

Restoring species-rich grassland at New Grove Meadows, Monmouthshire, Wales, UK

Janice S. Winder*

Box Bush, Birches Road, Penallt, Monmouthshire, NP25 4AW, UK

SUMMARY

Concern over the decline in species-rich grassland in the UK has led to a focus on restoration. This study looks at the rate of natural colonisation of species into semi-improved grassland from adjacent unimproved species rich grassland over a 12 year period. During this period the grassland had been managed traditionally with an annual hay cut followed by aftermath grazing and no input of fertilizer or farm yard manure. During 2000 and 2012 vegetation surveys were carried out on two unimproved fields and two semi-improved fields. These data were analysed for species-richness using two variables; Total species, and Wildlife Site Indicator species. A National Vegetation Classification survey was undertaken in 2012. Species-richness increased significantly in the semi-improved meadows during the study period. These meadows now meet the criteria for Wildlife Site designation and the National Vegetation Classification community is shifting from MG6 to the target community MG5.

BACKGROUND

Species rich grassland has suffered a dramatic decline in the UK over the past 100 years. Lowland semi-natural meadows have declined more than any other grassland type since the 1930's (Fuller 1987). Consequently there has been a major focus on re-creation and restoration of species-rich grassland (Defra 2006).

Methods of restoring species-rich meadows have proved effective such as hay strewing, brush harvesting (Edwards *et al.* 2007), cessation of artificial fertilizers (Kirkham *et al.* 2007) and the introduction of the hemiparasitic plant Yellow-rattle *Rhinanthus minor* (Pywell *et al.* 2004; Hellstom *et al.* 2011).

Hayes & Tallowin (2007) demonstrated that the most effective management for natural restoration involves hay cutting followed by aftermath grazing combined with no fertilizer input. Natural colonisation can only occur when there is a local seed source and a mechanism for dispersal of this seed into the restoration site.

This study at New Grove Meadows aimed to quantify the rate of species colonisation of traditionally managed semi-improved grassland when it is adjacent to species-rich grassland.

ACTION

Study site: New Grove Meadows is situated on the Trellech plateau in Monmouthshire, (grid ref: SO501069) at an altitude of 240m. The soil is free-draining brown earth over Lower Red Sandstone. The 5.34 ha site comprises four meadows (Figure 1); two unimproved and two semi-improved.

In 1997, New Grove Meadows were purchased by Gwent Wildlife Trust. A small 2.27 ha site comprising two unimproved species-rich fields, National Vegetation Classification community (Rodwell 1992) MG5a *Cynosurus cristatus-Centaurea nigra* grassland, *Lathyrus pratensis* sub-community (Countryside Council for Wales 1994 unpublished). The fields are of high conservation quality

supporting one of the largest populations of Green-winged orchid *Anacamptis morio* in Monmouthshire. Other species of interest include Common Spotted-orchid *Dactylorhiza fuchsia*, Common Twayblade *Neottia ovata*, Dyer's Greenweed *Genista tinctoria*, Moonwort *Botrychium lunaria* and Adders-tongue Fern *Ophioglossum vulgatum*. Competitive grass species are rare. The site is also important for waxcap fungi and dormice are present in the hedgerows. Previous management is unclear, though indications suggest that there were no recent fertilizer treatments or grazing management prior to purchase (Gwent Wildlife Trust 2002).

In 1998 two adjacent fields (3.07 ha) were purchased, and by contrast, these were semi-improved and dominated by grass species (herbaceous species were present but in low abundance). In 1998 these fields were classified as MG6b *Lolium perenne-Cynosurus cristatus* grassland, *Anthoxanthum*

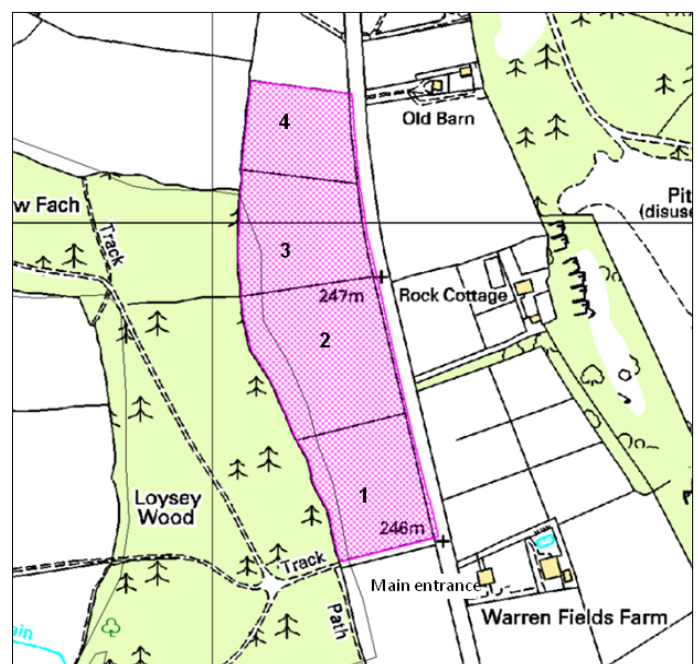


Figure 1. New Grove Meadows, SO501069 (Gwent Wildlife Trust 2002). Fields 1 and 2 are semi-improved; Fields 3 and 4 are unimproved.

* To whom correspondence should be addressed: boxbush01@btinternet.com

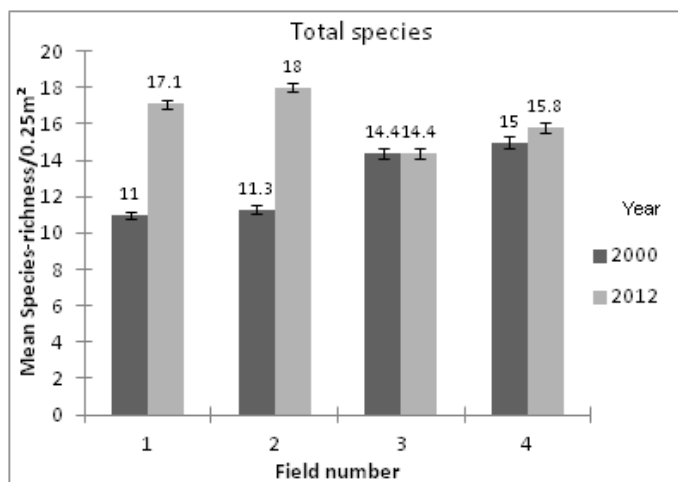


Figure 2. Total species. Means and standard error of species-richness/0.25m². A two-tailed t-test for independent samples show that the mean species-richness has increased significantly in Field 1 ($t = -19.56$; d.f. = 98; $P < 0.0001$) and Field 2 ($t = -21.17$; d.f. = 98; $P < 0.0001$); and not significantly in Field 3 ($t = 0.09$; d.f. = 98; $P = 0.924$) and Field 4 ($t = -1.69$; d.f. = 98; $P = 0.094$).

odoratum sub-community (Gwent Wildlife Trust 2002). Previous management had involved a cutting and grazing regime with the addition of farm yard manure and artificial fertilizers (Gwent Wildlife Trust 2002).

Prior to purchase the fields were managed as separate holdings. In 1998, the sites were incorporated and managed as one reserve, New Grove Meadows (Figure 1). Subsequently gateways were created for access of stock and machinery between the unimproved and semi-improved fields. The main access route for all stock and machinery for the site is through field 1, Figure 1. Traditional management was instigated; annual hay cut no earlier than 15 July followed by aftermath grazing, fertilizer and farm yard manure input was stopped. Since 2010 the meadows have been lightly grazed during the winter months by a small flock of 15-18 Hebridean sheep. Feeding of hay has only occurred when there is snow on the ground.

The main objective of purchase was to restore the MG6 grassland to the target community; MG5 (Gwent Wildlife Trust 2002).

In 2000, a botanical monitoring programme was initiated. A simple, standard, random sampling technique was chosen for ease of replication (Krebs 1989; Hurford *et al.* 2001). This method was considered suitable due to the homogeneity of each field. The survey was first carried out in July 2000 prior to hay cutting. Within each of the four fields, 50 randomly-located quadrats measuring 50 cm x 50 cm were sampled. Within each quadrat presence and absence of vascular plants was recorded.

The survey was repeated in July 2012 and the following two variables were used to assess for species-richness the fields: *i*) *Total Species*: all species recorded, *ii*) *Wildlife Site Indicator (Wildlife Site Indicator) species* (The South Wales Wildlife Sites Partnership 2004). Wildlife Site Indicator Species were used to assess recolonisation of species indicative of unimproved neutral grasslands in South Wales.

To confirm the current vegetation community a National Vegetation Classification survey was carried out in each of the four fields in 2012 following the standard methodology (Rodwell 1992). Five quadrats measuring 2 m x 2 m were sampled in each field on 12th & 13th July 2012. Published keys

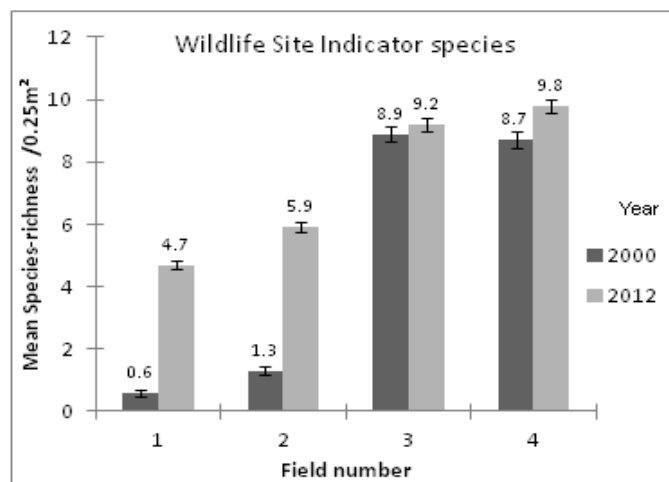


Figure 3. Wildlife Site Indicator (Wildlife Site Indicator) species. Means and standard error of species-richness/0.25m². A two-tailed t-test for independent samples show that the mean species-richness has increased significantly in Field 1 ($t = -21.69$; d.f. = 98; $P < 0.0001$), Field 2 ($t = -20.66$; d.f. = 98; $P < 0.0001$) and Field 4 ($t = -3.22$; d.f. = 98; $P < 0.01$) and not significantly in Field 3 ($t = -0.84$; d.f. = 98; $P = 0.4$).

combined with the computer software MATCH, (Malloch 1996) were used to confirm the communities.

Species-richness as a measure of diversity is used in this study. The average number of species/quadrat was calculated from the 50 quadrats for each field for the variables: *i*) *Total species* and *ii*) *Wildlife Site Indicator species*. These data were tested for significance of change in species-richness between 2000 and 2012 with a two-tailed t-test for independent samples using the computer software XLStatistics.

CONSEQUENCES

Botanical assessment and monitoring: The increase in species-richness over 12 years in the semi-improved fields is highly significant ($P < 0.0001$). The results are given in Figures 2 and 3.

Indicator Species: The Wildlife Site Indicator species recorded at New Grove Meadows during this study are listed in Table 1.

The increase of Wildlife Site Indicator species in the semi-improved fields is highly significant ($P < 0.0001$). The species in these fields that show the greatest increase in occurrence are Cat's-ear *Hypochaeris radicata*, Red Clover *Trifolium pratense* and Yellow-rattle *Rhinanthus minor*. Species that are frequent in the adjacent fields 3 and 4 and remain absent from fields 1 and 2 are Quaking-grass *Briza media*, Spring-sedge *Carex caryophylla*, Glaucous Sedge *Carex flacca* and Cowslip *Primula veris*.

The increase of Wildlife Site Indicator species in the unimproved field 3 is very slight and not significant however the increase in Field 4 is significant ($P < 0.01$). Eye-bright *Euphrasia officinalis* agg. is recorded in fields 2-4 for the first time in 2012.

National Vegetation Classification: The National Vegetation Classification survey revealed a shift in field 2 from MG6b *Lolium perenne*-*Cynosurus cristatus* grassland, *Anthoxanthum odoratum* sub-community to MG5a *Cynosurus cristatus*-*Centaurea nigra* grassland, *Lathyrus pratensis* sub-community. Eight of the constant species for MG5 have

constancy values of IV and V in field 2. Field 1 although classified MG6b reveals a close match to MG5a. Seven of the constant species for MG5 are have constancy values of IV and V in field 1. Fields 3 and 4 have remained within the MG5; the MG5c *Cynosurus cristatus-Centaurea nigra* grassland,

Danthonia decumbens sub-community is unexplained. This could indicate a previous history of lime and/or farm yard manure application. Table 2 gives the results of the National Vegetation Classification survey with the MATCH analysis.

Table 1. Wildlife Site Indicator (Wildlife Site Indicator) species present at New Grove Meadows 2000-2012. The results show the number of quadrats in which each species was present from a 50 quadrat/field sample. The total occurrences for each field are given.

Wildlife Site Indicator species	Semi-improved				Unimproved			
	Field 1		Field 2		Field 3		Field 4	
	2000	2012	2000	2012	2000	2012	2000	2012
<i>Anacamptis morio</i>	0	0	0	2	5	0	1	0
<i>Briza media</i>	0	0	0	0	22	39	28	45
<i>Carex caryophylla</i>	0	0	0	0	46	50	28	50
<i>Carex flacca</i>	0	0	0	0	1	1	5	4
<i>Centaurea nigra</i>	1	4	1	24	50	50	50	50
<i>Dactylorhiza fuchsii</i>	0	11	0	26	12	5	15	9
<i>Dactylorhiza maculata</i>	0	0	0	0	0	1	2	0
<i>Danthonia decumbens</i>	0	0	0	0	0	4	0	1
<i>Euphrasia officinalis agg.</i>	0	0	0	16	0	15	0	33
<i>Hypericum maculatum</i>	0	0	0	1	0	0	0	0
<i>Hypochaeris radicata</i>	6	48	20	49	50	50	48	43
<i>Lathyrus linifolius</i>	0	0	0	0	0	1	0	0
<i>Lathyrus pratensis</i>	10	21	16	7	0	0	3	0
<i>Leontodon hispidus</i>	0	0	0	7	49	30	47	49
<i>Leucanthemum vulgare</i>	3	0	0	2	30	21	21	4
<i>Lotus corniculatus</i>	2	5	12	47	49	50	49	50
<i>Luzula campestris</i>	0	0	0	3	31	37	19	12
<i>Neottia ovata</i>	0	0	0	0	0	0	0	2
<i>Polygala vulgaris</i>	0	0	0	2	25	21	15	25
<i>Potentilla erecta</i>	0	0	0	0	0	1	0	0
<i>Primula veris</i>	0	1	0	0	1	0	12	15
<i>Ranunculus bulbosus</i>	1	34	1	6	5	19	6	25
<i>Rhinanthus minor</i>	0	50	0	50	50	50	50	50
<i>Stellaria graminea</i>	2	8	1	1	0	0	0	0
<i>Trifolium pratense</i>	5	49	14	50	10	4	35	24
<i>Vicia cracca</i>	1	2	2	0	0	0	0	0
<i>Viola riviniana</i>	0	0	0	0	11	12	0	1
Total number of occurrences	31	233	67	293	447	461	434	492

DISCUSSION

This study provides evidence that species poor grassland when adjacent to species-rich grassland can increase in species-richness in the absence of interventions such as hay strewing or seeding in. Within 12 years this has been achieved at New Grove Meadows, with the instigation of traditional hay meadow management combined with no input of fertilizer or farm yard manure.

This result provides further evidence to support the conclusions of Hayes & Tallowin (2007). It is considered that the following mechanisms probably aid the dispersal of seed: the access gates created between the species-rich and the species-poor meadows allowing movement of stock and machinery; hay meadow management involving the turning and bailing of hay with movement of the machinery throughout all the meadows; and aftermath grazing of sheep throughout the meadows.

Continued monitoring to inform management is required to ensure the floristic diversity of fields 3 and 4 is retained and to demonstrate the continued improvement in species richness in fields 1 and 2.

Due to the timing of the surveys, early flowering species may not be detected, for example this study does not reflect the abundance of *Anacamptis morio* at the site.

Table 2. National Vegetation Classification survey results July 2012, New Grove Meadows SO501069

Field No.	NVC	Similarity co-efficient (%)
1	MG6b	66.3
	MG5a	62.3
2	MG5a	64.1
	MG6b	63.0
3	MG5c	56.5
	MG5a	52.4
4	MG5c	58.0
	MG5b	55.5

(MG6b *Lolium perenne*-*Cynosurus cristatus* grassland, *Anthoxanthum odoratum* sub-community; MG5a *Cynosurus cristatus*-*Centaurea nigra* grassland, *Lathyrus pratensis* sub-community; MG5b *Cynosurus cristatus*-*Centaurea nigra* grassland, *Galium verum* sub-community; MG5c *Cynosurus cristatus*-*Centaurea nigra* grassland, *Danthonia decumbens* sub-community, Rodwell, 1992).

ACKNOWLEDGEMENTS

Gwent Wildlife Trust for access to their site records. Alex Lockton and Richard Burkmar for their guidance in the preparation of this paper.

REFERENCES

- Defra (2006) Managements to achieve botanical diversification of improved grassland by natural recolonisation. BD1452 final report.
- Edwards A.R., Mortimer S.R., Lawson C.S. Westbury D.B., Harris S.J., Woodcock B.A. & Brown V.K. (2007) Hay strewing, brush harvesting of seed and soil disturbance as tools for the enhancement of botanical diversity in grasslands. *Biological Conservation*, **134**, 372-382.
- Fuller R.M. (1987) The changing extent and conservation interest of lowland grasslands in England and Wales: a review of grassland surveys 1930-1984. *Biological Conservation*, **40**, 281-300.
- Gwent Wildlife Trust (2002) Unpublished Management Plan
- Hayes M.J. & Tallowin J.R.B. (2007) Recreating biodiverse grasslands: long-term evaluation of practical management options for farmers. Pages 135-140. in: J.J. Hopkins, A.J. Duncan, D.I. McCracken, S. Peel & J.R.B. Tallowin (eds.) *High Value Grasslands, Providing Biodiversity, a Clean Environment and Premium Products*. British Grassland Society Occasional Symposium No. 38, British Grassland Society (BGS), Reading.
- Hellstrom K., Bullock J.M., Pywell R.F. (2011) Testing the generality of hemiparasitic plant effects on mesotrophic grasslands: A multi-site experiment. *Basic and Applied Ecology*, **12**, 235-243.
- Hurford C., Jones M.R. & Brown A. (2001) *Habitat Monitoring for conservation Management and Reporting 2: Field Methods*. Countryside Council for Wales.
- Kirkham F.W., Tallowin J.R.B., Sanderson R.A., Anne Bhogal A., Chambers B. J. & Stevens D.P. (2007) *The impact of organic and inorganic fertilizers and lime on the species-richness and plant functional characteristics of hay meadow communities*. CCW Contract Science Report No. 782, 35 pp, CCW, Bangor.
- Krebs C.J. (1989) *Ecological Methodology*. New York: Harper Collins.
- Mallcoch A.J.C. (1996) *Match Version 2.0: A computer program to aid assignment of vegetation to the communities and sub-communities of the National Vegetation Classification*. Unit of Vegetation Science, Lancaster University.
- Pywell R.F., Bullock J.M., Walker K.J., Coulson, S.J., Gregory S.J. & Stevenson, M.J. (2004) Facilitating grassland diversification using the hemiparasitic plant *Rhinanthus minor*. *Journal of Applied Ecology*, **41**, 880-887.
- Pywell R.F., Woodcock B., Tallowin J.B., Mortimer S. R. & Bullock J.M. (2012) Restoring species-rich grassland: principles and techniques. *Aspects of Applied Biology*, **115**, 11-21.
- Rodwell, J.S. (1992) *British Plant Communities Volume 3: Grasslands and montane communities*. Cambridge, Cambridge University Press.
- The South Wales Wildlife Sites Partnership (2004) *Guidelines for the Selection of Wildlife Sites in South Wales*. The South Wales Wildlife Site Partnership.