REVIEW OF TRENDS IN GRASSLANDS ACROSS THE UK

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A review of the extent of semi-natural and/or species-rich grasslands in the UK, exploring trends over time and between nations

It is widely accepted that there has been a large decline in the extent of species-rich grasslands across the UK since the 1930s. However, there have been limited studies exploring the recent overall trends in their extent. Therefore, this report was commissioned to review the existing evidence and data on the trends and extent of species-rich and semi-natural grasslands, broken down by UK nation where possible. The report should provide a more complete picture of their status, while also identifying where there are gaps in the available evidence. The report is intended to inform and guide the development of policies for the restoration, management and creation of species-rich grasslands.

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'Working together to help restore UK wildflower habitats'

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1.0 INTRODUCTION

1.1 Rationale

Grasslands cover a greater proportion of the United Kingdom land surface than any other major habitat type, they characterise our 'green and pleasant land' and are responsible for providing us with a wealth of benefits: storing carbon, providing a stronghold for wildlife, contributing to food production, mitigating flooding and pollution, and providing aesthetic appeal in our neighbourhoods and rural landscapes. Yet grasslands often receive less attention from government policy or investment opportunities than other UK habitats such as woodlands and peatlands.

There have been extensive declines in species-rich and long-established grasslands and uncommon grassland types appear to have suffered the most catastrophic declines. As well as a loss of grassland extent, there appears to be a hidden decline, a steady shift away from traditional management to more intensive practices, or neglect of grasslands that are high in biodiversity but low in agricultural productivity. This has further eroded the condition of our remaining grasslands. Taken as a whole, it would appear that there is a crisis in grassland conservation in the UK.

However, there are emerging opportunities to reverse these declines. The government has committed to a target to create or restore 500,000 hectares of wildlife rich habitat outside of protected areas and restore 75% of protected sites on land to favourable condition by 2042 in England (Nature Recovery Network, Defra). In England, there is the introduction of the new Environment Act 2021, which makes "biodiversity net gain" mandatory for new development, providing a new funding stream for nature recovery and restoration. There is potential to significantly increase the quantity and quality of our grassland habitats through the adoption of targeted agri-environment schemes across the UK, which are supposed to fund farmers to manage land sustainably and pay for local nature recovery.

In order to best appreciate how valuable grasslands are, and to secure their long-term protection, it is important to understand first in more detail what has happened to grasslands across the UK over the past hundred years. This report explores the definition of grassland types across the UK and delves into the available statistics on how grasslands have changed in status and extent over the past century, exploring the reasons behind the trends and understanding where the significant data gaps are in our understanding of them.

1.2 Report Structure and Method

We start by exploring different approaches to classifying grasslands, with reference to the UK Biodiversity Action Plan (UK BAP) Broad Habitat and Priority Habitat types (JNCC, 2000), Phase 1 (JNCC, 1990), the National Vegetation Classification (Rodwell et al. 1991 - 2000) and the UK Habitat Classification (UKHab Working Group, 2018). We briefly discuss where grassland definitions overlap and explore the value in establishing consistent definitions for semi-natural grasslands and long-established or ancient grasslands.

A major aim of the study is to explore the status and trends of grassland coverage in the UK, in particular looking to find evidence to justify the commonly quoted statistic regarding grasslands, that "around 97% of species-rich grasslands have been lost in the UK over the last 100 years". We corroborate trends revealed in the literature review by a data review exercise, which explores if and/or how datasets regarding grasslands can be used to explore grassland habitat trends over time. The drivers of decline in grassland habitats are also explored.

2.0 GRASSLANDS – DEFINITIONS AND CLASSIFICATIONS

2.1 Background

Grasslands in the broadest sense are vegetation communities dominated by grasses and other herbaceous plants, including flowering herbs, sedges, ferns and rushes. Grasslands occur across the whole of the UK and are the most widespread broad habitat type across all four nations (CEH Land Cover Map, 2020). Grasslands, in spite of their ubiquity and apparent similarities, occur in a wide range of environmental conditions; although a few generalisations can be drawn. Typically, grasslands are associated with mineral soils that are predominantly free-draining, or at least no more than seasonally or occasionally wet. Grasslands are typically characterized by a degree of either deliberate management, e.g. grazing or cutting for hay, or other disturbance, e.g. fire. In fact, in the UK, the vast majority of grasslands require intermittent to regular management in order to maintain the dominance of herbs and grasses and to prevent succession to heath, scrub and woodland habitats. In spite of similarities, wetlands, which form on permanently wet and waterlogged soils, are often characterised by bog mosses (*Sphagnum* spp.) and other bryophytes or the tall herbs and sedges associated with fen habitats.

The recognition that vegetation communities can be broadly predicted by gaining an understanding of the environmental, climatic and edaphic (soil) conditions where they occur was first described systematically in the UK by A.G. Tansley. There is no universally adopted approach to classifying habitats and therefore, whilst broad types of grasslands are widely recognised and have been relatively consistently defined, sub-divisions can diverge and converge considerably depending on the approach to classification that is taken. This lack of consistency in classification can lead to difficulties with determining the conservation status of different types of grasslands and makes it challenging to examine historical losses of important grassland types.

2.2 Grassland Classification

In the UK, there are currently four major approaches to habitat classification in use:

- the UK Biodiversity Action Plan Broad and Priority Action Plan habitat types (JNCC, 1995),
- Phase 1 Habitat Survey (JNCC, 2010),
- European Nature Information System (EUNIS) and its adaptation developed specifically for Scotland (NatureScot 2017), and
- The UK Habitat Classification (UKHab).

In addition to these major habitat classification systems, the UK National Vegetation Classification (NVC) (Rodwell et. al 1991- 2000) presents a detailed phytosociological[1] approach to classifying plant communities. Whilst the NVC approaches classification differently, it is widely used in the UK and has developed from an extensive evidence base of vegetation sampling.

2.2.1 UKBAP Broad and Priority Habitat Types

Between 1995 and 1999 the original list of UK Broad and Priority Habitat types were devised. The Broad Habitat list includes 37 types which cover the whole land surface and intertidal zone of the UK. The BAP Broad Habitat classification has been widely adopted in ecosystem appraisals, habitat surveys and assessments of habitat changes, including acting as the base classification for the UK Centre for Ecology and Hydrology (UKCEH) Land Cover Map, Countryside Survey, The UK National Ecosystem Assessment and Natural England's Living England

[1] Phytosociology is the study of groups of plant species that are usually found together.

Map. UKBAP Broad Habitats recognises 4 broad grassland types: Acid, Calcareous, Neutral and Improved grasslands. Arable and horticulture separates out annual grass leys and rotational set-aside land. Groundwater fed wetlands that are dominated by purple moor grass, common reed and reed sweet grass are also excluded from grassland broad habitat types.

Priority habitat types are select sub-divisions of Broad Habitat Types. UK BAP identifies 65 priority habitat types (including 16 which are predominately sub-tidal). There are five "true" priority grassland habitat types: lowland dry acid grassland, lowland calcareous grassland, upland calcareous grassland, lowland meadows and upland hay meadows.

In addition to these five types, there are a number of grass-dominated habitats and habitat complexes that occur in different ecosystem types:

- *Coastal and floodplain grazing marsh;*
- *Purple moor grass and rush pasture* and *reedbeds*, which occur within the Fen, Marsh and Swamp Broad Habitat Type and are considered at the wetter end of the grassland continuum;
- *Calaminarian grasslands*, a sparsely vegetated community characterised by metal-ion rich soils which are placed in the Inland Rock and Scree Broad Habitat Type;
- *Machair*, technically a coastal grassland on low-lying and typically flat sandy plains, but defined as a habitat complex that includes a wide range of coastal habitats within an agricultural management system typical of coastal crofting communities.
- *Traditional orchards* and *wood pasture and parkland* are habitat complexes that are characterised by their woody species, but recognised as often supporting grassland communities of high conservation value.

2.2.2 Phase 1 Habitat Survey

Phase 1 was originally devised in the 1970s as a rapid appraisal system of predominately rural areas and contains ninety habitat types ordered in a hierarchy. Phase 1 retains the main broad habitat divisions for grasslands based on acid, neutral and calcareous soil types as other classifications, but differs in its approach by focusing on the degree of agricultural 'improvement' or management, e.g. 'amenity grassland', as opposed to underlying environmental conditions or phytosociological characteristics of the vegetation. The Phase 1 classification did not make clear the distinction between typically species-poor marshy rush-dominated grasslands, species-rich tall herb communities, wet meadows and fen habitats. The focus upon habitat condition and management to sub-divide different grassland types within Phase 1 has led to imprecise boundaries, conflation between habitat type and condition and has consequently led to problems of habitat misidentification and inter-observer error (Cherrill and McClean, 1999).

2.2.3 EUNIS

EUNIS is a pan-European hierarchical classification system which is largely phytosociological in its divisions. Grasslands and lands dominated by forbs, mosses or lichens is one of 10 major habitat divisions within EUNIS and is broadly defined as land which is dry or only seasonally wet and supporting greater than 30% vegetation cover dominated by non-woody vegetation. Major divisions of grasslands are along a soil moisture gradient (Dry – Mesic - Waterlogged), with alpine conditions, saline influence and trees making further major divisions of the grassland ecosystem. Major divisions on soil moisture rather than soil pH mean that EUNIS does not fit well with most other systems in use in the UK. Although at the finer habitat scale, EUNIS was revised and updated in 2021 and now describes a total of 767 grassland types, predominately based on plant communities, and those that occur in the UK are readily recognisable within the NVC and UKHab. The EUNIS system corresponds closely to

Annex 1 habitat types, which were originally based upon CORINE biotopes[2]. The correspondence of EUNIS and Annex 1 allows for a direct relationship between many UKHab Level 5 habitats and related EUNIS types.

In 2017, Scottish Natural Heritage (now NatureScot) developed a EUNIS-based habitat manual for use in Scotland, which correlates EUNIS habitats that occur in Scotland with Annex 1, NVC and Priority BAP Habitats.

2.2.4 The UK Habitat Classification

The UK Habitat Classification was published in 2018 and provides a synthesis of many of the other habitat classifications in regular professional use through correspondence tables. UKHab directly records UK BAP Broad and Priority Habitats and all UK Annex 1 habitats within a nested hierarchy that ensures that the whole terrestrial, coastal and freshwater surface of the UK can be mapped in the UKHab system. UKHab uses soil pH for major divisions of grasslands, separating Acid, Calcareous and Neutral grasslands; and separately classifying Modified Grasslands as high fertility and species-poor swards characterised by intensive agriculture.

2.3 Is "semi-natural grassland" a useful collective term?

Naturalness is a founding criterion for determining conservation status in the UK (Ratcliffe, 1977) and remains a core principle for the selection of SSSIs (JNCC, 2013). Naturalness is an especially important consideration for climax community types that occur in essentially unmodified ecosystems, now restricted in the UK to mountain tops and cliffs, upland bogs, coastal cliffs, slopes and shorelines and intertidal habitats (JNCC, 2013).

Bullock et al (2011) describe semi-natural grasslands as *the remnants of habitats created by low-intensity, traditional farming, or, in some cases, the natural vegetation on poor soils*. It could be argued that only the latter, the sparse vegetation of naturally open habitats on cliffs and ledges are actually near-natural (Piggott and Walters, 1954), in the sense that they would be more likely to persist if human activity ceased. In a grassland context, "semi-natural" is therefore an almost uniquely British construct that allows for the cultural dimension of the traditional management of our landscape since the Neolithic period to be reflected within the definitions of these habitats. 'Semi-natural' grasslands are therefore either those with a long continuity of management or those grass, fern and herb-dominated habitats characterised by species that are tolerant of naturally stressed or challenging environmental conditions, e.g. tall-herb communities on mountain cliffs. In the majority of UK grasslands, the principal aim of conservation is therefore not necessarily towards a fully "natural" state, but to deliver stable functioning grassland ecosystems through management continuity.

Higher conservation-value semi-natural grasslands include those which attain high ecosystem functionality, measured in several traits such as species composition, structural diversity, nutrient cycling, decomposition, species interactions and physical conditions. A separate but complementary report prepared by SLR covers the ways in which grasslands contribute to the provision of ecosystem services, which is another aspect to consider when understanding the conservation value or definition of semi-natural grasslands. Highly modified or artificial grassland ecosystems, such as improved grassland for agricultural production, perhaps can be considered to have functionality in one sense, of provision, but is highly reliant on external inputs and has severely reduced functionality in terms of other ecosystem services, such as soil health or carbon storage.

Since many semi-natural grasslands exist on an interrupted succession pathway as a result of their management; mis-management (including neglect or lack of any management) could set habitats on a trajectory either towards other intermediate or climax communities (such as scrub or woodland), or towards more "modified" communities in low functionality grasslands. Deliberate human-management is therefore critical for the

[2] CORINE (coordination of information on the environment) is an inventory of European land cover split into 44 different land cover classes, it is used in satellite monitoring and to support environmental policy development.

maintenance of the majority of grassland plant communities of conservation interest and is finely balanced. An unmanaged or mis-managed grassland may still be classed as "semi-natural" but may lose its characteristic species, ecological condition and conservation value.

Whilst succession of grasslands towards other communities may have its own conservation value in some circumstances, e.g. in developing habitat mosaics which have value to a variety of species, the species diversity and provision of ecosystem traits unique to grasslands would likely be lost. Degraded grasslands which tend towards lower functionality and lower conservation value will lose their ability to adequately provide ecosystem services, such as carbon sequestration and flood mitigation; and importantly are likely to lose capacity to support characteristic and rarer species which often occupy relatively narrow niches in traditionally managed grasslands.

A further complexity is the distinction between newly created grasslands and the remaining long-established grasslands. Species-rich recently restored grasslands can obtain some comparable ecosystem traits to old traditionally managed sites, such as pollinating insect diversity and earthworm abundance (Poyry 2004, Forup 2005, Dahms 2010). However, the story is mixed with other studies finding no clear effect on plant species richness with grassland restoration (Lindborg 2004, 2005). Restored grasslands may show positive signs of restoration quickly (less than five years, Walker 2004), but differences in vegetation composition between restored and existing species-rich grasslands can still be detected up to 60 years after restoration (Fagan 2008).

Separating created grasslands from long-established habitats, especially where they may support very similar vegetation communities, will become increasingly important as the UK pushes forward with its nature recovery agenda. The conservation of "old" or long-continuity traditionally-managed grasslands, even where these are not especially species-rich, will become increasingly important and it may become necessary for us to develop new ways of identifying those remaining long-continuity grasslands in the UK.

Figure 2-1: Hay bailing is a traditional management technique that retains semi-natural and flower-rich swards © Lucia Chmurova

2.3.1 Other grassland terminology

The term "semi-natural" grassland can include habitats that receive some element of human management, yet retain high ecological value and ecosystem functionality – i.e., excludes improved leys and pastures for agricultural production. Several other grassland terms are also in frequent use – as shown in Figure 2-2 below. Section 7 contains a glossary of terms.

Wildflower meadow is now a commonly used term, generally to describe grasslands which have a high proportion of flowering herbs and forbs, yet still have permanent grass cover. The term is often used to describe areas newly planted with a specific "wildflower" seed mix. Whilst intentions behind wildflower meadow creation are often sound, creation without due consideration can often lead to negative consequences: for example, seed mixes may often be comprised of non-native species, and if establishment is attempted on soils that have been modified (e.g., high fertility), then competitive grass species may quickly overrun the habitat and reduce wildflower coverage over time without careful management, such as cutting or grazing. In some situations, re-seeding floristically-poor but long-established grassland communities with wildflowers could actually damage existing conservation value and highlights the need for appropriate baseline surveys before intervention.

"Species-rich" grassland is often considered synonymous with "semi-natural" grassland, as it is an assumed indicator of an ecologically valuable and functional habitat. However, care must be taken not to exclude other grassland habitat types that may be plant species-poor, but ecologically-rich in other ways, such as fungi-rich grasslands (see below).

Figure 2-2:
Word-cloud showing common grassland terminology

2.4 A preliminary definition for long-established or ancient Grasslands

The concept of "ancient" habitats has been used as a descriptor for high conservation value habitat since the characterisation of ancient woodlands (Rackham, 1980) and the publication of the first woodland inventories in the 1980s. A well-established approach to selecting sites of conservation value is where historical continuity of those habitats can be documented, particularly in instances where habitat management has clearly taken place (JNCC, 2013).

There are four main approaches for defining long-establishment as an indicator of conservation value in a habitat (based upon Plantlife (unpublished memo, 2021):

- A **time-related** and **documentary evidence-based** definition, based upon a key date beyond which grasslands could be considered ancient;
- a **phytosociological** or **indicator species** definition, which relies upon combinations of plant species or the presence of a number of indicators that are sensitive to disturbance;
- a **soil-related** or **eDNA meta-barcode[3] soil analysis** definition that tests for the presence of biomarkers, indicator species (including micro-organisms and fungi) or anthropogenic chemicals which could be used to date grasslands or develop multi-variate cluster analyses that group long-established habitats;
- a **cultural and historical** approach that focuses on the cultural values and documentary evidence.

Exploring each of these different approaches is beyond the scope of this study, but it is considered that a documentary date approach is the simplest.

The passing of The Tithe Commutation Act 1839 and related land reforms created Tithe Maps across England and Wales, many of which are available digitally. The Land Utilisation Survey of Great Britain (L. Dudley Stamp, 1931-1938) was the first systematic land use survey of Great Britain and is now available digitally. These maps have potential to provide a documentary basis for a definition of "long-established grassland", although unfortunately, neither recorded grassland habitats with any degree of accuracy and it is difficult to trace those grasslands that were ploughed in WW1 and WW2 and then reverted back to permanent grassland at the end of the wars.

It is recognised that there is no definitive source for identifying long-established grasslands, but it is considered any grassland that is known or likely to have been the same habitat type, and under a similar management system since 1936 would be meet emerging definition of being "long-established" (UKHab v2, UKHab Ltd. *in press*). This date seems like a reasonable compromise between the availability of documentary records, such as the 1931-1938 Land Utilisation Survey and scientific evidence that indicates that differences in habitat composition can still be detected in habitats that are more than 60 years post-restoration (Fagan, 2008).

2.5 Grassland fungi – overlooked indicators of conservation value grasslands

Often semi-natural grasslands, or ecologically valuable grasslands, are imagined to be species-rich and botanically diverse. However, important grassland habitats exist with relatively low plant diversity, typically on enclosed acid grasslands (although can also occur on calcareous soils), where fungi thrive at high abundance and diversity. These grasslands are incredibly important strongholds for these fungi species and so should not be excluded from grassland definitions on account of their plant diversity alone.

Grassland fungi are typically associated with unimproved, long-established grasslands and are likely to be an important indicator of habitat continuity, even in situations where botanical indicators are not evident. This

[3] eDNA is "environmental DNA", which is any DNA released from any organism that then persists in the environment. Meta-barcoding can reveal the diversity of bacteria, fungi and microscopic animals found in soils by classifying all DNA fragments found in a particular sample.

group of fungi show a strong preference for undisturbed grassland that is regularly grazed or mown, and with minimal chemical inputs. Five groups of grassland fungi – the CHEGD: C (Clavarioid fungi): H (Hygrocybe s.l.): E (Entoloma s.l.); G (Geoglossoid fungi); D (Dermoloma etc.) are typically identified and a scoring system has been established to provide clear thresholds for the selection of important sites (JNCC, 2018). Recent developments in eDNA analysis provides an opportunity to use these species as indicators where specialist field identification skills are not available.

2.6 Summary

A definition of "semi-natural" grassland should consider the following factors:

- Is the grassland a stress-tolerant climax community occurring on low fertility, coastal or high-altitude soils?
- What is the intensity and continuity of human management? What type of management is used?
- Has the grassland been long-established, or more recently created?
- What ecosystem functionality traits does the habitat have? For example, what is the soil condition, species composition and structural diversity like?

A semi-natural grassland of conservation value is likely to either being a climax community on poor soils, or be the subject of regular human management, such as cutting or low-intensity grazing, over a significant period of time, combined with the absence of chemical fertilisers and disturbance. Such grasslands are likely to possess high ecological value in terms of species they support; including higher plants, fungi and invertebrates; and their ability to provide a range of ecosystem services.

3.0 A REVIEW OF GRASSLAND STATUS AND TRENDS IN THE UK

3.1 Methodology

A wide variety of sources and types of literature were consulted to explore the status and trends of grassland coverage in the UK, specifically focussing on semi-natural grassland habitats. Where data sources also include improved grassland, agricultural land or other habitat types, these have been referenced. The evidence reviewed consisted of a wide range of sources and literature, including peer-reviewed articles, governmental reports, and grey literature. Throughout the report, we provide citations to the relevant literature, highlighting the sources that have informed our analysis and conclusions. While our literature review was not conducted in a strictly systematic manner, we have tried to thoroughly investigate and synthesise the existing knowledge on the topic.

We start by exploring the original paper behind the "97% loss" statistic, before exploring data relating to semi-natural grassland extent across the UK and within the countries. Next, we explore if and how different datasets can be used to understand more recent changes in semi-natural grassland extent. Using Land Cover Map data, we then summarise these recent changes across the UK.

3.2 Have grasslands really declined by 97% in the last century?

While there are numerous reports corroborating the overall decline of grasslands in the UK, the extent thereof varies. The statistic claiming a 97% decline of grasslands in the UK comes from a paper written by Fuller (1987) and has been deduced from the statement ***"Unimproved lowland pasture, excluding rough grasslands, has declined to around 0.2 M ha, 4% of today's total lowland grassland area and only 3% of that which had existed pre-war"*.**

This headline statistic of 97% decline is widely used, both in scientific literature as well as in a variety of materials published for advocacy or education purposes. A deeper exploration into the paper's findings is necessary though to fully understand the meaning behind the headline. We examine the original data within this report to determine the background behind this statistic.

Fuller consolidated the available literature at the time to quantify the changes of lowland grassland in the countries of England and Wales between the years 1930 to 1984. The grassland considered within this paper refers to "*unimproved (or seminatural) permanent pastures, excluding rough grazings",* and only applied to lowland settings. Agricultural and land survey data, as well as aerial photography, was used by Fuller to provide the input data to measure change over time, and the definition of grasslands in these different datasets was not always so clear-cut. For example, the very earliest surveys (1930-38) examined by Fuller classified grasslands as "meadowland and permanent grass" with no distinction between improved or unimproved, or lowland or upland, and with rough grazings and rotation grass placed in separate classes. At the time of these early surveys, most of the grassland habitats were found to be unimproved permanent pasture, although the classification criteria were not detailed enough for distinction between arable land recently converted to grassland versus long-established unimproved meadows.

Later surveys from the 1970s differed in composition and purpose from earlier surveys; for example, these surveys utilised a more detailed distinction between improved and unimproved grasslands based on the presence and extent of 'preferred species'. Preferred species are productive species often found in agricultural habitats, especially ryegrasses (*Lolium)*. Unimproved grasslands were defined as having less coverage of preferred species, instead being dominated by other native species, and were also classified as 'old' grasslands (ie. over 20 years old) thus being traceable in previous datasets within the series.

Limitations of the data used are discussed by Fuller, and primarily relate to the differing definitions of grasslands (particularly improved and unimproved) over time and between different datasets. It is believed that the action of converting unimproved lowland pastures to improved pastures is responsible for a large proportion of the

97% decline statistic. However, with the difficulty of comparing non-identical datasets it is not possible to understand how much of this relates to actual habitat change compared with definition differences.

Furthermore, this review was published in 1987, over 36 years ago, and therefore cannot paint an accurate picture of what has happened to grasslands in the UK since this time. An updated analysis would be necessary to merit use of the statistic for a time period of 'nearly a century'. In addition, care must be taken when using the statistic to summarise trends across the UK, as the datasets used in the paper applied only to lowland unimproved grassland that occurred in England and Wales – in fact, only one dataset from the ten used applied to Wales, with the overall trends being extrapolated to then cover lowland grassland in Wales.

Overall, Fuller demonstrates that during the 20th century there was undoubtedly a harsh decline in the extent of semi-natural grasslands in lowland England and Wales, with these grasslands being primarily converted to agriculturally improved grassland through the growing use of artificial fertiliser. The fate of semi-natural grasslands in the early 20th century that lie outside of Fuller's remit remains less clear, but is assumed to follow a similar trajectory to those examined in the paper. We now turn to datasets and examine the literature after this period to explore the story of semi-natural grassland decline at the end of the 20th century.

Figure 3-1: A large proportion of lowland unimproved meadows (left, © Matt Pitts) across England and Wales were converted to agriculturally improved grassland (right, © Bob Edmonds) in the mid-20th century.

3.3 Grassland decline: a picture across England, Wales, Scotland and Northern Ireland

Data on grasslands has been collected in numerous studies and initiatives with differing geographical coverage, definitions, ambitions and durations. Sources of data dating from 1930 – 1984 were the object of Fuller's review paper, and for this report additional studies have been examined spanning 1990 – 2022.

Whilst acknowledging their differences, collating these together shows that, without question, semi-natural grasslands have experienced a large decline in the UK across the 20th century. A summary of findings is below, both across the UK and within the countries.

3.3.1 UK-wide studies

When the JNCC first listed acid, calcareous, and neutral grassland types as UK Biodiversity Action Plan (UKBAP) Priority Habitats in 1995, estimates were made of the extent of each of these habitat types. The source of these estimates is unclear, but is thought to be from available land cover data and/or professional opinion. Examining Priority Habitat grasslands presents a good indicator for the extent and coverage of good-quality semi-natural grasslands, as any grasslands improved for agricultural productivity, for example, would not qualify.

However, upland acid grassland is not listed as a Priority Habitat, nor is a typically "species-rich" grassland type, but may still fall under a definition of semi-natural grassland depending on management regime and/or overarching land use. Furthermore, the distinction between upland and lowland (at 300m altitude) is relatively arbitrary as phytosociological assemblages are unlikely to change abruptly at this point and depend more on climatic conditions, which could vary with altitude on a local or regional scale. As detailed in Section 2.5, species poor grasslands which hold high fungal diversity may also fall outside scope for Priority Habitat inclusion but carry high value.

These estimates put the extent of priority habitat grassland across the UK at over 160,000 hectares (ha), roughly under 1% of the area of the UK. Of this, it was estimated 30,000 ha of lowland acid grasslands existed across the entire UK, between 33-41,000 ha of lowland calcareous grassland, and upland calcareous grassland covered approximately 22-25,000 ha. Neutral grassland priority habitat types comprised lowland meadows and upland hay meadows. The upland hay meadows did not have any past cover data available, although it was estimated that there was less than 1,000 ha covering the region of northern England, and less than 100 ha in Scotland. Lowland meadows were estimated to have an extent of less than 15,000 ha across the UK, with Fuller's paper cited for describing the level of decline.

The National Ecosystems Assessment (NEA) published in 2011 also listed extents for UKBAP Priority Habitat grasslands, using data from the "*2006 UKBAP Targets Review*". The original source for this was not found, so the data published in Bullock 2011, i.e. the grasslands summary chapter of the NEA, was used.

Estimates of priority habitat grassland extent differ to the 1995 study, sometimes markedly. For example, the extent of lowland dry acid grassland increased during this period to 62,000 ha (from 30,000 ha), and purple moor grass and rush also increased in coverage to 79,000 ha (from 56,000 ha). The extent of lowland and upland calcareous grassland appears to have remained stable, whereas lowland meadows showed a decline of approximately 4,000 ha (11,000 ha reduced from 15,000 ha in 1995).

Table 3-1 below summarises the extent estimates from these two studies across the UK and within the four countries.

Table 3-1:
Priority Habitat Grasslands extents estimated in 1995 and 2006

Priority Habitat Grassland Type	UK		England		Wales		Scotland		Northern Ireland	
Year	2006	1995	2006	1995	2006	1995	2006	1995	2006	1995
Lowland dry acid grassland	61,700	<30,000	20,100	*	36,500	*	4,400	50,000	670	*
Lowland calcareous grassland	41,000	33,000-41,000	39,000	*	1,100	<1,000	760	*		*
Lowland meadows	10,400	<15,000	7,200	**	1,300	**	980	2,000-3,000	940	*
Upland calcareous grassland	23,000	22,000-25,000	16,000	10,000	700	800	5,000	10,000-13,000	940	1,100
Upland hay meadows	900	*	870	<1,000	*	*	27	<100		*
Purple moor grass and rush	79,000	56,000	22,000	5,300	32,000	24,000	6,800	2,000	18,000	24,600

Sources: 1995: estimates of extent given in JNCC UKBAP Priority Habitat Definitions. 2006: taken from 2011 National Ecosystem Assessment report Chapter 6 – Bullock 2011, listed in this as from UKBAP 2006 UKBAP Targets Review

** = no estimate given*

*** = an estimate of 5000 – 10000ha was given to cover England and Wales*

UK-wide datasets also exist in relation to broader grassland habitat classifications. Whilst these may cover grasslands that fall outside of semi-natural grasslands, such as improved grasslands, amenity grasslands and in some cases arable land, other grassland categories that fall outside of Priority Habitat definitions are encompassed here.

Prior to JNCC's 1995 Biodiversity Action Plans, the Countryside Survey had launched land classification surveys covering the UK, combining field surveys and satellite data to develop land cover maps focussed on the rural environment. Data was first collected in 1978 and the Countryside Survey 1990 (CS90) report examined data collected from 1978 to 1990. Habitats were classified broadly – for example, the category "managed grass" included several subsets such as "recreational (mown) grass, well-managed grass, calcareous grass and non-agriculturally improved grass". The first report covered England, Scotland and Wales and thus provided summary data for Great Britain rather than the United Kingdom. The "managed grass" habitat group covered the largest area in Great Britain at 27% in 1990, with "rough grass and marsh" as another category that comprised just shy of 2% of Great Britain. This latter category included subsets of non-cropped arable land, unmanaged grassland, felled woodland and waste and derelict land. Of the 27% managed grass in GB, about 40% was estimated to be intensively managed as short-term ley or rye grass.

Comparisons with earlier datasets in 1978 and 1984 showed that "managed grass" declined by 2% overall, although underlying this was extensive increases in cover of "weedy swards" with >25% rye-grass, at the expense of other grass types. However, data was collected using a slightly different classification system in 1978 making direct comparison difficult – for example, grasslands were divided in more detail based on species.

The Countryside Survey undertaken in 1998 classified grassland in a different manner, using the division of broad habitat types of improved, neutral, calcareous and acid grasslands. Comparison with the 1990 survey in the CS2000 report (Haines-Young et al 2000) found that since 1990 – 1998, 13% of neutral grassland habitat was lost to arable, broadleaved woodland or built-up broad habitat classes in the UK. In this same time frame, acid and calcareous grasslands saw losses of 10 and 18%, respectively. In addition, the flora transitioned from typical meadow plants into tall, competitive plants. This survey collated data with the Northern Ireland Countryside Survey, thus providing data that covered the UK and not just Great Britain.

The Countryside Survey continued and another summary report was produced in 2007, tracking change between 1998 and 2007 with no change in broad grassland habitat type classification. With increased movements to protect, restore and recreate grasslands (for example, agri-environment schemes) during this time, the area of neutral grasslands, as well as improved grasslands, increased by 6% and 5% respectively (CSS, 2007). While generally there was no statistically significant change in the extent of acid, neutral and calcareous grasslands across all of the UK, Scotland and Wales demonstrated an increase in upland acid grassland, by 9% and 7%, respectively (Bullock, 2011). In addition, there was further evidence of the decline of species richness in lowland grasslands having slowed down or stopped completely between 1998 and 2007 (CSS, 2007). The Countryside Survey 2007 UK report summarised the land area of broad habitats from 1984 onwards with retrospective changes in definitions. Their summary tables are provided in Table 3-2 and Table 3-3 below.

Table 3-2:
The change in area ('000s ha and percentage) of grassland Broad Habitats in the UK between 1998 and 2007

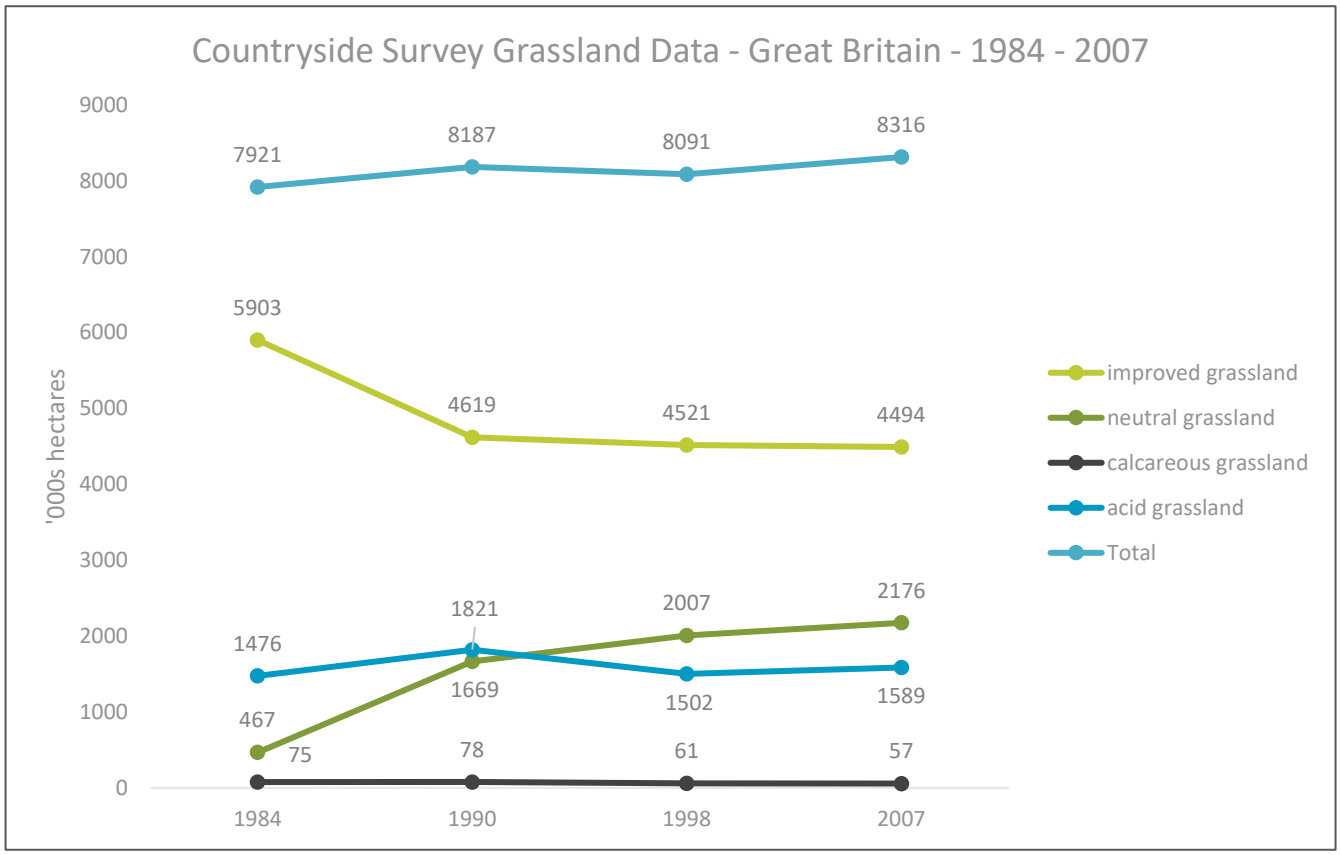
	UK - 1998 - 2007		
Grassland Type	Change ('000s ha)	% Change	Significance (p<0.05)
Improved Grassland	261	5.4	Significant increase
Neutral Grassland	136	6	Significant increase
Calcareous Grassland	-4	-6.3	
Acid Grassland	83	5.5	Significant increase

Table 3-3:
Estimated area ('000s ha) and percentage of land area of Broad Habitats in the UK from 1998 to 2007 and Great Britain from 1984 to 2007.

	Great Britain								UK			
	1984		1990		1998		2007		1998		2007	
Grassland Type	000s ha	% area of GB	000s ha	% area of GB	000s ha	% area of GB	000s ha	% area of GB	000s ha	% area of UK	000s ha	% area of UK
Improved Grassland	5903	25.3	4619	19.8	4521	18.2	4494	19.3	4806	19.4	5067	20.5
Neutral Grassland	467	2	1669	7.2	2007	8.6	2176	9.3	2271	9.2	2407	9.7
Calcareous Grassland	75	0.3	78	0.3	61	0.3	57	0.2	63	0.3	59	0.2
Acid Grassland	1476	6.3	1821	7.8	1502	6.4	1589	6.8	1516	6.1	1599	6.5
Total	**7921**	**33.9**	**8187**	**35.1**	**8091**	**33.5**	**8316**	**35.6**	**8656**	**35**	**9132**	**36.9**

Note that because of changes in definitions that have been applied retrospectively, the estimates from 1990 and more especially 1984 are not in all cases directly comparable with later surveys. Source: Countryside Survey 2007.

Figure 3-2: Graph displaying estimated area ('000s ha) for Broad Habitats in Great Britain based on Countryside Survey data from 1984 to 2007



Neutral grassland actually showed a large increase each period between 1984 and 2007, correlating with the decrease in improved grassland extent which declined significantly between 1984 and 1990, and then declined at a slower rate. However, as the Countryside Survey 2007 report states, underlying these changes are retrospective definition changes which may have a substantial influence on the results.

The Office for National Statistics (ONS) in 2015 published land cover ecosystem accounts for the UK. Whilst this was based on data from the Countryside Survey in 1998 and 2007, grassland classifications were sorted into "pastures" and "semi-natural grassland". In agreement with CS2007 data, the ONS concluded pastures (equivalent to "improved grassland") and semi-natural grassland (equivalent to all other grassland types from CS2007) comprised close to 40% of total UK land cover. Their report states that semi-natural grassland increased in extent by 155,000 hectares, or 3.9%, between 1998 and 2007.

3.3.2 England

In England, the Countryside Survey 2007 report found that the decline in acid and calcareous grassland extent that was experienced at the end of the 20th century had slowed, as no significant difference in extent was detected between 1998 - 2007. However, grassland condition was found to have changed during this time: for example, there was a significant decrease in plant species richness in neutral and acid grasslands.

Several studies in the literature provide results on English grassland trends spanning different and overlapping timeframes; for example, between 1960 and 2013, semi natural grasslands (including calcareous, wet, mesotrophic, and dry acid and lowland heath habitat categories) in England declined by 47% overall (Ridding, 2015). Dry acid grassland and heathland saw the greatest loss (85%) (noting that heathland is not classed as a

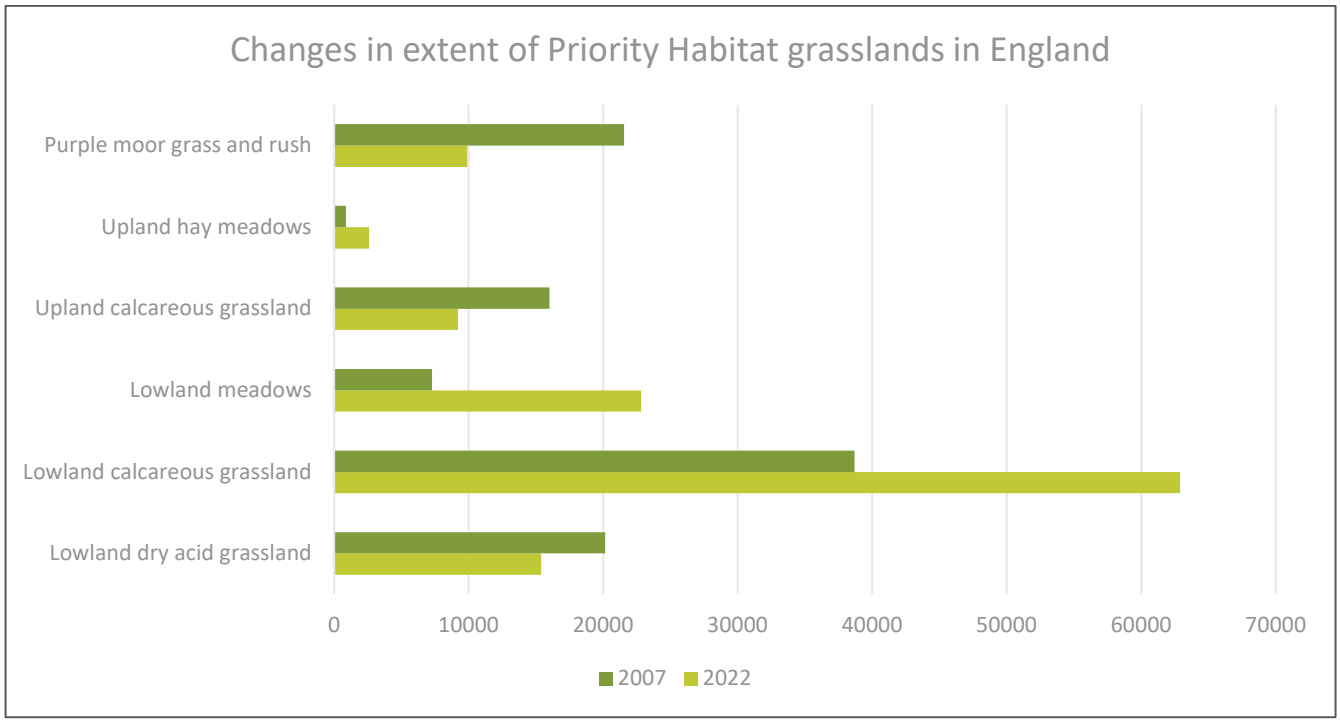
grassland type in other studies), while the extent of upland calcareous grassland loss was proportionately less, with a 39% loss (Ridding, 2015). Regional studies in England have demonstrated declines of varying extents, across different time frames and regarding specific grassland types: for example, a habitat mapping classification study in Dorset recorded a 97% decline in semi-natural grasslands between 1930 and 2000 (Hooftman, 2012), and in Worcestershire the Wildlife Trust documented losses of meadows within the county, with at least 64% destroyed between 1978 and 1996 (Holmes, 2005).

Protection of English grasslands under designation within Sites of Special Scientific Interest (SSSI) has shown some success, with strong evidence for lower losses of grassland habitat. Sites that have statutory protection as a SSSI were found to retain 91% more grassland than non-protected sites, which only retained 27% (Ridding et al, 2015), although notably this indicates grassland losses are still occurring in SSSIs.

Natural England provide an estimate of the extent of priority habitat grasslands through their Priority Habitat Inventory, which has been compared to the Countryside Survey 2007 Priority Habitat grasslands data from Bullock 2011 in Figure 3-3 below. This shows that there have been large increases in extent of reported lowland calcareous grassland and lowland meadows, with declines seen in lowland dry acid grassland and in upland calcareous grassland.

The picture across England is therefore mixed and trends obscured with changes in definition and approaches to collecting grassland inventory data. Some priority habitat grasslands have experienced recent significant declines and others maintained or increased in extent. For broad grassland habitat types, high rate of declines recorded in the mid-20th century slowed towards the 21st century, although underlying this trend is an indication that the condition, or quality, of broad grassland habitats has declined in recent years.

Figure 3-3:
Changes in extent of Priority Habitat grasslands in England



Data sources: Bullock 2011, PH Inventory 2022

3.3.3 Wales

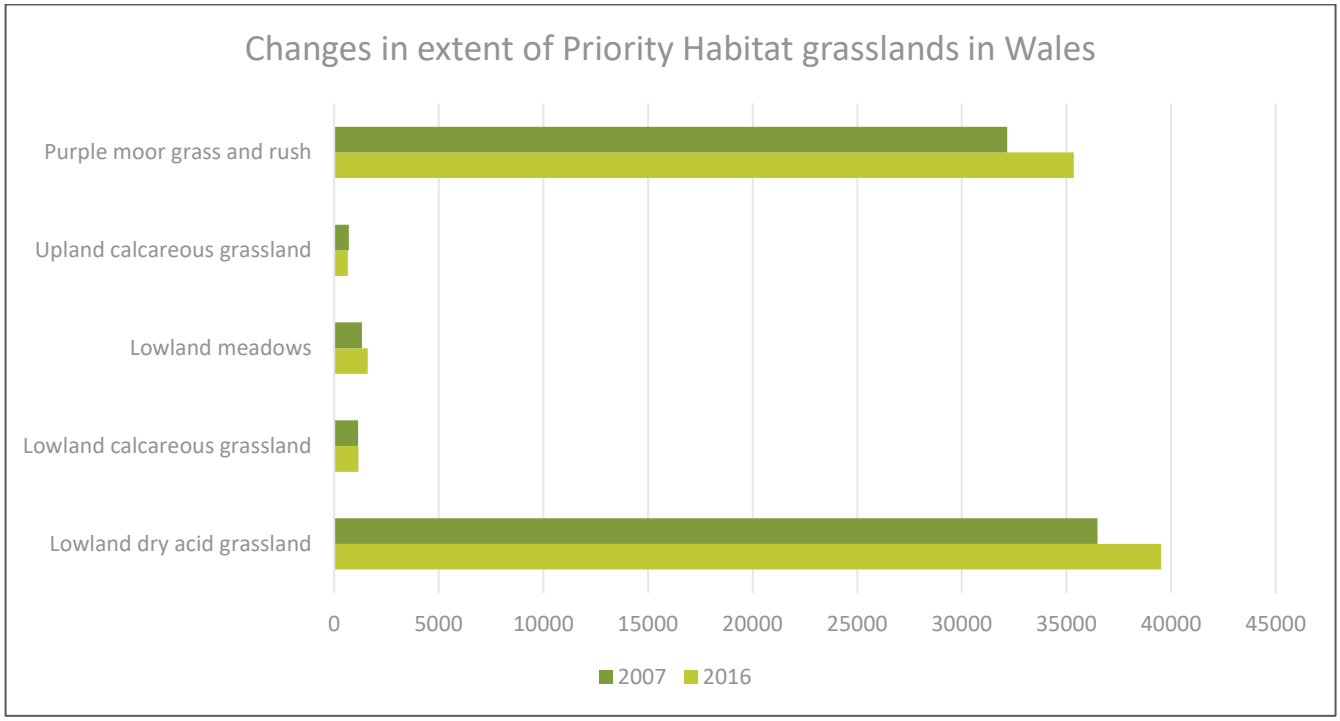
The State of Natural Resources Report (SoNaRR) (NRW, 2016) produced a summary on the evidence on extent, condition and trends of natural resources in Wales. Drawing from the Habitats of Wales (Blackstock, 2010) report, whilst two-thirds of Wales is covered by grassland habitats, only 9% of the land is classed as semi-natural grassland; most of the remaining habitats are classed as agriculturally improved grasslands.

In total, in 2010 there were 78,000 ha of priority habitat grasslands. Comparing with priority grassland habitat data from the Countryside Survey in 2007 shows that calcareous grassland (both lowland and upland) have experienced declines, whereas purple moor grass and lowland dry acid grassland experienced increases in extent during this period. However, since the time between these surveys is short, changes may reflect different survey approaches as opposed to direct extent changes.

In terms of broad grassland habitats, the Countryside Survey 2007 found that 12% of Wales had neutral grassland coverage, and 10% acid grassland coverage - indicating a difference in definitions between Blackwell 2010 9% statistic above. No significant change in broad grassland habitats was detected between 1998 and 2007. Similar to England, between 1998 to 2007 the species richness of Welsh grassland plants diminished in neutral and acid grasslands.

Studies on earlier datasets conclude that between the 1930s and 1990s, there was an estimated decline of more than 90% of lowland semi-natural grassland, and the grassland remaining has been described as being in poor condition, suffering from undermanagement, and being highly fragmented (Buckingham et al 2022).

Figure 3-4:
Changes in extent of Priority Habitat grasslands in Wales



Sources: SoNaRR 2016, Bullock 2011

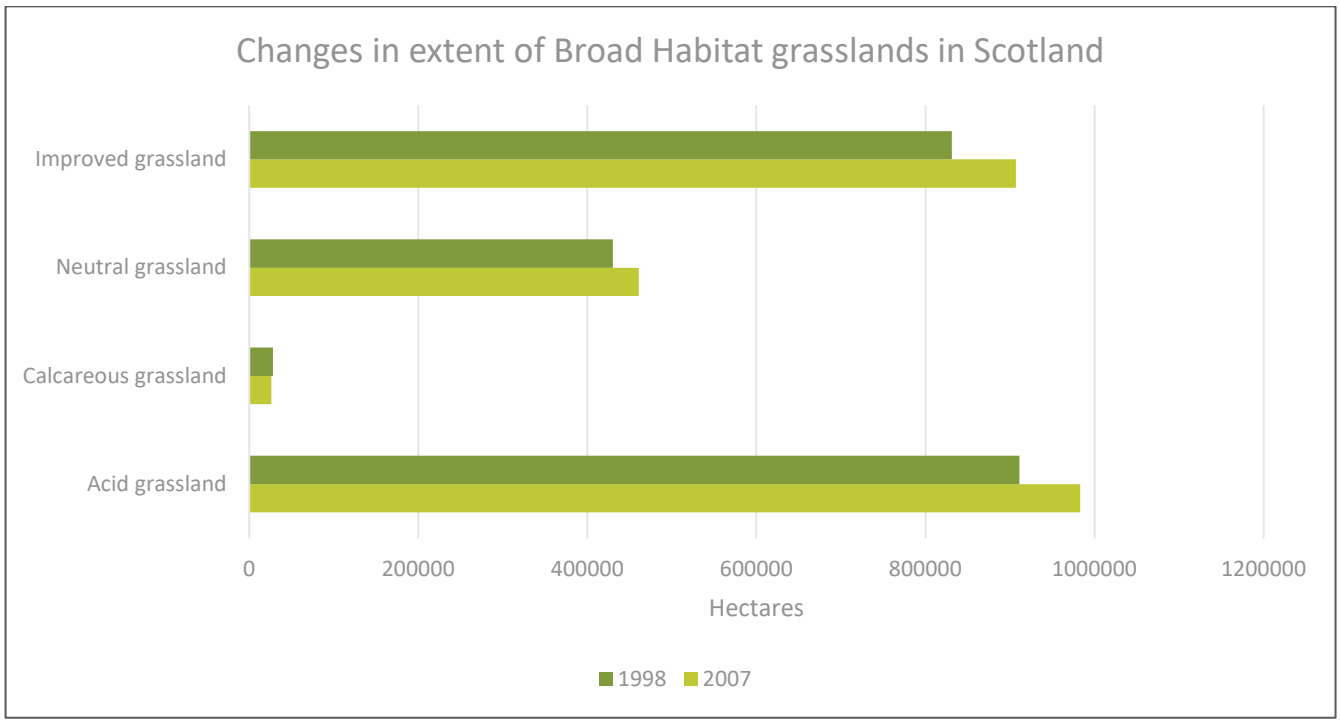
3.3.4 Scotland

Changes in extent of broad grassland habitat types were recorded for Scotland in the Countryside Surveys. Neutral Grassland was estimated to cover approximately 461,000 ha in 2007 or approximately 6% of Scotland. Although there was a 6% increase in estimated area between 1998 and 2007, this was not significant on account of the high variability of the results. This increase followed a period of stability between 1990 and 1998. However more detailed studies have shown that in this same period, whilst neutral grassland extent did not change significantly, they saw a 17% decrease in species richness, including in bird and butterfly larvae food plants. Whilst acid grassland increased in extent, the trend of species richness decline was also present in these habitats (NERC, 2009).

Calcareous grassland was estimated to cover approximately 26,000 ha (0.3%) of Scotland in 2007. Due to the small sample size it was deemed difficult to detect small changes in the area of this broad habitat: no change has been detected since 1990, and in the surveys over 95% of calcareous grassland polygons remained in the same habitat class between 1998 and 2007. Acid grassland covered approximately 983,000 ha, or 12% of Scotland, in 2007. Scotland is a key stronghold for this broad grassland habitat, containing over 60% of total acid grassland across Great Britain. The area of Acid grassland increased across Scotland by 8% between 1998 and 2007.

A study undertaken by NatureScot published in 2014 examined the extent and condition of lowland grassland Annex 1 and Priority Habitats in Scotland, at specific sites surveyed between 1983 – 2001 and 2010 – 2011. At the point of data collection in 2011, the most extensive BAP Priority habitat was the lowland dry acid grassland and Purple Moor-grass & Rush Pastures, which covered 52% and 32%, respectively, of the surveyed area. Upland Hay Meadow only covered 0.5%, 5% was Lowland Calcareous Grassland, and 11 % was Lowland Meadow. These values do not indicate the percent coverage of Scotland's total land cover area, however. Analysis of trends over time found that 16% of the grassland habitats had been lost since 1983, with only 41% being assessed as in 'favourable' condition. Net loss of lowland meadow priority habitat was greatest of those measured, and was deemed due to agricultural intensification and undermanagement.

Figure 3-5:
Changes in extent of Broad Habitat grasslands in Scotland



Source: Countryside Survey 2007

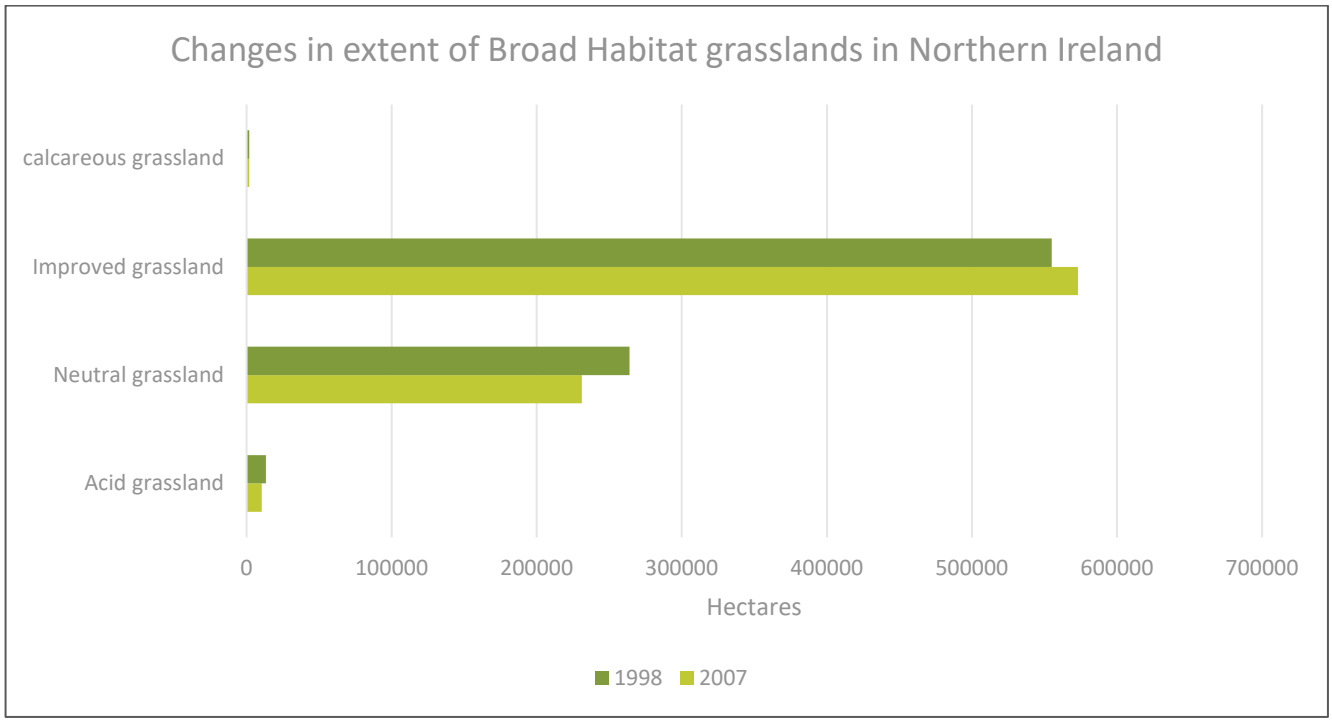
3.3.5 Northern Ireland

Analysis of baseline land cover data for Northern Ireland collected through the Northern Ireland Countryside Survey scheme between 1986 to 1991 showed that species-rich dry grassland had declined by 17% during that period. At this point in time, semi-natural grasslands made up 10% of all semi-natural vegetation in the country (25% land cover), which equated to around 35,000 ha, and species-rich and calcareous grasslands made up 9,000 ha (Northern Ireland CSS, 1997).

Whilst the rest of the UK saw an increase in neutral grassland between 1998 and 2007, Northern Ireland actually saw a 30% decrease, representing a continued decline as recorded in the countryside survey data collected 12 years previously. In addition, calcareous grassland cover reduced by 7% during this time, but then increased by 2% in 2007. Acid grassland decreased more, by 22%, with most being converted to dry heath (Cooper et al 2009).

No data earlier than 2007 was found relating to Priority Habitat grasslands for Northern Ireland, but comparisons over the years of Countryside Survey data show changes in extent of broad habitat types in Figure 3-6 below.

Figure 3-6:
Changes in extent of Broad Habitat grasslands in Northern Ireland



Source: Countryside Survey 2007

3.4 Can we use existing datasets to understand recent grassland decline?

As identified above, there are many datasets that identify the distribution of land cover or habitats which can be used to evaluate the coverage of grassland habitats across the UK. As well as analysing the literature for an understanding of overall trends and conclusions, any available datasets themselves were further assessed to explore their potential use to measure recent grassland decline.

A 'fitness for purpose' criteria was used to evaluate datasets depending on the intended use, which is to measure the change in grassland coverage over time. Therefore, the following dataset criteria was identified:

1. The dataset should detail coverage of specific grassland types (e.g. Acid, Neutral or Calcareous Grassland);
2. The dataset should cover habitats on a national level (e.g. England, Scotland, Wales or Northern Ireland); and
3. The dataset should be part of a collection which are comparable over time to assess change.

As part of the review, a catalogue was created to record any datasets, noting the information in Table 3-4. This included details on grassland type, coverage and temporal resolution which were key to the identification of datasets which were most suitable for use; and additional details which may impact considerations for use, such as minimum mapping unit.

Table 3-4:
Metadata collected for dataset catalogue for grasslands

Information	Example
Dataset Name	*Land Cover Map*
Source Organisation	*Centre for Ecology and Hydrology*
Classification of Grassland Types	*Acid, Neutral, Calcareous*
Accessibility (i.e. available for public download)	*Yes*
Licence Restrictions	*Non-Commercial Use*
Temporal Resolution (Year represented in dataset)	*2021*
Spatial Resolution / Minimum Mapping Unit	*10m*
Coverage	*England, Scotland, Wales and Northern Ireland*
Repeated Surveys Over Time	*Yes*

3.4.1 Summary of Review

Habitat and land cover datasets could be grouped into the following categories:

- Project-specific local habitat mapping exercises (e.g. academic field studies);
- Regional habitat mapping exercises (e.g. Kent Habitat Survey);
- National Habitat mapping exercises (e.g. Living England); and
- International land cover mapping exercises (e.g. Corine Land Cover).

3.4.2 Fitness for Purpose Evaluation

1: The dataset should detail coverage of specific grassland types

Several datasets were identified which classified different types of grasslands, such as the Scotland Habitat and Land Cover Map and England Habitat Networks, that could be used to identify the coverage of specific grassland types. However, the datasets used different habitat classification systems – for example the Scotland Habitat and Land Cover Map classified habitats according to EUNIS, but the Living England Habitat Map classified habitats according to UKBAP. Should datasets need to be used in conjunction to evaluate grassland coverage, a translation exercise may be required to ensure habitats parcels are categorised consistently.

2. The dataset should cover habitats on a national level

There were a number of datasets available which map habitats on a national level, such as Living England Habitat Map and the Lowland Grassland Survey of Wales, which could be used to summarise coverage at a national scale. However these datasets were limited to a single UK nation, but there were also datasets which covered multiple nations (for example the CEH Land Cover, Corine Land Cover, WorldCover datasets) that could be used to consistently assess coverage of habitats across all UK nations.

3. The dataset should be part of a collection which are comparable over time to assess change.

Most of the datasets identified through this study were found to represent habitats at a single point in time, however some organisations have repeated projects to create a dataset time-series which could be used to assess change over time using a similar methodology, such as the CEH Land Cover and Corrine Land Cover datasets. The methodology applied was noted to have changed as new technologies became available for some projects – the Corrine Land Cover 1990 dataset has a Minimum Mapping Unit of 50m^2 compared to a Minimum Mapping Unit of 10m^2 in the 2018 dataset as the accessibility of Earth Observation data increased.

3.4.3 Conclusion

From the datasets identified through this study and an application of the fitness for purpose criteria, the most suitable dataset to identify grassland change over time is the CEH Land Cover Dataset. Whilst other datasets also identified specific grassland types, this dataset could be used to evaluate coverage across all UK nations using a consistent methodology and is part of a series of datasets which can be used to assess change over time.

3.5 CEH LCM land classification 1990 – 2020 comparison

The findings of the above data review identified the Land Cover Map created by the Centre for Ecology and Hydrology as the most appropriate dataset to identify grassland change because it met all of the fitness for purpose criteria (measure the change in specific grassland types over multiple time periods consistently across the four nations of the UK). The 1990 and 2020 25m datasets were used in the calculation of land cover. Although 10m accuracy was available for the 2020 LCM, the 25m dataset was used for the given the scale of analysis and the resolution available.

For each of the datasets (1990 and 2020), zonal statistics were used to aggregate habitat pixels into either of the four nations. The classification method was the same between datasets so no translation was required.

The resulting data is provided as a spreadsheet in Appendix 1, and summary figures provided below. Where applicable, the results are discussed for each country and compared with the data reviewed in the above section. It is clear that there are considerable discrepancies between LCM data and other data found in this review, such as the Countryside Survey 2007 data, indicating that methodology and definition criteria may be responsible for most of the recorded change, rather than actual grassland extent differences.

3.5.1 UK-wide

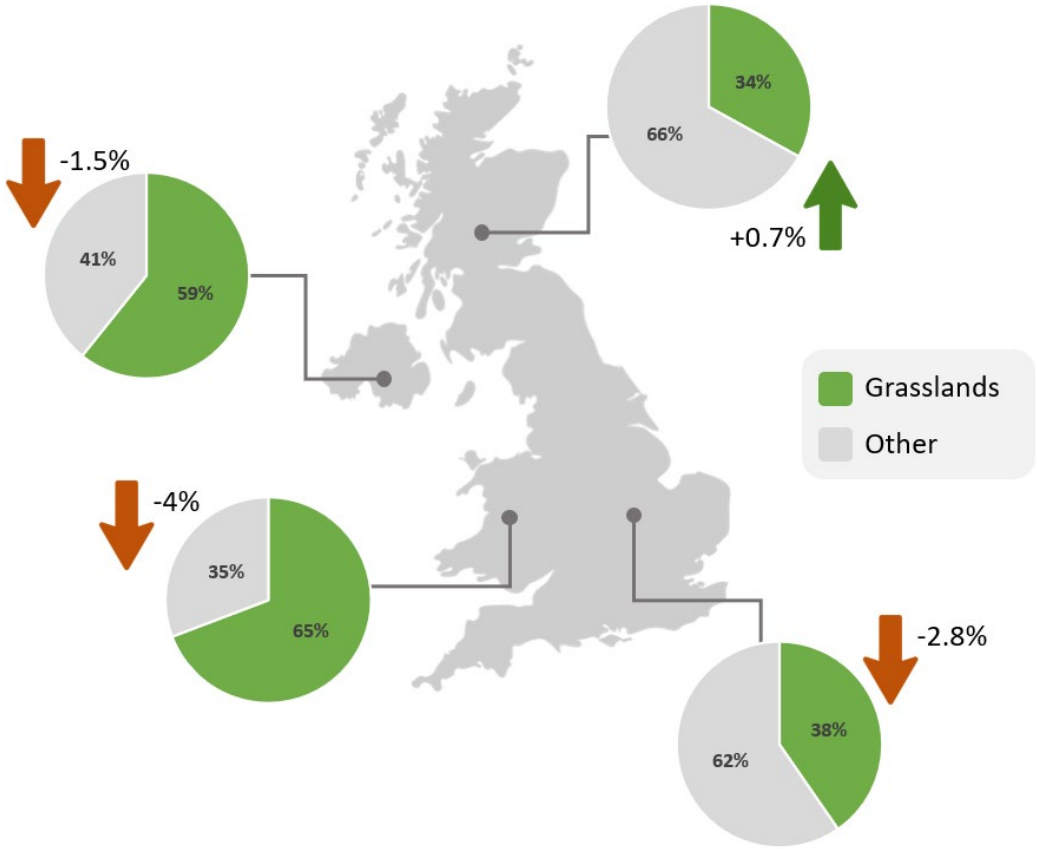
LCM data from 2020 demonstrates that the UK holds around 2.7 million hectares of semi-natural grassland (i.e., broad grassland habitats excluding improved grassland), or around 11% of total land area. Semi-natural grassland in this context was calculated by summing the neutral, calcareous and acid grassland categories in LCM data. The 2011 UK NEA report concluded that around 1% of UK land area (160,000 ha) comprised Priority Habitat semi-natural grasslands, thus demonstrating that the majority of semi-natural grasslands in the UK are not classified as Priority Habitats, e.g., upland acid grasslands. It is therefore important to consider both Priority Habitat and Broad Habitat classifications when examining semi-natural grassland cover, particularly in regards to enhancement of non-priority semi-natural grasslands. Table 3-5 below summarises the statistics for grassland extent in the UK in 2020, separated by improved and semi-natural grassland type and calculated as a proportion of each country's land cover. Figure 3-7 below also summarises the overall change in land cover with respect to grasslands between 1990 and 2020 using LCM data.

Table 3-5:
Land Cover Map 2020 summary data relating to grassland extent in the UK in 2020

	Semi-natural grassland as a proportion of country land cover	Improved grassland as a proportion of country land cover	All grassland as a proportion of country land cover
England	5%	32%	38%
Wales	23%	42%	65%
Scotland	16%	18%	34%
Northern Ireland	20%	39%	59%
United Kingdom	**11%**	**29%**	**40%**

Figure 3-7: Land Cover Map data showing grassland extent change in the UK between 1990 and 2020.

The pie charts are proportion of all grassland types (improved, neutral, acid and calcareous grasslands) versus all other land cover, separated by country, for 1990. The arrows indicate change in grassland extent (again, for all grassland types) by 2020, as a proportion of total land cover separated by country.



3.5.2 England

In England, overall grassland cover declined by approximately 7% from 1990 values, and by 2020 made up nearly 3% less of total land coverage. Reductions were recorded across all broad grassland types excepting acid grassland – the largest being in calcareous grassland at 40% reduction (although there is reason to suggest calcareous grassland has fared poorly in LCM interpretation – see below), followed by a 21% reduction in neutral grassland. Semi-natural grassland extent was measured at 5.4%, or over 700,000 ha, in 2020. The proportions of grassland extent change do not mirror the results found in the Countryside Survey, which found no significant differences in acid and calcareous grassland extent for example, yet found a large increase (12%, or 163,000ha) in neutral grassland cover not recorded in LCM.

3.5.3 Wales

Grassland covers a much larger extent of Wales than England, and is comparable to Northern Ireland with 65% cover in 2020. Semi-natural grassland covers 23.4% of Wales, the vast majority of this comprising acid grassland (21.8% of total area of Wales, or 450,000 ha). Again, the largest decline detected in this period was in calcareous grassland which apparently declined 91% from 600 hectares to 60 hectares between 1990 – 2000. Again, this does not correlate with other published data that shows calcareous grassland covers 12,000 hectares (CS2007, CS1998) in Wales. Similarly to England, acid grassland increased in extent by 11% (from 400,000 to 450,000 ha) and neutral and improved grassland showed declines.

The Countryside Survey 2007 results largely align with LCM data, with 22% of Wales' land area comprising acid and neutral grassland, a similar extent to the LCM semi-natural grassland cover (calcareous grassland has a proportionally smaller extent in Wales). No significant board habitat changes were detected between 1998 and 2007, which does not align with the extent changes detected by LCM.

3.5.4 Northern Ireland

By 2020, grasslands covered nearly 60% of Northern Ireland, down by 1.5% overall from 1990. Notably, very large changes in grassland extent were recorded in Northern Ireland between 1990 – 2020: improved grassland declined by 31% compared to 1990, and neutral and calcareous grasslands increased in extent from 8,300 and 550 ha to 220,000 ha and 14,000ha respectively – this represents nearly a 2500% increase, is clearly several orders of magnitude higher than data recorded for other countries in the UK, and is potentially erroneous – it may relate to retrospective definition changes for example. In addition, Countryside Survey data found a 30% decline in neutral grassland cover was experienced between 1998-2007, in contrast to the LCM recorded increase.

3.5.5 Scotland

Comparable to England, in 2020 Scotland has grassland cover of nearly 34%, with near equal proportions of improved grassland and acid grassland. The LCM 2020 data showed some potentially surprising results for Scotland: neutral grassland was classed as only 2,500ha in extent (<0.1% cover), with 0ha of calcareous grassland recorded in 2020. These were both down from 1990 coverage estimates of 12,000 ha for each type, representing nearly 80% decline for neutral grassland and 100% decline for calcareous grassland. It is suspected that these may be erroneous results. To add to this, from the Countryside Survey in 2007 calcareous grassland was estimated to cover 26,000 ha, representing doubled coverage from 1990 LCM data, and neutral grassland as 461,000 ha (6% of Scotland) in 2007.

3.5.6 Summary

The LCM dataset provides another estimate of semi-natural grassland extent, and its changes in recent decades, for the UK and constituent countries. Comparison with other data types, such as Countryside Survey, has revealed some significant differences, and the factors that should be considered when using LCM data are discussed below:

- Measuring land cover change in the UK is not without difficulty - the quality and quantity of satellite data that underpins land cover maps can be affected by cloud cover, especially in the UK. In addition land cover change in the UK happens at relatively small scales, which makes it fairly difficult to detect.
- Methods have changed over time, including for grasslands between LCM 1990 and LCM 2020. CEH are continuing work on improving their detection and assessment of grasslands, but it is likely that current observed changes in grassland extent (particularly the large changes observed in Northern Ireland, or calcareous grassland in Scotland, for example) are due to method changes rather than on-the-ground change. Change across total grassland extent, rather than changes within grassland categories, may be a more robust assessment of overall change at this time.
- Underlying satellite data has also changed between 1990 – 2020, which results in method alterations. Land use types have been aggregated to measure change, resulting in different sensitivities to particular land class types over time.

CEH anticipate that an updated change data set between 1990 and 2015 with revised methods will be released within the next year. It is recommended that this dataset is examined to explore grassland extent change to update the section above.

4.0 DRIVERS OF GRASSLAND DECLINES

The above review demonstrates that grassland priority habitats have experienced declines across the UK; with significant declines in the early to mid 20th century slowing towards the 21st century. Broad grassland habitats have experienced less severe declines in the past thirty years, with the overall proportion of grassland recorded in the UK remaining stable at around 35-36%. However, the overall statistics hide changes to grassland habitats that occur within the 'net' extent, with some habitat types experiencing large losses and gains in different regions.

Whilst there is evidence to suggest that declines may have slowed in recent decades, a better understanding of the drivers behind the declines is vital, particularly to better inform species-rich, priority habitat grassland creation, restoration or management actions to reverse the trend of decline in extent and condition of our most valuable grasslands for biodiversity.

The literature was consulted to assess if drivers of loss have been identified and studied, and whether these drivers have changed temporally over the last century, whether they differ between grassland types, and whether they differ across the countries of the UK.

Across the UK, after 1945, the main driver of grassland priority habitat loss was due to agricultural intensification and its associated activities (Harris et al, 2014; Bullock et al, 2011; Holmes et al, 2005). In more recent years, drivers such as atmospheric nitrogen deposition (e.g. from slurry spreading), inappropriate management, and fragmentation have continued to push the decline of these grasslands. In the uplands in particular, forestry has been a major driver causing the loss of acid grasslands (Bullock, et al, 2011), whereas the 1990 Countryside Survey also recorded a small proportion of broad grassland types lost to urban development.

The decline in priority grassland habitats is not only due to changes in extent from conversion to other land uses entirely, but also in changes to the condition and quality of those grasslands. Decline in species diversity and assemblages will result in declassification of areas from priority habitats to other grassland types, or from semi-natural to improved grasslands for example. The degree to which grassland areas have been degraded in terms of their condition is important to understand, as it can affect their suitability for restoration. For example, species and soil compositions can be modified to different extents depending on the nature of impacts.

A key driver for the decline in grassland condition is eutrophication arising from agricultural improvement – addition of fertilisers introduces excess nutrients into the soil with compounding implications for grassland species compositions. A study found that in Europe at least ten years are required for the properties of fertilised soils to reach suitable conditions to be considered successfully restored, with even a single application of fertiliser altering species composition, soil nutrients and species richness over decades (Tallowin 2005, Tutushimi et al., 2022).

Another key driver is the reduction in grazing – as low-intensity pastoral farming became more uneconomic during the 20th century, meadows that were abandoned for grazing or hay have declined in condition, reverting to "rank" grasslands that are species poor with little structural diversity. Lowland and upland meadow priority habitats for example, are reliant on yearly seasonal grazing and/or mowing regime, to maintain a biodiverse sward with grasses and herbaceous species. Between 1960 and 2013, 47% of semi-natural grasslands were lost, largely attributed to agricultural intensification as well as abandonment of remaining semi-natural grassland areas, and the decline continues in some areas.

The socioeconomic drivers behind this abandonment relate to the drive for higher production on our land. For example, a drive towards increasing the supply of dairy produce in the 20th century resulted in intensive single-product farms with the subsequent decline of mixed-use farms that previously contained arable, pasture and hay meadow land coverage in the Peak District, although this trend is mirrored across the country. Artificial fertiliser development concurrently assisted the conversion of land to improved, high-productivity grassland at the expense of meadows and semi-natural grassland habitats.

Figure 4-1: Neglect or inappropriate management can reduce the quality of grasslands, such as this tussocky meadow.

In Wales and England, drainage and ploughing in particular, activities associated with agricultural intensification, are cited as drivers of decline between 1930 to 1984. However, inorganic fertiliser use had increased at the same time, and were estimated to have affected 85% of grasslands particularly in lowland swards during this time. (Fuller 1987).

In Wales specifically, drainage, ploughing and fertiliser use continued to convert semi-natural grasslands into agriculturally improved grasslands into the 1990s; from 1996 to 2013, undermanagement, arable cultivation, and continued agricultural improvement contributed to the grassland decline (NRW, 2016). Buckingham et al (2002) reported that intensive farming (though fertiliser use, re-seeding, overgrazing and draining) was the main cause of grassland loss in Wales in the second half of the 20th century, and continued to be the cause of loss at the time of the report.

The trend is mirrored in England, where lowland semi-natural grasslands were ploughed, drained and fertilised for cultivation either for conversion to arable agriculture or for re-seeding as productive leys (Holmes et al, 2005). On a selection of nearly 2000 sites surveyed between 1960 and 1981 and compared with spatial habitat datasets from 2007 and 2013, it was found that of sites where grassland was lost, 45% was converted to improved grassland, with 43% lost to arable cultivation and the remaining proportions lost to woodland and urban land types. (Ridding et al, 2015).

Similarly, results from Northern Ireland's Countryside Survey attributed grassland declines to agricultural conversion (58% by 1997) and ryegrass (28%), as well as transformation to semi-natural woodland and scrub. In Scotland however, despite sparse literature cover for grassland loss drivers, those identified include over- and undergrazing, eutrophication and localised pollution (Bullock, 2011) as opposed to agricultural conversion.

It is clear that throughout the 20th century and across the UK, conversion of semi-natural grasslands to improved grasslands for agricultural production was the main driver behind the extensive declines. However, more recently, additional drivers including pollution, abandonment, inappropriate management and fragmentation have been identified that are likely to continue to contribute to grassland decline even in the absence of land use conversion drivers.

5.0 SUMMARY

Using available data, semi-natural grasslands have been found to comprise 11% of UK land cover, or approximately 2.7 million hectares (LCM, 2020). However, less than 1%, or 160,000 hectares, of UK land cover comprises high-quality grasslands that meet Priority Habitat designation (UK NEA, 2011). Between 1990 - 2007, coverage of some priority habitat grasslands has declined, such as lowland meadows across the UK and particularly in Scotland and Northern Ireland (Countryside Survey, 2007), and others have increased, such as lowland acid grassland in Wales. Similarly the picture of broad grassland habitat extent change is not clear, with neutral grassland coverage improving across the UK apart from in Northern Ireland, which experienced large declines (NI Countryside Survey, 2007).

It is clear from the review of the grassland statistics that are readily available for each UK nation that the blurred boundaries between habitat classifications, the absence of habitat condition data and the lack of a consistent baseline or long-term monitoring programme that it is almost impossible to produce reliable figures to justify the current quantification of the decline in area and quality of grasslands in the UK. There is no doubt that large declines have occurred, but characterising these in a common language is extremely difficult.

Numerous drivers for decline have been identified. Key to grassland decline through the 20th century was the development of artificial fertilisers, which combined with increased pressure for productive land drove the conversion of semi-natural grasslands into improved grasslands, or resulted in the abandonment of traditional management of pastures and hay meadows. Recent drivers include pollution (including the long-lasting effects of fertiliser application on restored sites), ongoing abandonment and fragmentation of semi-natural grassland habitats.

This review has revealed a number of data gaps, research directions and topics for further study in relation to gaining a better understanding of semi-natural grasslands and their changing coverage in recent decades. A few of these options are outlined below:

- It is recommended that a consistent approach to monitoring vegetation in the future is commenced, based upon clearly defined set of criteria. There is considerable potential for using Earth Observation (EO) for monitoring future land use change and there is probably some benefit in reviewing the quality and extent of historical EO datasets to see if they have value in characterising more recent habitat losses and changes in habitat condition. If EO, perhaps combined with systematic ground-truth surveys such as UKCEH's Countryside Survey, can provide high quality and consistent data sets, the long-term monitoring of the change in status of grasslands should become more straightforward.
- It is recommended that a working definition of ancient and long-established grasslands is agreed with major stakeholders in the near future to ensure that those remnants of old grasslands are protected from further harm and, wherever possible, are used to target habitat creation to create a network of high conservation value grasslands that is bigger, better and more joined up. The importance of soil structure, microfauna and field survey techniques for understanding the differences between ancient grasslands and restored or newly created grasslands could also be researched.

6.0 GLOSSARY[4]

Term	Definition	Source
Permanent	Grasslands established for more than 60 years	Fuller, 1987
Temporary	Land that has been in grass or other herbaceous forage for less than 5 years	Scottish Government (2018), Woodland Trust
Grassland	Areas with variable vegetation cover and not on waterlogged soils. Vegetation is at least 75% herbaceous (grasses, sedges, rushes, ferns, forbs) rather than woody, with salt-tolerant species absent or occasional.	UKHab, 2023
Calcareous grassland	Consists of vegetation on dry ground with scattered sedges and many calcicoles present. Found on basic soils (ie. pH>6.5).	Countryside survey (CSS), 2007
Acid Grassland	Grasslands occurring on acidic soil (ie. pH<5.5).	CSS, 2007
Purple moor grass and rush pastures	Grasslands occurring in lowland areas, on poorly drained, typically acidic soils in areas of high rainfall. The vegetation comprises types of fen meadow and rush pasture.	CSS, 2007
Neutral Grassland	Occurs on soils with a pH between 5.5 and 6.5 (ie. neither acidic or lime-rich). Includes all semi-improved and unimproved grassland on neutral soil, as well as enclosed and managed grassland such as pastures, a range of wet grasslands where the vegetation is dominated by grasses, sown grassland strips alongside arable fields, long-term set-aside or fallow land and tall unmanaged grasslands. It does not include improved species-poor grassland.	CSS, 2007
Semi-improved Grassland	Semi-improved grassland is a transition category made up of grasslands which have been modified by artificial fertilisers, slurry, intensive grazing, herbicides or drainage, and consequently have a range of species which is less diverse and natural than unimproved grasslands.	JNCC, 2016

[4] Glossary of regularly used terms in the report. Where available, a source for the definition is provided.

Term	Definition	Source
Improved Grassland	Species poor, grass dominated swards occurring on all soil types that have been either sown, or created by modification of unimproved grassland by fertilisers and selective herbicides, for agricultural or recreational purposes. It includes grassland that has been reseeded for more than one year. Improved grassland is synonymous with Modified Grassland (see below)	JNCC, 1999
Modified Grassland	Species poor (<9sp/m2) vegetation dominated by a few fast-growing grasses on fertile, neutral soils. It is frequently characterised by rye-grasses (Lolium spp.).	UKHab v2, 2023
Unimproved Grassland	Unimproved grasslands may be rank and neglected, mown or grazed. They may have been treated with low levels of farmyard manure, but should not have had sufficient applications of fertiliser or herbicide, or have been so intensively grazed or drained, as to alter the sward composition significantly. Species diversity is often high, with species characteristic of the area and the soils and with a very low percentage of agricultural species.	JNCC, 2016
Pasture	Land managed via grazing, typically but not exclusively referring to permanent pasture.	
Wildflower Meadow	Area of permanent grass where wildflowers grow. Wildflower meadows grow better on unproductive soil, where vigorous grasses don't out-compete the flowers.	
Semi-natural Grassland	Comprise acid, neutral, and calcareous grassland broad habitats, as well as purple moor-grass and rush pasture. Distinct from improved grassland by lack of recent cultivation, re-sowing or heavy fertilisation. A mixture of grasses and herbaceous plants, along with sedges, rushes, mosses and other low-growing species, often created by low-intensity, traditional farming or natural vegetation on poor soils or in	Bullock, et al., 2011 SoNaRR Welsh report 2016, taken from NEA

Term	Definition	Source
	exposed locations. They often contain a rich variety of grasses and herbs.	
Long-continuity habitat -grassland	Grassland that is likely to have been the same habitat since 1936 and subject to similar human management.	UKHab, 2023
Ancient Grassland	A semi-natural plant community maintained as grassland since 1840, on a site with no history of arable management or agricultural improvement since 1840 in any of the currently available land-use datasets	Inside Ecology, 2018 referencing Redhead et al. (2013)
Species-rich Grassland	Grasslands comprising rich variety of grasses and herbs. Species rich grasslands have a high diversity of native wildflowers and grasses, which have co-evolved with traditional farming techniques over the last 6000 years.	Bullock, et al., 2011 NatureScot, 2021
Amenity Grassland	Highly managed, species-poor grasslands	Bullock, et al., 2011
Hay Meadow	A type of neutral grassland; grasslands that are left to grow over the spring and summer and are cut for hay.	Plantlife
Leys	Temporary grass or legumes sown in rotation, with grain or other crops, usually as a soil conservation measure.	UKHab, 2023

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APPENDIX 01:

CEH LCM 1990, 2020 25m datasets

(provided in separate Excel spreadsheet)

APPENDIX 02:

Summary of data sources

(provided in separate Excel spreadsheet)

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