

Collecting scientific knowledge for conservation decision-making: Sustainable wildflower meadow planning and implementation of rewilding conservation in County Durham

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1. Introduction

Biodiversity has declined rapidly due to increasing anthropic impacts and climate change. (Living Planet Report 2020; Johnson et al., 2017) The UK is facing a decrease in species abundance of an average of 13% and 15% of species within the UK face the risk of extinction. Over decades, the importance of natural conservation and conservation studies has increased to tackle this biodiversity crisis. (National Biodiversity Network, 2019) However, conservation projects are not easily implemented due to the uncertainty of the management and output. (Sanderson et al., 2022) In decision-making, scientific evidence and learning from experiences are key to planning and managing sustainable and effective conservation. Therefore, scientific experimental knowledge of decision-support tools that guide where, how, and when conservation actions should occur is essential for practical and effective conservation. (Grantham et al., 2010)

Environmental conservation can be on various scales and applied to various landscapes. Wildflower meadow establishment is one of the cheap and effective biodiversity conservation methods as it does not cost much time, money, and effort, but meadow is key vegetation for local ecosystems providing food and habitats. Some studies show that the establishment of wildflowers can increase local biodiversity and add heritage values to the land for local people. (Ahern et al., 1992; Grass et al., 2016 ; Marshall et al., 2023) Therefore, wildflower meadows can be one of the most useful methods to be implemented, but more research is needed to identify the most effective method to create sustainable and biodiverse meadows.

In terms of large-scale conservation, County Durham consists of various landscapes and rare ecosystems protected as nature reserves or Areas of outstanding natural beauty (AONBs). On the other hand, Durham Council declared an ecological emergency in 2022 and County Durham needs further actions on both large and small scales of conservation for nature and biodiversity. (Durham Council, 2022). Moreover, Durham is located between North Cumbria and York, both of which have high-quality habitats. Therefore, effective conservation in County Durham is key to increasing the connectivity of biodiversity-rich areas across England for national biodiversity preservation.

My summer project collected scientific experimental evidence from four projects to help conservation decision-making from the county scale to the small urban area scale such as Durham University Estate. This study focuses on emerging new conservation methods, Rewilding, and wildflower meadow implementation for urban areas. The first three projects will help with where to plant wildflowers, how to create and how herbivory impacts meadows, all of which are key for effective and sustainable wildflower meadow conservation. The last report discusses the potential benefits and implementation of rewilding practices in County Durham for future conservation implementation. This report includes abstracts of each project, but full reports can be found at the link below each abstract.

2. Evaluation of Wildflower Meadow Establishment Methods

Abstract

Flower meadow is a managed landscape and there are multiple establishment methods. As wildflowers are sensitive to the fertility of soil and competition against weedy plants and grass, the removal of vegetation from the introduction sites is key in management before sowing seeds. So, this study investigated the best method for sustainable and biodiverse wildflower meadow establishment. Meadows were created at Botanic Garden in 2021 and at St Mary's College in 2022 at Durham University by six different methods including rotavating, chemical spray, strimming grasses (Strim), planting plug (Plantplug), blocking out land by a black cover and removing upper soil (Turf) as shown Figure 1. Turf, splay (R_S) and black-out (R_B) were applied after rotavating. The vegetation survey was conducted to compare Shannon diversity, plant composition, and species richness between different sites, years, and methods. There was a significant difference in Shannon diversity among the six treatments in 1st year of establishment with the highest diversity by R_B in both Botanic Garden and St Mary's College. In contrast, there was no significant difference among the six treatments in 2nd year. Table 1 and Figure 2 illustrate the diversity was high at rotavating and combinations of rotavating and other methods in both sites and both years. The plant composition from 1st year and 2nd year changed massively from annual to perennial flower, but both years showed dominant wildflowers like Corn chamomile in 1st year and ox-eye daisy in 2nd year with tall vegetation. The results suggested that rotavating and other treatments can create more diverse and sustainable wildflower meadows while Plantplug and Strim showed worse, but annual flowers need more management to continue flowering. So, to keep annual flowers and high evenness of meadow, more sowing of annual plants and less sowing density might be useful.

A link to the report: [Wildflower Survey report.docx](#)







Establishment method	Details of methods	Pictures
Durham Wildlife Trust Rotavate (DWT)	The topsoil was turned over and mixed by a rotavator and the seeds were sown.	
Rotavate Turf (R_T)	The all topsoil and grass were removed, and the seeds were sown to the subsoil.	
Rotavate & Spray (R_S)	Herbicide spray with a concentration of 200ml/1L water	
Rotavate & black out (R_B)	The soil was rotavated and black matting covered the soil.	
Strim Scalp (Strim)	The grass was very close to the soil and raking was applied as scarification. Then the seeds were sown.	
Plant plug (PlantPlug)	Matured wildflowers were transplanted at the ground directly. The grasses were cut shortly before they were planted.	

Figure 1 Six different methods of wildflower meadow site preparation

Biodiversity data and species richness

Methods	DWT		R_T		R_S		R_B		Strim		Plantplug	
Measurement	Mean Shannon Diversity	Species richness	Mean Shannon Diversity	Species richness	Mean Shannon Diversity	Species richness	Mean Shannon Diversity	Species richness	Mean Shannon Diversity	Species richness	Mean Shannon Diversity	Species richness
Botanic Garden 1st year	1.553	15	1.926	24	1.684	17	1.998	21	1.662	18	1.350	16
Botanic Garden 2nd year	1.818	20	1.757	24	1.523	20	1.717	17	1.819	16	1.559	22
St Mary 1st year	1.326	12	2.100	17	1.675	14	1.834	16	1.508	13	0.655	7

Table 1 Shannon diversity index of wildflower community from different treatments, years, and sites.

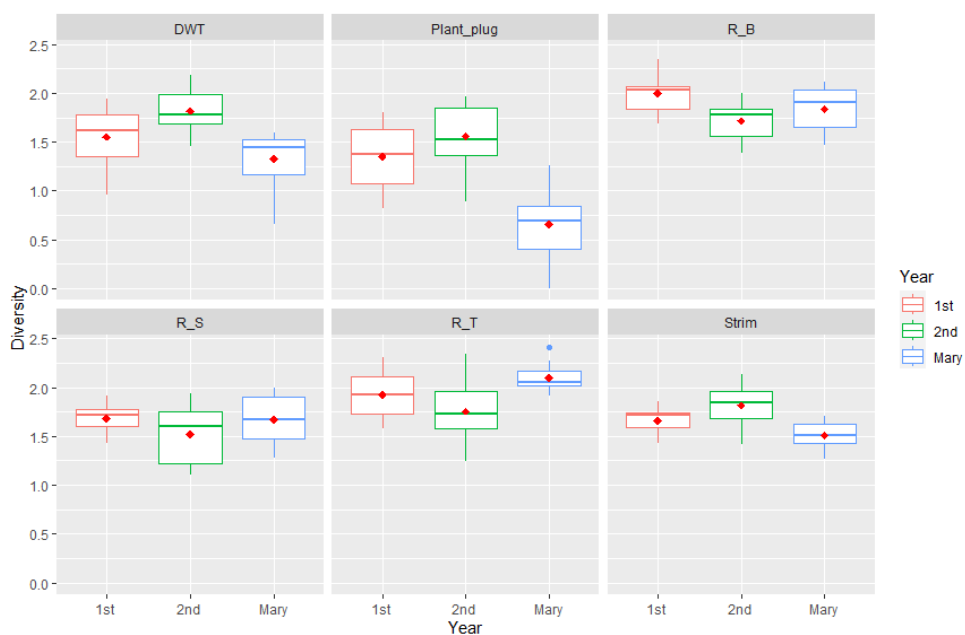


Figure 2 Boxplot of Shannon diversity index of wildflower community from trial meadow with different establishment treatments. The red plot shows the mean value of each Shannon diversity index.

Spiked Speedwell	Veronica spicata											13		
Tufted Vetch	Vicia cracca	17	11	17			13	13		17		17	13	
Upright Hedge Parsley	Torilis japonica													
White Campion	Silene latifolia	13	10	14	11	17		22	10			11	14	11
Wild carrot	Daucus carota	20	24			13		13				13		
Wood Sage	Salvia nemorosa		7	14	13	22	11					9		10
Yarrow	Achillea millefolium	11	11	14		8	7		10			10		22

Common name

Percentage of germinated seeds in first four weeks (Germination success) / %

Common name	Scientific name	A-100-O	A-100-G	A-50-O	A-50-G	B-100-O	B-100-G	B-50-O	B-50-G	C-100-O	C-100-G	C-50-O	C-50-G
Betony	Betonica officinalis	0	20	10	0	0	0	0	0	0	10	0	0
Birdsfoot trefoil	Lotus corniculatus	80	90	90	60	60	80	0	40	40	90	60	70
Columbine	Aquilegia vulgaris	0	0	0	0	0	10	10	0	10	20	30	0
Common Knapweed	Centaurea nigra	60	50	80	50	20	20	30	60	10	60	20	80
Common Agrimony	Agrimonia eupatoria	0	0	10	10	0	0	0	0	10	0	0	0
Common Daisy	Bellis perennials	40	60	60	40	30	40	20	30	70	30	40	30
Cowslip	Primula veris	0	0	0	10	20	10	0	0	10	0	0	20
Field Scabious	Knautia arvensis	20	20	10	40	30	40	10	20	0	50	0	30
Foxglove	Digitalis purpurea	30	10	10	20	0	0	0	10	0	40	0	10
Giant Bellflower	Campanula latifolia	0	0	10	0	0	0	10	0	0	0	20	0
Greater Knapweed	Centaurea scabiosa	20	20	60	90	30	50	30	40	30	60	10	80
Jacob's ladder	Polemonium caeruleum	20	30	20	30	30	10	20	10	20	50	50	0
Kidney vetch	Anthyllis vulneraria	60	90	70	80	70	80	60	80	70	90	0	90
Lady's bedstraw	Galium verum	60	100	70	80	70	90	40	80	30	60	0	60
Lady's mantle	Alchemilla mollis	0	10	30	10	40	0	20	0	0	10	10	0
Meadow Buttercup	Ranunculus acris	10	10	0	40	0	50	40	10	0	40	20	10
Meadow Cranesbill	Geranium pratense	0	0	0	0	0	10	0	0	20	10	20	0
Nettle-leaved bellflower	Campanula trachelium	0	0	0	0	0	0	10	30	0	40	10	0
Ox-eye daisy	Leucanthemum vulgare	10	50	20	50	10	50	0	90	20	60	40	40
Red Campion	Silene dioica	0	0	0	0	0	0	0	0	0	0	0	0
Salad burnet	Sanguisorba minor	100	100	40	80	70	100	90	80	70	90	90	90
Self-heal	Prunella vulgaris	20	20	20	20	40	20	20	20	10	60	40	10
Sheepsbit	Jasione laevis	0	0	0	0	0	0	0	0	10	0	0	0
Small Scabious	Scabiosa columbaria	0	30	30	20	0	20	0	20	0	30	0	20
Spiked Speedwell	Veronica spicata	30	30	30	30	0	20	0	0	0	80	0	10
Tufted Vetch	Vicia cracca	50	60	50	40	30	50	70	40	60	20	60	70
Upright Hedge Parsley	Torilis japonica	0	40	0	10	0	0	0	0	0	20	0	10
White Campion	Silene latifolia	60	80	60	70	70	40	50	70	10	60	80	60
Wild carrot	Daucus carota	60	60	40	70	40	60	10	40	20	70	20	20
Wood Sage	Salvia nemorosa	40	70	50	60	50	50	10	0	30	60	0	80
Yarrow	Achillea millefolium	50	70	50	40	70	90	0	70	40	100	0	60

Figure 3 (a) The number of days to germinate 50% of wildflower seeds for each condition; the deeper red colour shows the later germination. (b) Percentage germinated seeds in the first four weeks to measure germination success of each condition; The deeper the colour is the higher the percentage is.

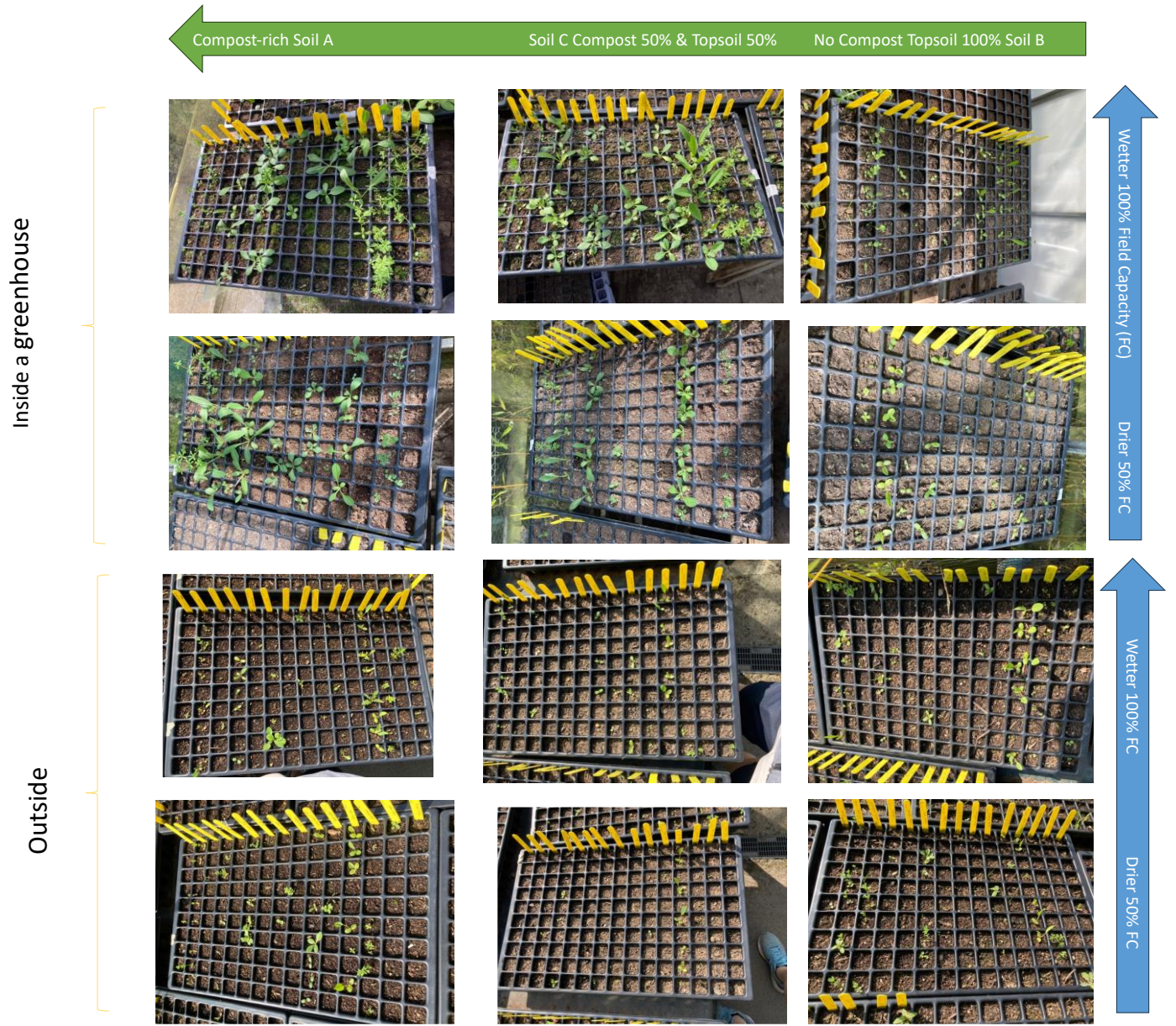


Figure 4 Comparing the germination success and speed with pictures of trays that contain the same wildflower species seeds at the same location in 4th week of the germination trial.

4. Grazing impacts on wildflower establishment and growth

Abstract

There are dynamic and complex interactions between herbivores and vegetation shaping ecosystems and thus biodiversity value. (Hester et al., 2006) Wild Rabbits (*Oryctolagus cuniculus*) are one of the main herbivores in the UK and they show both negative and positive impacts of grazing and disturbance on vegetation. So, rabbit grazing might affect the establishment of wildflowers, their growth, and sustainability. Therefore, this study going to evaluate the wildflower foraging pattern of rabbits and its impacts on plants. Each of six pairs of similar matured wildflowers was left with and without nets at three different sites with camera traps. Then the change in maximum height, the percentage of grazed leaves and the frequency of rabbit visits to see their grazing style and population. There was strong rabbit grazing preference and effects on grazed wildflowers removing all leaves and stems such as hawkweed, loosestrifes, viper's bugloss and wild carrot. Due to their all-or-nothing grazing styles as Figure 4 shows, the plant did not show regeneration and decreased the maximum height significantly. However, in a meadow, the impact on wildflowers might be different as rabbits can disturb plants by tramping and making burrows with grazing, but this study showed the specific preference of rabbits and the significant impacts of grazing at some wildflower species.

A link to the report: [Effect of rabbit grazing on wildflower establishment.docx](#)



Figure 4. The pictures of before and after rabbit grazing and the red circle showed the grazed sites. Both Yellow loosestrife and common knapweed were grazed from the stem completely.

5. The large and small-scale rewilding implementation in County Durham

Abstract

Rewilding is an emerging conservation approach which restores lost self-sustainable and ecological function by reducing or minimising human intervention and the rewilding contains a wide range of practices from Figure 5. The framework of rewilding conservation is an analysis of post-sustainable ecosystems and their current state, ecological viability assessment and adaptive management by monitoring. This review identified lost species and vegetation in County Durham and evaluated the benefits and limitations of rewilding practices for further conservation actions. Durham is located between high habitat quality areas of North Cambia and Yorkshire, but Durham's lack of woodland cover limits the reintroduction and natural expansion of locally lost species such as pine marten and red squirrel. Passive rewilding can be one of the solutions as non-human intervention lands slowly establish woodland that is suited to the local environment, which creates more resilient and biodiverse woodland habitats. However, passive rewilding will not be fast enough to catch up with the expansion of pine marten and red squirrel populations, so active tree plantation and passive rewilding are conducted together to create more heterogeneous extensive woodland. Natural grazing can be applied using livestock and managing the population actively to keep optimal stock density by active rewilding. Also, grazing can replace mowing, which tends to create more mosaic vegetation and slower vegetation change for the arthropod community. Furthermore, the reintroduction of locally extinct plants might recover specific interactions with other local species such as moths for black poplar and flowers for specialised bees. In addition, increasing the functional diversity of vegetation by reintroduction can raise the resilience of the ecosystem. Large-scale rewilding-land management should be considered to create more habitats. For example, stage zero river restoration can provide more habitat for aquatic communities and ecosystem service. In addition, stopping moorland burning might allow more plants to grow in Durham moorland. On a small scale, urban rewilding emphasises the importance of creating habits in urban areas using nest boxes and bug houses for urban ecosystems, which can also be applied at Durham University. Overall, rewilding practices can be used on big and small scales, and they will bring positive impacts on the local system, but careful feasibility study and communication with the local community is the key to implementing and running sustainable conservation.

A link to the report: [Rewilding desk reserach.docx](#)

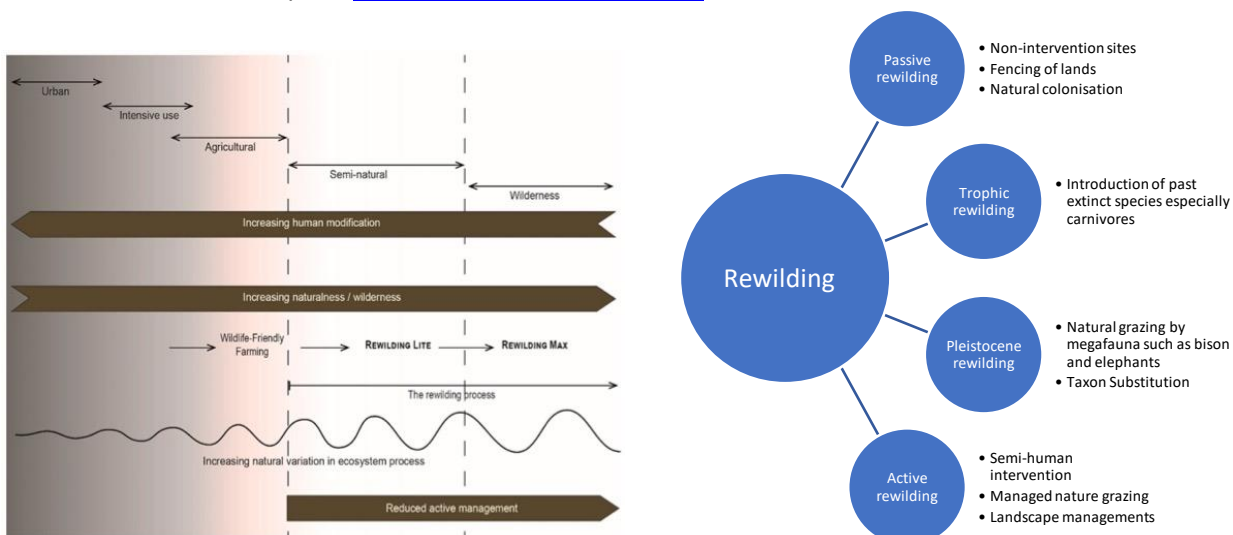


Figure 5. (a) Left diagram showing different degrees of human management and rewilding conservation image from Gordon, I.J., Pérez-Barbería, F.J. and Manning, A.D., 2021. Rewilding lite: Using traditional domestic livestock to achieve rewilding outcomes. *Sustainability*, 13(6), p.3347. (b) Right diagram showing multiple branches and approaches of rewilding

6. Discussion and Conclusion

Overall, this research identified effective wildflower management and establishment methods and the potential future conservation using rewilding practices. This scientific knowledge plays a key role in decision-making and provides valuable information for an evidence-based conservation approach. (Fazey et al., 2006) While scientific literature can inform effective management, many conservation plans remain unimplemented due to a lack of communication and social consideration of the influence of conservation. (Ban et al., 2013; Fazey et al., 2006) Talking to moorland managers and farmers, some land management is inherited with a long history, and it is an important culture, so it is difficult to make space for rewilding. The balance between ornamental flowers and wildflower meadows is also important for pollinators and people who visit the site. Therefore, careful consideration of both ecological and social conservation approaches with clear communication is key for conservation implementation. I wish to focus on scientific communication and conservation planning in a second-year summer leadership program using my research experience.

7. References

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