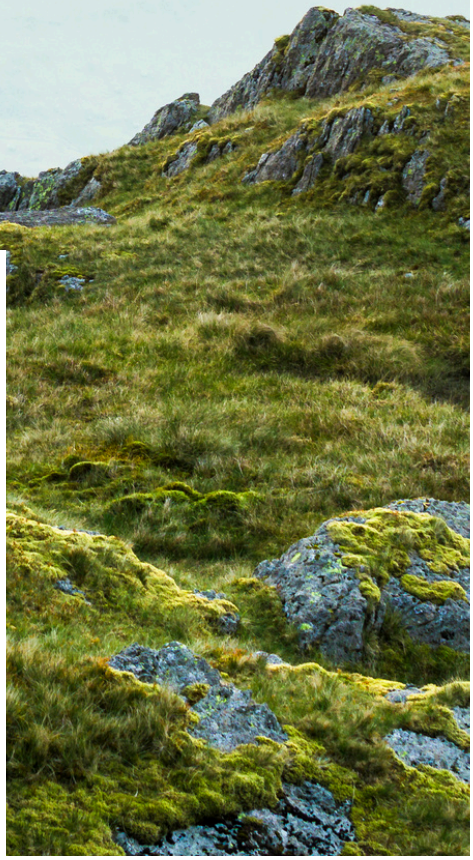
WEST LAKELAND CIC
FARMER-LED NATURE RECOVERY

HERDWICK
GUARDIAN OF THE FELLS

FEDERATION OF CUMBRIA COMMONERS

GRAZING IN UPLAND LANDSCAPES



An initial review of *Grazing Regimes for Nature Recovery* and recommendations for future approaches to management decision making in the Lake District

REVIEW AUTHOR:
PROFESSOR ROBIN PAKEMAN
Plant Ecologist, James Hutton Institute

COMMISSIONED BY:
HERDWICK SHEEP BREEDERS ASSOCIATION, FEDERATION OF CUMBRIA COMMONERS
WEST LAKELAND CIC

INTRODUCTION

Members of the Herdwick Sheep Breeders Association, Federation of Cumbria Commoners, and West Lakeland CIC, alongside their local communities, have voiced growing concerns about the expectation to reduce stocking rates to 0.05 LU/hectare across the Lake District for farmers to secure Higher Level Stewardship (HLS) agreement rollovers from Natural England on the fells.

The Natural England (NE) report, "Grazing Regimes for Nature Recovery: Experience from 25 Years of Agri-Environment Agreements in the Lake District's High Fells," has become a key justification for mandating these exceptionally low stocking levels in HLS rollovers. Given the significant influence of this report on shaping future agreements, it was imperative to have its findings rigorously reviewed by independent experts. This review also seeks to explore whether more socially equitable, environmentally effective, and contextually just approaches could be developed for negotiating and implementing agri-environment schemes in the Lake District and other upland areas.

To initiate this process, we engaged Dr. Robin Pakeman, a highly regarded upland ecologist with extensive experience working with Natural England and other land management organisations, to conduct an initial independent scoping review. Our aim is for this review to serve as the starting foundation for a genuinely collaborative process involving upland farmers, independent natural and social scientists, Natural England, and other local stakeholders. Together, we hope to co-develop innovative approaches to decision-making that balance diverse priorities and deliver desirable habitat outcomes for the future of our uplands.

WILLIAM RAWLING
Chair of Herdwick Sheep Breeders Association

JOHN ROWLAND
Chair of Federation of Cumbria Commoners

BACKGROUND

The Herdwick Sheep Breeders Association, Federation of Cumbria Commoners, and West Lakeland CIC commissioned a review of the Natural England (NE) document "Grazing Regimes for Nature Recovery: Experience from 25 years of agri-environment agreements in the Lake District's high fells" – referred to as GRNR below. This review would provide a commentary on the report and identify areas where I suggest further information is required for informed decision making.

It should be noted that this scoping review was produced over a short period and that it was carried out to highlight the main issues where further discussion and information gathering is needed. It was not possible to be exhaustive as to citing the current scientific and grey literature.

REPORT STRUCTURE

The rest of this review is divided into four sections:

1. A summary which synthesises the finding of the review under the research questions posed in the tender.
2. A set of recommendations for future action.
3. A detailed commentary on the "Grazing Regimes for Nature Recovery" report outlining areas where additional information is available or different conclusions could be reached.
4. A short biography of the author.

1. SUMMARY

Five research questions were posed by the commissioning organisations, and these are used to summarise the finding of the review:

1. What methods does Natural England use to monitor and evaluate grazing regimes?
2. How reliable and transparent are these methods and the data collected?
3. What are the key concerns of local farmers regarding current agri-environment schemes?
4. What potential areas require further research to improve biodiversity and sustainable farming practices?
5. What are the benefits and challenges of conducting a larger, long-term collaborative study?

WHAT METHODS DOES NATURAL ENGLAND USE TO MONITOR AND EVALUATE GRAZING REGIMES?

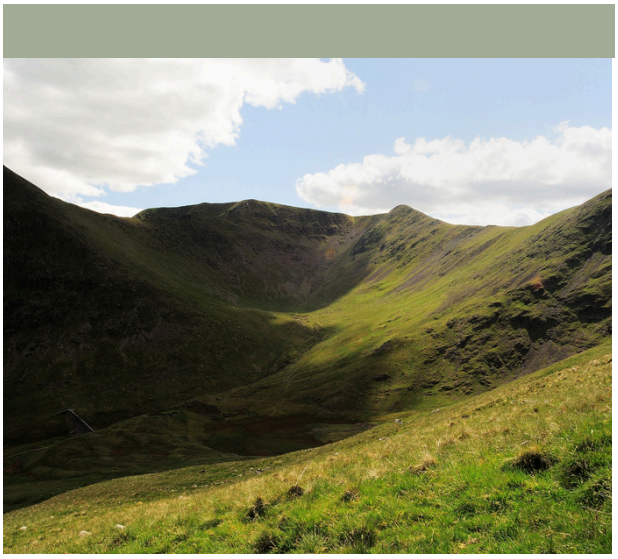
The primary data source for the monitoring and evaluation of grazing regimes is Site Condition Monitoring from the Sites of Scientific Interest (SSSI) across the Lake District. The method is known as Common Standards Monitoring and there is specific methodology for assessing upland habitats. Other guidance is available for features designated for individual species or assemblages.

Each SSSI has been designated for a range of features, e.g., dwarf shrub heath, but assessment in larger SSSIs is done by geographic units and then a feature level assessment amalgamated across all units. Assessment follows a separate methodology for each feature where the feature is compared, amongst others, against a hypothetical feature in good condition in terms of species composition, presence of positive and negative indicators, the amount of grazing some specific species have recently received and the height of the vegetation.

HOW RELIABLE AND TRANSPARENT ARE THESE METHODS AND THE DATA COLLECTED?

Common Standards monitoring has been adopted as the approach used for all designated areas across the UK by the relevant statutory agencies. Consequently, there is a considerable body of experience in using it in practice. However, a number of potential issues are associated with the approach:

- A single formula for good condition is provided for a habitat, so that variations in habitats as a result of climate, e.g., between regions of the UK or with altitude, rely on the judgement of the surveyor.
- The method focusses on management rather than other factors such as nitrogen deposition or climate change. A number of efforts have been made to introduce nitrogen deposition into the method but probably after the surveys the GRNR report was based on (Jones et al. 2016).
- It assumes vegetation can be fitted neatly into a set number of categories and the vegetation is then judged against the ideal structure for that habitat. Mosaics can be accounted for, but intermediate types are harder to deal with.
- There is no benchmarking against more precise methods. The closely related Habitat Impact Assessment methodology (MacDonald et al. 1998) uses the same measures to assess the level of grazing on heather (low impact = less than 33% shoots grazed), but overestimates damage compared to more precise and physiologically relevant measures of grazing offtake on blanket bog, dry heath and wet heath (Moore et al. 2018).
- The method aggregates detailed data from a set of surveyed points into a small number of categories. Condition is judged unfavourable if more than a certain proportion of points fail. Consequently, a great deal of precision is lost once only headline results are reported as features might fail to be in good condition by only a narrow margin or might be a long way from the threshold.
- It is not a method developed for monitoring through time, as the number of categories is too few to get a nuanced view of change.



WHAT ARE THE KEY CONCERNS OF LOCAL FARMERS REGARDING CURRENT AGRI-ENVIRONMENT SCHEMES?

The concerns of local farmers as presented in the GRNR fall into two broad areas: (1) will my business be profitable if stock numbers have to be reduced and (2) what are the likely ecological consequences of changes in management. Regarding the former, the recent introduction of Environmental Land Management Schemes (ELMS) introduces uncertainty into understanding how farm businesses would be affected by reducing stock numbers and makes decision making more complex. More information on the options under ELMS, and how they might affect profitability and sustainability at the farm level and at the landscape level, would inform debate. The GRNR was not able to cover this topic in detail.

The farmers also raised a number of ecological concerns, including around bracken, ticks and wildfire, which also need consideration as the knock-on consequences of management changes could be considerable and should be part of a wider scale assessment of impacts. The GRNR was not able to cover these areas in depth.

WHAT POTENTIAL AREAS REQUIRE FURTHER RESEARCH TO IMPROVE BIODIVERSITY AND SUSTAINABLE FARMING PRACTICES?

One area where there is limited information is the impact of changing grazing across multiple taxonomic groups. The best understood group is the response of plant species and vegetation to grazing, but even here much of the data is from comparing exclosures to unknown or poorly characterised stocking rates. Experimental data is limited (Pakeman 2004, Pakeman & Nolan 2009). Information on how other taxa respond to grazing is available for some groups such as birds (e.g., Pearce-

Higgins & Grant 2006) and some invertebrate groups (e.g., beetles, Dennis et al. 1997), but is missing for many components of biodiversity. A multi-taxa approach has only been taken at the Glen Finglas experiment, and this reveals complex trade-offs in managing for different components.

A second area is understanding the interactions between management, climate change and nitrogen deposition. In areas where water limitation is infrequent, increasing temperatures will lead to greater productivity. Similarly, continuing inputs of nitrogen will also increase productivity. In consequence, previous estimates of stocking rates may now be obsolete as the experiments they were based on were conducted in the 1970s through to the 1990s when climate was different and cumulative nitrogen impacts lower. Also, as diversity is often negatively affected by nitrogen deposition (Stevens et al. 2010), rising temperatures (Harrison 2020) and their interaction (Yue et al. 2020), then increased grazing may be necessary to conserve species-rich grasslands.

The third main area where information is lacking is how the economic model of upland farming will function under proximate drivers such as changes in agricultural support mechanisms and markets for meat and fibre, as well as under long-term drivers for net-zero. However, the larger scale implications of changes at a business level also need to be understood, as changes at the individual farm level could affect the management of commons or the viability of local communities.

WHAT ARE THE BENEFITS AND CHALLENGES OF CONDUCTING A LARGER, LONG-TERM COLLABORATIVE STUDY?

BENEFITS

- A larger study could synthesise data and information across multiple drivers (grazing, climate change, pollution), across multiple taxa (plants, invertebrates, vertebrates) and at multiple scales (patch to landscape). The study could also include social and economic information and take into account how changes in agricultural support payments are likely to impact farm businesses. Such a study would provide better information to base decision making and make the trade-offs explicit.
- Long-term, targeted monitoring would provide information to enable adaptive management so that the impacts on people and nature can be fine-tuned to maximise multiple benefits.
- A collaborative study that has the backing of all stakeholders would result in a set of agreed recommendations and approaches. One model that could be followed would be the Langholm Moor Demonstration Project (Langholm Moor Demonstration Project Board 2019) that brought together the landowner, conservation agencies (including NE), and NGOs representing different interest groups (Royal Society for the Protection of Birds, Game and Wildlife Conservation Trust).

CHALLENGES

- Bringing together disparate data sources and integrating them would need a multi-disciplinary team that would need appropriate resourcing.
- Maintaining resourcing over the long-term to allow adaptive management is a challenge especially if specific data has to be collected that is unique to this study.
- Agreeing the terms of reference for the study across the multiple stakeholders may not be straightforward. Agreement as to which experts to employ would need to be part of the terms of reference and experts would have to be either agreed by all partners or be proposed by independent stakeholders to enable buy-in from all parties.

2. RECOMMENDATIONS

The Conference of the Parties (COP) of the Convention on Biological Diversity (CBD) adopted the Ecosystem Approach as the primary framework for action under the Convention. The Ecosystem Approach is a strategy for integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. It acknowledges that ecosystems encompass processes, functions and interactions among organisms and their environment and that humans are an integral component of many ecosystems. It also acknowledges the need for adaptive management and that uncertainties are inherent in predicting the impacts of management. The Ecosystem Approach was adopted within Defra/NE's National Upland Outcomes framework.

Following the twelve principles of the Ecosystem Approach would suggest three steps for progress to an agreed framework for management decisions in the Lake District:

1. Independent facilitation

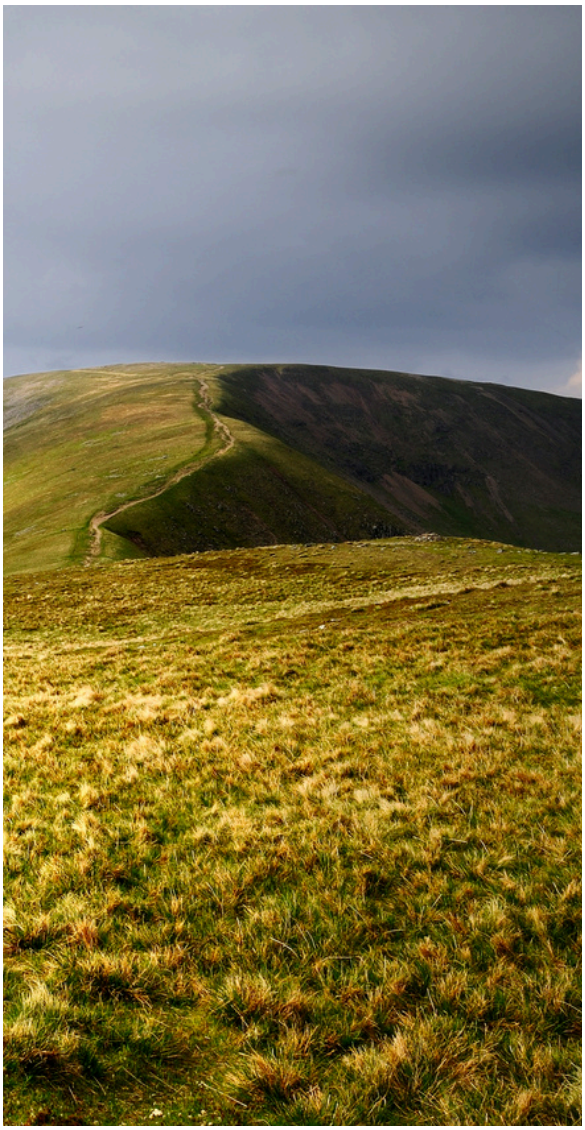
All stakeholders to come together with an independent facilitator to scope out how to review the available evidence.

2. Independent scientific panel

An independent panel of scientists appointed to review evidence on environment, economics, and social aspects to understand the drivers of change and to identify potential directions for upland management that would deliver multiple benefits.

3. Decision making framework

The stakeholders to agree a framework for future management decision making within the Lake District taking into account all drivers of change and specific socio-economic circumstances in the area.



3. DETAILED COMMENTARY ON "GRAZING REGIMES FOR NATURE RECOVERY: EXPERIENCE FROM 25 YEARS OF AGRI-ENVIRONMENT AGREEMENTS IN THE LAKE DISTRICT'S HIGH FELLS"

Individual points are linked to their position in the original document by quoting page and paragraph numbers, such that 3/4 refers to page three, paragraph 4. Paragraph numbering refers to paragraphs starting on that page and does not include the end of paragraphs starting on the previous page.

Where no comment has been raised it can be assumed that the statements made are uncontentious.

GENERAL COMMENTS

1. There is a clear contrast between the subject of the report "Nature Recovery" and the content which focusses on vegetation. This contrast in focus means that there is an assumption that Vegetation = Nature. However, vegetation is only one part of nature. Consequently, the report is only a partial view of how changing the management of the Lake District fells would impact biodiversity and ecosystem services.

2. This links through to a second point. The report is based around an analysis of condition assessment from SSSIs before March 2018, creating a number of issues. By focussing the analysis and future management changes on the condition assessment, decisions are being based on proxy data and managing for the proxy, not the desired result of managing for nature in the round. It also highlights the issues with condition assessment being imprecise: as the number of categories are small, considerable change can happen within one category whereas it is possible for a small change to flip a feature into another category. The analysis also is based on a single time point, so it not possible to identify changes in the SSSIs, just to have a snapshot assessment of the picture without any information on trends. Finally, there is an issue with a one size fits all approach with the same guidance on condition assessment applying across wide areas, with the Lake District is assessed in the same way as Dartmoor, despite the difference in latitude and climate.

Understanding the impacts of management change on biodiversity would need detailed trend analysis across multiple taxa to fully understand the consequences of changing management across the fells of the Lake District.

3. The report focusses on grazing as the biggest driver of condition and ignores other drivers and the potential interaction between drivers. The Lake District has seen high levels of acidic and nitrogen deposition which show high exceedances over critical loads (Rowe et al. 2020) with resultant impact on a host of sensitive communities. There are also continuing impacts of climate change which will also have an impact on natural communities. It is known that there are interactions between nitrogen deposition and grazing (e.g., van der Wal et al. 2003) and that even sites with active management can see diversity losses (van den Ber et al. 2011). Grazing can interact with climate change, and there is evidence that grazing can mitigate the impacts of climate change on diversity (Kaufmann et al. 2021). Finally, there is strong evidence of the interactive effects of climate change and nitrogen deposition on plant diversity (Britton et al. 2023a).

Consideration of a single driver without considering the interactions with other drivers would fail to address the underlying causes of change. It is possible that management change may have higher or lower impacts than expected because of these interactions.

4. The report is very site focussed, and it could be improved by taking a landscape level approach to identify key areas where management change could provide key benefits and areas where benefits might be low or may even be disbenefits. From a diversity point of view, to maximise total (gamma) diversity across the fells, then local level diversity (alpha) and turnover between sites (beta) need to be maximised. Hence having divergent management systems would provide the highest diversity.

5. It is entirely possible that reductions in grazing may have little impact on plant species diversity. For example, the meta-analysis by Herrero-Jáuregui & Oesterheld (2018) showed that increasing or decreasing stocking rates had little impact on diversity though there were changes in composition. Similarly, a large-scale grazing experiment in the southern Highlands of Scotland on a mosaic of upland vegetation showed that change was slow and, even after 15 years, only a few species had shown significant changes in cover (Pakeman et al. 2019). This is in contrast to the loss of species after grazing removal in some systems (Lezama et al. 2014).

6. Grazing is a potential tool to mitigate the impacts of nitrogen deposition. Within grasslands there is a paucity of studies using grazing itself to achieve this (Britton et al. 2023b), but there is a range of studies that show that mowing can be used to counter the effects of nitrogen deposition on grassland diversity (Collins et al. 1998, Kammer et al. 2022, Storkey et al. 2015, Wamelink et al. 2009). Coupled with studies that show grazing removal exacerbates the impacts of nitrogen on grassland diversity (Lu et al., 2021, Pakeman et al., 2017), it suggests that grazing is a key tool in reducing the impacts of continued nitrogen deposition.

7. A wide range of species are associated with open, grazed habitats and it is possible that these will suffer from decisions about reduced grazing and increased woodland cover. For instance, in a study in the Welsh uplands, curlew nested in higher densities in shorter vegetation (Johnstone et al. 2017). Curlew also had lower nesting success near woodland (Douglas et al. 2014) and showed lower population sizes and declines in populations where there was more woodland in the landscape (Franks et al. 2017). Curlew is just one example of a species associated with open ground. Similar arguments could be constructed for some species and opposing arguments for the benefits of more woodland for other species. Which species should be favoured is a discussion dependent on values as well as regional and national trends in species abundances. However, that discussion should be explicit about the trade-offs in decision making.

8. There is a call for further study of the impacts of changing flock numbers and flock sizes on hefting behaviour in the GRNR. This is an important topic and one that should be followed through by Natural England.

9. Possibly the most important subject to address in future is understanding the complex ecological, social and economic interactions present within the Lake District and how changes driven by external factors, including agricultural support policy, can propagate through these interactions and have unforeseen effects. Some regions may show a degree of resilience to change, but it is possible that land management systems in the Lake District might not be resilient in the face of external drivers. There should be a system scale assessment of how changes in land management could propagate through the region by bringing together external data, farmer perspectives and the views of a range of stakeholders. This would offer a more comprehensive understanding of the challenges and opportunities for sustainable farming in the region.

SPECIFIC COMMENTS

3/1. How is a "healthy habitat" defined? All habitats deliver ecosystem services; management and species composition determine the balance of the services provided. The list provided does not mention any services linked to production.

3/3. It would have been helpful in the report to see a more detailed look at the data to assess how useful it is for informing management decisions.

8/3. The focus of the report is on data from the Lake District High Fells SAC as this is the source of much of the data. However, how representative of the rest of the high ground is that SAC. Are recommendations based on the data suitable for wider deployment?

8/4. It is not possible to show recovery from a single condition assessment, only that proxies for recovery appear to indicate that recovery is taking place.

8/5. Sheep grazing could be reduced or excluded by using fences and may not require much reduction in total numbers.

8/12. Clear assessments of the relative strengths of different habitats in storing carbon need to be provided. There are also other approaches to slowing the flow of water that could help, including re-meandering, allowing water access to floodplains, and adding in leaky barriers to temporarily store water to reduce flood peaks.

11/3. It should be noted that soil and vegetation interact. There is developing evidence that tree establishment changes carbon cycling in the soil and can liberate carbon, meaning that tree establishment and, particularly, tree planting can result in net carbon losses from the system (Friggens et al. 2020). Modelling in Scotland suggests that upland areas can see net depletion of carbon stocks after tree establishment (Matthews et al. 2020); it is likely that this pattern is similar in the Lake District given its similarity to part of Scotland (GRNR 9/2). Protecting the carbon in peat and organic soils may mean keeping them free from woody vegetation. There has also been a failure to recognise that grasslands can store significant amounts of carbon (Bardgett et al. 2021, Bengtsson et al. 2019).

11/3. Sphagnum is not the only peat forming species as Cyperaceae (sedges), like cotton grass (Eriophorum spp.), and dwarf shrubs, like heather, also contribute.

15/1. The GRNR identified the key role of hefting of sheep as important in the management of commons. The hefting of the different flocks, and individuals within flocks, meant that animals were distributed over the whole common, spreading the effects of grazing. The balance of text here does not reflect the long-term role of hefting as a means of land management, but rather focusses on problems.

16/1. There are plenty of other controls on tree regeneration; seed supply, the presence of suitable germination sites, seedling predators such as slugs and voles. The process is more complex than suggested.

16/1. Heather is relatively resistant to grazing. It has been shown to maintain productivity levels with 40 % removal of current season's shoots over five years (Grant et al. 1982) and maintains competitive dominance over grasses at levels up to 30 % removal of current season's shoots (Pakeman & Nolan 2009). This is not the same measure as that used in Common Standards Monitoring which measures the number of shoots browsed.

16/1. It should also be noted that there are species that rely on open vegetation for their existence. These include short-statured plants such as thyme (Thymus polytrichus) as well as a range of invertebrate species.

17/3. What evidence is there for species loss as opposed to these species being ecosystem dominants since the original forest clearance?

18/1. It should be noted that this point about heavy grazing concerns only dwarf shrub vegetation and does not cover grasslands in the report by Martin et al. (2012, paragraphs 4.35 to 4.56).

18/1. It should be noted that Martin et al. (2012, paragraphs 4.19 to 4.22) report on multiple studies on grazing impacts on invertebrates including referencing some groups that do better under higher levels of grazing such as small-bodied beetles (paragraph 4.21). The GRNR review included simple measures such as overall abundance, which is not a proxy for the behaviour of individual species, some of which are associated with shorter vegetation and others with taller.

18/1. It should also be noted that the review by Martin et al (2012, paragraphs 4.63-4.81) highlighted bird species that were at higher densities under high levels of grazing (e.g. waders, skylark Alauda arvensis) as well as invertebrate species. In summary, different grazing levels offer opportunities to different species and identification of net effects is difficult.

18/2. Removal of grazing can lead to a reduction in plant species richness as low growing species are lost (Dupré & Diekmann 2001, Pakeman 2004). Grassland specialist invertebrate species may see an initial increase in richness and abundance but are then lost as succession proceeds (Öckinger et al. 2006).

18/4. Neither of the documents cited in support of this paragraph provide a quantitative definition of a low productivity environment (Grime 1977, Nisbet et al. 2004) and do not really cover grazing interactions with diversity. Arguably only the highest tops in the temperate Lake District with relatively mild temperatures and high rainfall might be considered globally as having low productivity. There are a range of models of environment-grazing-diversity patterns, but they are conceptual rather than quantitative (e.g., Cingolani et al. 2005, Milchunas et al. 1988) and hence it is difficult to take these general models and apply them to a specific situation. However, global meta-analyses conclude that ungrazed vegetation is lower in diversity than grazed vegetation (Gao & Carmel 2020).

19/2. The document "Site Improvement Plan for the Lake District High Fells SAC" does mention other potential drivers of change for the SAC including nitrogen deposition. However, it fails to offer any information on the severity of the impacts caused by each of the drivers and their possible interactions. There is no consideration of climate change as a threat to features within the SAC.

19/4. Undoubtedly grazing is a major driver, but no evidence is provided as to the likely size of impacts of other drivers, including the missing driver of climate change, and it should not be forgotten that the interactions between drivers may be particularly important in driving change.

20. Showing sheep numbers for Cumbria sheds little light on changes in sheep density across the fells of the Lake District. A large proportion of Cumbria is lowland grassland, so the numbers are driven by shifting balances between livestock and arable, the shifting balance between sheep and cattle in the lowland pastures, and the intensity of grassland management. Specific data on stocking rates from agricultural parishes within the Lake District may give a better idea of sheep numbers, but even here sheep numbers will be largely dependent on how intensively managed the intake land is, particularly in terms of fertiliser inputs.

21/1. It is questionable how much the increases in sheep numbers in these two parishes are a reflection of changes on the high ground. A substantial increase in low ground stocking could be occurring through increased fertiliser application. Only data from the open ground is useful in ascertaining stocking rate changes.

25/3. The publications cited to support this paragraph appear to be no longer available (Chesterton et al. 2006a, Chesterton et al. 2006b). Are they the same stocking densities as those presented in Nisbet & Glaves (2010) and the same livestock unit conversions in use in Environmental Stewardship (https://www.gov.uk/government/publications/environmental-stewardship-livestock-record-keeping/livestock-record-keeping-guidance-for-arable-or-grassland)? The sources of the data for the stocking densities are not given, so it is difficult to establish their relevance. In addition, there is no evidence that wet heath is more sensitive than dry heath to grazing (Hulme, et al. 2002, Pakeman et al. 2003), and restoration grazing levels are arbitrarily set to half that of maintenance grazing levels. To my knowledge, there is no information on sustainable grazing levels for Mountain Heath, Flushes and Western heath. There is also no information on Calcareous grassland, which is a vegetation type with a wide range of communities, which potentially have very different grazing sensitivities, and all require grazing to maintain their characteristic flora.

25/8. It should be noted that upland vegetation can take many years to react to changes in management (Pakeman et al. 2019). The Glen Finglas experiment is at a moderate altitude and consists of a mosaic of dry and wet grassland, mires and wet heath. It took 15 years before impacts of significant stocking changes, including removal, could be detected in terms of vegetation composition.

26/6. Data from condition assessment are from 2018 and hence provide only a snapshot. This means these data cannot provide an assessment of change. So even if a habitat is failing, it may have shown more improvement than one that has achieved its objectives.

27/2. Given the above comment (25/8), it is entirely possible that those sites partially or not achieving objectives are slower to respond than those that are. Condition assessment is an imprecise tool for assessing change over time, especially as Annex 1 points out that the data is from one timepoint and so is not useful for assessing change over time.

28/2. There are experimental data that show habitat recovery of wet heath at 1.4 sheep ha-1 yr-1 (Hulme et al. 2002) and dry heath at 0.9 sheep ha-1 yr-1 (Pakeman et al. 2003). It is possible that the lack of precision in the condition assessments is failing to pick up change that would be picked up by more precise methods.

28/4. The point "Monitoring of ESA agreements showed no evidence of habitat restoration occurring where Tier 1 prescriptions were followed (Nisbet and Glaves, 2010)" is hard to pinpoint in the cited paper. It does make the point that recovery happened at some sites on Tier 2, but it also states that this was over a three-year period where recovery may not be yet evident.

29/1. Even on a heavily grazed fell sheep will try and maximise energy intake and will be selective.

29/2. It is well known within the scientific literature that as competition for resources decreases then the best resources are focused on.

30/1. In habitat mosaics, the distribution of grazing impacts will depend upon the preference of the animals for different vegetation types and their arrangement in space. It has to be accepted that within a mosaic there may well have to be trade-offs between desired results for different vegetation types because of the selectivity of the animals (Moore et al. 2015). Not all aspirations can be met if there are conflicting requirements for different vegetation types.

30/2. It is not possible to assume that that growing periods are as strict and well-defined as is suggested. Growth very much depends on conditions the plant experiences, which may mean temperatures at ground level on a sunny winter's day may easily exceed air temperature. The citation of Martin et al. (2012, paragraph 4.48) is odd as the paper summarised (Welch 1988) deals with a restricted set of circumstances – the impact of sheep grazing on blaeberry (Vaccinium myrtillus). Extrapolation to other vegetation types is problematic.

32/4. I do not follow this statement concerning climate change adaptation. Unless there has been successful tree establishment and growth, then all the evidence provided is of ground disturbance which does not equate to climate change adaptation.

33/1. Cattle impacts on purple moor-grass (Molinia caerulea) are well known, but it would be useful to see the data produced. Also, cattle are not selecting fibre; they are forced to consume fibrous diets to ensure their intake of nutrients and energy.

33/6. The statement "where heather is undergoing regeneration from seed, this happens best in the complete absence of sheep" is a curious point to take from the paragraph in Martin et al. (2012, paragraph 4.13) which actually states "where heather is undergoing restoration from seed, summer cattle grazing, in the absence of sheep, can be almost as effective as complete grazing exclusion in facilitating establishment". The data from Mitchell et al. (2008, Figure 2c) show that at a site dominated by mat grass (Nardus stricta) sheep grazing reduces heather establishment by c. 20 %, but at the purple moor grass site, there was no difference between heather establishment in fenced or sheep grazed areas.

34/2. It is possible that areas of fragmented heath reflect other physical patterns in the landscape and not the effects of grazing. It is possible that reduced grazing may have little impact if grazing is not the cause of the patterns observed.

34/3. The initial good response may be from existing plants able to increase in stature in the absence of grazing. However, areas may not show regeneration for a number of reasons, including unsuitable soil conditions for dwarf shrub growth, and absence of seed or unsuitable conditions for germination. Some dwarf shrubs such as heather have very small seeds and need disturbance to stand a chance of establishment. If grazing is not the issue with regeneration, then further stock removal may not have any further impact.

35/2. This paragraph does not take into account a number of papers on Racomitrium lanuginosum heath. Armitage et al. (2012) used a natural gradient study to identify that nitrogen deposition was the key driver of low cover of this moss, with grazing and climate playing secondary roles. Nitrogen deposition enhances decomposition and this drives depletion of the moss mat (Britton et al. 2018). Nitrogen deposition also increases the growth of grasses which can attract grazers. R. lanuginosum decline appears to be driven by direct nitrogen impacts on the moss, shading by taller grasses and sedges and trampling by herbivores attracted to the graminoids (van der Wal et al. 2003). Lake District sites had some of the highest levels of nitrogen deposition in the study and these sites had some of the highest cover of graminoids (grasses, rushes and sedges, Armitage et al. 2014). To confirm this, transplant experiments were carried out and Lake District moss transplanted to the Highlands quickly recovered (Armitage et al. 2011). Exclusion of grazing enhanced moss growth, but the greatest reductions in R. lanuginosum cover were found in areas with the highest grazing pressure, likely due to shading as a result of increased grass growth (Armitage et al. 2012). Grazing reduction may work better than exclusion if grazing reduces the competitive effects of the graminoids on the moss. The alternative restoration treatment attempted in this study, phosphorus addition, enhanced moss growth and cover due the rebalancing of nutrient ratios in the moss.

35/3. The recovery of alpine moss heath communities may be driven by a range of factors. Falling levels of nitrogen pollution since 1990 (Fowler et al. 2004) will have reduced direct toxicity effects on the moss and reduced decomposition rates allowing for the build-up of the moss mat. Similarly, reductions in stocking levels will have reduced trampling but also the reduction in nitrogen deposition will have reduced grass growth and this will reduce the attraction of these areas for sheep.

35/4. I am unsure where this expectation comes from. Many tree species fundamentally change nutrient cycling rates and alter the conditions for the ground flora. Most woods dominated by species such as birch and ash have understories dominated by grasses (Hester et al. 1991, Mitchell et al. 2007, Rodwell 1991.

38/1. A robust comparison would list the species excluded by scrub establishment, such as heather, and their flowering periods.

40/1. A robust comparison would be to include species of open ground and their conservation status. For example, the moorland and upland specialists from the Defra upland bird index in the Lake District are Red Grouse (Amber according to Burns et al. 2020), Golden Plover (Green), Curlew (Red), Meadow Pipit (Amber), Whinchat (Red), Wheatear (Green), Snipe (Amber), Raven (Green), Black Grouse (no trend given), Hen Harrier (Red), Golden Eagle (Green), Merlin (Red) and Ring Ouzel (Red). A full consideration of the trade-offs in changing land use/cover is essential for any conservation planning.

42/1. The conclusions of Vera's (2000) work are contested, and evidence suggests that open woodlands such as wood pasture are a feature of Neolithic and later times (Mitchell 2005, Svenning 2002). Disturbance regimes in pre-Neolithic woodlands may have been driven by drivers other than herbivores (Whitehouse & Smith 2010).

42/6. Wood pastures are habitats managed by grazing and continued grazing is essential to maintain the open-ground flora. Tree regeneration usually needs protection (Forestry Commission Scotland 2009).

44/1. It is an open question whether some of these species would establish in areas currently accessible to grazing if grazing were removed given the difficulties of establishing from seed in closed turf and competition from existing species.

47/3. The Lake District suffers high levels of nitrogen pollution, with exceedance of critical loads by a large margin on the high ground and even on the fringes of the fells (Rowe et al. 2020). There are also very high exceedances for acidity, with some of the highest values for the UK. So, it is not correct to claim that it is grazing and people that have had the main impact on these habitats.

49/1. Large herbivore populations are controlled by both top-down (predator) and bottom-up (vegetation) factors (Martin et al. 2020). In the absence of predators, populations respond to the availability and quality of the forage available and land management can play a significant role in affecting population size (Ganz et al. 2024).

51-53. Farm economics are likely in considerable flux given changes to support payments and the closure of the Basic Payments Scheme. It would be very useful to do a new review of the economic sustainability of farming in the Lake District to feed into future decision making.

56-63. Throughout the responses to the comments of the farmers there does not seem to be relevant consideration of the points raised, for example 62/2 Ticks, where the comment by the farmer about vegetation height is responded to with a comment on climate change. There also appear to be some responses which do not have strong supporting evidence, for example 61/4 Bracken, where the impact of climate change on bracken is downplayed based on the argument that frost may limit its spread. Whilst this is true, climate change is predicted to increase the biomass of bracken across the uplands, particularly at moderate altitudes and to increase altitudinal limits (Pakeman & Marrs 1996).

56/1. Is there evidence that undergrazing is not a concern? Removal of stock will affect some species, particularly low growing plants, as well as invertebrates, characteristic of open areas.

60/4. Farmers raise the important issue of hefting breaking down as whole flocks are removed allowing the sheep to redistribute themselves according to the newly available grazing. The response only partially addresses the concerns. However, the call for further study of how hefting behaviour changes if flocks are removed or if flock sizes are reduced is highly appropriate.

61/2. Narthecium ossifragum tends to expand at low stocking levels or when stock are excluded (Pakeman et al. 2019).

61/4. Given the recent removal of the option of bracken control with Asulox, bracken management strategies need to be adapted. Very little is known about how livestock and bracken interact, but it is clear that they can prevent encroachment, especially cattle (Pakeman et al. 2019). The removal of Asulox as an option also makes woodland establishment more challenging as an option.

62/1. It would be useful to see the evidence that light grazing of Molinia will enable bog mosses to take over. Molinia needs quite high levels of grazing to knock it back (Grant et al. 1996).

62/2. One of the clearest environmental determinants of tick abundance is woodland. Gilbert et al. (2017) found that "pastures had higher densities of Ixodes ricinus ticks on the ground vegetation and more ticks biting lambs if there was more tree cover in or adjacent to pastures". Information

on the relationship between tick numbers and vegetation type and height is difficult to collect robustly as sampling methods may be affected by the vegetation (Tack et al. 2011).

62/2. Wet heaths and blanket bog are both vegetation types that burn frequently in Scotland – here there are proportionately more wildfires on these two habitats than on dry heath and acid grassland (Fielding et al. 2024). Fire risk is very much linked to human activity, but fire severity is driven by fuel load (Davies et al. 2016) as well as by weather (Naszarkowski et al. 2024). Fire danger is predicted to increase across the UK as a result of climate change (Arnell et al., 2021).

64/3. It is possible that the prescriptions have not been in place long enough to get a visible response (see 25/8).

65/1. How would "success" be defined for an agreement?

65/2. An economic assessment under the new English agricultural support framework is an urgent priority.

67/2. Climate change and both acidic and nitrogen deposition are having significant impact on vegetation and portioning out the impacts is non-trivial. Declines in atmospheric sulphur deposition and climate change appear to have had major impacts on grassland changes in Scotland (Mitchell et al. 2018). Climate, nitrogen and sulphur pollution and grazing have driven long-term changes in Scotland's moorland habitats (Britton et al. 2017).

67/3. This may be a matter of time as some habitats may be responding, but condition assessment is too imprecise a tool to assess this over the limited timescale that agreements have been in place.

67/6. However, it should be acknowledged that there will be a trade-off between the biodiversity associated with open habitats and those with scrub/woodland.

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4. AUTHOR

INTRODUCING THE AUTHOR OF THIS REVIEW

Prof. Robin Pakeman is an ecologist at the James Hutton Institute. He has 34 years of post-PhD research experience, including research on bracken control, habitat restoration and grazing impacts on biodiversity. He has published 222 papers in international, refereed journals (Web of Science data) and a range of reports for government departments and agencies.

He is a Fellow of the Chartered Institute of Ecology and Environmental Management and a Chartered Ecologist. He has been appointed Visiting Professor at the University of Liverpool and Honorary Professor at the University of Aberdeen. He has served on the Scientific Advisory Committee of NatureScot and as editor of Biological Conservation. He currently leads the Natural Resources Theme of the Scottish Government's Strategic Research Programme and has editorial duties for Applied Vegetation Science, the Nordic Journal of Botany and Oikos.

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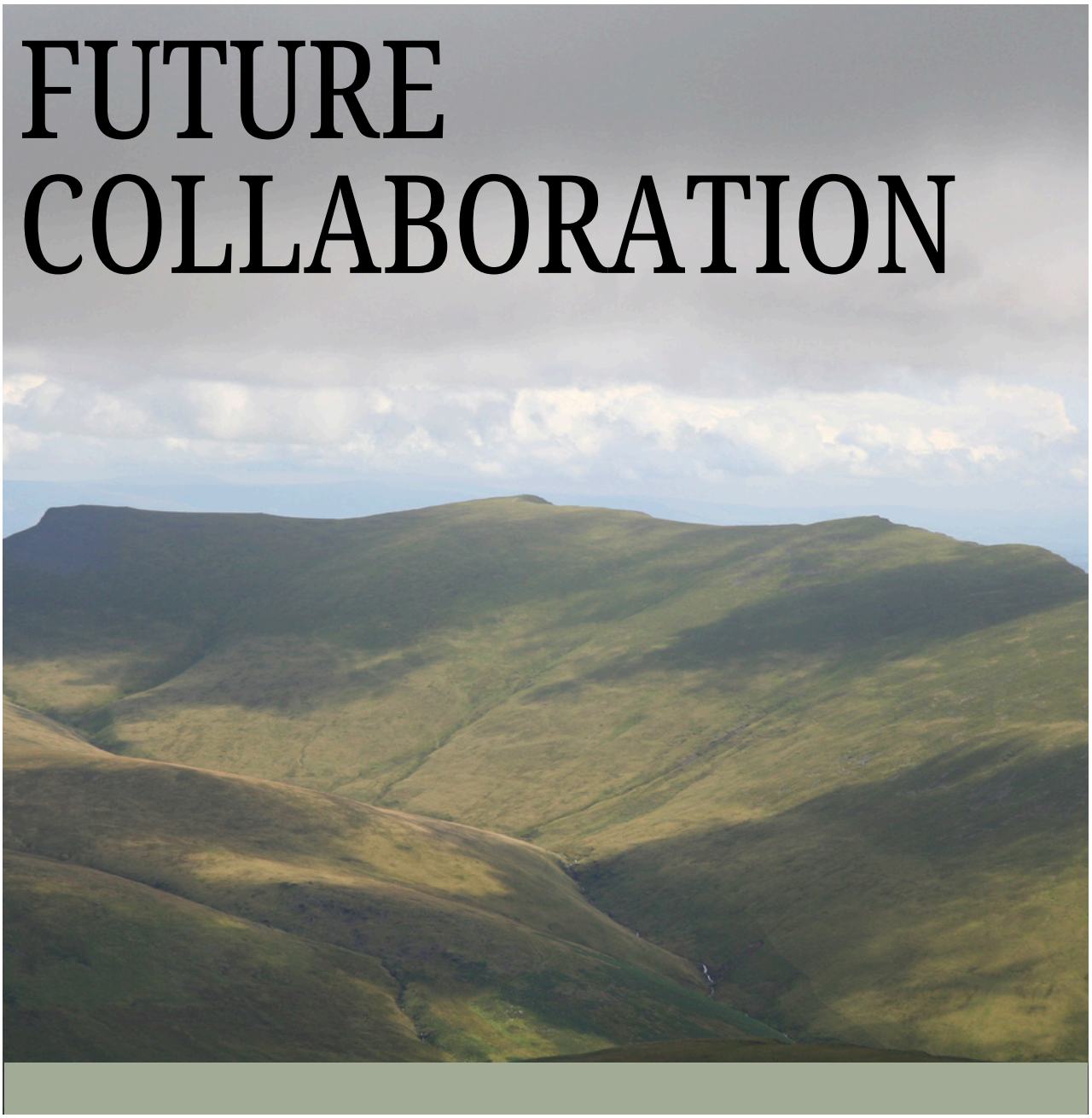
- Keswick Show
- Cockermouth Show
- Ennerdale Show
- Millom & Broughton Show
- Borrowdale Show
- Buttermere Show
- Skelton Show

FUTURE COLLABORATION



We warmly invite local businesses, rural and environmental organisations, and academic researchers to join us in turning these recommendations into meaningful action. By working together, we can continue to build on the findings of this initial review to create a more sustainable, inclusive, and productive future for our uplands. Your expertise, resources, and shared commitment are vital to developing innovative solutions and fostering a collaborative framework that enhances ecological health, economic viability, and community resilience.

Get in touch: jennifer@fellsfieldnotes.co.uk