North Cornwall B-Lines

Creating Pathways for Pollinators

A Review of Species-rich Grassland Management for Pollinators, for the National Trust

November 2023

Large Scabious Mining Bee (*Andrena hattorfiana*) © Paddy Saunders

Patrick Saunders

Kernow Ecology

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Introduction

The document reviews grassland management research and provides management recommendations for flower visiting insects on the North Cornwall Coast.

The North Cornwall coast is of key importance for various bee species because of the landscape scale connected late flowering grassland habitats (Saunders 2016). Key habitats include maritime grassland, dune grassland types and unimproved hay meadows or pastures. Semi-improved grasslands can also be important if they contain clovers. The National Trust manage a significant amount of the most important coastal grassland along this stretch of coast.

This document is mostly aimed for restoration of flower-rich sites for flower visitors rather than semi-natural habitats such as SSSI'S.

Summary

There can be conflicts between the restoration of flower-rich grasslands and the needs of butterflies and grasshoppers, as the former requires high summer biomass removal and the latter need undisturbed areas. Leaving grassland totally unmanaged should not be the alternative as butterflies also need a lot of flowers, and grasshoppers need short habitats.

Cutting and grazing are both useful approaches for maintaining species-rich grassland for both flowers and bees. Hay meadow regimes are a proven culturally important way of delivering a very high density and abundance of flowers. Cutting has some advantages in that site owners can have a lot of flexibility in when and how much to manage. But grazing is also an extremely important management method for species-rich grasslands. Research emphasises a mix of site-specific management methods across the landscape is needed. The document is aimed at species rich grassland restoration sites.

There is agreement between the reviewed papers and my personal experience that autumn cutting and/or winter grazing is safest for invertebrates, but this may conflict with production of hay, weed control and/or nutrient stripping (which all often require earlier removal of biomass). Rotational management of some refuges can be used as a mitigation for such sites. Winter grazing alone can be a simple effective method for maintaining species-rich grasslands, but this may need some nutrient stripping first.

Table 1. below gives a summary of the recommended options for species rich grassland restoration for invertebrates.

Table 1. Species-rich Grassland Restoration Options Flowchart.

Options become better for invertebrate conservation on far right. If site is becoming species-poor revert to middle restoration management or mix options from year to year.

SPECIES POOR →	**RESTORATION** →	**INVERTEBRATE RICH**
Is commercial hay needed ?	Is site flower poor or with high levels of scrub and/or perennial weeds ?	**NO** →
YES ↘	**YES** ↘	AUTUMN/WINTER Either Cut and Collect in September. Ideally leave 10-20% uncut and rotate these uncut sections as blocks, field verges or random strips. Then graze until March or even into April if scrub or tussock grass become more problematic. Or if fertility reduced manage by winter grazing alone. If stocking very high consider fencing off some edges or 10% to leave some winter refuges with tussock grasses.
SUMMER Cut and Collect in mid/late July. If possible leave 5-10 % uncut. AUTUMN WINTER aftermath graze.	SPRING Cut 20-30 % in June. Or graze until May. If breeding birds or Yellow Rattle cut or graze before April. SUMMER Cut and Collect remaining area in mid/late July or August. AUTUMN WINTER Aftermath graze.	Is scrub or perennial weeds increasing ?
	Is it becoming species rich ?	
	YES →	**YES** ←
	(GO FORWARD)	**(GO BACK)**

Overview of Grassland Conservation Management for Pollinators

Maritime grassland and dune grassland because of their low fertility usually require low management and both habitats can support high flower abundance on very light extensive grazing regimes or reduced cutting regimes. The balance between maintaining summer flowering without damaging invertebrate populations becomes more difficult on farmland with deeper soils and/or a history of agricultural fertilisation.

Picture 1: Clover Melitta © Patrick Saunders

Semi-natural meadows contain some of the most species-rich plant and bee communities in Europe, and hay meadows deliver in terms of providing very high abundance and diversity of flowering plants (Peterkin 2013). Yellow Rattle (*Rhinanthus minor,*) is effective in combination with this regime for delivering floral richness (Chaudron et al. 2021). In general, a regular mowing regime followed by hay removal has a positive effect on vascular plant species richness (Parr & Way, 1988) and higher mowing frequency was found more beneficial in more productive grasslands (Talle et. al. 2018). Jakobsson et al. (2018) suggest meadows should be mowed preferably twice per year, and hay should be removed after each cutting, although a study found removal of cuttings by itself generally did not result in significant increases of pollinators or flowers (Noordijk et al. 2009).

Hay meadows can be quite poor habitats for invertebrates, there can be large numbers of insects in hay meadows but of relatively few species (Cizek et. al 2012), and Kirby (1992) considers grazing generally the best management option for invertebrates in grassland. National Trust late-cut meadows on the North Coast at Tintagel and Godrevy support a rich pollinator fauna of scarce and Red Data Book bees. Godrevy Head and The Towans have 13 notable or rare bee species and Trevose Head has 9 notable or rare bee species. Comparing grazed habitats with hay meadows is a bit unfair, as many grazed sites need some cutting and vice-versa, and this document further elaborates why more nuanced approach is often needed. Restoration sites may need higher levels of biomass removal due a legacy of agricultural fertilisation.

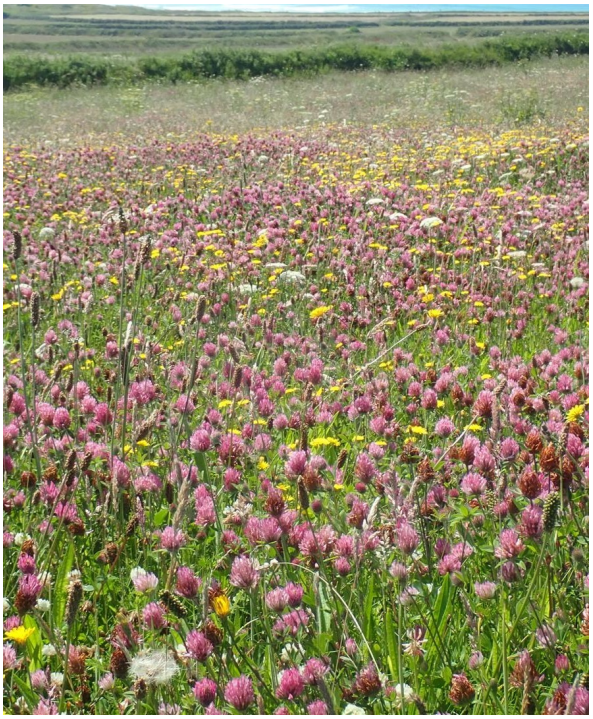
Harvesting and mowing causes very high mortality in invertebrates, with larger adult invertebrates such as grasshoppers and crickets being most affected. Humbert (2010) suggests the use of cutter bar mowers is recommended over rotary and flail mowers, as they cause half as much mortality, but overall mortality caused by hay processing and removal was found so high as to negate most of the benefit of using different cutting devices.

Removal of grassland biomass during peak activity has great impact. Grassland butterflies can be adversely affected by removal of larval habitat particularly in mid-summer (Valtonen et al. 2006). Hay cutting can result in excessive exposure to hot summer temperatures in the absence of taller grass to shelter in for grasshoppers (Gardiner 2022).

Total removal of pollen and nectar resources in the summer peak of foraging periods for bees has obvious negative impacts. Floral resource limitation was found to severely reduce butterfly survival, condition and flight activity for butterflies (Lebeau et. al. 2016). Lebeau (2015) found "scramble competition", whereby Meadow Brown butterflies (*Maniola jurtina*) were forced into the nectar flowers on uncut margins in intensive grasslands.

Management of hay meadows has become more homogenised with modern mechanised machinery and more prescriptive cutting times under agri-environment schemes, which is suggested to be an important factor in the drop in quality and loss of upland hay meadows (O'Reilly 2010). Older traditional systems were probably more flexible and haphazard and thus providing for greater refuges for invertebrates and diversity habitat features.

Grazing also has problems, tall sward flowers rarely seen in numbers unless protected from summer grazing include some vitally important bee resources such as Tufted Vetch (*Vicia cracca*) for Long-horned Bees (*Eucera longicornis*) (Saunders 2018). I have observed Kidney Vetch (*Anthyllis vulneraria*), Field Scabious (*Knautia arvensis*) and Angelica (*Angelica sylvestris)* are all critical for scarce bees and are also very vulnerable to summer grazing. Cornish habitats, particularly the dune sites can maintain a range of shorter habitats of value to a rich fauna included the Chough (Rylands 2012), and summer grazing is sometimes necessary to retain species richness and reduce tussock grasses in extensive semi-natural habitats (Hawes 2015).



Picture 2: Legume rich meadow in Cornwall © Patrick Saunders

Microclimate and aspect can be critical for invertebrates (Weiss et al. 2013). Reviews may underestimate site variability and local factors which can be more important than the "is it better to graze or to cut" question.

Many studies emphasise whole landscape heterogeneity (or mixed farming) is a critical factor to sustain diverse wild bee meta-communities (Maurer et al. 2022). Rare Bumblebees have a long flight period and only maintain viable populations over the landscape-scale. For example, Brown-banded Carder Bee (*Bombus humilis*) in Cornwall move from cliff top grassland in spring to other heathland and dune areas later in the summer (Saunders 2016).

To say either grassland is "better" than woodland or vice versa is very questionable. Scrub edge is a rich and valuable habitat for invertebrates. But there should be serious consideration as this may not add richness; creation of a wood edge habitat with associated generalist species may involve the loss of the specialist open flower rich grassland. Grass-nesting species such as rare bumblebees are vulnerable to predation by Badgers, the same is true for other open ground species such a Skylarks with Foxes which may increase with greater scrub or woodland edge habitats.

Maurer et al. (2022) emphasised open grassland habitats and flower margins supported a richer pollinator fauna than forest edges. Hall et al. (2022) found open landscapes lacking scattered trees scored better for bees. Scherber et al. (2019) found bee species richness significantly lower in forest habitats than in grassland. Grundel et al. (2010) and Winfree et al. (2007) found bee abundance was negatively related to canopy cover. Bobova et al (2015) found butterfly assemblages in Spain are changing with more prevalence of the species of closed canopy habitats with recent extinction events in Spanish butterflies biased towards open ground species. Eckerter et al. (2022) found in forests that canopy cover critical, with abundance of red-listed bee species increasing with the length of forest verges. The least wooded areas of Cornwall like the North Cornish coast, The Lizard and Land's End generally support the richest fauna of rare bee species.

Picture 3: Late cut meadow © Patrick Saunders

Alison et. al (2022) found in Wales the flower and pollinator abundance in woodlands and hedgerows is better than agricultural grassland types or heathland, and infer that woodland creation is beneficial. But the methodology in this study that suggests sampling was biased towards edge not closed canopy woodland. The bulk of the flowers which tipped woodland features into first place was brambles, which is important but more for generalist species.

"Re-Wilding" using extensive less controlled grazing management as implemented at Knepp will involve summer grazing which could be relatively erratic. I was unable to compare in the review but on typical Cornish farmland on deep-rich soils, I believe this would not achieve the "mega" flower abundance of hay meadows, and is more likely to provide a mosaic of scrub and grass with benefits for bush-crickets and dead wood insects rather than rare bees.

Salisbury Plain Training Area is possibly the biggest and best area of bees and flowers in the UK, but has very low soil fertility, it relies on munition testing, wild-fires and tanks to sustain open flower-rich grasslands (Toynton 2002). Cautious monitoring is needed if implementing extensive summer grazing regimes.

Comparison of Management Requirements by a Selection of Important Insect Taxa

Bees, ants, orthoptera and grassland butterflies are all very important taxa in grassland ecosystems. I have included a short review of their conservation management considerations.

Bees

The primary requirement is a high abundance of flowers (pollen resources) with most pollinator groups positively affected by flower cover (Alison et al. 2022). Species-rich grassland should be mowed preferably twice per year, and hay should be removed after each cutting (Jakobsson et al. 2018).

In Cornwall, very late flowering species are important for a suite of threatened species such as Large Scabious Mining Bee (*Andrena hattorfiana*) and Buff-banded Mining Bee (*Andrena simillima)* (Saunders 2023). In general, bees associated with late flowering meadows have experienced greater declines than spring flying pollinators (Balfour, 2018), and boosting late summer flower resources may be the most effective intervention to increase bumblebee populations on farmland (Timberlake et al. 2021).

Picture 4: Long-horned Bee © Patrick Saunders

Generally, a late hay meadow regime or grazing after flowering is recommended. But some research goes against this, Johansen et al. (2019) found in August the proportion of species flowering and flower density are highest in hay meadows that were previously mown around 25th June and had three times as many flowers per area unit as the meadows that were not yet mown.

Nest habitats are also important, including tall grassland for bumblebees or bare ground for solitary species. The nest habitats may not be essential to deliver in one field if in proximity to other habitats such as soft- cliff or dunes with bare ground (see Table 2 and Appendix 1).

Bare ground creation is desirable both for nesting bees, reptiles and other invertebrate species. Bee banks (Saunders 2023) or scrapes (Nichols et al. 2020) being beneficial. Winter poaching by cattle or harrowing may have benefits both to enhance seed establishment and maintain open successional habitats for invertebrates.

Grasshoppers

Grasshoppers can be important as prey for birds and spiders and thus very important as part of the grassland eco-system. They can be present at very low density under too heavy grazing or cutting, which can reduce cover and allow predation. Aim to provide heterogeneous sward with a range of vegetation types including both tall swards (with an optimum height of 10 to 20 cm) and bare ground for basking and egg laying (Gardiner 2022). Humbert (2010) found by September, numbers of adult grasshoppers had dropped to very low levels. Suitable cutting regimes include one at the end of May before nymph hatching and the second one should be delayed until the middle of September after reproduction (Marini et al. 2007). They can be very tolerant of winter management, winter burning was found to lead to higher numbers of Orthoptera in the post-burn year (Gardiner, et al. 2005).

Humbert (2010) demonstrates that providing uncut grass refuges is an effective measure to mitigate the negative impact of the harvesting process on grasshoppers. Leaving a refuge equal to 10% of the meadow surface increases final grasshopper population by approximately 60% (Humbert 2010).

Picture 5: Sawwort on maritime grassland

Butterflies

Common grassland butterflies can be quite tolerant of meadow management, but some species are vulnerable, as larvae can occur quite high in the sward.

Picture 6: Marbled white © Patrick Saunders

Butterfly Conservation advises leaving at least a third uncut each year, which allows breeding and overwintering for a variety of grass-feeding lepidoptera and other invertebrates (Cruickshanks 2018). The evidence supporting this is mixed and as mentioned before contradicts evidence for bees. Colom et. al. (2021) found abandonment of grassland led to significant reductions in the cover of typical grasslands plants, resulting in changes in butterfly assemblages including the populations of some legume-feeders collapsing. Valtonen et al (2006) found that by delaying the annual mowing until late summer or promoting mosaic–like mowing regimes, such as partial mowing, the quality of road verges as habitats for butterflies and diurnal moths can be improved. Rotationally mown grassland had a greater abundance and species richness of butterflies than annually mown grassland (Handek 2011).

Handek (2011) found that grassland cut in autumn had a higher abundance, but not species-richness, of butterflies than grassland cut in summer.

Valtonen et al (2005) found Ringlet (*Aphantopus hyperantus*) population densities showed little difference between late cut and partially mown areas. In this study results from completely uncut grassland areas were variable having either slightly higher or much lower population densities than the late cut areas, emphasising further this butterfly is quite tolerant of cutting management.

Ants

Wynhoff et al. (2011) found that highest abundance of ants is achieved by rotational mowing. A scheme of late (Sept-Oct) mowing with early summer mowing periodically (every 3-6) years, was effective to maintain ant diversity. Early mowing was needed to reduce scrub which was not effectively reduced by autumn cutting alone.

Nest mounds of Yellow Meadow Ant (*Lasius flavus*) are vulnerable to heavy machinery. Some micromanagement to protect nests mounds and/or encourage bare ground for nesting could be required.

Table 2. Important factors for invertebrates

Scrub edge	Cut in Autumn on a 5-10 year rotation. 2m wide round field boundary or less than 5% of field unit. If very high value site or small fields avoid too much scrub.
Tussock	Cut in Autumn. Cut every other year. 4m wide verge or 5-10% site. If possible rotate management either alternate fields or verges so some tussock grass is always left uncut. Another option is to leave a randomised one strip in 10 uncut.
Spring cutting or grazing	Caution needed! Spring cutting beneficial if high nutrient removal needed in early years for flower-rich restoration. Or ad-hoc small compartment for heterogeneous management. Caution needed to avoid cutting Yellow Rattle (*Rhinanthus minor*) or other hemiparasitic annuals. This is the best option to target difficult patches of Bracken or scrub encroachment.
Extra Late areas	Designate areas with important plants like Field Scabious (*Knautia arvensis*) or Devils Bit Scabious (*Succisa pratensis*) for late cutting areas. Cut in September or October once flowering has finished.
Timing	If possible, to increase the probability of escaping mowing machines, mowing ideally is better after the morning or when the area is warm and sunny. If possible, leave hay on site for a time to allow larvae to escape. Ideally near uncut areas.
Rotational	Any refuges are best either as hedgerows, verges or randomised areas cut in next year. Maybe possible to specify leave 1 in 10 rows uncut for contractor, but if too complicated rotations over fields possible say leave 1 field in 4 Uncut.
Scrapes	Every 3-4 years create some new bare ground features either scrapes or scuffed up areas.
Anthills	If possible, avoid driving over obvious Yellow Meadow Ant nests.
Wet Features	Ponds and ditches are valuable. Spoil from pond creation can complement bee bank creation.
Harrow or rotavate	Small areas could be of value.
Winter Poaching or Tracks	Round gates etc. can be valuable additional bee nesting areas. Permanent tracks with wheel ruts. Erosion such as footpaths can be valuable.
Green Hay	Local provenance introduction of selected species of high value is of value (Appendix 1.)
Dung	Livestock dung in spring / summer is of great value for invertebrates.
Yellow Rattle	Introduce local provenance Yellow Rattle to boost flower diversity.

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Appendix 1. Priority bees and associated key flower groups

Group	Flowers	Bees	Rare
Late aster	Cats-ear (*Hypochaeris radicata*), Hawkbits (*Leontodon spp.)* Hawks-beards (*Crepis spp*.) Ragwort (*Senecio*) Bristly Oxtongue (*Picris echioides*) Smooth Sow-thistle (*Sonchus oleraceus*)	Cat's Ear Nomad Bee (*Nomada integra*) Buff-tailed Mining Bee (*Andrena humilis*) Hawk's-beard Mining Bee (*Andrena fulvago*) Large Shaggy Bee (*Panurgus banksianus*) Pantaloon Bee (*Dasypoda hirtipes*)	NS NS NS Local NS
Late aster	Knapweeds (*Centaurea spp*.)	Buff-banded Mining bee (*Andrena simillima*) Black-headed Mining Bee (*Andrena nigriceps*)	RDB NS
Late aster	Fleabane (*Pulicaria dysenterica*)	Spined Mason Bee (*Osmia spinulosa*) Grey-banded Mining Bee (*Andrena denticulata*)	Local
Late mix	Late Asters and Legumes	Coastal Leaf-cutter Bee (*Megachile maritima*)	Local
		Brown-banded Carder Bumblebee (*Bombus humilis*)	S.41
		Moss Carder Bumblebee (*Bombus muscorum*)	S.41
		Green-eyed Flower Bee (*Anthophora bimaculata*)	Local
		Margined Colletes (*Colletes marginatus*)	NS
		The Silvery Leafcutter Bee (*Megachile dorsalis*)	NS
		Black Mining Bee (*Andrena pilipes sens. lat*.)	NS
		Orange-footed Furrow Bee (*Lasioglossum xanthopus*)	NS
Late Legume	Meadow Vetchling (*Lathyrus pratensis*) Tufted Vetch (*Vicia cracca*)	Long-horned Bee (*Eucera longicornis*)	S.41
Legume	Birdsfoot Trefoils (*Lotus sp*.)	Gold-fringed Mason Bee (*Osmia aurulenta*)	Local
Legume	Clovers (*Trifolium sp*.)	Clover Mellita (*Melitta leporina*)	Local
		Blunthorn Nomad Bee (*Nomada flavopicta*)	NS
Late mix	Field Scabious (*Knautia arvensis*)	Large Scabious Mining Bee (*Andrena hattorfiana*)	RDB
Late mix	Devils-bit Scabious (*Sucissa pratensis*)	Formerly important for Small Scabious Mining Bee (*Andrena marginata*)	NS
Umbell	Angelica (*Angelica sylvestris*)	Perkins Mining Bee (*Andrena rosae*)	RDB
Bartisia	Red Bartsia (*Odontites vernus*)	Red Bartsia Blunthorn Bee (*Melitta tricincta*)	NS

Bold highlights species either present on this site or occurring nearby
NS=Nationally scarce (Falk 1991) RDB = Red data Book (Falk 1991) Local = Localised species