DISCUSSION PAPER ON ANCIENT GRASSLANDS

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1. SCOPE

The British Ecological Society (BES) was commissioned by Plantlife to develop a practical definition of the term ‘ancient grasslands’ that can be used to help identify and protect grasslands of high nature conservation value more effectively. The definition is intended to provide a tool for the identification of ancient grassland sites and to allow Plantlife, other NGOs, and statutory bodies to advocate for stronger legal protection and better support for conserving and managing these grasslands throughout England, Scotland, and Wales. The creation of such a definition arrives within the context of National Policy and Planning Frameworks and recent legislating relating to ‘Irreplaceable Habitats’.

The scope of the project is as follows:

- Summarise existing literature on ancient grasslands and their characteristics.
- Develop a draft definition(s) of ‘ancient grasslands’ and associated identification methodology.
- Undertake expert consultation on the above, to refine the definition(s) and methodology and consider their strengths and weaknesses.
- Present a discussion of the potential legal protections that could be applied to ‘ancient grasslands’, potential negative impacts on grasslands excluded from the definition, and possible compromises or limitations associated with different approaches to the definition(s).

This discussion paper sets out the results of the literature review and presents a recommended definition of ‘ancient grasslands’ and associated methodology along with a discussion of its strengths and weaknesses, potential legal protections, and possible impacts of such a definition on other grassland types. A summary of the consultation responses is provided, with a record of opposing schools of thought where these arose. Finally, recommendations for next steps are made including suggestions for future research which could help strengthen the methodology and fill knowledge gaps identified during the literature review and consultation process.

2. INTRODUCTION

In the context of the climate and biodiversity crisis and the urgent need for nature recovery, grasslands have a lot to offer. Yet their potential contributions to ecosystem services delivery and nature-based solutions to climate change are under-valued in planning and policy frameworks. Furthermore, their potential for carbon storage and sequestration is typically overshadowed by woodlands and peatlands. Threats to grasslands posed by their perceived low biodiversity value relative to other habitats (Anderson, 2021) are compounded by a widespread false belief that they sequester little carbon. In some undisturbed grassland soils, even if plant diversity has been reduced by overgrazing, carbon stocks can be comparable to woodlands (Upson et al., 2016) and afforestation may even lead to carbon loss in certain systems (Friggens et al., 2020; Poeplau et al., 2011). This misconception, widespread amongst policymakers, adds urgency to the need to define ancient grassland habitats not only as reservoirs of important biodiversity but also sequestered carbon.

The variability of British grasslands makes them challenging for policymakers to consider when making decisions about land use change. One of the main difficulties is confusion over the various definitions of grasslands considered to be of high value from a biodiversity and nature conservation perspective. A plethora of terms have been applied to such grasslands in the past, including labels such as ‘agricultural’, ‘semi-natural’ and ‘unimproved’, which can be misinterpreted by members of the public and professionals in the planning system without an ecological or land management background. Meanwhile, the origin and value of woodlands labelled as ‘ancient’ is much less equivocal, and it is therefore understandable the conservation of such landscapes resonates strongly with the public.

In the case of woodland, conferring the label ‘ancient’ hinges on a demonstration that ‘the area has been wooded continuously since at least 1600 AD’ even if the trees have been cleared repeatedly in the subsequent four centuries. Whilst somewhat arbitrary, this temporal threshold seems to provide a good proxy for woods that have retained much of their medieval biodiversity value and the associated benefits from an ecosystem perspective. Lists of species strongly associated with these ancient woods (Ancient Woodland Indicators or AWIs) have been developed from surveys of sites of known age and have been used widely to identify ancient woodland stands.

The focus of this discussion paper is to develop a parallel approach for grasslands. Three immediate issues arise:

1. The documented history, and the mapping of grassland is less comprehensive than that for woodland. Whilst some valuable resources, such as tithe maps, are available for much of the country, only some grassland types are included on them and they only provide snapshots, and so could miss periods of more intensive agricultural management?

2. Whether the 400-year threshold applied to woodland is feasible for grassland is debatable. Whilst some current stands of grassland can be traced through the documentary records back to the Domesday Book, potentially older than some ‘ancient woodland,’ do they need to be 400 or more years old to have assembled a suite of species indicative of antiquity?

3. Most grassland habitats of current high nature-value are known to have experienced one or more periods of anthropogenic disturbance in the last 200 years, and so is the continuity criterion appropriate? Like woodlands, should the definition allow for

periods of more intensive human use, such as ploughing for crops followed by abandonment?

The term ‘ancient grassland’ is already in use amongst British ecologists and conservationists as a proxy for grasslands of high biodiversity value (e.g. Buisson et al., 2022, Feurdean et al., 2018). However, the label has not yet been clearly defined in the context of the UK planning system and therefore it cannot currently be used in an analogous way to ‘ancient woodland.’

In comparison, the term ancient woodland is clearly defined in planning guidance (Natural England and Forestry Commission, 2022) and ancient woodlands are afforded protection as an ‘irreplaceable habitat’ under planning policy frameworks for England, Wales, and Scotland which state that development affecting such habitats should be refused other than in ‘wholly exceptional circumstances’ such as nationally significant infrastructure projects.

The consultation exercise undertaken as part of the development of this discussion paper aimed to consider the options for providing a clear and workable definition for ‘ancient grassland’ from a British perspective. Existing uses of the term were investigated and are summarised in the literature review below. Some are based on the documented history of sites, as discussed above, whilst others use surrogates for age. The paper considers how to frame a definition(s) that could be used by both the planning system and rural policymakers, and furthermore to suggest practical methods by which to assess extant grassland to confer the label.

3. LITERATURE REVIEW

Existing uses of the term 'ancient grassland' and synonyms

Ancient/old grassland

Various studies use the terms 'ancient' or 'old' grassland, typically defined by an age class either driven by practical limitations of determining land-use history e.g. availability of historic maps (e.g. Pornon & Andalo, 2023; Löfgren et al.; 2020; Walker, 2000; Karlík & Poschlod, 2014, 2019; Schmid et al., 2017, Redhead et al., 2014), statistical analyses (Wagner et al., 2019), or stated without elaborating on the rationale (Albert et al., 2021; Fagan et al., 2008; Phoenix et al., 2008). Ages associated with these terms vary from 100 years to several centuries, or are, in some cases, undefined. All classifications imply long periods of extensive management/lack of disturbance, albeit with many sites having experienced short periods of cultivation at some point in their history (Wagner et al., 2019).

Martin Allen has proposed the following definition: "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." (Allen, M. (n.d.)).

'Old growth' or 'primary' grassland

Recent papers have argued for an 'old growth' concept for grassland like that used for woodland, which recognises grasslands as pre-agricultural relicts rather than anthropogenically arrested successional or secondary habitats (Nerlekar & Veldman, 2020; Poschlod and Wallis deVries, 2002; Feurdean et al., 2018; Veldman et al., 2015). This is perhaps less relevant to the UK, where virtually all grasslands with conditions suitable for tree establishment are managed for livestock or mown and are therefore considered to be semi-natural (López-Dóriga, 2024; Peterken, 2009; Mitchell, 2005), but 'old growth' characteristics such as species-richness, diversity, evenness, occurrence of long-lived perennial and stress-tolerant plant species, diverse underground structures, and high carbon storage may be of use in developing a definition of ancient grassland, as some of these can be of relevance in identifying older semi-natural grasslands (Pornon & Andalo, 2023).

Research on characteristics of 'ancient' grasslands relevant to potential definitions and methods of identification

Vascular plants

Chronosequencing studies have identified species restricted to old calcareous grasslands (>100 years) (e.g., Pornon and Andalo, 2023; Wagner et al., 2019; Redhead et al., 2014; Gibson and Brown, 1991) and 'indicators of long continuity' have been suggested for the MG5 NVC community (Natural England, 2013) and more generally for lowland calcareous grasslands (Table 13 in Porley, 1988) (see Annex 1). Natural England are due to publish work on chronosequencing of grasslands in 2024 (Katey Stephen, pers. comm). However, overall cover or summed frequency of indicator species has been shown to be a more reliable indicator of grassland age than species number (Wagner et al., 2019).

Several studies indicate a positive correlation between grassland age and occurrence of stress-tolerant species, as opposed to ruderal or competitive species (e.g., Nerlekar and Veldman, 2020; Wagner et al., 2019; Redhead et al., 2014b; Gibson and Brown, 1991b). This concept has been used to assess restoration success in floodplain meadows (Rothero et al., 2020). In addition, unpublished surveys have shown that extreme stress-tolerators such as *Pulsatilla vulgaris* have yet to recolonise chalk grassland ploughed briefly in the 1950s even though they occur only a few metres away on the adjacent Knocking Hoe National Nature Reserve in Bedfordshire (Kevin Walker, pers. obs.).

High α diversity, community evenness, and low β diversity are associated with older semi-natural grasslands (Pornon and Andalo, 2023) and several studies suggest that whilst species richness can recover relatively quickly, restored grasslands may take decades (>60 years) to recover to near natural species composition and functional traits (e.g., Buisson et al., 2022; Nerlekar and Veldman, 2020; Redhead et al., 2014; Woodcock et al., 2011; Fagan et al., 2008; Hirst et al., 2005). However, in cases of short duration disturbance, such as past peaks in agricultural production where grasslands were ploughed and later reverted to pasture (e.g. 1790-1815, 1940-1950), these differences can be difficult to detect, and other methods may be needed to date grasslands accurately (Wagner et al., 2019). Seed banks can reflect land use history over long periods, with the seeds of some ruderal species (associated with cultivation) persisting for over 150 years (Karlík & Poschlod, 2014).

Grassland fungi

CHEGD fungi (waxcaps and allies)[1] are typically associated with undisturbed, low nutrient status grasslands (Griffith et al., 2004; Feehan and McHugh, 1992). IUCN assess that several of the species found in the UK face high extinction threat (Annex1). However, given the biomass of these fungi is predominantly underground, the high weather-dependence of fungal fruiting (Griffith et al., 2013), inhibition of fruiting by long swards (Griffith et al., 2013) and lack of suitably experienced surveyors make effective assessment of diversity via fruit body surveys challenging. There are long-lived perennials, often not fruiting every year so potentially requiring several years of surveying is required (Newton et al., 2003).

Vascular plant richness is often a poor proxy for CHEGD diversity (Holden, 2013; Öster, 2008), in part because many pastures where these fungi fruit prolifically have reduced diversity due to heavy grazing that does not damage the underground fungal structures. Some larger, very long-lived CHEGD fungi are useful indicators of grassland age e.g. *Hygrocybe punicea*, now dominant in the control plots of the long-running Park Grass field site at Rothamsted Research (last ploughed in ca. 1815). However, this obvious species was absent when the site was surveyed in 1874 suggesting that it takes >60 years, and possibly up to 150 years, to reach maturity (Gareth Griffith, pers. obs).

[1] CHEGD grasslands are those that are rich in grassland fungi including the following groups: C (Clavariaceae [fairy clubs]): *Camarophyllopsis*, *Clavaria*, *Clavulinopsis*, *Hodophilus Lamelloclavaria*, *Ramariopsis*; H (Hygrophoraceae): *Cuphophyllus*, *Gliophorus*, *Gloioxanthomyces*, *Hygrocybe*, *Neohygrocybe*, *Porpolomopsis*; E (Entolomataceae): *Clitopilus*, *Entoloma*; G (Geoglossoid fungi): *Geoglossum*, *Glutinoglossum*, *Microglossum*, *Sabuloglossum*, *Trichoglossum*; D (Dermoloma etc): *Dermoloma*, *Pseudotricholoma*.

Recent use of soil eDNA to analyse fungal populations via metabarcoding (Detheridge & Griffith, 2021), which assesses mycelial abundance, has revealed that CHEGD are the dominant soil fungi in many undisturbed grasslands (often >50% total fungal biomass). This approach avoids the problems caused by the vagaries of fungal fruiting and provides accurate identification via the curated UNITE ITS2 database (https://unite.ut.ee/; Koljalg et al., 2013). Such analyses can be conducted at any time of year and can also identify the plants present via DNA present in roots, seeds or litter (Clasen et al., 2022). However, from a species conservation perspective where the presence/abundance of mature individuals is a key factor, it is not possible to determine from eDNA whether any mycelia detected are fertile.

Use of soil eDNA analysis has hitherto mainly focused on acidic soils in the upland fringes, driven by the need for urgent fungal biodiversity assessment, for example for grasslands targeted for tree planting where ecological surveys have generally failed to consider fungal conservation value. However, it would be useful to deploy this approach in different British grassland types to determine whether CHEGD fungi are a consistent feature of undisturbed grasslands more broadly. The fact that outside Europe CHEGD fruit bodies are more commonly found in (non-ectomycorrhizal) woodland habitats suggests that they can inhabit a broad range of soil types (Halbwachs et al., 2018).

Invertebrates

Invertebrates such as coleoptera can indicate environmental change over time (Woodcock et al., 2005; Brown and Hyman, 1986) and could potentially be used as a measure of grassland age. For example, beetle assemblages in restored floodplain meadows were shown to differ from those of long-established grasslands (Woodcock et al., 2006, 2008) and restoration of plant communities does not necessarily correspond with recolonisation of invertebrates, which may be due to factors including dispersal mechanisms, isolation of restoration sites, or microclimate (Woodcock et al., 2010, 2012; Knop et al., 2011). Ant hills have also been successfully used to predict age in calcareous grasslands (King, 1981, King & Timothy King, 2021), although this may not be a useful approach in mown grasslands.

As with fungi, lack of taxonomic expertise has hindered full appreciation of the biodiversity of grassland invertebrates. Many of these species spend most of their lives in soil (and the least known e.g. collembolans, all their lives), eDNA approaches above can be used for invertebrate taxa but are still being tested for some groups (Kirse et al, 2021). A further parallel with fungi is that whilst long-term overgrazing damages plant biodiversity, the presence of diverse soil fungal/insect populations is indicative of a healthy, undisturbed soil ecosystem, and could potentially be used to identify sites with high restoration potential.

Soil properties

Correlation between low soil phosphorus and mineral nitrogen and older grasslands is well established in the literature (Löfgren et al., 2020; Karlík and Poschlod, 2019; Schmid et al., 2017; Jaunatre et al., 2016; Fagan et al., 2008). High fungal biomass and fungal to bacterial biomass ratios have also been shown to be associated with unimproved/low input grasslands across a representative range of grassland types and regions in England (e.g., Smith et al., 2008; Bardgett et al., 2007; Bardgett and McAlister, 1999). Ellenberg N values have been shown to correlate with both nutrient levels and grassland age and could be useful as a proxy without the requirement for soil sampling (Löfgren et al., 2020; Schmid et al., 2017; Walker et al., 2004).

Undisturbed grasslands accumulate organic matter which can be dated via radiocarbon analysis, with the thermonuclear ‘bomb radiocarbon’ peak of the 1960s permitting high dating resolution for atmospheric CO_2 fixed into soils by plants over the past ca. 70 years (Leifeld et al., 2009).

4. CONSULTATION RESPONSES

Twenty-two expert consultees including representatives from government bodies, learned societies, expert ecologists, taxon specialists, and archaeologists, provided comments on an initial draft of this paper and attended a workshop to discuss and refine the definition(s) of 'Ancient Grasslands' and identification methodology. This section summarises the main points raised during the consultation process. A list of consultees is provided in Annex 2.

Rationale, aims, and scope of the project

The most extensive discussion centred around the need for and overall aims of the project, and the scope of the definition(s). All consultees agreed that grasslands in general require more protection given some types are falling through the cracks of existing policy and legislative frameworks and are at risk of loss, for example CHEGD grasslands in areas targeted for tree planting. However, there was concern that defining 'Ancient Grasslands' could create an implicit assumption that age is a proxy for nature conservation value, which carries a risk of inadvertently devaluing younger but equally valuable semi-natural grassland types. A related point was the potential circularity of using biology to define ancientness but also using 'ancient' to define biological value, which may be open to challenge in planning cases.

There was discussion around the need for a broader definition(s), encompassing all grasslands of nature conservation value, with 'ancient grasslands' as a subset, although there was recognition that this could cause confusion with existing terms e.g., priority grasslands. Another approach suggested a scope based on a continuum of age/disturbance which recognises the different disturbance histories in upland and lowland grasslands. Several consultees proposed degraded older grasslands with restoration potential should also be included, for example those with relatively undisturbed soil structure or other abiotic factors. A suggestion that the definition(s) should be flexible enough to allow long-established species assemblages to change in response to future warming and consider ecological functions as well as features was also put forward.

Other consultees felt that there is appetite within the sector for 'ancient grasslands' to be recognised, and a narrower definition would have advocacy value to drive sorely needed public recognition and policy action. The example of ancient woodlands was given, which benefits from a presumption towards retention and protection based on the premise that they are irreplaceable due to their age, which is a simple and effective message for advocacy purposes.

The concept of irreplaceability was discussed, both in relation to the planned consultation on 'irreplaceable habitats' for Biodiversity Net Gain (BNG) in England, which was seen as an opportunity for increased legal protection, and more generally around the differences between older and younger grasslands and how this relates to potential additional value and the rationale for additional protection. It was suggested that the link with irreplaceability is less obvious for grasslands, and the prevailing view that they can be easily recreated puts them at risk from land use change.

Whilst it was recognised that some younger grasslands are of high nature conservation value, several consultees noted that older grasslands have cultural value which should not be overlooked, and as more is understood about features such as soil biota, within-species genetic diversity, less well studied groups e.g., fungi, bryophytes, and invertebrates, and networks of interactions between groups of taxa, it is clear that these cannot be recreated in a short timeframe, if at all, and most consultees agreed that time should therefore be a key factor in the definition(s).

Format of definition

It was agreed that a single definition with multiple, adaptable criteria would be the most practical approach to defining 'ancient grasslands' as such a format would avoid difficulties of implementation in planning contexts and could cover the complexity and variability of grasslands whilst accounting for inevitable gaps in data availability. This would allow for a range of factors to be considered and 'ancient grassland' status to be conferred based on the balance of available evidence for individual grassland sites.

Consultees were asked to consider if the definition should be something entirely new or look to update/adapt existing methods of evaluation e.g., the Ratcliffe criteria (Ratcliffe, 1997). Whilst no consensus was reached, consultees were generally positive about the Ratcliffe criteria, and considered them to be useful and flexible. Limitations raised were that they are not climate change proof and focus on above ground features, and the inclusion of soil properties and fungi were suggested as a potential focus for updating them. It was suggested that updating the existing CIEEM guidelines (CIEEM, 2018) to include new research areas and capture overlooked grassland types would avoid confusion with existing terms and provide a way for consultant ecologists to apply the definition of 'ancient grasslands' in their work.

Potential criteria

Based on the literature review, the draft discussion paper proposed a series of criteria for assessing grasslands as ancient. These included set ages, species assemblages, abiotic factors including soil properties, and historical or cultural context.

There was consensus that a purely time-based definition like that of ancient woodland is unlikely to be practical or robust given the much weaker documentary evidence for grassland presence and continuity. The general view was that most, if not all, of the criteria proposed should be included as part of a 'tick list' to assess the overall balance of evidence for the age of individual grasslands, with no criterion being strong enough to stand alone.

Most consultees were broadly supportive of the use of indicator species, but several advised against over-reliance on one taxonomic group. There was acknowledgement that tailored lists of species reflecting both grassland types and regional variation are needed, which requires further research for most taxonomic groups under consideration.

Various additional criteria were suggested, including landscape context, archaeological/paleoenvironmental evidence, organic carbon content, bryophyte, lichen, and invertebrate assemblages, the presence of anthills, and more broadly consideration of the ecological processes required for long established grasslands in certain contexts to function normally e.g., hydrology.

Evidence gaps

The consultation process identified multiple areas where further research could increase the robustness of the criteria used to define ancient grassland or strengthen the rationale for the definition itself. These included:

- Soil organic carbon as a measure of age for different grassland types/regions
- Carbon sequestration and cycling for different grassland types and ages.
- The effect of disturbance events (e.g. short duration/shallow ploughing) on soil biology and structure.
- The utility of indicator species lists (which could be badged as ‘ancient grassland indicators’, like those used for woodland).
- The feasibility of specifying a fungal community indicative of restoration potential in old but degraded grasslands.
- Soil invertebrate assemblages/indicator species as a measure of age for different grassland types/regions and structures (potentially including palaeoecological evidence such as mollusc shells).
- Chronosequencing of vascular plant indicator species for non-calcareous grasslands and north/west regions.
- Chronosequencing of bryophyte and lichen indicator species for different grassland types/regions.
- Soil microbial communities and networks as a measure of grassland age.
- Relationships between different taxon groups and potential for proxies as a measure of age for different grassland types/regions.

Key areas of difference

The key areas of differing opinion were around the aims of the project and scope of the definition(s) as detailed above. However, several other areas arose during the consultation, and these are summarised below.

Age

What might constitute an appropriate cut-off date/age for defining ‘ancient grasslands’ drew differing opinions from the consultees. Some proposals aligned with the various sea changes in land use history/periods of widespread agricultural intensification e.g., pre-agriculture, enclosure, the industrial/agricultural revolution, WW1 and WW2. Others related to the practical limitations of availability and coverage of historical land use datasets, were based on data from existing chronosequencing studies, or were driven by a recommendation to align with separate, ongoing work on defining irreplaceable habitats.

The impact of disturbance and land use change

Discussion around soil properties and other characteristics resulted in a debate as to what types, level, and duration of disturbance or land use change (including temporary abandonment) grasslands can undergo and still retain or recover sufficient features and ecological functions to be considered ‘ancient’. Some consultees suggested no history of arable management would be acceptable, whilst others felt that most grasslands would have had varying levels of disturbance in their histories and applying a very strict criterion in this respect would risk excluding many valuable grasslands from the definition.

Terminology

Some consultees questioned whether ‘ancient grasslands’ is the appropriate term, given this could stretch back to the Bronze age, and suggested alternatives including ‘irreplaceable’, ‘old’, ‘long-established’ and ‘traditional’. Others suggested the term is already embedded in the sector and in public understanding and is likely to be used by policymakers because it is evocative and can be referred to quickly in planning contexts.

5. PROPOSED DEFINITIONS & METHODOLOGY

Proposed definitions

The literature review and consultation process highlighted the need for a clear and unambiguous definition of 'ancient grasslands' with time as a key factor. However, balancing this with the range and complexity of grasslands, particularly with respect to varying levels of anthropogenic disturbance and nature conservation value, is challenging. Documentary evidence of grassland presence and continuity is much weaker than that for woodland, the oldest readily available dataset with sufficient detail and coverage to determine land use for all areas of England, Scotland, and Wales being the Land Utilisation Survey of Great Britain (Stamp, 1934), dating back 86-93 years.

The approach proposed is a concise, time-based definition based on the available land use datasets, supported by a range of different criteria, detailed in the methodology, which could be used to gather evidence for the likely age and continuity of specific sites. Three options are proposed below, along with their associated advantages and disadvantages. Given the extensive discussion on the scope of the definition(s) that arose from the consultation process, consideration could be given to using either a single option, or to nesting two or more as different categories within an overarching dentition (as for ancient woodland) to encompass a continuum of ages. A fourth option, covering degraded grassland with potential for restoration is also proposed.

Option 1

> ***"Semi-natural grasslands that have remained relatively unmodified by agricultural intensification or land use change for at least 170 years (or 140 years in Scotland)"***
>
> Advantages:
>
> - Broadly overlaps with the end of the British industrial/agricultural revolutions & enclosure, and likely to correspond to public perception of 'ancient' which may be an advantage for advocacy.
> - Time period covered by Tithe maps in England and Wales and First Edition OS maps in Scotland.
> - Encompassed by the threshold set for habitats to be considered 'Irreplaceable' in ongoing work by Natural England and CIEEM, on the basis that creation or restoration of fully functional examples is unlikely/impossible within 100 years (Craig Llewellyn, per. comm).
>
> Disadvantages:
>
> - Tithe maps unavailable for Scotland and First Edition OS maps do not differentiate between meadow/pasture and arable land.
> - Excludes grasslands of high nature conservation value temporarily ploughed in WW1 & WW2, and younger grasslands with good CHEGD scores.

Option 2

"Semi-natural grasslands that have remained relatively unmodified by agricultural intensification or land use change for at least 100 years".

Advantages:

- Based on evidence from several studies on restoration timescales of vascular plant grassland communities following disturbance.
- Time period covered by Tithe maps in England and Wales and First Edition OS maps in Scotland.
- The round number is easy to remember and consistent across nations, which may be an advantage for advocacy.
- Aligns with the threshold set for habitats to be considered 'Irreplaceable' in ongoing work by Natural England and CIEEM, on the basis that creation or restoration of fully functional examples is unlikely/impossible within 100 years (Craig Llewellyn, per. comm).

Disadvantages:

- Tithe maps unavailable for Scotland and First Edition OS maps do not differentiate between meadow/pasture and arable land.
- May be considered 'old' rather than ancient by policy makers/the public.
- Excludes grasslands of high nature conservation value temporarily ploughed in WW2, and younger grasslands with good CHEGD scores

Option 3

"Semi-natural grasslands that have remained relatively unmodified by agricultural intensification or land use change since before WW2."

Advantages:

- Broadly aligns with the end of pre-industrial agriculture, easy to remember and consistent across nations, which may be an advantage for advocacy
- Dudley Stamp maps provide comprehensive cover of pre-war land use information across the nations.
- Would encompass grasslands of high nature conservation value temporarily ploughed in WW1 and younger grasslands with good CHEGD scores.

Disadvantages:

- Less likely to correspond to public perception of 'Ancient' (a less evocative term such as 'long-established grasslands' may be more appropriate).
- May be considered too broad a definition
- Would exclude grasslands of high nature conservation value temporarily ploughed in WW2 & younger grasslands with good CHEGD scores.
- Would fall outside the threshold set for habitats to be considered 'Irreplaceable' in ongoing work by Natural England and CIEEM, on the basis that creation or

restoration of fully functional examples is unlikely/impossible within 100 years (Craig Llewellyn, per. comm).

Option 4 (ancient grassland with potential for restoration)

> ***"Semi-natural grasslands that have been subject to some level of agricultural modification but have remained undeveloped for at least (x) years and retained some attributes of ancient/undisturbed grassland."***

The term 'relatively unmodified' captures the extent to which vegetation and soils have been modified by agricultural activities or land use change. The assumption is that ancient grasslands will have maintained their original complement of above-ground species as well as soil structure, chemistry, and biota whereas these will have been highly modified in 'agriculturally improved' grasslands. Key agricultural management activities likely to have brought about significant change will be the depth, frequency and duration of ploughing, repeated reseeding with forage varieties in pasture, and the repeated application of inorganic fertilisers on both pastures and arable land. These will vary in their impacts depending on soil and therefore grassland type and further research is needed to quantify the rates of re-assembly of abiotic and biotic features across a range of conditions.

Proposed identification methodology

The literature review and consultation evaluated a range of potential criteria for assessing grasslands as 'ancient'. No criterion was considered robust or developed enough to provide sufficient evidence to determine ancientness in isolation, which necessitates an investigative approach using multiple sources of information to assess the overall balance of evidence for the age of individual grassland sites.

A proposed set of criteria, their associated assessment methods, and notes on potential strengths and weaknesses are provided in Table 1. It should be noted that most of the criteria presented, particularly those based on field data, require further calibration/validation, potentially via the establishment of a series of expert working groups, to ensure they are robust.

It is envisaged that once sufficiently quantified, these criteria could form the basis of a checklist or scoring system which could be used to infer 'ancient grassland' status (or different categories therein) on individual sites. Consideration could be given to weighting either individual criteria or themed groups of criteria that research has shown to be more important/conclusive and to the use of 'discretionary attributes' relevant to specific grassland types as per Common Standard Monitoring (JNCC, 2004), such as floodplain connectivity for floodplain meadows.

Table 1: Proposed primary criteria for determining 'ancient grassland'.

Criterion	Method	Strengths	Weaknesses
Documentary evidence of age			
The grassland was unwooded, uncultivated, and undeveloped during the 1800s and/or prior to WW2 and there is no documentary evidence of subsequent land use change available.	Review of available early land use datasets to determine grassland presence at a fixed point in time e.g., Tithe, First Edition OS, and/or Dudley Stamp maps. Comparison with later OS map series, aerial photography, and satellite imagery to investigate continuity.	Follows precedent established for Ancient Woodland albeit with a more recent threshold. Simple and robust, no specialist expertise required. Can be applied to a clearly defined geographical area.	Available historic mapping may have gaps in coverage and/or insufficient detail to determine land use. Requires supporting evidence to evidence grassland continuity.
Landscape and historical context			
The grassland coincides with archaeological features e.g., barrows, dole stones, ridge and furrow, water meadow structures, spoil heaps in calaminarian grassland, pillow mounds etc.	Field survey and review of available historical datasets e.g., Historical Environment Records (HER), OS maps, ArchiUK[2] LIDAR etc.	Strong evidence of grassland continuity & relatively good data availability.	Geographical boundaries may be unclear for some features.
The grassland occurs in a location or has landscape features which indicate a reasonable probability of long establishment/lack of disturbance such as: Located on floodplain, site of medieval grazing moor, road-verge resulting from enclosure of medieval grazing moor, old churchyard, stately home etc.	Field survey and review of available documentary evidence e.g., Enclosure, Tithe or First Edition OS maps, Estate records etc.	Simple and robust, no specialist expertise required. For floodplain meadows, an existing method is available[3]	Requires supporting evidence to evidence grassland continuity.

[2] https://www.archiuk.com/
[3] https://floodplainmeadows.org.uk/sites/default/files/files/Historic%20Extent%20of%20Floodplain%20Meadows%20-%20Stour%20and%20Thames%20-%20Fjordr%201303022%20Final.pdf

Located in areas difficult to access or plough e.g., steep gradients, seabird islands etc.			
Ecological Distinctiveness			
The grassland supports vascular plant species indicative of long-established, or agriculturally unimproved grassland (including but not limited to Annex 1 or priority habitat types).	Field survey and/or eDNA analysis and review of available biological records and habitat datasets.	Indicator species/species assemblages are a well-established concept. Lists of 'key and characteristic indicators of long continuity' already exist for some grassland types e.g., calcareous grassland. Use of records from national datasets & local environmental records centres or eDNA techniques allow assessment outside the field season.	Currently data deficient, requires research and development of robust lists to encompass the range of grassland types/regional variation and agreement of appropriate thresholds e.g., presence/ cover/summed frequency etc. Requires suitably experienced surveyor e.g., FISC level ≥4. Cost implication of eDNA, particularly for large areas.
The vascular plant assemblage has traits indicative of undisturbed grassland.	Field survey & subsequent desk-based analysis.	Multiple potential traits are available, such as Ellenberg's N-value, Grime's C-score, TRY's plant lifespan etc.	Currently data deficient, requires research and development of robust quantitative thresholds. These traits could be replicated in a relatively young, restored grassland and some do not have data for all species across all grassland types/regions.
The grassland supports CHEGD fungal species or assemblages indicative of long-established, undisturbed, or agriculturally unimproved grassland.	Field survey and/or eDNA analysis and review of available biological records.	Indicator species/species assemblages are a well-established concept. A well-established scoring system for	Currently data deficient, requires the development of robust lists to encompass the full range of grassland types and regional variation.

		CHEGD sites, and a field survey method for initial scoping requiring limited mycological expertise are available (Bosanquet et al., 2018; Griffith et al, 2004). Lists of 'indicators of long continuity' already exist. Use of records from national datasets & local environmental records centres or eDNA techniques allow assessment outside the field season.	Cost implication of eDNA, particularly for large areas. Field surveys require multiple visits by trained mycologists. Formalisation required of 'preliminary' survey approaches achievable by non-experts e.g. recording red coloured waxcap species. Several species of fairy club (C) and earthtongues (G) are taxonomically poorly defined.
The grassland supports other (non-CHEGD) fungal species (incl. lichenised fungi) or assemblages indicative of long-established, or agriculturally unimproved grassland.	Field survey and/or eDNA analysis and review of available biological records.	Use of records from national datasets & local environmental records centres or eDNA techniques allow assessment outside the field season.	Currently data deficient, requires research to establish if some grasslands have other important fungal populations which can be linked to grassland age or restoration potential e.g. where shrubby ectomycorrhizal hosts (*Helianthemum* etc.) are present.
The grassland supports bryophyte or lichen species or assemblages indicative of long-established, or agriculturally unimproved grassland (including but not limited to Annex 1 or priority habitat types).	Field survey and/or and review of available biological records and habitat datasets.	Indicator species/species assemblages are a well-established concept. Lists of 'key and characteristic indicators of long continuity' already exist for some grassland types e.g., calcareous grassland. Use of records from national datasets & local environmental records centres allow	Currently data deficient, requires research and development of robust lists to encompass the range of grassland types/regional variation and agreement of appropriate thresholds e.g., presence/ cover/summed frequency etc. Potential for the impacts of Nitrogen deposition to make assessment more

		assessment outside the field season.	difficult in certain contexts. Requires suitably experienced surveyors.
The grassland contains complex habitat mosaics or features that provide unique conditions for specialist invertebrate species or assemblages indicative of undisturbed grassland.	Field survey and/or eDNA and review of available biological records.	Multiple candidate indicator species are available such as staphylinid beetles, picture-wing flies, old ant hills, collembolans, etc.	The precise environmental requirements of these species may not be well understood, so the basis of their correlation with long establish grassland may not be robust. Requires research and development of robust lists to encompass the range of grassland types/regional variation and agreement of appropriate thresholds e.g., presence/abundance etc. Requires a trained entomologist to identify key indicator species of undisturbed grasslands. eDNA techniques are available but still under development/assessment for some groups.
The grassland includes key characteristic ecological features and processes that are required for long established/ancient grasslands to function normally are intact e.g., Floodplain connectivity.	Field survey and analysis of available mapping and datasets.	Would provide supporting evidence for lack of high levels of agricultural modification.	May require technical specialists such as geomorphologists.
Environmental Context (Soils)			
The soil-carbon ^{14}C-radioisotope ratio is	Field sampling & laboratory analysis of	A repeatable scientific technique.	Cost implication of accelerator mass spectrometry analysis.

indicative of a long-established grassland site.	‘non-labile' soil organic matter.		
The soil profile shows no evidence of disturbance.	Field observation of soil pits.	Good indicator of physical soil disturbance (e.g. ploughing).	Requires an experienced soil surveyor. Currently data deficient, research required to investigate links between type and levels of past disturbance and recovery of biotic and abiotic factors. Perturbation by earthworms and other animals can disturb profiles.
The soil has properties indicative of undisturbed grassland.	Collection of soil samples and lab analysis.	Multiple potential properties are available, such as low bulk density, absence of pesticide residue, low phosphate availability, high fungal: bacterial biomass ratio, ratios of ruderal vs stress tolerant vascular plant species in the seed bank etc.	These properties may persist through periods of disturbance to the aboveground communities.
Environmental history			
Both historical and archaeological evidence suggests existence of undisturbed grassland throughout much of human history (including prehistoric periods)	Review of available historical/archaeological sources. Paleoenvironmental sampling.	Multiple sources of evidence are available e.g. written documents, art, maps; paleoenvironmental proxies such as pollen, insects, molluscs, plant macrofossils etc.	Requires assessment by a specialist historian/archaeologist. Evidence types/sources will vary by area and where data gaps exist, complex paleoenvironmental sampling (coring) and multiple specialists required to gather and assess new evidence.

			May not be able to distinguish different grassland types. Cost implication of collecting new data.
Historical and Cultural Association			
The grassland is of importance for its historical or cultural associations e.g. Runnymead (associated with the signing of the Magna Carta), historic estates, or remaining examples of lammas [4]meadows.	Review of available archive material.	Would provide supporting evidence for grassland age/continuity. Documented records of economic importance, of events and of artworks exist. The label can be applied to a clearly defined geographical area. It is simple and robust.	Assessment would involve documentary search by a trained individual.

Potential legal protections for 'ancient grasslands'

The planned consultation on 'irreplaceable habitats' with respect to the recent Biodiversity Net Gain (BNG) legislation in England provides the clearest opportunity to advocate for stronger legal protection of ancient grasslands.

Grasslands are not currently included in the schedule of 'irreplaceable habitats'[5] which are disapplied from mandatory net gain except in exceptional circumstances. The current legislation draws on the (non-exclusive) list of examples given in the National Planning Policy Framework, which defines 'irreplaceable habitats' as those which are "technically very difficult (or take a very significant time) to restore, recreate or replace once destroyed, taking into account their age, uniqueness, species diversity or rarity"[6]. Draft planning guidance in Scotland[7] refers to irreplaceable habitats in the context of BNG, although acknowledges the

[4] The Biodiversity Gain Requirements (Irreplaceable Habitat) Regulations 2024 (legislation.gov.uk)
[5] The Biodiversity Gain Requirements (Irreplaceable Habitat) Regulations 2024 (legislation.gov.uk)
[6] National Planning Policy Framework - Annex 2: Glossary - Guidance - GOV.UK (www.gov.uk)
[7] Development proposals: Core principles - Biodiversity: draft planning guidance - gov.scot (www.gov.scot)

need for a bespoke Scottish list[8]. Planning Policy Wales[9] however, includes both species-rich grasslands and long-undisturbed soils under its definition.

Despite the uncertainties around much of the available evidence, consultees acknowledged that all ancient grasslands were likely to be irreplaceable, given what is known about the timescales for the development/reassembly of at least some grassland types from available studies. However, it was also noted that younger grasslands for which the conditions for development are no longer present (which could include a range of younger examples such as calaminarian grasslands) could also be described as irreplaceable, and it was agreed that any advocacy should include these alongside ancient grasslands which are just one subset of ‘irreplaceable’ grassland habitats.

It should be noted that whilst this discussion paper provides a potential definition(s) of ‘Ancient Grasslands’ and associated criteria, it does not assume that ‘Ancient Grasslands’ are necessary of higher nature conservation value than certain other grassland types. Grasslands that support a range of plant, fungi, and invertebrate assemblages including but not limited to those which meet SSSI or existing priority habitat criteria, may not be considered ancient under the definition(s) proposed here but are still of high nature conservation value and it is important that these are treated with the protection afforded to these habitats within the planning system.

[8] Research into Approaches to Measuring Biodiversity in Scotland (www.gov.scot)
[9] https://www.gov.wales/sites/default/files/publications/2024-02/planning-policy-wales-edition-12_1.pdf

6. RECOMMENDATIONS

If a principal aim of developing a definition(s) of 'ancient grasslands' is to gain similar recognition and protection to that afforded to ancient woodland in planning policy, it must be both scientifically and legally robust, and straightforward for ecologists and others working in the planning system to apply.

Following the literature review and consultation exercise it is clear that whilst there are a range of methods which show good potential for identifying 'ancient grasslands' (whichever definition(s) is eventually adopted), there are currently uncertainties around much of the existing evidence and what it means and data gaps which need addressing before a sufficiently robust methodology can be developed.

Recommendations to address these issues and take this work forward are as follows:

- Review the proposed criteria and identified evidence gaps set out in this paper and consider convening specialist working groups to identify what research is required to quantify each of the proposed criteria for use as part of a robust practical method to identify 'Ancient Grasslands'.
- Liaise with CIEEM to ensure whichever definition is adopted can be incorporated into their professional guidelines and is accessible/practical for ecologists to apply
- Consider developing a decision tree tool, which could guide the user through identification of ancient grasslands but also signpost to younger grassland types which could be considered as irreplaceable, priority habitat, or otherwise of nature conservation value so these are not overlooked in the assessment process
- Collaborate with Natural England, CIEEM, the British Ecological Society and others regarding the planned consultation on 'irreplaceable habitats'
- Consider how younger CHEGD grasslands, such as those on former coal tips, could be protected. (Whilst this is outside the scope of defining 'ancient grasslands', a particular focus on waxcap species was included in the project specification and the consultation process identified that this approach would not necessarily capture all valuable waxcap grasslands.).

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ANNEX 1: POTENTIAL VASCULAR PLANT AND FUNGAL INDICATOR SPECIES

Table 3: Previously noted indicator species for ancient/old lowland calcareous grassland

Species	Source/age class		
	Wagner et al. (2019): (>200 years)	Redhead et al., (2014): (≈136 years)	Gibson & Brown (1991) (>100 years)
Agrostis capillaris		+	
Anthoxanthum odoratum		+	
Anthyllis vulneraria		+	
Arenaria serpyllifolia		+	+
Asperula cynanchica	+	+	
Avenula pubescens	+		
Betonica officinalis		+	
Brachypodium pinnatum		+	
Briza media		+	
Bromopsis erecta			+
Bryonia dioica		+	
Campanula glomerata		+	
Campanula rotundifolia	+	+	
Carduus nutans		+	
Carex caryophyllea	+	+	
Carex flacca	+	+	
Carex humilis		+	
Carex spicata		+	
Cirsium acaule		+	
Cirsium palustre		+	

Clinopodium acinos		+	
Clinopodium vulgare		+	
Deschampsia cespitosa		+	
Festuca ovina		+	+
Filipendula vulgaris	+	+	+
Galeopsis tetrahit		+	
Galium verum			+
Genista tinctoria		+	
Gentianella amarella		+	
Gymnadenia conopsea		+	
Helianthemum nummularium	+	+	+
Helictochloa pratensis		+	
Hippocrepis comosa		+	+
Hypericum hirsutum		+	
Koeleria macrantha	+	+	+
Linum catharticum		+	
Myosotis arvensis		+	
Origanum vulgare		+	
Picris hieracioides		+	
Pilosella officinarum		+	
Poa angustifolia		+	
Polygala vulgaris		+	
Poterium sanguisorba	+	+	
Primula veris		+	
Reseda lutea		+	
Rhamnus cathartica		+	

Rhinanthus minor		+	
Rubus fruticosus agg.		+	
Rumex acetosa		+	
Scabiosa columbaria		+	
Serratula tinctoria		+	
Sinapis arvensis		+	
Sonchus asper		+	
Stellaria graminea		+	
Succisa pratensis		+	
Thesium humifusum		+	
Thymus drucei		+	
Ulex europaeus		+	
Valeriana officinalis		+	
Verbascum thapsus		+	
Veronica arvensis		+	
Veronica officinalis			+
Viola hirta		+	

Table 4: Previously noted indicators of ‘long continuity’ for MG5 grassland (Natural England, 2013)

Species		
Anemone nemorosa	*Genista tinctoria*	*Serratula tinctoria*
Betonica officinalis	*Lathyrus linifolius*	*Silaum silaus*
Carex caryophyllea	*Pimpinella saxifraga*	*Succisa pratensis*
*Conopodium majus**	*Saxifraga granulata*	

*Can tolerate some fertiliser addition.

Table 5: Grassland fungi assessed as Globally Vulnerable or Endangered by IUCN (www.iucnredlist.org/; www.redlist.info/)

Species		
Camarophyllopsis schulzeri [VU]	*Hygrocybe aurantiosplendens* [VU] **	*Neohygrocybe ovina* VU **
Clavaria zollingeri VU	*Hygrocybe citrinovirens* VU **	*Porpolomopsis calyptriformis* VU **
Cuphophyllus flavipes [VU] **	*Hygrocybe intermedia* [VU] **	*Entoloma bloxamii* VU
Cuphophyllus canescens VU **	*Hygrocybe mucronella* [VU]	*Entoloma griseocyaneum* VU
Cuphophyllus colemannianus VU **	*Hygrocybe phaeococcinea* [VU]	*Entoloma_henricii* [VU]
Cuphophyllus lacmus VU **	*Hygrocybe punicea* VU **	*Entoloma porphyrophaeum* VU
Cuphophyllus lepidopus VU	*Hygrocybe spadicea* VU **	*Entoloma prunuloides* VU
Cuphophyllus radiatus [VU]	*Hygrocybe splendidissima* VU **	*Microglossum atropurpureum* VU
Gliophorus europerplexus VU	*Hygrocybe subpapillata* [VU] **	*Trichoglossum walteri* VU
Gliophorus reginae VU	*Neohygrocybe ingrata* VU **	*Dermoloma magicum* [VU]
***Gloioxanthomyces vitellinus* EN**	*Neohygrocybe nitrata* VU **	***Pseudotricholoma metapodium* EN**

Species		
Camarophyllopsis schulzeri [VU]	*Hygrocybe aurantiosplendens* [VU] **	*Neohygrocybe ovina* VU **
Clavaria zollingeri VU	*Hygrocybe citrinovirens* VU **	*Porpolomopsis calyptriformis* VU **
Cuphophyllus flavipes [VU] **	*Hygrocybe intermedia* [VU] **	*Entoloma bloxamii* VU
Cuphophyllus canescens VU **	*Hygrocybe mucronella* [VU]	*Entoloma griseocyaneum* VU
Cuphophyllus colemannianus VU **	*Hygrocybe phaeococcinea* [VU]	*Entoloma_henricii* [VU]
Cuphophyllus lacmus VU **	*Hygrocybe punicea* VU **	*Entoloma porphyrophaeum* VU
Cuphophyllus lepidopus VU	*Hygrocybe spadicea* VU **	*Entoloma prunuloides* VU
Cuphophyllus radiatus [VU]	*Hygrocybe splendidissima* VU **	*Microglossum atropurpureum* VU
Gliophorus europerplexus VU	*Hygrocybe subpapillata* [VU] **	*Trichoglossum walteri* VU
Gliophorus reginae VU	*Neohygrocybe ingrata* VU **	*Dermoloma magicum* [VU]
***Gloioxanthomyces vitellinus* EN**	*Neohygrocybe nitrata* VU **	***Pseudotricholoma metapodium* EN**

[VU] indicates the species that are assessed as VU but not yet formally published by IUCN. ** indicates those species considered by Bosanquet et al. (2018) to be high diversity indicators

ANNEX 2: LIST OF CONSULTEES

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