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The state of the UK's long-term experiments

An updated survey by the Ecological Continuity Trust

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NATURAL ENGLAND

Foreword

Natural England commission a range of reports from external contractors to provide evidence and advice to assist us in delivering our duties. The views in this report are those of the authors and do not necessarily represent those of Natural England.

Background

Long-term ecological experiments test the impacts of environmental change or management on biological communities, species populations and ecosystem processes under field conditions. Experiments compliment long-term monitoring by enabling cause and effect to be identified with confidence, novel approaches to be trialled on small areas and the effects of future changes to be anticipated. They are a vital part of the evidence base for decision making in conservation and land management. Many ecological process operate over periods of decades and longer so ecological experiments also need to operate over similar timescales if they are to realise their full value. It has however proved difficult to maintain many experiments for more than a few years. We commissioned this study to evaluate the extent of this problem, its causes and possible solutions. We were fortunate in that an earlier study by the Ecological Continuity Trust provided a baseline against which to assess change and this has provided the first reliable evidence that the UK is rapidly losing a large number of long-term ecological experiments. This represents a major loss of national capability that will be hard or impossible to replace. There are no easy solutions to the problem, particularly in a time of reducing public expenditure, but this report points the way to a new partnership approach with the potential to build a more sustainable future for long-term ecological experiments. Natural England will work with partners including the Ecological Continuity Trust to progress this as part of our wider evidence programme.

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Natural England Project Manager - Dr Mike Morecroft, Principal Specialist, Climate Change, Natural England, Mail Hub Block B, Whittington Road, Worcester WR5 2LQ **mike.morecroft@naturalengland.org.uk**

Contractor - Dr. Jerry Tallowin, Ecological Continuity Trust, Manor House, Little Wittenham, Abingdon, Oxon OX14 4RA **www.ecologicalcontinuitytrust.org/**

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Further information
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An updated survey by the Ecological Continuity Trust
on behalf of Natural England

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Executive Summary

Long-term ecological experiments (LTEs) test the effects of different aspects of environmental change or management on ecosystems in realistic field situations over timescales of years or decades. They are essential because many ecological processes operate on these timescales and because the effects of climate change, pollution, development and a range of other factors are long-term. The UK is however at risk of losing this critical component of national capability for ecological research and valuable data collected over many years.

There is increasingly wide recognition of the need to take a long-term view of the natural environment and the Department of Environment, Food and Rural Affairs is developing a 25 year plan for the environment. It is essential to ensure that a long-term approach is also taken to gathering the evidence needed to support policy and management decisions. Long-term ecological experiments are a critical element of this to ensure rigorous assessment is made of the impacts of environmental change and the effectiveness of management.

LTEs have however been at increasing risk in the last decade: in 2008, the Ecological Continuity Trust identified 49 long-term ecological experiments, of which 22 were found to be at significant risk.

This report, commissioned by Natural England in February 2014 summarises an update to the 2008 survey. The principal objectives of the updated survey were to:

1) Establish the current status and security of the UK's long-term ecological experiments (LTEs) for users of LTE results in research, education, policy, conservation and land management.
2) Produce options and recommendations to make data and outputs of LTEs accessible to scientific, practitioner and policy communities.

The update follows the same methodology used during the previous study, using literature searches and interviews to update information and identify further long term field experiments with robust experimental designs. In order to capture the full range of long-term ecological experiments (LTE), four categories were defined:

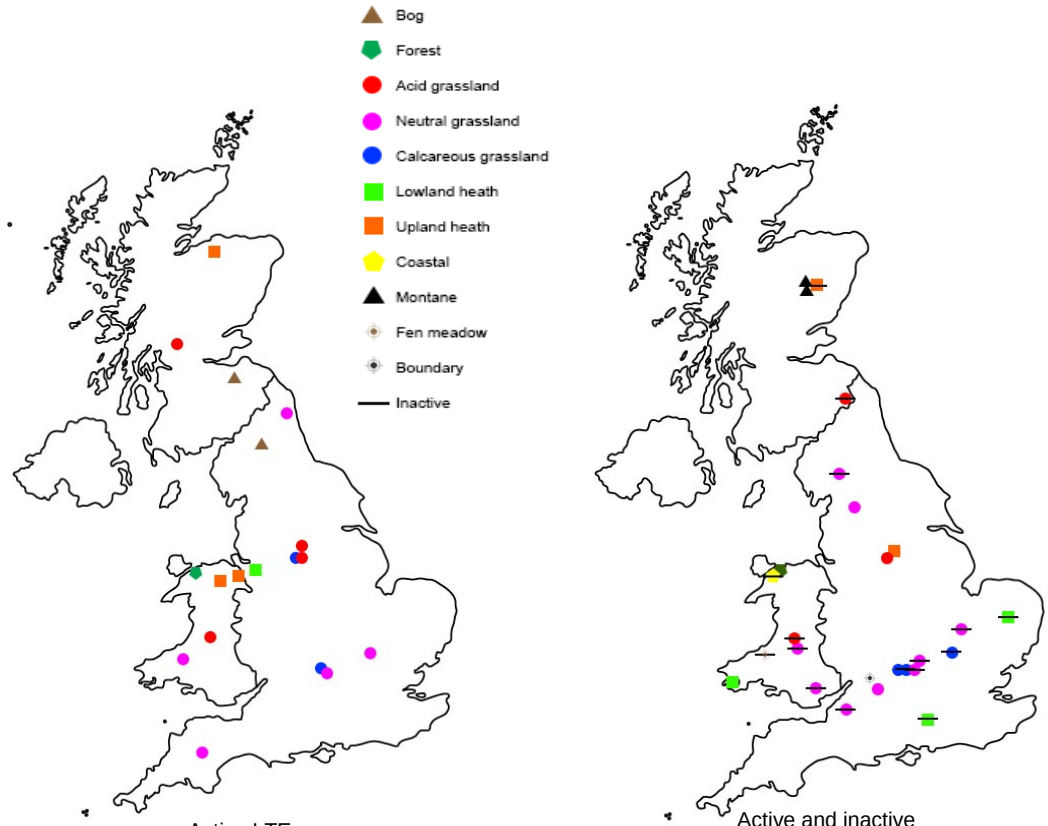
- Active long-term ecological experiments (active LTEs).
- Active post-treatment recovery experiments (active PTREs).
- Inactive post-treatment recovery experiments (inactive PTREs).
- Closed experiments.

All of the sites identified in 2008 and 2014 were scored against 14 experimental criteria to establish their relative importance as a research platform.

The survey established there are currently 26 active long-term ecological experiments in the UK based at 19 separate sites.

Calcareous grassland	**Acid grassland**	**Lowland heath**
Wytham A*	Pwllpeiran*	Little Budworth Common
Buxton (BCCIL)*	Wardlow (new)*	
	Peaknaze*	**Bog**
Neutral grassland	Glen Finglas*	Whim*
Park Grass*		Moor House*
Palace Leas	**Upland heath**	
North Wyke	Ruabon (old and new)	**Broad-leaved woods**
Denmark Farm	Clocaenog*	Henfaes (Diverse)
Somerford Mead*	Moorco*	THISTLE

A further 38 former LTEs are still accessible for research into the recovery of the ecosystem following cessation of treatments. However, the majority of these PTREs are not being actively studied. This constitutes a reduction of 62% of the UK's active experimental platforms in the past 6 years. Given the loss of treatments at 10 (43%) of those with the highest research value (*), these changes represent a significantly greater loss in terms of the UK's long-term ecological experimental research capacity.



Active LTEs

Active and inactive PTREs

Of the 26 remaining active LTEs, 5 are considered to be at immediate risk, with potential loss of the site within 1-2 years. A further 8 sites are considered to be under threat in the medium term (2-5 years). The principal threats identified in the survey can be summarized as a combination of one or more of:

- Lack of funds.
- Changes in key staff.
- Changes in site ownership and/or management.

Access to properly archived data is an important element of ensuring that the potential of long-term experiments is realized. In most cases large amounts of data have been collected at public expense but are under threat because of the way they are managed and archived, with only two LTEs having routine monitoring data publically available online. For most other sites, data are usually held electronically on staff computers backed up on institutional servers and/or network databases. A significant minority of LTEs and PTREs have no collated databases and/or the existing data archiving is unclear or believed to be incomplete.

In addition to traditional plot experiments, 6 experimental deer exclosures were identified. Of these, 3 are believed to be at least partially intact and have been monitored within the last 5 years.

If the potential of the UK's long-term experimental network to contribute to the UK Government's aspiration to halt biodiversity loss is to be realized, it is recommended that:

- A strategic network of existing LTEs and active PTREs is established based on the remaining priority sites, across a range of different habitats and incorporating different types of experiments. This would provide evidential underpinning for, and integrate with, the Government's aspiration to establish '*an ecological network…to conserve biodiversity and ecosystems services, shifting conservation from piecemeal activity towards a more effective, more integrated landscape-scale approach'* (Biodiversity Strategy 20:20: DEFRA, 2011).

- Sites within the network could also be used as hubs, contributing to knowledge exchange and the dissemination of research to local policy-makers, scientists and practitioners, as well as supporting the public understanding of science through open days and other educational and outreach activities. This is in line with the Biodiversity Strategy's explicit commitment to harness the collective effort of voluntary, academic and business sectors, and enthuse and educate the public about biodiversity.

- Institutional oversight of the whole network, and core funding for routine maintenance, data management and routine monitoring of priority experiments, would provide much needed stability and financial security for the remaining UK experimental base. It would also help raise the profile of long-term experiments, acting as a single open source of information on experimental design and technical issues for other field ecological experiments, as well as maintaining an online database of results from existing experiments and a much-needed archive for data, research papers and reports for closed or inactive sites.

In the interim, actions are required to make data and outputs of LTEs accessible to scientific, practitioner and policy communities and to secure datasets which are at risk:

- Funds are needed to support the collation and validation of data of long-term experiments at Colt Park, Dale, Glen Clunie / Glen Shee, Pwllpeiran and Rhos-Llawr cwrt, in collaboration with site managers and former researchers at the sites.

- Funds are needed to facilitate the migration and validation of data in out-of-date formats, for the Wytham 'Upper Seeds', Bamford, Hordron and associated bracken control experimental sites.

- A log of research activity and available datasets, similar to those compiled for BCCIL and Denmark Farm (Appendix 4) should be compiled for, in order of priority: (i) active LTEs, (ii) active PTREs, (iii) inactive PTREs and (iv) closed sites.

- A full publication list should be completed for all LTEs.

- An online database of UK long-term experiments should be established based on information already gathered as part of this survey, with primary, searchable fields based on the categories set out in Appendix 1. This could be hosted on the ECT website and developed in phases as part of a proposed website update.

- Links should be pursued with relevant initiatives, such as Conservation Evidence, and potential end-users or stakeholders such as Forest Research, Sylva, the Deer Initiative, the National Trust, the Country Landowners Association, the British Ecological Society, etc., in order to ensure that the database does not duplicate existing efforts, meets a real need and is designed with an interface with the potential end-user in mind.

- Further work needs to be undertaken to ascertain the status of the forestry deer exclosure experiments identified during this survey but for which no further information was obtained. The database compiled by Rob Fuller in the 1980s should be reviewed. Deer exclosure experiments should be included on the database once sufficient information on their status has been obtained.

1. Introduction

1.1 Long-term Experiments

The history of the UK's long-term experiments reflects our changing attitudes to the environment and contemporary questions on how we best manage our land. It demonstrates an evolution from managing the environment as a resource, to an increasing perception of man as a custodian with an inherent moral responsibility to protect and conserve the natural world.

The 19th century field experiments, such as those at Park Grass and Palace Leas, were driven by the need to increase the yield and nutritional value of hay and other crops during a period of rapid population growth. Post-war studies, such as those at Bibury and Aston Rowant, reflected the emerging concerns over agricultural intensification, chemical use and habitat loss. Subsequent experiments, like those at Wytham 'Upper Seeds' and Somerford Mead, represent the increasing awareness of the challenges associated not only with managing but restoring and recreating species-rich grassland, contributing to the evidence-base of the agri-environmental schemes which emerged in the 1990s. Contemporaneous with such initiatives have been experiments (e.g. Buxton Climate Change Impacts Laboratory; Wardlow Hay Cop) investigating long-range impacts, particularly addressing the emerging issues of chronic air pollution and global climate change.

Such concerns remain the focus of conservation initiatives and environmental policies, along with emerging issues of balancing food security and sustainable land management, maintaining and enhancing biodiversity and understanding and valuing the services that our ecosystems provide. The UK Government's Biodiversity 20:20 A Strategy for England's Wildlife and Ecosystems Services (DEFRA, 2011) articulates a vision of an environment rich in wildlife, within which our biodiversity is valued, conserved, restored and sustainably managed to be more resilient and able to adapt to change. It acknowledges that if we are to achieve this, we not only need to undertake concerted, collective landscape-scale conservation, but also to invest in research.

There is increasingly wide recognition of the need to take a long-term view of the natural environment, in particular, the Department of Environment Food and Rural Affairs is developing a 25 year plan for the environment alongside a 25 year plan for food and farming. This picks up a recommendation from the Natural Capital Committee that a long-term approach to our natural assets is required.

Long-term ecological experiments (LTEs) are an important tool for developing the required evidence-base, helping us not only to identify changes in ecosystems, such as species populations and community composition, but isolate the various different potential causes of change. They help us address important practical questions, such as how best to restore degraded ecosystems, recreate priority habitats and manage our impacts on the natural world. They help us to calculate the enduring effectiveness of different methods of land management, establish realistic time-frames for habitat restoration and provide 'model systems' against which to benchmark success. Ecological experiments carried out over extended periods shed light on the causes of sudden changes - 'regime shifts' or 'tipping points' - giving us vital insight into how long-term threats like climate change or pollution will be felt, and perhaps amplified or ameliorated, on the ground.

Aside from the immediate importance of these experiments for ecological science and environmental policy, such sites also have a latent value in their potential for

future, as yet unforeseen, research (Silvertown et al., 2010). The Park Grass experiment has generated over 200 scientific papers on topics ranging from nitrogen storage in the soil to the relationship between soil fertility, productivity and diversity. Its specimen archive continues to provide invaluable resources for genetic studies into long-term dynamics and plant populations and it is now recognized as a National Capability of immense value to science. Yet very few of these studies could possibly have been anticipated when the experiment was established in 1856.

Park Grass survived only because of the vision of its founder, who established the Lawes Agricultural Trust to provide a legacy to maintain the site. Other long-term experiments in the UK, however, have not been so fortunate. A survey of LTEs by the Ecological Continuity Trust in 2008, expanded on the review of long-term grassland and heathland studies undertaken by the former UK Lowland Grassland Habitat Action Plan (HAP) Steering Group (Morgan and Jefferson, 2007). It identified 49 long-term ecological experiments, of which 22 were found to be at risk. Information received since then indicates several of these active experiments have now been lost.

In order to establish the current status of the UK's long-term experiments, Natural England commissioned the Ecological Continuity Trust to update the survey in February 2014.

1.2 Scope of work

The principal objectives of the updated survey were to establish the current status of the UK's long-term ecological experiments, specifically:

- Produce an up-to-date set of records on LTEs in the UK, using the same categories as the previous ECT study, including contact/responsible officer details and the current/ future funding situation.

- Catalogue outputs (scientific papers, major reports, popular articles) from individual LTEs and summarise main scientific outputs and significance for policy and practice.

- Produce options and recommendations to make data and outputs of LTEs accessible to scientific, practitioner and policy communities.

The update follows the same methodology used during the previous study (Section 2), providing an overview of the state of the UK's LTEs in 2014 and the changes identified since 2008 (Section 3). A discussion of the implications of these changes to the national LTE capability and future threats is outlined in Sections 3 and 4, together with recommendations for future work needed to enhance and protect the UK's remaining LTEs and their data archives in Section 5.

This summary report is accompanied by a spreadsheet, cataloguing the survey findings in full.

2. Methodology

The 2008 survey of the UKs LTEs was undertaken by Dr Vicky Morgan (Joint Nature Conservation Committee), Mr Jerry Tallowin (Rothamsted Research) and Dr Sally Power (formerly Imperial College London) through literature search and interviews. Only controlled, replicated manipulative experiments were considered, with the exceptions of sites, such as Park Grass and Palace Leas, which pre-date modern statistical standards of design. For the purposes of the survey, 'long-term' was defined as sites that had a minimum of 6 years of treatments at the time of the survey.

The original 49 experimental sites were classified according to age, type (e.g. grazing, nutrient addition, climate change etc.) and broad habitat types (e.g. montane, calcareous grassland, lowland heath, etc.). Qualifying sites are shown in Table 2.1.

Literature reviews and interviews were repeated in February and March 2014 to establish the current status of qualifying sites and individual experiments, and identify further sites that met the inclusion criteria. These are shown in italics in Table 2.1.

Table 2.1 List of experimental sites that were considered as part of the ECT review, according to broad habitat
(Note: Sites may contain more than one distinct experiment)

Calcareous grassland	**Acid grassland**	**Fen-meadow/rush pasture**
Wytham A	Sourhope	Rhos Llawr-cwrt
Wytham B + ECN link	Pwllpeiran	
Buxton BCCIL	Wardlow - old and new	**Bog**
Royston	(Hartwood)	Whim
Aston Rowant hay spreading	Glen Finglas	Moor House
	Peaknase	
Neutral grassland		**Montane**
Park Grass	**Upland heath**	Glas Maol
Palace Leas	Ruabon - old and new	(Allt a' Mharcaidh)*
North Wyke	*Bamford Edge*	Culardoch
Cricklade North Meadow	Clocaenog	
Colt Park	Glen Clunie/Glen Shea	**Boundary**
Raisbeck & Pentwyn	Moorco	Bibury
Pwllpeiran/Trawsgoed	*Hordron Edge*	
Tealham and Tadham Moor		**Coastal**
Denmark Farm	**Lowland heath**	Newborough
Elan Valley	Thursley Common - old and new	
(Craddocks Farm)*	(Cannock Chase)	**Broad-leaved woods**
Marsh Gibbon	Euston & (Honington)*	Henfaes FACE
River Ray	Little Budworth	*Henfaes (Diverse)*
Monks Wood	(Mount Pleasant Farm)*	THISTLE
Somerford Mead	Dale Coastal Heath	
	(Sunnyside Farm)*	

*Site omitted on receipt of new information.
Italics indicate site has been included in 2014 surveys following receipt of further information.

During the updated survey, 7 of the original experimental sites – Craddock's Farm, Cannock Chase, Sunnyside Farm, Mount Pleasant Farm, Hartwood, Honington and Allt a' Mharcaidh - were removed from the survey on receipt of further information, which indicated they did not meet the stipulated criteria[*]. These are shown in the table in brackets, but have not been included in the analyses.

As several sites, such as Pwllpeiran have more than one experiment, the updated analysis is based on distinct experiments and not experimental sites. Experiments are deemed to be distinct when they are established independently, are not nested within the existing experimental plots nor rely upon them for scientific validity. Studies such as mesocosm experiments are not considered to be separate LTEs in this case.

A summary of each of these experiments is provided as Appendix 1.

Although the 2008 survey focused on active LTEs, the 2014 study also recognizes the value of terminated long-term experiments where monitoring is ongoing to establish how the ecosystem is recovering following cessation of the treatments. These sites are termed post-treatment recovery experiments (PTREs). In order to capture this capability, four categories of LTE were defined:

- Active experiments
- Active post-treatment recovery experiments
- Inactive post-treatment recovery experiments
- Closed experiments

Active experiments

Active LTEs are those that at the time of the survey were still receiving some or all of the original experimental treatments. If all experimental treatments had changed, the original experiment was deemed to have been terminated and a new experiment set up in its place.

Post-treatment recovery experiments

The survey includes sites that qualified as long-term experiments (i.e. had at least 6 years of experimental treatments), but at which treatments have now ceased. Where such sites are being monitored for post-treatment recovery of vegetation and/or soils, whether periodically (i.e. as part of a routine monitoring plan) or sporadically (i.e. at irregular intervals), these are deemed to be active post-treatment recovery experiments (PTREs).

Inactive and closed experiments

The survey recognizes former experiments, which remain accessible and marked but are no longer either treated or monitored. Post-treatment recovery monitoring studies may be possible at these sites, although the PTRE's Principal Investigator (PI) has indicated that there are no current plans to undertake such work. These are termed inactive PTREs.

[*] Sunnyside farm, Cannock Chase, Mount Pleasant Farm and Honington have now been established as decommissioned prior to 2008. Allt a'Mharcaidh and Craddock's Farm did not meet experimental criteria. Hartwood is also omitted as no further information was provided.

The state of any permanent markers or infrastructure at inactive sites may vary widely, depending on the site ownership and maintenance. It should also be noted that threats to these sites may not have been identified, as there is, at best, limited contact between the land-owner / manager and the researchers who previously used the site.

Experiments that are no longer accessible and/or marked are regarded as closed.

Assessment criteria

All of the sites identified in 2008 and 2014 were scored against 14 experimental criteria to establish their relative importance as a research platform. Criteria included:

- Uniqueness
- Statistical design
- Plot size (appropriateness to habitat driver and as potential future platform)
- Baseline data quality (i.e. including. plant, soil and meteorological data)
- Data availability / accessibility
- Continuity of treatment
- Number of ecological drivers being manipulated
- Longevity
- Expansion potential (e.g. presence of spare plots)
- Sample archives
- Co-operation / accessibility

The detailed guidelines for the application of these criteria is provided in Appendix 2.

The security of tenure at the sites and current funding status were then used to establish each site's relative vulnerability to closure in the immediate (1-2 years) future. These scores were used to identify priority sites for immediate investment / support. The full list of scores is provided as Appendix 3.

Forestry experiments

Although a separate survey of a database of 521 forestry trials and long-term experiments managed by the Forestry Commission was undertaken in 2008, ecological experiments in coniferous and broad-leaved woodland were not included in the original assessment. However, the 2014 review did attempt to establish the current status of the UK's long established deer / livestock exclosure experiments which focused on ecological impacts.

Despite the large number of exclosures, very few were found which involved the manipulation of environmental variables (fertilizer, management - including control of deer browsing - pest/disease control, etc.), and had an experimental design (i.e. replication of treatments, produced a data archive and had continuity of treatments for > 6 years).[†] Of the sites that qualified, most were no longer being studied, and up-to-date information on the status of the exclosure was scarce. Limited information was received on:

- Bradfield Woods

[†] Note: forestry experiments focusing on silviculture, such as provenance studies, were not considered as part of the survey.

- Coedydd Aber
- Denny Wood and the New Forest
- Lady Park Wood
- Monks' Wood
- Wytham Woods

As only limited data were received, these experiments have not been included in the subsequent analyses, but are discussed in the context of long-term forestry experiments. Other exclosures, which may be of interest, although no further information was received, include:

- Craigellachie, Aviemore
- Abernethy Forest
- Hayley Wood, Cambridgeshire
- Rounsea Woods, Cumbria
- Naddle Low

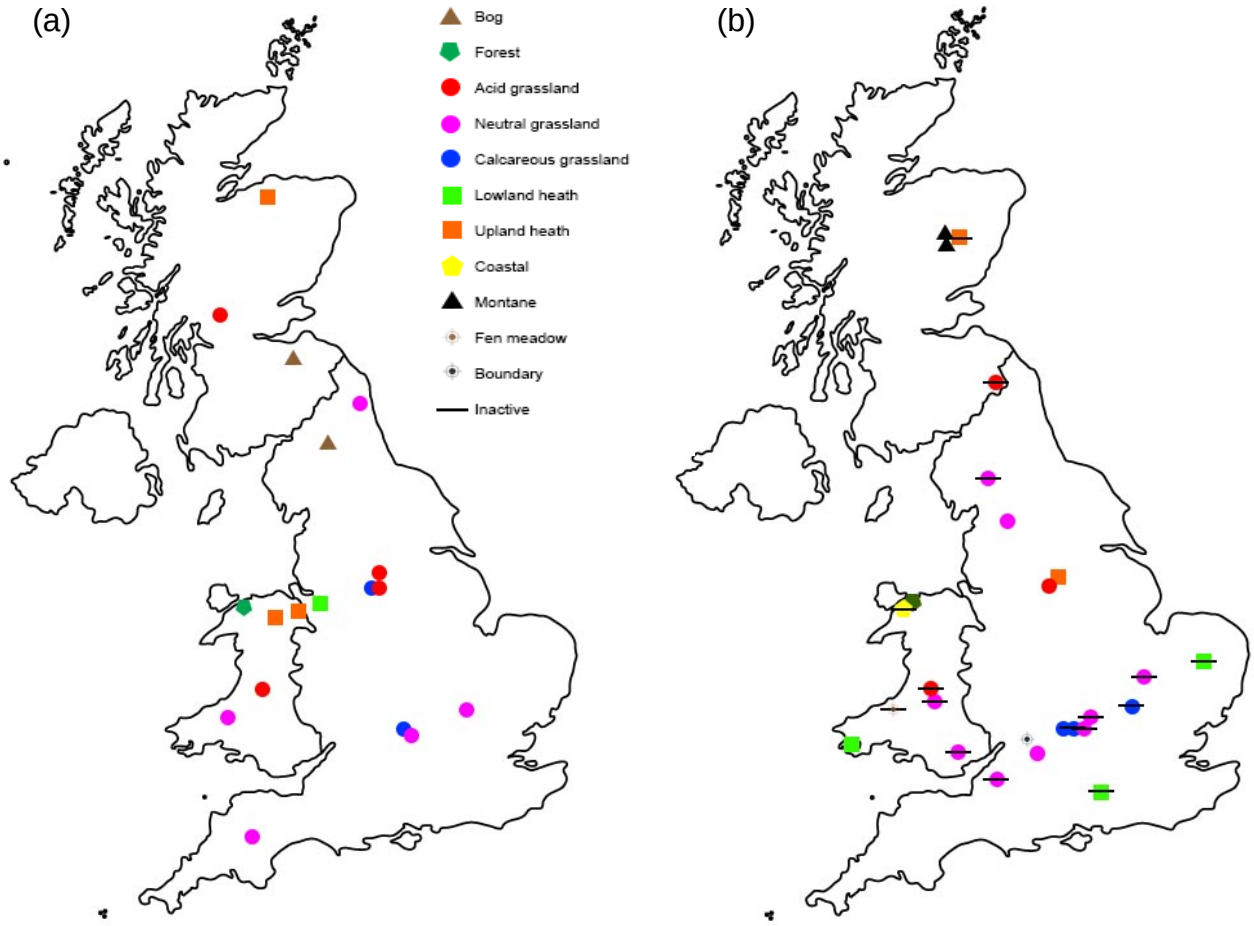
It is recommended that further work is undertaken to identify the current status of these sites.

3. Results

3.1 Long-term experiments in 2014

3.1.1 Distribution

Figure 3.1 Distribution of UK LTEs (a) Active (a) Post-treatment recovery experiments and inactive PTREs



Note: THISTLE is not shown, as the experiment comprises 20 individual sites spread over a large area in Scotland.

Table 3.1 Active long-term experimental sites in the UK, 2014 (* - priority sites)

Calcareous grassland	**Acid grassland**	**Lowland heath**
Wytham A*	Pwllpeiran*	Little Budworth Common
Buxton (BCCIL)*	Wardlow (new)*	
	Peaknaze*	**Bog**
Neutral grassland	Glen Finglas*	Whim*
Park Grass*		Moor House*
Palace Leas	**Upland heath**	
North Wyke	Ruabon (old and new)	**Broad-leaved woods**
Denmark Farm	Clocaenog*	Henfaes (Diverse)
Somerford Mead*	Moorco*	THISTLE

There are 26 active long-term ecological experiments in the UK based at 19 separate sites. The majority of these are based in grassland, particularly neutral and acid grassland, and upland heath environments. This reflects the relative ease of access and maintenance of grassland experiments compared to other habitats (Figure 3.1a; Table 3.1).

A further 38 former LTEs are still accessible for research into the recovery of the ecosystem following cessation of treatments. However, the majority of these PTREs are not being actively studied (Figure 3.1b). Active PTREs comprise:

- Aston Rowant (Ward plots)
- Bamford and Hordron Edge
- Bibury
- Colt Park
- Cricklade North Meadow
- Culardoch
- Dale
- Glas Maol
- Henfaes FACE
- Wardlow Hay Cop (old)

England has the highest proportion of the UK's experiment base, with 46% of the active LTEs and nearly 70% of both the active and inactive PTREs. Inactive PTREs are particularly prevalent on neutral and calcareous grassland in the south and south-east of England and South Wales (Figure 3.1b), reflecting the early (1960s onwards) establishment of land management and restoration experiments in these habitats (Section 3.1.3).

Seventeen of the 27 priority experiments (as opposed to sites) identified in 2008 remain active in 2014. These are located at 12 separate sites (Table 3.1).

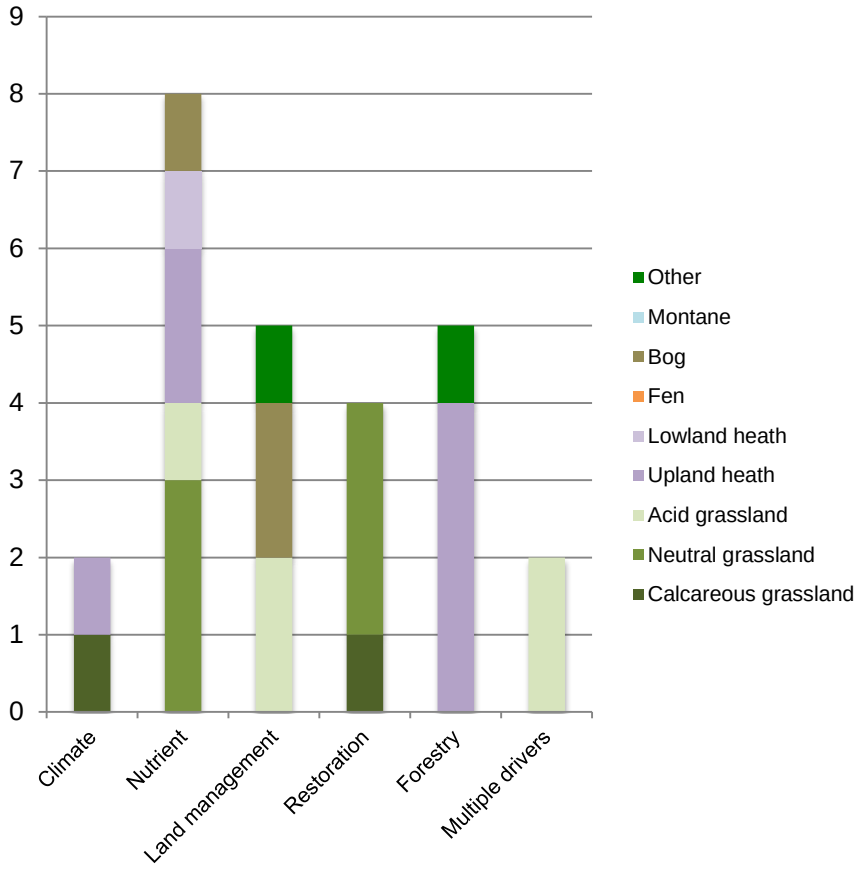
3.1.2 Experiment types

Six different types of LTE have been identified. These include climate change experiments, manipulating temperature and rainfall; nutrient-addition experiments adding nitrogen and other elements to experimental plots; land management sites manipulating drivers such as grazing and mowing, and restoration experiments, which involve soil removal and/or seeding and ongoing management to reestablish target communities and key species at the sites. Experiments that manipulate a combination of two or more of these types of driver within the main experimental design, are termed multiple driver experiments (Figure 3.2 and Table 3.2).

Table 3.2 Different types of LTEs in 2014

	2014					
Type of experiment	Climate	Nutrient	Land management	Restoration	Forestry	Multiple types of drivers
Active LTEs	2	8	5	4	5	2
Active post treatment recovery experiments	0	3	4	3	0	1
Inactive post-treatment sites	1	7	6	10	0	3
Total	**3**	**18**	**15**	**17**	**5**	**6**

Figure 3.2 Number of Active LTEs in the UK



Note: Multiple types of driver are experiments with, for example, both land management and nutrient manipulations as principal drivers.

(i) Climate experiments

Climate experiments typically manipulate temperature and rainfall either through active or passive heating systems (e.g. soil warming cables; passive infra-red) and the deployment of automated rain shelters to simulate the potential impacts of climate change, as predicted by UK climate models.

There are three active climate experiments in the UK: the Buxton Climate Change Impacts Laboratory (BCCIL), Clocaenog (Climoor) and its partner site at Peaknaze (Recovery Roof; considered a multiple driver experiment).

BCCIL is the second oldest climate change experiment in the world and was established to investigate the mechanisms underlying species, community and ecosystem response to climate change in an ancient upland calcareous grassland. The research at BCCIL, including investigations into stress tolerance, species and community resilience, microhabitat variability, genetic diversity and phenologic strategies for species adaptation, has far-reaching implications for our understanding of how climate change may affect the UK landscape, and how land management strategies can be adapted to mitigate adverse effects.

The Clocaenog site, which is part of the European EPRECOT and UK Terrestrial Umbrella / UKREATE and INCREASE[‡] networks, investigates the possible impact of climate change on Atlantic upland moorland ecosystems. Together with Peaknaze, studies have demonstrated the importance of soil moisture in regulating below-ground carbon dynamics and how ecosystem responses may affect the distribution of upland heath species in England and Wales (Sowerby et al., 2010). The research has been widely cited within the IPCC's Fourth Assessment Report (2007) – Impacts, Adaptation and Vulnerability (Parry, 2007).

All these experiments are considered to be priority sites (Table 3.1).

(ii) Nutrient addition experiments

Nearly a third (31%) of active experiments and actively monitored PTREs in the UK investigate the impacts of nutrient addition on ecosystems. These experiments typically comprise:

i. Fertilization studies: Manipulation of levels and/or types of fertilizer (usually nitrogen (N), phosphorus (P) and potassium (K) in farmyard manure versus inorganic fertilizer) together with lime applications, to determine effects on grassland productivity and biodiversity.

ii. Pollution studies: Experiments determining the impact of varying concentrations and forms of atmospheric pollutants (usually nitrogen) on different ecosystems.

The only active nutrient experiments investigating the impacts of fertilizer and lime in the UK are the Park Grass, North Wyke and Palace Leas experiments. Park Grass was founded in 1856 and is the oldest experiment on permanent grassland in the world. It was established to investigate methods of improving yields of hay but has since been used to elucidate some of the fundamental principles of ecology, including the relationship between plant species richness, biomass and soil pH, as well as providing one of the first demonstrations of local evolutionary change under different selection pressures (Silvertown et al., 2006).

[‡] EPRECOT - Effects of Precipitation Changes on Terrestrial Ecosystems - http://www.climaite.dk/eprecot/Eprecot.html; INCREASE is a Europe-wide network of climate change experiments in vulnerable shrubland, representing different climatic conditions. UKREATE comprises the UK Research on the Eutrophication and Acidification of Terrestrial Ecosystems, with various pollution experiments set up across different habitats in the UK.

Palace Leas, established in 1896, is the world's longest-running grazing and hay-cutting experiment and was set up to test the most efficient methods of increasing yields and improving the nutritional value of the hay. Subsequent studies have examined grazing and cutting impacts on soil microbiology and nutrient cycling, and historic datasets are currently being used to formulate statistical models of hay yield response to climate across a range of fertilities (Manning, pers. comm., 2011).

Although Park Grass has been designated a National Capability and is considered a priority LTE, due to the age of their foundation, neither Park Grass nor Palace Leas include replication or have expansion capacity for future research.

The North Wyke experiment examines the interactions between land drainage and nutrients in lowland neutral grassland ecosystems typical of western Britain, comparing drained and undrained swards in terms of animal and herbage production and the economics of field drainage in an agricultural context. Although useful for discrete studies such soil pathogens and optimizing management strategies, however, the experiment lacks long-term continuity, and is therefore not considered a priority site (J. Tallowin, pers. comm., 2014).

The remaining active nutrient-addition LTEs were established to investigate the impact of nitrogen as an atmospheric pollutant arising from traffic and industrial sources. They include experiments on upland grassland (Wardlow Hay Cop), upland and lowland heath (Ruabon and Little Budworth Common), and ombrotrophic bog (Whim), previously funded as part of the DEFRA UKREATE network. The experiments examine the acute and cumulative impacts of nitrogen pollution on UK ecosystems and have been integral to determining critical loads [§] of nitrogen, underpinning UK Environmental Stewardship Agreements and their Welsh equivalent, the Glastir (previously the Tir Mynydd, Tir Cynnal and Tir Gofal). Results *'show clear and consistent evidence of the impacts of nitrogen deposition…including evidence...that modest nitrogen loading can have significant impacts on semi-natural ecosystems and even low nitrogen inputs may induce effects over time through accumulated loading'* (Phoenix et al., 2012).

Wardlow Hay Cop, which is the world's longest running factorial nitrogen and phosphorus experiment on grassland, and Whim, which is the first worldwide to compare impacts of three forms of nitrogen at the same site, are considered to be priority sites (Table 3.1).

(iii) Land-management

Land management experiments constitute a fifth of the UK's active LTEs and over a third of LTEs are still actively monitored following the cessation of treatments. They typically comprise:

i. Grazing and hay cutting experiments, manipulating stocking density, timing of cutting and grazing, and / or herbivore type (e.g. cattle / sheep / rabbits) to investigate the impacts of herbivory and hay cutting on vegetation dynamics, soil structure and chemistry, and resultant parasite, invertebrate and predator population dynamics. Active UK grazing LTEs include the Brignant plots at Pwllpeiran, established to determine management practices to enhance biodiversity within semi-natural grassland communities, and the Glen Finglas

[§] A quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge". (Nilsson and Grennfelt 1988)

experiment, designed to examine the effects of livestock grazing on upland bird populations. Both are considered priority sites.

ii. Bracken control experiments, such as those at Bamford and Hordron Edge, were established to test the efficacy of herbicide application, cutting and bruising for bracken management. Prior to the cessation of treatments in 2012, these experiments contributed to policy objectives in the context of agri-environment schemes and Biodiversity Action Plan targets towards reversing bracken invasion / colonisation on UK moorland (Cox et al., 2007). They continue to be actively monitored as PTREs.

iii. Burning experiments to investigate the impact of different burning cycles on heather colonization, botanical diversity and carbon sequestration. The only active UK burning experiment is Hard Hill, Moor House, which was established in 1954, and has contributed to conservation management policy for moorland shooting estates and blanket bogs, as well as wildfire-mitigation strategies on dwarf-shrub-dominated peatlands (Hyohyemi et al., 2013). It is considered to be a priority site.

iv. Drainage control experiments, investigating the effects of raised water levels on botanical and invertebrate biodiversity in floodplain meadows, such as the active PTRE at Cricklade North Meadow, and inactive experiments at Tadham and Tealham Moor.

(iv) Restoration experiments

Restoration studies are characterized by the active experiments at Wytham, Somerford Mead, North Wyke ('Mol-rush' experiment) and Denmark Farm, North Wales, which were established to provide information to farmers and land-managers on the recreation of habitats, usually grassland, from arable land. Active restoration experiments typically include an initial experimental phase of soil treatment (e.g. removal, rotavation), seeding and/or hay spreading treatments followed by experimental grazing management, hay-cutting and/or other land management treatments as part of the ongoing restoration.

Of the four remaining active restoration experiments, Wytham and Somerford Mead are considered to be priorities. The Wytham 'Upper Seeds' experiment was established in 1985 to understand the long-term effects of different grazing regimes on the restoration and recreation of lowland calcareous grassland. It has provided evidence for conservation policy and best practice guidance for calcareous grassland recreation and restoration across the UK and contributed to the Environmental Stewardship Higher Level Scheme. The Somerford Mead experiment examines methods of seeding and grazing management to re-establish floodplain meadows. Both sites continue to provide a platform for botanical and invertebrate ecological research, as well as a reference and benchmark for similar sites.

A significant number of long-term restoration experiments remain as inactive post-treatment recovery monitoring sites (e.g. Dale, Pembrokeshire; Rhos-Llawr-cwrt). The tendency for such sites to remain as monitoring sites long after their establishment reflects both their location within nature reserves or on land owned by charitable conservation organizations, as well as their original conservation goal.

(v) Forestry

Five active forestry experiments have been identified in 2014. The majority of these comprise the MOORCO experimental platform, consisting of a series of birch plantations, established in the 1970s, to test the effects of birch as an ecosystem engineer. The MOORCO platform has since been used to test the impact of vegetation change on soil microbial communities, carbon storage and ecosystems services, and underpins evidence for predicting impacts of proposed woodland expansion within the Cairngorms National Park. It is considered a priority site.

The Henfaes DIVERSE forestry site, examining the relationship between diversity and forest ecological functioning and sustainability, is still becoming established. It has not been much used for research, although some studies are now underway into tree mortality during establishment (A. Smith, pers. comm., 2014).

(vi) Deer exclosures

In addition to traditional forestry plot experiments, 6 experimental deer exclosures were identified during the survey. Of these, 3 exclosure experiments – Lady Park Wood, Monks' Wood and Wytham Woods – are believed to be at least partially intact and have been monitored within the last 5 years (Wytham: Mike Morecroft, pers. comm., 2014; LPW; MW: George Peterken, Ed Mountford, Arnie Cooke, pers. comm., 2014). These sites have been used to establish the long-term impacts of deer browsing on woodland regeneration and ground vegetation, particularly bramble (Morecroft et al., 2001; Peterken & Mountford, 2002, 2004). Subsequent work at Wytham has examined the evidence for a causal relationship between deer herbivory and changes in small mammal populations in British woodland, specifically the decline in bank voles over the last 40 years (Buesching et al., 2001).

Experimental exclosures at Bradfield Woods, Suffolk, were the first studies in Europe to test the impacts of deer browsing on woodland bird species (Gill & Fuller, 2007). They are believed to remain intact, although are no longer actively monitored following the closure of the woodland canopy since coppicing, which has rendered the site of less interest for bird studies (Rob Fuller, pers. comm., 2014). Exclosures at Coedydd Aber National Nature Reserve, established to assess the impact of deer browsing and ground vegetation on an upland alder wood, are also considered inactive (Jim Latham, pers. comm., 2014).

Another long-term deer exclosure experiment at Denny Inclosure, the 'Denny Pens' in the New Forest may have been lost (Robin Gill, pers. comm., 2014), although more work is needed to update the status of this and other sites identified during the survey (Craigellachie, Aviemore; Abernethy Forest; Hayley Wood, Cambridgeshire; Rounsea Woods, Cumbria and Naddle Low).

(vii) Experiments with multiple types of driver

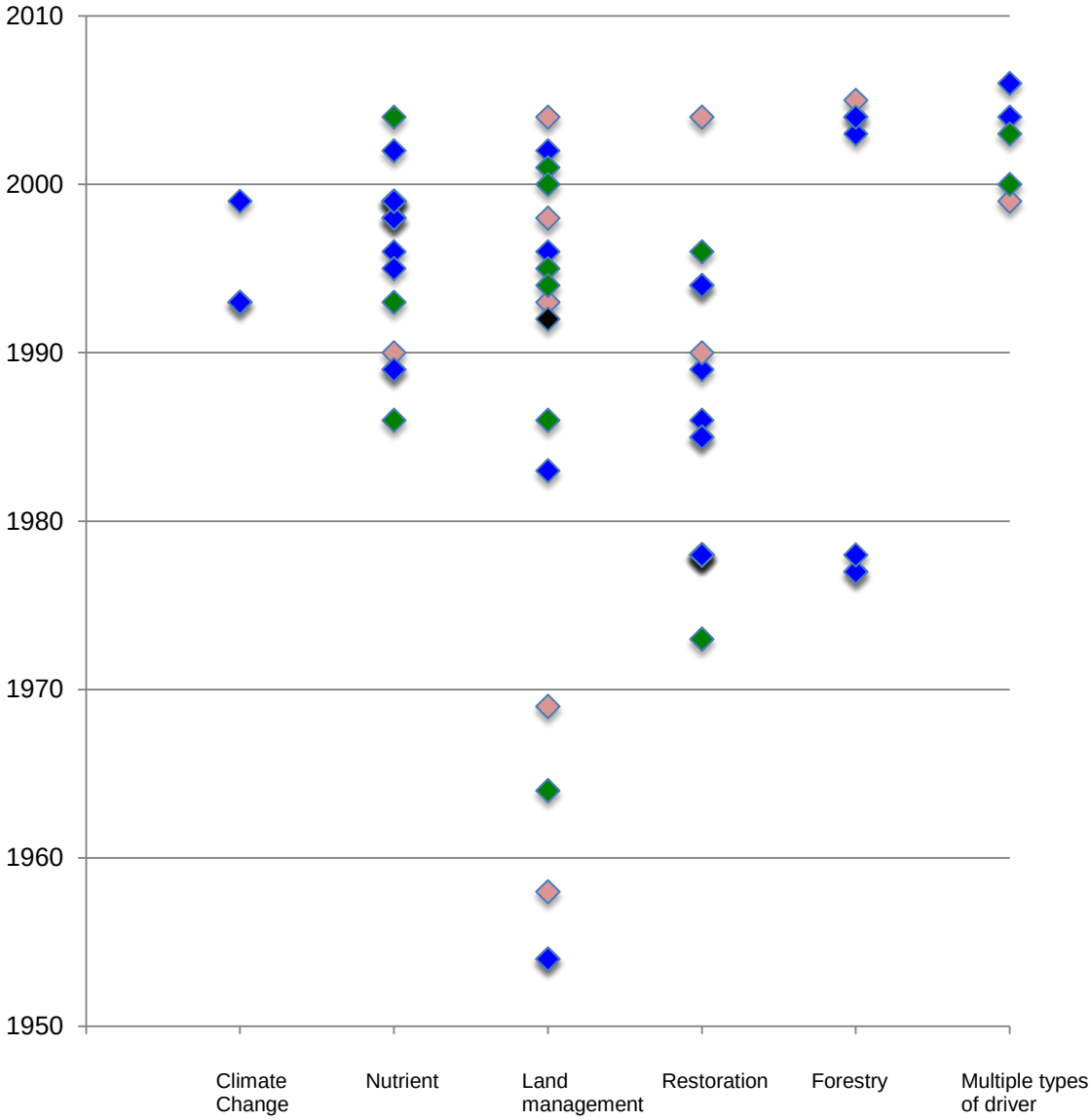
Two active LTEs have been identified as having different types of primary drivers. These are the climate and pollution studies at Peaknaze and the grazing and restoration experiments at the Paddocks in Pwllpeiran. The Peaknaze site is part of DEFRA's Terrestrial Umbrella and UKREATE network, and examines the interactions between pollution and climate change on upland acid grasslands in central England. The Paddocks was established to investigate the impacts of different types of herbivory (sheep, cattle and mixed grazing) on the management and restoration of degraded upland habitats. Treatments at the Paddocks were

interrupted for two years following the temporary closure of the site, prior to its transfer to Aberystwyth University in 2014 (Mariecia Frazer, pers. comm., 2014).

3.1.3 Age

Figure 3.3 shows the date of inception of the different types of experiment, omitting the two oldest sites (Park Grass and Palace Leas). The age distribution broadly demonstrates the changing environmental concerns over the post-war period, with long-term land management and restoration experiments starting to be established in the 1960s and '70s, concomitant with growing concerns over habitat loss associated with post-war agricultural intensification and widespread fertilizer and biocide use.

Figure 3.3 Date of inception of different types of the UK LTEs
Blue denotes active experiments; pink active post-treatment recovery monitoring; green, sites which are not being actively monitored; black shows closed experiments. Note the oldest experiments at Park Grass and Palace Leas have been omitted.

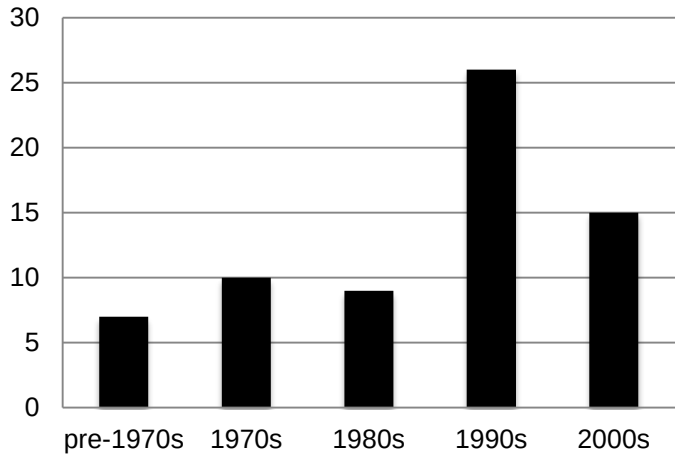


Climate change and nutrient LTEs typically date from the late 1990s and early 2000s, indicative the growing concerns over global warming and air pollution, as well as the emergence of Countryside Stewardship and Environmentally Sensitive Area

schemes, which set out to improve the environmental value of farmland, and establish good practice for sustainable land management. Experimental platforms manipulating several types of driver tend to have a more recent foundation, reflecting both technical advances in equipment, and our growing understanding of the complexities of the inter-relationships between natural processes, and the cumulative and syncretic effects of our management of the land.

The mean age of active LTEs is 33 years (24 years if the two oldest active sites, Park Grass and Palace Leas are excluded). The peak period for LTE establishment was the 1990s and early 2000s, with approximately 41 experiments having been established during that time.

Figure 3.4 Decade of establishment, UK LTEs (including active and inactive sites)



3.1.4 Ownership

The majority of the active LTEs are managed by dedicated research institutions, namely the Centre of Ecology and Hydrology (CEH: 27%); the James Hutton Institute in Scotland (JHI: 23%) and Rothamsted Research, which maintains three active LTEs in England (RR: 11.5%).

Five universities[**] manage 7 of the active LTEs in England and Wales (27%) with 2 sites regarded as unaffiliated, although with university ties (Buxton Climate Change Impacts Laboratory and Wytham 'Upper Seeds'). One active experiment – Denmark Farm – is maintained by a charity, the Shared Earth Trust.

3.1.5 Data management and archiving

Only two datasets of the 26 active LTEs and 38 PTRE experiments identified have routine monitoring data publically available online. These are:

- Park Grass Experiment, Rothamsted
- Buxton Climate Change Impacts Laboratory.

[**] Aberystwyth, Bangor, Manchester Metropolian, Newcastle and Sheffield. The Universities of Bournemouth and Liverpool and the Open University also maintain active monitoring programmes at PTREs.

The results from Park Grass have been compiled into a permanent, managed bespoke database for secure storage of data from all Rothamsted's Classical Experiments. Together with the accompanying meteorological records, associated documentation and sample archive, the Electronic Rothamsted Archive (e-RA)[††] is integral to the site's designation as a National Capability and a strategic component of the site's international research base.

The majority of BCCIL's datasets, (specifically data from routine monitoring of the climate change experimental plots) up to and including 2012 are available online via the Fridley laboratory website (http://plantecology.syr.edu/fridley/tab_data.htm). A log of research activity is also available online. This is a formal requirement of the LTE's current funding from the National Science Foundation of America (Jason Fridley, pers. comm., 2014). Even so, some data, mostly from 'nested projects' undertaken at the platform by other researchers, have not been collated for the site.

The data from the closed Sourhope Rigg Foot experiment is also published online, although the data discovery database interface will shortly be removed from the NERC Sourhope website (http://soilbio.nerc.ac.uk/datadiscovery/).

The majority of the remaining experiments, whether managed by research institutions, universities or other custodians, have a data archive managed by the site's Principal Investigator. Data are usually held in multiple Excel spreadsheets (more rarely collated into a single Access databases or similar) and held on staff or personal computers backed up on institutional servers. Sites such as Whim, which are part of a European or UK network, also typically upload data onto network databases (e.g. CEH terrestrial database; ÉCLAIR).[‡‡] Access to these data is generally mediated through the LTE's Principal Investigator, to protect intellectual property rights. However, respondents indicated that most of these archives do not routinely include data collated from nested studies at the platform undertaken by other researchers.

A significant minority of LTEs and PTREs have no collated databases and/or the existing data archiving is unclear or believed to be incomplete. These include:

- Colt Park
- Dale
- Glen Clunie / Glen Shee
- Mount Pleasant Farm
- Palace Leas
- Pwllpeiran (multiple LTEs)
- Rhos-Llawr cwrt

In some cases, projects have been proposed or are underway to rectify current data archiving issues, including a digital archive containing experimental procedures, online database and a digital publications library for the Palace Leas plots (Manning, pers. comm., 2011). In others, data are known to have been lost following the death of the experiment's founder (Mount Pleasant Farm: A. Davy, pers. comm., 2014), or are scattered across multiple people and sites (Rhos-Llawr cwrt; Colt Park: David Wheeler, Colin Newlands, pers. comm., 2014).

[††] http://www.era.rothamsted.ac.uk/

[‡‡] Effects of Climate Change on Air Pollution and Response Strategies for European Ecosystems, a four year project funded by the EU's Seventh Framework Programme for Research and Technological Development (FP7).

There are also significant data archiving issues at the active Wytham experiment and the active PTREs at Bamford and Hordron Edge, as well as the inactive and closed bracken management experiments at Carneddau, Cannock Chase and Sourhope (Rob Marrs, pers. comm. 2014). Parts of these datasets are held in out-of-date formats, which require migration to become accessible for wider research. At least ten years of unpublished data from Wytham '*are not currently usable for people who did not understand [the former PI's] system'*, according to Clive Hambler (pers. comm., 2014).

Similarly, data from a number of sites are held by retired ecologists working voluntarily to maintain long-term experiments. This is typical of deer exclosure experiments and LTEs and PTREs maintained by charitable institutions. This includes the active LTE at Denmark Farm, whose data have been collated by a retired site ecologist, Dr Richard Williams. A comprehensive data archive does not appear to have been collated by the Shared Earth Trust (R. Williams, pers. comm., 2014). Current and historic data from the Active PTRE at Aston Rowant (Ward Plots) are also held by an independent researcher, Dr Tim King, as are the datasets from monitoring campaigns undertaken voluntarily by Dr Cooke, Dr George Peterken, Dr Ed Mountford and Dr Jim Latham at Monks', Lady Park and Denny Woods and Coedydd Aber.

3.2 Changes since 2008

Table 3.3 Status of research experiments in 2008 and 2014

	2008	**2014**
Active LTEs	42	26
Active post treatment recovery experiments	7	11
Inactive post-treatment sites	17	27
Total experiments identified	**66**	**64**

3.2.1 Closed experiments

Three experiments have been lost since 2008. These are:

- Trawsgoed (Pwllpeiran)
- Rigg Foot (Sourhope)
- Gaisgill (partner to Raisbeck)

The Trawsgoed plots, which were established to study the impacts of grazing and hay-cropping on natural grassland regeneration (without seeding), were a partner site to the Brignant experiments at Pwllpeiran. They were lost in 2008 after being accidentally ploughed.

The Sourhope flagship research site was closed when funding ceased on the completion of the NERC's soil biodiversity programme (1998-2003). The Rigg Foot experimental site was eventually ploughed (Andy Sier, pers. comm., 2014).

The Gaisgill experiment was the partner to the Raisbeck LTE, located on an improved, species-poor upland hay meadow site; both were also twinned with the lowland hay meadow sites at Pentwyn and Bush. The experiments were established to identify sustainable nutrient input practices for the maintenance of botanical diversity and community structure in the meadows, and determine optimum land

management practices for the restoration of botanical diversity to species-poor meadows. The Gaisgill site was also used to investigate the potential of green hay spreading to enhance plant species-richness in species-poor upland meadows. Treatments ceased in 2010 and the Gaisgill site was lost in 2013, when it was returned to the farmer and fertilized (Anne Bhoghal, pers. comm., 2014).

All of the sites closed between 2008-2014 were considered as priority experiments (Table 3.1).

3.2.2 New experiments

One 'new' LTE – i.e. an experiment established between 2003 and 2008, which was too young to meet the longevity criteria at the last survey – has been identified. The Bangor Henfaes Diverse study was established in 2004 to explore the relationship between tree diversity and forest ecological functioning and sustainability (Section 3.2.1 *(v)*).

3.2.3 Cessation of experimental treatments

Treatments stopped at a further 14 experiments between 2008 and 2014. The majority of these experiments were mothballed with no plans for further research in the short to medium term:

- Elan Valley
- Newborough
- Pentwyn & Bush (2 experiments)
- Raisbeck
- Pwllpeiran (2 experiments)
- Thursley Common (1 experiment)

Six of these experiments were considered to be priorities in the 2008 survey. These include the grazing management experiments at Pwllpeiran, the three remaining nutrient experiments at Pentwyn, Raisbeck and Bush, the nutrient and burning experiments at Thursley Common, which are discussed in more detail below.

A further 6 experimental sites (Bamford and Hordron Edge, Colt Park, Culardoch, Dale and Henfaes FACE) are now considered to be active PTREs.

3.3 Discussion

3.3.1 Loss of overall UK experimental capacity

Although value remains in long-term post treatment recovery studies, the loss of 3 LTEs and cessation of treatments at 14 others constitutes a reduction of 62% of the UK's active experimental platforms in the past 6 years. Given the loss of treatments at 10 (43%) of those with the highest research value, these changes represent a significantly greater loss in terms of the UK's long-term ecological experimental research capacity.

This amounts to a cumulative total of 192 years of research, and capital and maintenance costs running into tens of million of pounds. Assuming all the experiments that had been lost were re-established concurrently, these facilities would take a minimum of 20 years to replace.

3.3.2 Loss of active research at priority sites

Whilst some of the research sites closed may have reached the end of their scientific value – the closure of the woodland canopy over time at Bradfield Woods, for example, rendered the experiment of less interest for bird studies (Rob Fuller, pers. comm., 2014) – the closures and cessation of treatments at several LTEs represent a major capability loss.

The cessation of treatments at Raisbeck, Pentwyn and Bush and the closure of Gaisgill are particularly significant, as the paired experiments were the only remaining modern, replicated, continuously maintained LTE focusing on the botanic and agronomic impacts of nutrient addition for sustainable land management (Kirkham et al., 2008; Tallowin et al., 2014). Previous work at these sites has been fundamental to improving management and restoration of upland and lowland meadows, a Biodiversity Action Plan habitat that has undergone a 97% decline in England and Wales over the last century. Moreover, the unique, species-rich upland hay meadow LTE at Raisbeck – representative of a habitat of which it is estimated there are less than 1,000 ha remaining in northern England – is now thought to be at extreme risk (J. Tallowin, pers. comm., 2014). Although the sites at Pentwyn and Bush are more secure, the research value of the four combined experiments, comprising comparable upland and lowland LTEs as well as species-poor and species-rich plots, has been significantly diminished by the loss of treatments since 2010.

Likewise, the cessation of treatments at Thursley Common has led to the loss of active research at the only long-term lowland heathland experiment studying the effects of different management methods on nitrogen storage and removal in Europe. Lowland heath is also a priority habitat, a Biodiversity Action Plan target which has experienced an 80% loss since 1800, and it is estimated that the UK retains a fifth of the world's remaining stock. Results from Thursley Common have been integral to maintaining and enhancing a valuable and rare habitat with studies leading to a revision of the critical loads of nitrogen for lowland dry heaths at the European level (Power et al., 1998a, b; Phoenix et al., 2012). Research has also contributed to an improved understanding of how management can be used to mitigate the long-term impact of nitrogen deposition both in the UK and Europe-wide.

Of the remaining inactive PTREs, two are considered unique. The Newborough site provided the only UK evidence on nitrogen impacts in dune environments and research underpinned calculations of critical load for nitrogen in coastal dune grassland habitats (Lawrence Jones, pers. comm., 2014). Similarly, Henfaes FACE was the only experiment in the UK studying the impacts of increased carbon dioxide concentrations on forest ecosystem dynamics and biogeochemical cycling. Understanding how forests alter the carbon flux between the atmosphere and terrestrial biosphere is fundamental to establishing the potential of forest above- and below- ground ecosystems to sequester carbon and hence ameliorate the effects of climate change (Smith et al., 2013a,b).

3.3.3 Loss of LTEs in experimental diversity

The loss of active LTEs also has implications beyond the loss of specific experiments and the value of research at an individual site. Since 2008, there has been an overall loss in the number and diversity of LTEs (Figure 3.5), restricting the potential for comparisons between experiments and across different ecosystems. This makes it more difficult to distinguish between site specific and habitat-wide impacts, and elucidate processes, thresholds and responses to similar drivers in different sites.

Most notable has been the decline in LTEs based on grassland, particularly neutral grassland, and lowland heath since 2008 (Table 3.4). Following the loss of research at Thursley Common, the only remaining active lowland heath experiment in the UK is the nutrient addition experiment at Little Budworth Common, which has no secure funding (Simon Caporn, pers. comm., 2014).

Although the relative decline in studies in upland heath has been less severe, the cessation of treatments at Bamford and Hordron Edge following the closure of partner sites at Sourhope, Carneddau and Cannock Chase, has also resulted in the loss of the only active long-term bracken control LTEs in the UK. Although post-treatment recovery monitoring is ongoing, this represents a significant loss in capacity, particularly considering these sites previously provided the evidence base for agri-environment schemes and Biodiversity Action Plan targets geared to reversing bracken invasion / colonisation on UK moorland.

Figure 3.5: Relative proportions of LTEs across different habitats (a) 2008 (b) 2014

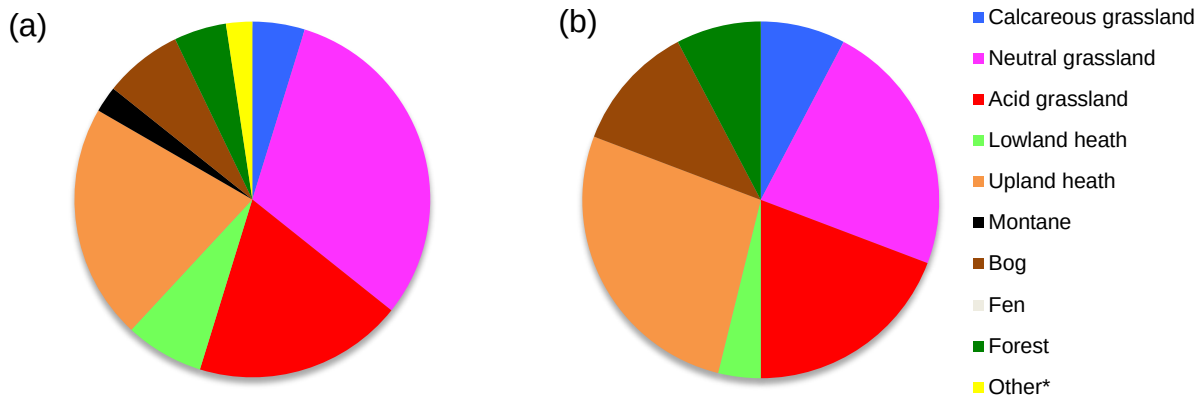


Table 3.4 % Loss of Active LTEs by habitat, 2008-2014

	Grassland			Heath						
	Calc.	Neut.	Acid	Lowl.	Upl.	Montane	Bog	Fen	Forest	Other*
% change since 2008	0%	-53%	-37%	-66%	-22%	-100%	0%	0%	0%	-100%

The loss of the remaining active nutrient and grazing treatments at Culardoch and Newborough has resulted in the total loss of experimental capacity in coastal or montane ecosystems, whilst the cessation of treatments and monitoring at Dale, Pembrokeshire, which evaluated different methods of recreating coastal heathland, means that all the UK's active restoration experiments are now on grassland.

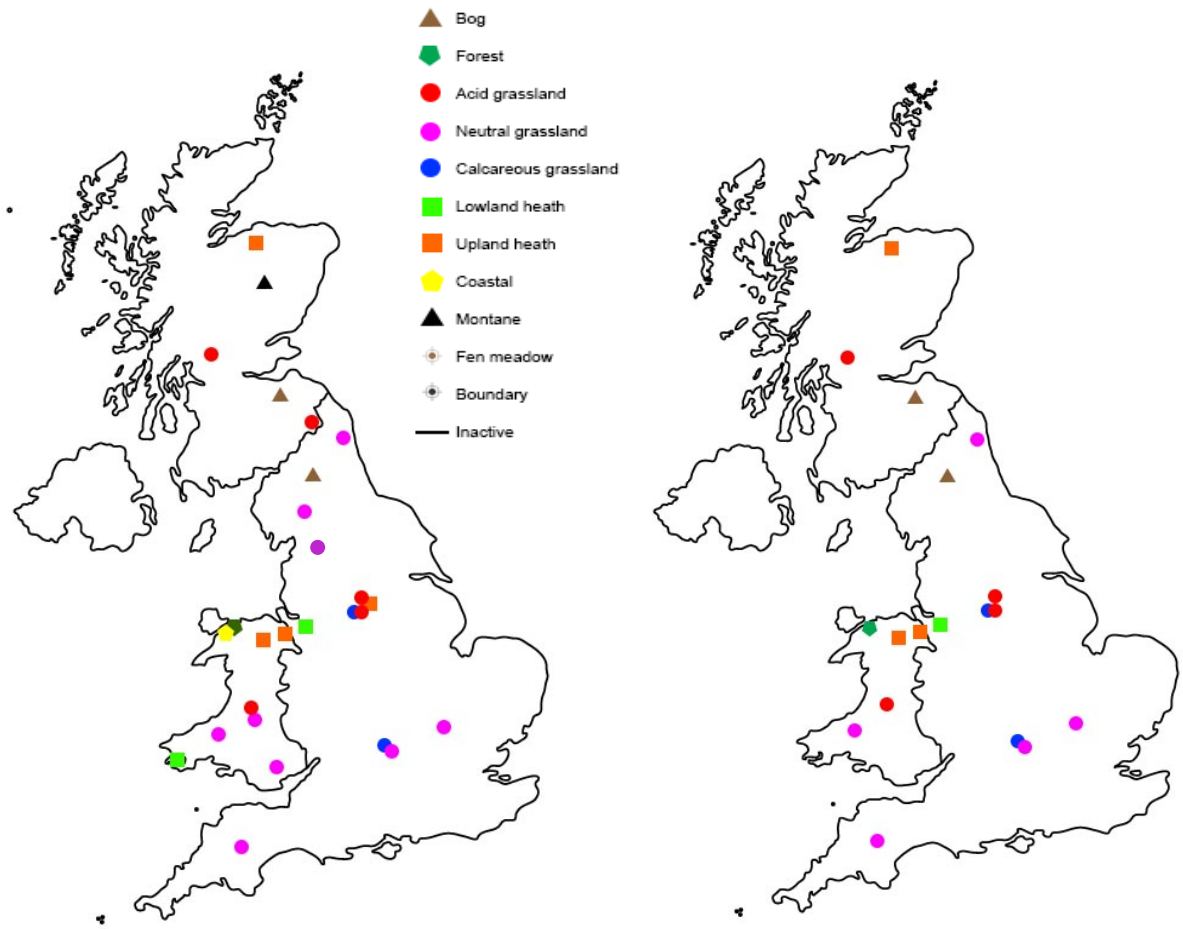
The overall decline in experimental diversity undermines the potential for future research into these ecosystems, which will be needed to support the aspirations of the Biodiversity Strategy 20:20, namely to '*halt the loss of biodiversity and continue to reverse previous losses through targeted actions for species and habitats'* and create and restore 200,000 ha across 19 broad habitat types by 2020. (Biodiversity 20:20 A strategy for England's Wildlife and Ecosystem's Services, *DEFRA 2011).*

3.3.4 Loss of geographic range

The changing geographic distribution of LTEs also has implications for ecological research and training, limiting the accessibility of active long-term ecological experiments. The absence of active sites in the south and south-east is particularly notable, meaning students in these areas are less likely to have access or even be familiar with ongoing research at active experimental sites (Figure 3.6). The distance to travel and costs of accommodation will also make it more difficult for students to undertaken undergraduate dissertations, Masters or Ph.D studies based on existing active LTEs. This has important implications for the future of long-term experimental ecological research, and the security of all but a few of the most famous sites.

The issue may be exacerbated in the long-term by the changing ownership of the UK's long-term experiments, with dedicated research institutions, such as the Centre for Ecology and Hydrology (CEH), Rothamsted and the James Hutton Institute (JHI), becoming relatively more important compared with Government-funded advisory bodies, such as Natural Resources Wales, commercial organizations (ADAS Ltd.) and University departments since 2008. Whilst this may be a function of the greater degree of protection such institutions provide long-term experiments, their ownership by institutions without students may lead to a lack of awareness or familiarity with the potential of existing LTEs by students during the formative years of their research.

Figure 3.6 Distribution of Active LTEs 2008 and 2014



4. The Future of Long-term Experiments

4.1 Experiments under threat

4.1.1 Overview

Of the 26 remaining active LTEs, 5 are considered to be at immediate risk, with potential loss of the site within 1-2 years:

- BCCIL
- Clocaenog
- Denmark Farm
- Peaknaze
- Brignant, Pwllpeiran

These include all the UK's long-term climate change experiments, a quarter of the active priority experiments and 50% of the LTEs remaining on calcareous grassland. These sites represent 90 cumulative years of research.

A further 8 sites (Glen Finglas, Little Budworth Common, the Paddocks, Pwllpeiran, Ruabon, Wardlow Hay Cop, Whim Bog and Wytham 'Upper Seeds') are considered to be under threat in the medium term (2-5 years). These are all priority sites. If these sites are closed, the UK will lose the last remaining active LTE on lowland heathland, 5 of the remaining UKREATE nitrogen pollution experimental network, including the world's longest running factorial nitrogen and potassium experiment on grassland, and the first LTE worldwide to compare impacts of all three forms of nitrogen at the same site. Also at risk are the last remaining active LTEs on calcareous grassland, as well as the oldest extant arable to grassland reversion experiment in the UK.

Of the remaining active and inactive post-treatment monitoring experiments, both the Nanty Paddocks and Tir Emrys plots at Pwllpeiran, as well as the experimental plot at Raisbeck, are considered to be at immediate risk.

4.1.2 Threats

The principal threats identified in the survey can be summarized as a combination of one or more of:

i. Lack of funds
ii. Changes in key staff
iii. Changes in site ownership and/or management

Potential threats to the intellectual property and previous research investment have also been identified in the way experimental data are managed and archived for active LTEs, PTREs and closed experimental sites.

(i) Funding

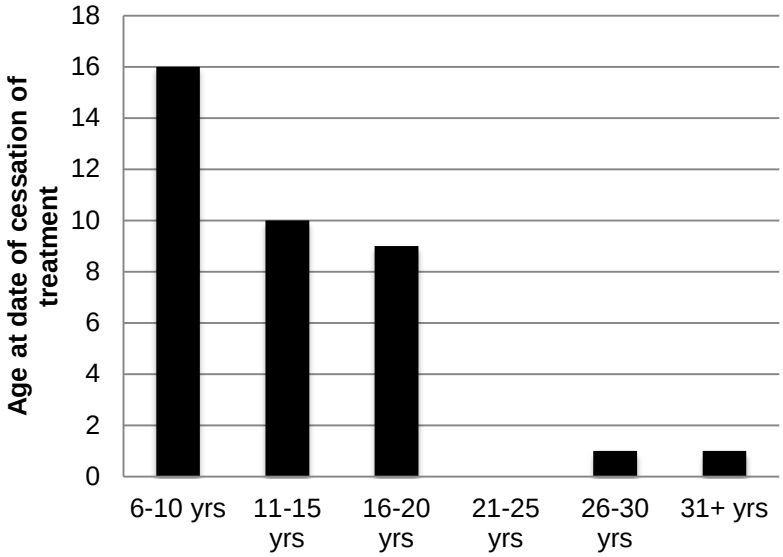
Most LTEs are funded by NERC, BBSRC, DEFRA, the Welsh Assembly or Scottish Government. They are funded as discrete projects over a defined period (usually 4-5 years). These projects have specific, short-term objectives, which may be extended, although survey respondents indicated it becomes increasingly difficult to obtain further project funds as sites age. This reflects both the tendency for the rate of

change of ecosystem responses to experimental drivers to decline after the first phase following establishment, as well as shifts in research and policy interests over time. These factors make it both more difficult to publish results from experiments as well as making publications more infrequent, diminishing the perceived relevance and/or value of the LTEs.

The problem of obtaining long-term funding for experiments is exacerbated by the nature of University funding based on the current assessment frameworks. The Research Assessment Exercise (RAE) and now the Research Excellence Framework (REF) has a relatively short-horizon (4-5 yrs), whereas long-term experiments may take decades following their initial foundation for their latent value to be realized. The longevity of individual LTEs within a University department may therefore depend on other factors, including a site's value for staff training or student research (e.g. Wardlow Hay Cop, Palace Leas), as well as the willingness of individual researchers to act as 'champions' of an experiment over the long-term. Many of the remaining active LTEs and PTREs managed by Universities are currently managed and/or monitored on a voluntary basis by University staff. This includes Bibury, BCCIL, Ruabon, Little Budworth Common and Wytham 'Upper Seeds'.

Funding issues are reflected in the age of date of loss of the UKs active experiments, illustrated in Figure 4.1. The average age at cessation of experimental treatments is 12 years for both inactive and actively monitored post-treatment recovery sites. The average age of sites closed since 2008 is 12 years. It is also notable that the mean age of the UK's active experiments has increased from 20 to 33 (14 to 24 years if Park Grass and Palace Leas are omitted) since 2008, reflecting the absence of new experiments being established since 2004.

Figure 4.1 Age at date of cessation of experimental treatments



Note: Experiments for which date of cessation of treatments is unknown have been omitted

Long-term funding is particularly problematic for LTEs such as BCCIL or Clocaenog with high infrastructural costs – the estimated cost to maintain such infrastructure, excluding research is estimated at £90,000-£150,000 p.a. This makes climate change experiments both more difficult to establish, as well as placing them at particular risk. Whilst sites with lower labour costs, such as Wardlow Hay Cop (est.

£10,000 p.a. including survey and treatments), may be sustained for a short periods through use of technicians or post-graduate students, climate change experiments like BCCIL cannot be maintained without dedicated staffing, and are therefore vulnerable to even short periods without external funds.

This makes large-scale platforms, analyzing multiple drivers, or those with costly, complex infrastructure much more likely to be established and sustained within the framework of a research institution such as the James Hutton Institute, rather than a University Department, charity or Governmental body. This may be one of the reasons why the ownership and management of the UK's remaining long-term experiments has become focused on research institutions rather than University departments since 2008. It may also explain the relatively high retention of LTEs in Scotland, where only 2 active experiments are no longer receiving treatments compared to the 33% decrease in the number of active LTEs in England and a 47% fall in the number in Wales since 2008. All the remaining sites in Scotland have been integrated into the newly established James Hutton Institute, with the exception of the THISTLE and Whim, which remain administered by CEH, Edinburgh (Table 4.1).

Table 4.1 Loss of regional capability

	% loss of regional capacity between 2008-2014		
Region	England	Scotland	Wales
Active LTEs	33%	22%	47%

(ii) Changes in key staff

With the exceptions of very old sites, such as Park Grass and Palace Leas, which are perceived to be an institutional asset or National Capability, most LTEs are founded and maintained by the same members of staff throughout their life. These researchers become 'champions' or perceived 'owners' of individual LTEs, rather than the University departments or institutions. Whilst this individual investment of effort may help secure the future of LTEs in the medium term, as founders are more likely to contribute time and effort on a voluntary basis for something they perceive as their legacy, it also makes it more difficult for new, particularly early stage researchers, to become involved in the management of LTEs in the longer term.

This presents a problem of succession when the experimental founder retires or moves to another position, illustrated by the issues at Thursley Common, Wytham 'Upper Seeds', and BCCIL. The emigration of the founder of Thursley Common stopped all active research, as no alternative custodian could be found (Sally Power, pers. comm., 2014), whilst Wytham was nearly lost following the death of its founder, and has only been saved by the sustained efforts of a voluntary scientific team. Likewise, day-to-day management at BCCIL continues to be undertaken voluntarily by a retired Professor from Sheffield University, with funding from the National Science Foundation of America paying for technical support and ongoing research in partnership with the University of Syracuse, USA. This has made the site extremely vulnerable, in spite of its obvious research value as the oldest climate change experiment in Europe and twenty-one year record of ground-breaking research. Managing the succession through key 'break-points' such as retirement is therefore one of the most important challenges to securing the future of the remaining active LTEs.

(iii) Changes in site ownership and/or management

The majority of LTEs are established by informal agreement with land-owners, putting them at risk from changes to ownership or tenants at the site. Whilst LTEs on National Nature Reserves or sites protected by Parliament (e.g. National Trust land), may be largely protected from changing site management, sites owned by farmers, shooting estates or short-term tenants are not.

This issue was illustrated by the problems experienced by the Pwllpeiran research facility in Wales, which was managed by ADAS until 2011. After the decision by ADAS not to renew their lease, the land-owners, the Welsh Assembly Government, proposed to break-up and sell the site. Although lobbying by researchers at the University of Aberystwyth, charitable organisations and Natural Resources Wales eventually reversed this decision, the uncertainty over Pwllpeiran's future, and the delays resulting from the confusion, led to treatments at several experiments being stopped. Those that have been maintained have been saved as the result of individual voluntary efforts, not by any long term planning for the sites. Despite an estimated £2 Mn having been set aside to reestablish the research farm's facilities following its transfer to the University of Aberystwyth in 2014, there remains considerable uncertainty over funding of these experiments in the short term.

(iv) Data management and archiving

Data from several sites has been identified as at risk during the survey, including:

- Colt Park
- Dale
- Glen Clunie / Glen Shee
- Pwllpeiran (multiple LTEs)
- Rhos-Llawr cwrt

Poor data management is particularly problematic for inactive PTREs or closed experiments, where historic records were retained as paper archives, on old computer software and / or were not properly collated and archived before the active research ceased. Re-establishing site procedures and treatments, or even the whereabouts of historic data may be extremely challenging if the site founder has died, or retired, and only becomes more difficult over time. Without a log of research activity or staff who were intimately involved in the research, it may be impossible to collate a comprehensive record even if digital files are available. Maintaining these archives and making them readily accessible for future research is also likely to be challenging where there is no ongoing active research or funding for the site itself.

As with experimental infrastructure, the most vulnerable times for data management and archiving is during periods of changing management and/or retirement of key staff. If this accompanies site closure, or a cessation of active research, there may be no obvious person or institution to pass the data to. Thus, it has not been possible to establish the whereabouts of data from the closed Trawsgoed experiment or the inactive Nanty Paddocks LTE at Pwllpeiran. It is also suspected that some of the historic data from these experiments may have been lost during the transfer of ownership and management of the Pwllpeiran site (Dr Mariecia Fraser, pers. comm., 2014). Likewise, it has not been possible to establish the data archive for the Colt Park experiment following the retirement of the Principal Investigator, Dr Roger Smith, although paper files and selected spreadsheets have been retained by NNR staff.

Identifying a future data repository is also a particular problem for LTEs maintained on a voluntary basis by individuals, or by charities without data management capabilities. This includes the active LTE at Denmark Farm, whose data have been collated by a retired site ecologist, Dr Richard Williams, and historic data from the active PTRE at Aston Rowant (Ward Plots), which are currently retained by an independent researcher, Dr Tim King. The long-term problem of data archiving is also characteristic of most of the research undertaken on deer exclosure experiments, particularly the datasets from monitoring campaigns undertaken voluntarily by Dr George Peterken, Dr Ed Mountford and Dr Jim Latham at Denny and Lady Park Woods and Coedydd Aber, as well as the voluntary monitoring carried out by Drs Arnold Cooke, Tim Sparks and Owen Mountford at former sites in Monks' Wood.

5 Conclusions

In spite of the demonstrable contributions of long-term experiments to ecological science, practical land management and environmental policy, there has been relatively little investment in maintaining or expanding our experimental infrastructure since 2008. Since the peak of experimental ecological research in the 1990s and early 2000s, one new experiment has been identified which has lasted for more than six years. During the same period, the UK has lost three priority experiments and treatments have stopped at another 14 sites. This constitutes a reduction of 62% of the UK's active experimental platforms and termination of 192 years of experimental research; given the loss of treatments at 10 (43%) of the experiments deemed of the highest research value, these changes represent a significantly greater loss in terms of the UK's long-term ecological experimental research capacity.

Of the active sites remaining, 5 are considered to be at immediate risk of closure, including all the UK's long-term climate change experiments and a quarter of the sites identified as most valuable to science. Current funding structures, focused on short-term objectives, have been the primary cause of this problem: project funding does not fully take account of the latent value of long-term studies, nor the cost-benefits in maintaining established facilities with decades of existing data to underpin future research. Nor do the current university assessment frameworks, with their relatively short horizon, recognize long-term, frequently voluntary contributions to maintaining experiments that may take decades following their initial foundation for their latent value to be realized.

The piecemeal approach to LTE management and data archiving has been identified as serious issues, with sites being at the highest risk of closure when founding members of staff retire or change post. This reflects the degree to which experiments continue to be maintained by individual scientists over the long-term, frequently on a voluntary basis, rather than integrated and embedded into an institution and recognized as an asset or national capability.

The success of experimental networks like UKREATE, INCREASE and EPRECOT, as well as monitoring networks such as the Environmental Change Network, offer a model that could be adopted for long-term experiments, namely the establishment of a strategic network of the most valuable LTEs. Similar networks have demonstrated the considerable benefits which can accrue when long-term studies are integrated, technical knowledge and experience is shared, data are centrally archived and sites are embedded within an institutional framework.

An LTE network, based across a range of different habitats and incorporating different types of experiments, would provide evidential underpinning for, and integrate with, the Government's aspiration to establish '*an ecological network which would effectively conserve biodiversity and ecosystems services, shifting conservation from piecemeal activity towards a more effective, more integrated landscape-scale approach'* (Biodiversity Strategy 20:20: DEFRA, 2011).

Sites within the network should be used as hubs, contributing to knowledge exchange, adding scientific value to existing and developing LTEs and the dissemination of research to local policy-makers, scientists and practitioners, as well as the supporting the public understanding of science through open days and other educational and outreach activities. This is in line with the Biodiversity Strategy's explicit commitment to harness the collective effort of voluntary, academic and business sectors, and enthuse and educate the public about biodiversity.

Addressing funding challenges

Reductions in spending in large parts of the public sector are a major challenge to maintaining experiments at the present time and securing a large additional investment in an experimental network would be very difficult in the next few years. However, a coordinated network offers opportunities for cost efficiencies, for example shared use of equipment, access to expertise and adopting common approaches to site and database management.

There are also opportunities to access alternative sources of funding more easily when centrally coordinated. One particular problem is that many experiments go through periods of intense activity but funding is not continuous and it is hard to maintain treatments and basic monitoring between large research grants and contracts. In many cases the costs are relatively small but are not eligible for most funding sources. This may lead to new experiments being established at much greater cost at a later date and prevents a proper understanding of some of the most important ecological processes.

Since it was established in 2008 the Ecological Continuity Trust (ECT) has financially supported LTEs via a grants scheme. The level of funding has been relatively small but even quite small grants have been invaluable in bridging gaps in funding and addressing practical management problems on sites (for example renewing fencing) where other sources of funding were not available.

The ECT can facilitate the establishment of an LTE Network and be a conduit for philanthropic contributions for this purpose. Other sources of funding will however be required to meet the needs identified in this report. A broad coalition of public, private and charitable funding is likely to offer the best chance to reverse current trends and capitalize on the rich resource that long term experiments represent. The need for this is now critical.

In addition to the overarching strategic needs there are some immediate specific requirements to maintain long-term experiments and maximize their value:

- Funds are required to support the collation and validation of data of long-term experiments at Colt Park, Dale, Glen Clunie / Glen Shee, Pwllpeiran and Rhos-Llawr cwrt, in collaboration with site managers and former researchers at the sites, as well as to identify the whereabouts of data for the New Forest Putnam plots and the Wytham B Climate Change experiment.

- Funds are required to facilitate the migration and validation of data in out-of-date formats, for the Wytham ‘Upper Seeds’. This would make a significant contribution to the ongoing renaissance facilitated by the ECT with grants from the Patsy Wood Trust to the Wytham LTE following its near-closure in 2010.

- A log of research activity and available datasets, similar to those compiled for BCCIL and Denmark Farm (Appendix 4) should be compiled for, in order of priority: (i) active LTEs, (ii) active PTREs, (iii) inactive PTREs and (iv) closed sites.

- A full publication list should be completed for all LTEs.

- An online database of UK long-term experiments should be established. This could be hosted on the ECT website and developed in phases as part of a proposed website update. The Phase I database should be based on information already gathered as part of this survey, with primary, searchable fields based on the categories set out in Appendix 1. In the first instance, the database should be geared to providing contact details, essential background information on experimental design and treatments, including a site plan, as well as a summary of key research findings suitable for policy-makers and practitioners as well as scientific researchers. The interface should be designed to be flexible, to reflect the needs of the end user(s) – i.e. those looking for evidence to support decision-making, interested in data available in specific habitats or regions, etc. - as well as providing a directory for researchers or students interested to undertake work at a site.

- The Phase II database should be updated to include a publication list, a log of research activities and available datasets for each site once these tasks have been completed.

- Phase III developments should include enabling downloads of spreadsheets submitted by (and subject to agreement of) sites' Principal Investigators, where no existing online sources are available (e.g. Denmark Farm; forestry exclosures, etc.). Further initiatives may include an online library of unpublished reports or similar grey literature not widely available through websites such as DEFRA or Web of Science.

- During ECT website development links should be pursued with relevant initiatives, such as Conservation Evidence, and potential end-users or stakeholders such as Forest Research, the Sylva Foundation, the Deer Initiative, the National Trust, the Country Landowners Association, the British Ecological Society, etc., in order to ensure that the database does not duplicate existing efforts, meets a real need and is designed with an interface with the potential end-user in mind. Involving key stakeholders during development and linking to associated sites once the website is established will help raise awareness of the online facility. Links should also be pursued with the relevant University / departmental / institutional webpages and contacts.

- Further work needs to be undertaken to ascertain the status of the forestry deer exclosure experiments identified during this survey but for which no further information was obtained. The database compiled by Rob Fuller in the 1980s should be reviewed. Deer exclosure experiments should be included on the database once sufficient information on their status has been obtained.

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APPENDICES

Appendix 1: Summaries of UK LTEs, 2008-2014

ASTON ROWANT / Well's plots		
Project code/names		NA
Type of experiment	LAND MANAGEMENT	INACTIVE PTRE
Details	Grazing experiment	Lowland Calcareous Grassland
Dates established	1964-1994	
Location	Oxfordshire, England	SU7296
Institution	CEH, Wallingford	
Contact	Richard Pywell rfp@ceh.ac.uk	
Address	Centre for Ecology & Hydrology, Maclean Building, Benson Lane, Crowmarsh, Gifford, Wallingford, Oxfordshire, OX10 8BB	
Description	Studies impacts of grazing intensity on lowland calcareous grassland.	
Plot size	1/3 acre - 3 acres	
Treatments	3 treatments: (1) No grazing; (2) Grazing by 1 sheep per acre (2.5 per ha); (3) Grazing by 3 sheep per acre (7.5 per ha). 3 replicates each treatment. Treatments ceased in 1994.	
Subplots		
Treatments		
Baseline data	Vegetation recorded twice a year 1964-1969 & once in 1973 comprising rooted frequency in 50 20x20cm quadrats per acre. Also mean height of vegetation recorded; sheep weighed. Fixed-point photography.	
Data archiving	Data retained by CEH Wallingford.	
Partner sites		
Key Research	Changes in grassland structure, especially tussockiness. Impacts of scrub grazing noted, especially at higher grazing pressure. Juniper not grazed. See Wells, 1976; Wells 1969.	
Notes	The plots have not been monitored since 1994 and there are no plans to. However, it would be possible to relocate the plots should there be interest in doing so.	

ASTON ROWANT / Ward plots

Project code/names		NA
Type of experiment	LAND MANAGEMENT	ACTIVE PTRE
Details	Grazing, burning and rotavation experiment	Lowland Calcareous Grassland
Dates established	1969-	45
Location	Oxfordshire, England	SU 730966
Institution	Independent	
Contact	Tim King | info@timjking.co.uk	
Address		
Description	Experiment into the secondary succession of chalk grassland to scrub and impact on floristic diversity of flowering plant species and seed banks.	
Plot size	12 x 10 m	
Treatments	4 blocks of 4 treatments: (1) grazed (2) ungrazed; (3) ungrazed following burning; (4) ungrazed following rotavation.	
Subplots		
Treatments		
Baseline data	All species in plot & DOMIN in quadrats from 1969-1982. 5 plots each of 36 quadrats surveyed 1990-91 & permanently marked. Also vegetation structure and other features. Believed to be annually monitored since 2007.	
Data archiving	All historic and current data (including Ward studies) held by Tim King.	
Partner sites		
Key Research	Demonstrated 14 years of secondary succession to scrub from chalk grassland. Analysed inter-annual variability and longer term directional trends in floristic diversity and proliferation of specific species at different stages after different initial disturbances. Postulated that reintroduction of grazing before establishment of high dominance of woody species would reverse observed changes. ***Ward, L.K. and Jennings, R.D. (1990)*** *Succession of Disturbed and Undisturbed Chalk Grassland at Aston Rowant National Nature Reserve: Dynamics of Species Changes, Journal of Applied Ecology , Vol. 27, No. 3, pp. 897-912.* ***Ward L.K. & Jennings R.D. (1990)*** *Succession of disturbed and undisturbed chalk grassland at Aston Rowant National Nature Reserve: details of changes in species. Journal of Applied Ecology, 27, 913-923*.	
Notes	Site is believed to be monitored annually by Dr Tim King, following the retirement of Dr Ward. However, there have been no recent publications (Simon Mortimer, pers. comm., 2014).	

ASTON ROWANT / Hay spreading

Project code/names	Lewknor plots; BD1414 and BD1441	29
Type of experiment	RESTORATION	INACTIVE PTRE
Details	Arable reversion	Lowland Calcareous Grassland
Dates established	2001-6	
Location	Oxfordshire, England	SU7269
Institution	Reading University	
Contact	Simon Mortimer	s.r.mortimer@reading.ac.uk
Address	School of Agriculture, Policy and Development, University of Reading, Whiteknights, PO Box 237, READING, RG6 6A	
Description	Arable reversion experiment to determine efficacy of green hay for calcareous grassland restoration.	
Plot size	10 x 10 m	
Treatments	4 blocks, replicated with 2 experimental plots, randomly allocated (i) control (receiving no restoration management) or (ii) single hay-spreading treatment. Green hay was harvested from local donor sites. Grazing by sheep from May over 3–4 months in blocks of 4–5 weeks until sward 4–7 cm. Sward allowed to regrow to 15–20 cm after each grazing period.	
Subplots		
Treatments		
Baseline data	Plant community composition was recorded for all experimental plots between May to July, starting the year after restoration was initiated (2002-4). Beetle sampling carried out 2002-4, three times a year (May, July and September). Site has been monitored sporadically since 2004.	
Data archiving	Monitoring and management held in spreadsheets by Simon Mortimer	
Partner sites	Princes Risborough, Buckinghamshire (chalk grassland, established 1998; **also known as Brush Hill***); Hastingleigh, Kent (chalk grassland, established 1999; **also known as Cold Blow***); Penshurst, East Sussex (lowland hay meadow, established 2000; **also known as Rocks Farm**); Aston Clinton, Buckinghamshire (chalk grassland, established 2000*); Netherfield, East Sussex (lowland hay meadow, established 2001; also known as Little Sprays. All studied until 2005.	
Key Research	Data integral to multi-site studies into improving the efficacy of grassland enrichment and reversion initiatives and establishing best practice for lowland arable reversion and enhancement. Project demonstrated the benefit of green hay spreading to promote restoration success for plant communities in both mesotrophic and calcareous grasslands, as well as associated species of phytophagous beetles. The proportion of species-rich grassland and its connectivity to the experimental sites within the local landscape was shown to be linked to increased restoration success of the beetle, demonstrating land restoration and management choices should take into account wider landscape when considering restoration of invertebrate diversity. *(**Woodcock, B. A et al.** The role of management and landscape context in the restoration of grassland phytophagous beetles. Journal of Applied Ecology 2010, 47, 366–376).*	
Notes	The site is permanently marked and has security of tenure on the NNR, but it has not been monitored since 2006, following the cessation of DEFRA funding in 2005.	

BAMFORD EDGE

Project code/names		26
Type of experiment	LAND MANAGEMENT	ACTIVE PTRE
Details	Bracken control	Upland Heath
Dates established	2004-2012	
Location	Derbyshire, England	SK 213 841
Institution	Liverpool University	
Contact	Rob Marrs calluna@liv.ac.uk	
Address	Applied Vegetation Dynamics Laboratory, School of Vegetation Dynamics Laboratory, University of Liverpool, Liverpool, L69 7ZB	
Description	Experiment to investigate the benefits of bracken bruising as a management technique.	
Plot size	20 x 20 m	
Treatments	3 replicate blocks of 66 m x 45 m, with 6 main plots in a randomized block design. 6 bracken control treatments: untreated, cutx2/yr, cutx3/yr, bruise x2/yr, bruise x3/year, asulam once as overspray + spot kill annually until extinction.	
Subplots		
Treatments		
Baseline data	Baseline data on vegetation, bracken rhizomes and soils collected. The experiments are complemented by landscape scale vegetation mapping by remote sensing and digital elevation modelling to help establish restoration objectives within a wider landscape context. Detailed analysis of the available seed bank has also been undertaken better to understand the potential for recolonization.	
Data archiving	The full suite of data from the site is not available electronically due to database migration issues. The experiment would benefit from a short (<month) project to migrate and validate all data (Rob Marrs, pers. comm., 2014)	
Partner sites	Hordron Edge	
Key Research	No specific publications for the site. See: Ph.D thesis: *COX, E.S. 2007. The implications and effects of bracken (Pteridium aquilinum (L.) Kuhn) control on species diversity, re-vegetation and bracken performance. University of Liverpool .*	
Notes	Restrictions on the use of the herbicide absulam has meant the treatments have had to stop at Bamford Edge and the paired Hordon Edge site. The experiments now investigate the rate of bracken recovery / recolonisation following treatment.	

BIBURY

Project code/names		26
Type of experiment	LAND MANAGEMENT	ACTIVE PTRE
Details	Herbicide treatment	Road verge
Dates established	1958-1962/1990	
Location	Gloucestershire, England	SP119048
Institution	Sheffield University	
Contact	Nigel Dunnett n.dunnett@sheffield.ac.uk	
Address	Department of Landscape, University of Sheffield, Arts Tower , Western Bank , Sheffield, S10 2TN	
Description	Studying impact of herbicides and growth retardants on floristic diversity.	
Plot size	20 x 4 m	
Treatments	20 m lengths of verge were sprayed with (i) maleic hydrazide (growth retardant) (ii) maleic hydrazide +2,4- (herbicide; (iii) 2,4-D only. Six 20 m lengths acted as unsprayed controls for (i) and (ii); 2 plots of more ancient vegetation act as controls for the 2,4-D only plots, with cut at a height of 0.5 m annually in November ('topping'). (Yemm & Willis 1962). All spraying ceased in 1990.	
Subplots		
Treatments		
Baseline data	Permanent marked quadrats used for vegetation monitoring each July. Estimates of species biomass backed up by harvested & dried samples at intervals during the study. Experimental studies carried out ex situ using plant material transplanted from the study site.	
Data archiving	All data held by Nigel Dunnett.	
Partner sites		
Key Research	Over 100 species have been recorded from the site. The dataset represents a unique long-term record of the dynamics of a complete plant community (Dunnett et al., 1998) and has been used to test hypotheses on plant biomass and diversity relationships, as well as community and species responses to climatic variations. The findings from this research are of direct relevance to the application of ecological ideas to the design and management of herbaceous plantings in parks and gardens. It has been demonstrated that the biomass and species richness of vascular plants at the site are at or near equilibrium and it is now impossible to distinguish treated and control plots in terms of bio-mass, species richness or composition (Thompson et al., 2005). *See **Dunnett, N.P. et al**. **1998** A 38 year study of relations between weather and vegetation dynamics in road verges near Bibury, Gloucestershire. Journal of Ecology 1998, 86, p610-623. **Thompson et al. 2005** Biodiversity ecosystem function and plant traits in mature and immature plant communities; **Thompson, K., Petchey, O. L., Askew, A. P., Dunnett, N. P., Beckerman, A. P. and Willis, A. J. (2010),** Little evidence for limiting similarity in a long-term study of a roadside plant community. Journal of Ecology, 98: 480–487. doi: 10.1111/j.1365-2745.2009.01610.x*	
Notes	The plots are permanently marked and the site has been monitored every July by the same recorder and using the same protocol. Annual monitoring at Bibury is believed to be privately funded although this has not been confirmed with the current PI. There is some risk that monitoring may cease and/or continuity will be lost on the current researcher's retirement.	

BRADFIELD WOODS / Exclosures

Project code/names			NA
Type of experiment	DEER EXCLOSURE	INACTIVE	
Details		Coppiced woodland	
Dates established	1999-2003		
Location	Suffolk, England	TL933575	
Institution	British Trust for Ornithology		
Contact	Rob Fuller	rob.fuller@bto.org	
Address	British Trust for Ornithology, BTO, The Nunnery, Thetford, Norfolk IP24 2PU.		
Description	Deer exclosures and unfenced 'control' used to establish impacts of deer browsing on woodland bird species in a coppiced woodland managed for conservation. The woods are managed on a 25-year cutting cycle with an average of 1.15 ha (±0.45 sd) cut each year between 1998 and 2008.		
Plot size	0.42 ha		
Treatments	Eight deer exclosures with one or two exclosures constructed per year in newly cut coppice. Each exclosure was paired, in a split-plot design, with an adjacent area of similar size cut at the same time (the controls). Fencing treatments were allocated randomly within the eight split-plot pairs. The experimental treatment contrasted complete exclusion of deer, with initial partial exclusion in years 1–2 (owing to the presence of a brushwood fence) followed by regular browsing by roe deer, Reeves's muntjac and fallow deer.		
Subplots			
Treatments			
Baseline data	Annual monitoring of vegetation structure and bird population data, comprising: canopy cover; density of field layer and shrub vegetation. During 2006 and 2007, relative abundance of invertebrates was sampled simultaneously in exclosures and controls by water trapping and estimation of foliage damage. Bird populations were studied in paired exclosure and control plots through mist netting.		
Data archiving	Data are held electronically in spreadsheets by Rob Fuller and Chase Holt at British Trust for Ornithology. A lot of data remain to be published, including inter-exclosure variability (Rob Fuller, pers. Comm., 2014)		
Partner sites			
Key Research	Study was the first deer exclusion experiment in Europe to test avian responses to deer, and the first to focus on regenerating woodland. It is also the first study to have included examination of habitat use by woodland birds in Europe during the post-breeding period. The experiment demonstrated impacts of deer browsing on vegetation structure by reducing canopy cover and shrub layer foliage density. The study also demonstrated that there are seasonal variations in bird responses due to browsing-induced modification of habitat structure in winter as well as in the breeding season, probably due to changes in both shelter and for- aging resources. The results are of particular relevance in view of the observed decline in woodland bird species in recent years and the increasing population of several deer species in lowland England. See ***Gill, R.M.A and Fuller, R.J. 2007*** *The effects of deer browsing on woodland structure and songbirds in lowland Britain. International Journal of Avian Science. (Ibis) 149 (Suppl. 2), 119–127.* ***Holt, C.A., Fuller, R.J., and Dolman, P.M. 2011*** *Breeding and post-breeding responses of woodland birds to modification of habitat structure by deer. Biological Conservation 144, 2151–2162.*		
Notes	Sites are regarded as reasonably secure (Rob Fuller, pers. Comm. 2014), although the closure of the woodland canopy over time since coppicing has rendered the experiment of less interest for birds studies.		

BUXTON CLIMATE CHANGE IMPACTS LABORATORY / BCCIL

Project code/names			33
Type of experiment	CLIMATE CHANGE	ACTIVE LTE	
Details		Upland calcareous grassland	
Dates established	1993 -	21	
Location	Derbyshire, England	SK 05350 70439	
Institution	University of Sheffield / University of Syracuse, USA		
Contact	Professor Phil Grime / Prof. Jason Fridley	j.p.grime@sheffield.ac.uk	
Address	Department of Animal and Plant Sciences, Alfred Denny Building, University of Sheffield, Western Bank, Sheffield S10 2TN / (Department of Biology, 107 College Place, Syracuse NY, 13244)		
Description	A climate change experiment involving elevated winter temperature, controlled summer drought, supplemented summer rainfall, elevated winter temperature and summer drought, elevated winter temperature and supplemented summer rainfall, and ambient controls.		
Plot size	3 x 3 m		
Treatments	Manipulations are applied in a fully randomised block design, replicated five times, each with spare plots. (i) control [ambient climatic conditions]; (2) winter warming [continuous elevation of temperature to 3 degrees centigrade above ambient from November 1st to May 1st using heating cables fastened to the soil surface; (3) summer drought [rainfall excluded in July and August using automated, retractable shelters and pipework] (4) supplementary rainfall [applied as required to raise receipt to 20% above long-term monthly average in June to September] (5) winter warming + drought ([combines treatments (2) and (3)].(6) winter warming + supplementary rainfall [combines treatments (2) and (4)].		
Subplots			
Treatments	In each block there are three spare plots which have allowed new experiments to be introduced during the course of the main experiment. A new seasonal warming experiment was established in 2011/2 to apply treatments to tall and short grassland in 25 outdoor microcosms. The experiment used small transplants of ten of the most abundant species in the Main Experiment together with two southern grasses to synthesise a set of matched grassland communities. Treatments were applied following a year of establishment.		
Baseline data	Vegetation surveyed annually since 1994 with nondestructive point quadrat touches (with gaps in 2005, 2007, and 2008) in early summer that correlate with total plot biomass. In 1994 a 1 m2 permanent quadrat was established in each plot and vascular plant cover was surveyed in 1994 and 2003, along with soil depth. Permanent microsite quadrats were established within each 3x3 m plot in 2008 at the 100 cm2 scale (8 per plot; see Fridley et al. 2011 for details). Species cover and environmental parameters have been monitored in microsites annually (2009-2011 controls only). Environmental data including soil depth and pH for each microsite are available.		
Data archiving	Online data archives to 2012 at https://sites.google.com/site/fridleylab/home/data		
Partner sites	Former lowland calcareous grassland site at Wytham (Wytham B)		

BUXTON CLIMATE CHANGE IMPACTS LABORATORY / BCCIL (cont.)	
Key Research	The ultimate objective of the BCCIL experiments is to contribute to our understanding of the processes by which ecosystems in UK (and elsewhere in the world) will be modified by future changes in climate. Early research established that productive vegetation at Buxton was resilient to the climate manipulations, whilst those at Wytham were substantially altered, suggesting a higher resilience to climate forcing. Further investigations into the potential causes of this resistance, including the relative significance of stress tolerance, microhabitat variability, genetic diversity and phenologic strategies, demonstrated that although the proliferation of stress tolerant species was a factor, individual species also exhibit characteristic changes in distribution along the soil depth gradient indicating that adjustments in species distributions with respect to fine-scale micro-topography is buffering plant populations against extinction. Initial data also suggest that genome size, having implications for growth rate and temperature sensitivity, are important factors in determining phenological responses to climate change and studies are ongoing into the relationships between genome size, leaf growth, phenology and warming. Further research into the extent to which resistance to climate change detected at BCCIL can be attributed to genotypic variation in component populations through investigating whether genetic divergence has developed in response to the different treatments is also being undertaken. Studies at BCCIL have also investigated the mechanisms preventing the colonization of 'alien' species adapted to higher ambient temperatures, with initial results showing that limited seed dispersal rather than climatic factors prevents invasion. Research is also ongoing into the impacts of long-term climatic treatments on genetics and epigenetics and the heritability of traits and the impacts of climate treatments on ecosystem function, including how well soils sequester carbon, and the impacts of climate variables on soils microbes and invertebrates.
Notes	The experiment is funded by the US NSF. This funding will cease in 2017. As costs are considerable, funding needs to be secured as soon as possible. The site is run on a day to day basis by retired voluntary staff with the site technician paid as a postdoc. There is no obvious replacement for the technician, and he is seeking to leave. There is no obvious successor for hand-over from current elderly site manager in the event of his inability to continue working at BCCIL. Experiment currently associated with but not administered by University of Sheffield, although it is believed they meet some costs. This remains a sensitive issue as the costs for utilities could not be met by the current funding (Jason Fridley, pers. comm., 2014). Although a lease has been discussed, there are no formal land tenure arrangements. This has recently caused some issues between the landowner and the University of Sheffield. However, relations between scientists and the landowner remain good and the landowner remains actively supportive of research at the site. Site infrastructure (excluding research equipment) is old and in need of replacement to maintain access and safety. The site must be formally embedded into a research institution for long-term security (Jason Fridley, 2014). NOTE – **CLOSED PARTNER LTE AT WYTHAM** - Although the site was closed and equipment removed around 5 years ago, the plots remain marked and could be revisited for post treatment monitoring (Mike Morecroft pers. comm., 2014). However, it has not been possible to establish the status of the data archive, and it is quite possible that it has been at least partially lost (Mike Morecroft, pers. comm. 2014)

CLOCAENOG / Climoor

Project code/names		32
Type of experiment	CLIMATE CHANGE	ACTIVE LTE
Details		Upland Heath
Dates established	1999	15
Location	Wales	
Institution	Centre for Ecology and Hydrology, Bangor	
Contact	Dr Bridget Emmett | bae@ceh.ac.uk	
Address	Environment Centre Wales, Deiniol Road, Bangor, Gwynedd, LL57 2UW	
Description	Second oldest climate change experiment in the UK. It investigates the possible impact of climate change on an Atlantic upland moorland, using automatic roof technology to warm experimental plots and reproduce drought conditions in other experimental areas.	
Plot size	3 x 4 m	
Treatments	Treatments comprise night time warming (+0.7 C) using retractable roof technology, but increasing growing days by 111% compared to control; Summer drought (July - September) reducing rainfall by 69%. The experiment has 3 replicates in a randomized block design.	
Subplots		
Treatments	Night-time temperature; Summer rainfall.	
Baseline data	Climate (temperature, rainfall cloud condensation.); Soil water quality, soil gaseous flux, soil nitrogen transformation, litter decomposition, vegetation production, nutrient status and compositional changes, soil carbon dynamics, root turnover, microbial composition.	
Data archiving	No information supplied; assumed CEH terrestrial database.	
Partner sites	Peaknaze / Recovery Roof	
Key Research	Initial results show that drought treatments experienced reduced soil moisture year-round, despite the high mean-annual rainfall. This relative soil moisture deficit stimulated soil respiration and altered below-ground carbon dynamics. Cross-site comparison work with other experiments in Denmark and the Netherlands have also shown that the moisture status of a habitat is crucial in predicting the response in terms of carbon balance to a drought situation (Sowerby et al. 2008). The IPCC fourth assessment report in 2007 - Climate Change 2007 – Impacts, Adaptation and Vulnerability cites extensively from the Climoor publication list and data from CLIMOOR (and Peaknaze) have been used in collaborative modelling exercises, integrated experimental and modelling approaches on the effects of precipitation changes on ecosystems across local, regional, and global scales as part of EPRECOT (Effects of Precipitation Changes on Terrestrial Ecosystems. - http://www.climaite.dk/eprecot/Eprecot.html). Warming treatments over the first ten years show little change in the dominated heather species, in contrast to that predicted by models such as CliMOVE, although less dominant species, such as the crowberry, *Empetrum nigrum*, appear particularly susceptible to warming throughout the growing season, with reductions to both biomass and growth rate, and 'bud break' delayed by up to 9 days compared to control plots (Prieto et al., 2009). Other species, such as bilberry (*Vaccinium myrtilus*), experienced advanced bud break in warmed plots by up to 6 days. These variations may have implications for the distribution of heath species in Wales and Northern England. Initial results from the UK Climoor and its European 'sister' sites was published in a special issue of Ecosystems, volume 7, number 6, in Sept 2004.	
Notes	Defra and EU funding for Clocaenog ceased in 2013, and only one year of NERC National Capability funding remains. Maintenance costs are such that the experiment is unlikely to continue without a major grant, although it unclear whether this will be sought by CEH.	

COLT PARK

Project code/names			28
Type of experiment	RESTORATION		ACTIVE PTRE
Details			Neutral Grassland
Dates established	1990-2008		
Location	Yorkshire, England		SD 760729
Institution	Natural England		
Contact	Colin Newlands	Colin.Newlands@naturalengland.org.uk	
Address			
Description	Began as an experiment into restoration and management of upland hay meadow, comparing different regimes to mimic the traditional management and aspects of the Pennine Dales ESA management prescription. Now maintained as a recovery / monitoring experiment.		
Plot size	12 x 36 m		
Treatments	Initial restoration techniques used include seed sowing, hay cropping, shaking seed out of hay on-site, grazing with sheep and donkey. No herbicides or pesticides were used. **1990:** Three grazing treatments, replicated three times, and randomly allocated to three blocks of 0·043 ha. (1) autumn grazing with cattle (2) spring grazing with sheep (3) both regimes. **1998 onwards**: (1) and (2) abandoned. (3) Three replicates of the autumn- and spring-grazing treatment were retained by allowing livestock free access. Livestock was removed in mid-May for the growth of the hay crop. Experimental treatments ceased in 2008.		
Subplots	Each plot is divided into three 12 x 12m sub-plots. Further sub-divisions		
Treatments	Two fertilizer treatments [no fertilizer or 25 kg nitrogen ha–1 plus 12·5 kg ha–1 phosphate (P2O5) and potash (K2O)] randomly allocated. Each fertilizer treatment was subdivided into two 6 × 6-m sub-sub-plots and a seed-addition treatment was randomly allocated to one of them. Seed was collected locally from populations around the experimental site, in woods, roadside verges and uncut field edges. Seed of 19 species were bought from a commercial source, sown by hand in each autumn 1990 – 92, at amounts of between 0·05 and 1·5 kg ha–1 (0·2–5·6 g subsubsubplot–1) for commercial seed and 6·9 kg ha–1 (25 g subsubsubplot–1) for the locally collected seed mixture. The seed treatment was repeated in August 1999 with the addition of 15·4 kg ha–1 of commercial seed of each of *Lotus corniculatus* L., *Briza media* L. and *Ranunculus bulbosus* L. Seed of *Geranium sylvaticum* L. was collected in July 2000 from roadside verges in Allendale and Weardale and sown into the experiment at the rate of 0·5 kg ha–1 (159 seeds subsubplot–1) in September 2000. In 1998, each seed treatment was further subdivided into two 6 × 3-m subsubsub plots and two FYM treatments were allocated at random to each subdivision. Treatments were no FYM and 12 tonnes ha–1 annum–1 FYM applied in April 1999, then November–December from 1999.		
Baseline data	Veg sampled in alternate years from 1994 (before hay-cut) in nested quadrats up to 2x2m; vasc spp & % cover. Hay dry-weight measured. Soil P measured, also fertility assessed using Ellenberg fertility values. Measured signature fungal fatty acids in soil.		
Data archiving	It has not been possible to establish that records held by the NNR are comprehensive, with a combination of paper files and electronic (Excel) spreadsheets held. It is believed the full datasets are retained by Roger Smith (retired PI) and/or Newcastle University.		
Partner sites			

COLT PARK (cont.)	
Key Research	Research sought to establish the combined effects of different management choices on above-ground vegetation and below-ground microbial communities. The studies informed management prescriptions on how best to increase plant diversity, restore rare vegetation types and achieve agri-environmental objectives. The results demonstrate that the enhancement of biodiversity in meadow grassland is a long-term (> 10-year) secondary succession, most rapidly achieved in the absence of mineral fertilizer by cutting for hay in mid-July and autumn grazing with cattle. The sowing of key functional species was also important in facilitating the staged colonization of other sown species. It was concluded that the development of the soil seed bank probably lags behind increases in vegetation diversity initiated by seed sowing. This emphasizes the need to introduce additional species as seed when increased diversity is a target for the restoration management of previously intensively managed grasslands. These results demonstrate that biodiversity goals for upland meadows need to plan beyond the typical 5–10-year management agreement period of agri-environment schemes. *Review paper: Smith, R.S., Shiel, R.S., Bardgett, R.D., Millward, D., Corkhill, P., Evans, P., Quirk, H., Hobbs, P.J. & Kometa, S.T. (2008) Long term change in vegetation and soil microbial communities during the phased restoration of meadow grassland. Journal of Applied Ecology, 45, 670-79.*
Notes	The original long tem experiment has now finished, although the original plots are still being monitored every other year (2010, 2012, 2014) for vegetation changes (Colin Newlands, pers. comm, 2014). The experimental platform is, however, being used for a new study into carbon sequestration, soil dynamics, pollination and ecosystem function run by Richard Bardgett at the University of Manchester.

CRICKLADE NORTH MEADOW

Project code/names		29
Type of experiment	LAND MANAGEMENT	ACTIVE PTRE
Details	Water-logging/drainage experiment on traditionally managed lowland hay meadow	Neutral Grassland
Dates established	1998/9	
Location	Oxfordshire, England	SU094946
Institution	Open University	
Contact	David Gowing d.j.gowing@open.ac.uk	
Address	Department of Environment, Earth and Ecosystems, The Open University, Walton Hall ,Milton Keynes, MK7 6AL	
Description	The experiment contrasts the vegetation responses following the clearance of a culvert in 1999 within a traditionally managed lowland hay-meadow (or lammas land), to areas of poor drainage within the same field.	
Plot size		
Treatments		
Subplots		
Treatments		
Baseline data	Annual vegetation surveys of fixed points in summer from 1998 across 130 quadrats within the area of the culvert, and a further 70 quadrats were located to act as a control, in an area that had not seen such changes. Further additions brought the total to 320 monitoring points. Hydrology is monitored by data loggers (siince 2004), and manually since 1979. These represent the longest running hydrological dataset for any floodplain habitat.	
Data archive	The data are retained by Prof. Gowing and the Floodplain Meadows Partnership. The intention is to make all data publically available.	
Partner sites		
Key Research	Scientific findings from North Meadow are used in forming policy and advice for management of similar meadows across the country and it is therefore considered a nationally important research and demonstration site. Research has demonstrated the impact of flooding and recovery cycles to the floristic diversity in floodplain meadows, with significant differences observed between areas of good versus poor drainage. It has informed Natural England's guidance for the management and restoration of similar sites, particularly the significance of hay removal (D. Gowing, pers. Comm., 2014). Work has also supported recent Annexes to the National Vegetation Classification pertaining to floodplain meadows. Studies are currently underway into the relationship between specific measures of flooding (e.g. number of days flooded / drought; median soil water depth; amplitude of seasonal fluctuation, etc.) and their relationship to botanical data to establish the specific limiting factors affecting community and species responses in floodplains. The research has also been used to establish a regression line that can be used to predict the response of grassland at other sites to alterations in water regime and was used to test the impact of nutrient (phosphorus) and sediment deposition during substantial summer floods. Results suggested regular floods on a similar scale would threaten the conservation value of floodplain grasslands. *See: DEFRA REPORT PROJECT NO. BD1321 Response of grassland plant communities to altered hydrological management; Gowing, D. Urgency application: Impact of summer flooding on floodplain biodiversity via nutrient deposition (NE/F009232/1).*	
Notes	Although the experimental site is secure, ongoing monitoring at Cricklade may be at risk following the scheduled end of the Floodplain Meadows Partnership in 2017. However, discussions are already underway with CEH, Wallingford and the Wildlife Trusts to carry on monitoring and research at the site.	

CULARDOCH

Project code/names			27.5
Type of experiment	MULTIPLE TYPES OF DRIVER		ACTIVE PTRE
Details	Nutrient, burning and climate change experiment now monitored as a recovery experiment.		Montane
Dates established	1999-2011/2		
Location	Scotland		NO 183 985
Institution	James Hutton Institute		
Contact	Dr Andrea Britton	Andrea.Britton@hutton.ac.uk	
Address	Craigiebuckler, Aberdeen, AB15 8QH		
Description	The experiment investigated the influence of fire, nitrogen deposition and grazing on the vegetation and soils. The three variables were combined in a fully factorial, randomized split-block experimental design with six replicates. Fire treatments simulated the effect of low-intensity burns, which occur on prostrate Calluna heathland when management fires spread from adjacent subalpine heaths. Nitrogen experiments were used to mirror long-term acute high-level N inputs, against a background deposition of 12 kg ha-1yr-1. Grazing was simulated through clipping. Open top polycarbonate chambers to simulate warming were placed on 24 of the plots with uncovered plots acting as controls.		
Plot size	8 x 9 m		
Treatments	Fire: each block was divided into two sub-blocks, one of which was randomly chosen to have the vegetation removed by burning as a single event.		
Subplots	3 x 9 m		
Treatments	Nitrogen treatment comprised four levels of nitrogen addition: 0, 10, 20 and 50 kg N ha−1 year−1 in addition to the estimated background level of 10 kg N ha−1 year−1. This range included deposition levels commonly found in the UK and Europe, with 50 kg N ha−1 year−1 plus background being slightly above the upper end of the current range. Plots were clipped once year−1 to simulate grazing, and the clippings removed. Clipping was applied randomly across the plots. Open top polycarbonate chambers to simulate warming were placed on 24 of the plots with uncovered plots acting as controls.		
Baseline data	Species diversity (higher plants, mosses and lichens) and percentage cover were recorded annually. Also chemistry of heather tssue, soil and soil water chemistry.		
Data archive	Data is held in spreadsheets by Dr Andrea Britton and is available on request.		
Partner sites			

CULARDOCH (cont.)	
Key Research	The study demonstrated that the biodiversity of low- alpine Calluna–Cladonia heathlands may be reduced by even low rates of nitrogen deposition. Effects of nitrogen deposition on species richness were manifest mainly in the lichen component of the vegetation, and occurred quickly (within 1 year at the highest deposition rate but also within 4 years at low deposition rates). Fire had a large effect on vegetation diversity and composition, but both were quick to recover. Species richness recovered within 4 years and vegetation composition was predicted to recover within 7 years. These data support the current critical load of nitrogen for this community of 5–15 kg N ha−1 year−1 and suggest that lichen diversity could be a useful indicator of nitrogen deposition impacts in alpine habitats. Later studies also showed positive growth responses of the dominant shrub (C. vulgaris) to N addition levels even at low levels. In combination with other disturbance factors such as fire, these changes have the potential to lead to deleterious changes in community diversity and to impact on ecosystem processes such as nitrogen- and carbon-cycling. The research demonstrated that effective conservation of biodiversity in low-alpine heathland requires action at national and international levels to reduce nitrogen deposition where the critical load is currently exceeded. Saturation of upland is also resulting in nitrate loading to rivers, reducing water quality for wildlife and increase treatment costs. *SEE: Britton, AJ; Fisher, JM, 2007 Interactive effects of nitrogen deposition, fire and grazing on diversity and composition of low-alpine prostrate Calluna vulgaris heathland. JOURNAL OF APPLIED ECOLOGY Volume: 44 Issue: 1 Pages: 125-135. REVIEW OF 9 SITES: Phoenix, G.K., Emmett, B.A., Britton, A.J., Caporn, S.J.M., Dise, N.B., Helliwell, R. Jones, L., Leake, J., Leith, I.D. Sheppard, L.J., Sowerby, A., Pilkington, M.G. Rowe, E.C. Ashore, M.R. and Power, S. A., 2012 Impacts of atmospheric nitrogen deposition: responses of multiple plant and soil parameters across contrasting ecosystems in long-term field experiments. GLOBAL CHANGE BIOLOGY 18, 1197–1215, doi: 10.1111/j.1365-2486.2011.02590.x*
Notes	Funding for the post-treatment monitoring of the experiment runs out in two years. Researchers will apply for funding to meet new project criteria in 2016.

DALE / Trehill

Project code/names			28
Type of experiment	RESTORATION		INACTIVE PTRE
Details	Coastal heathland restoration		Lowland heath
Dates established	2004 - 9		
Location	Pembrokeshire, Wales		SM766082
Institution	Natural Resources Wales (formerly CCW)		
Contact	Jon Hudson (NRW) / Andrew Tuddenham (NT)	jon.hudson@naturalresourceswales.gov.uk	
Address			
Description	Established to evaluate different methods of re-creating coastal heathland vegetation on ex-arable land with raised soil nutrient and high pH levels. The experiment comprised a fully randomized block design covering 2 ha with 12 treatments replicated five times within separate blocks, giving a total of 60 separate plots. Post-treatment monitoring is ongoing by Bournemouth University.		
Plot size	10 x 10 m		
Treatments	The treatments included soil acidification by elemental sulphur (low / high / nil rate) combined with topsoil stripping (upper 20-30 cm by excavator, 2004) Control - No stripping; and heather and gorse brash addition, as seed source (control - No heather brash addition). Sulphur at 0 t/ha/yr; 4 t/ha/yr; 8 t/ha/yr		
Subplots			
Treatments			
Baseline data	Soil chemistry, botanical surveys of permanent 2 x 2 m quadrats to establish % cover of vascular plants; % bare ground; % brash.		
Data archive	Original data from the experiment are held electronically in various formats (excel, word, pdf) by Natural Resources Wales. Some of the later post-treatment recovery monitoring data and data / information are believed to be missing. Natural Resources Wales and the National Trust are proposing a project to collate all the data from the experiment, although this contract has not been let.		
Partner sites			
Key Research	The results of the experiment showed that soil stripping had no direct effect on nutrient levels due to the former mixing of nutrients throughout the whole plough layer through tillage. However, it did reduce the total nutrient pool and change soil physical conditions. Sulphur application was highly effective at lowering soil pH to target levels, although led to large increases in soil extractable phosphate, which is known as a limiting factor for successful heathland re-creation. In terms of development of coastal heath vegetation, results demonstrated that the addition of brash was essential as a seed source of a number of key ericaceous/dwarf shrub species such as *Calluna vulgaris*, *Erica cinerea* and *Ulex gallii,* none of which established on plots without the addition of brash. Other target 'maritime' forb species were capable of colonising suitable treatments by natural means. The early development of heathland communities only occurred where small amounts of sulphur were applied, 4t/ha appearing the most effective within the timescale of the study. The short period of study did not allow the prediction of the topsoil stripping treatments which will lead to the most successful re-creation of heathland in low sulphur treatment conditions		
Notes	The plots remain marked and have been monitored by researchers from Bournemouth University (vegetation / soils / invertebrates). However, the data archive is 'scattered', with only the original data on the experiment held in spreadsheet form by NRW, and later surveys / reports after 2006 apparently missing (Jon Hudson, pers. comm, 2014).		

DENMARK FARM

Project code/names			20
Type of experiment	RESTORATION		ACTIVE LTE
Details	Grassland restoration experiment		Neutral grassland
Dates established	1986 -		28
Location	Ceredigion, North Wales		SN586536
Institution	Shared Earth Trust		
Contact	Dollie Schwenk / Richard Williams / Jan Martin	info@denmarkfarm.org.uk; RJW oquidnunc@gmail.com / drjan.martin@virgin.net	
Address	Denmark Farm Conservation Centre, Betws Bledrws , LAMPETER , Ceredigion, SA48 8PB / R J Williams, Troedyrhiw, Talgarreg, Llandysul, Ceredigion, SA44 4HB		
Description	Restoration by hay-cropping and grazing in the absence of re-seeding in a lowland situation. Comparisons of different treatment blocks within habitats. Monitoring largely ceased in 2000.		
Plot size	ca. 3,000 m2		
Treatments	4 Treatments with 1 replication in different fields: cattle grazing only; hay + cattle grazing; grazing +/- lime; hay+grazing +/- lime in just one field.		
Subplots			
Treatments			
Baseline data	Various routine vegetation surveys, including periodic surveys of birds, bats, mammals and invertebrates. Monitoring largely ceased in 2000.		
Data archive	Data are held by ecologists Jan Martin and Richard Williams as paper reports and electronic files. Richard Williams has compiled a log of available data. Much of the monitoring data were also fed into standardised national recording schemes.		
Partner sites			
Key Research	Overall the grazing and cutting regimes have continued to be effective in restoring the diversity of the previously agriculturally improved grassland. General diversification and change has continued, although the rate of change has slowed in recent years. In some cases there have been large, rapid (1-3 year), and unexpected changes in frequency of particular species after 15-20 years of restoration with consistent management (R. Williams, unpubl. data., 2009/11). The grassland work was used by CCW (now Natural Resources Wales) when setting up the protocols for Tir Gofal and similar agri-environment schemes. Some advisory and management recommendations have also been self-published. Survey records at the site have also demonstrated that restoration of depleted intenstive farmland can result in a rapid increase in a broad range of bird species. (*Taylor, N. and Williams, R., 2000 Breeding Birds and the Restoration of a Grassland Farm. Welsh Birds, Vol. 2(5)*.). The site was also previously used for training courses in land management and restoration.		
Notes	Although management has remained 'largely consistent' with occasional omissions of hay cutting (Richard Williams, pers. comm., 2014), the site has not been monitored since the early 2000s and the lack of current funding means that the long term value of the work is unlikely to be realised. It is likely that plot markers etc. will soon be lost (R. Williams, pers. comm., 2014), and management regimes may well change due to extreme funding pressures on the land-owner.		

ELAN VALLEY MEADOWS

Project code/names		21
Type of experiment	NUTRIENT (fertilization)	INACTIVE PTRE
Details	Nutrient treatment experiments on species rich upland hay meadows	Neutral Grassland
Dates established	2004-2014	
Location	Radnorshire, South Wales	SN912628
Institution	Natural Resources Wales / Elan Valley Trust	
Contact	Stuart Smith st.smith@ccw.gov.uk	
Address	Ffordd Penrhos, Bangor, Gwynedd LL57 2BX / Elan Valley Trust, Elan Estate Office, Elan Village, Rhayader, Powys, LD6 5HP	
Description	The experiment was established to ascertain sustainable levels of fertiliser and lime for maintaining both a hay cropping regime and high floristic diversity. The experiment comprised 6 replicated nutrient treatments in 5 blocks established in separate meadow enclosures at: **Hirnant (2 blocks)** - MG6, MG5a, **Penglaneinon (2 blocks)** - MG5a, **Rhos yr Hafod** (1 block) - MG5. At the two Penglaneinon enclosures only, an additional low rate (12 t/ha applied every 2 years) of sheep manure (Sheep FYM) was applied with or without lime to evaluate the potential for using sheep-based manure.	
Plot size	5 x7 m	
Treatments		
Subplots		
Treatments	HIGH RATE FYM: 12 t/ha every year (High rate), with or without initial lime; LOW RATE FYM: 12 t/ha applied every 2 years, with or without initial lime. Control - Nil FYM with or without initial lime in the form of ground limestone. At the two Penglaneinon enclosures only, an additional low rate (12 t/ha applied every 2 years) of sheep manure (Sheep FYM) was applied with or without lime to evaluate the potential for using sheep-based manure. Fields were managed traditionally with spring grazing, followed by a late summer hay-crop and aftermath grazing thereafter. The Hirnant site (MG6) is the subject to meadow restoration management.	
Baseline data	Soil pH, Soil chemistry (macronutrients), Botanical monitoring, fixed quadrats. (Inc. % cover of all species, bare ground and litter; mean sward height.), Dry matter hay yield, Hay nutrient content.	
Data archive	Data are currently held electronically by NRW.	
Partner sites		
Key Research	The experiment is designed to identify whether a compromise can be made between hay yields and botanical diversity. Results to date indicate that the nutrient treatments are highly dynamic and site specific and that the longer-term effects on the meadow vegetation quality can only be confidently assessed by a longer period of monitoring, particularly of key indicator species. A final report is currently underway and will be completed in 2014 (Stuart Smith, pers. comm., 2014).	
Notes	The funding for treatments came to an end in 2014 and there are no plans to continue monitoring the site, although they may be used for training purposes in the future. Funds to install permanent markers have been obtained, and this work will be undertaken in 2014 (Stuart Smith, pers. comm., 2014).	

EUSTON / Breckland

Project code/names		18
Type of experiment	RESTORATION	INACTIVE PTRE
Details	Heathland restoration	Lowland heath
Dates established	1994-2003	
Location	England	TL 906782
Institution	Centre for Ecology and Hydrology, Wallingford	
Contact	Prof. Richard Pywell rfp@ceh.ac.uk	
Address	Centre for Ecology & Hydrology, Maclean Building, Benson Lane, Crowmarsh, Gifford, Wallingford, Oxfordshire, OX10 8BB	
Description	Lowland heath restoration experiment in paired sites through seeding, pH reduction and topsoil removal, with subsequent studies investigating impacts of grazing. Euston had not been heath for 60 years, arable before.	
Plot size	20 x 4 m	
Treatments	(1) Autumn 1994: establishment of sown species; with additions of 3 & 6 t/ha of elemental sulphur to reduce pH; (2) Spring 1995 establishment of species, undersown in Spring barley; (3) Topsoil removal (to depth of 35 or 40 cm), sown spp established Autumn 94; (4) Controls - existing sown grass species retained or destroyed by cultivation Autumn 94. Sown seed mix used (34 kg/ha), plus broadcasting of heather litter (750 kg/ha) in Spring. 4 replicates per treatment.	
Subplots		
Treatments	At Euston, plots split in Dec 1997 & winter sheep-grazing introduced to half the sub-plots, followed by cutting to 3cm with herbage removed; no sheep available in 1998, sheep grazing resumed in winter 1999.	
Baseline data	Following measurements made at start/in 1st winter: Seedbank; topsoil pH, extractable P, K & Mg, organic matter; particle size distribution through profile; soil mineral N; nitrate concentrations in drainage water; overwinter changes in N supply. No Calluna recorded from seedbank at either site; 4 heathland spp in seedbank at Euston, 2 at Honington, all at v low frequencies. K Walker et al (2004) also made botanical assessment in 1999 (2x2 m quadrats), assessed seed bank & measured soil nutrients & laboratory density. Seed viability of the sown species was tested ex situ; Vegetation recorded in April & Sept each year to 1999 - % cover each species of vascular plant, plus bryophytes, lichens, litter, rabbit droppings measured using randomly placed 50 x 50 cm quadrats.	
Data archive	Retained by CEH Wallingford.	
Partner sites	Honington (now closed)	
Key Research	See: Walker (2004), Pywell et al 2001, Chambers et al 1996	
Notes	The Euston site is still extant, but hasn't been recorded since 2003. There are no plans to do so.	

GLAS MAOL

Project code/names		26
Type of experiment	NUTRIENT (pollution)	ACTIVE PTRE
Details	Nitrogen addition	Montane
Dates established	1998-2005	
Location		
Institution	James Hutton Institute / Aberdeen University	
Contact	Dr Andrea Britton / Rene Ven der Wal | Andrea.Britton@hutton.ac.uk	
Address	James Hutton Institute, Craigiebuckler, Aberdeen, AB15 8QH	
Description	A nitrogen loading experiment, simulating an increase in atmospheric N deposition in the form of wet deposition episodes on permanent plots located at two sites on the summit, c. 200 m apart, in montane heath. The low N addition was designed to simulate natural occult pollution episodes at sites in the UK receiving high rates of deposition, taking into account that N concentrations in occult deposition can be an order of magnitude higher than in rainfall. There were five replicate blocks at each site, each containing one plot per treatment. Treatments ceased in 2005.	
Plot size	0.6 x 0.6 m	
Treatments	Two forms of N, KNO3 and NH4Cl, were applied in solution to separate plots at each of the two sites at rates equivalent to 10 and 40 kg N ha−1 yr−1. These rates represent low and high N deposition levels within the UK (United Kingdom Review Group on Acid Rain, 1997). Four different treatments -low NO3–, low NH4+, high NO3–, high NH4+ and control were applied in 0.5 litre amounts as a fine mist, using a knapsack sprayer. Annual additions were divided into a total of seven applications between June and August 1998–99, and an average of five applications, carried out every two to three weeks, each summer from 2000 to 2002. Distilled water was used as a control.	
Subplots		
Treatments		
Baseline data	Vegetation cover recorded at 120 pin points, using first (canopy) and second (ground layer) intercepts. *Racomitrium* shoot growth, nitrogen reductase activity, membrane potassium leakage and tissue nitrogen from sampled plots. Soil and water chemistry.	
Data archive	Data has been collated by Rene Van der Val; copies held by Andrea Britton.	
Partner sites		
Key Research	Research provides evidence for the detrimental effects even low doses of reduced or oxidised nitrogen on *Racomitrium* physiology and performance within montane heath. Additions of only 10 kg N ha−1 yr−1 to a relatively unpolluted site within the UK deposition range were shown to be beyond the habitat's critical load, causing toxic effects to *Racomitrium* and loss of cover. Very high sensitivity of the moss to small increases in atmospheric N deposition demonstrates the potential for loss of ectohydric bryophytes from communities receiving excess N deposition, and supports a low critical load for montane heath. The importance of taking ion type into account when considering the critical load of N for a habitat also demonstrated. Findings strongly suggest that atmospheric N deposition may have contributed to loss of Racomitrium within montane heath in more polluted areas of Britain. Loss of Racomitrium cover will clearly affect ecosystem integrity, leading to changes in N cycling and plant community dynamics. Thus there are longer-term implications for habitat survival, and for potential for recovery once N deposition is reduced through implementation of the Gothenburg protocol (National Expert Group on Transboundary Air Pollution, 2001). *SEE: S. K. Pearce, S. J. Woodin and R. van der Wal Physiological and growth responses of the montane bryophyte Racomitrium lanuginosum to atmospheric nitrogen deposition. New Phytologist (2003) 160: 145–155*	

Notes	Experimental treatments ceased in 2005. Recovery monitoring has 2 more years of funding from the Scottish Government (until 2016). As soil chemistry has recovered, there is no intention to carry on with monitoring after this date, although ongoing vegetation monitoring is a possibility, dependent on the recovery achieved by 2016.

GLEN CLUNIE / GLEN SHEE

Project code/names	Also known as JWF plots or Invercauld		22.5
Type of experiment	NUTRIENT (fertilization)		INACTIVE PTRE
Details			Upland heath
Dates established	1993-pre2005?		
Location	Scotland		NO 139815 and NO 123734
Institution	James Hutton Institute		
Contact	Sue Hartley / (Ruth Mitchell)	sue.hartley@york.ac.uk / (ruth.mitchell@hutton.ac.uk)	
Address	James Hutton Institute, Craigiebuckler, Aberdeen, AB15 8QH		
Description	Experiment manipulated moorland vegetation using fencing and fertilizer treatments to determine whether changes in vegetation composition, quality and structure produced by vertebrate herbivores and by nutrient inputs had 'knock-on' effects for the species richness and abundance of invertebrate herbivores. Four sites of upland heather moorland were selected on two moors in the Grampian mountains: Glen Clunie where the soils were wet, acidic and peaty and the grazing pressure from red deer and sheep was moderately highand; and Glen Shee, which is drier moor where the soils were of brown earth types and grazing pressure was very high, particularly from sheep.		
Plot size			
Treatments	Four blocks of vegetation were selected and two of these were fenced to exclude grazing.		
Subplots			
Treatments	Each of the 16 fenced or unfenced blocks contained four experimental plots to which the fertilizer treatments were applied in a standard fractionated factorial design: the plots in one of the fenced or unfenced blocks at each site received N, P, K, or NPK, whilst the plots in the second of the fenced or unfenced blocks received NP, KN, KP or no fertilizer. Thus, four of the fenced plots at each site received N and four did not. N was added as ammonium nitrate at 75 kg N ha−1 yr−1. P was added as 'superphosphate' at 12·5 kg P ha−1 yr−1 and K as potas- sium sulphate at 25 kg K ha−1 yr−1. The fences were erected in March 1993 and fertilizer was applied annually in two doses in spring and early summer, beginning in early April 1993.		
Baseline data	Soil cores were collected from each of the four main sites in April 1993 and 1995, and the quantity of organic material present was determined. Randomly selected samples of the current year's shoots of *Calluna* and the dominant grass species were collected on each plot in May 1993 and 1995 and analysed for total nitrogen content. Vegetation measurements were carried out on three randomly selected 1-m2 sites on each of the 64 main subplots. Hemiptera were sampled only on the control plots and on the plots receiving the N-only treatments in the fenced and unfenced blocks at all four sites, i.e. on 16 of the 64 plots available.		
Data archive	The data are held by Sue Hartley (ex – York) as the experiments founder 'probably in box files' and are not readily available' (Ruth Mitchell, pers. Comm., 2014). Ruth Mitchell (James Hutton Institute) may also hold some datasets.		
Partner sites			

Key Research	Results showed that protection from grazing caused a rapid and dramatic increase in Calluna cover whereas grazing caused a decline in Calluna cover, particularly when combined with nitrogen addition. However, in the absence of grazing, substantial nutrient addition did not lead to a significant decline in Calluna Nitrogen addition resulted in an increase in grass cover, although which species increased depended on whether the plot was grazed. Grazing was an important indirect driver of hemipteran community diversity owing to its effect on the shoot and canopy structure of Calluna, on the competitive balance between Calluna and grasses, and on Calluna shoot allocation patterns. Thus grazing management is likely to have a significant impact on the biodiversity of moorland hemipteran communities with grazing regimes that maintain a mosaic of dwarf shrub and grass cover on moorlands likely to maximize the species richness. Fertilizer addition had a significant overall effect on the species richness and abundance of Hemiptera, which may in turn increase food supply for several moorland bird species. Results suggest that greater attention needs to be paid to soil type, and site-specific factors, when determining management regimes for moorlands. *SEE: S. E. HARTLEY and R. J. MITCHELL Manipulation of nutrients and grazing levels on heather moorland: changes in Calluna dominance and consequences for community composition. Journal of Ecology 2005 93, 990–1004; S. E. HARTLEY, S. M. GARDNER and R. J. MITCHELL Indirect effects of grazing and nutrient addition on the hemipteran community of heather moorlands. Journal of Applied Ecology 2003 40, 793–803.*
Notes	The plots were left in a good condition following the closure of CEH Banchory. However, they have not been revisited since treatments ceased. The date treatments stopped in unclear. As nitrogen additions were at a very high level, and 'perhaps unrealistic' as a natural model, they are regarded as limited long term value for future monitoring. (Mitchell, pers. Comm., 2010)

GLEN FINGLAS

Project code/names			30
Type of experiment	LAND MANAGEMENT		ACTIVE LTE
Details	Grazing experiment		Acid grassland
Dates established	2003 -		11
Location	Scotland		
Institution	James Hutton Institute		
Contact	Dr Nick Littlewood	Nick.Littlewood@hutton.ac.uk	
Address	Craigiebuckler, Aberdeen, AB15 8QH		
Description	Experiment consists of 4 grazing treatments and 6 replicates to establish the effects of livestock grazing on upland birds (meadow pipits), vegetation dynamics and arthropods. There are four grazing treatments with six replicates of each (24 total). The experiment was arranged across three locations, each containing two replicate blocks, each block composed of four plots. The eight plots within each paired replicate block were arranged adjacent to one another. Grazing treatments were assigned randomly to the four plots in each of the six replicate blocks. Baseline data on plants, invertebrates and breeding birds were collected within the plot areas but before the erection of the fences in 2002. Grazing treatments have been applied from 2003 onwards.		
Plot size			
Treatments	Treatments of (i) nine ewes per plot (2.72 ewes haK1), (ii) three ewes per plot (0.91 ewes haK1), (iii) two ewes per plot (0.61 ewes haK1), and (iv) ungrazed were randomly allocated to fenced plots within each block in early 2003 (before the meadow pipit breeding season). During the autumn of 2003 (after the breeding season), cattle were added to treatment iii to contrast solely sheep grazed treatments in 2003 and mixed livestock grazing treatments in 2004 and 2005. Treatment I is regarded as high-intensity grazing. Treatments II and III are each low-intensity grazing regimes and are approximately equivalent in terms of livestock units. Livestock are in the plots from April to December each year.		
Subplots			
Treatments			
Baseline data	Annual meadow pipit abundance; 'crude' vegetation structure, e.g. sward height. Every third year, more detailed vegetation studies through pinframe quadrats and invertebrates through suction and sweep net. Within each plot, meadow pipit territories are mapped paying particular attention to bird breeding behaviour, such as song flight, alarm calls, food or faecal sac carrying, mate guarding and using nest locations when available (Evans et al. 2005 for methods). No. of breeding territories per plot was a surrogate for breeding pipit abundance.		
Data archive	Routine monitoring (core) data are held electronically in an Access database by the PI at the JHI. Not all data from nested studies undertaken by associates or visitors using the site are collated.		
Partner sites			

Key Research	Early work suggested that low intensity, mixed livestock grazing improves the breeding abundance of a common insectivorous passerin. Studies also generated quantitative evidence of the contribution of cattle to the maintenance of structural diversity and arthropod abundance in grazed ecosystems. However, later studies have established that structural changes, including the build up of leaf litter and increasing biomass and vegetation density has reduced populations on grazed plots in comparison to ungrazed areas. This is believed to relate to the relative visibility of invertebrate prey species. These results demonstrate that short-term results do not predict long-term outcomes. More recent work on ecosystem functions suggest that no sheep and low-intensity sheep grazing are better upland management practices for enhancing plant and soil C sequestration than commercial sheep grazing, with grazing reducing the density of tussocks in the sward, thus reducing C stocks held in *M. caerulea* swards across the landscape. *SEE: Evans et al. To graze or not to graze? Sheep, voles, forestry and natureconservation in the British uplands. Journal of Applied Ecology 2006 43, 499–50*; *Vandenberghe, C., Prior, G., Littlewood, N., Brooker, R. & Pakeman, R. (2009) Influence of livestock grazing on meadow pipit foraging behaviour in upland grassland. Basic and Applied Ecology 10: 662-670*; *Smith, S.W., Vandenberghe, C., Hastings, A., Johnson, D., Pakeman, R.J., van der Wal, R. & Wooding, S.J. (2014) Optimizing carbon storage within a spatially heterogeneous upland grassland through sheep grazing management. Ecosystems 17: 418-429.* A review paper looking at the last 14 years of research is currently in preparation (N. Littlewood, pers. comm., 2014).
Notes	Site is currently funded by the Scottish Government, with funds running out in 2016. Researchers 'are working on the assumption that funding will be renewed as the site is a long term capabillity' with future investigations proposed into carbon storage and sequestration and nutrient cycling (Littlewood, pers. Comm., 2014).

HENFAES / FACE

Project code/names	Free air elevated experiment	30
Type of experiment	NUTRIENT (pollution)	ACTIVE PTRE
Details	Elevated carbon dioxide experiment	Broad-leaved woodland
Dates established	2004-9	
Location	Henfaes Farm, Bangor North Wales	
Institution	Bangor University	
Contact	Andy Smith	a.r.smith@bangor.ac.uk
Address	School of Environment and Natural Resources, University of Wales, Bangor. LL572UW, UK	
Description	Study to elucidate how forest ecosystem dynamics and biogeochemical cycling is altered by elevated atmospheric CO_2 (eCO_2) levels predicted for the year 2050; specifically: (i) to ascertain if eCO_2 promotes a differential tree species growth response altering forest compositional dynamics; (ii) assess how eCO_2 alters tree root and mycorrhizal systems and C sequestration; (iii) determine effect of increasing tree species diversity on above- and below-ground biomass accumulation when trees are grown in eCO_2; (iv) examine how rhizodeposition is altered by eCO_2 and what impact there is on the soil microbial community structure, and function; (v) examine how eCO_2 alters demand for P in forest ecosystems and whether depletion of soil P pool may become limiting to forest responses; (vi) evaluate the impact of elevated CO_2 on leaf litter quality and its subsequent effects on soil fauna.	
Plot size		
Treatments	Eight octagonal plots, four ambient and four CO_2 enriched, creating a 2 × 4 factorial block design across the two fields planted with three tree species (*Alnus glutinosa* (L.) Gaertner, *Betula pendula* Roth. and *Fagus sylvatica* L.) selected for their contrasting shade tolerance, successional chronology and to represent a range of taxonomic, physiological and ecological types.	
Subplots		
Treatments		
Baseline data		
Data archive	Data are held electronically (Excel) on University servers. U:\College of Natural Sciences\SENRGy\BangorDIVERSE	
Partner sites		
Key Research	Research demonstrated that responses to elevated CO_2 were predominantly found in below ground systems. This has significant implications for carbon cycling and sequestration by woodland. Above-ground response to elevated CO_2 is affected significantly by intra- and interspecific competition. Fine root biomass and morphology responded differentially to the elevated CO_2 at different soil depths in the three species when grown in monocultures. In polyculture, a greater response to elevated CO_2 was observed in coarse roots to a depth of 20 cm, and fine root area index to a depth of 30 cm. Data suggest that existing biogeochemical cycling models parameterized with data from species grown in monoculture may be underestimating the belowground response to global change.. SEE: Smith, A.R., Lukac, M., Hood, R., Miglietta, F. and Godbold, D.L. (2013) Elevated CO_2 enrichment induces a differential biomass response in a mixed species temperate forest plantation. New Phytologist 29:217-228; Smith, A.R., Lukac, M., Bambrick, M., Miglietta, F. and Godbold, D.L. (2013) Tree species diversity interacts with elevated CO_2 to induce a greater root system response. Global Change Biology 19:217-228.	
Notes	Elevated CO_2 treatments ceased in 2009, however studies are still ongoing.	

HENFAES / DIVERSE

Project code/names			NA
Type of experiment	Forestry	ACTIVE LTE	
Details		Broad-leaved woodland	
Dates established	2004	10	
Location	Henfaes Farm, Bangor North Wales		
Institution	Bangor University		
Contact	Dr Andy Smith	a.r.smith@bangor.ac.uk	
Address	School of Environment and Natural Resources, University of Wales, Bangor. LL572UW, UK		
Description	BangorDIVERSE is a forest diversity experimental infrastructure with the aim of exploring the relationship between tree diversity and forest ecological functioning and sustainability. The experiment comprises 92 plots in a fully replicated (n=4) planting design of one, two and three species of each tree. Species were selected due to their contrasting shade tolerance, successional chronology and to represent a range of taxonomic, physiological and ecological types.		
Plot size	0.01 ha to 0.16 ha		
Treatments	The experiment comprises 92 plots in a fully replicated (n=4) planting design of one, two and three species mixtures of alder (*Alnus glutinosa* L.), birch (*Betula pendula* Roth.), beech (*Fagus sylvatica* L.), ash (*Fraxinus excelsior* L.), sycamore (*Acer pseudoplatanus* L.), chestnut (*Castanea sativa* Mill.), and oak (*Quercus robur* L.) at a density of 10,000 stems ha-1. Individual plots contain between 80-160 trees dependent on mixture composition. The plots were thinned to 2,500 stems ha-1 during the winter of 2012-13 to avoid damage to the tree crowns and foliage.		
Subplots			
Treatments			
Baseline data	Baseline soil biogeophysical parameters were determined across the entire experimental site at 10 m intervals during 2003 prior to planting. These measurements included: total C & N, DOC, DON, NO3, NH4, phenols, pH, cations, and molybdate reactive P. Every tree in the experiment was surveyed in 2005 and 2012;		
Data archive	Data held electronically by PI.		
Partner sites			
Key Research	The site has not previously been much used for research, whilst the experiment becomes established (Smith, pers. Comm., 2014). Some studies are now underway into mortality data. *SEE: Ahmed, I.U.M.T, Smith, A.R., Jones, D.L., Godbold, D.L. (in prep) Tree species identity influences the accumulation of recalcitrant deep soil carbon: Ahmed, I.U.M.T. (2011) Ecosystem carbon dynamics: as influenced by tree species and mixture in a temperate deciduous woodland. PhD thesis, Bangor University, Bangor, UK.*		
Notes			

HORDRON EDGE

Project code/names			26
Type of experiment	LAND MANAGEMENT		ACTIVE PTR
Details	Bracken control		Upland Heath
Dates established	1993/4-2012		
Location	Derbyshire, England		SK 213 870
Institution	Liverpool University		
Contact	Rob Marrs	calluna@liv.ac.uk	
Address	Applied Vegetation Dynamics Laboratory, School of Vegetation Dynamics Laboratory, University of Liverpool, Liverpool, L69 7ZB		
Description	Hordron experiment consists of three replicate blocks of 60m x 30m with six main plots divided into 10 x 40 m with 2 m buffer zones. Main treatments (applied randomly) consist of (1) cutting and absulam addition; (2) Stock fencing (sub-treatments) (3) Calluna restoration (4) Control.		
Plot size	10 x 30 m		
Treatments	**Cutting and spraying = (1)**Cut once per year (June); **(2)**Cut twice per year (June, August);**(3)** Sprayed with asulam; Sprayed with asulam in year one then cut in second year. Cut in first year, asulam treatment in second year.		
Subplots	10 x 15 m and 10 x 5 m		
Treatments	**Stock grazing / exclusion on subplots:** Sheep exclusion; Free-range grazing (<0.5 sheep / ha) both applied randomly. These sub-plots (10 m × 18 m) were further split (three 10 m × 5 m) and three **Calluna restoration sub-sub-plots:** : (1) Calluna seed applied as brash 'Calluna-brash' comprising 20-cm stems at 13 t.ha–1; (2) Calluna seed applied as litter 'Calluna- litter' at 1.2 t.ha–1, that had been sucked from under a mature Calluna stand from a local source; (3) no Calluna seeding 'no-Calluna-seeding'. Later (1993) Seed addition at 12 ka / ha with Agrostis castellana as a nurse crop.		
Baseline data	Annual monitoring, June-August (1993-2002) of: Cover of species including bryophytes and lichens, Bracken litter depth, Cover of litter of other species, Bare ground, Rock cover, Density and length of bracken fronds, Bracken frond dimensions. Local seed bank in depth horizons.		
Data archive	The full suite of data from the site is not available electronically due to database migration issues. The experiment would benefit from a short (<month) project to migrate and validate all data (Rob Marrs, pers. comm., 2014)		
Partner sites	Bamford Edge; also former sites at Cannock Chase, Sourhope, Carneddau (now closed or inactive)		
Key Research	Paired Hordron Edge, together with its associated sites (Carneddau, Cannock Chase, Sourhope, Bamford Edge) have produced 18 published papers, principally on the efficacy of different bracken management methods, contributing to policy objectives in the context of Agri-environment schemes and Biodiversity Action plans towards reversing bracken invasion / colonisation on UK's moorland. As well as establishing the long-term effectiveness of cutting, herbicide treatment and reseeding, the studies have investigated the role of the bracken litter layer in impeding germination of other species to limit regeneration potential. The need for litter layer disturbance prior to seed addition for regeneration has been demonstrated. Later studies have examined the impact of bracken management treatments on ecosystem services including carbon and mineral cycling and storage and the potential for conflicts with conservation targets (bracken reduction to increase biodiversity) and consequent impacts on mineral and carbon cycles (mineral depletion and carbon release). Meta-analyses show that there is considerable site variation, possibly		

	caused by differences in climatic regime, substrate, and past and current management practices, which affect the outcome of management and make determining a single treatment approach for similar sites problematic. See *LE DUC, M.G., PAKEMAN, R.J. & MARRS, R.H. 2003. Changes in the rhizome system of bracken when subjected to long-term experimental treatment. Journal of Applied Ecology, 40, 508-522; COX, E.S., MARRS, R.H., PAKEMAN, R.J. & LE DUC, M.G. 2007. A multi-site assessment of the effectiveness of Pteridium aquilinum control in Great Britain. Applied Vegetation Science, 10, 429-440; COX, E.S., MARRS, R.H., PAKEMAN, R.J. & LE DUC, M.G. 2008. Factors affecting the restoration of heathland and acid grassland on Pteridium aquilinum-infested land across the UK: a multisite study Restoration Ecology, 16, 553-562. doi: 10.1111/j.1526-100X.2007.00326.x; STEWART, G.B., COX, E.S., LE DUC, M.G., PAKEMAN, R.J., PULLIN, A.S. &. MARRS, R.H 2008. Control of Pteridium aquilinum: meta-analysis of a multi-site study in the UK. Annals of Botany, 101, 957-970. doi:10.1093/aob/mcn020.*
Notes	Restrictions on the use of the herbicide absulam has meant the treatments have had to stop at Bamford Edge and the paired Hordon Edge site. The experiments now investigate the rate of bracken recovery / recolonisation following treatment.

LADY PARK WOODS / Exclosures

Project code/names		?	NA
Type of experiment	DEER EXCLOSURE	ACTIVE	
Details		Broad-leaved woodland	
Dates established	**Various exclosures 1970s and 1980s**		
Location	Wye Valley, Wales		
Institution			
Contact	Dr George Peterken / Dr Ed Mountford	gfpeterken@tiscali.co.uk / ed.mountford@jncc.gov.uk	
Address			
Description	Deer exclosures and unfenced 'control's used to establish impacts of deer browsing on woodland bird species in a broad-leaved woodland managed for conservation.		
Plot size			
Treatments			
Subplots			
Treatments			
Baseline data			
Data archive	The electronic data archive is retained by George Peterken and Owen Mountford.		
Partner sites			
Key Research	The most notable consequence of excluding deer was to preserve the bramble, which outside the exclosures was intensively grazed (until the construction of the perimeter fence). In the remaining experimental exclosure, (as well as round the perimeter of the reserve), it is evident that deer have a substantial effect on ground vegetation. Comparison to the fenced reserve demonstrate that deer were preventing regeneration, as there is now a new regeneration of saplings, particularly ash, and basal growth of lime and hazel. (George Peterken, pers. comm., 2014).		
Notes	The non-intervention part of the reserve was deer-fenced in 2007, so only the single exclosures in the unfenced, managed compartment of the reserve is still considered relevant as an experiment. (George Peterken, pers. comm. 2014).		

LITTLE BUDWORTH COMMON

Project code/names			29
Type of experiment	NUTRIENT (pollution)	ACTIVE	
Details	Nitrogen and controlled drought experiment.	Lowland Heath	
Dates established	1996		
Location	Cheshire, England	SJ56	
Institution	Manchester Metropolitan University		
Contact	Simon Caporn	s.j.m.caporn@mmu.ac.uk	
Address	Dalton Research Institute, John Dalton Building, Faculty of Science and Engineering, John Dalton Building, Chester Street, Manchester, M1 5GD		
Description	Experimental aim to investigate ecological response to nitrogen; specifically to test hypothesis that elevated atmospheric nitrogen deposition increases the sensitivity of Calluna vulgaris and associated vegetation to environmental stresses e.g. a controlled drought experiment in 1997 and natural outbreaks of heather beetle outbreak (1998 and 1999).		
Plot size			
Treatments	0, 20, 60 or 120 kg/ha/yr N by monthly applications of ammonium nitrate. In the autumn of 2002 the plots were subjected to a management cut, and the vegetation removed to a height of 10 cm, and harvested. The moss and litter layers remained intact.		
Subplots			
Treatments	Since 1994, subplots receive either just water or N, P and N+P as monthly applications of ammonium nitrate. Since 2000 have also had plots to study the effect of N, seed-sowing and gap formation on competitive interactions Calluna-bryophytes-grasses.		
Baseline data	Measured vegetation using point quadrat technique. Monitoring is undertaken yearly, though may vary in future dependent on funding.		
Data archive	Core annual monitoring data are archived onto a central database maintained by CEH (Laurence Jones). However, there is no comprehensive database which includes all studies at the site (ie. Nested studies which use the plots)		
Partner sites	DEFRA UKREATE NETWORK: Thursley Common, Tir Emrys Pwllpeiran, Wardlow Hay Cop, Whim Bog, Peaknaze, Ruabon.		
Key Research	Studies at first demonstrated significant increase in heather cover on watered plots, with positive effect of N treatment; later results more ambiguous. There were also significant early increases in *Deschampsia flexuosa* in response to 120 KgN/ha/yr & droughing. Mean bryophyte cover on watered plots increased steadily through the experiment. Collected & analysed leachate from 2000, to examine nitrogen flux through the soil; results consistent with high levels of nitrogen immobilisation in the soil and vegetation. Studies developed an N budget for the site, including detailed measurements of N immobilisation in soil pools and leaching losses, while continuing to assess grass-heath competition. The results from the experiment, as with all the UK UKREATE and Terrestrial Umbrella sites, contributed to the DEFRA guidance on nitrogen, and provided the science supporting critical loads and critical levels for nitrogen. 'The UKREATE sites show clear and consistent evidence of the impacts of N deposition across nine sites of contrasting vegetation, soils, climate and ambient N deposition...There is clear evidence...that modest N loading can have significant impacts on seminatural ecosystems and even low N inputs may induce effects over time through accumulated loading'. REVIEW OF THE UKREATE NETWORK SEE: *Phoenix GK, Emmett BA, Britton AJ, Caporn SJM, Dise NB, Helliwell R, Jones MLM, Leake JR, Leith ID, Sheppard LJ, Sowerby A, Pilkington MG, Rowe EC, Ashmore MR, Power SA (2012). Impacts of atmospheric nitrogen deposition: responses of multiple plant and soil parameters across contrasting ecosystems in long-term field experiments. Global Change Biology, 18: 1197-1215*		

Notes	Funding for the Little Budworth and Ruabon experiments ceased in 2011 though the experimental treatments have been maintained by Drs Chris Field and Simon Caporn, although this is not part of their academic roles. New data are collected as as part of undergraduate projects and this is fairly successful Further dedicated funding is being considered, but 'is difficult to get for long-established experiments through the NERC'. (Simon Caporn, pers. comm., 2014). Nevertheless, the PI is confident that the sites will remain open in to the future, in that there no access or ownership issues.'

MARSH GIBBON FARM

Project code/names	BD1431		27
Type of experiment	LAND MANAGEMENT		INACTIVE
Details	Grazing experiment		Neutral Grassland
Dates established	2000-6		
Location	Oxfordshire, England		
Institution	Centre for Ecology and Hydrology, Wallingford		
Contact	Prof. Richard Pywell	rfp@ceh.ac.uk	
Address	Centre for Ecology & Hydrology, Maclean Building, Benson Lane, Crowmarsh, Gifford, Wallingford, Oxfordshire, OX10 8BB		
Description	Five grazing treatments were applied to 0.5 ha plots in a randomized block design with three replicates. All included lenient summer cattle grazing and only one had winter sheep grazing. A series of weed control sub-treatments were undertaken within grazing treatments using a split-plot design with replication at the block level. Five sub-treatments were common to both sites and were undertaken in 2000 and 2001 (ii-v had high thistle infestations).		
Plot size	0.5 ha		
Treatments	Plots had a combination of tight (5-7 cm) vs. lenient (8-10 cm) spring cattle grazing and tight (3-5 cm) vs. lenient (6-8 cm) autumn sheep grazing.		
Subplots	10 x 10 m		
Treatments	A series of weed control sub-treatments were undertaken within grazing treatments using a split-plot (10x10 m) design with replication at the block level. Five sub-treatments were common to both sites and were undertaken in 2000 and 2001 (ii-v had high thistle infestations): i)No additional treatment, low thistle infestation; ii) No additional treatment, high thistle infestation; iii) Cutting June, cutting September; iv) Herbicide (Clopyralid) wiping June; v) Cutting June, herbicide wiping September.. There was an additional treatment of hay cutting on a three year rotation		
Baseline data	Data on thistle shoot density was obtained in September (2000-2005) within ten randomly placed quadrats (1x1 m) in each sub-treatment plot. Effects on non-target forbs were investigated by recording rooted frequency in three random quadrats (1x1 m) within each sub-treatment plot in 2000, 2001, 2002 and 2005.		
Data archive	Spreadsheets held by CEH.		
Partner sites			
Key Research	Results suggest two complementary approaches to the environmentally sustainable control of thistles in permanent grassland, and provide more general lessons about combining weed management and biodiversity conservation. The first approach is the prevention of infestation by avoiding the creation of large patches of bare ground which may trigger the initial colonization from the seed bank or by wind-dispersed seed. The second approach is the control of existing infestations by combinations of weed control treatments and grazing management regimes. Lenient livestock grazing to maintain a relatively dense and competitive sward in the spring and autumn is the key to effective long-term control of existing thistle infestations in continuously grazed grasslands.' *Pywell R.F., Hayes M.J. & Tallowin J.B. (2010) Minimizing environmental impacts of grassland weed management: can Cirsium arvense be controlled without herbicides? Grass and Forage Science, 65, 159-174.*		
Notes	Plots are inactive and fencing has been removed.		

MONKS' WOOD 1-4

Project code/names	MONKS' WOOD 1 - 4	27
Type of experiment	RESTORATION (4)	4 INACTIVE
Details	Seeding establishment and grassland restoration	Neutral Grassland
Dates established	1978-1994	
Location		TL200795
Institution	Centre for Ecology and Hydrology, Wallingford	
Contact	Prof. Richard Pywell rfp@ceh.ac.uk	
Address	Centre for Ecology & Hydrology, Maclean Building, Benson Lane, Crowmarsh, Gifford, Wallingford, Oxfordshire, OX10 8BB	
Description	Monks Wood 1: 8 seed mixtures plus a control, in a randomised block layout with 4 replicas. Up to 1985, management was hay cutting & removal in Jul-Aug followed by second cut in Oct. From 1986, management was a single August cut each year, with cut materials left in situ (Wells et al 1994). NB. according to Wells (1995), plots managed by cutting 1x per year in August, with cuttings removed. Monks' Wood 2: Slot-seeded Improved grassland transect. Monitored -1986, 1988, 1989. Monks' Wood 3: Container-grown plants Improved grassland population census. Monitored -1984 to 1986, 1988 Monks' Wood 4: Hay bales Arable quadrat. Monitored 1981, 1982, 1988	
Plot size	5 X 2 m	
Treatments	Hand sown seed mixtures. 3 'short herb' , 3 'tall herb, 2 commercial mixtures; nurse crop used.	
Subplots		
Treatments		
Baseline data	Arable quadrat. Monitored 1979 to 1982, 1984 to 1986, 1988, 1989, 1991, 1994. 2 months after sowing, rooted frequency of individual species measured in 40 x 40cm quadrats, height & structure of vegetation recorded; 1979-1994 total above-ground biomass estimated at 1 or 2-yearly intervals in July, also biomass by species of a sub-sample.	
Data archive	Data held in spreadsheets by Richard Pywell.	
Partner sites	Long-term monitoring sites Ovington Plots, Judith's Hedge, Wilderness 1 & 2 (data held and updated by Drs Owen Mountford, CEH and Tim Sparks)	
Key Research	Research, in combination of studies at 24 other sites, had important implications for practical restoration programmes and policies through elucidating the ecological characteristics of the component species, together with knowledge of how they assemble, interact and function as communities. The research examined the linkage between species' performance and traits according to four non-exclusive hypotheses. The ability to establish and persist in restored vegetation communities requires: (H1) good gap colonization ability; (H2) strong competitive capability; and (H3) ability to undergo vegetative regeneration. (H4) The study showed that successful species are generalists associated with fertile habitats. Within the forbs, good establishment in the first year was linked to traits determining colonization ability: ruderality, percentage germination of seeds and autumn germination. However, traits linked to competitive ability, vegetative growth and seed bank persistence became increasingly important determinants of success with time. Species with generalist habitat requirements, and especially those associated with fertile soils, performed increasingly well with time. This reflects the development of a closed vegetation in which the ability to grow vigorously and out-compete other established plants is important.	

	Stress-tolerators, habitat specialists and species of infertile habitats performed badly. This may reflect high residual fertility in restored grasslands and particular niche requirements of these species. This may be a problem as grassland restoration often targets communities characterized by species with these traits and many are food plants of invertebrates of conservation value. *SEE: COMBINED DATASETS FROM ALL PLOTS SEE: RICHARD F. PYWELL, JAMES M. BULLOCK*, DAVID B. ROY,LIZ WARMAN, KEVIN J. WALKER and PETER ROTHERY Plant traits as predictors of performance in ecological restoration. Journal of Applied Ecology 2003 40, 65–77.*
Notes	The site is owned by CEH and the plots remain, although the fencing has been removed and no monitoring has been done since 1994.

MONKS' WOOD / Exclosures

Project code/names		?	NA
Type of experiment	DEER EXCLOSURE	ACTIVE	
Details		Broad-leaved woodland	
Dates established	**Various exclosures** 1978, 1993, 1999 and 2004		
Location	Cambridgeshire, England		
Institution			
Contact	Dr Arnold Cooke / Chris Gardiner	Chris.Gardiner@naturalengland.org.uk / rosarn@rosecooke.eclipse.co.uk	
Address			
Description	Fencing was erected in 1999 around two compartments (27 and 30) in the south west corner of the wood, an area of 10.6 ha, and around compartment 23 in the centre of the wood (6.1 ha). Thus about 11% of the wood was fenced, the aim being to exclude deer from areas with most of the traditional coppice plots (Massey 1994) and some of the more interesting features of the ground flora, e.g. the best remaining stands of bluebell and dog's mercury. In addition, sets of small (c 4x4 m) experimental fences were erected in 1978, 1993 and 2004. The 1978 exclosures were initially intended to exclude rabbits and hares (muntjac were still rare then). The muntjac population in Monks Wood has been controlled since 1998 and is still decreasing, but roe deer have increased.		
Plot size	10.6 ha and 6.1 ha exclosure		
Treatments			
Subplots			
Treatments			
Baseline data	Monitoring on the 2004 exclosures continued until 2010. However, with a changing deer population, it became progressively more difficult to interpret the significance of vegetation differences between small functioning exclosures and unfenced control plots. Monitoring deer and their impacts inside and outside the two main exclosures erected in 1999 continues		
Data archive	The electronic data archive is retained by Arnie Cooke		
Partner sites			
Key Research	SEE: Arnold S Cooke. Monitoring muntjac deer Muntiacus reevesi and their67 impacts in Monks Wood National Nature Reserve. English Nature Research Reports 681		
Notes	The 1999 exclosures are still in place, although 'they have rarely, if ever, been fully effective against muntjac'. The 1978 exclosures are believed to have been lost. Most if not all of the 1993 fences are still intact, as are those from 2004. (Arnold Cooke, pers. comm., 2014). Monitoring on the 2004 exclosures continued until 2010. However, with a changing deer population, it became progressively more difficult to interpret the significance of vegetation differences between small functioning exclosures and unfenced control plots. Monitoring deer and their impacts inside and outside the two main exclosures erected in 1999 continues on a voluntary basis but the PI is uncertain how long this will remain possible.		

MOORCO / B.I.G

Project code/names	Ballogie, Invercauld and Glensaugh		30
Type of experiment	FORESTRY		ACTIVE LTE
Details	Grazing impact on woodland succession		Upland Heath
Dates established	2005/6-		9
Location	Scotland		Glensaugh NO675801; Ballogie: NO550930; Invercauld NO170950
Institution	James Hutton Institute		
Contact	Dr Ruth Mitchell	ruth.mitchell@hutton.ac.uk	
Address	Craigiebuckler, Aberdeen, AB15 8QH		
Description	The experiment aims to identify mechanisms and rates of change as well as the role of herbivores in driving changes during succession from moorland to woodland. It is established across 3 sites: Ballogie, Invercauld and Glensaugh. There are 4 blocks at Invercauld and Glensaugh, 3 blocks at Ballogie. Treatments are identical within each block.		
Plot size			
Treatments	Within each block (i) Grazing by large herbivores – unfenced; (ii) No grazing by large herbivore – fenced. Within each fenced or unfenced plot are: Planted birch (1m spacing); Planted pine (1m spacing); Heather control; Low density birch (single trees planted); Clumped birch (clumps of 4 trees – only at Glensaugh).		
Subplots			
Treatments	Sub-plot treatments comprise: Litter addition – birch and pine litter added annually to birch, pine and control plots to assess if tree litter is driving below ground changes; Weeding - removal of a) moorland species, b) early successional species c) late successional species, carried out annually to test the role of understorey species in driving changes.		
Baseline data	Vegetation (species composition); soil chemistry; soil seedbank; soil physical properties; At Invercauld only: soil respiration; soil water chemistry; root growth; root chemical content; soil temperature; soil moisture.		
Data archive	Data held in Access database by Ruth Mitchell		
Partner sites			
Key Research	The experiment was designed to investigate how trees affect soil organic matter dynamics. It is still in its establishment phase. However, the initial five years of tree planting with birch and pine at the Invercauld field site has shown little impact on CO_2 and DOC but that the variation in response of CO_2 and DOC is related to time of season and soil type. Results will help understand the impact of changing land cover and inform the preservation of soil carbon stocks (through losses from land-use): Scotland's soils contain a carbon stock of national and international importance, predominantly in the form of upland and blanket peat. Preservation of that carbon stock is mandatory to reduce contributions through land-use induced losses to national emissions and feeding back to atmospheric CO_2 levels.		
Notes	Sites are funded on a 5 year rolling basis with the next funding cycle beginning in 2015. JHI intends to apply for funds to continue the MOORCO experiments.		

MOORCO / Chronosequence

Project code/names	Chronosequence plots		30
Type of experiment	FORESTRY		ACTIVE LTE
Details	Birch colonisation and nutrient enrichment.		Upland Heath
Dates established	1970s		40+
Location	Scotland		Tulchan NJ154373; Craggan NJ190323; Kerrow NH325295
Institution	James Hutton Institute		
Contact	Dr Ruth Mitchell	ruth.mitchell@hutton.ac.uk	
Address	Craigiebuckler, Aberdeen, AB15 8QH		
Description	13 sites were established in first generation birch woodlands that had colonised heather moorland to test theories that birch woodland increased soil fertility. At each site, 3 replicate plots were established in open heather moorland and in a range of even aged birch stands of different ages. The plots have now been established for c. 40 years, providing a range of plots with trees aged from 40 years to over 100 years. The Macaulay Institute and CEH Banchory have continued work at 3 of these sites – Tulchan, Craggan and Kerrow.		
Plot size			
Treatments	None – site selection		
Subplots			
Treatments			
Baseline data	Vegetation in 1m2 quadrats (not permanently marked): 1975, 1986, 2004, 2009; Soil chemical and physical data: 1973, 1986, 2004; Soil profiles: 1974; Seedbank data: 1975, 1986, 2004; Tree density, height, DBH etc: 2004.		
Data archive	Access database maintained by Ruth Mitchell		
Partner sites			
Key Research	Changes in vegetation and soils are similar under all sites, although the extent and rate of the change varies considerably. When moorland was colonised by birch woodland the following changes were shown to occur: Increased numbers of earthworms; a gradual breakdown of surface mor humus following the death of the heather; Increased rates of cellulose decomposition; increased fertility. A change from a heather dominated ground flora to a grass and herb rich flora was also observed. Results demonstrate that (1) the vegetation composition predicts the soil microbial community at least as well as the soil chemical data. (2) The vegetation composition may represent a more stable 'summary' of the effects of multiple drivers over time and may thus be a better predictor of the soil microbial community than one-off measurements of soil properties. (3) Soil chemistry and plant composition are, in substantial amounts, explaining different parts of the variation within the soil microbial community. (4) Trees may control soil community structure through the manipulation of resources and the soil physio-chemical environment.		
Notes	Due to the long-term nature of the plots the plots are not visited or sampled frequently. This can lead to the mistaken impression by land-owners that we are no-longer interested in the plots. The land-owner for the plots at Kerrow recently gave permission for a pylon and access track to be built over the plots as part of the Beauly-Denny power line. Sites are funded on a 5 year rolling basis with the next funding cycle beginning in 2015. JHI intends to apply for funds to continue the MOORCO experiments. The near-loss of the sites following the closure of CEH Banchory and subsequent damage to the Kerrow plots illustrates the vulnerability of long term experimental assets to organizational changes, and the importance of individual researchers to act as 'champions' for experimental platforms.		

MOORCO / Planted plots

Project code/names	John Mills Planted Plots		30
Type of experiment	FORESTRY	ACTIVE LTE	
Details	Birch colonisation and nutrient enrichment.	Upland Heath	
Dates established	1977-9	36+	
Location	Scotland	Delnalyne NJ1902 1746; Craggan A NJ1966 3245; Kerrow NH336 299	
Institution	James Hutton Institute		
Contact	Dr Ruth Mitchell	ruth.mitchell@hutton.ac.uk	
Address	Craigiebuckler, Aberdeen, AB15 8QH		
Description	A replicated experiment, at 3 sites (Delnalyne; Craggan; Kerrow), consisting of paired plots of planted birch on open heather moorland and moorland 'control' plots to test the effects of birch as an ecosystem engineer, particularly on soil chemistry. They have since been used to test (i) the impact of vegetation change on soil microbial community and below ground processes; (ii) changes in carbon pools following woodland establishment on moorland; (iii) impact of tree colonisation on biodiversity and ecosystem services; (iv) predicting the impact of woodland expansion within the Cairngorms National Park. At one of the sites (Craggan B) plots were also made where birch was felled and heather planted, to test the durability of the impacts of the ecosystem engineer, birch, following recolonisation of heather.		
Plot size	12 x 12 m; 16 x 16 m		
Treatments	In each pair, the two treatments, heather control and planted with Betula pubescens, were randomly assigned to the plots.		
Subplots			
Treatments			
Baseline data			
Data archive	Access database maintained by Ruth Mitchell		
Partner sites			
Key Research	This work has provided experimental evidence that birch acts as a top-down engineer, driving cascading effects on both above- and below-ground communities, soil chemical and physical properties and ecosystem processes. Results demonstrate: Under the birch, plant species richness decreased and the ground vegetation composition changed, from being dominated by *Calluna vulgaris* to being dominated by either grasses and *Vaccinium myrtillus* or bare ground depending on the density of the trees. The depth of the soil organic horizon, its moisture content and percentage carbon were all smaller under the birch than under the heather. Concentrations of available phosphorus and mineralisable-N were significantly greater in the soil under birch than under the heather plots. Decomposition was faster in the birch than in the heather plots. Under birch, total microbial biomass declined and species richness increased. Changes in the soil microbial community were also related to changes in mineralizable N. Mineralizable N was correlated with both decreasing total soil microbial biomass and decreasing fungal:bacterial ratio.		
Notes	Due to the long-term nature of the plots the plots are not visited or sampled frequently. This can lead to the mistaken impression by land-owners that we are no-longer interested in the plots. The land-owner for the plots at Kerrow recently gave permission for a pylon and access track to be built over the plots as part of the Beauly-Denny power line. Sites are funded on a 5 year rolling basis with the next funding cycle beginning in 2015. JHI intends to apply for funds to continue the MOORCO experiments. The near-loss of the sites following the closure of CEH Banchory and subsequent damage to the Kerrow plots illustrates the vulnerability of long term experimental assets to organizational changes, and the importance of individual researchers to act as 'champions' for experimental platforms.		

MOORCO / Felled plots

Project code/names	John Mills Felled Plots		30
Type of experiment	FORESTRY		ACTIVE LTE
Details	Birch colonisation and nutrient enrichment.		Upland Heath
Dates established	1978		36
Location	Scotland		NJ1902 3224
Institution	James Hutton Institute		
Contact	Dr Ruth Mitchell	ruth.mitchell@hutton.ac.uk	
Address	Craigiebuckler, Aberdeen, AB15 8QH		
Description	**Craggan (B)** - 12 plots arranged in a paired-plot design established in mature *Betula pubescens* woodland (first-generation woodland on previous Calluna-dominated moorland). The *Betula pubescens* trees in one of each of the paired plots were felled in 1978 and the wood and brash removed. The vegetation in the felled plots was sprayed to kill *Pteridium aquilinum* and all *Betula* seedlings that had established. *Calluna vulgaris* was planted in the felled plots and the plots were weeded occasionally over the next 20 years to remove any *Betula* seedlings that had established.		
Plot size	16 x 16 m		
Treatments	Removal of ecosystem engineer and replanting against control.		
Subplots			
Treatments			
Baseline data	Soil chemical and physical data in 1978, 1987, 2003; Vegetation (% cover) in permanently marked quadrats in 1985 & 2003; Tree measurements in 2003		
Data archive	Access database maintained by Ruth Mitchell		
Partner sites			
Key Research	After 20 years soil chemical properties, microarthropod communities and decomposition rates were not significantly different between plots with and without the birch. However, the results do give the first indication of a change towards soil properties more typical of a *Calluna* moorland. The work also shows that the role of birch in driving changes in the ecosystem is durable 20 years after the removal of the birch.		
Notes			

MOORHOUSE / Grazing

Project code/names			34
Type of experiment	LAND MANAGEMENT		ACTIVE
Details	Grazing and burning experiment		Bog
Dates established	1954		60
Location	Upper Teesdale, England		
Institution	CEH,		
Contact	Dr Rob Rose	rjr@ceh.ac.uk	
Address	Library Avenue, Bailrigg, Lancaster, LA1 4AP		
Description	Research began in 1952 with the opening of the Moor House Field Station. Experimental plots were established on a variety of vegetation types to examine the impact of **sheep grazing intensity** on vegetation and soils, these comprised 5-10 transects within grazed and ungrazed (enclosed) plots on a variety of grassland communities. These experimental plots were compared with adjacent plots which had free range grazing. One ungrazed plot has been lost, due to the impact on the lack of grazing on an *Saxifraga herculus*, for which the site is designated.		
Plot size	30 x 90 m		
Treatments	5-10 transects within grazed and ungrazed (enclosed) plots on a variety of grassland communities. These experimental plots were compared with adjacent plots which had free range grazing.		
Subplots			
Treatments			
Baseline data	Vegetation recording was last undertaken in 2004? External funds are required for the 2014 survey (there is the desire to monitor the site every 10 years). Site is also an ECN and UK Environmental Change Biodiversity Network site: Meteorology, atmospheric chemistry, water chemistry, stream flow, soils, vegetation, butterfly and bat recording, weekly fixed point photography, site management and phenology.		
Data archive	Data has been collated electronically in 2014 by Prof. Rob Marrs and Dr Rob Rose for the grazing experiment and publication is in prep.		
Partner sites			
Key Research	Experiments at Moorhouse are an important contributor to studies on upland land management, particularly burning and grazing. Vegetation change in the uplands tends to be relatively slow because of climatic limits on production and decomposition. Thus experiments need to be undertaken over long time spans. Data from the grazing experiment are currently being analysed and publication is in prep. *SEE Marrs R., and Rose, R., in prep.*		
Notes	External funds are required for the 2014 survey (there is the desire to monitor the site every 10 years). In the 1990s, Moorhouse was as a flagship site of the Terrestrial Initiative in Global Environmental Research (TIGER).		

MOORHOUSE / Hard Hill

Project code/names	Hard Hill Burning Experiment		34
Type of experiment	LAND MANAGEMENT	ACTIVE	
Details	Grazing and burning experiment	Bog	
Dates established	1954	60	
Location	Upper Teesdale, England		
Institution	Centre for Ecology and Hydrology, Lancaster		
Contact	Dr Rob Rose	rjr@ceh.ac.uk	
Address	Library Avenue, Bailrigg, Lancaster, LA1 4AP		
Description	**Hard hill burning experimental treatment** was established to investigate heather burning for moorland management. It is a randomised block experiment with four blocks over range of altitudes. Each block is divided into grazed and ungrazed sub-blocks. Each sub-block is divided into plots which are burned every ten years, burned every twenty years and not burned (Control)		
Plot size	30 x 30 m		
Treatments	Each block is divided into grazed and ungrazed sub-blocks.		
Subplots			
Treatments	Burning regime (10 yrs, 20 ys or unburnt on grazed and ungrazed subblocks) in four blocks at different altitudes.		
Baseline data	Site was burnt in 2006/7 and vegetation recording (including biomass, vegetation structure) updated. In 2011, the unburned reference controls which had been lost over time were relocated using a combination of map locations and aerial photography by Rob Marrs. These had not been burnt for the last 90 years. These have also been remarked and rerecorded.		
Data archive	Data have recently been collated, with publication in prep. (Prof. Rob Marrs, Rob Rose, pers. comm., 2014). Rerecording and burning is uptodate.		
Partner sites			
Key Research	Moorlands on blanket bog are high-priority ecosystems from a conservation viewpoint in the British Isles; they are often managed through using prescribed burning to increase their productivity for sheep and red grouse. However, there is an increasing demand to conserve these moorlands for other environmental services, e.g. carbon sequestration and water supplies and prescribed burning has been highlighted as a threat with considerable debate over its use as it is perceived to produce a *Calluna vulgaris* monoculture and a decline in preferred peat-forming species. The HHBE is the only properly-designed experiment testing the effects of prescribed burning rotations, (Lee, Allen & Marrs, 2011; 2013). Recent updated results show that there are significant effects between treatments for vegetation height, total biomass and *C. vulgaris* biomass. However, the main effects were detected between the short-rotation burn (5 years since the most recent burn) and the longer treatments. There was very little difference between the long-rotation burn and vegetation last burned 56/57 or even ca. 90 years ago. Where burn return interval is long (>20 years), *C. vulgaris* becomes dominant and there was no evidence that preferred peat- forming species (*Eriophorum/Sphagnum*) increased. Where burn return interval is short (10 years), *E. vaginatum*/*Sphagnum* abundance increased. Found no evidence to suggest that prescribed burning was deleterious to the abundance of peat-forming species; indeed, it was found to favour them. There was also no evidence to suggest that burning rotations beyond 20 years assisted the conservation of biodiversity. Indeed, research suggests that biodiversity falls off after this time and that burning before 20 years is needed to ensure plant species conservation (Lee, Allen & Marrs, 2011, 2013).		

	These results inform conservation management policy for blanket bogs in the UK and more generally for future wildfire-mitigation strategies on dwarf-shrub- dominated peatlands elsewhere. *SEE Hyohyemi Lee, Josu G. Alday, Angus Rosenburgh, Michael Harris, Hugh McAllister, Rob H. Marrs Change in propagule banks during prescribed burning: A tale of two contrasting moorlands. Biological Conservation 165 (2013) 187–197; Hyohyemi Lee, Josu G. Alday, Rob J. Rose, John O'Reilly and Rob H. Marrs Long-term effects of rotational prescribed burning and low-intensity sheep grazing on blanket-bog plant communities. Journal of Applied Ecology 2013. doi: 10.1111/1365-2664.12078; HyoHyeMi Lee, Katherine Allen & Rob Marrs. Analysis of the biomass accumulation within the Hard Hill Grazing and Burning experiment (HHGBE) at Moor House NNR. 2011.*
Notes	Data for the bracken and burning experiments has been analysed up to 2007. In the 1990s, Moorhouse was as a flagship site of the Terrestrial Initiative in Global Environmental Research (TIGER).

NEW FOREST / Denny Pens exclosures

Project code/names		? NA
Type of experiment	FORESTRY	Status to be confirmed. Believed closed.
Details	Deer exclosures	Broad-leaved woodland
Dates established	1963? -	
Location	New Forest, England	
Institution	Forest Research	
Contact	Robin Gill	robin.gill@forestry.gsi.gov.uk
Address	Forest Research, Alice, Holt Lodge Farnham Surrey GU10 4LH UK	
Description	Two 5·6 ha enclosures were established in 1963 within an area of heavily grazed deciduous woodland in the New Forest, Hampshire.	
Plot size	5.5 ha	
Treatments		
Subplots		
Treatments	One 5.5 ha enclosure was kept free of all large herbivores, while the other was maintained with a population of fallow deer (c 1 per ha).	
Baseline data	The vegetation of both was surveyed 6 years, 14 years and 22 years after enclosure. Surveys were undertaken in 1983–1984 and in 1985 of the small mammal communities and ground invertebrates in the two areas.	
Data archive	Unknown; may have been lost?	
Partner sites		
Key Research	Changes over time in species composition and age structure of trees in the two areas are discussed, as are changes in composition, diversity and biomass of the ground flora and shrub layer. Clear differences were apparent between the plots over time. While in the grazed plot no regeneration was apparent, rapid regeneration of birch, beech, oak, Scots pine, Douglas fir and holly had occurred in the ungrazed plot by 1969; by 1985, with closure of the canopy, establishment had virtually ceased. Clear differences were also recorded in species composition of both trees and ground flora, with species resistant to grazing more abundant in the grazed plot and with many graze-sensitive or palatable species absent in that plot becoming re-established in the ungrazed area. Analysis of the three-dimensional profile of the vegetation also showed clear differences in vertical structure. Marked differences in mammal communities and ground invertebrates following surveys in 1983-9 again reflect structure and species composition of the vegetation under the grazed and ungrazed regimes. Even after 22 years, the vegetation of the ungrazed area remains strikingly species-poor, and the study has implications for conservation and herbivore exclusion in grazed woodlands. *SEE: R.J. Putman, P.J. Edwards, J.C.E. Mann, R.C. How, S.D. Hill Vegetational and faunal changes in an area of heavily grazed woodland following relief of grazing.Biological Conservation Volume 47, Issue 1, 1989, Pages 13–32.* Putman R.J. (1986) *Grazing in Temperate Ecosystems; Large Herbivores and their Effects on the ecology of the New Forest*. Croom Helm. 200pp. ISBN 0-7099-4036- X.	
Notes	It is believed these exclosures may have been lost (Robin Gill, pers. Comm., 2014), although they were still in place 'several years ago'. (Ed Mountford, pers. comm., 2014).	

NEWBOROUGH

Project code/names		27
Type of experiment	LAND MANAGEMENT AND NUTRIENT	INACTIVE
Details	Grazing management and nutrient addition	Coastal
Dates established	2003-11	
Location	North Wales	
Institution	Centre for Ecology and Hydrology, Bangor	
Contact	Dr Lawrence Jones | lj@ceh.ac.uk	
Address	Environment Centre Wales, Deiniol Road, Bangor, Gwynedd, LL57 2UW	
Description	Experiment was established to investigate the impact of grazing on the ecosystem services of a dune grassland ecosystem. Sites were chosen in an area of fixed dune grassland at the landward end of the dunes. Care was taken to select areas of uniform vegetation as far as possible to minimise variation within and between blocks. Prior to construction of grazing exclosures the vegetation was a uniform 4–6cm height. Within each of the nine grazing plots, four different nitrogen (N) treatments were applied: unwatered control, watered control, low N treatment (7.5 kg ha− 1 year− 1) and high N treatment (15 kg ha− 1 year− 1). These subplots were established with a buffer zone of at least 1.50 m between each subplot and the fence to avoid possible edge effects. Within each grazing plot, another experiment was set up in April 2004 to assess whether vegetation growth was limited by N or P alone or co-limited by both.	
Plot size	10 X 10 m	
Treatments	Each block consisted of one fully grazed unit (unfenced), one rabbit grazed unit (fenced with 10 cm × 10 cm mesh to exclude large grazers) and one un-grazed unit (fenced with 10 cm × 10 cm mesh and an additional 2.7 cm × 3.7 cm mesh buried 20 cm underground to prevent rabbit access. Experimental blocks are separated from each other by hundreds of metres and by low dunes.	
Subplots	2.05 × 2.05; 1 × 1.25	
Treatments	Within each of the nine grazing plots, four different **nitrogen (N) treatments** were applied: unwatered control, watered control, low N treatment (7.5 kg ha− 1 year− 1) and high N treatment (15 kg ha− 1 year− 1). These subplots were established with a buffer zone of at least 1.50 m between each subplot and the fence to avoid possible edge effects. N was applied as ammonium nitrate in 5 l of deionised water per plot on 13 occasions per year. The watered control received 5 l of deionised water only, the unwatered control no treatment at all. As the experiment was trying to simulate increased concentrations of N deposited in rainwater, N was applied more frequently at times of higher long-term average rainfall: six times during the wettest months from October to January (every three weeks), four times in February/March and August/September (every four weeks), and three times in the driest months April to July (every six weeks). **A phosphorus addition experiment was added in 2004**: phosphorus was applied as sodium dihydrogen orthophosphate (NaH2PO4 . 2H2O) at 20 kg ha− 1 year− 1 in 5 l of deionised water. Nitrogen was applied at 15 kg ha− 1 year− 1 every two weeks in 2 l of deionised water, at the same solute concentration as in the larger main N addition plots, from April to August 2004 and again from April to June 2005. Mesocosms were also constructed with seven sand dune grassland species comprising a mix of fast- and slow-growing species and retained for 28 weeks.	

NEWBOROUGH (cont.)	
Baseline data	Grazing: Soil moisture content and temperature were recorded within each experimental unit, at six locations, once a month from June to September 2009. Samples to determine bulk density and soil organic matter content were collected during September 2009. Vegetation height was measured at five points within five 1 m × 1 m quadrats per experimental unit. Within two quadrats from each unit above-ground live vegetation and plant litter was collected from a 25 cm × 50 cm area cut to ground-level. One root core of 5 cm diameter and 10 cm depth was also taken per quadrat. Plant percentage cover, species richness and number of species flowering were recorded during July in five 1 m × 1 m quadrats from each experimental unit. Within the nitrogen subplots: Assessments of plant species composition were carried out in 1 × 1 m quadrats. Repeat point quadrat surveys, measurements of vegetation height, biomass sampling and rabbit pellet counts were carried out in the N and P plots at the same time as for the main experiment, using the same methods .Last monitoring campaign 2011.
Data archive	The data are held in several Excel spreadsheets by CEH Bangor. They have not been collated into a single database, although could readily be made available if required.
Partner sites	
Key Research	**Grazing:** In managed grasslands, the basic trade-off is between intensive management to maximise food production and extensive management resulting in lower production, but increased biodiversity and a wider range of cultural services (Power, 2010). Results from this case study and the wider scientific literature indicate that extensively cattle grazed or mixed pony/cattle grazed grassland should be conserved for the ecosystem services of plant genetic diversity, food provision, cultural environmental appreciation and potential pollination services. Un-grazed grassland should be conserved for the ecosystem services of invertebrate biodiversity, water storage and flood control (particularly on hill-side slopes), nutrient cycling and the potential for pest regulation. *SEE: Ford H, Garbutt A, Jones DL, Jones L (2012) Impacts of grazing abandonment on ecosystem service provision: Coastal grassland as a model system. Agriculture, Ecosystems and Environment 162 (2012) 108– 115.***Nitrogen:** Data and results from the experiment provide the only UK evidence on N impacts in sand dunes, with associated results from the experiment & the diverse measures of ecological processes & functions (e.g. due to grazing). The experiment has provided key underpinning evidence to support the critical load for Nitrogen in coastal dune environments (Laurence Jones, pers. comm., 2014).
Notes	The nitrogen treatments and monitoring ceased in 2011 with the cessation of DEFRA funding. However, grazing continues and it would be possible to return to monitor the site for post-treatment recovery in the future. CEH Bangor are proposing to undertake future work at the site, although no funding is currently in place.

NORTH WYKE / Land drainage

Project code/names	Rowden Land Drainage Experiment		27
Type of experiment	NUTRIENT	ACTIVE LTE	
Details		Neutral Grassland	
Dates established	1983		
Location	Devon, England	SX6698	
Institution	Rothamsted Research, North Wyke		
Contact	Jerry Tallowin	jerry.tallowin@bbsrc.ac.uk	
Address	North Wyke, Okehampton, Devon, EX20 2SB		
Description	A lowland grassland site typical of conditions in wetter, western Britain, two long term experiments have been conducted: **Drainage, re-seeding, and nitrate addition experiment** on an area of acid grassland (M23) with 2 replications: **Native turf treatment**: low/high N; undrained / deep-drained. **Reseeded grassland** - all high N with undrained / deep drained plots.		
Plot size			
Treatments	Nitrogen fertilizer has been added over the years according to project regimes. Phosphorus and K have been added in the spring every year, with K added to cut plots as required. The P and K was increased on the grass/clover paddocks to 50 kg P and 100 kg K ha-1 yr-1 in 1989-91 but was reduced to 40 kg P and 80 kg K ha-1 yr-1 in 1992 due to the build-up of soil reserves. The paddocks were limed at the start of NW20 in at 5 t ha-1 to the reseeds in 1982, permanent paddocks in 1983 and to all paddocks in 1986. The paddocks were limed again in August 2000 using ground limestone at 5 t ha-1. *SEE: ROWDEN DRAINAGE EXPERIMENTAL HISTORY* for further details of changing regimes.		
Subplots			
Treatments			
Baseline data	All vegetation recorded, height & composition, also productivity & nitrate loss.		
Data archive	Raw data and reports held by CEH (drainage studies) and Rothamsted Research, North Wyke. Yearly reports available from DEFRA.		
Partner sites			
Key Research	SEE Garwood & Armstrong; Hill.		
Notes	The site has not received consistent treatments over the years and therefore lacks long-term continuity (Tallowin, pers. comm., 2014)		

NORTH WYKE / Fen Meadow Restoration

Project code/names	Mol-rush Project		27
Type of experiment	RESTORATION	ACTIVE LTE	
Details		Neutral Grassland	
Dates established	1989 & 92		
Location	Devon, England	SX6698	
Institution	Rothamsted Research, North Wyke		
Contact	Jerry Tallowin	jerry.tallowin@bbsrc.ac.uk	
Address	North Wyke, Okehampton, Devon, EX20 2SB		
Description	**Fen Meadow restoration project** (aka 'Mol-rush' project) looked at soil stripping and soil treatments in large (9 x 2 m) and small (2 x 2 m) plots. Plots control rotovated & planted. Treatments - topsoil removed; addition lignitic clay, or lignitic clay and chopped straw, or chopped straw in combinations. Sowed a mixture of Mol-rush species collected from semi-natural grasslands in the locality. Plots mown mid-July-mid-Aug (expt 1 only). Both experiments included some glyphosate treatment of some or all of the plots to control competitive clonal species. Controlled molluscs in all plots.		
Plot size	9 x 2m; 2 x 2m		
Treatments	Treatments - topsoil removed; addition lignitic clay, or lignitic clay and chopped straw, or chopped straw in combinations.		
Subplots			
Treatments	In later years, have looked at seedling germination & establishment, irrigation, cutting of canopy & control of re-growth with glyphosate, soil disturbance & germination of 5 spp (Cx ovalis, Cirs. dis., Mol. caer., Succ. prat., Holc. lan.).		
Baseline data	Atmospheric inputs, ammonia, soil solution chemistry and river water chemistry. Botanical records kept.		
Data archive	Raw data and reports held by Owen Mountford CEH (drainage studies) and Rothamsted Research, North Wyke. Yearly reports available from DEFRA.		
Partner sites			
Key Research	SEE Garwood & Armstrong; Hill.		
Notes	The site has not received consistent treatments over the years and therefore lacks long-term continuity (Tallowin, pers. comm., 2014)		

PARK GRASS

Project code/names			30
Type of experiment	NUTRIENT		ACTIVE LTE
Details			Neutral Grassland
Dates established	1856 -		158
Location	Hertfordshire, England		TL1212
Institution	Rothamsted Research		
Contact	Dr Andy Macdonald	andy.macdonald@rothamsted.ac.uk	
Address	Rothamsted Research, Harpenden, Hertfordshire, AL5 2JQ		
Description	Begun in 1856 by Sir John Lawes and Sir Henry Gilbert, Park Grass is the oldest experiment on permanent grassland in the world. Its original purpose was to investigate methods of improving yields of hay through application of inorganic and organic fertilisers, and lime. Grassland is ungrazed, cut twice a year. Following many years of trials, soil pH now varies from 3.5 to 7. It is not replicated.		
Plot size	0.2 ha		
Treatments	Application of inorganic and organic fertilisers, and lime plots and subplots. **Inorganic nitrogen** as ammonium sulphate and sodium nitrate, **Organic nitrogen** in farmyard manure and pelleted poultry manure, **Acidity** - pH 7, 6, 5 and control, **Minerals:** Phosphorus (P) as superphosphate, Potassium (K) as potassium sulphate, Sodium (Na) as sodium sulphate, Magnesium (Mg) as magnesium sulphate, Silicon (Si) as sodium silicate. **Details of the treatments in each plot are provided in the Guide to the Classical Experiments', which can be downloaded from: http://www.rothamsted.ac.uk/long-term-experiments-national-capability**		
Subplots	0.05 ha		
Treatments	In 1903, most plots were halved and the effects of regular liming tested. This was modified in 1965 with the division of most plots into four sub-plots, three of which are limed to maintain pHs of 5, 6 and 7. The fourth sub-plot receives no lime and the pH of these ranges from 3.5 to 5.7 depending on the fertilizer treatment. The plots are cut each year for hay, usually in June, and a second cut is taken in the autumn. Since 1990, nitrogen fertiliser has been withheld from half of all sub-plots formerly receiving 96 kg N ha-1 as either ammonium sulphate or sodium nitrate to study processes controlling soil acidification, heavy-metal mobilisation and botanical changes.		
Baseline data	The plots are cut each year for hay, usually in June, and a second cut is taken in the autumn. There are archived herbage (since 1856) and soil (since 1870) samples available for retrospective analysis. See e-Ra website.		
Data archive	Data are retained by a dedicated online database, E-RA; part of the National Capability. www.era.rothamsted.ac.uk		
Partner sites			
Key Research	Nearly 200 scientific papers have been published about Park Grass since its inception. Over that history, Park Grass has demonstrated that conventional field trials probably underestimate threats to plant biodiversity from long term changes, such as soil acidification; how plant species richness, biomass and pH are related; demonstrated that competition between plants can make the effects of climatic variation on communities more extreme; provided one of the first demonstrations of local evolutionary change under different selection pressures. Data from the original experiments continue to provide valuable information on the relationship between soil fertility, productivity and diversity. The long time-series of data also allows scientists to detect the impacts of changing background conditions, such as the decline in species composition due to nitrogen deposition from industrialisation.		

	Archived soil and plant samples are an increasingly valuable resource to study historic changes, such as the deposition of pollutants like poly-aromatic hydrocarbons, dioxins and nuclear fallout. Genetic studies and analyses of nitrogen storage and cycling using stable isotopes are other examples of research. Since 1990, experiments into processes of soil acidification, heavy metal mobilisation and associated botanical changes have been undertaken at Park Grass. Soil carbon analyses have been used to develop and validate RothC, a computer model that simulates the turnover of soil organic carbon now linked to Global Climate Models and used by more than 1400 scientists in 94 countries. *SEE: Silvertown, J.; Poulton, P.; Johnston, E.; Edwards, G.; Heard, M.; Biss, P.M. (2006), "The Park Grass Experiment 1856-2006: its contribution to ecology", Journal of Ecology 94 (4): 801–814, doi:10.1111/j.1365-2745.2006.01145.x*
Notes	The Park Grass experiment is funded by the Lawes Trust and the BBSCR as a National Capability. The site is not regarded as being at risk. The age of the experiment means it is not replicated as it was begun prior to the advent of modern statistical design.

PALACE LEAS

Project code/names		24
Type of experiment	NUTRIENT	ACTIVE LTE
Details		Neutral Grassland
Dates established	1896	120
Location	Hertfordshire, England	NZ2091
Institution	University of Newcastle	
Contact	Dr Simon Peacock	simon.peacock@newcastle.ac.uk
Address	School of Agriculture, Food and Rural Development, Agriculture Building, University of Newcastle Upon Tyne, NE17RU, UK.	
Description	The experiments on Palace Leas Hay Meadows were begun in 1896, making them the world's longest-running grazing and hay cutting experiment and 14 out of the original 21 plots remain. Their original aim was to improve old grassland at low cost and without resowing, and the experiment used combinations of liming, fertilisers and animal manures to test the most efficient methods of increasing yields and regrowth, as well as improving the nutritional value of the hay. Subsequent research has included soil microbiology, nutrient cycling and soil processes, as well as studies of botanical composition and the effects of changing climate	
Plot size	120 x 15	
Treatments	Treatments comprise combinations of presence/absence of N, P, K fertilisers, FYM and untreated control. There is also one plot with 20 t ha-1 FY and no other fertilisers. There is no replication. Hay is cropped each year, followed by aftermath grazing (all plots grazed together as one unit, therefore preferential grazing affects results). Treatments have been consistent in their application since the experiment began.	
Subplots	Various	
Treatments	Various	
Baseline data	**Hay yield** has been measured each year. Total dry matter, carbon content of off-take Irregularly; Carbon and nitrogen content of off-take: has been measured irregularly. Some work done on microbial communities. Species data are available for 9 of the years between 1899 & 1987, not all years' data are comparable. **Soils**: Total carbon, Biomass carbon, Carbon measurements in other organic matter fractions, Carbon dioxide evolution, Total nitrogen, Total mineral nitrogen: Nitrate nitrogen, Ammonium nitrogen, Soil bulk density or weight, atmospheric nitrogen deposition and other soil nutrients have been measured irregularly. .	
Data archive	Data is held by the University of Newcastle. There are also irregularly archived soil and crop samples dating from 1985. In 2011, it was reported by R. Shiel that there was no centralised archive of this data. However, in May 2011 the research farm funded a project aiming to collate publications and data from Palace Leas, including a digital archive containing: 1. A procedures archive. 2. A database and 3. A digital publications library for the PL plots. However, it has not been possible to establish whether all historic data has been collated as yet.	
Partner sites		
Key Research	Their original aim was to improve old grassland at low cost and without resowing, and the experiment used combinations of liming, fertilisers and animal manures to test the most efficient methods of increasing yields and regrowth, as well as improving the nutritional value of the hay. Other investigations include research into clover ecotypes, archaeological investigations of diagenesis, detailed studies of soil fauna (enchytraeids), and an examination grazing preferences in the aftermath phase. Subsequent research has included soil microbiology, nutrient cycling and soil processes, as well as studies of botanical composition and the effects of changing climate. In 2011, correspondence with Peter Manning indicated there were plans to develop a data archive and use this to formulate statistical models of hay yield response to climate across a range of fertilities. The progress of this project is not known.	

Notes	After those at Rothampsted Palace Leas is thought to be the longest running experiment in the UK. It pre-dates replication in experimental design. The site has ongoing institutional support from the University of Newcastle. No further information on the long-term future for this experiment was obtained, due to the recent retirement of key staff. However, it is not regarded as at risk (R. Sheil, pers. comm., 2014).

PEAKNAZE / Recovery Roof

Project code/names	Recovery Roof		31
Type of experiment	CLIMATE CHANGE		ACTIVE LTE
Details			Upland Heath
Dates established	2006		8
Location	Derbyshire, England		
Institution	Centre for Ecology and Hydrology, Bangor		
Contact	Dr Bridget Emmett	bae@ceh.ac.uk	
Address	Environment Centre Wales, Deiniol Road, Bangor, Gwynedd, LL57 2UW		
Description	The Recovery Roof experiment, situated on the wet upland acid grasslands of the Peak District, between Sheffield and Manchester, was set up in 2006 to investigate the nature and rate of recovery of moorlands following reductions in air pollution over the latter half of the 20th century. The experiment simulates both predicted changes in pollution levels and future climate and measures animal, plant and soil responses. It is one of the few manipulation experiments which examines the interactions of multiple drivers at one site. Extractable roof technology is used to increase night time warming (ca. 0.7 C), increasing growing days by 111% compared to controls. The roofs are also used to force summer drought (July - September). Pollution studies are undertaken by rainfall exclusion with irrigation by clean rain. The treatments are arranged in a randomized block design with three replicates.		
Plot size	3 x 4 m		
Treatments	Night-time warming ((0.7 C) using retractable roofs, increasing growing days by 111% compared to control; summer drought (July - September). The polluted rain is a reconstituted solution, consisting of rainfall collected at the site from large collection surface, which is deionised to pure water and then mixed with a chemically reconstituted rainfall solution, with nitrogen and sulphur related pollutants added.		
Subplots			
Treatments			
Baseline data	Climate (temperature, rainfall.); Soil water quality, soil gaseous flux, soil nitrogen transformation, litter decomposition, vegetation production, nutrient status and compositional changes, soil carbon dynamics, root turnover, microbial composition.		
Data archive	The data are retained by CEH Bangor. No further information was supplied. It is assumed that data are archived as part of the UKREATE / INCREASE sites.		
Partner sites	Clocaenog / Climoor		
Key Research	Temperature is an important limiting factor of biological activity in uplands. Predicted increases in temperature therefore have the potential to cause significant impacts on UK and Europe upland ecosystems. The Climoor and Peaknase (Recovery Roof) experiments were established to test these hypotheses. Initial results show that drought treatments experienced reduced soil moisture year-round, despite the high mean-annual rainfall. This relative soil moisture deficit stimulated soil respiration and altered below-ground carbon dynamics. Cross-site comparison work with other experiments in Denmark and the Netherlands have also shown that the moisture status of a habitat is crucial in predicting the response in terms of carbon balance to a drought situation (Sowerby et al. 2008). The IPCC fourth assessment report in 2007 - Climate Change 2007 – Impacts, Adaptation and Vulnerability cites extensively from the Climoor publication list and data from CLIMOOR (and Peaknaze) have been used in collaborative modelling exercises, integrated		

	experimental and modelling approaches on the effects of precipitation changes on ecosystems across local, regional, and global scales as part of EPRECOT (Effects of Precipitation Changes on Terrestrial Ecosystems. - http://www.climaite.dk/eprecot/Eprecot.html). Warming treatments over the first ten years show little change in the dominated heather species, in contrast to that predicted by models such as CliMOVE, although less dominant species, such as the crowberry, *Empetrum nigrum*, appear particularly susceptible to warming throughout the growing season, with reductions to both biomass and growth rate, and 'bud break' delayed by up to 9 days compared to control plots (Prieto et al., 2009). Other species, such as bilberry (*Vaccinium myrtilus*), experienced advanced bud break in warmed plots by up to 6 days. These variations may have implications for the distribution of heath species in Wales and Northern England. *Initial results from the UK Climoor and its European 'sister' sites was published in a special issue of Ecosystems, volume 7, number 6, in Sept 2004.*
Notes	Site is partnered with Clocaenog and part of a European-wide network of heathland climate change experiments. Defra and EU funding ceased in 2013, and only one year of NERC National Capability funding remains. Maintenance costs are such that the experiment is unlikely to continue without a major grant, although it unclear whether this will be sought by CEH.

PENTWYN & BUSH (2)

Project code/names			31
Type of experiment	NUTRIENT		INACTIVE (2)
Details	**Paired nutrient enrichment and recovery experiments** in species rich (Pentwyn) and species-poor (Bush) sites.		Neutral Grassland
Dates established	1999-2010		8
Location	Gwent, South Wales		SO5209
Institution	Rothamsted Research		
Contact	Mr Jerry Tallowin / Dr Rob Dunn	jerry.tallowin@rothamsted.ac.uk / Robert.Dunn@rothamsted.ac.uk .	
Address	North Wyke, Okehampton, Devon, EX20 2SB		
Description	Begun in 1999, Pentwyn/ Bush and Raisbeck/Gaisgill are twinned mesotrophic meadow sites in Cumbria (Raisbeck)/Gaisgill and South Wales (Pentwyn/Bush). Pentwyn is located on species rich *Cynosurus cristatus-Centaurea nigra* (lowland) site; Bush on an adjacent species poor agriculturally improved meadow. The aim of the experiment is to identify sustainable nutrient input practices for the maintenance of botanical diversity and community structure in the meadows, and determine optimum land management practices for the restoration of botanical diversity to species-poor meadows. The experiment consists of 19 treatments on 35 m2 plots in a randomized block design replicated three times at each site. Soil pH is regulated to pH 6.0 by addition of ground limestone.		
Plot size	7 x 5 m		
Treatments	Fertilizer treatments were: 6, 12 or 24 tonnes ha-1 of FYM applied annually or triennially, or the inorganic N, P and K equivalent (as ammonium nitrate, phosphate and potassium oxide) to applying 12, or 24 t FYM ha-1 either annually or triennially, or lime applied either alone or with 12 t FYM ha-1 applied annually or triennially. A treatment representing continuation of past inputs was also applied. Controls - no lime, no fertiliser, no manure. Both sites, coupled with Raisbeck / Gaisgill are subject to autumn grazing and hay cutting.		
Subplots			
Treatments			
Baseline data	Soil chemistry, soil microbes, Botanical community change.		
Data archive	Data are retained by ADAS and Rothamsted Research (**although ADAS are no longer under contract**). A large volume of the floristic data on individual species at the Pentwyn and Raisbeck sites remain to be analysed although there are currently no funds available for this. (Jerry Tallowin, pers. comm, 2014		
Partner sites	Raisbeck & Gaisgill		

PENTWYN & BUSH (2 – cont.)	
Key Research	The paired experiments at Pentwyn and Bush and Raisbeck and Gaisgill are a unique resource, not only providing insights into the sustainable management of species-rich upland and lowland meadows, but providing a platform with which to investigate a range of other ecosystem services from species-rich grasslands. Results demonstrate that knowledge of soil physical and chemical status and past fertility management is important in deciding what level of fertilizer use might be tolerable for species and positive indicator richness maintenance. Relatively modest inputs, by agricultural standards, can reduce the ecological value of sensitive vegetation in meadows with no recent history of such inputs, whereas moderate inputs of fertilizer and lime are likely to be ecologically sustainable where there is a long history of such inputs. Comparisons with the species poor sites showed that restoring species-diversity to meadows by simply withholding fertilizers is a long-term process, but even applying FYM rates commonly used in traditional meadows can significantly inhibit recovery. Studies at Pentwyn /Bush also showed (controversially) that how nitrogen is applied (i.e. as inorganic N or FYM) doesn't matter, so long as the overall nutrient loads are balanced. This undermines standard agri-environment agreements, which usually stipulated that FYM should be used. With regard to agronomics, the studies also demonstrated that fertilizer applications that maintained the floristic diversity of the species-rich hay meadows, or allowed diversity to increase in species-poor meadows provided no consistent agronomic benefits when the meadows were cut in mid to late summer. Fertilizer applications that maintained the floristic diversity of meadows were insufficient to raise the phosphorus content of the hay to optimal levels for productive livestock. Justification for continued periodic fertilizer application to mid-late summer cut species-rich hay meadows should therefore be based primarily on maintaining mesotrophic conditions and the biodiversity richness of meadow communities. *Tallowin et al., Sustainable nutrient management of semi---natural neutral grasslands. Report to Defra on the Pentwyn and Raisbeck LTE; Francis W. Kirkham, Jerry R. B. Tallowin, Robert M. Dunn, Anne Bhogal, Brian J. Chambers and Richard D. Bardgett Ecologically sustainable fertility management for the maintenance of species-rich hay meadows: a 12-year fertilizer and lime experiment. Journal of Applied Ecology 2014, 51, 152–161. Francis W. Kirkham, Jerry R.B. Tallowin, Roy A. Sanderson, Anne Bhogal, Brian J. Chambers, David P. Stevens The impact of organic and inorganic fertilizers and lime on the species-richness and plant functional characteristics of hay meadow communities. BIOLOGICAL CONSERVATION 141 (2008) 1411–1427.*
Notes	Funding for the Pentwyn and Bush sites along with the partner sites at Raisbeck and Gaisgill was lost in 2010. All treatments ceased. The site is still maintained by the Gwent Wildlife Trust, and is accessible treatments could be restarted should funding become available, although there would be a loss of continuity. Otherwise, the sites still retain value as a post-treatment recovery site, although there are no immediate plans for further monitoring. Site management is still undertaken by the site owners, Gwent Wildlife Trust, as a hay meadow. However, there are no current formal access or research agreements with GWT.

PWLLPEIRAN / Tir Emrys

Project code/names	BD1211 (OLD BD0101 and BD0106, BD0115 - BD1211 AND BD1218)		31
Type of experiment	NUTRIENT AND LAND MANAGEMENT		INACTIVE
Details	Nitrogen addition and grazing experiment		Acid Grassland
Dates established	1989/1985 - 2013		
Location	Wales		SO5209
Institution	Centre for Ecology and Hydrology		
Contact	Prof. Bridget Emmett		bae@ceh.ac.uk
Address	Environment Centre Wales, Deiniol Road, Bangor, Gwynedd, LL57 2UW		
Description	In 1989 a series of 2 ha paddocks were established across Pen y Garn hill with different stocking rates. One aim was to examine the impacts of seasonal stocking density on vegetation composition. In 1995/6 a nitrogen addition experiment was created in two of the paddocks (a 'light' and 'heavy' grazed paddock: The **Tir Emrys plot**s) This nested experiment involves fortnightly additions of ammonium sulphate and sodium nitrate to replicated plots. Funding for this experiment ceased in 2013 and there have been neither grazing nor nitrogen treatments since. It is unclear whether there is any intention to continue to monitor the plots in the future.		
Plot size			
Treatments	The experiment consisted of 5 paddocks, with no replication, looking at different stocking rates and different timing of stocking (e.g. short period high intensity versus longer low intensity grazing). These sites were also formerly demonstration sites. These experiments stopped in 2011/2. A light and heavy grazing plot was used for the nitrogen addition experiments.		
Subplots	1 ha		
Treatments	Ammonium nitrate applied at 0, 10 , 20 kgN / Ha / yr. Replicated (3 per treatment) under light and heavy grazing.		
Baseline data			
Data archive	Data archives from a number of the Pwllpeiran experiments are unclear following the redundancy of key staff in 2012 and ADAS's removal from the site following the end of its lease.		
Partner sites			
Key Research	GRAZING: SEE Sarah M. Gardner, Sarah L. Hetherington & David Allen. Assessment of vegetation change and Calluna/Nardus interactions in relation to spatial variation in grazing pressure on upland moor. BD1211 (OLD BD0101 and BD0106, BD0115 - BD1211 AND BD1218??) http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=7565 NITROGEN: The nitrogen plots at Pwllpeiran were established to determine the interaction between grazing pressure and nitrogen deposition on the re-establishment of dwarf shrubs and species richness. As part of the UKREATE network, research also focussed on changes in nitrogen fluxes and critical chemical values in soils, vegetation and waters, which are indicative of changes in species performance. The results from the experiment, as with all the UK UKREATE and Terrestrial Umbrella sites, contributed to the DEFRA guidance . 'The UKREATE sites show clear and consistent evidence of the impacts of N deposition across nine sites of contrasting vegetation, soils, climate and ambient N deposition...There is clear evidence...that modest N loading can have significant impacts on seminatural ecosystems and even low N inputs may induce effects over time through accumulated loading'. REVIEW OF THE UKREATE NETWORK SEE: Phoenix GK, Emmett BA, Britton AJ, Caporn SJM, Dise NB, Helliwell R, Jones MLM, Leake JR, Leith ID, Sheppard LJ, Sowerby A, Pilkington MG, Rowe EC, Ashmore MR, Power SA (2012). Impacts of atmospheric nitrogen deposition: responses of multiple plant and soil parameters across contrasting ecosystems in long-term field experiments. Global Change Biology, 18: 1197-1215		

PWLLPEIRAN / Brignant

Project code/names	BD1424		31
Type of experiment	LAND MANAGEMENT	ACTIVE	
Details	Grazing experiment	Acid Grassland	
Dates established	1994		
Location	Wales	SO5209	
Institution	University of Aberystwyth		
Contact	Dr Gareth Griffiths	gwg@aber.ac.uk	
Address	Room S27, Cledwyn Building, Penglais, Aberystwyth, Ceredigion, SY23 3DA		
Description	The **Brignant plots** were established in 1994 to investigate the effects on sward biodiversity of grazing and cutting strategies in combination with withdrawal of fertiliser inputs to improved pasture. They were linked to a similar lowland site, Trawsgoed, which was subsequently ploughed. Site covers 0. 5 ha.		
Plot size	30 x 50 m		
Treatments	18 plots in three blocks of 6. Treatments comprise: Control - grazing, fertiliser and lime; Hay cut and aftermath grazing, plus lime; Grazing only (without lime); Grazing only (with lime), Hay cut only (split plots with and without lime; Hay-cut and aftermath grazing, without lime. Treatments replicated 3 times in a randomized plot design.		
Subplots	1 x 0.1 m		
Treatments	Locally-harvested seed of 9 native wildflower species were broadcast directly onto the sward surface within 3 permt quadrats (1m x 0.1m) in each plot in 1996. In 1998 seed of 3 of the above species, which had not established successfully in the first sewing, were broadcast into new permt quadrats within the plots.		
Baseline data	Ten 0.4m2 permanent quadrats; % cover all vasc plants. Invertebrates sampled by timed sweep-netting 3 times in 1999. Mean annual dry weight yields calculated & spring herbage analysed for N, P, K, Ca, Mg & Na content; also pepsin cellulase digestibility measured at hay-cut & in October. Soil samples taken winter 1999 & analysed for total C & N, extractable P, exchangeable K, Ca, Mg & Na; also pH & bulk density. NOTE: Treatments have been maintained, but no detailed recording since 2000, although other researchers have worked on the site (their data has not been collated or retained). Invert work was carried out by a Spanish entemologist in 2013. It is unclear whether these data have been retained. Continuity of vegetation monitoring has been interrupted, with no routine vegetation survey for 'at least 10 years' and none planned in the short term.		
Data archive	Results from the Pwllpeiran site are incorporated in to DEFRA reports but have not been collated into a single database and there is no retention of data / research carried out by other scientists who use the site.		
Partner sites	Closed site at Trawsgoed - It is unclear where the data from this site are.		
Key Research	The Brignant biodiversity plots were established on ADAS Pwllpeiran in 1999 as one of several sites across the UK to determine management practices to enhance biodiversity within semi-natural grassland communities. All other sites have since been lost making Brignant unique within the UK for its longevity and relevance. The results and conclusions to date can be instrumental in formulating policy in various environmental stewardship schemes across the UK. Open days and published posters have disseminated information to farmers, students and other scientific bodies. The plots have been used to train ecologists in preparation for knowledge transfer to the agricultural sector, in particular farmers participating in habitat schemes e.g. Glister, Tir Gofal. (Bernard Griffiths, ADAS, 2012)		

Notes	The Pwllpeiran site was recently under threat (2011/2), though has now been leased to IBERS (University of Aberystwyth) to manage as a new upland research platform. However, the experiments have yet to be embedded in the institutional framework of the platform and it is unclear what the plans are for the maintenance of the experiment. £2m was set aside for investments in the site; however, very little of this sum was allocated to maintain the experimental infrastructure. The Brignant plots remain unfunded and treatments are being maintained by individual scientists. Previously, the intensity of grazing was managed across the plots, with sheep kept in certain plots for set periods to reduce the effects of selective grazing. The difficulties at the site have meant sheep now moved freely within the grazed plots, so grazing preference / selective grazing has been introduced as an uncontrolled variable into the grazed plots. Researchers are concerned that paper files, reports and other data may have been lost when the original work ended. SEE:Rosa García, R and Fraser, M.D. in press. Fauna-flora relationships within improved upland grasslands managed under alternative extensification regimes; Pavlů V., Pavlů L. and Fraser M. in press. Long-term effects of extensification regimes on soil and botanical characteristics of improved upland grasslands. M.D. Fraser, V.J. Theobald, M.S. Dhanoaa, O.D. Davies Impact on sward composition and stock performance of grazing Molinia-dominant grassland.

PWLLPEIRAN / Paddocks			
Project code/names	**BD1228 AND BD1243; These are also known as the system plots and now known as LOT 9)**		31
Type of experiment	LAND MANAGEMENT	ACTIVE	
Details	Grazing experiment with nested heather restoration experiment	Acid Grassland	
Dates established	2002-2011 & 2013-2017	9+1	
Location	Wales	SO5209	
Institution	ADAS		
Contact	Dr Nigel Critchley	Nigel.Critchley@adas.co.uk	
Address	c/o ADAS UK Ltd, Newcastle University, NEFG Offices, Nafferton Farm, Stocksfield, Northumberland NE43 7XD, UK ADAS UK Ltd.		
Description	A series of 4 replicated treatments in **the Paddocks** covering 74 ha which investigated sheep, cattle and mixed grazing on *Nardus sp.* degraded heath, begun in 2002. Nested within it are 54 replicated plots looking at restoration methods for heather, including the effects of different grazing scenarios, effects of disturbance and seeding. The experiment ceased ca. 2011 following the cessation of the second phase of DEFRA funding. However, treatments restarted after 2 years (summers), in 2013. The experiment is scheduled to continue until 2017.		
Plot size	74 ha		
Treatments	54 replicated plots with: No grazing; cattle trampling; rotavating; seeding.		
Subplots			
Treatments			
Baseline data	Vegetation composition. 2015 next monitoring		
Data archive	The data is archived and available		
Partner sites			
Key Research	*SEE: Environmentally sustainable & economically viable grazing systems for restoration & maintenance of heather moorland: E&W BD1228http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=10072;*		

PWLLPEIRAN / Nanty Paddocks			
Project code/names	LS3402 and LS3407		31
Type of experiment	LAND MANAGEMENT	INACTIVE	
Details	Sheep and cattle grazing on molina grasslands.	Acid Grassland	
Dates established	2000-8		
Location	Wales		
Institution	Natural Resources Wales		
Description	A 16 ha experiment ('**Nanty Paddocks**') was begun in 2000 to look at sheep and cattle grazing on *Molina sp.* dominated grassland.		
Plot size	16 ha		
Treatments			
Subplots			
Treatments			
Baseline data			
Data archive	The data archiving for the Nanty paddocks experiment is unclear. All original staff had already moved on and a lot of the management detail and information invested in individuals 'is almost certain to have been lost.' It is also suspected data have been lost.		
Partner sites			

RAISBECK

Project code/names			31
Type of experiment	NUTRIENT		INACTIVE
Details	Nutrient addition and upland meadow management experiment		Neutral Grassland
Dates established	1999-2010		
Location	Cumbria, England		NY6306
Institution	Rothamsted Research		
Contact	Mr Jerry Tallowin / Dr Rob Dunn	jerry.tallowin@rothamsted.ac.uk / Robert.Dunn@rothamsted.ac.uk .	
Address	North Wyke, Okehampton, Devon, EX20 2SB		
Description	Begun in 1999, Raisbeck / Gaisgill and Pentwyn are twinned mesotrophic meadow sites in Cumbria (Raisbeck/Gaisgill) and South Wales (Pentwyn). Raisbeck is located on species rich *Anthoxanthum odoratum-Geranium sylvaticum* (upland) meadow (an SSSI) and with an adjacent agriculturally improved (species poor) meadow at Gaisgill, which has since been lost. Pentwyn and Bush are corresponding lowland sites. The aim of the experiment is to identify sustainable nutrient input practices for the maintenance of botanical diversity and community structure in the meadows, and determine optimum land management practices for the restoration of botanical diversity to species-poor meadows. The experiment consists of 19 treatments on 35 m2 plots in a randomized block design replicated three times at each site. Soil pH is regulated to pH 6.0 by addition of ground limestone. The treatments consist of varying concentrations of NPK as manure and fertiliser and controls - no lime, no fertiliser, no manure in permanently marked plots. Site, as well as Pentwyn/Bush, was subject to hay making and autumn grazing. Site, along with Pentwyn/Bush and Gaisgill, were subject to autumn grazing and hay cutting. A separate study investigated the potential of green hay spreading to enhance plant species-richness at the species-poor upland meadow at Gaisgill (now lost)		
Plot size	7 x 5 m		
Treatments	Fertilizer treatments were: 6, 12 or 24 tonnes ha-1 of FYM applied annually or triennially, or the inorganic N, P and K equivalent (as ammonium nitrate, phosphate and potassium oxide) to applying 12, or 24 t FYM ha-1 either annually or triennially, or lime applied either alone or with 12 t FYM ha-1 applied annually or triennially. A treatment representing continuation of past inputs was also applied. Controls - no lime, no fertiliser, no manure. Site, coupled with Pentwyn / Bush are subject to autumn grazing and hay cutting.		
Subplots			
Treatments			
Baseline data	Soil chemistry, soil microbes, Botanical community change.		
Data archive	Data are retained by Rothamsted Research and ADAS, **although ADAS are no longer formally contracted to manage / oversee research at the site.** A large volume of the floristic data on individual species remains to be analysed. Given the proliferation of key species (e.g. geranium sylvaticum and wax caps) in particularly plots within the experiment, analysis would potentially yield valuable information on conservation and management of hay meadows for target species (Jerry Tallowin, pers. comm., 2014).		
Partner sites	Pentwyn and Bush; closed species-poor site at Gaisgill.		

RAISBECK (cont.)	
Key Research	The paired experiments at Pentwyn and Bush and Raisbeck and Gaisgill were a unique resource, not only providing insights into the sustainable management of species-rich upland and lowland meadows, but providing a platform with which to investigate a range of other ecosystem services from species-rich grasslands. Results demonstrate that knowledge of soil physical and chemical status and past fertility management is important in deciding what level of fertilizer use might be tolerable for species and positive indicator richness maintenance. Relatively modest inputs, by agricultural standards, can reduce the ecological value of sensitive vegetation in meadows with no recent history of such inputs, whereas moderate inputs of fertilizer and lime are likely to be ecologically sustainable where there is a long history of such inputs. Comparisons with the species poor sites showed that restoring species-diversity to meadows by simply withholding fertilizers is a long-term process, but even applying FYM rates commonly used in traditional meadows can significantly inhibit recovery. Studies at Pentwyn / Bush also showed (controversially) that how nitrogen is applied (i.e. as inorganic N or FYM) doesn't matter, so long as the overall nutrient loads are balanced. This undermines standard agri-environment agreements, which usually stipulated that FYM should be used. With regard to agronomics, the studies also demonstrated that fertilizer applications that maintained the floristic diversity of the species-rich hay meadows, or allowed diversity to increase in species-poor meadows provided no consistent agronomic benefits when the meadows were cut in mid to late summer. Fertilizer applications that maintained the floristic diversity of meadows were insufficient to raise the phosphorus content of the hay to optimal levels for productive livestock. Justification for continued periodic fertilizer application to mid-late summer cut species-rich hay meadows should therefore be based primarily on maintaining mesotrophic conditions and the biodiversity richness of meadow communities. Green hay spreading studies at Gaisgill also showed that the total number of species per m2 and the richness and cover of MG3 positive indicator species were enhanced by this practice. *SEE: Tallowin et al., Sustainable nutrient management of semi-natural neutral grasslands. Report to Defra on the Pentwyn and Raisbeck LTE; Francis W. Kirkham, Jerry R. B. Tallowin, Robert M. Dunn, Anne Bhogal, Brian J. Chambers and Richard D. Bardgett Ecologically sustainable fertility management for the maintenance of species-rich hay meadows: a 12-year fertilizer and lime experiment. Journal of Applied Ecology 2014, 51, 152–161. F. W. Kirkham, A. Bhogal, B. J. Chambers, R. M. Dunn and J. R. B. Tallowin Effects of spreading species-rich green hay on the botanical composition of an agriculturally improved hay meadow in northern England. Grass and Forage Science 2012. Francis W. Kirkham, Jerry R.B. Tallowin, Roy A. Sanderson, Anne Bhogal, Brian J. Chambers, David P. Stevens The impact of organic and inorganic fertilizers and lime on the species-richness and plant functional characteristics of hay meadow communities. BIOLOGICAL CONSERVATION 141 (2008) 1411–1427.*
Notes	Funding expired in 2010 and treatments ceased, although the experiment site was retained at a post-treatment monitoring site until 2012, when it was handed back to the farmer. As a consequence, the Gaisgill site was treated with fertiliser and lost (Anne Bhogal, pers. comm., 2014). Attempts are underway to prevent any low level fertiliser treatment on the associated unimproved Raisbeck plots (Jerry Tallowin, pers. comm., 2013). The site is therefore regarded as at immediate and high risk. The experiment treatments could be restarted at Raisbeck, subject to receipt of funding; however, there would be a loss of continuity. Otherwise, ongoing studies would be into monitoring post-treatment recovery following nutrient treatments. It should be noted that there is currently no oversight of the Raisbeck site as formal ADAS involvement ceased following the withdrawal of DEFRA funds.

RHOS-LLAWR CWRT		
Project code/names		26
Type of experiment	RESTORATION	INACTIVE
Details		Fen Meadow
Dates established	1996-2002	
Location	South Wales	SN4149
Institution	Natural Resources Wales	
Contact	David Wheeler	David.Wheeler@cyfoethnaturiolcymru.gov.uk
Address	Rhos Llawr Cwrt, National Nature Reserve, Near Aberaeron, Ceredigion	
Description	Restoration of Molinia-Juncus vegetation from improved pasture (damp neutral semi-improved grassland, with MG6, MG7), using aluminium sulphate soil treatment, selective herbicides to remove clover and cutting to remove remaining biomas as 3 separate treatments, also control. Target vegetation: M23a & Agrostis-Carex-Succisa grassland. Sulphate and herbicide additions ceased in 2002, and biomass removal adopted. Management was subsequently extended to other fields.	
Plot size	10 X 40 m	
Treatments	3 Separate treatments: application of aluminium sulphate to reduce pH, selective herbicides to remove clover and cutting to remove remaining biomass against control.	
Subplots		
Treatments		
Baseline data	Soils samples taken (also from an unimproved part of the NNR, for comparison) & analysed for a common suite of properties, including Phosphorus adsorption. Vegetation sampled non-destructively in 0.25m2 quadrats within 1m2 quadrats. Focus of restoration was habitat for butterfly, which is more frequently monitored.	
Data archive	Reports were submitted to CCW although were not readily accessible during this survey. Some raw data are held in spreadsheets by David Wheeler. The original data are available in the Ph.D study undertaken at Aberystwyth University. (Contact Bill Adams for details)	
Partner sites		
Key Research	Project established to extend habitat of the Marsh Frittilary Butterfly. Experimental aspects of restoration used as model for CCW (now NRW) into restoration and land management of wider habitats and protected species. Results demonstrated the most practical long-term management for the NNR and other sites was the removal of biomass by cutting and grazing. This was partly a practical decision, owing to the dampness of the site and the difficulty of moving machinery on the site. There were also widespread reductions in clover in the area (including untreated plots) which meant herbicides rendered unnecessary. *SEE: Adams et al 1999*	
Notes	Following the completion of the experiment, a cutting and removal of biomass was adopted as the management and extend to other fields. Monitoring on the site has ceased, although marked plots remain and post-treatment monitoring is possible. Some limited vegetation survey (species lists and surveillance) continue. Results have not been widely disseminated, although were published in a book on management planning and restoration.	

RIVER RAY

Project code/names	BD1404	28
Type of experiment	RESTORATION	INACTIVE
Details	Restoration seeding experiment	Neutral Grassland
Dates established	1994 - 2001	
Location	England	SP651202
Institution	Centre for Ecology and Hydrology	
Contact	Prof. Richard Pywell	rfp@ceh.ac.uk
Address	Centre for Ecology & Hydrology, Maclean Building, Benson Lane, Crowmarsh, Gifford, Wallingford, Oxfordshire, OX10 8BB	
Description	5 treatments for restoration from arable - adjacent Long Herdon Meadow SSSI was used to identify targets for restoration. Treatments comprised (i) natural regeneration, (ii) hay bales, (iii) 3 seed mixtures, in 3 replicate blocks each consisting of 10 plots. Hand-sown seed mix was based on CSS seed mix; intermediate mix; expensive mix, including all available potential species from target community. 3 different types of hay bales were sourced from SSSI. Compared use of nurse crop (*L. multiflorum*) versus no nurse crop.	
Plot size	38 x 18 m	
Treatments	Treatments comprised (i) natural regeneration, (ii) hay bales, (iii) 3 seed mixtures, in 3 replicate blocks each consisting of 10 plots. Hand-sown seed mix was based on CSS seed mix; intermediate mix; expensive mix, including all available potential species from target community. 3 different types of hay bales were sourced from SSSI. Compared use of nurse crop (*L. multiflorum*) versus no nurse crop.	
Subplots		
Treatments		
Baseline data	Sampled soil seedbank. Vegetation establishment monitored -1995 to 1998	
Data archive	Data are held electronically by CEH Wallingford	
Partner sites		
Key Research	Early results suggested that the use of hay bales was relatively unsuccessful; the chances of restoration are unlikely to be improved by the use of a nurse crop. Longer term results are required. Last full assessment c 2001 (O. Mountford Pers. Comm., 2014).	
Notes	The site has not been monitored since 2001 and is considered inactive, although it should be possible to return to the site if desirable. There are no current plans to do so (Richard Pywell, pers. comm., 2014).	

ROYSTON HEATH (3)

Project code/names		27
Type of experiment	RESTORATION	INACTIVE (2)
Details	Seeding experiment	Lowland calcareous grassland
Dates established	1973 & 1978	
Location	Hertfordshire, England	TL341399
Institution	Centre for Ecology and Hydrology	
Contact	Prof. Richard Pywell	rfp@ceh.ac.uk
Address	Centre for Ecology & Hydrology, Maclean Building, Benson Lane, Crowmarsh, Gifford, Wallingford, Oxfordshire, OX10 8BB	
Description	Terry Wells' work: 3 experiments on arable chalk soil which had previously grown 11 successive cereal crops. Soil analysed for fertility before experiment began.	
Plot size	5 x 2 m	
Treatments	Royston Experiment I (1973): 7 seed mixtures sown plus control in randomised block with 5 replicates. Forbs sown at 100 seed /m2, grasses at 1000 seed /m2. Plots cut twice during 1st summer to control arable weeds; subsequently cut in August (mowings removed) & October (mowings left). 2 sites/plots, one started in 1973 (Royston Experiment 1&2); one in 1978 (Royston Experiment III) - comprised four blocks each with nine 5 m x 2 m plots separated by a 1 m wide guard row of *Phleum pratense* between plots and 2 m between blocks. Eight different herb/grass mixtures, together with one unseeded plot, were sown at random in each block." Welch 1994 (App 1 of Wells et al 1994).	
Subplots		
Treatments	Royston 1&2: 7 seed mixtures sown plus control in randomised block with 5 replicates. Forbs sown at 100 seed /m2, grasses at 1000 seed /m2. Hand sown seed mixtures; Arable; quadrat. Royston III: Eight different herb/grass mixtures, together with one unseeded plot, were sown at random in each block	
Baseline data	Royston Experiment 1&2: First site Monitored - 1974 to 1977, 1979, 1981, 1985, 1986, 1994; Royston III: Monitored 1978 to 1981. Sites were last monitored in 2003. Pitfall traps & D-vac results were recorded in another experimental plot nearby in 1973-1975 and, in 1994, at the Royston Expt I & III sites. In 1994 the study focussed on beetles ants harvestmen woodlice millipedes centipedes and snails. Also covered in less detail were plant bugs, leafhoppers, flies, sawflies, bees, and parasitic wasps.	
Data archive	Data retained by CEH Wallingford	
Partner sites	A butterfly transect was set up on both experiments in 1994 and results compared with transects on old-established chalk grassland in Bedfordshire (Barton Hills, Dunstable Downs, Whipsnade Downs & Totternhoe Chalk Quarry).	
Key Research	Research at Royston Heath, in combination of studies at 24 other sites, had important implications for practical restoration programmes and policies through elucidating the ecological characteristics of the component species, together with knowledge of how they assemble, interact and function as communities. The research examined the linkage between species' performance and traits according to four non-exclusive hypotheses. The ability to establish and persist in restored vegetation communities requires: (H1) good gap colonization ability; (H2) strong competitive capability; and (H3) ability to undergo vegetative regeneration. (H4) The study showed that successful species are generalists associated with fertile habitats. Within the forbs, good establishment in the first year was linked to traits determining colonization ability: ruderality, percentage germination of seeds and autumn germination.	

	However, traits linked to competitive ability, vegetative growth and seed bank persistence became increasingly important determinants of success with time. Species with generalist habitat requirements, and especially those associated with fertile soils, performed increasingly well with time. This reflects the development of a closed vegetation in which the ability to grow vigorously and out-compete other established plants is important. Stress-tolerators, habitat specialists and species of infertile habitats performed badly. This may reflect high residual fertility in restored grasslands and particular niche requirements of these species. This may be a problem as grassland restoration often targets communities characterized by species with these traits and many are food plants of invertebrates of conservation value. *SEE: COMBINED DATASETS FROM ALL PLOTS SEE: RICHARD F. PYWELL, JAMES M. BULLOCK*, DAVID B. ROY,LIZ WARMAN, KEVIN J. WALKER and PETER ROTHERY Plant traits as predictors of performance in ecological restoration. Journal of Applied Ecology 2003 40, 65–77. See also the NCC Focus on Nature Conservation publication No 15 Wild flower grasslands from crop-grown and hay-bales 1986.*
Notes	The plots still exist and are permanently marked, however the last monitoring was undertaken in 2003. There are no plans for further work (Richard Pywell, pers. comm., 2014).

RUABON / Old

Project code/names			26.5
Type of experiment	NUTRIENT	ACTIVE LTE	
Details	Nitrogen addition experiment with managed burn.	Upland Heath	
Dates established	1989	25	
Location	North Wales	TL341399	
Institution	Manchester Metropolitan University		
Contact	Dr Simon Caporn	s.j.m.caporn@mmu.ac.uk	
Address	Dalton Research Institute, John Dalton Building, Faculty of Science and Engineering, John Dalton Building, Chester Street, Manchester, M1 5GD		
Description	The original 1m2 plots, replicated 4 times, were established in 1989 on an area of upland *Calluna* moorland in North Wales were established to investigate the impact of nitrogen on upland ecosystems. The whole area was subjected to a controlled management burn in March 2000, leading to removal of *Calluna* canopy, but leaving litter and peat layers intact. Post fire recovery has been followed.		
Plot size	1 m2		
Treatments	The plots have been treated with nitrogen applied as monthly applications of ammonium nitrate in 0, 40, 80, 120 kg N ha-1 y-1 . Controlled management burn in March 2000.		
Subplots			
Treatments			
Baseline data	Vegetation structure and Calluna growth have been surveyed regularly. A large variety of other ecological and nutrient cycling measurements have been made at various points in time.		
Data archive	Annual reports are on the DEFRA UKREATE website. Monitoring data are archived onto a central database, however, there is no comprehensive database which includes all studies at the site (ie. Nested studies which use the plots)		
Partner sites	Ruabon (new); UKREATE partner sites – Wardlow Hay Cop; Whim Bog; Clocaenog; Peaknaze; Little Budworth Common.		
Key Research	The results from the experiment, as with all the UK UKREATE and Terrestrial Umbrella sites, contributed to the DEFRA guidance. 'The UKREATE sites show clear and consistent evidence of the impacts of N deposition across nine sites of contrasting vegetation, soils, climate and ambient N deposition...There is clear evidence...that modest N loading can have significant impacts on seminatural ecosystems and even low N inputs may induce effects over time through accumulated loading'. *REVIEW OF THE UKREATE NETWORK SEE: Phoenix GK, Emmett BA, Britton AJ, Caporn SJM, Dise NB, Helliwell R, Jones MLM, Leake JR, Leith ID, Sheppard LJ, Sowerby A, Pilkington MG, Rowe EC, Ashmore MR, Power SA (2012). Impacts of atmospheric nitrogen deposition: responses of multiple plant and soil parameters across contrasting ecosystems in long-term field experiments. Global Change Biology, 18: 1197-1215*		
Notes	Funding for the Little Budworth and Ruabon experiments ceased in 2011 though the experimental treatments have been maintained by Drs Chris Field and Simon Caporn, although this is not part of their academic roles. New data are collected as part of undergraduate projects and this is fairly successful Further dedicated funding is being considered, but 'is difficult to get for long-established experiments through the NERC'. (Simon Caporn, pers. comm., 2014). Nevertheless, the PI is confident that the sites will remain open in to the future, in that there no access or ownership issues.'		

RUABON / New

Project code/names			29.5
Type of experiment	NUTRIENT	ACTIVE LTE	
Details	Nitrogen addition experiment with managed burn.	Upland Heath	
Dates established	1998	25	
Location	North Wales	TL341399	
Institution	Manchester Metropolitan University		
Contact	Dr Simon Caporn	s.j.m.caporn@mmu.ac.uk	
Address	Dalton Research Institute, John Dalton Building, Faculty of Science and Engineering, John Dalton Building, Chester Street, Manchester, M1 5GD		
Description	The new Ruabon plots (4m2), replicated 4 times, were set up in 1998 on the same site and received monthly applications of nutrients until March 2003, when the plots were split		
Plot size	4 m2		
Treatments	Monthly applications of nutrients (0, 10, 20,40,120 kg N +/- 20 kg P ha-1y-1).		
Subplots	2 m2		
Treatments	Split plots with one side receiving continuing treatments as before; other side no further treatments ('recovery experiment')		
Baseline data	Vegetation structure and Calluna growth have been surveyed regularly and soil and plant nutrients have been monitored at various points in time.		
Data archive	Annual reports are on the DEFRA UKREATE website. Monitoring data are archived onto a central database, however, there is no comprehensive database which includes all studies at the site (ie. Nested studies which use the plots)		
Partner sites	Ruabon (old); UKREATE partner sites – Wardlow Hay Cop; Whim Bog; Clocaenog; Peaknaze; Little Budworth Common.		
Key Research	The results from the experiment, as with all the UK UKREATE and Terrestrial Umbrella sites, contributed to the DEFRA guidance . 'The UKREATE sites show clear and consistent evidence of the impacts of N deposition across nine sites of contrasting vegetation, soils, climate and ambient N deposition...There is clear evidence...that modest N loading can have significant impacts on seminatural ecosystems and even low N inputs may induce effects over time through accumulated loading'. *REVIEW OF THE UKREATE NETWORK SEE: Phoenix GK, Emmett BA, Britton AJ, Caporn SJM, Dise NB, Helliwell R, Jones MLM, Leake JR, Leith ID, Sheppard LJ, Sowerby A, Pilkington MG, Rowe EC, Ashmore MR, Power SA (2012). Impacts of atmospheric nitrogen deposition: responses of multiple plant and soil parameters across contrasting ecosystems in long-term field experiments. Global Change Biology, 18: 1197-1215*		
Notes	Funding for the Little Budworth and Ruabon experiments ceased in 2011 though the experimental treatments have been maintained by Drs Chris Field and Simon Caporn, although this is not part of their academic roles. New data are collected as part of undergraduate projects and this is fairly successful Further dedicated funding is being considered, but 'is difficult to get for long-established experiments through the NERC'. (Simon Caporn, pers. comm., 2014). Nevertheless, the PI is confident that the sites will remain open in to the future, in that there no access or ownership issues.'		

SOMERFORD MEAD

Project code/names	Alison's Meadow		31
Type of experiment	RESTORATION	ACTIVE LTE	
Details	Grazing for floodplain restoration following seeding	Neutral grassland	
Dates established	1985/6-	28	
Location	Oxfordshire, England	SP460097	
Institution	Centre for Ecology and Hydrology / FAI Farms		
Contact	Owen Mountford / Richard Pywell / Ben Woodcock / Jo Copping, FAI	Owen Mountford om@ceh.ac.uk	
Address	Centre for Ecology & Hydrology, Maclean Building, Benson Lane, Crowmarsh, Gifford, Wallingford, Oxfordshire, OX10 8BB		
Description	The Somerford Mead experiment was set up in 1985 to provide information to farmers and land-managers desiring to re-create floodplain grassland from arable land. A study of the seed bank was followed by sowing with ancient floodplain meadow seeds in 1986. The grassland was then cut early in July and grazed by a mixture of 12 heifers and 50 sheep in the autumn of 1987 and 1988. Every year since 1989 the meadow has been cut for hay in early July and either grazed by cattle, sheep or left ungrazed.		
Plot size	0.4 ha		
Treatments	Randomised block design with nine 0.4 Ha plots. Treatments comprise: Resown species-rich flood-meadow with annual hay cutting (end of June/early July) and autumn grazing : 3 plots - cattle grazing (2) 3 plots - sheep grazing (10) 3 plots - Ungrazed control.		
Subplots			
Treatments			
Baseline data	Annual botanical assessment. 1986-1989 and 1990-2013 (except 2000). Vegetation monitoring will recommence in 2015 (2014 omitted) and a new regime instigated, with routine monitoring likely every 2-4 years.		
Data archive	Historic datasets, paper files and Excel passed to Owen Mountford, CEH 2013. 'These are the kind of databases that CEH likes to make available, and will probably do so in due course, though it isn't a current priority' (Owen Mountford, pers. comm., 2014)		
Partner sites			
Key Research	The traditional management of cutting for hay followed by cattle grazing has produced a sward which is slightly less species- rich but richer in invertebrates, than the sheep-grazed treatments but both of these treatments are richer in both plants and invertebrates than the ungrazed plots. The experiment continues to provide an excellent platform for other research into the colonisation of invertebrates and soil flora and fauna.		
Notes	The site has been taken over by CEH Wallingford. As a consequence, the current monitoring regime is likely to change, with annual monitoring being replaced by monitoring in 2-4 year intervals, beginning 2015. The site may be at long-term risk if it does not become embedded into CEH's ongoing projects following the retirement of Owen Mountford in 2016.		

SOURHOPE / Bracken

Project code/names	Bracken control (This is NOT RIGG FOOT)	NA
Type of experiment	LAND MANAGEMENT	INACTIVE PTRE
Details	Bracken control	Acid grassland
Dates established	1993/4-?	
Location	Borders, Scotland	
Institution	Liverpool University	
Contact	Rob Marrs calluna@liv.ac.uk	
Address	Applied Vegetation Dynamics Laboratory, School of Vegetation Dynamics Laboratory, University of Liverpool, Liverpool, L69 7ZB	
Description	One of a series of related bracken control experiments (Cannock Chase, Carneddau, Hordron Edge) established to test the efficacy of different management methods (cutting, herbicdies) and reseeding methods. Two sites studied: Sourhope 1 and Sourhope 2, established 1993 and 4 respectively	
Plot size	10 x 40 m	
Treatments	Six bracken control treatments allocated randomly within each block (1) Experimental control: 'no-treatment'; (2) Cut once yearly in June; (3) Cut in June and August 'cut- twice-yearly'; (4) Cut in June followed by herbicide (absulam) spraying in the late summer of year 2; (5) Herbicide in year one only; (6) Herbicide in year 1 followed by a cut in June of year 2. Asbsulam applied at 4.4 kg active ingredient per ha in 400 L water per ha. Single application of herbicide in 1996, three years after first treatment at Sourhope 2.	
Subplots	10 x 18 m	
Treatments	Two sub-treatments (1994 & 1995) were no seeding and seeding with 60 kg seeds per ha of *Festuca ovina, Agrostis capillaris, Poa pratensis* mixture (5:4:3) plus some *Rumex acetosa*.	
Baseline data		
Data archive	Data are held by Rob Marrs. Unclear if Sourhope data are also affected by database migration issues (Full suite of data for associated sites at Bamford and Hordron is not available electronically. The experiment would benefit from a short (<month) project to migrate and validate all data (Rob Marrs, pers. comm., 2014)).	
Partner sites	Cannock Chase, Carneddau, Hordron Edge	
Key Research	Together with its associated sites (Hordron, Carneddau, Sourhope) data from Cannock Chase has been used to understand the efficacy of different bracken management methods, contributing to policy objectives in the context of Agri-environment schemes and Biodiversity Action plans towards reversing bracken invasion / colonisation on UK's moorland. Results of meta-analyses show that there is considerable variation in the efficacy of the same management between sites, possibly caused by differences in climatic regime, substrate, and past and current management practices, which make determining a 'one-size fits all' approach to upland heath restoration sites colonised by bracken problematic. Differences are also found between treatment performance in achieving conservation targets in acid grassland and heathland sites. *SEE: COX, E.S., MARRS, R.H., PAKEMAN, R.J. & LE DUC, M.G. 2007. A multi-site assessment of the effectiveness of Pteridium aquilinum control in Great Britain. Applied Vegetation Science, 10, 429-440; COX, E.S., MARRS, R.H., PAKEMAN, R.J. & LE DUC, M.G. 2008. Factors affecting the restoration of heathland and acid grassland on Pteridium aquilinum-infested land across the UK: a multisite study Restoration Ecology, 16, 553-562. doi: 10.1111/j.1526-100X.2007.00326.x; STEWART, G.B., COX, E.S., LE DUC, M.G., PAKEMAN, R.J., PULLIN, A.S. &. MARRS, R.H 2008. Control of Pteridium aquilinum: meta-analysis of a multi-site study in the UK. Annals of Botany, 101, 957-970. doi:10.1093/aob/mcn020.*	
Notes	The site was revisited in 2013. There are no further plans to revisit the site. **NOTE: The Rigg Foot experiment at Sourhope is now closed and ploughed.**	

TEALHAM & TADHAM MOOR (1)

Project code/names			28
Type of experiment	NUTRIENT		INACTIVE
Details	Nutrient enrichment and grazing; subsequent recovery.		Neutral Grassland
Dates established	1986-1994 (split plots 1990-4)		
Location	Somerset, England		ST422448
Institution	Centre for Ecology and Hydrology		
Contact	Dr Owen Mountford	Owen Mountford om@ceh.ac.uk	
Address	Maclean Building, Benson Lane, Crowmarsh Gifford, Wallingford, Oxfordshire, OX10 8BB		
Description	Established in 1986, the Tadham project sought to address uncertainties about the effect of fertilisers on the species rich grassland of the Somerset Levels, one of the UK's largest remaining wetlands. The experiment comprised hay cutting, aftermath grazing and nitrogen and phosphorus addition on 3 randomized blocks in *Cynosurus cristatus-Centaurea nigr*a and *Cynosurus cristatus-Caltha palustris* flood pasture. Nitrogen was added twice a year in five nitrogen treatments: 0, 25, 50 100 & 200 kg/ha. Phosphorus and potassium removed in hay were replaced as triple superphosphate and muriate of potash. There was a summer hay cut with aftermath grazing by cattle to equalise the herbage on each plot by varying stocking intensity. Plots were sub-divided in 1990, with fertilisation ceasing on half of each plot.		
Plot size	0.6-1.1 ha.		
Treatments	Nitrogen treatments twice a year (mid-April and early July) as ammonium nitrate. : 0, 25, 50 100 & 200 kg/ha/yr. Phosphorus and potassium removed in hay were replaced as triple superphosphate and muriate of potash. Summer hay cut with aftermath grazing by cattle to equalise the herbage on each plot by varying stocking intensity.		
Subplots	Various		
Treatments	Plots were sub-divided in 1990, with fertilisation ceasing on half of each plot. Plot size 0.6 in nigh N and 1.1 ha in control. **Small-scale experiments**: as above but also with larger amounts of P & K; cutting only (2 x pa). Plot size 1.5 x 5m, in expt area of 25 x 35m. **Reversion expt:** rotovation & use of herbicides, plot size 4x2m. **Cutting date expt**: plot size 2x4m. **Grazing exclusion study:** plot size 5x5m; **Seed longevity experiment** - 1994-2004, (*see Bekker et al 1998.)*		
Baseline data	Plant species composition, Above ground biomass, Root biomass, Soil moisture and chemistry, Plant tissue chemistry. Dry-matter yields of herbage & of N, P & K were measured at each cut between 1986 & 1993; Vasc plants & bryophytes in randomly located quadrats in May. Depth water table measured, also rainfall & air & soil temperatures. Soil N measured monthly in some plots from 2 weeks after hay-cut to March, in 3 years 1987-1990; autumn de-nitrification was measured in some plots in 1988-1990.		
Data archive	Annual and final reports as well as data archived at Rothamsted Research (Jerry Tallowin) and CEH Wallingford (Owen Mountford). Reports are also available from DEFRA.		
Partner sites	Tealham & Tadham Moor (2)		

Key Research	Established in 1986, the Tadham project sought to address uncertainties about the effect of fertilisers on the species rich grassland of the Somerset Levels, one of the UK's largest remaining wetlands. The research demonstrated that the addition of nitrogen fertiliser at levels as low as 25 kg/ha were unsustainable for the plant species diversity of the meadows. The application of inorganic phosphorus and potassium also caused rapid losses to the meadow flora under cutting management. The project also showed that, as a result of the high rates of leaching productivity increases associated with fertiliser addition did not continue after the initial year. This prompted conservation organisations to put blanket bans on the fertilization of species rich grassland. (This has since been refined and demonstated at Pentwyn; J. Tallowin, pers. comm., 2014). Smaller plots used for P and K studies with cutting g in mid summer and removing grazing demonstrated that sensitivity of grasslands increased significantly without grazing. Believed to be because grazing buffered / diluted some impacts of fertilizer application by redistributing nutrients, creating disturbance to the sward and soil to increase leaching potential, and buffered static effects of cutting (in creating a uniform sward) by introducing structural heterogeneity, creating more niches for plants / seeds to establish, etc. Following the cessation of phosphorus addition, the experiments also showed that the recovery of plant diversity was slow and uncertain, leading to a greater understanding of the importance of reducing soil fertility prior to restoration. Although the original treatments ceased in 1994, periodic monitoring is ongoing. Recent results show vegetation species composition showed clear effects of nitrogen additions and that there is a lag in the response of vegetation compared to soil recovery (*SEE: Stevens et al., in press).*
Notes	The experimental treatments ceased in 1994, although still has research value, with studies being undertaken periodically to investigate the recovery of the species rich grassland following nitrogen application. There are no current plans for further work, however.

TEALHAM & TADHAM MOOR (2)

Project code/names	BD1313		28
Type of experiment	LAND MANAGEMENT		INACTIVE
Details	Nutrient enrichment and grazing; subsequent recovery.		Neutral Grassland
Dates established	1996-99		
Location	Somerset, England		ST422448
Institution	Centre for Ecology and Hydrology		
Contact	Dr Owen Mountford	Owen Mountford om@ceh.ac.uk	
Address	Maclean Building, Benson Lane, Crowmarsh Gifford, Wallingford, Oxfordshire, OX10 8BB		
Description	A second phase of experiment (1) water levels were artificially raised and dry controls introduced where the original water levels were maintained. A replicated block experiment was set up to test the impact of raised water-levels (RWL) on biodiversity and agriculture.		
Plot size	0.6-1.1 ha.		
Treatments	The experiment applied RWL to three blocks and compared these plots with unaltered dry controls. A programme of hydrological monitoring underpinned the ecological, agricultural and soil studies.		
Subplots			
Treatments			
Baseline data	Quadrats in the unfertilised (control) plots; vegetation height & biomass (grasses, forbs, mosses). The results from this experiment were put into a longer-term context using dipwell data from earlier work at Tadham. For each year, a daily water-table record was calculated, together with **mean water-table** and both **drought** and **wetness stress indices**.		
Data archive	Annual and final reports as well as data archived at Rothamsted Research (Jerry Tallowin) and CEH Wallingford (Owen Mountford). Reports are also available from DEFRA.		
Partner sites	Tealham & Tadham Moor (1)		
Key Research	Research demonstrated that application of raised water-levels to areas with high botanical (or invertebrate) biodiversity value should be exercised with caution, and consideration given to alternative prescriptions for increasing site wetness, especially with regard to avoiding anoxia and sward death at the start of the growing season. A number of key findings emerged: (i) Raised water-levels led to a decline in the species typical of semi-natural old hay meadows. (ii) Increased aeration stress in the *RWL* plots produced an initial sward die-back and spread of *Agrostis stolonifera*, which subsequently declined to be replaced by a species-poor swamp with *Carex riparia, Glyceria* spp, *Ranunculus repens* and *Calliergon cuspidatum*. (iii) Some impact of the previous fertiliser treatments was detectable up to 7 years after the cessation of fertiliser application (2000 in the N+ plots and 1996/7 in the N- plots). Those plots to have received high levels of nitrogen for seven years continued to show higher cover of certain grasses, and reduced cover of low forbs *etc*. (iv) There was some interaction between altered water-regime and past fertiliser treatment, and it appeared that the previous agricultural management altered the invasibility of the community, favouring certain species. (v) Within the span of the experiment, the implementation of *RWL* led to the partial replacement of an old meadow vegetation (National Vegetation Classification **MG5** and **MG8**) by a ruderal community (*NVC* **OV28**), swamp (*NVC* **S6**, **S22**) or inundation grassland (*NVC* **MG13**). With respect to **agronomic impacts** in terms of effects on hay yield, hay quality and output from grazing the hay aftermath, of the imposition of		

	Environmentally Sensitive Area Tier 3 raised water level (RWL) conditions. Tier 3 RWL imposed a production penalty compared with non-RWL conditions. Reductions in both hay yield (ca 10%) and live-weight production from the hay regrowth (>40%) were found under RWL. However, the RWL conditions appeared to provide greater predictability in hay production compared with non-RWL meadows. Previously fertilised grass-dominant plots showed both a greater negative response to RWL when they were first established, and then greater variation between years under RWL than unfertilised meadows. *SEE: J.O. MOUNTFORD and T.H. SPARKS (eds) THE IMPACT OF RAISED WATER-LEVELS ON THE BIODIVERSITY AND AGRICULTURAL VALUE OF LOWLAND WET GRASSLAND. Final Report to the Ministry of Agriculture, Fisheries and Food. BD1313.*
Notes	

THISTLE			
Project code/names	CO2427		28
Type of experiment	LAND MANAGEMENT	ACTIVE LTE	
Details	Grazing in woodland	Broad-leaved woodland	
Dates established	2003	11	
Location	Scotland	Multiple sites	
Institution	Centre for Ecology and Hydrology, Edinburgh		
Contact	Dr Adam Vanbergen	adv@ceh.ac.uk	
Address	CEH Edinburgh, Bush Estate, Penicuik, EH26 0QB, Scotland		
Description	Comparison of ca. 20 upland woodland sites which have traditionally been grazed or ungrazed by cattle, some in excess of 100 years. Monitoring of sites to identified interactions between herbivores, parasites, vegetation and pollinators		
Plot size			
Treatments			
Subplots			
Treatments			
Baseline data			
Data archive	Data is held by PI / CEH in Excel spreadsheets but in the process of being archived with CEH databases		
Partner sites			
Key Research	Studied trophic interactions and impact of long-term grazing on woodland systems.		
Notes	Although this is not a traditional plot experiment, being created from multiple pre-existing woodland sites, it has a high degree of security, as there are multiple individual woodland 'plots' with long established management regimes. The loss of several such sites or sudden change in management is therefore deemed to be extremely unlikely. (Adam Vanbergen, pers. comm., 2014). Proposals are in preparation to extend ongoing studies in pollinators.		

THURSLEY COMMON / Old

Project code/names		28
Type of experiment	NUTRIENT	INACTIVE PTRE
Details	Nitrogen application and recovery	Lowland Heath
Dates established	1989-96	
Location	England	SU9139
Institution	Imperial College	
Contact	Prof. Sally Power, University of Western Australia	
Address	FOR SITE: Silwood Park, Imperial College London	
Description	The initial experiment on heather-dominated lowland heath with podsolic soils with shallow litter and humus layers over greensand. It set out to answer: (i) What is the impact of increasing nitrogen deposition on the growth, phenology and health of heather? (ii) What effect does the extra nitrogen have on the nitrogen budget for the heath ecosystem? Four replicate blocks with randomized duplicate control and nitrogen addition plots with management sub-plots nested within. Has full set of 'extra' plots - i.e. one control and one N additional plot per replicated block. Nitrogen application has now ceased on this experiment, and Thursley Common is being used to monitor heath recovery following nitrogen treatment.	
Plot size	4 x 4 m	
Treatments	Four replicate blocks with randomized duplicate control and nitrogen addition as ammonium sulphate at 0 or 30 kg N/ ha / yr and control of artificial rain. Has full set of 'extra' plots - i.e. one control and one N additional plot per replicated block. Nitrogen ceased in 1996	
Subplots	2 x 2 m	
Treatments	One-off treatments in 1998: low-intensity mow (litter layer intact), high-intensity mow (*Calluna* & litter removed to ground-level), low temperature burn, simulated accidental (high temperature) burn.	
Baseline data	Shoot samples taken & shoot nitrogen measured. Shoot extension, flowering & litter production also measured. Destructive harvest carried out in 1996, to construct nitrogen budget. Above-ground plant material separated into age-classes & litter, dried & N-concentration measured. Soils samples taken & soil water from beneath the rooting zone collected. Decomposer activity of the soil measured.	
Data archive	Data are retained electronically by Sally Power. It is unclear whether or not they are also available through Imperial College London / Silwood Park	
Partner sites	Thursley Common (new); UKREATE sites Wardlow Hay Cop; Ruabon; Whim Bog; Clocaenog; Peaknaze; Little Budworth Common	
Key Research	Researchers found that more than two thirds of the nitrogen accumulated in the litter and soil and led to increased microbial populations and higher rates of conversion of nitrogen to soluble inorganic forms. Results have been key to modelling the impact of nitrogen deposition under varying conditions and have contributed to an improved understanding of the role of management to mitigate the impact of eutrophication. The experiments have also led to a revision of the critical loads of nitrogen for lowland dry heaths at the European level. Eight years after nitrogen treatment ceased, its effects were still measurable in terms of reduced resistance of heather to drought, increased canopy height and a persistent increase in soil microbial activity. Studies carried out looking at response of heather beetles collected from the site, showed that larval growth rates & adult weights significantly higher when reared on plants which had received extra N. Also showed small effect of N on plant sensitivity to abiotic stress (frost-hardiness, rate of water loss). *SEE: Power et al (1998 b). Uren et al 1997; Power et al 1998 a, b, 2001.* The results from the	

	experiment, as with all the UK UKREATE and Terrestrial Umbrella sites, contributed to the DEFRA guidance. 'The UKREATE sites show clear and consistent evidence of the impacts of N deposition across nine sites of contrasting vegetation, soils, climate and ambient N deposition...There is clear evidence...that modest N loading can have significant impacts on seminatural ecosystems and even low N inputs may induce effects over time through accumulated loading'. *REVIEW OF THE UKREATE NETWORK SEE: Phoenix GK, Emmett BA, Britton AJ, Caporn SJM, Dise NB, Helliwell R, Jones MLM, Leake JR, Leith ID, Sheppard LJ, Sowerby A, Pilkington MG, Rowe EC, Ashmore MR, Power SA (2012). Impacts of atmospheric nitrogen deposition: responses of multiple plant and soil parameters across contrasting ecosystems in long-term field experiments. Global Change Biology, 18: 1197-1215*
Notes	These plots remain accessible for remonitoring although there are no plans to do so. In the absence of the founding PI, it is unclear how long the sites will remain marked and accessible. No-one as yet has been identified at Silwood Park who has any knowledge or custodianship of these sites. It is unclear where the data are retained; it is assumed with Prof. Sally Power.

THURSLEY COMMON / New

Project code/names		32
Type of experiment	NUTRIENT AND LAND MANAGEMENT	INACTIVE PTRE
Details	Heathland management through burning and mowing and nutrient impacts	Lowland Heath
Dates established	1998-2012	
Location	England	SU9139
Institution	Imperial College	
Contact	Prof. Sally Power, University of Western Australia	
Address	FOR SITE: Silwood Park, Imperial College London	
Description	The new Thursley Common experiment is the only long-term heathland manipulation study of its type in Europe. It was instigated in 1998 to look at 4 management regimes: low and high intensity mowing and burning. It comprises a four block nitrogen treatment in new plots with the control of artificial rain, treatment of N every 2 weeks as ammonium sulphate.	
Plot size		
Treatments	Ammonium sulphate at 0 or 30 kg N/ ha / yr plus artificial rain, and control of artificial rain.	
Subplots		
Treatments	Low intensity mow (1998), High intensity mow (1998), Low temperature (350-550C, management) burn (1998), Simulated accidental burn. (1998)	
Baseline data	Height and density of Calluna canopy. Frequency of Calluna, other higher plants, lichens and bryophytes. Shoot length & % cover. Shoot and soil chemistry. Calluna measured at the end of the growing season; seedling establishment (all vascular plants) recorded in 1999; post-management total soil Nitrogen contents determined in 1998 from samples to 10 cm depth; rates of litter production and decomposition measured as dry weight every 12 weeks. Sensitivity of the shoots to frost and insect herbivory (the heather beetle, *Lochmaea suturalis*). Soil microbial community analysis.	
Data archive	Data are retained electronically by Sally Power. It is unclear whether or not they are also available through Imperial College London / Silwood Park	
Partner sites	Thursley Common (OLD); UKREATE sites Wardlow Hay Cop; Ruabon; Whim Bog; Clocaenog; Peaknaze; Little Budworth Common	
Key Research	Results show that the intensity of burning affects stored nitrogen removal but little or no impact on the rate of recovery from the effects of earlier nitrogen addition (Power et al., 2006). 'Continuation of the expt is necessary for several more years to cover a greater part of the life-cycle of Calluna, …..and ultimately to provide a better experimental appraisal of the validity of the critical load suggested for dry heathlands'. The results from the experiment, as with all the UK UKREATE and Terrestrial Umbrella sites, contributed to the DEFRA guidance. 'The UKREATE sites show clear and consistent evidence of the impacts of N deposition across nine sites of contrasting vegetation, soils, climate and ambient N deposition...There is clear evidence...that modest N loading can have significant impacts on seminatural ecosystems and even low N inputs may induce effects over time through accumulated loading'. *REVIEW OF THE UKREATE NETWORK SEE: Phoenix GK, Emmett BA, Britton AJ, Caporn SJM, Dise NB, Helliwell R, Jones MLM, Leake JR, Leith ID, Sheppard LJ, Sowerby A, Pilkington MG, Rowe EC, Ashmore MR, Power SA (2012). Impacts of atmospheric nitrogen deposition: responses of multiple plant and soil parameters across contrasting ecosystems in long-term field experiments. Global Change Biology, 18: 1197-1215*	

Notes	These plots remain accessible for remonitoring although there are no plans to do so. In the absence of the founding PI, it is unclear how long the sites will remain marked and accessible. No-one as yet has been identified at Silwood Park who has any knowledge or custodianship of these sites. It is unclear where the data are retained; it is assumed with Prof. Sally Power.

WARDLOW HAY COP / New

Project code/names	Cressbrookdale		31
Type of experiment	NUTRIENT	ACTIVE LTE	
Details	Nitrate addition experiment; separate recovery experiment	Acid and calcareous grassland	
Dates established	1995? -	19	
Location	England	SK1773	
Institution	University of Sheffield		
Contact	Dr Gareth Phoenix (Prof. Jonathan Leake)	gphoenix@sheffield.ac.uk	
Address	Department of Animal and Plant Sciences, Alfred Denny Building University of Sheffield, Western Bank, Sheffield, S10 2TN, UK		
Description	One calcareous and one adjacent acidic grassland site in Derbyshire. Experiment comprises nitrate additions to simulate increasing loads of Nitrogen deposition using a randomised blocked design, with three replicates per treatment. Whilst the area has room for additional plots to be set up, there are no spare plots incorporated into the experimental design.		
Plot size			
Treatments	Monthly nitrogen as NH4NO3, input at - 0, 35, 140 kg N ha-1 yr-1) and/or P addition (50 kg ha-1 yr-1)		
Subplots			
Treatments			
Baseline data	Vegetation surveyed annually (1990-1996), using 50 points per plot. Total productivity in the absence of grazing was calculated in 1996 by the use of 0.6m2 exclosures. Shoot total N & P were measured in 1995. (Carroll et al 2003). Veg survey and flowering data, soil and soil chemistry data available		
Data archive	Monitoring data are submitted to the CEH terrestrial database. Monitoring datasets are also held at Sheffield University. Data from nested studies on the platform (e.g. soil chemistry, tissue chemistry, enzyme and floweirng surveys) have not been collated). This would be a useful project to secure all data for the experimental site (G. Phoenix, pers. comm., 2014).		
Partner sites	Wardlow Hay Cop (old); UKREATE sites Thursley Common (old and new); Ruabon; Whim Bog; Clocaenog; Peaknaze; Little Budworth Common		
Key Research	The site is the world's longest running factorial nitrogen and potassium experiment on grassland. The results from the experiment, as with all the UK UKREATE and Terrestrial Umbrella sites, contributed to the DEFRA guidance . 'The UKREATE sites show clear and consistent evidence of the impacts of N deposition across nine sites of contrasting vegetation, soils, climate and ambient N deposition...There is clear evidence...that modest N loading can have significant impacts on seminatural ecosystems and even low N inputs may induce effects over time through accumulated loading'. *REVIEW OF THE UKREATE NETWORK SEE: Phoenix GK, Emmett BA, Britton AJ, Caporn SJM, Dise NB, Helliwell R, Jones MLM, Leake JR, Leith ID, Sheppard LJ, Sowerby A, Pilkington MG, Rowe EC, Ashmore MR, Power SA (2012). Impacts of atmospheric nitrogen deposition: responses of multiple plant and soil parameters across contrasting ecosystems in long-term field experiments. Global Change Biology, 18: 1197-1215*		

Notes	Site is currently being maintained by general grant funding, towards maintaining treatments. It has significant institutional support and is secure for at least 1-2 years. A new grant for the site will be submitted in summer 2014. Following the reduction in traffic emissions due to the use of cleaner fuels, nitrogen deposition is a less urgent pollution issue and the proposed new research project will focus on carbon storage and carbon cycling studies. If received, it should secure the site for 3 years. Whilst routine vegetation monitoring data are well-archived, nested studies, data from nested studies carried out on the platform have not been collated. This would be a useful project to secure all data for the experimental site (G. Phoenix, pers. comm., 2014). Due to restricted funds, the last full vegetation survey was 2011.

WARDLOW HAY COP / Old

Project code/names	Cressbrookdale	25
Type of experiment	NUTRIENT	ACTIVE PTRE
Details	Nitrate addition recovery experiment	Acid and calcareous grassland
Dates established	1990 -	19
Location	England	SK1773
Institution	University of Sheffield	
Contact	Dr Gareth Phoenix (Prof. Jonathan Leake)	gphoenix@sheffield.ac.uk
Address	Department of Animal and Plant Sciences, Alfred Denny Building University of Sheffield, Western Bank, Sheffield, S10 2TN, UK	
Description	A recovery experiment (following earlier, high, N loadings (over 12 years) to replicated 1m2 plots), and has provided intact soil cores for a parallel mesocosm experiment at Sheffield. The latter is providing complementary, detailed information about soil processes and nutrient budgets, following N long term manipulations.	
Plot size	3 X 3 m	
Treatments	Early experiments comprised (1) Untreated; distilled water only; 3.5, 7 or 14 gN/m2/yr as Ammonium Nitrate (NH4NO3); 14 gN/m/yr as Amonium Sulphate ((NH4)2SO4); glucose (glucose was to reduce N availability by stimulating microbial demand (Carroll 2003). Since 1992, 1 previously untreated 1 m2 plot in each block was treated with 100kg N/ha/yr; 5og P/ha/yr; both; none; applied twice a year (Carroll 2003). (2) - water only; N (Ammonium Nitrate) at 3.5 and 14 g/m2/yr; P (as NaH2PO4.H2O) at 3.5 gP/m2/yr; combinations of previous 2 treatments. Treatments applied for 18 months (except in CG plots, where P treatment stopped after 12 m, because of significant increases in productivity). These are referred to (Johnson et al 1999) as SHORT TERM plots; plot size was 3x3m.	
Subplots		
Treatments		
Baseline data	Last vegetation surveys were undertaken in 2011.	
Data archive	Monitoring data are submitted to the CEH terrestrial database. Monitoring datasets are also held at Sheffield University. Data from nested studies on the platform (e.g. soil chemistry, tissue chemistry, enzyme and floweirng surveys) have not been collated). This would be a useful project to secure all data for the experimental site (G. Phoenix, pers. comm., 2014).	
Partner sites	Wardlow Hay Cop (new); UKREATE sites Thursley Common (old and new); Ruabon; Whim Bog; Clocaenog; Peaknaze; Little Budworth Common	
Key Research	Studies of microbial & decomposition processes have interesting results - N enhancement caused a decline in in situ decomposition of litter and reduced mycorhizal infection. In enhanced N- plots, plants allocate proportionally more biomass above than below ground. I.e. major effects of N deposition were demonstrated on below-ground processes.*Global Change Biology, 18: 1197-1215*	
Notes	Site is currently being maintained by general grant funding, towards maintaining treatments. It has significant institutional support and is secure for at least 1-2 years. A new grant for the site will be submitted in summer 2014. Following the reduction in traffic emissions due to the use of cleaner fuels, nitrogen deposition is a less urgent pollution issue and the proposed new research project will focus on carbon storage and carbon cycling studies. If received, it should secure the site for 3 years. Whilst routine vegetation monitoring data are well-archived, nested studies, data from nested studies carried out on the platform have not been collated. This would be a useful project to secure all data for the experimental site (G. Phoenix, pers. comm., 2014). Due to restricted funds, the last full vegetation survey was 2011.	

WHIM BOG

Project code/names			32
Type of experiment	NUTRIENT	ACTIVE LTE	
Details	Nitrate addition recovery experiment	Bog	
Dates established	2002 -	12	
Location	Scotland		
Institution	Centre for Ecology and Hydrogy, Edinburgh		
Contact	Dr Matt Jones	matj@ceh.ac.uk	
Address	CEH Edinburgh, Bush Estate, Penicuik, EH26 0QB, Scotland		
Description	The site is an ombrotrophic bog that has not been managed in recent years and supports a thriving bryophyte and lichen community in 'gaps' where the Calluna has died back. The experiment was designed to separate the effects of oxidised and reduced N on ombrotrophic bog vegetation, Calluna, lichens and mosses in particular. Importantly this site is in an area of low background N and S deposition. The experiment is the first to compare all 3 N forms at the same site and should yield data on Critical Levels for NH3. ECLAIR funding has recently been obtained to study the combined carbon and nitrogen cycles and study how ozone affect nitrogen responses.		
Plot size	13 m2		
Treatments	Gaseous exposure is achieved through the field release of NH3 gas, providing a transect of increasing concentrations ranging from background (0.3-0.4 mg m-2) to 80 mg m-2. In addition, there are replicated (x4) 13m2 plots investigating the effects of different forms of wet deposited N, with and without the addition of P&K, at the same site. wet deposited NH4Cl and NaNO3 (at 0, 8, 24 and 56 kg N ha-1 yr-1)), with and without PK additions.		
Subplots			
Treatments			
Baseline data	Gutters installed to collect throughfall and pre-treatment samples will be collected for chemistry from the vegetation and soil both on the edge and out with the plots. All plots surveyed for vegetation cover and composition. Site retains a long record of above and below ground chemistry. A LICOR system for continuous methane and CO_2 monitoring is installed and this system is also used for real time C flux monitoring on the plots. Flux data from the low N deposition plots is also being collected, and CN data for soil and various species is available. Burial of t bags has allowed assessment of decomposition conditions to see how N form and dose affects water soluble phenol in these materials. Measurement of DOC and DON in soil water collected in dipwells.		
Data archive	Routinely monitored data are archived in an Access database. Nested studies are not all collated into one database. The majority are also uploaded to ÉCLAIR ([Effects of Climate Change on Air Pollution and Response Strategies for European Ecosystems], a four year project funded by the EU's Seventh Framework Programme for Research and Technological Development (FP7).		
Partner sites	UKREATE sites Thursley Common (old and new); Ruabon; Wardlow Hay Cop; Clocaenog; Peaknaze; Little Budworth Common.		

Key Research	The experiment is the first worldwide to compare all 3 N forms at the same site and should yield data on Critical Levels for NH3. It is unique, being sited on an ombrotrophic bog, with very low background levels of N and S deposition. The results from the experiment, as with all the UK UKREATE and Terrestrial Umbrella sites, contributed to the DEFRA guidance. 'The UKREATE sites show clear and consistent evidence of the impacts of N deposition across nine sites of contrasting vegetation, soils, climate and ambient N deposition...There is clear evidence...that modest N loading can have significant impacts on seminatural ecosystems and even low N inputs may induce effects over time through accumulated loading'. Future research is likely to focus on below ground system and the evaluation of ecosystem services from conservation to carbon sequestration, GHG emissions and water chemistry in addition to understanding how changes in vegetation affect the delivery of these services. *REVIEW OF THE UKREATE NETWORK SEE: Phoenix GK, Emmett BA, Britton AJ, Caporn SJM, Dise NB, Helliwell R, Jones MLM, Leake JR, Leith ID, Sheppard LJ, Sowerby A, Pilkington MG, Rowe EC, Ashmore MR, Power SA (2012). Impacts of atmospheric nitrogen deposition: responses of multiple plant and soil parameters across contrasting ecosystems in long-term field experiments. Global Change Biology, 18: 1197-1215*
Notes	Also part of the EXPIR network in Europe. Expir funding is coming to an end, though sufficient funding is in place for a year. It is intended to apply for further core funds. The power supplies at the site needed to be updated. However, it was not anticipated that this would cause funding or continuity issues at the site, or access problems with the land-owner (Dr Shepherd, pers. comm., 2014).

WYTHAM A / Upper Seeds

Project code/names		31
Type of experiment	RESTORATION	ACTIVE LTE
Details	Grazing experiment for restoration of calcareous lowland grassland	Lowland Calcareous Grassland
Dates established	1985 -	29
Location	Oxfordshire, England	SP4509
Institution	University of Reading / University of Oxford	
Contact	Prof. Simon Mortimer / Mr Clive Hambler	s.r.mortimer@reading.ac.uk /clive.hambler@zoo.ox.ac.uk
Address	School of Agriculture, Policy and Development, University of Reading, Whiteknights, PO Box 237, READING, RG6 6AR	
Description	The 'Upper Seeds' experiment at Wytham Hill, Oxford, was established by Dr Charlie Gibson. Its purpose is to understand the long-term effects of different grazing regimes on the restoration and recreation of lowland calcareous grassland and provide a reference and benchmark for similar sites. The site covers approximately 10 ha on Wytham Hill, Wytham Woods, an SSSI. The main experiments on grazing and succession started in 1985. Prior to this the site was managed as an arable field, at least up to 1982. Three treatments (ungrazed controls, short-period spring and short-period autumn grazing) have been replicated six times in two squares, 3 x 3 grids of 30 x 30 m paddocks, arranged as latin squares. Two other treatments (continuous autumn grazing and spring plus autumn grazing) have been applied to larger areas outside the paddocks. Spring plus autumn grazing has also been applied from 1988 to two ancient grassland patches. An area has also been disturbed (for the purpose of conserving plant species of arable land) by intermittent ploughing/disc harrowing in the late 1990s with ploughing reinstated from 2000 onwards. Grazing was interrupted because of scrub between 2010-2013	
Plot size	30 x 30 m	
Treatments	The experiment consists of two Latin squares, incorporating 9 plots each, which are subject to various grazing treatments: Short period autumn grazed, Short period spring grazed, Ungrazed controls. (6 replicates) These are surrounded by larger areas, subject to other treatments: Spring and autumn grazed; Long period autumn grazed; Deer only grazed; Annual plough. Treatments interrupted by scrub 2010-2013.	
Subplots		
Treatments		
Baseline data	Plant spp monitored using point quadrat pins and height intervals. Analysed results in terms of colonisation and extinction & local species pool. Compared insectivory with grazing. Compared analysis of species colonisation with analysis of plant communities. Vegetation surveys have been undertaken every other year since the founder's death – 2009, 2011, 2013. Plan to return to annual surveys (bryophytes and flora) in 2014, following the clearing of the scrub, as anticipate flush of growth for up to 10 years. Data were also collected during scrub removal on accumulated scrub biomass, weight of woody species, diameter of trees and tree cores for tree rings to enable felled trees to be aged.	
Data archive	Data are held by Simon Mortimer (vegetation) with some invertebrate also held by Clive Hambler (Oxford). Historic data collected by Charlie Gibson are in an old electronic format and need converting. 'They are also not currently usable for people who did not understand Charlie's system' (Clive Hambler, pers. comm., 2014). A project is required to publish up to 10 years of data and make it more accessible for research.	
Partner sites	Wytham B + ECN link – Former climate change experiment, now closed.	

WYTHAM A / Upper Seeds (cont.)	
Key Research	Specific objectives of the experiment were to: (i) Demonstrate how ancient species-rich grassland re-establishes from arable land. (ii) Show the long-term effects of different management regimes on the rate / direction of vegetation succession.(iii) (iv) Illustrate the responses of different types of plants to different grazing. (v) Couple the vegetation changes to trends in invertebrate populations. Over 20 academic articles and book chapters have been written on the experiment, addressing (amongst other topics): the colonisation and persistence of annual species, trends in problem weeds, the establishment of mid- and late-successional species, the long-term effects of grazing on key species and related management advice. The experiment has also provided an excellent platform for other research, such as the ecosystem services of invertebrate populations. Results from the research have contributed towards improving understanding of the processes involved, and the development of, species-rich calcareous grassland on ex-arable land. They have also informed conservation policy and best practice guidance for calcareous grassland creation and restoration across the UK and contributed to the Environmental Stewardship Higher Level Scheme, which provides incentive payments to land managers to create such grassland. Current studies, including Ph.D students, focus on ecosystem functions of soils and soil invertebrates, 'and there should be a number of papers withn the next few years' (Clive Hambler, pers. comm., 2014). As a restoration site it offers indications / model for rate of succession to reestablish ancient grassland of significance and it could become an important tool for biodiversity offsetting as a benchmark and model of the potential rates and mechanisms of restored site management.
Notes	Although charitable funds have been found to clear and re-fence the site in recent years, the site remains vulnerable due to lack of dedicated funds and paid staff to run and maintain the experiment. Although the site is being used by several researchers and students the site remains outside Oxford University, and needs to be fully embedded within a University or research institution and recognised as a valuable long-term research capability. No data have been published since 2002, although active research into ecosystem function has recommenced. Historic data are currently unavailable, and need converting from outdated electronic formats. Treatments at the site were interrupted from 2010-2013 although will recommence 2014. NOTE – **CLOSECD CLIMATE CHANGE EXPERIMENT AT WYTHAM B**- Although the site was closed and equipment removed around 5 years ago, the plots remain marked and could be revisited for post treatment monitoring (Mike Morecroft pers. comm., 2014). However, it has not been possible to establish the status of the data archive, and it is quite possible that it has been at least partially lost (Mike Morecroft, pers. comm. 2014)

WYTHAM / Exclosures

Project code/names			NA
Type of experiment	FORESTRY	ACTIVE LTE	
Details	Deer exclosures	Mixed woodland	
Dates established	1997		
Location	Oxfordshire, England	SP 462080	
Institution	Natural England / University of Oxford		
Contact	Dr Mike Morecroft	Mike.Morecroft@naturalengland.org.uk	
Address			
Description	Testing hypothesis that rising populations of fallow, muntjac and roe deer were responsible for fall in bramble and woodland forbs compared to grasses by establishing deer exclosures in closed canopy open woodland and open canopy ('clearing') exclosures, with comparable controls in existing permanently recorded plots (see supporting data). Three large exclosures were established in ancient coppice woodland (W8a) in 1997; a further three 10 x 10 m exclosures in clearings, with differing fencing heights (2 m deer fencing; 1.25 m deer fencing; 2 m deer fencing with gap of 0.2 at base) to enable different deer species to graze.		
Plot size	0.3 ha and 100 m 2		
Treatments	Three 0.3 ha woodland exclosures; three 10 x 10 m in clearing with three differing fence heights (2 m; 1.25 m; 2 m with basal gap of 0.2 m).		
Subplots			
Treatments			
Baseline data	1993: 45 vegetation monitoring plots; nine rerecorded 1998 and 1999. Three identical monitoring plots in woodland exclosures monitored 1997,1998, 1999. Counts of bramble plants at rooting points within exclosure monitoring point and controls in March and May 2000 with measures of percentage cover. Faecal pellet counts in 52 10 x 10 m plots 1998,1999, 1990. System of 163 permanent monitoring plots estabished in 1974 throughout Wytham Woods. Recorded in 1984/5, 1981/2, 1999		
Data archive	Data are retained by Dr Mike Morecroft and have been archived with CEH ECN databases held at Lancaster.		
Partner sites			
Key Research	The study adds to the weight of evidence that rising deer populations have been changing the ground vegetation of British woodlands in recent decades. Results following 2 years of exclosure showed increases of forbs in the exclosures, which supports the proposition that deer have been an important factor in the changes at Wytham since the 1970s. However, the lack of significant change in individual species frequencies suggests that vegetation recovery may be slow. The recovery of bramble in the clearing plots indicates that the interaction between canopy closure and herbivory is an important factor in bramble regeneration. *SEE: Morecroft, M. D., M. E. Taylor, S. A. Ellwood, and S. A. Quinn. 2001. Impacts of deer herbivory on ground vegetation at Wytham Woods, central England. Forestry 74, no. 3: 251.* Follow up work on small mammals concluded that deer have also been a causal factor in the decline in bankvole numbers (Buesching et al., 2011) that have been observed over the past 40 years. However, despite residual effects on vegetation, the small mammal community at Wytham has recovered over the past 10 years in the exclosed sites. This may reflect the recovery of the bramble, providing both food and cover, particularly for bank voles, which have a different habitat selection and survival strategies from field mice. *SEE: Buesching, C. D., C. Newman, J. T. Jones, and D. W. Macdonald. 2011. Testing the effects of deer grazing on two woodland rodents, bankvoles and woodmice. Basic and Applied Ecology; Bush, E. Woodland recovery after removal of deer: cascade effects for small mammals. Report; Buesching, C., C. Newman, and Jones. 2011. Effects of deer grazing on small mammals.*		

Appendix 2: Assessment criteria

All of the sites in our 2008 survey were scored against the following criteria:

Uniqueness / novelty
Statistical design
Security of tenure
Plot size appropriate to habitat, driver and as future platform
Longevity
Expansion potential (e.g. spare plots)
Data availability
Continuity of treatment
Drivers

Each of the above criteria were scored up to a maximum of 3.

Sample archive
Co-operation / accessibility

Scored up to a maximum of 2.

The following principles/guidelines were used in scoring each criterion.

Uniqueness/novelty:
Not all existing LTEs are totally novel therefore the following was applied.

Any LTE that has repeated the same experimental manipulations of another older ongoing LTE in the same habitat, but added one or more extra drivers to examine possible interactions scores 3.
Any LTE that has repeated the same experimental manipulations of another older ongoing LTE, but on a different habitat type or in a different environment scores 2.
Any LTE that simply repeated the same experimental manipulations of another older ongoing LTE on the same habitat type scores 1.

Statistical design
The following scoring system was applied to all LTEs

	No^{s} of randomised replicates			
Total number of treatments	4+	3	2	No reps
≥ 16	*3*	*3*	*2*	*0*
11 – 15	*3*	*3*	*2*	*0*
6 – 10	*3*	*2*	*1*	*0*
≤ 5	*3*	*2*	*0*	*0*

Security of tenure
High security e.g. National Trust land = 3,
National Nature Reserve (NNR), Research Institute or University owned land = 2
Private freehold land with 25 year or more lease = 1,
Land under short-term lease < 25 years = 0

Plot size appropriate to habitat, to manipulated driver & as future platform
Plot sizes of a few square metres were generally considered to be weak in relation to potential for future subdivision and, depending on knowledge experience of drivers/habitats being manipulated, received a score of 1 – 2.

Plant, soil & met data including baseline data
The general assumption was that most data on all three should be available for many/most years and thus would receive a score of 3.
If one of the three had not been recorded at all = 2.
If more than one missing and/or incomplete = 1, none = 0

Longevity
0 to 6 years scores 1,
7 to 14 years scores 2,
15 or more years scores 3

Expansion potential
Two or more "spare" control plots per replicate block = 3.
Plot size sufficiently large to split and still be appropriate for habitat and/or driver = 2.
Area of habitat around plots managed in the same way as the control and sufficiently large to contain new treatment plots + new control = 1.
No expansion potential = 0.

Data availability
No restrictions to data availability = 3.
Accessibility of some data restricted in the short-term (< 5 yrs), and/or gaps in data (i.e. lack of continuity if experiment suspended) = 2.
Accessibility of some data restricted (for foreseeable future) and/or if expt set up by someone who has retired and the data archive is not 100% available to successor = 1.
No data available = 0

Continuity of treatment
Unbroken record of treatment application = 3.
A break in continuity of 1-2 years = 2.
A break in continuity of > 2 years and/or more than one break in continuity of 1-2 years = 1.

Drivers
Scoring based on the number of ecological drivers being manipulated; 1 for 1, 2 for 2 and 3 for 3 or more.

Sample archive
Soil, water, plant/animal samples from baseline and subsequent years archived in conditions that ensure stability = 2,
Some samples missing from archive = 1,
No archived material = 0

Cooperation / availability
High = 2,
Some restrictions = 1,
Very limited = 0

Appendix 3: Score sheet for UK LTEs, 2008-14

Site name	Uniqueness/ novelty: score 3	Statistical design: score 3	Security of tenure: score 3	Plot size appropriate to habitat score: 3	Plant soil & met data including baseline data: score 3	Longevity: score 3	Expansion potential eg spare plots: score 3	Data availability: score 3	Continuity of treatment: score 3	Sample archive: score 2	cooperation / availability: score 2	Usefulness: score 2	National/ international links: score 1	Associated research and databases: score 1	Accessibility: score 1	Total score
Calc grassland																
Wytham A	3	3	3	2	3	3	1	2	3	1	2	2	1	1	1	**31**
Wytham B + ECN link	3	3	2	3	3	2	1	3	0.5	1.5	2	2	1	1	1	**29**
Buxton BCCIL	3	3	2	2	3	2	3	3	3	2	2	2	1	1	1	**33**
Royston	3	3	2	2	3	2	1	3	3	0	2	2	0	0	1	**27**
Aston Rowant hay spreading	3	3	3	2	3	2	2	3	1	1	2	2	0	1	1	**29**
Neutral grassland																
Park Grass	3	0	3	3	3	3	0	3	3	2	2	2	1	1	1	**30**
Palace Leas	3	0	2	3	1	3	0	2	3	1	2	1	1	1	1	**24**
North Wyke (agric	3	2	2	3	3	2	1	3	0	1	2	2	1	1	1	**27**
Cricklade N Meadow	3	1	3	3	3	2	2	3	1	1	2	2	1	1	1	**29**
Colt Park	3	2	3	3	2	3	1	3	3	0	1	2	1	1	0	**28**
Raisbeck & Pentwyn	3	3	2	2	3	2	2	3	2	2	2	2	1	1	1	**31**
Pwllpeiran/Trawsgoed	3	2	2	3	3	2	2	3	3	1.5	2	1.5	1	1	1	**31**
Tadham	3	1	3	3	3	2	2	3	1	1	2	1	1	1	1	**28**
Denmark Farm	2	1	2	3	1	2	0	1	3	0	2	2	0	0	1	**20**
Elan Valley	1	1	2	3	1	1	1	3	3	1	2	2	0	0	0	**21**
Craddocks Farm	3	2	1	3	3	1	3	3	1	2	2	2	1	1	1	**29**
Marsh Gibbon	2	3	1	2	2	2	2	3	3	1	2	2	1	0	1	**27**
River Ray, Bucks	2	3	1	2	2	2	2	3	3	1	2	2	1	1	1	**28**
Monks Wood	3	3	2	2	3	2	2	3	3	0	2	1	0	0	1	**27**
Somerford Mead	3	3	3	3	2	3	1	3	3	0	2	2	1	1	1	**31**

Acid grassland																
Sourhope	3	3	2	3	3	2	3	3	3	2	2	2	1	1	1	**34**
Pwllpeiran	3	3	2	2	3	2	1	3	3	2	2	2	1	1	1	**31**
Wardlow (old)	3	3	3	1	3	1	0	3	0	2	2	1	1	1	1	**25**
Wardlow (new)	3	3	3	2	3	2	0	3	3	2	2	2	1	1	1	**31**
Peaknaze	3	3	3	2	3	1	1	3	3	2	2	2	1	1	1	**31**
Hartwood&Sourhope	2.5	2	2	3	3	2	0	3	2	2	2	1				**24.5**
Glen Finglas	3	3	3	3	2	1	1	3	3	2	1	2	**1**	**1**	**1**	**30**
Fen-meadow/rush pasture																
Rhos Llawr-cwrt NNR	2	2	3	3	3	2	3	3	0	1	1	2	0	1	0	**26**
Upland heath																
Ruabon (old)	3	3	3	1	3	3	0	3	0	2	2	1	1	1	0.5	**26.5**
Ruabon (new)	3	3	2	2	3	2	0	3	3	2	2	2	1	1	0.5	**29.5**
Clocaenog	3	2	3	3	3	2	1	3	3	2	2	2	1	1	1	**32**
Glen Clunie/Glen Shea	2	2	1	2	2	2	0	3	3	1	2	1	0	1	0.5	**22.5**
MOORCO	3	3	2	3	3	1	2	3	2	2	2	2	0	1	1	**30**
Lowland heath																
Thursley Common (old)	3	3	3	2	3	3	0	3	0	2	2	1	1	1	1	**28**
Thursley Common (new)	3	3	3	2	2	2	2	3	3	2	2	2	1	1	1	**32**
Cannock Chase	1	2?	3?	3	2	2		3?			2	1	0	0		**11**
Euston & Honington	1	3		3	3	2		3	2?		2	1	0	0		**18**
Little Budworth	3	3	2	1	3	2	0	3	3	2	2	2	1	1	1	**29**
Mount Pleasant Fm	1	2?		2	2	2			?low			1	0	0		**8**
Dale Coastal H Pembs	2	3	3	2	3	0	3	3	3	2	2	2	0	0	0	**28**
Sunnyside Farm	1			3	1	1						0	0	0		**6**
Bogs																**0**
Whim	3	3	3	2	3	1	2	3	3	2	2	2	1	1	1	**32**
Coastal																
Newborough	3	?	2	2	2	1	2	3	3	2	2	2	1	1	1	**27**

Montane																
Moor House	3	3	3	3	3	3	2	3	3	1	2	2	1	1	1	**34**
Glas Maol	3	3	2	1	2.5	2	0	3	2	2	2	2	1	0	0.5	**26**
Allt a' Mharcaidh	Monitoring/measurement only, not manipulation															
Culardoch	3	3	2	1	3	1	0	3	3	2	2	2	1	1	0.5	**27.5**
Scots pine woodland																
Boundary																
Bibury	3	2	2	3	1	3	2	2	1	1	2	1	1	1	1	**26**
Broad-leaved woodland																
Henfaes Bangor FACE	3	3	2	3	3	1	0	3	3	2	2	2	1	1	1	**30**
THISTLE (C02427)	3	3	2	3	2	1	2	2	3	?	2	2	1	1	1	**28**
51 sites																
			amended by JT in 2009 on receipt of up to date info													
			amended by JT 11 Feb 2014 to include Somerford Mead													
Note: Bamford and Hordron scores assessed by Rob Marrs, 2011.																
subject to further assessment																

Appendix 4: (i) Example research activity log (Jason Fridley, BCCIL) (ii) Example log of available datasets (R.J. Williams, Denmark Farm)

(i)
2012

Date	Activity	Personnel	Description
Oct-Nov	Simulated grazing	Askew	All plots strimmed to 5 cm height
July	Centaurea removed	Grime	Centaurea killed with glyphosate, some plot areas affected, esp lower blocks
June-Aug	Rainshelter repairs	Askew	Refitting of new polycarbonate to existing shelters
June 11	AGM	Askew, Cadman, Fridley, Grime, Chinchilla-Soto, Whitlock,	Annual BCCIL meeting
June 5-15	Microsite survey	Grime, Fridley	Cover survey of 240 microsites, all treatments
June 5-8	Harvest, competition experiment	Fridley	160 individuals of Agrostis capillaris and Briza media harvested, all 5 blocks
June, July, Sept	Flower survey, microsites	Buckland	Flower counts of each species in 240 microsites (middle 100 cm2, plus outer 300 cm2)
May-June	Briza-Carex genotype experiment setup	Buckland	Pot design, soil filling, and planting of genotypes of Briza meda, Carex flacca, and (non-target) Agrostis capillaris in BCG experiment

(ii)

p=printed copy only
w=word docx=excel file
(N.B. see additional info
attached to cells as 'Comments'

Survey	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04
Annual Reports									p	p	p	w	w	w						
Other Summary Reports																				
FLORA																				
Permanent Quadrats							(x)	x	x	x	x	x	x	x	x	x	x	x	x	
Plant Species inventory (Grassland)										x	x	x								
Permanent Plots													x	x	x	x	x	x	x	
Inventory: Bryophytes										p?w										
Inventory: Lichens														x						
Pond Surveys AOC				?					w (3)	w(8)										
Field notes (inc spp lists)					w					?w	w									
FAUNA																				
Birds																				
Breeding Birds DF	(x)	(x)	(x)	(x)	(x)	x	x	x	x	x	x	x	x	x	x	x	x	x		
Common Bird Census (DF & BG)								x	x	?p	?p	x	x	x	x					
Nest Box Usage					?p	?p	?p	?p	?p	x	x	x	x	x	x	x	x	x		
Owl pellet analysis												x								