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Ecological Solutions and Evidence

PRACTICE INSIGHTS

Perspectives on conservation grazing: The need for monitoring and communication

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Abstract

1. Conservation grazing is widely used to manage open ecosystems, but inconsistent definitions and inadequate reporting of grazing patterns hinder effective communication among researchers, practitioners and policymakers, limiting the understanding and success of conservation grazing regimes.
2. We demonstrate detailed measurement of the grazing pattern (comprising timing, intensity, duration and frequency) in management units within a single nature recovery site—Ainsdale Sand Dunes National Nature Reserve, in the United Kingdom. We highlight the potential value of using existing records of livestock movements to create a detailed picture of how the pattern of grazing varies between management units and over time.
3. The pattern of grazing at Ainsdale Sand Dunes National Nature Reserve (Ainsdale NNR) has changed over time due to responsive management approaches. These management approaches also result in differences between grazing enclosures.
4. We recommend that standard definitions are agreed upon to unify terminology for conservation grazing patterns and regimes. This will improve clarity, reporting and monitoring. We encourage sites to record daily livestock movements to track grazing patterns and plant communities, to monitor their impacts. We propose a common framework for describing grazing patterns to enable the effective use of data and allow comparisons across other sites.
5. *Practical implication*. Bridging the gap between academics and land managers is essential, as limited staff, resources, time and in-house expertise often prevent managers from moving beyond data collection to effective data use in decision-making. Strengthening this connection will enhance the monitoring, analysis and communication of the analysis of grazing patterns, and support improved nature recovery outcomes.

KEYWORDS
coastal sand dune, conservation grazing, livestock, nature recovery

1 | INTRODUCTION

Conservation grazing uses domesticated herbivores to replace wild mammals, to maintain open ecosystems by preventing scrub and forest establishment and promoting habitat heterogeneity through the selective consumption of plants (Lyons et al., 2023). As such, domesticated livestock serve as a key tool for maintaining and restoring biodiversity in open habitats (Borer & Risch, 2024; Hewett, 1985; Millett & Edmondson, 2015). Management decisions determine the grazing regime, which consists of stock type, stocking rate and grazing pattern (see Tables 1 and 2 for definitions). Variation in the timing, intensity, frequency and duration of grazing in each management unit results in distinct grazing patterns (Table 3), which determine key aspects of ecosystem functionality (Stanley et al., 2024). However, these components are currently not well recorded or communicated, with confusion over definitions and measurements and a focus on only two aspects of grazing patterns: grazing intensity and timing (Chapman, 2007; Mason et al., 2019), largely ignoring duration and frequency of grazing. Further confusion arises from a lack of consistent terminology. For instance, 'mob', 'targeted', 'intense' and 'pulse' are used interchangeably. Grazing regimes emerge from a complex interplay between management planning, livestock availability, pragmatism and historical practices, often leading to unclear and unplanned grazing patterns. As a result, the full detail of the management intervention is usually not fully known. This results in a lack of understanding of realised grazing patterns, limiting the ability to compare different grazing interventions and to accurately assess their effectiveness as an intervention.

The aim of this Practice Insight is to highlight how management decisions can shape the grazing pattern in a conservation grazing regime, and how a detailed understanding of the grazing pattern can be gained with little data recording effort. We define 'conservation grazing' as the use of domestic livestock where the primary objective of the grazing is to manage the land for nature conservation objectives. We use a case study of Ainsdale Sand Dunes National Nature Reserve (Ainsdale NNR), drawing on over 30 years of conservation grazing. We are a group of practitioners who manage conservation grazing at Ainsdale NNR and applied ecology researchers who undertake research at Ainsdale NNR. Here, we provide a detailed analysis of livestock densities within the reserve based on the transcription of livestock diaries, recording all livestock movements for 25 years. From these data, we define the conservation grazing pattern using four key dimensions—intensity, duration, frequency and timing—adapting these dimensions from the framework presented by Stanley et al. (2024) for understanding grazing management in agricultural

TABLE 1 Components of a conservation grazing regime.

Term	Definition	Measurement
Stocking rate	Site-wide livestock densities	Livestock Units (LU)[a], per ha per year across the entire site
Livestock choice	The characteristics of livestock used in a conservation grazing regime	Species, breed, sex, size, life stage
Grazing pattern	The detailed breakdown of when, how much, how long and how often grazing takes place in a management unit (e.g. enclosure/paddock)	Timing, intensity, duration and frequency (Table 2)

[a]We used the following for Livestock Units calculation: cattle = 1.0 LU, sheep = 0.15 LU based on Kent Wildlife Trust (2025).

TABLE 2 Definitions proposed for components of conservation grazing pattern.

Term	Definition	Measurement	Figure
Timing	The time of year that a management unit is grazed	Day, month, season	Figure 2
Intensity	The number of livestock grazing a management unit at a specific time	Livestock units per ha for the given management unit	Figure 3
Duration	The total amount of time that a management unit is grazed each year	Total number of days that livestock is in a management unit	Figure 4
Frequency	Number of times that livestock are added to a management unit each year	Number of movements into an area per year	Figure 5

TABLE 3 Conservation grazing patterns and management objectives. We have grouped terms together where objectives and characteristics are similar.

Term	Definition	Objective	Characteristics
Mob/targeted/intense/pulse	Targeted high-intensity grazing	Controlling scrub and invasive or dominant species	High intensity, long duration, low to high frequency
Patch/mosaic	Spatially variable grazing pressure	Creation of habitat patches which are more- or less-heavily grazed resulting in diverse structure	Long duration, high frequency
Seasonal	Grazing in specific seasons	Response to phenological phenomena, for example, winter grazing to avoid consumption of plants in flower	Variable
Rotational/prescribed	Livestock are periodically moved between enclosures	Allows higher intensity grazing by providing time for vegetation to recover	Long duration, low frequency
Rest-rotation	Rotational grazing where areas receive no grazing for at least 1 year	Allows taller vegetation to develop which may provide for specific habitat requirements (e.g. nesting birds)	Low frequency
Strip grazing	Grazing in narrow, managed strips	Allows for higher intensity grazing than rotational	Short duration, high intensity, high frequency
Prescribed	Rotational grazing with clear focussed aims	Promote specific plant species or soil conditions	Variable
Continuous	Long periods of time of grazing	Mimics 'natural' grazing to some extent	Long duration, low frequency

systems. We present these data in the context of the underlying decision-making process, without which it is near impossible to effectively evaluate the grazing regime, providing a level of detail which is rarely, if ever, considered. By presenting a framework and approach for considering the elements of the grazing pattern, we want to begin a conversation about how to evaluate conservation grazing in a more systematic and evidence-based way.

2 | AINSDALE SAND DUNES NATIONAL NATURE RESERVE

Coastal sand dunes are biodiverse habitats of high conservation value due to the assemblages of plants and animals, including rare species. Ainsdale Sand Dunes National Nature Reserve (Ainsdale NNR) in Merseyside, on the north-west coast of England (Lat: 53.59° N, Long: 3.07° W) spans approximately 500 ha, including beach, open dune, wet slack, scrub and pine woodland habitats. Open dunes cover about 150 ha, featuring a humid dune system with a high frontal dune ridge. Ainsdale NNR was purchased by the UK Nature Conservancy Council in 1965 and is now owned and managed by Natural England, a non-departmental public body funded by the UK government. The reserve is protected under national and international conservation laws as a National Nature Reserve (NNR), Site of Special Scientific Interest (SSSI), Special Area of Conservation (SAC) and Ramsar site (Bailey et al. (2022) for overview of UK protected area designations). A key management aim is to maintain and restore the extent, distribution, structure and function of open sand dune habitats (Gee, 1998). Conservation grazing with livestock is an important tool for achieving this aim.

Historically, dune plant communities depended on the natural dynamics of coastal dune systems and grazing by rabbits (Ranwell, 1960). However, the dramatic decline in rabbit populations in 1953 due to myxomatosis, coupled with a reduction in dynamic processes on coastal dunes in the United Kingdom (Provoost et al., 2011) has resulted in increased vegetation height and scrub cover. These changes have threatened the open nature of the ecosystem and high biodiversity-value habitats and species. To mitigate this, habitat restoration in the 1980s initially focussed on manual scrub removal, mowing, turf-stripping and excavation. In 1991, livestock grazing was introduced in response to the deteriorating condition of the reserve. This management shift coincided with growing public and conservationist awareness of using grazing as a management tool (Small et al., 1999) and with the publication of management handbooks such as the Grazing Animals Project (Tolhurst & Oates, 2001).

Livestock grazing began in February 1990 with a small-scale trial (30 Herdwick sheep) in a 10-ha grazing enclosure ('Small Enclosure', Figure 1) on the open dunes. Further enclosures followed, and currently grazing enclosures at Ainsdale NNR cover 107 ha, including five enclosures on open dunes (96 ha) and some broadleaf woodland on dunes (11 ha). The enclosures enable livestock to be moved around the site based on habitat and livestock welfare needs. Enclosure placement was based on a range of

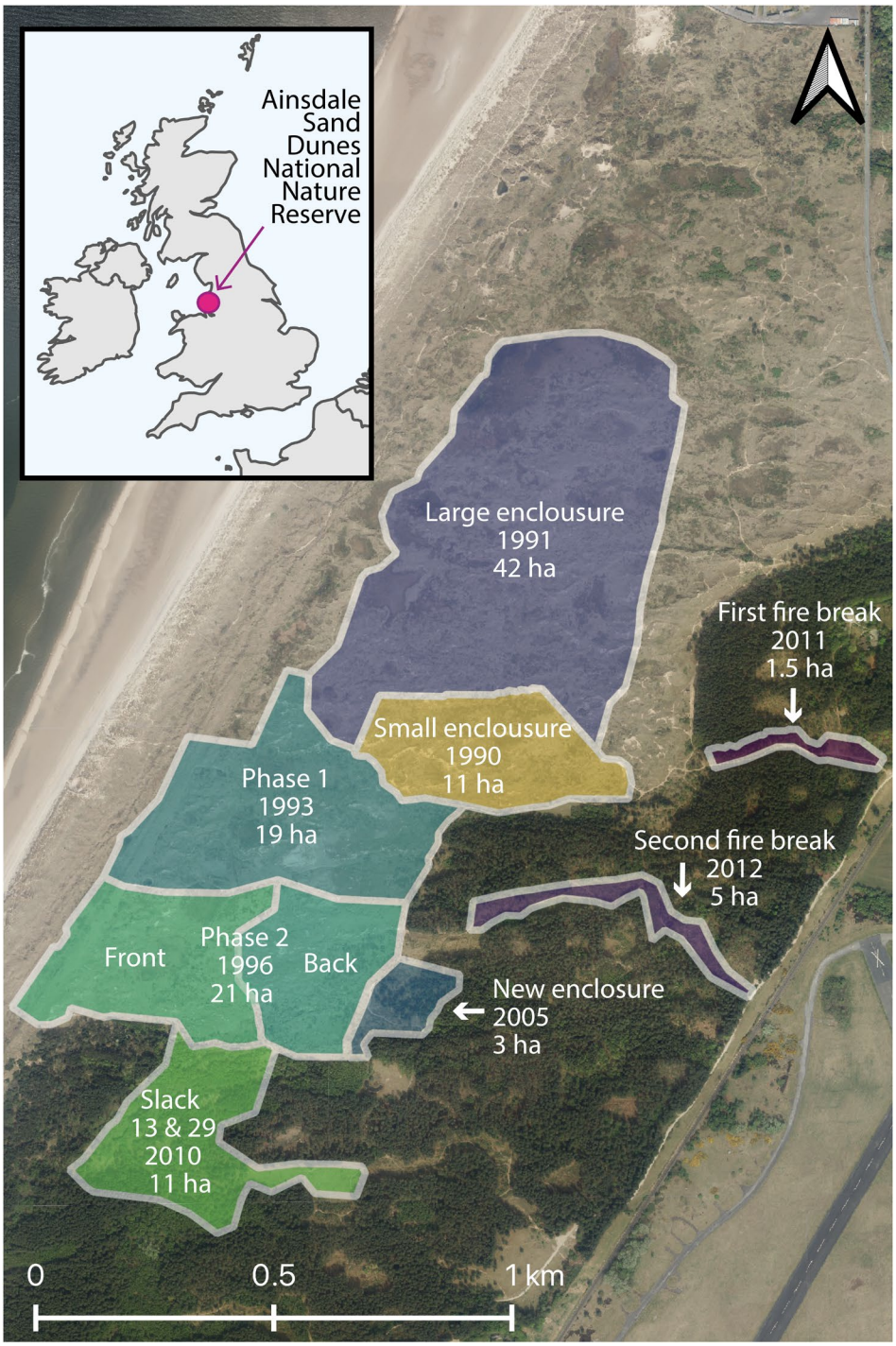

FIGURE 1 Ainsdale Sand Dunes National Nature Reserve (pink circle) and the grazing enclosures (named by site managers in daily operations: Large enclosure, small enclosure, phase 1, phase 2 front, phase 2 back, new enclosure, slack 13 and 29, first firebreak, second firebreak). The year is when the enclosure was established and size of the enclosure.

criteria reflecting nature recovery objectives and site practicalities. Grazing enclosures are located on the hind dunes because of public pressure on the frontal dunes, and fences are placed primarily along existing estate tracks and flat areas, which are practical for putting up fencing. An important driver for all management on site is the habitat needs of Natterjack toads, and so enclosures encompass dune slacks.

3 | STOCKING RATE AND LIVESTOCK CHOICES

A key decision for conservation grazing is the type of animal to use (e.g. species, breed, sex, age, body size, learned experience; Liu et al., 2015; Rook et al., 2004). Sheep are more selective grazers than cattle in high diversity grasslands, but less selective in low diversity grasslands (Xu

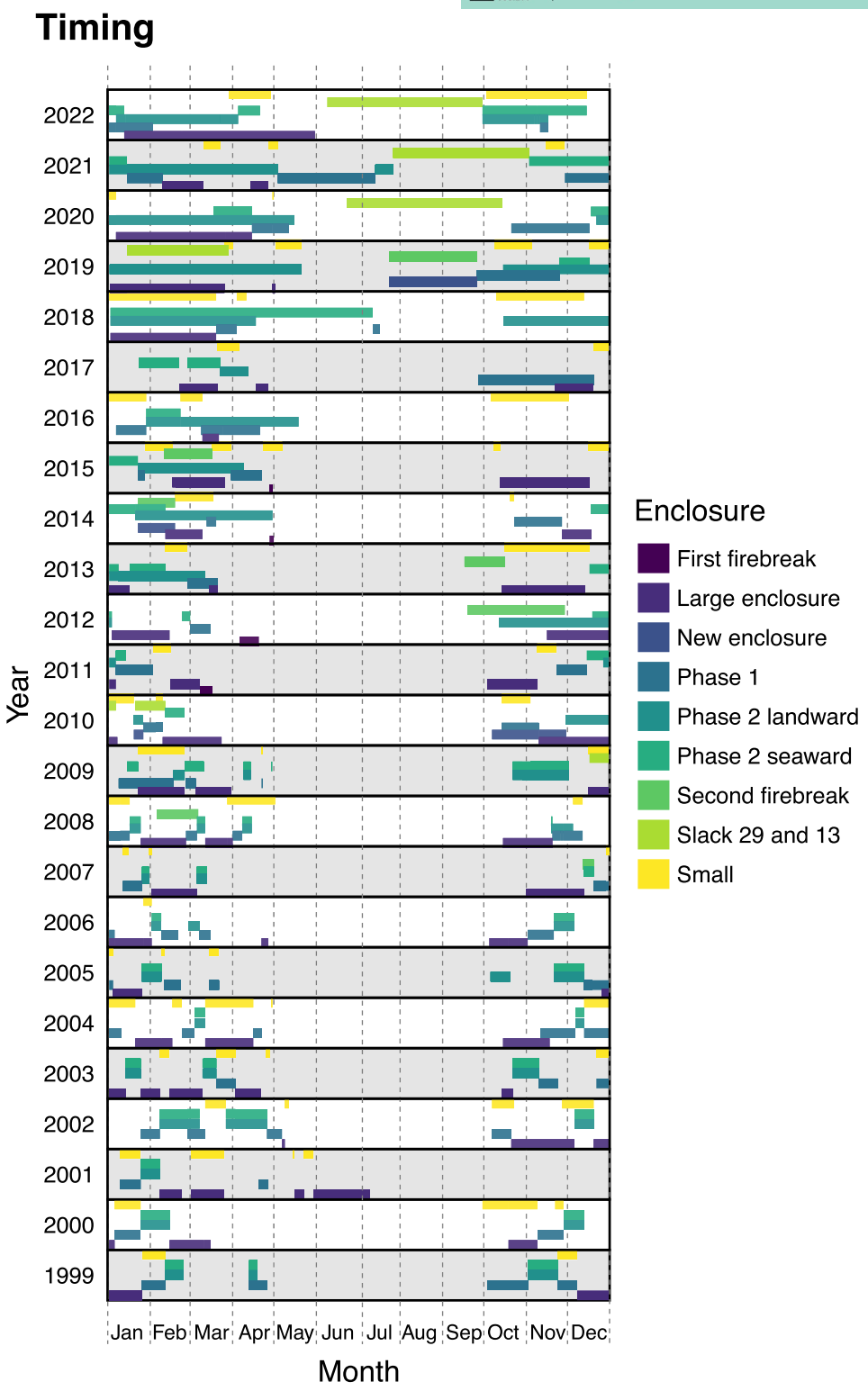

FIGURE 2 Timing of livestock placement within nine grazing enclosures on Ainsdale NNR from 1999 to 2022.

et al., 2024). Smaller herbivores generally select high-quality food due to high energy demand relative to gut capacity, while larger animals can digest lower-quality food due to larger gastrointestinal tracts and their capacity to eat higher quantities (Illius & Gordon, 1993). Large animals like cattle can push through and damage shrubby vegetation in a way that sheep cannot, while smaller animals like rabbits, despite their size, can cause significant disturbance through burrowing (Burggraaf-van Nierop & van der Meijden, 1984). Sheep, with their narrow mouths and highly curved incisor arcades, can access higher-quality parts of plants (Xu et al., 2024) and graze closer to the ground than cattle, and vegetation shortened by sheep can then be grazed by rabbits, which are less able to graze in tall vegetation (Rook & Tallowin, 2003).

Hardier breeds are expected to be better able to use vegetation of poor forage quality (Chapman, 2007) and so traditional or rustic livestock are often recommended for nature conservation (see grazing animal project), but there is limited evidence on the underlying difference in foraging behaviour between breeds (Rook et al., 2004). The digestive process within different breeds is similar, but nutritional requirements may vary between breeds and behavioural differences may contribute to hardiness. Young animals and females typically exhibit greater selectivity in their forage choices than older animals or males (Prache et al., 1998). Furthermore, learned behaviour and experience may influence how livestock interact with the sward (Prache et al., 1998).

Ainsdale NNR is grazed with a herd of approximately 200 Herdwick sheep (1990-present), 6–32 Hebridean sheep (2005–present), 8 Icelandic sheep (2010–2020), 3–5 Shetland cattle (2008–present) and 4 Longhorn cattle (2022–present). Rabbit numbers vary year-to-year, so grazing pressure cannot be relied on. The sheep graze the open dunes; cattle graze the open dunes and woodland. The introduction of different livestock serves various ecological purposes, with each breed contributing differently to vegetation management. The herd of Herdwick sheep is sourced through a collaboration between Natural England and a hill sheep farmer in Cumbria and so have no experience of grazing coastal dunes. Every October, 250 18-month-old shearling gimmers (sheared once at 15 months, non-pregnant) Herdwick ewes are transported from the farm to Ainsdale NNR, with the number determined by how many sheep can fit into a trailer. Removing these young ewes from the farm during the winter means more food for the remaining ewes and space for the rams. The young sheep need less intervention, which is beneficial to the Ainsdale NNR managers, and winter-only grazing removes the need to find grazing for the sheep in the summer. The farmer covers haulage costs and pays Natural England for the grazing, while Natural England covers staff, volunteer and vet costs. The exchange was initiated by the reserve manager at the time, who had experience from a similar arrangement between a nature reserve and a farm in Cumbria. This pragmatic, dynamic approach to conservation grazing underscores how practicalities shape decision-making.

4 | CHALLENGES AND OPPORTUNITIES

The public use the open dune areas for walking, particularly dog walking, which can pose a particular threat to livestock, and at

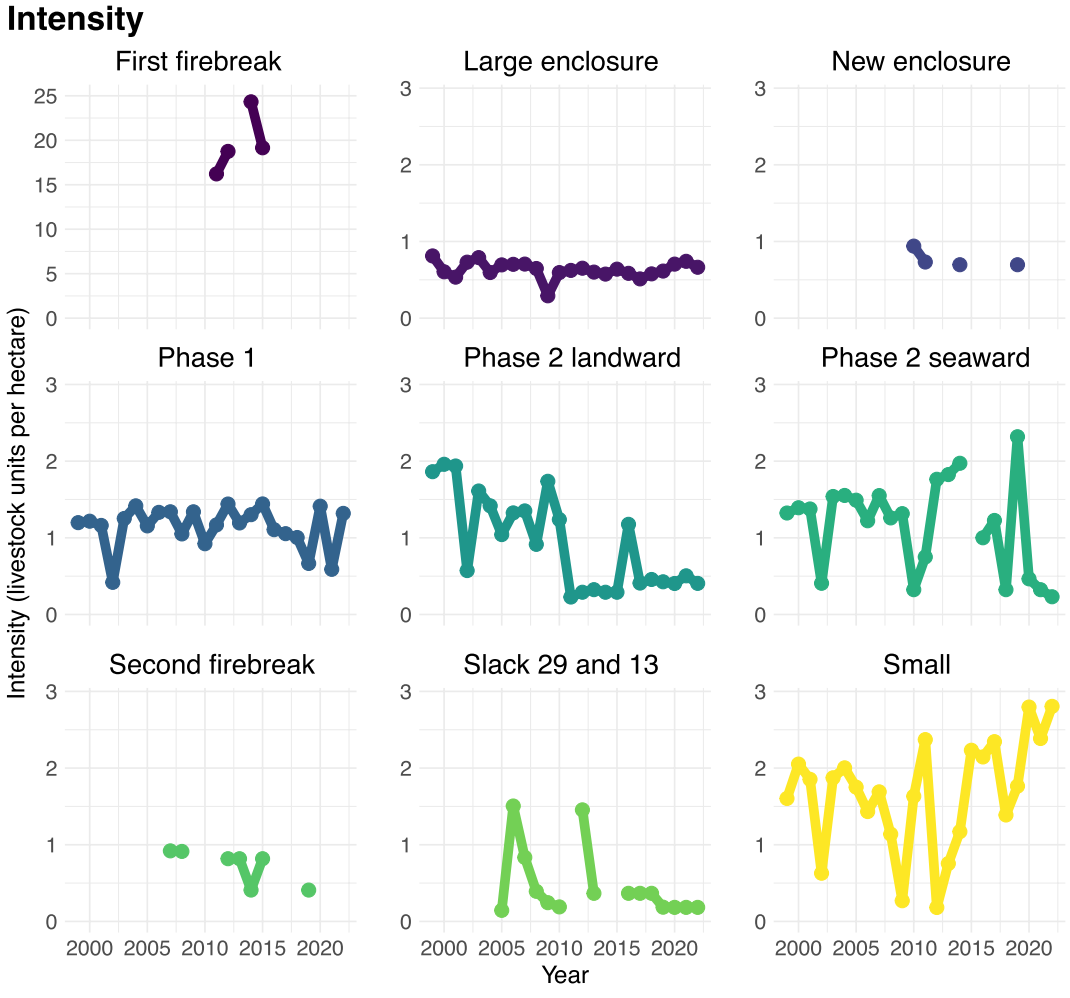

FIGURE 3 Intensity of grazing within nine grazing enclosures at Ainsdale NNR from 1999 to 2022.

Ainsdale NNR livestock have been lost to dog attacks. To reduce public pressure, access was initially restricted across core areas. Initially, a permit system made it easier for the site manager to approach people that breached the access requirements, but the site is now entirely open access and dogs are expected to be kept under close control. A significant number of dogs, however, are observed running off the lead and this affects sheep behaviour. There has also been some strong local opposition to grazing on the reserve, particularly during consultation for introducing grazing to the Sefton Council owned Ainsdale and Birkdale Sandhills Local Nature Reserve in 2012. At that time, at least 40 holes were cut in fences at the NNR overnight and some resistance to grazing remains, but this is much reduced at present.

No fence GPS collars have the potential to revolutionise conservation grazing. The cattle at Ainsdale NNR are fitted with 'Nofence' GPS collars enabling the creation of 'virtual fences' for the cattle, which present new possibilities for managing the grazing pattern without the need for physical fences or barbed wire. The GPS collars may also provide opportunities to graze into the summer through using precision fencing to prevent cattle grazing in sensitive areas. A similar system is available for sheep, and this might provide significant future opportunities for controlling grazing patterns and for understanding where within enclosures livestock are choosing to graze.

5 | PATTERNS OF GRAZING

We present grazing pattern data for Ainsdale NNR, where daily livestock movements have been recorded in paper diaries since 1999. These detail all livestock movements to, from and within the reserve. By transcribing livestock movements, we created a database of livestock numbers in each enclosure over time (Millett et al., 2025). This allowed for detailed summaries of grazing patterns, using data that was easy for staff to collect and useful for daily management.

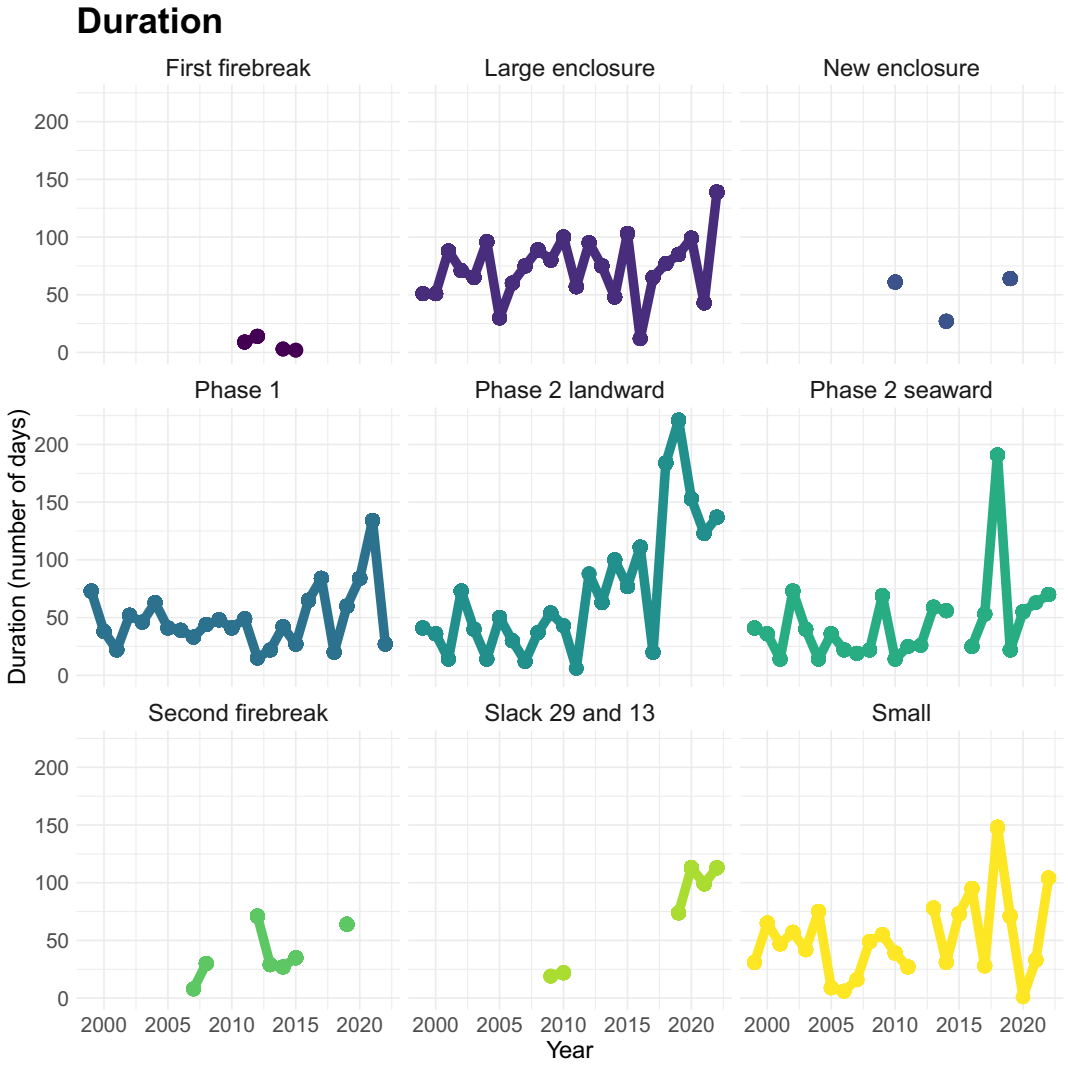

FIGURE 4 Duration (the number of days per year) for which livestock grazed each of nine enclosures in each year from 1999 to 2022.

5.1 | Timing

Timing relates to the time of the year when grazing takes place and is important because of seasonal differences in the impact of grazing on plants (Figure 2). At Ainsdale NNR, the original winter-grazing regime suited the grazier and the site at that time. On average, grazing starts in October and ends in April, and timing varies slightly across years and enclosures, though slacks 29 and 13 were recently switched to summer cattle grazing. Winter grazing is challenging due to lower forage quality and weather-related access issues but generally has a lesser impact as many species are dormant and recover in the growing season. Summer grazing causes more desirable disturbance to vegetation but also presents some difficulties, including damage to flowers (particularly orchids) and impacts on Natterjack toad breeding success due to poaching around pools and trampling risks. Additionally, increased public interactions in summer, especially with dogs, require more staff management and control.

5.2 | Intensity

The total number of livestock within the NNR represents the 'stocking rate' and is a function of decisions on the number and type of livestock to bring on site (Figure 3). The stocking rate has remained steady but has been increased recently in response to shrub growth. Grazing intensity is a function of the overall stocking rate and livestock placement. The livestock are moved between enclosures as complete flocks/herds, so variations in stocking densities are influenced by differences in the size of enclosures. For example, the 'Large' (44 ha) enclosure has a stocking density of around 0.65 LU/ha, while the 'Phase I' (19 ha) enclosure has about 1.2 LU/ha, and the 'Small' (10 ha) enclosure reaches 2.5 LU/ha. High stocking densities in the 'First Firebreak' reflect short periods when the entire flock was moved into the small enclosure due to dog attacks, and grazing intensity changes in 'Phase 2 landward' correspond to a shift from the Herdwick herd to the smaller Hebridean herd.

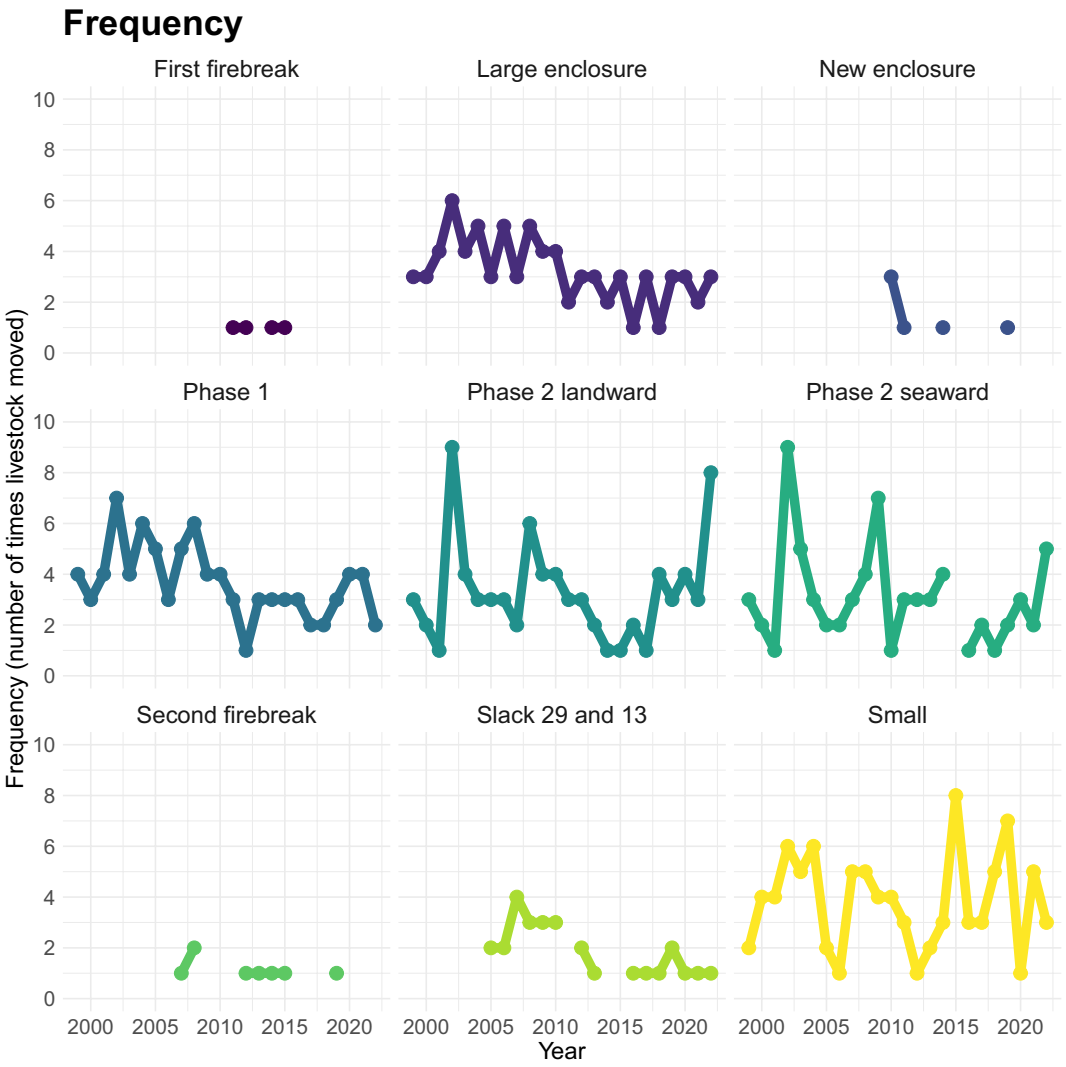

FIGURE 5 The frequency (number of times livestock are moved) with which each of the nine enclosures was grazed within each year from 1999 to 2022.

5.3 | Duration and Frequency

The aim of livestock management at Ainsdale NNR is that every active compartment is grazed annually (Figures 4 and 5). Sheep are moved between enclosures based on visual checks of grass availability, the number of catkins on creeping willow in spring and sheep condition. Decisions made balance animal welfare needs and conservation benefits, resulting in variations in the duration of grazing for different enclosures. For example, the 'Large' enclosure tends to be grazed for longer (around 75 days/year) than the 'Phase 1' and 'Small' enclosures (around 50 days/year). On average, each enclosure is grazed on two to three occasions, and a clear change can be seen in 2010, before which enclosures were grazed more frequently.

6 | ADVICE AND KEY TAKEAWAYS

We have mapped the components of the grazing pattern into a framework (Figure 6) to visualise the grazing pattern and compare between different enclosures and years within a project and between different conservation grazing projects. This can be used to inform management by quantifying the result of on-the-ground decisions and so helping to guide future grazing strategies. Development of this framework to agree on a common point of comparison would enhance understanding and communication of conservation grazing management. For example, at Ainsdale NNR, the differences in grazing regime between the 'Large' and 'Phase 1' and 'Small' enclosures can be seen, with an increase in grazing duration over time and higher grazing intensity in Phase 1.

We offer the following recommendations:

Definitions: Establish clear, agreed definitions of grazing regimes for better communication across conservation projects. We have provided suggestions in Table 3, but a wider consultative process is required.

Framework: Refine and adopt a common framework (e.g. Figure 6) for use across conservation grazing projects. Quantifying the pattern of grazing that falls into different regimes and research to understand how differences in these grazing patterns impact conservation outcomes should be a priority.

Data: Regular data collection and analysis would enable land managers to adjust grazing regimes effectively. Recording daily livestock movement records, even with simple diaries, can provide excellent insight. Developing clear pipelines for data analysis,

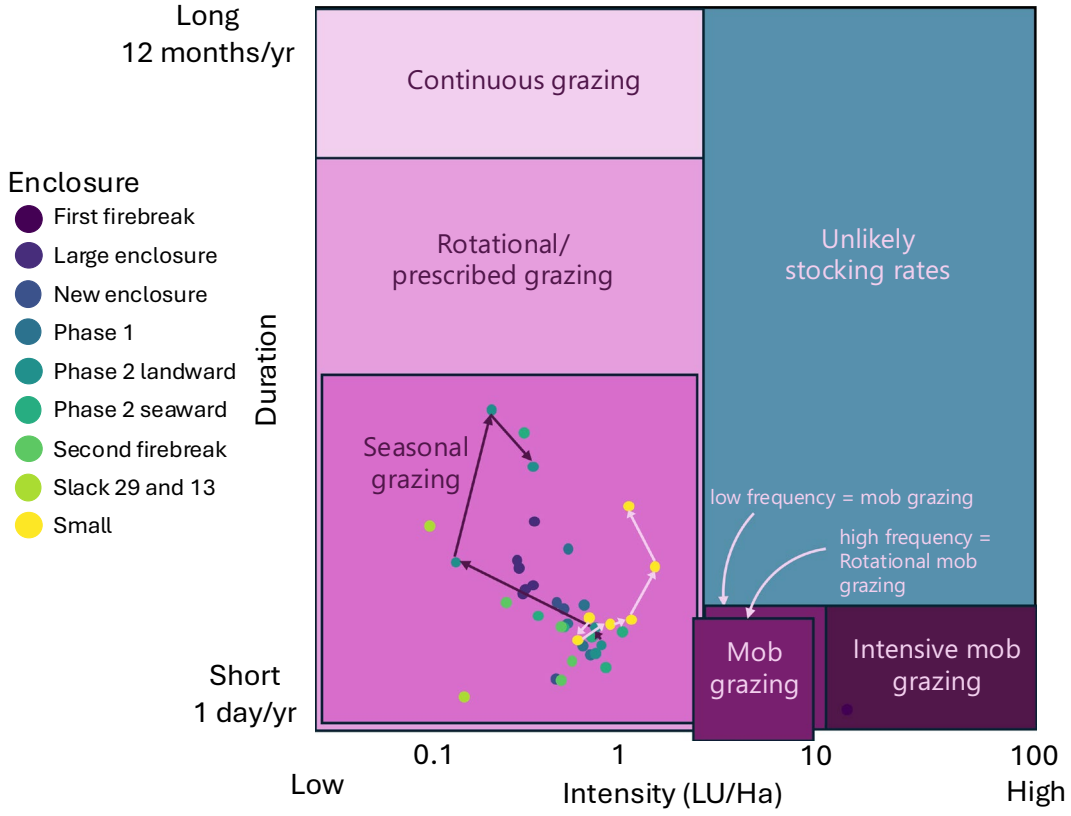

FIGURE 6 Framework for comparing conservation grazing patterns and regimes. Here we consider three of the four components of grazing patterns: intensity, duration and frequency. The intensity and duration of grazing can be plotted to understand how these vary, with frequency as a third axis which overlays this. We have plotted values for each grazing enclosure at Ainsdale NNR, using mean values for four-year periods. We have highlighted changes over time for two enclosures with arrows. Overlayed on this are estimates of where different grazing patterns (Table 3) might lie within this framework. The boundaries of different grazing regimes are illustrative to demonstrate the potential for this approach to aid management decisions.

presentation and reporting alongside (semi-) automation could provide powerful management tools.

Monitoring: Standardised monitoring of plant species before and after grazing would transform the ability to evaluate impacts and would allow comparison of grazing pattern variations both within and between sites. The Natural England Long-Term Monitoring Network might provide a good basis for such standardisation.

Bridging the gap between academics and land managers is essential; limited staff, resources and in-house expertise often hinder managers from moving beyond data collection to effective use in decision-making. Creating detailed datasets such as this one enables grazing patterns to be compared to site condition, which can then be used in decisions on future grazing regimes. These decisions can be on whether to graze or not, what livestock to use and whether other means of vegetation management such as mowing, turf-stripping or scrub removal might be needed to achieve the desired site condition. We demonstrate that collaboration unlocks the full potential of data, especially when organised within a structured framework to share best practices and refine conservation grazing strategies. Standardised data recording within this framework also aligns with policy processes like the Natural England Strategy for Science on NNRs, aiming to strengthen the evidence base for decision-making. By collecting, reporting, and evaluating intervention data, we can drive better outcomes in nature conservation.

AUTHOR CONTRIBUTIONS

Jonathan Millett, Ciara Dwyer and Sally Edmondson conceived the ideas. Jonathan Millett and Sally Edmondson collated grazing data. Natalie Hunt, Charlotte Webster, Peter Gahan, Dave Mercer, James O'Brien and Barry Smith recorded livestock movements and contributed site management information. Jonathan Millett, Ciara Dwyer and Maud M.A. van Soest led the writing of the manuscript. Ciara Dwyer led data analysis and visualisation, supported by Jonathan Millett. All authors contributed critically to the drafts and gave final approval for publication.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

PEER REVIEW

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DATA AVAILABILITY STATEMENT

The original data are available in Millett et al. (2025): https://doi.org/10.17028/rd.lboro.27927405. This contains the raw data and R code used to calculate metrics for the pattern of grazing and a summary of the pattern of grazing (duration, intensity, timing and season) for each enclosure in each year.

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