

Institution: Edge Hill University		
Unit of Assessment: A5 Biological Sciences		
Title of case study: Grassland conservation; research and action into the sympathetic restoration, re-connection and management of UK grassland habitats.		
Period when the underpinning research was undertaken: 2012 – 2018		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Prof Paul Ashton Dr Ian Powell Dr Anne Oxbrough	Prof of Botany Senior Lecturer in Ecology Reader in Ecology	Sept 1994 - present Sept. 1993 - present Dec 2012 - present
Period when the claimed impact occurred: 2017 - 2020		
Is this case study continued from a case study submitted in 2014? N		
1. Summary of the impact		
<p>The UK's grasslands of high nature value, including upland calcareous grassland and hay meadows, have been in serious decline for the past 60 years. Research into the impacts of management of these two grassland types at Edge Hill University has led to upland calcareous habitats being managed for invertebrate conservation for the first time. It has resulted in the extensive hay meadow restoration in North West England to incorporate landscape scale connectivity. Finally, it has contributed towards changing priorities when identifying outcomes for agri-environment funding. The research data also provides a benchmark and target for future conservation action.</p>		
2. Underpinning research		
<p>Grasslands of high nature value, including upland calcareous grassland and hay meadows, are amongst the most biodiverse habitats in Europe. The UK has a significant proportion of Europe's upland calcareous grassland and UK hay meadows are unique in their plant composition. Post-war agricultural intensification has resulted in the reduction and fragmentation of such grasslands. This has had various negative effects on biodiversity: i.e., in community composition, species number, genetic diversity and connectivity. These issues inspired a body of research at EHU, utilising both upland calcareous grassland and hay meadows, into the impact of current management methods, the extent of long-term change at local and landscape scale and effective methods to restore such grasslands. The work has been led by Prof. Ashton with significant support throughout from Dr. Oxbrough and Dr Powell. The aim was to enable scientifically informed conservation of these habitats to be undertaken.</p> <p>Natural England (NE, the statutory conservation body) wanted to know whether managing grassland for plant diversity has a positive effect on the biodiversity of other taxa, as is commonly assumed. This request for information formed the basis of the Upland Calcareous Grassland Project. The uniqueness of the project derived from its focus upon invertebrates. These are typically ignored in studies of conservation management impact. Using surveys of both vegetation and invertebrates, in areas of contrasting habitat and management, the project found that: low intensity sheep grazing, cattle grazing and the absence of grazing all benefit conservation, though the beneficiaries vary (R1); plant species composition is not a suitable proxy for carabid beetle assemblage (R1); non-target habitats such as heathland and acid grasslands in the upland matrix house distinct spider assemblages each with different rare species (R2), while targeted habitats had distinct spider assemblages in each grazing regime (R3). As a whole, the research indicates that low intensity conservation grazing, in addition to no grazing, should be promoted across upland calcareous grassland landscapes to maintain habitat heterogeneity and hence biodiversity.</p> <p>Understanding the extent of the change in hay meadows through the quarter century duration of Agri-Environment schemes (AES) and assessing the effectiveness of restoration approaches, required botanical surveying and comparison with historical data (R4) or donor meadow data (R6). The study of long-term impact of AES had been neglected, this study being timely due to likely change of AES funding. This restoration study (R6) considered the rare upland meadows, most</p>		

previous studies focussed upon lowlands. Distinctively, it incorporated a spatial context, assessing whether proximity to potential donor sites was a contributory factor to success.

The landscape connectivity work was undertaken using genetic markers on a key meadow species, *Rhinanthus minor* (Yellow rattle; R5) sampled from the landscape matrix in representative areas of both the uplands and lowlands. This is an insect pollinated, annual plant; characteristics that make it highly sensitive to landscape fragmentation. This addressed the gap in the understanding of how fragmentation of the UK's grassland landscape had impacted upon meadow plant connectivity. There is no comparable study, despite such knowledge being central to implementing the shift from site specific to landscape scale conservation advocated by The Lawton Report (2010).

These studies showed that AES schemes have been largely effective in maintaining diverse plant communities over their 25-year lifetimes, but meadow homogeneity had increased, with some loss of rare species (R4). Green hay transfer is an important step in upland hay meadow restoration (R6) but does not yield a full complement of meadow species, with additional measures required if restored communities are to more closely resemble the reference donor sites. Proximity to other high nature value grasslands had no impact upon post restoration community composition.

Genetic diversity in upland and lowland regions has largely been maintained (R5). However, population differentiation was higher in the lowland region, implying reduced connectivity. Conservation strategies aimed at retaining connectivity should maintain large populations and also focus upon existing and additional species-rich grassland fragments, particularly in areas of intensive land-use.

3. References to the research

Note. All the following were published in peer reviewed journals considered to be of international reputation within the field.

R1. Lyons A., Powell I., Ashton P.A. and Oxbrough A. (2017) "Impacts of contrasting grazing management on plants and carabid beetles in upland calcareous grasslands" *Agriculture, Ecosystems and Environment*, 244: 22 – 34. <https://doi.org/10.1016/j.agee.2017.04.020>

R2 Lyons A., Powell I., Ashton P.A. and Oxbrough A. (2017) "Habitat associations of epigeal spiders in upland calcareous grassland landscapes: the importance for conservation" *Biodiversity and Conservation*, 27: 1201-1219 <https://doi.org/10.1007/s10531-017-1488-4>

R3 Lyons A., Powell I., Ashton P.A. and Oxbrough A. (2018) "Epigeal spider assemblage responses to vegetation structure under contrasting grazing management in upland calcareous grasslands" *Insect Conservation and Diversity* 11; 383-395 <https://doi.org/10.1111/icad.12287>

R4. Sullivan, E., Powell, I., & Ashton, P. A. (2018) "Long-term hay meadow management maintains the target community despite local-scale species turnover" *Folia Geobotanica*, 53; 159-173 <https://doi.org/10.1007/s12224-018-9322-7>

R5 Sullivan, E. R., Barker, C., Powell, I. & Ashton, P. A., (2019) "Genetic diversity and connectivity in fragmented populations of *Rhinanthus minor* in two regions with contrasting land-use" *Biodiversity and Conservation*. 28; 3159-3181 <https://doi.org/10.1007/s10531-019-01811-x>

R6 Sullivan, Elizabeth., Hall, N., & Ashton, Paul. (2019). "Restoration of upland hay meadows over an 11-year chronosequence: an evaluation of the success of green hay transfer. *Restoration Ecology*, 28(1); 127-137 <https://doi.org/10.1111/rec.13063>

4. Details of the impact

The conservation of Europe's high nature value grasslands is a significant component in the maintenance and restoration of native biodiversity and landscape protection. The Edge Hill grassland research has influenced such work through dissemination, liaison and partnership between researchers, their work, and conservation practitioners, through collaboration with the relevant government body (Natural England), statutory and locally designated land (National Parks, AONBs and SSSIs plus LNRs) and NGO stakeholders (e.g., Lancashire Wildlife Trust and the National Trust).

Alongside the peer reviewed academic output (R1-R6), wider dissemination of the work amongst stakeholders and interested parties was undertaken in various ways. Edge Hill facilitated conferences and workshops (see **E1** and **E2** below). This included the Edge Hill Grassland Conservation Conference (**E1**) in 2017 which was attended by conservation practitioners from Natural England, the National Trust and the Wildlife Trust amongst other agencies; and the Bowland Meadows day in 2018 attended by landowners, land managers and conservation practitioners. Both events included lectures and field visits. A technical report emerged from the Upland Calcareous Grassland Project (**E3**) and also an article in British Wildlife magazine (**E4**). Most recently (Nov 2020) Natural England have agreed to publish a hay meadow conservation report based upon the Edge Hill meadows work (**E5**), though final output has been delayed by NE. Throughout the duration of the grassland work informal contact was maintained with relevant stakeholders. Cumulatively the academic output plus formal and informal dissemination improved conservation of two significant grassland types and the wider landscape in which they are found. This had impact in three areas: (i) changed management practices in upland calcareous grassland to ensure invertebrate species conservation; (ii) informed hay meadow conservation and promoted connectivity and (iii) farm policy change.

(i) Changing management practices in upland calcareous grassland to ensure invertebrate species conservation.

The UK has a significant responsibility to conserve this habitat having 22000-25000ha of the 600 000ha in Europe. Within England this habitat is primarily in the Yorkshire Dales and east Cumbria. Significant land managers in these areas are Natural England and the National Trust. The Edge Hill upland calcareous grassland research (R1-R3) led directly to changes in management practice in both of these organisations. As the site manager of the 1014ha Ingleborough NNR noted 'Edge Hill's research ... has enabled us to understand much better the impact of cattle/sheep grazing regimes on the vegetation and invertebrate communities. Specifically, the Edge Hill study looked at beetle and spider communities that hadn't been assessed before, which was useful because it provided benchmark data against which any management changes can be assessed.' 'The study is having an impact on the management of the reserve now and in the future' (**E6**).

With no previous work on invertebrate community composition, the project provided baseline data to serve as a reference on invertebrate species prior to management actions by Natural England managers at Ingleborough NNR (**E6**). Prior to this study, conservation management focussed entirely upon botanical diversity, the accepted view being that improving botanical diversity would enhance all other biodiversity. The discovery that this relationship is not true (R1) meant that invertebrate groups had to be considered separately to plants. The conservation grazer responsible for the area noted the change in focus "...your findings repeatedly crop up in the discussions that regularly take place between ourselves and the reserve staff in deciding the most appropriate grazing regime...these discussions now take more account than previously of the habitat needs of invertebrates generally...." At a practical level this has seen a mix of heavy, light and zero grazing to enable a more varied vegetation structure which in turn supports a wider range of invertebrates to flourish (**E7**), as was recommend by the research and wider dissemination (**E3**). Additional action has also been taken in suitable areas to plant trees to encourage permanent scrub (**E6**) which was also identified as supporting distinct spider communities and species (R2). These are non-target habitats being managed for their invertebrate biodiversity for the first time. The area under this management consideration incorporates Ingleborough SSSI (5773ha) and

Malham-Arncliffe SSSI (4994ha), almost 11000ha.

Following Brexit, the basis of AES is being altered. This is enshrined in the recent Agriculture Act (2020). AES payments, which underpin much of the grazing within the upland calcareous grassland habitat will be based upon the new Environmental Land Management (ELM) Scheme. This will be rolled out by DEFRA in 2024, with the government currently running tests and trials. As part of the development of the ELM scheme (2017-2022) the National Trust commissioned the Yorkshire Dales Park Authority to analyse condition assessment data on priority habitats over the past decade. In an August 2020 meeting to discuss using this habitat condition research to inform the ELM scheme, the Upland Calcareous Grassland project is referenced as evidence showing that structural diversity, sampling and monitoring is key in developing conservation management strategies (**E8**).

ii) Hay meadow conservation and connectivity

Direct outcomes of the hay meadow research in the Bowland AONB included the 2016 restoration of upland hay meadows; New Ing Meadow SSSI (2.04ha) and Tarnbrook Meadow SSSI (10.8ha). The sites are two of the few remaining herb rich hay meadows in Lancashire. The survey data gathered to produce R4 was used as the target community (**E10**) and the restoration was undertaken by Bowland Hay Time project in collaboration with NE, using the approach analysed in R6. Subsequent assessment of the two sites, at Tarnbrook in 2018 and New Ing in 2020, outlined on the NE website (**E9**) shows that this restoration was successful, both sites now being described as 'unfavourable-recovering'. This is the technical term for a positive management intervention to a previously declining site. Following the species identified as absent from green hay meadow restoration activity (R6), plug planting was incorporated into two other meadow restoration programmes in Bowland AONB by Bowland Hay Time project (**E11**).

Hay meadow restoration (R6) and an intention to increase meadow connectivity (R5) directly informed the on-going restoration and creation of 42.6ha of species-rich grasslands by Lancashire Wildlife Trust (**E12**) within the Wigan Greenheart landscape. This is a network of various greenspaces, canals and woodlands, many established on derelict ex-industrial land within Wigan MBC. This area falls within the Great Manchester Wetlands locally determined Nature Improvement Area (NIA), these NIAs being established as a result of the Lawton report (2010), which advocated a move to landscape-based conservation. Subsequent extension of the number of meadows across several sites in the Wigan Greenheart area increased the total to 70ha (**E13**). Whilst a marked local increase in the habitat, it is also significant nationally, increasing the national cover of hay meadows by nearly 1%. It also contributes to local landscape grassland connectivity for plants and other taxa, in keeping with the recommendations of the Lawton report. The site manager reports (**E11**), 'the benefits to a range of wildlife has become clear increasing the abundance of hay meadows and the connectivity between them in the North West'.

iii) Farm policy change

Defra is considering various approaches to funding as it develops the new ELM scheme (highlighted above). The NT in the Yorkshire Dales is part of a Defra-funded ELM Test Project, on the feasibility of a whole farm results-based approaches to AES payments. Part one of the test examined upland habitats, including calcareous grassland, part two focused on pollinator habitats on enclosed upland farmland, which include hay meadows. One element of the test was to investigate whether change achieved through conservation-focused management of habitats could be achieved within the timescales of AE management agreement periods. Based upon research expertise, notably that in R6, Ashton was commissioned as a co-author of a literature review which assessed the timescales of habitat-related outcomes which may be the objectives of ELM scheme funding. This review cites R1, R2, R6 and **E3**. The literature review was a component of the final report on the trial, submitted by the National Trust to Defra in November 2020 (**E14**).

Impact case study (REF3)

The aim of Edge Hill's grassland research was to enable scientifically informed conservation of these habitats to be undertaken. This has been achieved through dissemination of new knowledge and resultant altered management. Additional impact is yet to come from the Nov 2020 NE publication, based entirely upon EHU meadows work, on long term change and genetic connectivity (**E5**).

5. Sources to corroborate the impact

E1 Grassland Conference email feedback series.

E2 Forest of Bowland Meadows Day feedback series.

E3 Lyons A., Oxbrough A. and Ashton P.* (2018) Managing biodiversity in upland calcareous grassland landscapes: a case study of spiders and ground beetles. Edge Hill University, Lancashire, UK. Pages 1-32. ISBN: 978-1-900230-62-9

E4 Lyons, A., Ashton, P., Powell, I., Oxbrough, A. (2018) Spiders in the grass: the effect on upland spider communities of grazing British Wildlife 29 (6); 426-432.

E5 Natural England Website publication

E6 Natural England, Ingleborough NNR, Testimonial Statement.

E7 Conservation grazier, Testimonial

E8 National Trust/Yorkshire Dales National Park Authority Meeting Transcript 13.08.2020

E9 Tarnbrook and New Ing SSSIs condition assessments

E10 Tarnbrook restoration with ES data as target & New Ing

E11 Plug Plant evidence

E12 Wildlife Trust, Projects Manager, Testimonial Statement.

E13 Wildlife Trust Management Plans showing implemented management prescriptions. Amberswood, Kirkless, Wigan Flashes, Bee Forever Management Plan.

E14 National Trust Payment for Outcomes ELMS test literature review.