Land Management Practices for Rare Butterfly Species – Influences on Macro Moth Community Assemblages at Warton Crag SSSI, north Lancashire.

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Introduction

Butterflies and moths have experienced considerable population declines in recent years. Whilst many species are now well recorded, there are still knowledge gaps for many species life histories. Much of the habitat management carried out country-wide is done so based on butterfly species status once assessed using the Red List criteria. Therefore, nature reserves are being managed based on the requirements of very few species. The true number of Lepidopterans present at any given nature reserve is often an order of magnitude greater than represented by the specialists they are managed for.

Aims

To provide baseline data for potential future studies at Warton Crag, north Lancashire and the surrounding area. Whilst moths are reasonably well recorded within the Arnside and Silverdale Area of Outstanding Natural Beauty (AONB), there are limited standardised sampling efforts to compare against and usually of only individual species, and normally of priority status. Therefore, through this survey, it was hoped that a better understanding could be gained about species presence across the reserve, their distribution and abundances, and how, if at all, the management implemented influences this. Reserve staff can then begin to establish how the species are responding to the current management being implemented for the rare butterflies with the aim of being better informed of the requirements of a greater number of species.

Figure 1. Modified Anglian Lepidopterist Supplies Heath-style moth trap.

Rare butterflies

- High brown fritillary *Argynnis addipe* (Dennis and Schiffermüller, 1775).
- Pearl bordered fritillary *Boloria Euphrosyne* (Linnaeus, 1758).
- Northern Brown Argus *Aricia Artaxerxes* (Fabricius, 1793).

Rare moths

- Barred Tooth-striped *Trichopterix polycommata* (Dennis and Schiffermüller, 1775)
- Least minor *Photedes captiuncula* (Treitschke, 1825)
- White-spotted sable *Anania funebris* (Ström, 1768)

Method

A total of 21 days over a three-month period were used to survey the moths and their habitats between the 03/06/2018 and 08/08/2018 inclusively. 12 habitat patches were identified and sampled in “managed” and “unmanaged” pairs, except for the two grassland habitat patches which both were managed (**Fig. 2**). Data were collected from each pair once a month with species accumulated and variables averaged for the period.

Most species fly between the months of May and September. To capture the highest degree of species richness of each site, trapping commenced between June and August. Sampling was only conducted on nights when the minimum night temperature was not forecast to drop below 10 ^{o}C, persistent heavy rain was not expected, and windspeed was lower than 5 on the Beaufort scale (9.3 m/s or 33 km/hr).

Table 1. Numerical system used for the sample sites, whether it was managed or not (M = Managed, U = Unmanaged, G = Grazed, C = Cut), broad vegetation type, the 10-figure grid reference and the respective NGO the section of the reserve is managed by(LNR = Local Nature Reserve, RSPB = Royal Society for the Protection of Birds, LWT = Lancashire Wildlife Trust).

Site	M/U	Hab Dom	Grid	Section
1	M	Scrub	SD4920072610	LNR
	U		SD4883072734	RSPB
2	M	Scrub	SD4891372711	RSPB
	U		SD4884972768	RSPB
3	M	Tree	SD4925372479	LNR
	U		SD4943672442	LNR
4	M	Tree	SD4879772725	RSPB
	U		SD4926473027	LWT
5	M	Tree	SD4890573110	RSPB
	U		SD4950672745	LNR
6	G	Grassland	SD4912672665	RSPB
	C/G		SD4903872590	RSPB

The moth traps used for sampling were selected due to their ease of transportation and catch retention. Two, 15W actinic Heath-style traps were used with blue bulbs and powered by a 20Ah lead-acid leisure battery. The original Anglian Lepidopterist Supplies traps were adapted by exchanging the black, collapsible body for large, 30-litre, white food-grade buckets (**Fig. 1**). The white bucket complimented the bulb by increasing reflectance, whilst the depth of the container increases the retention rate of specimens that enter, making it more difficult for them to escape once entering. The larger trap body also aimed reduce shading effects of the vegetation on the trap. Most species were identified in the field and permission was sought and granted by Natural England to remove specimens of the confusion species and worn individuals for examination of their genitalia.

The vegetation was sampled within a habitat patch by transect and quadrat method. Variables thought to influence moth behaviour were recorded along a 15 meter transect within a 1m x 1m quadrat at 0m, 5m, 10m, and 15m in a left-right, left-right manner on the first and third site visits only. Transects ran either side of the moth trap which was located centrally within a habitat patch. Colour-coded canes marked the start of the transect (green/yellow), central trap site (blue), and end (red) so the precise locations were returned to. Ten-figure grid references of each were noted using a grid reference application.

The most influential environmental variables to a moth's ability to fly were recorded from the moth trap site. The Kestrel, a small mobile weather station, was held at arms-length above the head and readings recorded once the device had stabilized. All variables were recorded just before the moth trap had been left out, up to two hours before dusk.

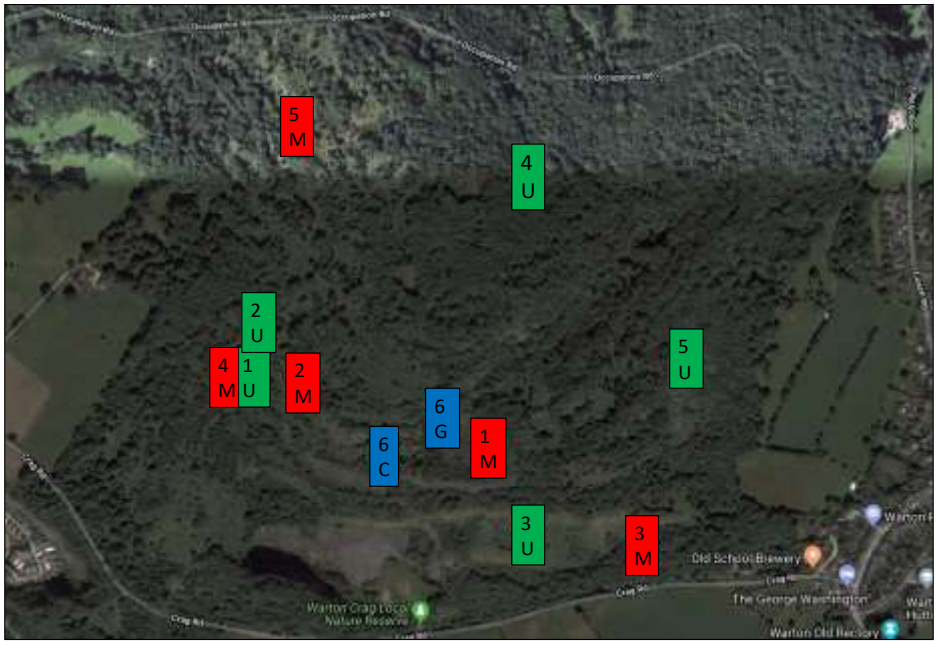

Figure 2. Sampling sites and their respective locations across the reserve. Note that the sampling sites are not directly comparable spatially.

Results

In total, 4169 individuals of 280 moth species were recorded throughout the sampling period. Of these, 185 were macros and 95 were micros. Three of the macro species were recorded in the AONB for the first time in the history of entomological recording in the area; Waved carpet, Saltern ear and Common wainscot. Many rare and uncommon micro species were also encountered during sampling which were authenticated by the respective county moth recorders for Vice County (VC) 60. However, it is unknown how many had not been recorded prior to this study. There was no significant difference in species richness between managed and unmanaged sampling sites (**Fig. 3**).

Statistical analysis of the environmental variables recorded revealed they had not influenced the diversity indices across the reserve. Due to the adverse weather conditions that prevailed during the Summer of 2018, the environmental parameters measured during each sampling session were consistent across the months of June, July and August. Again, the vegetation variables recorded were not found to be statistically significant in their influence on the diversity indices recorded and calculated during sampling. However, plant species richness was greater at managed sites, but not significantly so. This will most likely be due to the colonisation of early successional species exploiting the newly exposed patches.

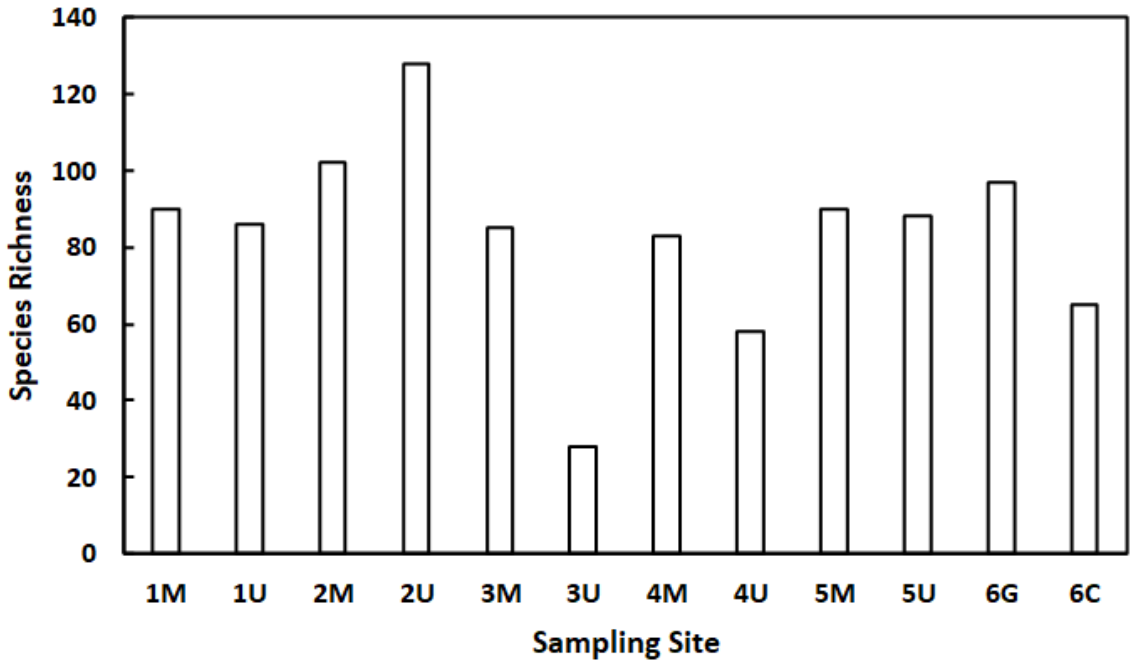

Figure 3. Accumulated macro and microlepidoptera species richness across all sampling sites, both managed and unmanaged.

Diversity Indices

Species richness was, on average, greater across sites that were dominated by scrub species regardless of whether management had occurred or not. Overall, sites dominated by Gorse *Ulex europaeus,* had the greatest recorded abundance, species richness and unique species (**Tab. 2**). Although unique species is an arbitrary expression, it is was deemed useful to highlight individual site difference and total reserve heterogeneity.

Table 2. Pairwise site comparison of managed and unmanaged habitat patches for the six dominant vegetation types.

	Pairwise site comparison											
	Haw/Black		Gorse		Hazel		Ash		Birch		Grass	
Diversity indices	1M	1U	2M	2U	3M	3U	4M	4U	5M	5U	6G	6C
Abundance	334	296	584	589	269	91	357	267	449	302	376	243
Species richness	90	86	102	128	85	28	83	58	90	88	97	65
Unique species *	7	13	10	24	10	1	7	3	5	9	7	10

Shared species	51	67	19	32	48	45

The relative importance of each broad habitat type to species richness and abundance across the combined managed and unmanaged habitat patches is now more apparent (**Tab. 3**). Abundance is greater at managed patches, but species richness is greater at unmanaged patches of scrub and marginally lower at unmanaged patches dominated by tree species.

Table 3. Pairwise comparison of managed and unmanaged habitat patches grouped into broad vegetation types, excluding grassland as no truly comparative unmanaged sites could be identified.

	Pairwise comparison by broad vegetation type			
Diversity indices	Scrub managed	Scrub unmanaged	Tree managed	Tree unmanaged
Abundance	918	887	1065	654
Species richness	150	167	156	154
Unique species	19	35	24	14
Shared species	98		74	

Rare Macrolepidoptera

The following list of uncommon, local and rare macrolepidoptera was attained through the adaptation of Brian Hancock's (2015) AONB macro moth list whereby local status is assigned based upon mapmate records, with a dash of local knowledge applied a more applicable twist. It is worth noting that the status applied here would not be suitable for use throughout Lancashire and should be approached in a vacillating manner. Such advice should also be considered when approaching the microlepidoptera list compiled.

Table 4. Macro moth species status list adapted from the AONB macro species list compiled by Hancock (2015). Only the uncommon, local and rare species recorded across all sites during the sampling period are listed.

Vernacular	**Latin Binomial**	**Local Status ***
Alder moth	*Acronicata alni*	Uncommon
Barred rivulet	*Perizoma bifaciata*	Uncommon
Brown scallop	*Philereme vetulata*	Uncommon
Cloaked minor	*Mesoligia furunculi*	Uncommon

Dark brocade	*Blepharita adusta*	Uncommon
Dark marbled carpet	*Chloroclysta citrata*	Uncommon
Gold swift	*Hepialus hecta*	Uncommon
Heart and club	*Agrotis clavis*	Uncommon
Lunar thorn	*Selenia lunularia*	Uncommon
Magpie moth	*Abraxas grossulariata*	Uncommon
Miller	*Acronicta leporine*	Uncommon
Mullein wave	*Scopula marginepunctata*	Uncommon
Orange swift	*Hepialus sylvina*	Uncommon
Ruby tiger	*Phragmatobia fuliginosa*	Uncommon
Rustic Shoulder-knot	*Apamea sordens*	Uncommon
Sallow kitten	*Furcula furcula*	Uncommon
Tawny-speckled pug	*Eupithecia icterata*	Uncommon
Treble-bar	*Aplocera plagiata*	Uncommon
Turnip moth	*Agrotis segetum*	Uncommon
Annulet	*Charissa obscurata*	Local
Barred carpet	*Perizoma taeniata*	Local
Barred chestnut	*Dairsia dahlia*	Local
Barred umber	*Plagodis pulveraria*	Local
Blomer’s rivulet	*Discoloxia blomeri*	Local
Cream wave	*Scopula floslactata*	Local
Dark umber	*Philerme transversata*	Local
Grass emerald	*Pseudoterpna pruinata*	Local
Haworth’s pug	*Eupithecia haworthiana*	Local
Pale tussock	*Calliteara pudibunda*	Local
Pebble Hook-tip	*Drepana falcataria*	Local
Pinion-streaked snout	*Schrankia costaestrigalis*	Local
Rufous minor	*Oligia versicolor*	Local
Seraphim	*Lobophora helterata*	Local
Slender pug	*Eupithecia tenuiata*	Local
Sloe pug	*Pasiphilia choloereata*	Local

Small rufous	*Coenobia rufa*	Local
Striped Twin-spot carpet	*Nebula salicata latentaria*	Local
Tawny marbled minor	*Oligia latruncula*	Local
Tawny-barred angle	*Macaria liturata*	Local
Twin-spot carpet	*Perizoma didymata*	Local
Bordered sallow	*Pyrrhia umbrata*	Rare
Cloaked pug	*Eupithecia arbietaria*	Rare
Common wainscot	*Mythimna pallens*	Rare
Confused	*Apamea furva*	Rare
Large ear	*Amphipoea lucens*	Rare
Marbled white spot	*Protodeltote pygarga*	Rare
Reddish light arches	*Apamea sublustris*	Rare
Saltern ear	*Amphipoea fucosa*	Rare
Straw underwing	*Thalpophila matura*	Rare
Waved carpet	*Hydrelia sylvata*	Rare

*The local status provided may not reflect the national status given to species in Waring and Townsend (2009).

Rare Microlepidoptera

It is unknown how many of the "rare" microlepidoptera have or have not been recorded at Warton Crag or the wider recording area of the AONB. However, regardless of this, a considerable list has been acquired not only for the micro but also the macrolepidoptera (**Tab. 4 and 5**).

Table 5. Micro moth species status list adapted from the updated version of the VC60 micro moth list compiled by Palmer (2014). Only the uncommon, local and rare species recorded across all sites during the sampling period are listed.

Latin binomial **	**Status ***
Agriphila inquinatella	Uncommon
Blastodacna hellerella	Uncommon
Epinotia bilunana	Uncommon
Eucosma campoliliana	Uncommon
Eupoecilia angustana	Uncommon

Lathronympha strigana	Uncommon
Nematopogon schwarziellus	Uncommon
Phycitodes binaevella	Uncommon
Aethes cnicana	Local
Apotomis turbidana	Local
Argyresthia albistria	Local
Incurvaria praelatella	Local
Matiella fusca	Local
Metzneria metzneriella	Local
Mirificarma mulinella	Local
Mompha miscella	Local
Olindia schumacherana	Local
Paraswammerdamia albicapitella	Local
Prays ruficeps	Local
Teleiodes sequax	Local
Acompsia cinerella	Rare
Apodia bifractella	Rare
Eana incanana	Rare
Eulamprotes atrella	Rare
Hellinsia tephradactyla	Rare
Hypsopygia glaucinalis	Rare
Lampronia corticella	Rare
Monochroa lucidella	Rare
Pseudoswammerdamia combinella	Rare
Pyrausta ostrinalis	Rare

*The status assigned to micro species does not reflect the national status suggested in Sterling and Parsons (2009) nor by Davis (2012).

**Latin binomial is the only widely accepted naming system of micro moth species unlike the macro moths which do.

Discussion and conclusions

Whilst management appeared to be an important factor in the species richness of habitat patches dominated by tree species, this was not true of patched dominated by scrub

(**Fig. 2**). The opposite was seen, whereby, species richness was greater in unmanaged patches. This highlights the complexity of such sites and that a matrix of managed and unmanaged patches at various ages would be most beneficial to maintaining maximum species richness at the reserve.

More unique species were recorded in sites of unmanaged scrub (**Tab. 2**). Moth abundances were higher in managed habitat patches (**Tab. 2 and 3**). This may be due to an increase in their ability to move through an area unhindered by a tangled network of vegetation.

The proportions of uncommon, local and rare species of macro and microlepidoptera were similar when overall species totals are considered (**Tab. 4 and 5**). However, when looked at for each individual habitat patch, those that were not common accounted for less than 20% of the species accumulated. This rose to over 20% for the micros recorded at each habitat patch.

Whilst the modification, and in some parts, restoration of the habitat at Warton Crag Nature Reserve is essential if the rare butterfly species are to persist into the future, it is apparent that mass application of the habitat requirements of these rare species would not be beneficial to many moth species. If continued, many moth species may become locally extinct. This could prove detrimental given the sheer number of uncommon, local and rare macro and micro species recorded during sampling comparative to the three rare butterflies and three rare moths (five diurnal and one nocturnal species) currently being considered whilst management plans are drafted. It would be ignorant and inconsiderate to believe that the requirements of these six could become the umbrella for all others.

The lack of extensive sampling within a large order with a pronounced presence is owed to the inherent difficulties in not only the sampling standardisation issues but those presented in identification. Training volunteers to identify the main butterfly families and thereafter the species likely to be encountered (which can be further reduced to the species expected to be encountered at a given site) is relatively easy and can be sufficiently achieved during one season (Spring/Summer of one year). Whereas, the training of an individual to potentially identify thousands of moth species independently would take years to gain adequate competence.

The reserve would benefit from more extensive sampling across a wider range of habitat patches given the inherent heterogeneity found at such sites. Multiple successional stages should be considered a priority for sampling not only because they have the potential to hold many rare species of Lepidoptera, but because they are rarely extensively and methodically sampled in the area if at all and usually the first sites to succumb to being mass-managed (clear felling).

Just because no significance has been determined between habitat patches that have been managed and unmanaged, it should not be assumed that the effects are either positive nor negative on species of non-butterfly Lepidoptera. An increase in sampling size in terms of the quantity of sampled habitat patches has the potential to improve the quality of the results attained which should be a major consideration for methodology adaptation of any potential future sampling.