



Machair to meadows:

making the most of Scotland's grasslands

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When we think of Scotland's iconic landscapes, perhaps mountains come to mind. Yet, there is also reason to celebrate our more unsung habitats. **From machair to meadows, species-rich grasslands are intrinsic to Scotland's biodiversity, history, and identity – whilst producing food and playing an often-overlooked role in tackling climate change.** However, they are facing tremendous threats. This report unearths the richness of Scotland's grasslands and examines why they are in need of urgent action.

Summary of recommendations

Urgent action is needed to stem the losses and restore Scotland's species-rich grasslandsⁱ. **The Scottish Government must take a strategic approach to grasslands**, which means:

- Urgent protection of existing species-rich grasslands;
- A monitoring programme and evidence base;
- Recognition of species-rich grasslands as a nature-based solution to climate change;
- Appropriate financial incentives and advisory support for management, restoration, and creation of species-rich grasslands;
- Stronger protections for species-rich grasslands within planning policy;
- Better management of private and public grassland greenspaces for biodiversity;
- Investment in protected sites monitoring.



Spring Squill *Scilla verna*

ⁱ The term 'species-rich grasslands' used throughout this report also includes those grasslands that are of conservation value, but are not necessarily botanically diverse; for example, acid grasslands.

Defining Scotland's grasslands

Not all grass is equal. High-input agriculture (for example, using lots of fertilisers) often produces monoculture fields that are of little value to wildlife. Grasslands with fewer inputs can be abundant in wild plants and fungi – thriving hotspots for biodiversity. Grassland could therefore be seen as a spectrum; from very species-poor and low-nature value, to more sensitively managed and semi-natural, and to the gold standard species-rich or semi-natural grassland.

Definitions can varyⁱⁱ and be used for different purposes. Some common terms are:

Species-rich grasslands: have a 'high diversity of native wildflowers and grasslands, which have co-evolved with traditional farming methods over the last 6000 years.'¹ They support healthy populations of wildlife, and provide a wealth of ecosystem services, such as carbon storage.

Unimproved/semi-natural grassland: can often be species-rich – though not necessarily always, depending on grassland type. They have few or no inputs, such as fertiliser, as well as no – or low levels of – rye grass and white clover. Cutting and/or grazing is often needed to prevent succession to scrubland, for example through traditional agricultural practices like crofting.

Improved/species-poor grassland: grassland which has been agriculturally managed to increase productivity. For example, through fertiliser addition, drainage, herbicide use, ploughing and re-seeding.

Acid, Calcareous, Neutral, Purple Moor Grass and Rush Pasture: broad types of semi-natural grassland, within which are further sub-categories.²

Machair: a type of species-rich grassland unique to the north-west of Scotland and Ireland, mostly fronted by sand dunes.³

ⁱⁱ A more detailed exploration of grassland definitions can be found in our report: <https://www.plantlife.org.uk/wp-content/uploads/2023/07/Plantlife-report-1-Status-Trends-and-Definitions-of-UK-Grasslands.pdf>

What remains - and where

Over a third of Scotland's land is covered by grassland (34%); a slim majority of this is agriculturally 'improved' grassland (18%), in contrast to more semi-natural grassland (16%), which is better for nature⁴ and provides more ecosystem services.

Grassland makes up one fifth of Scotland's total agricultural area. Cattle and sheep farms are mainly in upland areas, where the harsh climate and topography make it difficult to grow crops – which are defined as Less Favoured Area (LFA). With 85% of Scotland's agricultural land classed as LFA⁵, **livestock farming on grassland is a vital part of the rural economy.**

It is challenging to give exact estimates of grassland extent due to gaps in data and variances between studies. However, the Countryside Survey in 2007 estimated⁶ that in Scotland:

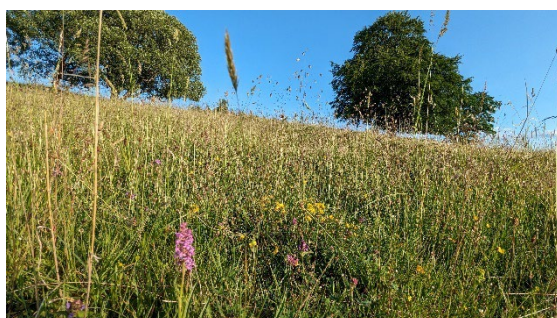
- Neutral grassland covered 6% (461,000 ha);
- Calcareous grassland covered 0.3% (26,000 ha);
- Acid grassland covered 12% (983,000 ha) – Scotland is a stronghold for acid grassland, containing over 60% of total acid grassland across Great Britain.⁷

Whilst it's clear that the **loss of the majority of species-rich grasslands** since the Second World War has taken place right across the UK, there are trends that are specific to Scotland; according to some surveys, **species-richness has declined** in neutral and acid grasslands.⁸

The Botanical Society of Britain & Ireland's (BSBI) latest Plant Atlas 2020 also highlights declines in condition and extent of these grassland types.⁹ This is a **worrying trend that indicates the overall health of grassland habitats is being degraded**, putting plants and other wildlife at risk. **Species associated with semi-natural grasslands in Scotland have experienced particular declines in their distribution**¹⁰, such as:

- Moonwort (*Botrychium lunaria*) – primarily due to grassland improvement, eutrophication and scrub invasion;
- Globeflower (*Trollius europaeus*) – primarily due to the agricultural improvement of hill land by drainage, the application of fertilizer, and changes in grassland management from hay to silage production.

Top and middle: Species-rich grassland, Perthshire



Globeflower, *Trollius europaeus*

Threats and challenges

Species-rich grasslands require precise and continuous cutting and/or grazing regimes, with little or no fertiliser to maintain low soil fertility. Therefore, **any changes to this balanced management can impact the unique processes in the ecosystem**, ultimately degrading or destroying the sensitive grassland.

Over the past century, farmers have been **incentivised to intensify farming practices with higher inputs**, resulting in permanent species-rich grassland being ploughed up, fertilised, and re-seeded, or overgrazed by livestock.

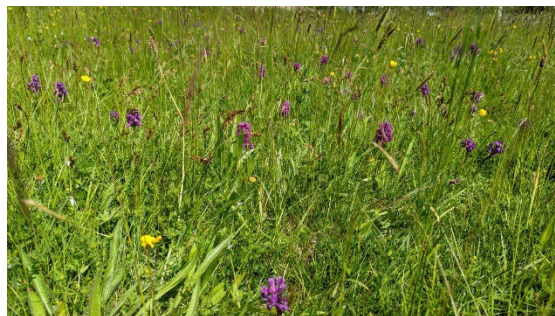
Nitrogen from air pollution and nitrogen-based fertilisers harms grassland plants and fungi directly, with excess nitrogen also leaching into soils and watercourses. Nitrogen deposition leads to higher nutrient levels, favouring common species which can cope with these conditions. These common species dominate and crowd out the more sensitive nutrient-poor loving plants. Surveys of grassland sites since 1980 show that nitrogen pollution is hampering the recovery of many Scotland's lichen species, which have declined in distribution¹¹. In particular, upland and alpine ecosystems have been impacted by nitrogen deposition¹². As nitrogen can travel long distances in the atmosphere, even grasslands far from any sources of pollution have excess nitrogen levels.

Land abandonment poses a risk to species-rich grasslands, as the lack of grazing and active management allows scrubs or more virulent plant species to encroach. The decline of cooperation amongst farmers, when maintaining traditional drainage systems, has been a particular issue for wet grasslands. The abandonment of small-scale crofting is especially prevalent in northern and western areas¹³, with on-going concerns around whether younger generations will continue crofting.

Species-rich grasslands are vulnerable to **climate change**. Projections¹⁴ for Scotland's climate predict wetter, milder winters and hotter, drier summers, with the climate already changing faster than predicted¹⁵. Semi-natural habitats that are often in isolated fragments, like species-rich grasslands, are more likely to be impacted by climate change¹⁶. Coastal erosion also poses a threat to machair.

The **undervaluation of grassland's capacity to store carbon**¹⁷ securely within their soils has led to land use decisions that systematically prioritise woodland and peatland.

Northern Marsh Orchid *Dactylorhiza purpurella*



Heath Fragrant-orchid *Gymnadenia borealis*



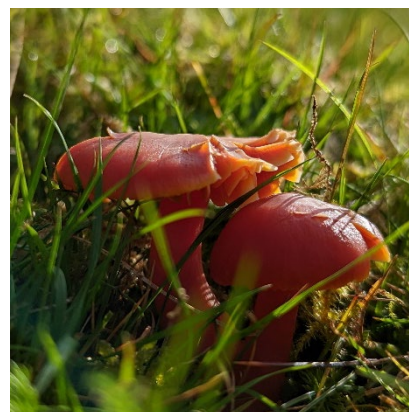
Common Twayblade *Neottia ovata*



Inappropriate tree planting is increasingly recognised as a threat to open habitats¹⁸, particularly where there are insufficient safeguards in rapidly developing private markets. The private sector has been responsible for around 90% of new woodland planting in Scotland in recent years¹⁹.

Without stronger protections in the planning system, **inappropriate development** can destroy the remaining fragments of species-rich grassland, with ecological site surveys often failing to reflect their value – particularly for waxcap fungi.

Crimson Waxcap *Hygrocybe punicea*



Limited understanding of species-rich grasslands can lead to them being undervalued and overlooked in the Scottish Government’s policymaking. A lack of awareness at an individual level can also lead to other habitats being systematically prioritised in decision-making, for example in community habitat restoration schemes.

Scotland has incredibly valuable biodiversity, SSSIs covering 12.6% of Scotland’s land area²⁰. However, these **protected areas are not necessarily healthy**. Of all the SSSI habitats, the latest statistics show that **grasslands had the second lowest proportion of features in favourable condition**²¹. Amongst the pressures facing all SSSIs, invasive species and over-grazing made up the greatest proportion – both threaten semi-natural grasslands in particular. According to data from NatureScot²², nearly half of grassland Sites of Special Scientific Interest (SSSI) are in some form of unfavourable condition²³. Since 2010, 37% of grassland SSSI sites have not had a condition assessment, therefore it’s unclear whether there have been further changes in site condition that have not been monitored.

Case Study: Oceanic Wet Grassland in the Scottish Coastal Lowlands

A small team of staff from the Floodplain Meadows Partnership set off for the Outer Hebrides to revisit the astonishingly rich grasslands; Oceanic Wet Grasslands. It had become clear that there was potentially as much species-rich wet grassland on the Outer Hebrides as in the whole of the rest of the UK combined, including some previously undefined types.

The Floodplain Meadows Partnership have been studying their composition, soil-hydrology, and management and worked with colleagues in Scotland and Ireland to compare them with other wet-grassland types present in the UK. This work has confirmed five new vegetation communities which are distinct from those in England, Wales and Ireland. On our visit, we collected vegetation, soil, and hydrology data from sites on South Uist. In partnership with the University of Edinburgh, we interviewed crofters about their management practices and the challenges they might face. The long-term dataset will help us to understand the soil-water regimes in more detail and begin to monitor changes in the grassland sites.

We hope to return to the islands in 2025, and that our continuing research into these beautiful grasslands will contribute to the recognition of their high conservation value – and help to protect them against the threats of land abandonment, changes in agri-environment subsidy regulations and the impacts of climate change.

Case study provided by the Floodplain Meadows Partnership.

Valuing species-rich grassland

Despite the fact that species-rich grasslands are amongst our rarest habitats, they often go uncelebrated and unnoticed. In Scotland, **grasslands have been part of land and language for centuries**; ‘water-meadows’ were in Pictish vocabulary before the 10th century²⁴.



Common Knapweed *Centaurea niara*

Wildlife

The unique interaction between sea, weather, land, and traditional crofting techniques has produced machair – a highly floristically diverse species-rich grassland. This machair, and other types of species-rich grassland across Scotland, are often **maintained by the continuation of low-input farming**. Iconic grassland species, such as Scottish Primrose (*Primula scotica*) need a delicate balance of low fertility and grazing or cutting in order to thrive. Other wildlife also depend on these sensitive habitats, for example:

- the Great yellow bumblebee (*Bombus distinguendus*) – one of Great Britain’s rarest bumblebees, has declined by 80% in the last century and is now only found in the north Highlands and the Islands of Scotland²⁵;
- the Short-necked oil beetle (*Meloe brevicollis*) – is classed as ‘Vulnerable’ on the International Union for Conservation of Nature’s Red List;
- Curlews (*Numenius arquata*) – populations in Scotland have declined by more than 50% since 1994²⁶.

Climate

The Scottish Government has committed to meeting a Net Zero target for greenhouse gas emissions by 2045, and a 75% reduction by 2030²⁷. The agriculture and land use sector has a vital role to play in helping mitigate and adapt to climate change. **Species-rich grassland is an important, but undervalued, nature-based solution to climate change**. The undisturbed soils of species-rich grassland can securely store more soil organic carbon per hectare than intensively managed grassland or cropland²⁸.

Evidence suggests that the **species-rich grassland plant communities can draw down carbon deep into the soil with their complex rooting structures**. Their healthy soils are full of ecosystem engineers and mycorrhizal fungi, which facilitate carbon storage. This also means that healthy grasslands can help **mitigate extreme weather events**. For example, the deep alluvial soils of floodplain meadows can help store and slow the flow of floodwater²⁹.

There's the **potential for grasslands in Scotland to store more soil carbon with changes in management that increase the grassland species-richness**. For example, by using different grazing techniques like rotational grazing, and stopping fertiliser use – which also reduces the farm's overall greenhouse gas emissions³⁰.

Food and people

With **grasslands covering one fifth of Scotland's agricultural land**, their management must play an essential role in achieving the Scottish Government's vision for Scotland to become a 'global leader in sustainable and regenerative agriculture'³¹. **Species-rich grassland is inherently productive farmland**. Livestock are needed to graze and maintain the floristic and fungal diversity, which in turn provide a wide range of nutrients for the livestock. This can reduce the need for antibiotics and worming medicines and support healthier livestock, as well as healthier meat and dairy products^{32,33}. Lower input farming systems that work with nature have been shown to help farmers increase their resilience to climate change, restore nature, and also become more profitable³⁴.

The Mob Grazing Diversity Project

The Mob Grazing for Diversity project was developed in response to stakeholder concerns about the risks associated with loss of species rich grassland in the national park. As an application to the Green Recovery Fund, the project was designed to deliver ecosystem outcomes by working with farmers across the Cairngorms National Park.

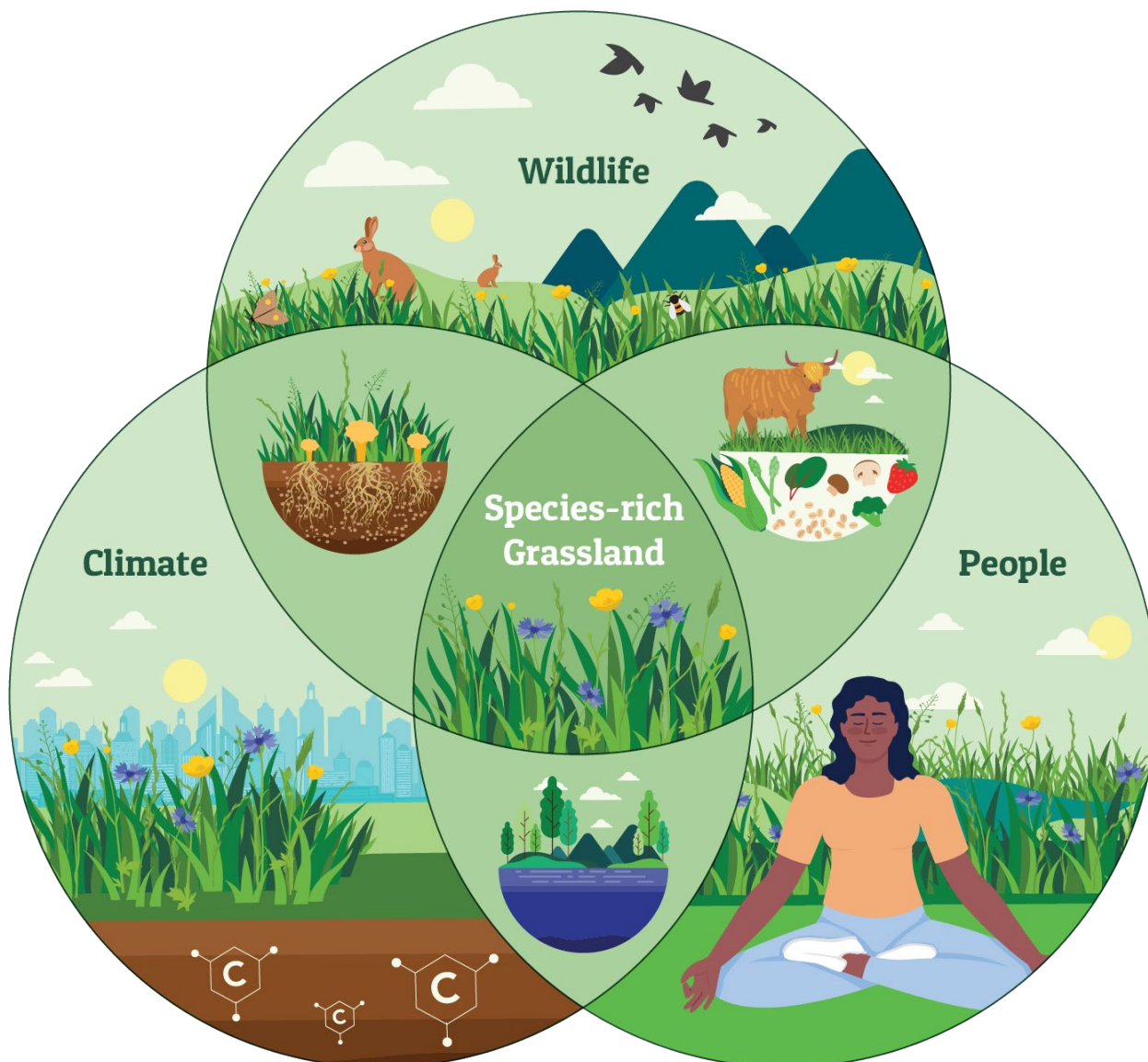
The aim was to achieve sustainable grassland management through adaptive grazing management, or mob grazing, to promote ecosystem restoration and high agricultural productivity. Working with five farms across the national park, each farm would need to produce a grazing management plan, implement adaptive grazing management, optimise sward productivity through rotational grazing systems and maintain permanent habitats in good biodiversity condition. Working in partnership, a project was developed that would support each farm to work with a farming mentor to learn how to implement mob grazing, use of equipment and practicalities of implementing their grazing management plan.

Project partners: Nature Friendly Farming Network; Pasture for Life; Cairngorms National Park Authority; Plantlife Scotland; Cairngorms Trust supported year one by providing Green Recovery Funding; additional support from RSPB Scotland and NatureScot.

Many pollinators depend on connected, species-rich grassland habitats, and provide important **pollination services** for crops and other plants. Insect pollination services in Scotland are valued at an estimated £43 million per year³⁵.

The aesthetic beauty and sensory experience of meadows can **enhance people's health and wellbeing**. People in Scotland really value the benefits of being in nature; over four-fifths of adults in Scotland visited the outdoors for recreation within a 12-month period, and have high levels of concern about their natural environment³⁶.

Imagine a Venn diagram of value for wildlife, climate, and people - with species-rich grasslands at its heart.



From the same area of species-rich grassland, we receive all these 'multifunctional' benefits. Covering more than a third Scotland's land, **grasslands could therefore be a huge national asset to help meet the Scottish Government's targets** on nature recovery, climate, sustainable farming, and health and wellbeing.

Recommendations

Species-rich grasslands are being hugely undervalued and neglected in policy and practice. **The Scottish Government must take a strategic approach in order to protect, restore, manage and create species-rich and semi-natural grassland.** Urgent action is needed to meet societal needs and national and international commitments, alongside securing the floristic and fungal future of Scotland's precious grassland heritage. This means:

- **Urgent protection of existing species-rich grasslands;**
- **A monitoring programme and evidence base** – capturing data on trends in grassland extent and ecological condition, alongside a valuation of their ecosystem services;
- **Recognition of species-rich grasslands as a nature-based solution to climate change** within climate policies and strategies;
- **Appropriate financial incentives and advisory support** to farmers, crofters, and landowners for managing, restoring, and creating species-rich grasslands – through an ambitious agri-environment scheme and robust private market mechanisms;
- **Stronger protections for species-rich grasslands within planning policy;**
- **Better management of private and public grassland greenspaces for biodiversity,** including road verges;
- **Investment in protected sites monitoring** to ensure that all of Scotland's protected grasslands are regularly monitored and action to restore and maintain them is undertaken.

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References

- ¹ *Species Rich Grasslands guidance leaflet* (2021). <https://www.nature.scot/doc/species-rich-grasslands-guidance-leaflet#:~:text=Species%2Orich%2Ograsslands%2Ohave%2Oa%2Ohigh%2Odiversity%2Oof,insects%2C%2Obirds%2C%2Obats%2C%2Oamphibians%2Oand%2Omany%2Oother%2Oanimals.>
- ² NatureScot has adopted the European Nature Information System (EUNIS) for habitat classification: <https://www.nature.scot/doc/naturescot-commissioned-report-766-manual-terrestrial-eunis-habitats-scotland.>
- ³ *Machair* (no date). <https://www.nature.scot/landscapes-and-habitats/habitat-types/coast-and-seas/coastal-habitats/machair.>
- ⁴ SLR Consulting, Plantlife (2023) *Review of Trends in Grasslands across the UK*.
- ⁵ The Scottish Government (2019) *The Less Favoured Area Support Scheme (Scotland) Amendment Regulations 2019: EQIA*.
- ⁶ These figures are estimates from a Countryside Survey in 2007. They vary slightly to the figure of total semi-natural grassland coverage cited previously in this report, which is from the UK's Centre for Ecology and Hydrology's "Land Cover Map" (2020). Differences in figures may be explained by the use of different methodologies between studies.
- ⁷ The Scottish Government (2019) *The Less Favoured Area Support Scheme (Scotland) Amendment Regulations 2019: EQIA*.
- ⁸ The Scottish Government (2019) *The Less Favoured Area Support Scheme (Scotland) Amendment Regulations 2019: EQIA*.
- ⁹ Walker, K.J., Stroh, P.A., Humphrey, T.A., Roy, D.B., Burkmar, R.J. & Pescott, O.L. (2023) *Britain's Changing Flora. A Summary of the Results of Plant Atlas 2020*. Durham: Botanical Society of Britain and Ireland.
- ¹⁰ State of Nature Partnership (2023) *State of Nature Scotland*.
- ¹¹ Ibid.
- ¹² The James Hutton Institute., the Scottish Government (no date) *Impact of atmospheric Nitrogen deposition on upland and alpine ecosystems*.
- ¹³ Walker, K.J., Stroh, P.A., Humphrey, T.A., et al., (2023).
- ¹⁴ Adaptation Scotland (2021) *Climate Projections for Scotland Summary*.
- ¹⁵ The James Hutton Institute. (no date). *Summary for Policy Makers: Climate trends, future projections and extremes and their implications for Natural Capital and policy*.
- ¹⁶ Wilson, O.J. and Pescott, O.L. (2023) 'Assessing the exposure of UK habitats to 20th- and 21st-century climate change, and its representation in ecological monitoring schemes,' *Journal of Applied Ecology*, 60(9), pp. 1995–2006. <https://doi.org/10.1111/1365-2664.14455.>

¹⁷ Plantlife (2023) *Grasslands as a Carbon Store*.

¹⁸ NatureScot Research Report 1309 – *Understanding the indirect drivers of biodiversity loss in Scotland* (no date). <https://www.nature.scot/doc/naturescot-research-report-1309-understanding-indirect-drivers-biodiversity-loss-scotland>.

¹⁹ Ibid.

²⁰ *Sites of Special Scientific Interest (SSSIs)* (no date). <https://www.nature.scot/professional-advice/protected-areas-and-species/protected-areas/national-designations/sites-special-scientific-interest-sssis>.

²¹ *The proportion of Scotland's protected sites in favourable condition 2023* (no date). <https://www.nature.scot/doc/proportion-scotlands-protected-sites-favourable-condition-2023>.

²² NatureScot (2024) *Grassland features on SSSI's – condition assessment request – Plant Life*. Unpublished.

²³ This includes 'unfavourable declining', 'unfavourable no change', and unfavourable recovering'; 138 out of 281 grassland SSSI sites. 1 site was classed as 'partially destroyed'.

²⁴ Ross A (2008). *Literature review of the history of grassland management in Scotland*. Scottish Natural Heritage Commissioned Report No. 313.

²⁵ Bumblebee Conservation Trust (no date). *Great Yellow Bumblebee Factsheet*.

²⁶ *Official Statistics – Scottish Terrestrial Breeding Birds 1994 – 2022* (2024). <https://www.nature.scot/doc/official-statistics-scottish-terrestrial-breeding-birds-1994-2022>.

²⁷ *Climate change* (no date). <https://www.gov.scot/policies/climate-change/>.

²⁸ Emmett, B. A., Reynolds, B., Rowe, E., Spurgeon, D., Brittain, S. A., Frogbrook, Z., ... Woods, C. (no date). Countryside Survey: Soils Report from 2007.

²⁹ CaBA Biodiversity Group (2018) *Biodiversity Pack Habitat Guides Wet Grasslands*.

³⁰ Plantlife (2023). *Grasslands as a Carbon Store*.

³¹ The Scottish Government (2022) *Sustainable and regenerative farming – next steps: statement*.

³² Pasture for Life (no date). *Research demonstrating the health benefits of Pasture for Life meat*.

³³ Davis, H. et al. (2022) *Nutritional Benefits from Fatty Acids in Organic and Grass-Fed Beef, Foods*, 11(5), p. 646. <https://www.mdpi.com/2304-8158/11/5/646>.

³⁴ The Wildlife Trusts., Nature Friendly Farming Network (2023) *Farming at the sweet spot – how farming with nature can make you happier, healthier, and wealthier*.

³⁵ Scottish Natural Heritage (no date) *Pollinator Strategy for Scotland 2017-2027*.

³⁶ Stewart, D. & Eccleston, J. (2020) *Scotland's People and Nature Survey 2019/20 – outdoor recreation, health, and environmental attitudes modules*. NatureScot Research Report No. 1227.

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Plantlife is the global charity working to enhance, protect, restore and celebrate the wild plants and fungi that are essential to all life on earth. With two in five plant species at risk of extinction, biodiversity loss is now the fastest it's ever been – which means our work has never been more vital. We champion and accelerate conservation action, working at the heart of a global network of individuals and organisations, to influence and inspire landowners and land managers, public and private bodies, governments and local communities. As time begins to run out, we are using our position as the global voice for wild plants and fungi to bring lasting and positive change to our natural world – for everyone's sake.

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