance used and their results.	**Objective**	See and hear how the water levels are controlled by a range of measures.
Topics covered	■ Machinery operations used ■ Motor manual (chainsaw/ chipper) ■ Immediate results and finish ■ Follow up works required	**Topics covered**	■ Pumping station ■ Use of contour bunds to reduce flows ■ Use of dams and sluices on internal ditches and drains, and tilting weirs on principal drains ■ Telemetry control
Presenter	Estate Foreman, Ed Brightman, Estate Workers and machinery contractors	**Presenter**	Tim Kohler, Senior Reserve Manager, Humberhead Peatlands NNR

15:30	Board mini bus back to venue	
Thorne Rugby Club		
16:00	Closing plenary	Robert Burnett, Manager, Yorkshire and Northern Lincolnshire, Natural England
16:15	Close	

Organisation List

- Colleges – Myerscough
- Committee on Climate Change
- Doncaster East Internal Drainage Board
- Doncaster Naturalist's Society
- Environmental Land Management Solutions Limited
- Forest Research
- Individuals (e.g. residents)
- IUCN UK Peatland Programme
- JBA
- Local Authorities - Doncaster
- Masterpile
- Moors for the Future
- Natural England
- National Trust
- Nature Reserves - Little Woolden Moss Reserve
- Penny Anderson Associates
- Richard Wilson Ecology
- Terra Ecology UK
- Thorne and Hatfield Conservation Forum
- Universities – Leeds and York
- Wildlife Trusts – Yorkshire, Lincolnshire, Shropshire, Lancashire, Cheshire

Workshop Speakers

Dr Roger Meade

Roger graduated at Manchester University in 1976, having worked in pharmaceutical industry laboratories for nine years before university. He stayed on to study for and complete a PhD in physiological pathways for nitrogen assimilation in selected mire plants, including wetland bryophytes, and took up a post in the Nature Conservancy Council's (NNC) Wales Field Unit in 1979. After two years he moved to a 'county officer' role in South Wales, then to South Yorkshire in 1986.

Roger's NCC and then English Nature jobs have included county officer (roles such as the identifying and notifying of SSSIs), local team deputy manager and then from 1999 peatland specialist for English Nature until retirement in 2006. He has chaired national groups such as the UK Wetland HAP Steering Group and the JNCC's UK Lead Coordination Network for Lowland Mires, and has visited wetlands with specialists in several countries such as the Baltic States, Germany, The Netherlands, Siberia and New Zealand.

Wetlands have been a common theme in Roger's career, initially inspired as a volunteer for the Cheshire Conservation Trust, in managing a small peatland reserve at Danes Moss near Macclesfield in the early 1970s. Restoration of damaged bogs has been a major interest

throughout, contributing to the changeover from peat extraction to the restoration of some of England's largest sites, such as the Humberhead and South Solway peatlands.

Since 2006 Roger has developed his own consultancy, often working with others such as JBA Consulting Ltd and Rigare Ltd on projects ranging from peatland conservation policy to NVC survey and eco-hydrological interpretations. He also works as a volunteer with the National Trust at Marsden Moor and organised a conference there in September 2015 to explore the role of Purple Moor-grass in upland mire communities and how to diversify the habitat where appropriate.

Lucy Ryan
PhD student, University of York

Lucy began as a PhD student at the University of York in October 2015, studying the foraging and breeding of the European nightjar and has a strong interest in the practical applications of scientific research, to both UK and Worldwide habitat and species conservation. She is working to understand more about their diversity of their movements and their diet, as well as their breeding success and survival.

Lucy began her career in conservation by undertaking a BSc in Environmental studies at Manchester Metropolitan University, graduating in 2007 and moving on to hold positions at Torbay Coast and Countryside Trust, Northamptonshire Wildlife Trust and Dundee Council. She returned to academia in 2012 to complete a Masters by Research in Conservation and Resource Management at the University of Liverpool, concentrating on wading birds and waterfowl in her thesis projects.

Lucy is a keen ringer, and has been involved in several ringing groups and projects both at home and abroad, and hopes to achieve her A permit in a few years' time. Her experience in both practical conservation and academia has resulted in a breadth of knowledge, readily applied to the nightjar project on the Humberhead Peatlands and she hopes to go on to work on other multidisciplinary projects after the completion of her PhD.

Ed Brightman
Assistant LIFE+ Project Manager, Natural England

Ed studied at the University of Leeds, graduating in 2005. Completing his final year dissertation he investigated the relationship between upland drainage and water quality by assessing aquatic invertebrate communities. Following this he volunteered for the then BTCV, leading groups of volunteers on practical conservation activities around the Leeds area.

Keeping the environment and countryside an important part of his career he took a post as an outdoor tutor. Teaching school groups the importance of and diversity of nature.

Ed always had the desire to work on practical conservation, and although his time spent teaching was enjoyable, he moved on to develop those skills working for the National Trust. Completing the NT ranger development

course, involving residential studies at Reaseheath College, he gained a range of machinery operation certificates. Putting these skills into practice across the properties of Hardcastle Crags and Marsden Moor, Ed worked with other rangers and volunteers completing woodland management, access works, upland management and wildlife surveys. This role maintained the teaching skill when leading guided walks, hosting visiting school groups and running holiday activities. Ed Joined Natural England as Foreman for the Restoring the Humberhead Peatlands EU Life+ Project in the early staged in March 2014. This position has since developed into an Assistant Project Manager role. From the initial stages of leading the in house estate Team and completing summer spraying works Ed has taken on writing specifications for and evaluating the large scale clearance work, producing communication materials, attending public information sessions and managing the social media page for the Reserve.

Tim Kohler

Senior Reserve Manager, Natural England

Tim Kohler graduated from Wolverhampton Polytechnic with an Applied Biology degree in 1986. His first job was as a senior botanical surveyor for the Montgomeryshire Wildlife Trust, where he spent 18 months, part paid (via a Manpower Services Commission post) and part voluntary, surveying around 80 second tier wildlife sites. He then moved to the adjacent Shropshire Wildlife Trust, working with second tier sites, and planning casework and ending my year with the Trust preparing management plans for woodlands in the Severn Gorge.

He joined the Nature Conservancy Council in March 1990 as an assistant to the conservation officer covering the West Midlands, again looking at second tier wildlife sites, but this time in a much more urban setting. In April 1991, on the formation of English Nature he moved to Colchester, to become a Regional Urban Officer, covering Essex, Suffolk, Norfolk and Hertfordshire were his role there was

to promote Urban Nature Conservation and involved working with a wide range of partners, both on policy and on practical management of urban sites.

In 1992 Tim moved back to Yorkshire as a Conservation Officer in South Yorkshire, dealing with the full range of English Nature's activities in the County, looking after SSSIs (including Thorne and Hatfield Moors), providing advice on wildlife issues and on planning applications. In late 1998 his role changed to take on Biodiversity issues for the Team, and spent much of the following 4 years encouraging and assisting with the development of Local Biodiversity Action Plan groups and plans. Tim reverted to covering South Yorkshire until the formation of Natural England in 2006, when he took on Agri-environment scheme and SSSI work in the Doncaster area. At the beginning of 2016 he took on the role of Senior Site Manager for the Humberhead Peatlands NNR.

Bryan Wainwright

Reserve Manager, Natural England

Bryan completed his Joint Honours BSc Countryside Management & Ornithology at Bishop Burton College. At the Humberhead Peatlands NNR he is responsible for water level management on the open milled peat areas which involves work on drains with various types of dams and sluices, and use of a large pump, when necessary. He also works with the LIFE+ Project, as part of the SPA requirement for nightjars, helping Lucy Ryan with her tracking research. He leads for the reserve on all bird work. This role covers everything from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monitoring and recording work, particularly for species of conservation concern, to habitat management and helping the ringing group. In recent years much of his time has been taken up with the nesting of cranes and before obtaining this position he was the annual Crane Warden.

Outside the crane breeding season, he did other contracts for Natural England, including four fixed term contracts directly employed firstly by Scott's UK on the bog restoration work for Natural England, then as an Advisor. He has been a volunteer for English Nature and Natural England from leaving school until now, mainly involved with recording work of vertebrates, particularly birds. He has produced annual reports and wrote three papers (as well as co-authoring others) for publication. In his own time he also runs the Thorne Moors Birding Blog (Birding Site Guide) to encourage people to submit records.

During 2006-2008 he spent 21 months in voluntary conservation work in South America, in SE Brazil Atlantic forest and Paraguay. He was for 6 months also a professional bird guide for Mindo Bird Tours, Ecuador, based at Reserva Las Gralerias, Mindo. Following his return to the UK he spent a year as a residential volunteer with the RSPB, first at Dungeness and then at Minsmere.

Dr Richard Smith

LIFE+ Science and Monitoring Officer, Natural England

Richard has been Science and Monitoring Officer on the 'Restoring the Humberhead Peatlands' LIFE+ project since 2015 and is based at the Humberhead Peatlands National Nature Reserve.

He is responsible for coordinating and implementing a range of monitoring activities, in relation to restoration of the peatlands at Thorne and Hatfield Moors. These cover: European nightjar foraging and population size; raised mire vegetation communities; invertebrate assemblages; and ground water levels. In addition, he is overseeing socio-economic assessments of the project, which include studies of ecosystem services and an economic impact assessment.
Richard specialises in entomology and has studied ecology in a diverse range of settings: from the summits of the Cairngorms in Scotland (University of Aberdeen / Institute of Terrestrial Ecology) to urban, domestic gardens (University of Sheffield). A common thread to this work has been understanding the inter-relationships between invertebrates, plants and their physical environments.
Outside research, Richard has worked for Buglife - The Invertebrate Conservation Trust, where he focused on conservation in the UK Overseas Territories and habitat creation projects for insect pollinators. Continuing the theme of entomology, he helped to relaunch the Database of British Insects and their Foodplants online, with the Biological Records Centre (Centre for Ecology and Hydrology). Over many years, he has also studied the risks of alien plant pests for the UK government's Plant Health Service.


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Workshop Technical Papers

Hydrology and the Water Level Management Plan

Making Moor Space Workshop

Tim Kohler, Senior Site Manager Humberhead Peatlands NNR (tim.kohler@naturalengland.org.uk)
Darren Whitaker, Project Manager, JBA Consulting (Darren.Whitaker@jbaconsulting.com)

Abstract
The Thorne Water Level Management Plan (WLMP) develops work previously carried out on the Humberhead Peatlands NNR. The aim is to maintain water levels across a topologically varied site at or around the level of the peat surface. A mixture of surface bunds, fixed plastic pile weirs, controllable dams and a new pumping station are being installed to achieve this.

Keywords
Hydrology, Peat, Dams, Bunds, Plastic Piling

Introduction
The Humberhead Peatlands complex is made up of two large bodies of continuous peat soil, generally referred to as Thorne and Hatfield Moors, but including a number of other named areas, such as Crowle Moor. The site has been highly modified by the action of people, the main changes being the removal of peat and the digging of drainage ditches intended to dry out the site to allow peat removal. The restoration of the site depends on the restoration of a hydrology that at least approximates the original hydrology, the ideal water level being at or around the ground surface level, with flooding being as much a problem as drought. The site is fed only by rainfall, which typically results in having too much water in the winter, and not enough in the summer.

The Thorne Water Level Management Plan (WLMP) has been prepared by JBA consulting for a consortium of Internal Drainage Boards, led by Doncaster East IDB, funded by Central Government (via the Environment Agency) under a National initiative to prepare WLMP for all wetland Sites of Special Scientific Interest. This builds on and develops the work that had already been carried out since the initial handover of parts of the area in 1994.

Challenges
The key challenges are around how to create a stable hydrology on a highly diverse site. Different sections of the site can have a radically different topography, with some almost flat, and others with complexes of cuttings and baulks. The site is divided up into compartments by former trackways, drains and headlands of higher peat, all with different hydrological properties and peat depths. Some trackways and headlands have very low permeability and form dams, while others have weak points and do not provide much of a barrier. It is not always obvious which will form good barriers, and which will not. Neither is it always apparent which drains are connected, and where the mineral layers beneath the peat are clays of varying consistency, generally being soft. This creates significant difficulty for the larger structures, as they do not have a firm base to sit on.

Methods
The first step in the development of the WLMP was to carry out an analysis of the site, looking at: LIDAR images to understand the topography; data from existing water level monitoring and gathering further water level data; weather data (rainfall and evaporation data); soil and geological data; examination of numerous reports on the structure of the peat and how well water passes through it and ecological data.

This was used to create a series of conceptual models of the different parts of the site, and a theoretical model of the surface drainage of

the site. From these a series of interventions were designed. These consist of:

- Surface bunds – these are to slow the rate of water movement across the surface and upper layers of peat, increasing the retention of water on the site, particularly in the upper layers of peat. These are built by digging a narrow trench through the upper layers of degraded oxidised peat to more solid humified peat further down. The trench is then filled with good peat from borrow-pits to create a low permeability barrier;

- Plastic pile bunds – used to reinforce weak points and reduce water flow, these are also used where there is insufficient good peat to form bunds, or conditions are very wet and a more impermeable barrier is needed. They are made of interlocking sections of relatively thin plastic pile;

- Fixed dams, weirs, and culverts – made of plastic or steel piles, these are to try to set specific levels, usually in drains, and to form dams across wider gaps where thin plastic piles or peat bunds would not have the structural stability to contain the water. Where plastic piling has been used this is of a thicker gauge;

- Controllable Dams – these are used in the main drains to allow better control of water flows and are generally quite large engineered structures. They include either removable boards or electrically operated tilting weirs, which will allow us to adjust water levels in the drains. These are powered from solar cells and some are tied into a remote control network, along with some water level monitoring;

- Pumping Station – A new pumping station is to be constructed to replace the existing pump. Although the capacity of the new pump will not be greater than the current one, it will be much more efficient, and have a greater degree of control, allowing a variable rate of discharge as opposed to the current on/off pump. Again this will have the capacity to be remotely controlled.

- A remote telemetry network which gathers data from a number of fixed recording points and allows the remote viewing of water level data and control of some of the adjustable dams and the pumping station via a web portal.

Progress so far...

Around 2/3rds of the planned work has been completed over the last 2 years, and the remaining works should be completed over the coming winter. Savings on some parts of the project will allow some further works which are currently in the planning stage.

Lessons learned so far...

One of the main lessons is that we don't understand the site as well as perhaps we thought we did! Some of the dams have shown that water was actually flowing in a different direction to the one we thought, and some dams have had greater or lesser effects than anticipated. Although the theoretical models have been very helpful, they don't give all the answers. The challenges of constructing the larger structures on the soft, underlying geology, required many of the originally designed steel pile structures to be changed for plastic ones, the steel ones being much heavier and at risk of sinking into the clay. This is at the cost of design life of the structures which has been reduced, although in practice it is probable that the plastic structures will actually last as long as the steel ones would have.

Next steps

The main activity is to complete the remaining planned structures, and any further works the budget will allow. There will then be a period of settling in, while we monitor the performance and impacts of the structures and see whether they are doing what we thought they would do. We will probably require an extended period of tinkering to get the best out of the system.

Catering for insect and spider assemblages in lowland raised bog restoration: a case study from the Humberhead Peatlands

Making Moor Space Workshop

Richard M Smith,
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Abstract
Invertebrates contribute the greatest number of species to peatland faunas. They form the foundations of food webs and also provide flagship species to help communicate restoration messages. However, invertebrates are only considered infrequently in restoration projects. The invertebrate assemblages of Thorne and Hatfield Moors were studied in relation to rewetting and scrub clearance. Sampling focused on the standardised techniques of pitfall and pan trapping, to obtain baseline assessments of beetles, spiders and flies. Results will be analysed in relation to defined acid mire assemblages, using PANTHEON, a new web-based tool for conservation practitioners. The trade-off between effort and resource requirements in invertebrate monitoring is discussed.

Keywords:
Lowland raised bogs, peatland restoration, invertebrates, insects, spiders, flagship species.

Introduction
The principal, and crucial, focus of lowland peatland restoration is usually reinstating an appropriate hydrological regime. This may be accompanied by removing tree cover, which reduces water losses and allows the original vegetation to re-colonise. Restoration may also include the reintroduction of plants, such as Sphagnum mosses, to accelerate the re-establishment of peat forming vegetation. Once these vital steps have been reached, what next? Monitoring should show the peatland's recovery if the correct conditions are maintained. But what of the animal populations that constitute an intact bog ecosystem?

Most animals in peatlands are invertebrates, holding varied and often complex relationships with plants and other members of food webs. Certain invertebrates evoke the spirit of peatlands, be they dragonflies, butterflies, spiders or – less welcome – biting flies! Which ones survive in degraded bogs and which ones are likely to return following restoration? Answering such questions requires restoration projects to understand the needs of invertebrate assemblages.

The 'Restoring the Humberhead Peatlands' LIFE project offers an opportunity to study the acid mire invertebrate assemblage, and share its results with other practitioners. One of the project's objectives is to monitor how invertebrates respond to two restoration activities: scrub clearance and raising water levels. This is being achieved through field sampling before and after restoration works take place.

Challenges
Which invertebrates do you study?
Choosing which invertebrates to focus on during restoration is a conundrum: projects need to identify key species that may be special to a site as well as the assemblages characteristic of acid mires. This will depend on what records already exist. Although lowland mires may be relatively species poor compared to other habitats, they support a disproportionate number of threatened species, due to historic losses of the habitat. Many sites will be designated as Sites of Special Scientific Interest (SSSI) and, where invertebrates are a 'designated interest feature' – either as individual species, a taxonomic group, or as a broader assemblage - they will require invertebrate monitoring as part of the assessment of favourable condition (JNCC, 2008).

The Interpretation Manual of EU Habitats (EU28, 2013), covering the range of peatland Priority Habitats, contains a smattering of indicator invertebrates for active raised bogs only. These comprise fewer than 20 dragonflies, butterflies, spiders, ants, and grasshoppers / crickets.

The 'Review of the Invertebrate Assemblage of Acid Mires' (Boyce, 2004) is more informative, at least for England. It covers British invertebrate groups reasonably thoroughly, covering dozens of species that have close associations with mire habitats. More importantly, it explains which features of mires are important for particular suites of species: this provides real ecological insights into the requirements of invertebrates.

Practicalities of monitoring

The other main challenge of invertebrate monitoring is a practical one: time and resources. Comprehensive invertebrate surveys often recommend numerous sampling visits during the active season (roughly May to September); although a single session in summer may suffice for monitoring peatland assemblages (Drake et al., 2007). This is the good news. Carrying out in-depth sampling, using standardised trapping, takes time to deploy traps and then sort and identify samples. It may take up to 6 months to assemble the results of sampling, as invertebrate specialists often identify material over the winter season.

Methods

A programme of pitfall and pan trap (or water trap) sampling was used for baseline (2015) and follow-up (2016) invertebrate surveys. Eight sites were selected as replicates, four on each of Thorne and Hatfield Moors. At each site, traps were placed at two sub-sites: one with existing tree cover in 2015, which would be cleared in 2016; and one without tree cover, to act as a control. This allowed the effects of scrub clearance and water level change to be separated. The same sites were used for fine-scale vegetation monitoring, so that changes in the invertebrate assemblage could be interpreted in relation to vegetation change.

Each sub-site was sampled with 9 pitfall traps and 3 water traps. These were deployed for a fortnight at a time, in July and September 2015 and May and July 2016. Traps were spaced about 2-4m apart to capture small scale habitat variation. Pitfall traps were pinned down in saturated ground to stop them floating out, e.g. in Sphagnum lawns. Bog pools were absent from most sampling sites, so were not included, but they do support an important aquatic assemblages of beetles and bugs.

Progress so far...

For each sub-site, samples of the 9 pitfall and 3 water traps were bulked across trap type for analysis. So, altogether, the two survey periods in 2015 and 2016 generated 64 invertebrate samples each. The 2015 samples were sorted into broad taxonomic groups over winter in 2015 / 16, producing more than 500 sub-samples. Beetles, spiders, flies and solitary bees and wasps were identified by specialists between January and May 2016; more than 100 spider and 130 beetle species were identified.

Changes at monitoring sites will be analysed in relation to the composition of the assemblages and the number of species associated with acid mires. This will use Natural England's ISIS tool (Invertebrate Species Habitat Information System, Drake et al., 2007) which scores invertebrate species lists according to Broad and Specific Assemblage types (BATs and SATs). The BAT for Thorne and Hatfield is Permanent wet mire (W31), which includes the SATs Open water in acid mire (W311) and Sphagnum bog (W312) (Lott et al., 2007). The target for defining favourable condition is 6 Sphagnum bog species.

New software, called PANTHEON, is due for launch as an online tool in 2017, in conjunction with the Biological Records Centre. It incorporates ISIS and extends the analysis of assemblages. Species can be classified hierarchically, in relation to their habitat and resource requirements.

One of eight invertebrate monitoring sites, before and after invasive rhododendron was cleared (Cassons Gardens, Thorne Moors, July 2015 and July 2016).

Lessons learned so far...

Cost-effectiveness

Invertebrate sampling has been a substantial undertaking: each trapping period required a minimum of 8 days for one member of staff to deploy and recover traps (thus approximately 4 weeks in each of 2015 and 2016). This excluded time required to source, purchase and assemble equipment. Sorting and labelling the 64 samples from 2015 required about 1.5-2 hrs per sample, for a trained member of staff. This amounted to 13-17 days of sorting, which could not be done continuously due to a risk of repetitive strain. The key taxonomic groups – beetles, spiders, flies and solitary bees and wasps – were identified by three separate specialists, at a total cost of £11-12k.

Although invertebrate studies have been an objective of the LIFE project, it is unlikely that the same intensity of monitoring could be sustained by the nature reserve's staff or budget in future. Examination of the species occurring in multiple sampling periods – May, July and September – will show which taxa would best serve as narrower targets for monitoring. Alternative approaches are possible, such as monitoring habitat features or indicator species (see 'Next steps' below).

Coverage of the invertebrate assemblage

The Humberhead Peatlands NNR is the headquarters of three key species of Sphagnum bog invertebrates, which occur virtually nowhere else in Britain: the Thorne pin palp ground beetle (*Bembidion humerale*); the mire pill beetle (or 'bog hog', *Curimopsis nigrita*); and a fly in the same group as house flies, the 'hairy canary' (*Phaonia jaroschewskii*). All are poorly detected by the trapping techniques used to explore the effects of scrub clearance and rewetting, but they remain priorities for monitoring. Therefore specific surveys will be needed to monitor the occurrence and population sizes of these species.

A sense of perspective is required in monitoring the invertebrate assemblages of large sites. On the Humberhead Peatlands, Hatfield Moors (1,400ha) and Thorne, Crowle and Goole Moors (1,900ha) together form the largest lowland, raised bog complex in the UK. Despite the extensive damage caused to the Moors by peat extraction, the reserve contains a wide diversity of habitats within and around the raised bog. Some are the result of human activities over the centuries. Together, they form a rich, semi-natural landscape that has maintained habitat continuity over a long period. This is perhaps why more than 5,000

invertebrate species have been recorded. So the value of the reserve for invertebrates lies not just in the acid mire assemblages, but in ancient woodland, wet woodland, saline and heathland ones too.

Next steps

Assessments of vegetation

To make invertebrate monitoring more cost effective, it is necessary to consider alternative approaches. Indirect assessment of assemblages, based on an understanding of their habitat needs, is one option. Important features to monitor in acid mires are the presence of: open Sphagnum lawns; grass, rush, or sedge tussocks with associated litter; ericaceous dwarf shrubs; scattered trees and scrub; and bare, wet peat (Boyce, 2004). These features are already monitored when making Favourable Condition assessments of vegetation and there is scope to relate them to the invertebrates identified in sampling. Similarly, positive and negative plant indicators for raised bogs are measured during Favourable Condition assessments. These too could be linked to invertebrates, e.g. the presence of bracken, birch and extensive heather would be indicative of conditions being too dry for the W312 Sphagnum bog assemblage.

Flagship species

Invertebrates have great potential to communicate messages about lowland bog restoration. There are some charismatic species that non-specialists can relate to, such as the white-faced darter dragonfly, *Leucorrhinia dubia* of bog pools; the raft spider *Dolomedes fimbriatus*, of the lagg fen zone; the bog bush cricket, *Merioptera brachyptera*, typical of wet heath; or large heath butterfly, *Coenonympha tullia*. This latter species, whose caterpillars feed on cotton-grasses Eriophorum, is largely restricted to mire habitats in the northern half of Britain. Although it is considered a poor disperser, it has spread to previously milled peat areas within 10 years on Thorne Moors.

Such flagship species are attractive to citizen science. They potentially harness the support of experienced amateurs, who can improve the sustainability of monitoring efforts by linking them to national schemes, e.g. the Butterfly or Dragonfly Monitoring Schemes.

Species reintroductions

In many cases of bog restoration, invertebrates will have already been lost and are unlikely to return. Although suitable breeding habitat may have been recreated in sufficient quantity, potential source populations are unable to recolonize. In such situations species reintroduction may be desirable. Well planned reintroductions have been achieved for the white-faced darter at Fowlshaw Moss in Cumbria (Cumbria Wildlife Trust, 2010) and in Cheshire's Delamere Forest (Meredith, 2015). Unfortunately, well-meaning but unauthorized reintroductions of the large heath butterfly have occurred on the Humberhead Peatlands, at Hatfield Moors.

Collating evidence

There appear to be relatively few projects that collect direct evidence of the effects of restoration on invertebrates, e.g. Slamannan Bog restoration project (Buglife, 2015). Therefore the current LIFE project will collate the available evidence to contribute to case studies for other practitioners.

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Evapotranspiration Reduction (Scrub Control) on Degraded Lowland Raised Bog

Making Moor Space Workshop

Edward G. Brightman, Natural England,
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Abstract
The LIFE+ project aims are to clear 572ha of scrub, comprising 234ha on Hatfield Moors, 338ha on Thorne Moors, including 200ha Rhododendron colonisation. This ranges in varying degrees of density from total cover mature rhododendron, rhododendron under birch scrub to scattered small birch and willow. This is to be cleared through the use of a combination of contract works and an in-house estate team. Methods ranged from motor manual cutting, mechanised flailing and chemical treatments.

Keywords
Scrub, Trees, Clearance, Control, Evapotranspiration, Rhododendron, Birch, Chipper, Flail, Mulcher, Chainsaw, Glyphosate, Bog, Peat, Tracks, Vegetation.

"The rhododendrons stood fifty feet high, twisted and entwined with bracken, and they had entered into alien marriage with a host of nameless shrubs, poor, bastard things that clung about their roots as though conscious of their spurious origin."
Rebecca by Daphne du Maurier

Introduction

Following the withdrawal of peat winning, much of the Peatlands of Thorne and Hatfield Moors were left dry and bare from the drainage and extraction of peat. This was ideal for the colonization of scrub, particularly the windblown seeds of birch and encroachment of neighbouring colonies of rhododendron. With the moors becoming the ward of what is now Natural England, in order to restore the lost bog habitat, early works were done to block drains and saturate the peat surface. In some places this drowned out some scrub. However due to the resilient nature of the colonizing trees and their ability to pump water from the ground and out through their leaves, they continued to thrive, modifying the ground conditions to the detriment of the mire species – sphagnum, cotton grasses and others. In areas where the bog flora has remained or returned since earliest works ceased, this encroachment has a shading effect, suppressing the development of the bog. With funding through the EU LIFE+ Project we are able to reverse some of this process, using a skilled team of estate workers alongside, specialist equipment developed by contractors. Predominantly, this is the use of wider tracks on vehicles allowing the team to travel and work on the soft wet peat that still remains the main substrate across the Moors. These methods are based on the experiences of other sites where restoration work has been carried out, but due to its size; work on the Humberhead Peatlands held its own unique challenges.

Challenges

Many challenges faced the project, from the initial stages and throughout, ranging from administrative issues, site logistics, weather and species considerations. From the first season of clearance work (winter 2014/2015), the estate team was only fully appointed in February, leaving a few weeks of working at full capacity. Regarding contracting works, NE procedures required the use of a framework contract, which was delayed by 6 months. Due to the late delivery of the framework, for the second season works (winter 2015/1016), there was emphasis on the contractors technical capacity to deliver the work, above overall cost. This had an impact on our remaining budget for the following seasons' works, but it meant that the targets set for that phase of the project were achieved.

These delays put us a step behind parallel works being done on site including water level management. This had the effect of raising water tables within compartments due for clearance, along with a very wet winter. Moving across the work site became more challenging. High water levels also impacted on access tracks which led to more time required for ongoing repairs.

In general the site logistics are a challengedue to the size and topography of the NNR including; the distance to the work site from the NNR office base, distance across the work site on peat/clay tracks and large areas of impenetrable vegetation within compartments. All of these issues make it difficult to move around the sites for both assessment and work.

With the Reserve being such a vast area and refuge for wildlife, there were other stakeholders involved in the process. Concerns were raised over the archeological value of rhododendrons on site being linked to a nursery belonging to a renowned local Victorian horticulturalist located adjacent to the moors. This had to be investigated and negotiated to facilitate the eventual clearance of one site. Species considerations also had to be made including leaving exclusion zones around badger sets and bog myrtle being left for careful cutting by NE staff.

Methods

The clearance work has been conducted using contractors and the NE estate team, applying different methods tackling different vegetation types. Vegetation was categorized into two density types; dense birch and rhododendron at greater than 60 percent cover, and scattered birch and rhododendron of less than 60 percent cover.

Contractors were following the specifications:

Method 1: Hand cut birch and willow to retain 10% cover in scatter trees, clumps and lines as specified by the project officers, enhancing Habitat for Nightjar and removing all rhododendron. Windrow heavy birch cover, treating all cut stumps with Roundup ProActive™ at 10% solution. This motor manual cutting was done using chainsaws and clearing saws.

Method 2: Flail all scrub to ground, reducing all timber to chip. In continuous-cover rhododendron and birch scrub. Several 360 degree excavator mounted flails on 1.2m tracks, a self-propelled tracked forest mulcher and tracked side by side ATVs for access.

The Natural England Estate Team carried out various works including:

- Foliar spraying on 4% solution Roundup ProActive™ on Rhododendron.
- Cut and windrow birch and stump treatment of 10% solution Roundup ProActive™.
- Cut and chip rhododendron and birch and stump treatment of 10% solution Roundup ProActive™.
- Trial of mechanical operations.
- Track repairs, preparing access routes.

Equipment used:

- Softrack with Berti flail or Bush Hog mower.
- Bobcat flail mulcher.
- Dual wheel tractor with bush hog.
- Wheeled side by side ATV.
- 9 inch diameter Vari-track Chipper.
- Chainsaws –Stihl MS261 MS201.
- Clearing saws - Stihl FS560C.
- Tractor or Softrak mounted Allman Farmer 200 sprayer, running x3 spraying lances.
- Berthoud Knapsack sprayers (full cone nozzle) x 3
- Tree Popper

Progress so far...

The project milestones towards the final target of 572ha of scrub clearance were that by 31st March 2016, (the end of the second winter felling season), 188 hectares on Thorne Moors and 134 hectares on Hatfield Moors would be cleared.

Up to this milestone date, 158.2 hectares had been cleared on Thorne and 154.1 hectares cleared on Hatfield.

In more detail; in the winter season (18th August 2015 to 31st March 2016) contractors cleared 61.7ha on dense scrub, with the Estate Team clearing 18.5ha of dense scrub and 46 hectares of scattered scrub on Thorne Moors. In the same season, contractors cleared 29.5 hectares of dense scrub and 43 hectares of scattered scrub, with the Estate Team clearing 3.1 hectares of dense scrub and 64 hectares of scattered scrub on Hatfield Moors.

With additional works by small contracts issued up to 31st March 2015, a further 32 hectares of clearance completed on Thorne Moors and 14.5 hectares clearance on Hatfield Moors.

Summary

Clearance Works completed 18th August 2015 to 31st March 2016 (Hectares)				
Thorne	**Contractors**	**Estate Team**	**Total**	**Target 2017**
Dense	61.7	18.5	80.2	
Scattered	0.0	46.0	46.0	
Combined	61.7	64.5	126.2	338
Hatfield				
Dense	29.5	3.1	32.6	
Scattered	43.0	64.0	107.0	
Combined	72.5	67.1	139.6	234

Outputs & Targets

Works to March 2015	Works to March 2016	Milestone	Target	Remaining
Thorne				
32.0	158.2	188.0	338.0	179.8
Hatfield				
14.5	154.1	134.0	234.0	79.9

Following the winter clearance, the scrub control continued across Thorne Moors through the summer treating rhododendron regrowth with herbicide. The target for the 30th September 2016 is to cover 92 hectares of regrowth. To the end of August this year, 42 hectares of regrowth has been treated. This shortfall against the target is due to the lack of rhododendron cleared in the first year of the project. The rhododendron did not have time to regenerate sufficiently to facilitate treatment in the spring and summer immediately following the 2016 clearance.

Lessons learned so far...

Clearly, we have learnt a lot including:

- When and where best to use in house resources and external assistance.
- Understanding what water levels can do to reducing contractors accessibility within and between compartments.
- What impact a raised water table can do to a previously hardy, vegetated peat track.
- Underestimating the time to assess sites sufficiently for writing accurate specifications.
- Accurate maps of area sizes for contracts to avoid late contract changes.
- Reliance on machinery and its tendency to break down or be unavailable.
- Government procurement rules and timescales, which can be frustrating, but necessary.
- Liaison and involvement of stakeholders for guidance on sensitive sites.
- Familiarity with traversing bogs on foot, requirement for use of waders!

Next steps

The focus over recent months has been on completing scrub clearance works, including planning the work of the Estate Team and writing/letting contracts for the remaining works.

The targets outlined above have been allocated to both contractors and the Estate Team, with the estate team focusing their efforts on Thorne Moors, leaving the remaining areas on Hatfield to be worked by contractors.

Until the end of September 2016, spraying will continue with the Estate Team when conditions allow maximise progress. With the shortfall in the spraying completion this year, there will be enough rhododendron regrowth earlier in the season to be able to catch up with the targets set for the project.

Contractors using excavator flail machines, working through continuous mature rhododendron.

Estate team working in more sensitive areas of the Reserve where trees were cut, stumps treated and arisings chipped.

Getting to grips with the goatsucker; monitoring our nocturnal nightjars:

Making Moor Space Workshop

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Abstract
The European Nightjar is a migratory, sparsely-distributed bird that breeds in the UK, with quite specific habitat requirements for nesting. This is one of the few peatland sites in the UK to be designated an SPA because of its nightjar population, with around an estimated 80 churring males (Middleton, 2016). Habitat manipulation on-site for peatland restoration has implications for the nightjar population and detailed monitoring is necessary for future management. Monitoring methods include surveys for presence of breeding territories, nest searching for breeding locations and tracking with the latest GPS tag technology to understand their foraging movements.

Keywords
Nightjar, tracking, GPS.

Introduction
The European nightjar (*Caprimulgus europeaus*) is a ground-nesting bird which maintains a wide breeding range across the whole of Europe (Cramp 1985). They migrate annually from Africa to breed in the United Kingdom on areas of heathland, lowland moorland and peatland and areas of rotationally managed coniferous forest (Cramp 1985). They have recently been downgraded from 'Red' to 'Amber' listed in the 2016 Birds of Conservation Concern Report, as a result of some population stabilisation following a sharp 50% decline in both numbers and range (Eaton et al. 2015). Although numbers appear to have stabilised, significant range expansion has not been seen, and the specific habitat requirements and how the birds disperse to new sites, are not yet fully understood.

The Humberhead Peatlands is designated as a Special Protection Area (SPA) as a result of the nightjar population on both Hatfield and Thorne Moors. Nightjars are generally surveyed following a standard churring male protocol (Cadbury 1981), but numbers of churring males are not always representative of breeding pairs present as although many males churr and defend territories, they do not always have partners and so are not 'breeding' (Sharps et al. 2015). Using this standard method, there were estimated to be 34 churring males on Thorne and 31 on Hatfield.

The nightjar monitoring element of the LIFE+ project is being undertaken as a partnership between Natural England and the University of York, in the form of a PhD studentship which commenced in 2015. Fieldwork is primarily undertaken by a NERC-funded PhD student Lucy Ryan, with support from Natural England volunteers and University of York field assistants, and consists of surveying, catching and tagging nightjars, as well as locating nests to ring chicks and measure productivity.

Challenges
The primary challenges of the project are:

- to identify breeding territories of churring male nightjars
- to capture and tag free flying birds
- to recapture the tagged birds to obtain data on their movements
- to locate nests of these cryptically camouflaged birds in a difficult to navigate habitat.

Methods
Nocturnal churring male surveys were carried out at the start of the season to identify

breeding territories across both Thorne and Hatfield Moors. A small team (a minimum of two people for both accuracy and health and safety) conducted the surveys at dusk when nightjar activity is at its highest (Cadbury 1981). We walked areas of suitable habitat and identified churring males. These were marked with a GPS unit and on a map. Particular types of behaviour were recorded, with special interest paid to short churring bouts followed by their distinctive 'bubbling' call, which indicates the presence of a female and therefore a potential breeding pair.

Once breeding territories had been identified, these areas were then targeted for mist netting, tagging and nest searching, particularly if a male had been seen interacting with a female. Areas were suitable for catching if mist nets could be erected in a sheltered area, with dark background vegetation, so that the nets were less visible. Areas were visited from 19:45 onwards, in order to set up a minimum of three nets prior to dusk, which varied from 21:30 to 22:10 in midsummer.

Each catching team consisted of at least one British Trust for Ornithology (BTO) licensed ringer. Ecotone 30 and 44mm mesh nets were set up by the team, with minimal noise to reduce disturbance. Once set, the team moved away from the nets to a sheltered position to avoid being seen too much by the birds. Tape lures were used, under special licence from the BTO, to play male churring and contact calls, to attract territorial males present in the area to the nets. Once a bird was caught, it was fitted with a BTO standard metal ring and processed. A number of biometric measurements are taken, such as wing length, weight, fat and pectoral muscle score, head and keel length.

A subset of birds were then fitted with a Pathtrack Nanofix GPS tag, weighing between 1.75 and 1.8g, in order to collect information on their movements over a period of 5-6 days. These are archival tags, meaning they need to be retrieved in order to download the data that has been collected; birds therefore need to be recaptured.
Nests were located by walking systematically across an area where nightjar breeding activity had been identified from nocturnal surveys. Bamboo canes were used to rustle and disturb the vegetation in order to flush a female from the nest. A minimum of two people were again needed. If a nest was found, the location was recorded on a GPS unit, the site was photographed and the number of eggs or chicks was noted, as well as time, date, weather and habitat type within 1.5m of the nest site. Nests were revisited a minimum of 7 days later, if eggs were present. If chicks were present, an estimate of hatching date was made and then the nest was revisited when the chicks would be suitable for ringing (c. 9 -10 days old) and then again within the next 10 days to see if the chicks had fledged.

Progress so far...

Fieldwork during 2015 and 2016 has been very successful, with a total of 71 birds caught and ringed, which includes adults, fledged juveniles and chicks in the nest. Seven tags were deployed in 2015 and four were retrieved (three males, 1 female). 21 GPS tags were deployed in 2016 on six females and 15 males; 11 of these were retrieved from two females and nine males.

Nest searching has proved difficult, because females sitting on nests are extremely hard to locate, due to their cryptic and complex camouflage. Five nests were located in 2015, with three of these successfully fledging. In 2016, by focusing on areas in which we had seen displaying males during our nocturnal surveys, 11 nests were found although only five of these fledged young. All surviving chicks were ringed. Unsuccessful nests all failed at egg stage, although cause was almost always unknown.

Lessons learned so far...

The identification of specific nightjar breeding behaviour, particularly the differences

Nightjar summer visitors to Hatfield Moors.

Nightjar nest located in bracken on Thorne Moor.

between paired and unpaired nightjar males, has been very useful. Introducing nocturnal surveys in 2016 allowed the team to concentrate on this aspect of the fieldwork, which provided important information. Differentiating between birds with long churring bouts and few elements of displaying behaviour, and those with short churring bouts and specific contact calls, enabled us to use our time more efficiently, particularly with regard to searching for nests.

Next steps

Nightjar monitoring on the Humberhead Peatlands will continue beyond the LIFE+ project until 2018. We are aiming to deploy another 30+ tags on both sites, in order to explore the birds' responses to the habitat management that will take place over the 2016/17 winter season. By continuing into 2018, we will be able to observe further changes as succession starts to occur in the cleared and rewetted areas of the NNR.

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Common cotton grass on the Humberhead Peatlands
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