Chapter 8 Appendix

Contents

8.2 Appendix B (Chapter 3)

8.2.1 Bray-Curtis community dissimilarities and species distribution in 2010 and 2011

Table 8-1. The eight focal and other Lepidoptera species recorded at surveys at the Stonehenge Landscape including common names, scientific name, and ID used for figures and graphs in this chapter. Ecological group of species associated with Ruderal vegetation (Ruderal-veg), short-turf herb-rich grassland (Herb-rich) and short-tall sward open grassland (Open-grass) (Shreeve *et al.* 2001) and mobility groups of sedentary, Intermediate and widespread (Pollard and Yates 1993).

Common name	**Latin name**	**ID**	**Ecological group**	**Mobility group**
Focal species				
Adonis Blue	*Lysandra bellargus*	*Lys.bel*	Herb-rich	Sedentary
Small Heath	*Coenonympha pamphilus*	*Coe.pam*	Open-grass	Sedentary
Marbled White	*Melanargia galathea*	*Mel.gal*	Open-grass	Sedentary
6-spot Burnet	*Zygaena filipendulae*	*Zyg.fil*	Herb-rich	Sedentary
Common Blue	*Polyommatus icarus*	*Pol.ica*	Herb-rich	Intermediate
Meadow Brown	*Maniola jurtina*	*Man.jur*	Open-grass	Sedentary
Small Tortoiseshell	*Aglais urticae*	*Agl.urt*	Ruderal-veg	Widespread
Large White	*Pieris brassicae*	*Pie.bra*	Ruderal-veg	Widespread
Other species				
Brown Argus	*Aricia agestis*	*Ari.age*	Herb-rich	Intermediate
Chalkhill Blue	*Polyommatus coridon*	*Lys.cor*	Herb-rich	Sedentary
Forester /Cistus Forester moth	*Adscita statices/ geryon*	*Ads.sta*	Herb-rich	Sedentary
Small copper	*Lycaena phlaeas*	*Lyc.phl*	Herb-rich	Intermediate
Dark-green Fritillary	*Argynnis aglaja*	*Arg.agl*	Open-grass	Intermediate
Dark-green/Silver-wash Fritillary	*Argynnis aglaja/paphia*	*Arg.sp*	Open-grass	Intermediate

Gatekeeper	*Pyronia tithonus*	*Pyr.tit*	Open-grass	Sedentary
Large Skipper	*Ochlodes sylvanus*	*Och.ven*	Open-grass	Sedentary
Ringlet	*Aphantopus hyperantus*	*Aph.hyp*	Open-grass	Sedentary
Peacock	*Inachis io*	*Ina.io*	Ruderal-veg	Widespread
Green-viened White	*Pieris napi*	*Pie.nap*	Ruderal-veg	Intermediate
Hummingbird Hawk-moth	*Macroglossum stellatarum*	*Mac.ste*	Ruderal-veg	Widespread
Red Admiral	*Vanessa atalanta*	*Van .atl*	Ruderal-veg	Widespread
Small White	*Pieris rapae*	*Pie.rap*	Ruderal-veg	Widespread
Small White/Green-veined White	*Pieris rapae/napi*	*Pie.rana*	Ruderal-veg	Intermediate
Brimstone	*Gonepteryx rhamni*	*Gon.rha*	Woodland	Widespread

Table 8-2. The mean Bray-Curtis dissimilarity (and Standard Error SE) between the highest quality chalk grassland fragment (Luxenborough bank) and the other habitat types and grassland re-creation ages and the total number and distribution of eight focal species of day-flying Lepidoptera in relation to habitat type (total number recorded). Chalk grassland fragments (Chalk), barrow groups (Barrow), semi-improved pasture (Semi-imp), older grassland re-creation fields 7–10 years old (Older Grass), newer grassland re-creation fields 1–5 years old (Newer Grass) and arable land (Arable). The distribution of eight focal Lepidoptera species in matrix transects running from chalk grassland fragments into an adjacent land cover types of either newer grassland re-creation of 1-2 years old (Newer Grass) or Arable land (Arable).

		Habitat transects						**Matrix Transects**	
	Code	**Chalk**	**Barrow**	**Semi-imp**	**Older Grass**	**Newer Grass**	**Arable**	**Newer Grass**	**Arable**
Bray-Curtis dissimilarity		0.33	0.39	0.51	0.48	0.58	0.88	N/A	N/A
SE		0.03	0.09	0.09	0.06	0.05	0.12	N/A	N/A
Lysandra bellargus	*Lys.bel*	4	6					2	
Coenonympha pamphilus	*Coe.pam*	2	9	1				9	
Melanargia galathea	*Mel.gal*	2	12		1				10
Zygaena filipendulae	*Zyg.fil*	67	1		162	1			3
Polyommatus icarus	*Pol.ica*	38	90	1	29	7		82	
Maniola jurtina	*Man.jur*	101	103	3	50	4		43	23
Aglais urticae	*Agl.urt*	19	29	2			1	23	10
Pieris brassicae	*Pie.bra*	91	103	22	24	16	1	21	16

8.2.2 Comparison of mean densities of Lepidoptera in different habitat and matrix transects

Table 8-3. Mean (and Standard Error SE) response measure of total Lepidoptera density (Total), richness and Open-grass and Herb-rich ecological group and Wilcoxen sum rank test and Mixed-effects model results (4dp) comparing habitat transects (mean per 100m of transect) and matrix transects (total per transect). Results of Wilcoxen sum rank test comparing Lepidoptera response between chalk grassland sites on slopes and Barrows (Chalk) to grassland re-creation of 1-10 years (Re-creation) and comparing adjacent matrix types of newer grassland re-creations (Newer-grass) and arable land (Arable). Mixed-effects models with broad habitat/matrix type, time replicate and the interaction of these as fixed effects and transect identity as random effects.

	Habitat transects					**Matrix transects**		
Response measure	**Chalk**	**Re-creation**	**W=**	**Wilcox p=**	**Mixed-effects p=**	**Newer-grass**	**Arable**	**Mixed-effects p=**
Total	23.78	8.39	30	0.0649	0.1543	60.75	33.75	0.1897
SE	6.89	5.00				16.22	8.62	
Richness	5.51	2.99	36	**0.0022**	**0.0004**	5.17	4.64	0.9275
SE	0.23	0.35				0.82	0.37	
Open-grass	0.33	0.28	20	0.8182	0.0944	0.25	0.34	0.5413
SE	0.08	0.08				0.04	0.06	
Herb-rich	0.31	0.30	19	0.9372	0.8795	0.30	0.05	0.1401
SE	0.05	0.10				0.06	0.03	

8.2.3 Comparison between the west and east side of chalk grassland fragments Full-moon bank and Luxenborough Bank and when those records in the chalk grassland fragment were excluded.

Table 8-4. Results of Minimum Adequate Model for Mixed-effects models with, a) broad habitat type, survey replicate and the interaction of these as fixed effects and transect identification as random effects. b) just the data from Luxenborough Bank and Full-moon Bank where transects were orientated to the west and the east of the fragment. Fixed effects of matrix type, survey replicate and the sheltered or exposed position of transects and the interaction of these as fixed effects with transect identification as the random effect. c) Results when Lepidoptera surveyed in Segment 1 of the transects which was in the chalk grassland fragment were removed for transects at the four chalk grassland fragment locations. Response variable as Lepidoptera density, species richness and of the different ecological and mobility groups.

	a) Fixed effects for all data in matrix transects	**b) Just Luxenborough Bank and Full-moon Bank**	**c) Just segments 2-6 of the transects**
Response	p=	p=	p=
Total Lepidoptera	0.1543	0.3294	0.2238
Lepidoptera species richness	**0.0004**	0.8124	0.5870
Ruderal-veg	**0.0358**	0.2820	0.9547
Open-grass	0.0944	0.6902	0.3543
Herb-rich	0.8795	0.0409	0.1314
Widespread	**0.0331**	0.4260	0.6473
Intermediate	0.1368	0.2345	0.2982
Sedentary	0.5559	1.0000	0.2783

8.2.4 Comparison of environmental variables between grassland re-creation and chalk grassland fragments

8.2.4.1 Habitat transects

Table 8-5. The environmental variable description (Description), abbreviated identifier used in graphs in Chaper 3 (ID) and mean unit of measurement (Unit), the Wilcoxon sum rank result (W=, p=) compared between chalk grassland fragments on slopes and barrows to grassland re-creation aged 1-10 years since sowing. Only p values of significant variables are shown.

Description	**ID**	**Unit**	**W=**	**p=**
Density of Asteraceae flowering units	AstM	Density	31	**0.0411**
Number of year to restore that habitat type	Age2	Years		
Percentage coverage of bare ground	BG%M	Percentage		
Variation in percentage coverage of bare ground at the within transect scale	BG%TranCV	Coefficient of variation		
Variation in percentage coverage of bare ground at the between segment scale	BG%SegCV	Coefficient of variation		
Percentage coverage of cloud	CloudM	Percentage		

Density of Dipsacaceae flowering units	DipM	Density		
Density of Fabaceae flowering units	FabM	Density	5.5	**0.0542**
Percentage of linear features in a buffer 100m from the transect	Lin100	Percentage		
Richness of nectar flowering units	NectarRc	Richness	30	**0.06494**
Mean density of nectar flowering units	NectarM	Density		
Mean vegetation density	VegM	cm		
Variation in vegetation density at the within transect scale	VegTranCV	Coefficient of variation		
Variation in vegetation density at the between segment scale	VegTranCV	Coefficient of variation		

8.2.5 Lepidoptera nectar feeding analysis

A total of 234 Lepidoptera were recorded feeding on nectar plants in at habitat transects in 2010, chalk grassland fragments had the highest density of Lepidoptera feeding , followed by the barrow groups (87 and 83 individuals, respectively). Chalk grassland fragments and barrow groups also had a higher number of different Lepidoptera species feeding (13 and 12, respectively) compared to the old and newer grassland re-creation fields (three different species feeding). The species with the highest densities feeding in chalk grassland fragments and old grassland re-creation (7-years old) were the 6-spot Burnet moth (*Zygaena filipendulae*) and for barrow groups the species with the highest density feeding were Meadow Brown (*Maniola jurtina*) .

The species that dominated the Lepidoptera/nectar plant network were *Z. filipendulae* and *M. jurtina* and *Centaurea scabiosa*, *Cirsium arvense* and *Centaurea nigra* nectar plants . The relationship between the Lepidoptera species and the nectar plant that they were feeing on varied between habitat types, for example , *Z. filipendulae* and *Maniola jurtina* had the highest density feeding on *Centaurea nigra* in chalk grassland fragments but on *Centaurea scabiosa* in older Ggassland re-creation fields.

Network indices were calculated in R (version 3.0) and included the number of Lepidoptera and the number of nectar plants recorded in the interactions, the number of links recorded as the portion of the total number of potential links (connectance), the mean number of links per species of nectar plant and Lepidoptera (links per species), the mean number of nectar plants per Lepidoptera (generality) and the mean number of Lepidoptera per nectar plant (vulnerablity). The level of specialism of the whole network was also measured whereby a value of 0 is for no specialism and 1 is complete specialism (H2) and whether there are more species at the higher trophic level (Positive asymmetry) or more at the lower trophic level (negative asymmetry).

The network structure of the different habitat types showed that connectance, links per species, generality, vulnerability and H2 were all higher in chalk grassland fragments and barrow compared to grassland re-creation grassland with grassland re-creation showing negative asymmetry. However, older grassland re-creation was similar in terms of generality to chalk grassland fragments.

Table 8-6. Network properties of Lepidoptera recorded feeding in different habitat types across the Stonehenge Landscape Network analysed on R Bipartite package (R version 3.0). In all habitats, chalk grassland fragments, barrow groups, older grassland re-creation that were7-10 years old (Older-grass) and newer grassland re-creation that was 1-5 years old (Newer-grass).

Network index	**All habitats**	**Chalk**	**Barrow**	**Older-grass**	**Newer-grass**
Number of Lepidoptera	15	13	12	3	3
Number of nectar plants	20	12	12	7	4
Connectance	0.20	0.22	0.19	0.52	0.33
Web asymmetry	-0.17	0.04	0.00	-0.40	-0.14
Links per species	1.78	1.36	1.13	1.10	0.57
Generality	5.08	3.09	2.72	3.21	1.50
Vulnerability	3.76	4.14	3.91	1.51	1.00
H2	0.40	0.41	0.41	0.21	N/A

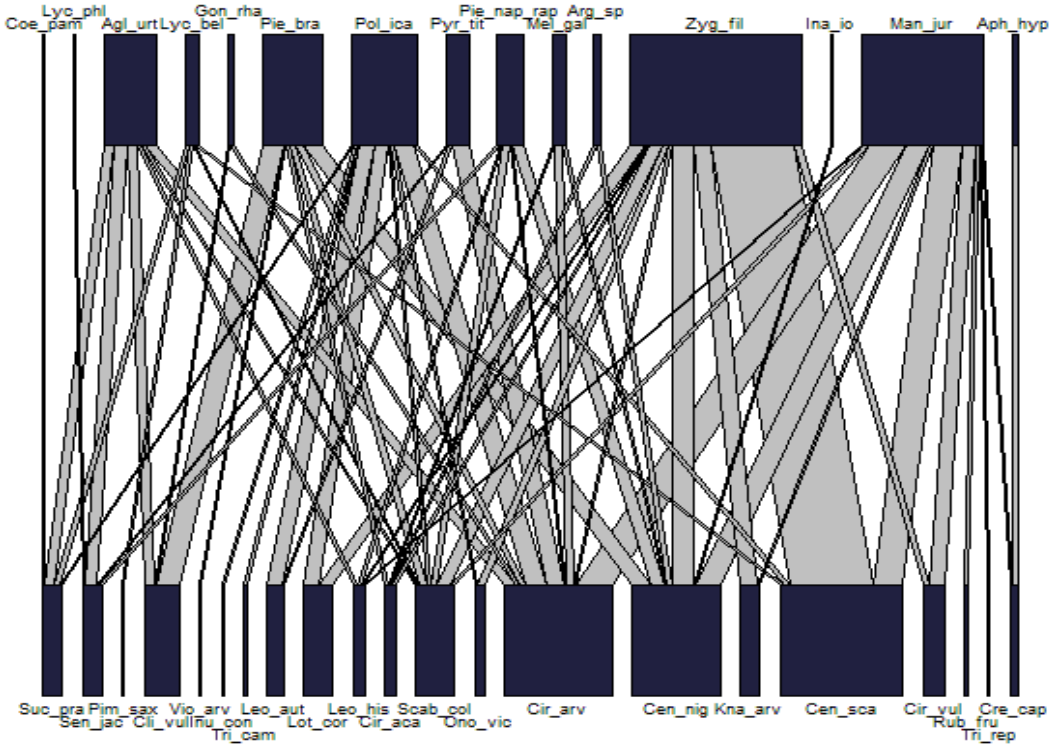

Figure 8-1. Network showing the Lepidoptera species and the nectar plant species they were feeding in all habitats across the Stonehenge landscape.

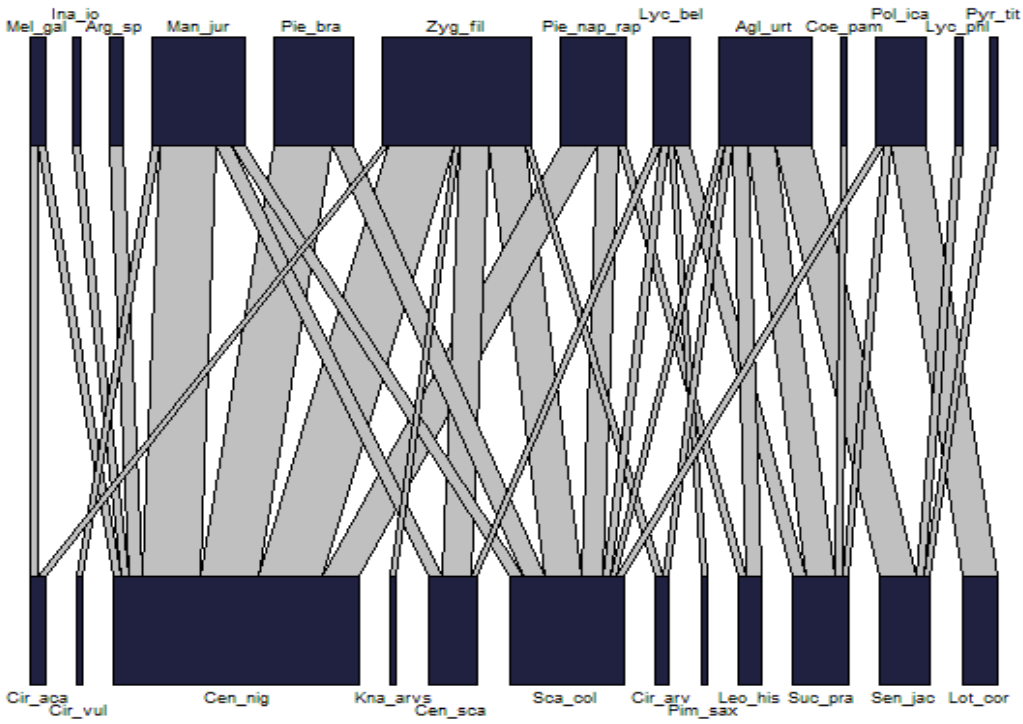

Figure 8-2. Network showing the Lepidoptera species and the nectar plant species they were feeding in all chalk grassland fragments.

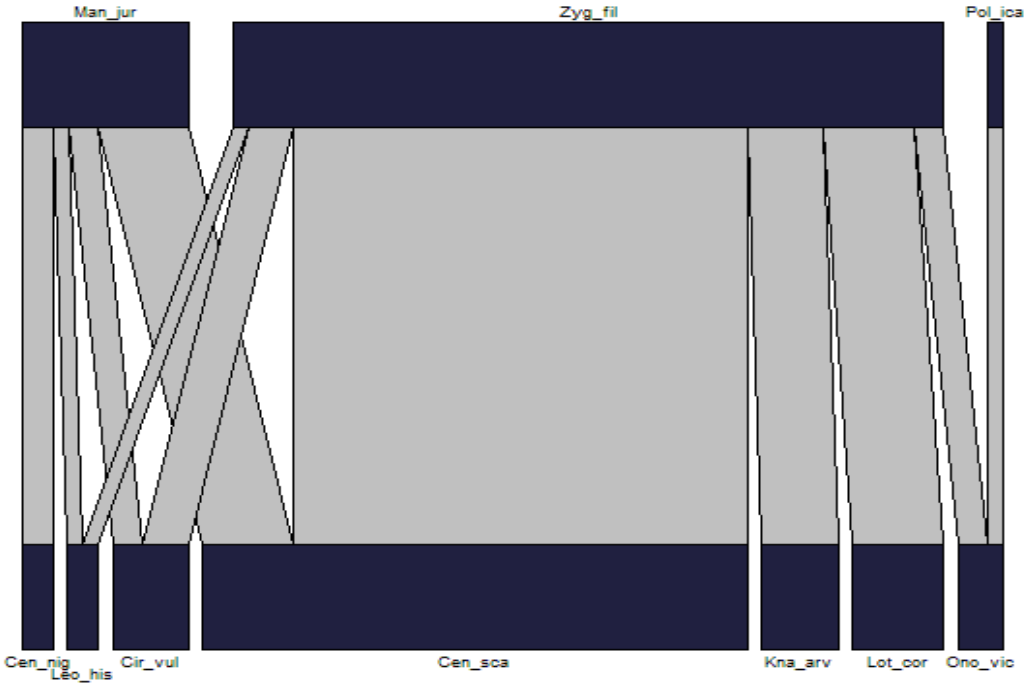

Figure8-3. Network showing the Lepidoptera species and the nectar plant species they were feeding in older grassland re-creation 7-10 years old.

Lepidoptera showed a preference for *Leontodon autumnalis, Centaurea scabiosa and Knautia arvensis* when the number of Lepidoptera recorded feeding was divided by the density of that plant at the survey site. Individual species differed in their preference for different nectar plants across the Stonehenge Landscape. For the most commonly surveyed butterflies, and *M.jurtina* showed a preference for *Cirsium vulgare* and *Centaurea scabiosa,* Common blue (*Polyommatus icarus*) for *Leontodon autumnalis* and Z.*filipendulae* for *Knautia arvensis* and *Centaurea scabiosa.* The less common butterflies such as Marbled white (*Melanargia galathea*) showed a preference for *Cirsium arvense* and *Cirsium acule* and Adonis blue (*Lysandra belargus*) for *Succissa pratensis* and *Centaurea scabiosa*.

This preference different between habitat types for some species, for example In Chalk grassland fragments, *M.galathea* showed a preference for *Cirsium vulgare* and *Centaurea sp., P.icarus* for *Succisa pratensis* and *Lotus corniculatus,* and Z.*filipendulae* for *Centaurea scabiosa, Centaurea nigra*

and *Cirsium arvense*. In the older grassland re-creation *M.jurtina* showed an additional preference for *Centaurea scabiosa*, and Z.*filipendulae* for *Knautia arvensis*.

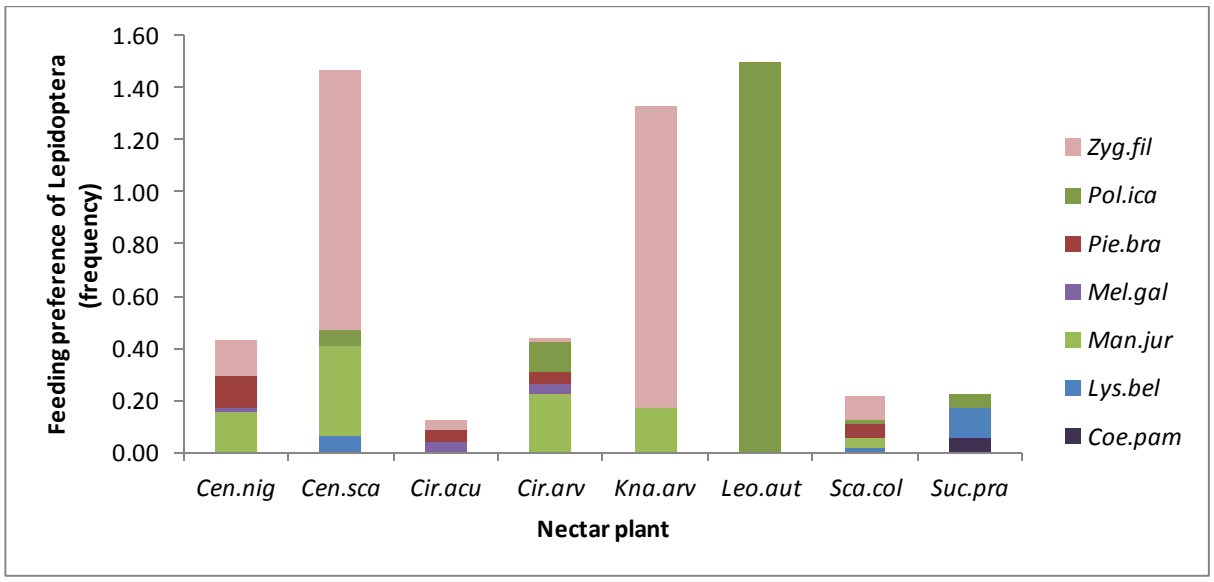

Figure 8-4. the feeding preference of 7 focal Lepidoptera species to nectar plants across the Stonehenge landscape. Lepidoptera species of *Zygaena filipendulae, Polyommatus icarus, Pieris brassicae, Melanargia galathea, Maniola jurtina, Lysandra bellargus* and *Coenonympha pamphilus*. Nectar flower species *Centaurea nigra, Centaurea scabiosa, Cirsium acaule, Knautia arvensis, leontodon autumnalis (Scorzoneroides autumnalis), Scabiosa columbaria* and *Succisa pratensis*.

Table 8-7. Nectar feeding preferences (number of individuals feeding divided by the number of flowering units available 2dp)for all Lepidoptera species surveyed across the Stonehenge landscape in different habitat types overall, in barrow groups, Chalk grassland fragments, Newer grassland re-creation that was 1-5 years old(Newer-grass) and older grassland re-creation that was 7-10 years old(Older-grass).

Nectar plant Species	**ID**	**All habitats**	**Barrow**	**Chalk**	**Newer-grass**	**Older-grass**
Centaurea nigra	*Cen.nig*	0.55	0.00	0.52	0.00	0.00
Centaurea scabiosa	*Cen.sca*	1.47	0.64	0.47	0.00	6.00
Cirsium acaule	*Cir.acu*	0.17	1.00	0.11	0.00	0.00
Cirsium arvense	*Cir.arv*	0.65	0.77	0.29	0.00	0.00
Cirsium vulgare	*Cir.vul*	1.00	1.00	1.00	0.00	1.67
Clinopodium vulgare	*Cli.vul*	0.04	0.04	0.00	0.00	0.00
Crepis capillaris	*Cre.cap*	0.01	0.03	0.00	0.00	0.00
Inula conyza	*Inu.con*	0.07	0.07	0.00	0.00	0.00
Knautia arvensis	*Kna.arv*	1.33	0.00	0.00	0.00	0.83
Leontodon autumnalis	*Leo.aut*	1.75	1.75	0.00	0.00	0.00
Leontodon hispidus	*Leo.his*	0.06	0.00	0.06	0.00	0.06
Lotus corniculatus	*Lot.cor*	0.01	0.00	0.02	0.01	0.01
Pimpinella saxifraga	*Pim.sax*	0.01	0.00	0.01	0.00	0.00
Rubus fructus	*Rub.fru*	0.07	0.07	0.00	0.00	0.00
Scabiosa columbaria	*Sca.col*	0.29	0.00	0.29	0.00	0.00
Senecio jacobaea	*Sen.jac*	0.02	0.03	0.03	0.00	0.00
Succisa pratensis	*Suc.pra*	0.44	0.00	0.53	0.00	0.00
Trifolium repens	*Tri.rep*	0.00	0.01	0.00	0.00	0.00

Table 8-8. Nectar feeding preferences (number of individuals feeding divided by the number of flowering units available 2dp)for different Lepidoptera species surveyed across the Stonehenge landscape in different habitat types overall, in barrow groups, Chalk grassland fragments, Newer grassland re-creation that was 1-5 years old(Newer-grass) and older grassland re-creation that was 7-10 years old (Older-grass). See table 8.1 for Lepidoptera species abbreviation and above table for nectar species abbreviations.

Lepidoptera Species		**Nectar plant**	**All habitats**	**Barrow**	**Chalk**	**Newer-grass**	**Older-grass**
Small Tortoiseshell	*Agl.urt*	*Cir.arv*	0.07	0.08	0.14	0.00	0.00
(Aglais urticae)		*Cli.vul*	0.01	0.01	0.00	0.00	0.00
		Leo.his	0.02	0.00	0.04	0.00	0.00
		Sca.col	0.02	0.00	0.02	0.00	0.00
		Sen.jac	0.01	0.00	0.02	0.00	0.00
		Suc.pra	0.22	0.00	0.27	0.00	0.00
Ringlet	*Aph.hyp*						
(Aphantopus hyperantus)		*Cre.cap*	0.01	0.02	0.00	0.00	0.00
	Arg.sp	*Cen.nig*	0.03	0.00	0.03	0.00	0.00
		Cir.acu	0.04	0.50	0.00	0.00	0.00
Small Heath	*Coe.pam*						
(Coenonympha pamphilus)		*Suc.pra*	0.06	0.00	0.07	0.00	0.00
	Gon.rha	*Cir.arv*	0.01	0.02	0.00	0.00	0.00
		Cli.vul	0.00	0.00	0.00	0.00	0.00
Peacock *(Inachis io)*	*Ina.io*	*Cen.nig*	0.02	0.00	0.02	0.00	0.00
Adonis Blue	*Lys.bel*	*Cen.sca*	0.06	0.09	0.07	0.00	0.00
(Lysandra bellargus)		*Pim.sax*	0.01	0.00	0.01	0.00	0.00
		Sca.col	0.02	0.00	0.02	0.00	0.00
		Suc.pra	0.11	0.00	0.13	0.00	0.00
Small Copper	*Lyc.phl*						
(Lycaena phlaeas)		*Sen.jac*	0.00	0.00	0.00	0.00	0.00
Meadow Brown	*Man.jur*	*Cen.nig*	0.15	0.00	0.12	0.00	0.00
(Maniola jurtina)		*Cen.sca*	0.35	0.36	0.13	0.00	1.00

		Cir.arv	0.22	0.26	0.00	0.00	0.00
		Cir.vul	0.67	1.00	1.00	0.00	0.67
		Cre.cap	0.00	0.01	0.00	0.00	0.00
		Kna.arv	0.17	0.00	0.00	0.00	0.00
		Leo.his	0.01	0.00	0.00	0.00	0.03
		Rub.fru	0.07	0.07	0.00	0.00	0.00
		Sca.col	0.04	0.00	0.04	0.00	0.00
		Tri.rep	0.00	0.01	0.00	0.00	0.00
Marbled White	*Mel.gal*	*Cen.nig*	0.02	0.00	0.02	0.00	0.00
(Melanargia galathea)		*Cir.acu*	0.04	0.00	0.05	0.00	0.00
		Cir.arv	0.04	0.06	0.00	0.00	0.00
Large White	*Pie.bra*	*Cen.nig*	0.12	0.00	0.12	0.00	0.00
(Pieris brassicae)		*Cir.acu*	0.04	0.50	0.00	0.00	0.00
		Cir.arv	0.04	0.06	0.00	0.00	0.00
		Cli.vul	0.02	0.03	0.00	0.00	0.00
		Sca.col	0.05	0.00	0.05	0.00	0.00
Green-veined/Small White	*Pie.nap/rap*	*Cen.nig*	0.08	0.00	0.08	0.00	0.00
(Pieris rapae/napi)		*Cir.arv*	0.01	0.02	0.00	0.00	0.00
		Leo.his	0.01	0.00	0.02	0.00	0.00
		Sca.col	0.05	0.00	0.05	0.00	0.00
		Sen.jac	0.00	0.03	0.00	0.00	0.00
Common Blue	*Pol.ica*	*Cen.sca*	0.06	0.18	0.00	0.00	0.00
(Polyommatus icarus)		*Cir.arv*	0.12	0.15	0.00	0.00	0.00
		Inu.con	0.07	0.07	0.00	0.00	0.00
		Leo.aut	1.50	1.50	0.00	0.00	0.00
		Lot.cor	0.00	0.00	0.02	0.01	0.00
		Sca.col	0.02	0.00	0.02	0.00	0.00
		Suc.pra	0.06	0.00	0.07	0.00	0.00
Gatekeeper	*Pyr.tit*	*Cir.arv*	0.10	0.13	0.00	0.00	0.00

(Pyronia tithonus)		*Leo.aut*	0.25	0.25	0.00	0.00	0.00
		Sen.jac	0.00	0.00	0.00	0.00	0.00
6-spot Burnet moth	*Zyg.fil*	*Cen.nig*	0.14	0.00	0.14	0.00	0.00
(Zygaena filipendulae)		*Cen.sca*	1.00	0.00	0.27	0.00	5.00
		Cir.acu	0.04	0.00	0.05	0.00	0.00
		Cir.arv	0.01	0.00	0.14	0.00	0.00
		Cir.vul	0.33	0.00	0.00	0.00	1.00
		Kna.arv	1.17	0.00	0.00	0.00	0.83
		Leo.his	0.01	0.00	0.00	0.00	0.03
		Lot.cor	0.00	0.00	0.00	0.00	0.01
		Sca.col	0.09	0.00	0.09	0.00	0.00

In summary, the results indicate that the species that dominate the Lepidoptera/nectar plant feeding plant relationships at the Stonehenge landscape are *Z. filipendulae* and *M. jurtina, Centaurea scabiosa*, and *Centaurea nigra*. There is much variation between the Lepidoptera species and the nectar plant that they are feeding on between different habitat types. it appears that this Lepidoptera species/nectar plant relationship is more complex in chalk grassland fragments and barrow groups compared to the new grassland re-creation. The complexity of this relationship and its similarity between target habitat and restored habitat may be a measure of grassland re-creation success.

8.2.6 Explanatory variables for Multivariate analyses

There were a large number of potential explanatory variables compared to numbers of transect sample sites and species size. To avoid over-parameterisation of the models and Type II error, Lepidoptera total density, species richness and individual species response to environmental variables using Generalized Linear Models (Linear response, Poisson distribution) were used to select ecological relevant variables for inclusion in the ordination models . All species and samples were given equal weighting except for sample (g) in the habitat quality model for habitat transects (sample g had outlying values so was down-weighted to half of the others to account for this anomaly; results without down-weighing did not significantly affect the variables in the final model).

8.2.6.1 Habitat transects

Nectar flower richness- Nectar flower species richness had significant simple and conditional effects in RDA and explained the most amount of variation (26.9%, simple effect p=0.002, conditional effect p=0.004) when compared to the Shannon' diversity and mean number of nectar flowers.

Vegetation density- Vegetation density significantly explained Lepidoptera density (p=<0.0001) and provided a strong but non-significant trend for Lepidoptera species richness (p=0.0744) and is an important environmental variable with species specific responses to different vegetation densities .

Coverage of bare-ground- the percentage coverage of bare ground significantly explained Lepidoptera density (p=0.0003) and is likely to be negatively correlated with the quality of the habitat but it is also a resource for some butterfly species for thermoregulation and courtship.

Age- The number of years it would take to restore the habitat type (Age2) had significant simple and conditional effects in RDA and explained the most amount of variation (27.5%, simple effects p=0.004, conditional effects p=0.018). In this Age2 age measure, chalk grassland fragments are classed as 60 years and semi improved pasture as 3 years rather than measured as the minimum number of years that the habitat had been in the landscape, resulting in 100 years for chalk grassland and 50 years for semi-improved pasture which did not have significant conditional effects.

Linear features at 100m buffer from transects- Five RDA ordinations with environmental variables as the proportions of chalk grassland, neutral and rough grassland, semi-improved pasture, arable land and linear features at different buffer scales (50m, 100m, 250m, 500m and 1km) from the transect showed that Lepidoptera community responses were not significant. The RDA at the 100m buffer scale explained the most variation of 39.3% (11.7% adjusted) (first axis p =0.131, all axes p=0.173) and only linear features at the 100m and 250m scales had significant simple and conditional effects (p=<0.05) even when the variation shared with other significant variables were taken out. Linear features at the 100m buffer had 7 significant species responses (GLM) compared to 5 at the 250m scale (RDA models were also run with linear features at the 250m buffer in comparison with the 100m buffer and results did not differ significantly).

Co variables – Lepidoptera density was significantly affected by weather conditions but no co variables were used as RDA models showed that Lepidoptera community composition was not significantly affected by weather conditions (first axis p=0.773, all axes p=0.490) or sampling day (first axis p= 0.789, all axes p=0.921) and no individual weather or sampling day measure variable had significant simple or conditional effects.

Table 8-9. Lepidoptera density and richness response to the environmental variables (GLM, Poisson distribution, log link function, Linear response) in habitat transects. Environmental variables including the proportion of chalk grassland and linear features in different sized buffers from transects, measures of the age of the habitat, nectar flower resources and habitat characteristics.

Environmental variable	**Measure**	**Variable Label**	**Lepidoptera Response**	**p value (4dp)**	**AIC (2dp)**
Habitats in the Landscape					
Chalk grassland	50 m buffer	Chalk50	Density	<0.0001	216.98
(Source habitat)			Richness	NS	N/A
	100 m buffer	Chalk100	Density	<0.0001	245.35
			Richness	NS	N/A
	250 m buffer	Chalk250	Density	0.0349	272.24
			Richness	NS	N/A
	500 m buffer	Chalk500	Density	0.0016	262.89
			Richness	NS	N/A
	1000 m buffer	Chalk1000	Density	0.0001	251.49
			Richness	NS	N/A
Linear features	50 m buffer	Lin50	Density	<0.0001	228.14
(Connectivity)			Richness	NS	N/A
	100 m buffer	Lin100	Density	<0.0001	217.84
			Richness	NS	N/A
	250 m buffer	Lin250	Density	<0.0001	182.52
			Richness	NS	N/A
	500 m buffer	Lin500	Density	<0.0001	225.49
			Richness	NS	N/A
	1000 m buffer	Lin1000	Density	0.0009	260.51
			Richness	NS	N/A
Weather and Sampling					
Cloud	Mean % coverage	CloudM	Density	0.0059	267.37

			Richness	NS	N/A
	Variation	CloudCV	Density	NS	N/A
			Richness	NS	N/A
Temperature	Mean ^{o}C	TempM	Density	0.0021	263.85
			Richness	NS	N/A
	Variation	TempCV	Density	0.0181	270.58
			Richness	NS	N/A
Wind speed	Mean MpH	WindM	Density	0.0007	259.81
			Richness	NS	N/A
	Variation	WindCV	Density	0.0002	254.09
			Richness	0.0607	N/A
Sampling day	Day no.	DayM	Density	0.0039	265.99
			Richness	NS	N/A
	Variation	DayCV	Density	0.0060	267.39
			Richness	NS	N/A
<u>Nectar plant measure</u>					
Nectar plant flower	Shannon	NectarDv	Density	<0.0001	172.93
			Richness	0.0368	12.24
	Density	NectarM	Density	0.0034	265.56
			Richness	NS	N/A
	Richness	NectarRc	Density	<0.0001	189.28
			Richness	0.0364	12.22
Asteraceae family	Density	AstM	Density	<0.0001	217.02
			Richness	NS	N/A
Dipsacaceae family	Density	DipM	Density	<0.0001	235.94
			Richness	NS	N/A
Fabaceae family	Density	FabM	Density	NS	N/A
			Richness	NS	NA

Age of the habitat measure					
Age absolute	Years	Age	Density	<0.0001	186.84
			Richness	0.0144	9.84
Age 2 -years to restore that habitat type	Years	Age2	Density	<0.0002	158.39
			Richness	0.0181	10.46
Habitat characteristics					
Bare ground % coverage	Mean	BG%M	Density	0.0003	255.98
			Richness	NS	N/A
	Segment variation	BG%SegCV	Density	<0.0001	237.31
			Richness	0.0277	11.55
	Transect variation	BG%TranCV	Density	<0.0001	193.25
			Richness	NS	N/A
Vegetation Density	Mean cm	VegM	Density	<0.0001	120.67
			Richness	0.0744	N/A
	Segment variation	VegSegCV	Density	<0.0001	159.07
			Richness	NS	N/A
	Transect variation	VegTranCV	Density	<0.0001	181.80
			Richness	NS	N/A

8.2.6.2 Matrix transects

Cloud mean percentage coverage- This variable had the highest significance and lowest AIC (p=<0.0001, AIC 65.35) for Lepidoptera density out of all the explanatory variables and explained more variation in RDA than the variation in the percentage of cloud coverage (24.1% and 20.4% respectively). Exploratory data analysis showed that the variation in cloud coverage and mean cloud coverage did not have significant conditional effects once the other variable had been selected.

Percentage coverage of bare ground- This variable was significant in explaining Lepidoptera density (p=0.0003) and is potentially a good measure of habitat quality, is used as a thermoregulation and courtship resource for some Lepidoptera species .

Mean vegetation height- This variable significantly explained Lepidoptera density (p=0.0001), has been shown to be a significant variable in previous models (habitat transects) and different species have different optimum height requirements .

Nectar flower richness- This variable had higher significance and lower AIC than the mean density of nectar plants (p<0.0001, p=0.0233 respectively) and has been show in previous models (habitat transects) to be an important variable.

Table 8-10. Lepidoptera density and richness response to the environmental variables (GLM, Poisson distribution, log link function, Linear response) in matrix transects. Environmental variables including, nectar flower resources and habitat characteristics at different scales and weather conditions plus notes of the linear relationship.

Environmental variable	**Measure**	**Variable Label**	**Response**	**p**	**AIC**	**Notes**
Nectar resources						
Nectar plant flower	Richness	NectarRc	Density	<0.0001	106.96	Positive
	Richness		Richness	NS		
	Mean	NectarM	Density	0.0233	152.08	Positive
	Mean		Richness	NS		
	Transect variation	NectarTranCV	Density	0.0035	144.83	Negative
	Transect variation		Richness	NS		
	Segment variation	NectarSegCV	Density	0.0193	151.47	Positive
	Segment variation		Richness	NS		
Asteraceae family	Mean	AstM	Density	<0.0001	71.89	Positive
	Mean		Richness	NS		

	Transect variation	AstTranCV	Density	<0.0001	91.40	Negative
	Transect variation		Richness	NS		
Dipsacaceae family	Mean	DipM	Density	<0.0001	100.22	Positive
	Mean		Richness	NS		
	Transect variation	DipTranCV	Density	NS		
	Transect variation		Richness	NS		
Fabaceae family	Mean	FabM	Density	<0.0001	114.40	Positive
	Mean		Richness	NS		
	Transect variation	FabTranCV	Density	0.0209	151.74	Positive
	Transect variation		Richness	NS		
Habitat characteristics						
Vegetation density	Mean	VegM	Density	0.0001	120.59	Negative
	Mean		Richness	NS		
	Transect variation	VegTranCV	Density	<0.0001	117.24	Positive
	Transect variation		Richness	NS		
	Segment variation	VegSegCV	Density	0.0001	120.06	Positive
	Segment variation		Richness	NS		
Bare ground % coverage	Mean	BG%M	Density	0.0003	129.86	Negative
	Mean		Richness	NS		
	Transect variation	BG%TranCV	Density	0.0001	103.67	Positive
	Transect variation		Richness	NS		
	Segment variation	BG%SegCV	Density	0.0003	129.90	Positive
	Segment variation		Richness	NS		
Weather conditions						
Cloud % Coverage	Mean	Cloud%M	Density	0.0001	65.35	Negative
	Mean		Richness	NS		
	Variation	Cloud%CV	Density	0.0414	153.76	Negative
	Variation		Richness	NS		

Temperature	Mean	TempM	Density	NS		
	Mean		Richness	NS		
	Variation	TempCV	Density	NS		
	Variation		Richness	NS		
Wind speed	Mean	WindM	Density	NS		
	Mean		Richness	NS		
	Variation	WindCV	Density	0.0003	128.66	Negative
	Variation		Richness	NS		

8.2.6.3 Landscape measures, habitat quality, nectar resources, habitat characteristics and PCNM.

Table 8-11. Summary of unconstrained (PCA) and constrained (RDA) models including environmental variables in full model containing all the environmental variables (Full) and after interactive forward selection (FS=) and total (Total) and adjusted (Adj) variation explained (2dp), explained variation cumulatively. RDA models for , a) habitat types at different landscape scales (Landscape measures), b) the best age measure to use full model and c) model after forward selection (FS) of habitat quality, nectar resources and habitat characteristics, analysis when, sample g was not down-weighted.

	Variation Explained %		**Cumulative explained variation**				**Permutation test p**	
Model	**Total**	**Adj**	**Axis 1**	**Axis 2**	**Axis 3**	**Axis 4**	**First axis**	**All axes**
Unconstrained			55.35	74.54	85.68	92.68		
a) Landscape measures								
Chalk grassland, other grassland, linear features, arable and improved pasture								
50 m buffer	38.10	9.90	25.88	32.1	36.11	37.22	0.227	0.218
100 m buffer	39.30	11.70	29.51	35.64	38.38	39.1	0.131	0.173
250 m buffer	28.80	0.00	18.98	24.03	26.5	28.4	0.470	0.553
500 m buffer	27.70	0.00	17.47	24.2	26.45	27.43	0.584	0.606
1000 m buffer	27.30	0.00	15.98	23.77	25.73	26.90	0.657	0.636
Chalk Grassland and linear features								
50 m buffer	28.50	18.30	23.34	28.49	67.70	82.03	0.046	0.039

100 m buffer	21.40	10.10	17.48	21.35	62.13	78.74	0.084	0.069
250 m buffer	18.60	7.00	17.96	18.61	57.16	76.14	0.098	0.140
500 m buffer	14.90	2.70	12.71	14.88	58.63	76.87	0.248	0.282
1000 m buffer	9.30	0.00	8.44	9.33	60.37	77.06	0.486	0.600
b) How to measure the age of the habitat- model Age/Age 2, BG%, DD Lin 100, NR								
Age (absolute)	58.50	39.60	42.76	50.56	54.87	58.16	0.008	0.006
Age2 (years to restore)	63.80	47.30	45.93	53.28	60.39	63.46	0.004	0.002
c) when sample g was not down-weighted, all samples had equal weighting								
Habitat quality								
Age 2, Linear features 100m buffer, Bare ground %mean, Nectar flower richness, Mean vegetation height								
Full Model	63.80	47.30	45.93	53.28	60.39	63.46	0.004	0.002
FS=Age2, VegM, NectarRc	55.10	44.70	43.23	50.34	55.06	73.08	0.002	0.002
When sample g was down-weighted to 0.5 of the others								
Age2, Lin100, BG%M, NectarRc,VegM (2c DW)	63.30	46.60	43.52	54.18	61.59	62.77	0.006	0.002
FS=Age 2, VegM, NectarRc (2c DW)	54.00	43.30	40.86	48.19	53.95	76.36	0.002	0.002
Nectar resources								
Mean nectar plant density, Richness, Asteraceae, Fabaceae and Dipsacaceae								
Full model	56.20	36.30	35.36	49.99	55.28	56.02	0.052	0.004
FS=NectarRc and DipM	42.70	34.50	32.99	42.66	69.97	82.41	0.004	0.002
Habitat characteristics								
Vegetation height and Bare ground coverage mean, within transect and within segment variation								
VegM, BG%M, VegTranCV, VegSegCV, BG%TranCV, BG%SegCV	57.40	31.80	40.85	53.96	56.14	57.02	0.028	0.028
FS= VegM, VegTranCV, BG%TranCV	52.40	41.40	39.03	51.2	52.4	71.8	0.002	0.002

Table 8-12. Summary of constrained (RDA) models when the potential auto-correction from transect location and proximity to one another was removed by PCNM analysis (-Landscape PCNM). Models of environmental variables after interactive forward selection and total (Total) and adjusted (Adj) variation explained (2dp), explained variation cumulatively. RDA models for , a) habitat quality b) nectar resources and c) habitat characteristics.

	Variation Explained %		**Cumulative explained variation**				**Permutation test p**	
Model	Total	Adj	Axis 1	Axis 2	Axis 3	Axis 4	First axis	All axes
a) habitat quality								
Habitat quality-landscape PCNM								
(Landscape), Age2, VegM, NectarRc	45.70	32.10	30.35	39.68	45.72	67.88	0.008	0.001
b) Nectar resource								
Nectar resources-landscape PCNM								
(Landscape), NectarRc, DipM	31.50	20.90	19.43	31.48	63.77	78.98	0.057	0.008
c) Habitat characteristics								
Habitat characteristics -landscape PCNM								
(Landscape), VegM, VegTranCV, BG%TranCV	43.50	29.40	27.18	42.22	43.52	66.22	0.039	0.002

8.2.6.4 Variation partitioning habitat transects

Table 8-13. Variation partitioning of the variables selected by interactive forward selection for the proportion of chalk grassland and linear features within buffers around transects, for habitat quality model, nectar resource model and habitat characteristics model. the variation explained (%) and significance (p) by all variables (All a+b+c) by variable a (a), by variable b (b) and by variables c (c) (or shared explained variation).

	Variable							
	All a+b+c		**a.**		**b.**		**c.**	
Model	**%**	**p**	**%**	**p**	**%**	**p**	**%**	**P**
Chalk grassland an linear features in buffers around habitat transects								
	All		a. Chalk		b. Linear		c. Shared	
Buffer 50m	18.30	0.039	3.90	0.120	4.00	0.174	10.40	N/A
Buffer 100m	10.10	0.069	0.40	0.326	5.40	0.098	4.30	N/A
Buffer 250m	7.00	0.125	-5.40	0.993	12.40	0.032	<0.10	N/A
Habitat quality								
	All		a. Age 2		b.VegM		c. NectarRc	
	43.30	0.002	7.30	0.035	18.80	0.019	3.50	0.140
Nectar resources								
	All		a. NectarRc		b. DipM		c. Shared	
	34.50	0.001	8.20	0.017	12.40	0.015	13.90	N/A
Different nectar families								
	All		a.AstM		b.DipM		c.FabM	
	30.00	0.004	4.60	0.131	13.70	0.018	5.50	0.094
Habitat characteristics								
	All		a .VegM		b.VegTranCV		c .BG%TranCV	
	41.40	0.001	13.20	0.004	-1.70	0.68	9.30	0.014

Table 8-14. Results of PCNM analysis where variation partitioning of the variables selected by interactive forward selection for the habitat quality, nectar resource and habitat characteristics model (a. Model) is separated from the variation explained by the spatial properties of the transects (proximity to each other, b. landscape, PCO.8) and the variation that is shared by both (c. Shared). The variation explained (%) and significance (p).

Model	**a+b+c**		**a. Model**		**b. Landscape**		**c. Shared**	
	%	**p**	**%**	**p**	**%**	**p**	**%**	**p**
Habitat quality								
Age 2, VegM NectarRc (2c DW)	42.30	0.002	28.00	0.002	-1.00	0.019	15.30	N/A
Age 2, VegM, NectarRc	42.20	0.001	27.40	0.001	-2.40	0.016		N/A
Nectar resources								
NectarRc, DipM	32.70	0.002	17.80	0.001	-1.80	0.016	16.60	N/A
Habitat characteristics								
VegM, VegTranCV, BG%TranCV	39.90	0.001	25.00	0.001	-1.50	0.016	16.40	N/A

8.2.6.5 Variation partitioning for matrix transects

Table 8-15. Variation partitioning of the variables chosen by interactive forward selection. variable and the percentage of variation that it explains. All variables contribution, variable a contribution, variable b contribution and variables c contribution (or shared explained variation). proportion of varitaun explained (%) and the significance (p).

	Explained Variation % and p value for variation partitioning							
	All a+b+c		**a.**		**b.**		**c.**	
Model	**%**	**p**	**%**	**p**	**%**	**p**	**%**	**p**
Habitat quality								
	All		a.VegM		b.BG%M		c.NectarRc	
Variables	34.50	0.002	9.50	0.046	4.50	0.144	6.4	0.116
	All		a. VegM		b. CloudM		c. NectarRc	
Co-variables and variables	37.30	0.002	12.80	0.010	7.30	0.066	5.3	0.112

Nectar resources								
	All		a.AstM		b.Nectar Rc		c.Shared	
	39.00	0.002	17.40	0.006	18.10	0.008	3.5	N/A
Different nectar families								
	All		a. AstM		b. DipM		c. FabM	
	27.30	0.008	10.60	0.044	-0.30	0.412	9	0.090
Habitat characteristics								
	All		a. VegM		b. VegTranCV		c.BG%TranCV	
	32.60	0.008	12.00	0.012	1.70	0.278	8.2	0.086
	All		a. VegM		B.BG%M		C. Shared	
	28.10	0.002	16.00	0.014	4.20	0.144	7.9	

8.2.6.6 Ecological and mobility group results for habitat transects

Table 8-16. Summary of constrained (RDA) models when constrained by ecological (Eco) or mobility (Mob) group including separate environmental variables and the habitat quality, nectar resource and habitat characteristics model. Total (Total) and adjusted (Adj) variation explained (2dp), cumulative explained variation of axes1-4 and the p value on the first and all axes after 999 iterations of the Monte-carlo permutation test. When sample g was down-weighted to 0.5 of the others (2c DW) and not down-weighted (No).

			Variation explained %		**Cumulative explained variation**				**Permutation test p (3dp)**	
Model	**2c weight**	**Group**	**Total**	**Adjusted**	**Axis 1**	**Axis 2**	**Axis 3**	**Axis 4**	**First Axis**	**All Axes**
Individual variables										
Age 2	DW	Eco	1.40	0.00	1.44	100.00				0.986
		Mob	1.10	0.00	1.14	100.00				0.906
	No	Eco	1.90	0.00	1.93	100.00				0.956
		Mob	2.00	0.00	2.00	100.00				0.842
BG%M	DW	Eco	21.40	5.70	21.40	100.00				0.280
		Mob	29.60	20.80	29.57	100.00				0.062
	No	Eco	20.90	5.10	20.91	100.00				0.298

		Mob	22.60	12.90	22.59	100.00				0.128
VegM	DW	Eco	3.00	0.00	2.96	100.00				0.936
		Mob	2.10	0.00	2.14	100.00				0.832
	No	Eco	7.10	0.00	7.05	100.00				0.750
		Mob	5.10	0.00	5.09	100.00				0.630
Lin100	DW	Eco	6.20	0.00	6.21	100.00				0.844
		Mob	1.40	0.00	1.39	100.00				0.920
	No	Eco	21.50	5.80	21.51	100.00				0.237
		Mob	7.80	0.00	7.83	100.00				0.534
NectarRc	DW	Eco	40.30	28.30	40.29	100.00				**0.044**
		Mob	31.10	22.50	31.15	100.00				0.062
	No	Eco	36.90	24.30	36.94	100.00				0.056
		Mob	39.00	31.30	38.96	100.00				**0.021**
Models										
Habitat quality										
Age2, VegM, NectarRc	DW	Eco	24.4	9.30	23.82	24.39	24.40	67.55	0.064	0.138
	DW	Mob	19.70	9.70	19.43	19.71	67.91	86.44	0.058	0.096
	No	Eco	26.00	11.20	24.63	25.99	26.01	67.12	0.056	0.114
		Mob	25.40	16.10	25.30	25.42	69.04	86.58	**0.024**	**0.028**
Nectar resources										
Nectar Richness and Dipsacaceae density										
NectarRc, DipM	No	Eco	37.40	24.80	24.28	37.36	80.24	100	0.082	0.024
		Mob	24.30	14.80	23.96	24.26	69.87	100	**0.038**	0.064
Habitat characteristics										
Mean vegetation density, Bare ground and vegetation density within Transect variation										
VegM, VegTranC	no	Eco	12.00	0.00	9.78	11.18	12.04	63.55	0.666	0.702

V, BG%TranCV									
	Mob	4.70	0.00	4.02	4.72	63.30	96.49	0.830	0.838

8.2.6.7 Ecological and mobility group results matrix transects

Table 8-17. Summary of constrained (RDA) models when constrained by ecological (Eco) or mobility (Mob) group including separate environmental variables and the habitat quality, nectar resource and habitat characteristics model. Total (Total) and adjusted (Adj) variation explained (2dp), cumulative explained variation of axes1-4 and the p value on the first and all axes after 999 iterations of the Monte-carlo permutation test. Mob2-Mobility group with Pienap/rap as widespread rather than intermediate

		Variation Explained %		**Explained variation (cumulative)**				**Permutation test p**	
Matrix Model	**Group**	**Total**	**Adjusted**	**Axis 1**	**Axis 2**	**Axis 3**	**Axis 4**	**First Axis**	**All Axes**
Individual variables									
NectarRc	Eco	20.30	3.20	20.28	100.00			0.398	0.400
	Mob	8.70	0.00	8.73	100.00			0.550	0.550
	Mob2	7.50	0.00	7.47	100.00			0.574	0.574
CloudCV	Eco	46.30	34.80	46.29	100.00			0.028	0.028
	Mob	18.10	7.10	18.05	100.00			0.232	0.232
	Mob2	26.10	16.20	26.09	100.00			0.104	0.104
VegM	Eco	31.20	16.50	31.23	100.00			0.140	0.140
	Mob	14.70	3.30	14.65	100.00			0.322	0.322
	Mob2	18.60	7.70	18.58	100.00			0.214	0.214
CloudM	Eco	11.80	0.00	11.78	100.00			0.640	0.640
	Mob	10.70	0.00	10.72	100.00			0.436	0.436
	Mob2	9.90	0.00	9.94	100.00			0.414	0.414
AstM	Eco	21.40	4.50	21.37	100.00			0.324	0.324
	Mob	18.00	7.00	17.96	100.00			0.220	0.220

	Mob2	23.80	13.60	23.76	100.00			0.136	0.136
Habitat quality									
CloudM, VegM, NectarRc	Eco	41.70	29.20	25.09	39.31	41.68	76.40	0.030	0.002
	Mob	15.00	3.60	12.17	14.96	53.16	84.76	0.280	0.290
	Mob2	20.70	10.10	18.10	20.67	58.55	88.36	0.080	0.106
Nectar resources									
NectarRc, AstM	Eco	29.60	14.50	25.97	29.55	80.62	100.00	0.064	0.082
	Mob	17.50	6.50	14.56	17.5	69.23	100.00	0.250	0.220
	Mob2	21.90	11.50	20.31	21.93	74.93	100.00	0.088	0.092
Habitat characteristics									
VegM, BG%M	Eco	21.00	4.10	19.42	21	77.47	100.00	0.286	0.356
	Mob	11.00	0.00	10.70	10.99	72.14	100.00	0.418	0.458
	Mob2	12.80	1.20	12.42	12.84	72.89	100.00	0.328	0.352
Matrix type (arable or grassland re-creation n=12)									
	Eco	21.20	4.30	21.20	100.00				0.372
	Mob	11.10	0.00	11.13	100.00				0.452
	Mob2	12.00	0.30	11.99	100.00				0.392

8.3 Appendix C (Chapter 4)

8.3.1 Comparing Lepidoptera density and behaviour at different survey boundaries

8.3.1.1 All comparison a, b and c results summary

Table 8-18. Results of comparison between proportions of Lepidoptera displaying different boundary behaviour in total and in ecological and mobility groups between, a)control and boundary surveys, b) the fragment and matrix side of the boundary and, c) at boundaries with adjacent matrix (land cover) of grassland re-creation grassland or arable. Plot exiting behaviour, group or combination being tested (Test on), what site is being compared (Compare), test used (Test) Chi-Squared result (X^2), significance (p=) and comments on the results (Comments). Ecological groups of Ruderal, Open-grass and Herb-rich association (Shreeve *et al*. 2001) and mobility groups of sedentary, intermediate and widespread.

Test on	Compare	Test	X^2	p	Comments
a)					
Behaviour Category	Boundary/Control	Fisher's Exact		<0.0001	Cross lower at boundary
Behaviour Cross/not Cross	Boundary/Control	Chi-squared	40.94	<0.0001	Cross lower at boundary
Behaviour Follow/not Follow	Boundary/Control	Chi-squared	27.96	<0.0001	Follow higher at boundary
Ecological group	Boundary/Control	Fisher's Exact		<0.0001	Open-grass higher at boundary
Mobility group	Boundary/Control	Fisher's Exact		<0.0001	Sedentary higher at boundary
b)					
Behaviour Category	Chalk/Matrix	Fisher's Exact		<0.0001	Cross boundary lower in chalk fragments
Behaviour Cross/not Cross	Chalk/Matrix	Chi-squared	75.53	<0.0001	Cross boundary lower in chalk fragments
Behaviour Follow/not Follow	Chalk/Matrix	Chi-squared	18.73	<0.0001	Follow boundary higher in chalk fragments
Ecological group	Chalk/Matrix	Fisher's Exact		<0.0001	Open-grass higher in chalk fragments
Mobility group	Chalk/Matrix	Fisher's Exact		<0.0001	Sedentary higher in

					chalk fragments
<u>Those that exited the plot by crossing boundary</u>					
Ecological group	Chalk/Matrix	Fisher's Exact		0.2159	No difference
Mobility group	Chalk/Matrix	Fisher's Exact		0.2974	No difference
<u>Those that exited the plot by following boundary</u>					
Ecological group	Chalk/Matrix	Fisher's Exact		<0.0001	Follow boundary by Herb-rich higher in chalk fragments
Mobility group	Chalk/Matrix	Fisher's Exact		<0.0001	Follow boundary by Sedentary higher in chalk fragments
c)					
Behaviour Category	Grassland re-creation/Arable	Fisher's Exact		0.0468	Cross boundary higher with grassland re-creation matrix
Behaviour Cross/not Cross	Grassland re-creation/Arable	Chi-squared	8.09	0.0442	Cross boundary higher with grassland re-creation matrix
Behaviour Follow/not Follow	Grassland re-creation/Arable	Chi-squared	0.52	0.4698	Follow boundary lower with grassland re-creation matrix
Ecological group	Grassland re-creation/Arable	Fisher's Exact		0.1718	
Mobility group	Grassland re-creation/Arable	Fisher's Exact		0.0417	Sedentary lower at grassland re-creation matrix
<u>Those that exited the plot by crossing boundary</u>					
Ecological group	Grassland re-creation/Arable	Fisher's Exact		0.0219	Cross boundary by Herb-rich higher with grassland re-creation
Mobility group	Grassland re-creation/Arable			0.0219	Cross boundary by Sedentary higher with Grassland re-creation

<u>Those that exited the plot by following boundary</u>					
Ecological group	Grassland re-creation/Arable	Fisher's Exact		0.6229	No difference
Mobility group	Grassland re-creation/Arable			0.1501	No difference
<u>Those that exited the plot by crossing/not crossing</u>					
Short grass	Grassland re-creation/Arable	Chi-squared	3.37	0.0662	Cross boundary by Herb-rich higher
Tall Grass	Grassland re-creation/Arable	Chi-squared	6.17	0.0130	Cross boundary by Open-grass lower with Grassland re-creation
Intermediate	Grassland re-creation/Arable	Chi-squared	0.00	1.0000	No difference
Sedentary	Grassland re-creation/Arable	Chi-squared	7.79	0.0053	Cross boundary by Sedentary higher with grassland re-creation
<u>Those that exited the plot by following/not following</u>					
Herb-rich	Grassland re-creation/Arable	Chi-squared	3.23	0.0723	Follow boundary by Herb-rich higher at Grassland re-creation
Open-grass	Grassland re-creation/Arable	Chi-squared	0.00	0.9939	No difference
Intermediate	Grassland re-creation/Arable	Chi-squared	0.14	0.7132	No difference
Sedentary	Grassland re-creation/Arable	Chi-squared	0.29	0.5912	No difference

8.3.1.2 Comparisons a- Differences between controls

Table 8-19. Numbers of Lepidoptera flight paths recorded crossing the dummy boundary in control plots of arable land, chalk grassland fragment and grassland recreation. Results of Chi-squared between observed and expected proportions X^2, Degrees of freedom (df) and significance (p).

Control type	**Group**	**Behaviour**		**Chi-squared results**		
		Cross	**Other**	**X^2**	**df**	**p**
Arable	Ruderal-veg	42	27	0	1	1
	Open-grass	5	3			
	Herb-rich	0	0			
Chalk	Ruderal-veg	19	8	17.14	2	0.0002
	Open-grass	64	119			
	Herb-rich	40	33			
Grassland re-creation	Ruderal-veg	21	25	1.71	1	0.1907
	Open-grass	6	0			
	Herb-rich	3	11			
Arable	Intermediate	32	21	0.09	2	0.9561
	Sedentary	4	2			
	Widespread	11	7			
Chalk	Intermediate	18	20	3.18	2	0.2036
	Sedentary	97	136			
	Widespread	8	4			
Grassland re-creation	Intermediate	8	15	0.05	1	0.8277
	Sedentary	6	0			
	Widespread	16	23			

Table 8-20. Numbers of Lepidoptera flight paths recorded following the dummy boundary in control plots of arable land, chalk grassland fragment and grassland recreation. Results of Chi-squared between observed and expected proportions X^2, Degrees of freedom (df) and significance (p).

Control type	**Group**	**Behaviour**		**Chi-squared results**		
		Follow	**Other**	**X^2**	**df**	**p**
Arable	Ruderal-veg	17	52	0	1	1
	Open-grass	2	6			
	Herb-rich	0	0			
Chalk	Ruderal-veg	5	22	2.92	2	0.2317
	Open-grass	60	123			
	Herb-rich	19	54			
Grassland re-creation	Ruderal-veg	13	33	1.41	1	0.2352
	Open-grass	0	6			
	Herb-rich	7	7			
Arable	Intermediate	11	42	1.41	2	0.495
	Sedentary	2	4			
	Widespread	6	12			
Chalk	Intermediate	11	27	1.05	2	0.5905
	Sedentary	71	162			
	Widespread	2	10			
Grassland re-creation	Intermediate	10	13	0.54	1	0.462
	Sedentary	0	6			
	Widespread	12	27			

8.3.1.3 Comparison b- Differences between the side of boundary

Table 8-21. Results of comparison between proportions of Lepidoptera displaying different plot exiting behaviour in total and of different ecological and mobility groups between those in the chalk grassland fragment and matrix side of the boundary. Densities in Chalk and Matrix plots and Grand Total, test used (Test) Chi-Squared result (X^2), significance (p=) and whether the observed at boundary surveys was higher or lower than the expected (Than expected).

Totals	**Chalk**	**Matrix**	**Grand Total**	**Test**	**X^2**	**p=**	**Than expected**
Plot exit behaviour Category				Fisher's Exact		<0.0001	
Avoid	91	26	117				Higher
Cross	67	87	154				Lower
Follow	246	63	309				Higher
Stay	56	8	64				Higher
Plot exit behaviour Cross/not Cross				Pearson's Chi-squared	75.53	<0.0001	
Cross	67	87	154				Lower
Other	393	97	490				Higher
Plot exit behaviour Follow/not Follow				Pearson's Chi-squared	18.73	<0.0001	
Follow	246	63	309				Higher
Other	214	121	335				Lower
Ecological group				Fisher's Exact		<0.0001	
Ruderal-veg	47	70	117				Lower
Herb-rich	98	39	137				Same
Open-grass	313	75	388				Higher
Woodland	2	0	2				
Mobility group				Fisher's Exact		<0.0001	
Intermediate	75	75	150				Lower
Sedentary	360	81	441				Higher
Widespread	25	27	52				Lower

Grand Total	460	184	644		
Those that exited the plot by crossing boundary					
Ecological group			Fisher's Exact	0.2159	
Ruderal-veg	22	19			
Herb-rich	16	30			
Open-grass	28	38			
Mobility group			Fisher's Exact	0.2974	
Intermediate	21	35			
Sedentary	34	42			
Widespread	12	9			
Those that exited the plot by following boundary					
Ecological group			Fisher's Exact	<0.0001	
Ruderal-veg	19	31			Lower
Herb-rich	61	9			Higher
Open-grass	165	23			Higher
Mobility group			Fisher's Exact	<0.0001	
Intermediate	45	23			Lower
Sedentary	193	26			Higher
Widespread	8	14			Lower

8.3.1.4 Comparison c- Differences between adjacent land cover type

Table 8-22. Results of comparison between proportions of Lepidoptera displaying different plot exiting behaviour in total and of different ecological and mobility groups between those in the chalk grassland fragment side of the boundary with adjacent matrix of either Grassland re-creation grassland or arable. Densities in plots with adjacent Grassland re-creation and arable and Grand Total, test used (Test) Chi-Squared result (X^2), significance (p=) and whether the observed at boundary surveys was higher or lower than the expected (Than expected).

Totals	Grassland re-creation	Arable	Grand Total	Test	X^2	p=	Rest than expected?
Plot exit behaviour Category				Fisher's Exact		0.0468	
Avoid	16	38	54				Lower
Cross	34	29	63				Higher
Follow	86	143	229				Higher
Stay	22	34	56				Same
Plot exit behaviour Cross/not Cross				Chi-squared	8.09	0.0441	
Cross	34	29	63				Higher
Other	124	215	339				Lower
Plot exit behaviour Follow/not Follow				Chi-squared	0.25	0.4690	
Follow	86	143	229				Lower
Other	72	101	173				Higher
Ecological group				Fisher's Exact		0.1710	
Ruderal-veg	12	31	43				Lower
Herb-rich	37	45	82				Higher
Open-grass	107	168	275				Same
Woodland	2	0	2				NA
Mobility group				Fisher's Exact		0.0417	
Intermediate	36	32	68				Higher
Sedentary	115	198	313				Lower
Widespread	7	14	21				Lower
Grand Total	158	244	402				

Those that exited the plot by crossing boundaries						
Ecological group				Fisher's Exact	0.0219	
Ruderal-veg	6	15	21			Lower
Herb-rich	11	5	16			Higher
Open-grass	16	9	25			Higher
Mobility group					0.0219	
Intermediate	11	10	21			Same
Sedentary	19	12	31			Higher
Widespread	4	7	11			Lower
Those that exited the plot by following boundary						
Ecological group				Fisher's Exact	0.6229	
Ruderal-veg	5	14	19			
Herb-rich	21	35	56			
Open-grass	59	94	153			
Mobility group					0.1501	
Intermediate	21	21	42			
Sedentary	63	116	179			
Widespread	2	6	8			
For those that exited the plot by crossing boundaries						
Short grass				Chi-squared	3.37	0.0662
Cross	11	5	16			Higher
Other	26	40	66			Lower
Tall Grass				Chi-squared	6.17	0.0130
Cross	16	9	25			Lower
Other	91	159	250			Higher
For those that exited the plot by following boundaries						
Herb-rich				Chi-squared	3.24	0.0723
Follow	21	35	56			Higher
Other	16	10	26			Lower

Open-grass				Chi-squared	0.00	0.9939	
Follow	59	94	153				
Other	48	74	122				
For those that exited the plot by crossing boundary							
Mobility group							
Intermediate				Chi-squared	0.00	1.000	
Cross	11	10	21				
Other	25	22	47				
Sedentary				Chi-squared	7.79	0.0053	
Cross	19	12	31				Higher
Other	96	186	282				Lower
For those that exited the plot by following boundary							
Mobility group							
Intermediate				Chi-squared	0.14	0.7132	
Follow	21	21	42				
Other	15	11	26				
Sedentary				Chi-squared	0.29	0.5912	
Follow	63	116	179				
Other	52	82	134				

8.3.2 Behaviour probability and boundary permeability

8.3.2.1 Behaviour probability

Table 8-23. The proportion of Lepidoptera (%) exiting the survey area by, a) crossing the boundary and, b) following the boundary. Results of Chi-squared test comparing this proportion to the 33% that would be expected if survey area exit behaviour was random (e.g. 33% would exit by crossing, 33% by avoiding and 33% by following the boundary). Separate for all Lepidoptera (Totals) and different ecological (Ruderal-veg, Herb-rich, Open-grass) and mobility (Sedentary, Intermediate, Widespread) groups (Group), adjacent land cover type (Adjacent). Proportion showing that behaviour (%), Chi-squared test (X^2) p vale (p=). Percentage recorded that behaviour and Chi-squared test for given probabilities 2 decimal places, p value 4 decimal places.

Group	**Adjacent**	**Crossing**			**Following**		
Total		**(%)**	**X^2**	**P=**	**(%)**	**X^2**	**P=**
	Arable	13.81	21.00	**<0.0001**	68.10	192.00	**<0.0001**
	Grassland	27.37	1.52	0.4674	61.05	32.85	**<0.0001**
Ecological group							
Ruderal- veg	Arable	50.00	3.75	0.1534	46.67	2.40	0.3012
	Grassland	44.44	0.50	0.7788	55.56	0.15	0.9260
Herb-rich	Arable	11.63	9.12	**0.0105**	81.40	44.70	**<0.0001**
	Grassland	38.46	0.31	0.8574	57.69	6.94	**0.0311**
Open-grass	Arable	6.57	44.16	**<0.0001**	68.61	76.73	**<0.0001**
	Grassland	18.97	5.39	0.0676	63.79	24.22	**<0.0001**
Mobility group							
Intermediate	Arable	32.26	0.02	0.9920	67.74	16.52	**0.0003**
	Grassland	38.46	0.31	0.8574	57.69	6.94	**0.0311**
Sedentary	Arable	7.27	50.43	**<0.0001**	70.30	101.48	**<0.0001**
	Grassland	21.54	4.07	0.1307	63.08	25.88	**<0.0001**
Widespread	Arable	50.00	1.75	0.4169	42.86	0.57	0.7515
	Grassland	50.00	0.50	0.7788	50.00	0.50	0.7788

8.3.2.2 Boundary permeability

Table 8-24. Mean (SE) permeability (%) estimates for chalk grassland fragments with boundarys of adjacent matrix of Grassland re-creation and arable for total Lepidoptera and the different ecological (Ruderal, Open-grass and Herb-rich) and mobility (Sedentary, Intermediate and Widespread) groups for Lepidoptera surveyed. For Lepidoptera on the chalk grassland fragment and matrix side of the boundary anf from thr matrix (adjacent land cover) side of the bouindary. Following used to compare exiting behaviour from the chalk grassland fragment boundary of the plot to the perpendicular boundary of the plot (following behaviour) and the opposite boundary of the plot(avoiding behaviour).

		From chalk fragment side of the boundary			From Matrix side of the boundary		
Exit behaviour	Response	Total	Grassland re-creation	Arable	Total	Grassland re-creation	Arable
Cross	Total	57.64	82.47	39.01	85.71	100.00	75.00
		21.78	14.11	6.37	32.40	0.00	14.73
Cross	Ruderal-veg	76.53	66.67	83.93	54.07	33.33	69.62
		28.93	33.33	11.80	20.44	33.33	17.55
Cross	Herb-rich	53.74	61.11	48.21	42.86	33.33	50.00
		20.31	30.93	20.49	16.20	33.33	28.87
Cross	Open-grass	35.01	51.52	22.63	100.00	100.00	100.00
		13.23	28.91	11.04	37.80	0.00	0.00
Cross	Intermediate	59.86	61.90	58.33	50.00	33.33	62.50
		22.63	31.23	22.05	18.90	33.33	21.92
Cross	Sedentary	34.46	51.52	21.67	100.00	100.00	100.00
		13.02	28.91	10.26	37.80	0.00	0.00
Cross	Widespread	64.29	33.33	87.50	46.43	33.33	56.25
		24.30	33.33	12.50	17.55	33.33	21.35
Follow	Total	95.62	92.78	97.75	62.15	71.39	55.23
		36.14	3.89	1.31	23.49	8.28	20.34
Follow	Ruderal-veg	93.65	100.00	88.89	33.79	33.33	34.13
		35.40	0.00	7.86	12.77	33.33	22.43

Follow	Herb-rich	91.11	79.26	100.00	34.29	26.67	40.00
		34.44	11.57	0.00	12.96	26.67	24.49
Follow	Open-grass	84.30	65.33	98.53	64.46	80.95	52.08
		31.86	32.69	1.47	24.36	19.05	22.15
Follow	Intermediate	93.65	88.89	97.22	53.83	71.11	40.87
		35.40	5.56	2.78	20.35	19.75	23.65
Follow	Sedentary	97.02	94.00	99.29	66.84	80.95	56.25
		36.67	3.24	0.71	25.26	19.05	21.35
Follow	Widespread	64.29	66.67	62.50	64.29	66.67	62.50
		24.30	33.33	23.94	24.30	33.33	23.94
Avoid	Total	93.45	88.89	96.88	NA	NA	NA
		35.32	11.11	3.13			
Avoid	Open-grass	93.45	88.89	96.88	NA	NA	NA
		35.32	11.11	3.13			
Avoid	Sedentary	93.45	88.89	96.88	NA	NA	NA
		35.32	11.11	3.13			

8.3.3 GLMM

8.3.3.1 Model iterations

Table 8-25. Minimum Adequate Model selection for GLMM based on all behaviours at boundaries. Model iteration from full model and the variable deleted with lowest significance in the subsequent model iteration, AIC, BIC, loglink, deviance and Chi-squared of model iteration compared to the previous iteration.

Model	Model iteration	AIC	BIC	logLik	deviance	Chi p=
All Lepidoptera						
	Model 8 overall compared to null					<0.0001
1	Model 1 Maximal Model	185.4	245.6	-70.71	141.4	
2	Model 1-Plot	179.4	231.4	-70.71	141.4	1
3	Model 2-Matrix Type: Total Sp Density	175.4	221.9	-70.71	141.4	1
4	Model 3- Wind Direction: Wind Cat	173.4	217.2	-70.71	141.4	0.9999
5	Model 4- Wind Direction	171.4	212.5	-70.71	141.4	1
6	Model 5- Wind Cat	169.4	207.7	-70.71	141.4	0.9998
7	Model 6- Total Sp Density	167.4	203	-70.71	141.4	1
8	Model 7- Matrix Type	163.4	193.5	-70.71	141.4	1
9	Model 8- Month	163.4	193.5	-70.71	141.4	<0.0001
10	Model 8- Month: Exit Behaviour	165.7	184.9	-75.87	151.7	0.03544
Ecological group						
Ruderal-veg	Null					
Herb-rich						
	Model 10 overall compared to null					<0.0001
1	Model 1 Maximal Model	93.75	154	-24.88	49.75	
2	Model 1- Wind Direction: Wind	91.75	149.2	-24.88	49.75	1

	Cat					
3	Model 2- Matrix Type: Short Sp Density	87.75	139.7	-24.88	49.75	1
4	Model 3- Wind Direction	85.75	135	-24.88	49.75	1
5	Model 4- Plot	79.75	120.8	-24.88	49.75	1
6	Model 5- Matrix Type	75.75	111.3	-24.88	49.75	1
7	Model 6- Wind Cat	73.75	106.6	-24.88	49.75	1
8	Model 7- Herb-rich Sp Density	71.75	101.9	-24.88	49.75	1
9	Model 8- Month: Exit behaviour	82.51	101.7	-34.25	68.51	0.000878
10	Model 8- Month	71.75	101.9	-24.88	49.75	1
11	Model 10- Exit behaviour: Month	78.51	92.19	-34.25	68.51	0.004599
<u>Open-grass</u>						
	Model 10 overall compared to Null					<0.0001
1	Model 1 Maximal Model	147.3	207.5	-51.67	103.3	
2	Model 1- Wind Direction: Wind Cat	145.3	202.8	-51.67	103.3	1
3	Model 2- Matrix Type: Open-grass Sp Density	141.3	193.3	-51.67	103.3	1
4	Model 3- Open-grass Sp Density	139.3	188.6	-51.67	103.3	0.9998
5	Model 4- Plot	133.3	174.4	-51.67	103.3	1
6	Model 5- Month: Exit behaviour	132.8	162.9	-55.41	110.8	0.1128
7	Model 6- Wind Direction	130.8	158.2	-55.41	110.8	1
8	Model 7- Wind Cat	128.8	153.4	-55.41	110.8	0.9999
9	Model 8- Matrix Type	124.8	144	-55.41	110.8	1
10	Model 9- Month	120.8	134.5	-55.41	110.8	1
<u>Mobility group</u>						
<u>Intermediate</u>						
	Model 10 Compared to Null					<0.0001
1	Model 1 Maximal Model	101.5	161.6	-28.73	57.45	

2	Model 1- Month: Exit behaviour	99.94	149.2	-31.97	63.94	0.1653
3	Model 2- Matrix Type: Intermediate Sp Density	95.94	139.7	-31.97	63.94	1
4	Model3- Wind Direction: Wind Cat	93.94	135	-31.97	63.94	0.9999
5	Model 4- Wind Direction	91.94	130.3	-31.97	63.94	1
6	Model 5- Plot	85.94	116	-31.97	63.94	1
7	Model 6- Intermediate Sp Density	83.94	111.3	-31.97	63.94	0.9999
8	Model 7- Matrix Type	79.94	101.8	-31.97	63.94	1
9	Model 8- Wind Cat	77.94	97.1	-31.97	63.94	1
10	Model 9- Month	73.94	87.63	-31.97	63.94	1
Sedentary						
	Model 8 overall compared to null					<0.0001
1	Model 1 Maximal Model	157.7	217.9	-56.87	113.7	
2	Model 1- Wind Cat: Wind Direction	155.7	213.2	-56.87	113.7	0.9999
3	Model 2- Matrix Type: Sedentary Sp Density	151.7	203.7	-56.87	113.7	1
4	Model 3- Wind Direction	149.7	199	-56.87	113.7	1
5	Model 4- Plot	143.7	184.8	-56.87	113.7	1
6	Model 5- Matrix Type	139.7	175.3	-56.87	113.7	1
7	Model 6- Sedentary Sp Density	137.7	170.6	-56.87	113.7	1
8	Model 7- Wind Cat	135.7	165.8	-56.87	113.7	0.9998
9	Model 8- Month: Exit behaviour	138.6	157.7	-62.29	124.6	0.02822
10	Model 8- Month	135.7	165.8	-56.87	113.7	<0.0001
Widespread	Null					

8.3.3.2 GLM crossing

8.3.3.2.1 Model iterations

Table 8-26. Minimum Adequate Model selection of GLM based on the proportion on Lepidoptera exiting plots by crossing the boundarys for Lepidoptera in the chalk grassland fragment side of the boundary. Model number and iteration, Degrees of Freedom (DF), AIC (3 decimal places), Deviance (residual deviance for all but the Null model, 3 decimal places), Chi-squared result between the current and previous iteration of the model (p=, 4 decimal places) and notes on which is the Minimum Adequate Model (MAM).

Model	Model iteration (crossing)	DF	AIC	Deviance	p=	Notes
	All Lepidoptera					
	Null	23		48.382		
1	Maximal	13	89.711	21.931		
2	Model 1-TotalSpDensity	13	89.711	21.931	1.0000	
3	Model 2-MatrixGrassland re-creation:TotalSpDensity	15	90.049	26.270	0.1143	
4	Model 3-AstandDip	16	88.052	26.273	0.9561	MAM
5	Model 4-N1	17	90.434	30.654	0.0363	*
Ecological group						
	Herb-rich Null					
	Open-grass					
	Null	19		42.747		
1	Maximal	9	64.099	21.698		
2	Model 1-WithorAgainstChalkBoundary	9	64.099	21.698	1.0000	F test
3	Model 2-WithorAgainstChalkBoundary:WindCatMpH	11	60.692	22.291	0.7432	
4	Model 3-Matrix Grassland re-creation	12	58.922	22.521	0.6316	
5	Model 4-AstandDip	13	57.104	22.704	0.6695	
6	Model 5-N1	14	56.182	23.781	0.2992	
7	Model 6-CVDropDisc	17	61.915	27.751	0.4564	
8	Model 7-Replicate	18	60.039	27.874	0.7258	MAM
9	Model 8-WindCatMpH	19	62.773	32.608	0.0296	*

	Widespread Null					
	Intermediate					
	Null	16		14.623		MAM
1	Maximal	6	45.774	5.859		
2	Model 1-MatrixGrassland re-creation:IntermediateSpDensity	7	43.831	5.917	0.8102	
3	Model 2-IntermediateSpDensity	8	41.87	5.955	0.8443	
4	Model 3-WindCatMpH	8	41.87	5.955	1.0000	
5	Model 4-N1	9	41.306	7.3911	0.2308	
6	Model 5-MatrixGrassland re-creation	10	39.334	7.4194	0.8663	
7	Model 6-Replicate	11	37.524	7.6087	0.6635	
8	Model 7-WithorAgainstChalkBoundary:WindCatMpH	13	38.919	13.005	0.0673	(*)
9	Model 7-AstandDip	12	37.225	9.3105	0.1920	
10	Model 9-CVDropDisc	15	38.389	12.474	0.1321	
11	Model 10-WithorAgainstChalk Boundary:WindCatMpH	17	36.445	14.530	0.3578	
	Sedentary					
	Null	22		49.674		
1	Maximal model	12	74.943	27.392		
2	Model 1-Matrix Grassland re-creation	13	72.997	27.446	0.8177	F test
3	Model 2-CVDropDisc	14	71.996	28.445	0.3175	
4	Model 3-Replicate	15	70.927	29.376	0.3345	
5	Model 4-AstandDip	16	70.302	30.752	0.2409	
6	Model 5-N1	19	77.382	36.075	0.1160	
7	Model 6-WithorAgainstChalkBoundary	19	77.382	36.075	1.0000	
8	Model 7-WindCatMpH:WithorAgainstChalkBoundary	21	75.623	38.316	0.3261	
9	Model 8-WindCatMpH	22	76.233	40.926	0.1062	MAM

8.3.3.3 GLM Following

8.3.3.3.1 Model iteration following

Table 8-27. Model selection of GLM based on the proportion on Lepidoptera exiting plots by following the boundary for Lepidoptera in the chalk grassland fragment side of the boundary. Model number and iteration, Degrees of Freedom (DF), AIC (3 decimal places), Deviance (residual deviance for all but the Null model, 3 decimal places), Chi-squared result between the current and previous iteration of the model (p=, 4 decimal places) and notes on which is the Minimum Adequate Model (MAM).

Model	Model Iteration (Following)	DF	AIC	deviance	Chi p=	
	All Lepidoptera					
	Model 9 overall compared to Null				0.03771	*
	Model 10 overall compared to Null				0.05252	(*)
1	Model 1 Maximal Model	13	103.15	21.714		
2	Model 1- Wind Direction: Wind Cat	14	101.15	21.721	0.9347	
3	Model 2- Wind Cat	15	99.236	21.803	0.7739	
4	Model 3- Drop Disc CV	16	97.437	22.004	0.6543	
5	Model 4- Month	17	95.454	22.022	0.8935	
6	Model 5- Ast and Dip	18	93.741	22.308	0.5925	
7	Model 6- Total Sp Density	18	93.741	22.308	1	
8	Model 7- Matrix Type: Total Sp Density	20	92.567	25.134	0.2434	
9	Model 8- Matrix Type	21	91.728	26.295	0.2812	
10	Model 9- Wind Direction	22	92.524	29.091	0.09449	(*)
	Ecological group					
	Ruderal-veg					
	Model 10 Overall compared to Null				0.08593	(*)
1	Model 1 Maximal Model	3	40.736	5.3897		
2	Model 1- Matrix Type: Ruderal-veg Sp Density	4	40.004	6.6578	0.2601	
3	Model 2- Wind Direction: Wind Cat	5	40.843	9.4961	0.09204	(*)
4	Model 3- N1	6	38.844	9.4971	0.9738	

5	Model 4-Ast and Dip	7	36.968	9.6214	0.7244	
6	Model 5- Month	8	35.03	9.683	0.8039	
7	Model 6- CV Drop Disc	11	35.455	12.109	0.7805	
8	Model 7- Ruderal-veg Sp density	12	34.82	13.469	0.2434	
9	Model 8- Wind Cat	13	33.852	14.506	0.3087	
10	Model 9- Matrix Type	14	32.567	15.22	0.398	
11						
	Herb-rich					
	Model 10 Overall compared to Null				0.001168	**
1	Model 1 Maximal Model	1	36.166	<0.00001		
2	Model 1- Wind Direction: Wind Cat	2	34.166	<0.00001	1	
3	Model 2- Matrix Type: Herb-rich Sp Density	3	32.166	<0.00001	1	
4	Model 3- Wind Cat	4	31.28	1.1147	0.2911	
5	Model 4- Wind Direction	4	30.166	<0.00001	1	
6	Model 5- CV Drop Disc	5	28.356	0.19041	0.6626	
7	Model6- Ast and Dip	6	26.382	0.2165	0.8717	
8	Model 7- N1	8	26.267	2.1018	0.17	
9	Model 8- Matrix Type	9	24.456	2.2903	0.6642	
10	Model 9- Wind Cat	10	23.188	3.0222	0.3923	
	Open-grass					
	Model 10 overall compared to Null				0.06921	(*)
1	Model 1 Maximal Model	9	79.404	15.771		
2	Model 1- Ast and Dip	10	77.424	15.79	0.8889	
3	Model 2- Wind Cat	10	77.424	15.79	1	
4	Model 3- CV Drop Disc	11	75.56	15.926	0.7118	
5	Model 4- Month	12	73.623	15.989	0.8022	
6	Model 5- Open-grass Sp Density	12	73.623	15.989	1	
7	Model 6- Matrix Type: Open-grass Sp	14	71.531	17.897	0.3852	

	Density					
8	Model 7- Matrix Type	15	69.553	17.919	0.8821	
9	Model 8- Wind Direction	15	69.553	17.919	1	
10	Model 9- Wind Cat: Wind Direction	18	67.92	22.286	0.2245	
	<u>Mobility group</u>					
	<u>Intermediate</u>					
	Model 10 Overall compared to Null				0.08507	
1	Model 1 Maximal Model	6	45.518	5.7005		
2	Model 1- Matrix Type: Intermediate Sp Density	7	43.556	5.7378	0.8469	
3	Model 2- Intermediate Sp Density	8	41.657	5.8394	0.75	
4	Model 3- Wind cat	8	41.657	5.8394	1	
5	Model 4- Matrix Type	9	40.748	6.9298	0.2964	
6	Model 5- N1	10	39.134	7.3163	0.5342	
7	Model 6- Month	11	37.298	7.4798	0.6859	
8	Model 7- Ast and Dip	12	36.951	9.133	0.1985	
9	Model 8- CV Drop Disc	15	37.957	12.139	0.1463	
10	Model 9- Wind Direction: Wind Cat	17	37.256	15.438	0.1922	
	<u>Sedentary</u>					
	Model 10 Overall compared to Null				0.0638	(*)
1	Model 1 Maximal Model	12	89.65	20.693		
2	Model 1- Wind Direction	12	89.65	20.693	1	
3	Model 2- Wind Cat	12	89.65	20.693	1	
4	Model 3- Month	13	87.812	20.855	0.6871	
5	Model 4- Matrix Type	14	85.973	21.016	0.6883	
6	Model 5- CV Drop Disc	15	84.282	21.326	0.5779	
7	Model 6- Sedentray Sp Density	15	84.282	21.326	1	
8	Model 7- Matrix Type: Sedentray Sp Density	17	82.59	23.633	0.3154	
9	Model 8- Wind cat: Wind Direction	20	77.74	24.783	0.7651	

10	Model 9- Ast and Dip Widespread Null	21	76.76	25.803	0.3124	

8.4 Appendix D (Chapter 5)

8.4.1 Comparisons a, b, c

8.4.1.1 Full results tables

Table 8-28. Results of total number of Lepidoptera either on both sides of the boundary, in the un-mown side, the mown side and at either treatment or control boundaries or in the sheltered or exposed block

			Boundary		Block	
Boundary side		**Total**	**Control**	**Treatment**	**Exposed**	**Sheltered**
All Lepidoptera						
Both	Density	389	197	192	209	180
Un-mown		230	105	125	124	106
Mown		159	92	67	85	74
Both	Cross	159	90	69	82	77
Un-mown		89	57	32	42	47
Mown		70	33	37	40	30
Both	Follow	74	21	53	47	27
Un-mown		38	6	32	26	12
Mown		36	15	21	21	15
Both	Avoid	36	18	18	21	15
Un-mown		22	7	15	14	8
Mown		14	11	3	7	7
Maniola jurtina						
Both	Density	148	73	75	83	65
Un-mown		83	36	47	45	38
Mown		65	37	28	38	27
Both	Cross	52	28	24	29	23
Un-mown		24	15	9	12	12
Mown		28	13	15	17	11
Both	Follow	26	10	16	19	7

Un-mown		13	3	10	9	4
Mown		13	7	6	10	3
Both	Avoid	20	9	11	13	7
Un-mown		12	3	9	7	5
Mown		8	6	2	6	2
Zygaena filipendulae						
Both	Density	195	105	90	101	94
Un-mown		120	58	62	64	56
Mown		75	47	28	37	38
Both	Cross	88	51	37	42	46
Un-mown		53	34	19	24	29
Mown		35	17	18	18	17
Both	Follow	36	9	27	23	13
Un-mown		22	3	19	16	6
Mown		14	6	8	7	7
Both	Avoid	14	8	6	7	7
Un-mown		8	3	5	6	2
Mown		6	5	1	1	5

8.4.1.2 Comparison a- Lepidoptera between treatment and control boundaries

Table 8-29 . Mean and Standard Error (SE) of all Lepidoptera (n=389), Meadow brown (*Maniola jurtina* n=148) and 6-spot Burnet moth (*Zygaena filipendulae* n=195) at treatment boundaries (Treatment) with a mown area adjacent and in controls that weren't mown (Control). Results of Students T-test, df=22.

Group	**Measure**	**Treatment**	**Control**	**T=**	**P=**
All Lepidoptera	Mean	16.00	16.42	0.0900	0.9268
	SE	2.95	3.37		
Man.jur	Mean	6.25	6.08	0.9311	0.9311
	SE	1.53	1.14		
Zyg.fil	Mean	7.50	8.75	0.4600	0.6518

	SE	1.56	2.24

Table 8-30. Results of Chi-squared test between observed and expected proportions (X^2) for all Lepidoptera , Meadow brown (*Maniola jurtina*) and 6-spot Burnet moth (*Zygaena filipendulae*) in plots with a mown boundary and in controls that weren't mown. Degrees of freedom (df) and p value (p).

Measure/Behaviour	**Group**	**X^2**	**df**	**p=**
Numbers of	*Man.jur* and *Zyg.fil*	0.5199	1	0.4709
Cross/not cross				
	All Lepidoptera	3.4303	1	0.0640
	Man.jur	0.4065	1	0.5237
	Zyg.fil	0.8088	1	0.3685
Follow/not follow				
	All Lepidoptera	17.0393	1	<0.0001
	Man.jur	1.0085	1	0.3153
	Zyg.fil	13.3934	1	0.0003

8.4.1.3 Comparison b- Lepidoptera between sheltered and exposed blocks

Table 8-31. Mean and Standard Error (SE) of all Lepidoptera (n=389), Meadow brown (*Maniola jurtina* n=148) and 6-spot Burnet moth (*Zygaena filipendulae* n=195) at the "exposed" and "sheltered" block.

Group	**Measure**	**Exposed**	**Sheltered**
All Lepidoptera	Mean	17.42	15.00
	SE	3.05	±3.24
Man.jur	Mean	6.92	5.42
	SE	1.40	±1.26
Zyg.fil	Mean	8.42	7.83
	SE	1.73	±2.13

Table 8-32. Results of Chi-squared test between observed and expected (X^2) at plots in sheltered and exposed locations (both mown boundary and in controls that weren't mown), degrees of freedom (df) and p value (p). Student's T-test based on mean results from 3 survey periods per plot with 4 plots in each Exposed and Sheltered location (n=12).

Group	**Measure**	**X^2**	**df**	**p=**
	Man.jur and *Zyg.fil*	0.4612	1	0.4971
Cross/not cross				
	All Lepidoptera	0.3665	1	0.5449
	Man.jur	0	1	1
	Zyg.fil	0.7866	1	0.3751
Follow/ not follow				
	All Lepidoptera	3.0508	1	0.0807
	Man.jur	2.9093	1	0.08807
	Zyg.fil	2.0265	1	0.1546

8.4.1.4 Comparison c- Lepidoptera either side of the boundary

Just the un-mown side of the boundary compared to the mown side Results of chi tests and t tests comparing between survey areas

Table 8-33. Chi-squared (X^2) and significance (p) within plots between the un-mown and mown side of the boundary for all Lepidoptera and *Maniola jurtina* (*Man.jur*)and *Zygaena filipendulae* (*Zyg.fil*).

	Control				**Treatment**			
	un-mown	**"mown"**	**X^2**	**p**	**un-mown**	**mown**	**X^2**	**p**
Total								
Man.jur	36	37			47	28		
Zyg.fil	58	47			62	28		
Total lep	105	92			125	67		
Cross								
Man.jur	15	13	0.0073	0.9317	9	15	3.1654	0.0752
Zyg.fil	34	17	0.5020	0.4786	19	18	1.5062	0.2197
Total lep	57	33	0.6461	0.4215	32	37	5.0183	0.0251
Follow								
Man.jur	3	7	1.9351	0.1642	10	6	0.0790	0.7786
Zyg.fil	3	6	2.0451	0.1527	19	8	0.6451	0.4219
Total lep	6	15	7.2909	0.0069	32	21	0.0024	0.9609
Avoid								
Man.jur	3	6	1.1500	0.2836	9	2	2.1667	0.1410
Zyg.fil	3	5	1.1153	0.2909	5	1	0.4740	0.4912
Total lep	7	11	2.3805	0.1229	15	3	3.5863	0.0583

8.4.2 Behaviour probabilities and boundary permeability measures

8.4.2.1 Behaviour probabilities

Table 8-34 . Results of chi-squared test between the proportion exiting the plot compared to expected if movement was random. Plots with boundaries next to a mown area (Boundary) and control un-mown plots with dummy "boundaries" (Control). For all Lepidoptera and Meadow brown butterfly *Maniola jurtina* and 6 spot Burnet moth *Zygaena filipendulae* separately (*Man.jur* and *Zyg.fil* respectively). Proportion exiting the plot by the designated behaviour (%), Chi-squared test (X^2) and p value (p=) all 2 decimal places, p values 4 decimal places. Probability of exiting randomly is 33.3%.

Group	Plot type	Crossing			Following		
		%	X^2	p=	%	X^2	p=
All Lepidoptera	Control	38.26	1.62	0.4439	4.03	57.59	**<0.0001**
	Treatment	40.51	1.83	0.4007	40.51	1.83	0.4007
Man.jur	Control	30.61	0.16	0.9216	6.12	16.33	**0.0003**
	Treatment	32.14	0.02	0.9911	35.71	0.07	0.9649
Zyg.fil	Control	40.97	2.18	0.3371	3.61	32.99	**<0.0001**
	Treatment	44.19	2.28	0.3200	44.19	2.28	0.3200

8.4.2.2 Boundary permeability

Table 8-35. Boundary permeability (%) proportion of Lepidoptera exiting plot by different behaviours that approached the boundary of the plot including those that stayed in the plot

	Control	**Treatment**	**Total**	**Control**	**Treatment**	**Total**	**Control**	**Treatment**	**Total**
Species	**Crossing (%)**			**Following(%)**			**Avoiding (%)**		
All Lepidoptera	55.14	44.79	49.96	24.92	51.35	38.14	20.61	35.66	28.13
	6.83	8.90	5.55	13.09	4.39	8.11	9.55	6.94	6.16
Man.jur	57.58	37.86	47.72	22.92	47.92	35.42	30.00	68.75	49.38
	8.11	16.76	9.39	15.73	8.59	9.55	23.80	13.77	14.69
Zyg.fil	68.70	77.84	73.27	18.75	76.61	47.68	35.00	27.38	31.19
	3.56	9.39	4.96	18.75	8.43	14.50	23.63	16.54	13.43

8.4.3 GLMM results

8.4.3.1 Lepidoptera behaviour on both sides of the boundary- Random effect is individual boundary survey ID

8.4.3.2 Crossing boundaries

8.4.3.2.1 Model iterations

Table 8-36. GLMM for proportion of Lepidoptera crossing boundaries, Model iteration (model), Variables, AIC, BIC, Log-link and deviance of the model and the chi-squared between the model and the previous iteration (Chi p=).

Model	Model iteration Cross	AIC	BIC	Log-link	Deviance	Chi p=
	All Lepidoptera					
1	Maximal model	36.02	47.80	-8.010	16.02	
2	Model 1- Treatment: Total Density	34.88	45.48	-8.439	16.88	0.3140
3	Model 2- Rep	34.88	45.48	-8.439	16.88	
4	Model 3- Treatment: Rep	43.98	49.87	-16.990	33.98	**0.0018**
	Man.jur					
1	Maximal model	37.44	49.22	-8.721	17.44	
2	Model 1- Treatment: *Man.jur* Density	35.83	46.43	-8.914	17.83	0.5339
3	Model 2- Rep	35.83	46.43	-8.914	17.83	1.0000
4	Model 3- *Man.jur* Density	35.94	45.37	-9.972	19.94	0.1459
5	Model 4- Treatment: Rep	32.08	36.79	-12.04	24.08	0.3877
6	Model 5- Treatment	31.34	34.88	-12.670	25.34	0.2612
	Zyg.fil					
1	Maximal model	44.93	56.71	-12.470	24.93	
2	Model 1- Treatment: *Zyg.fil* Density	42.95	53.56	-12.480	24.95	0.8763
3	Model 2- Block	41.29	50.72	-12.650	25.29	0.5600
4	Model 3- *Zyg.fil* Density	40.09	48.34	-13.040	26.09	0.3724
5	Model 4- Rep	40.09	48.34	-13.040	26.09	1.0000

6	Model 5- Treatment: Rep	39.75	43.29	-16.880	33.75	0.1047

8.4.3.3 Following boundaries

8.4.3.3.1 Model iterations

Table 8-37. GLMM for proportion of Lepidoptera following boundaries, Model iteration (model), Variables, AIC, BIC, Log-link and deviance of the model and the chi-squared between the model and the previous iteration (Chi p=). (same result even when you don't take this out here for all model 3)

Model	Model iteration follow	AIC	BIC	Log-link	Deviance	Chi p=
	All Lepidoptera					
1	Maximal model	32.74	44.52	-6.372	12.74	
2	Model 1-Treatment: Total Density	30.95	41.55	-6.475	12.95	0.6500
3	Model 2- Treatment: Rep	32.11	40.34	-9.049	18.10	0.0762
4	Model 3- Block	32.45	39.52	-10.23	20.45	0.1248
5	Model 4- Rep	30.19	34.9	-11.09	22.19	0.4201
	Man.jur					
1	Maximal model	40	51.78	-10	20	
2	Model 1-Treatment: *Man.jur* Density	38.09	48.7	-10.05	20.09	0.7603
3	Model 2- Treatment: Rep	37.34	45.59	11.67	23.34	0.1973
4	Model 3- Rep	35.18	41.07	-12.59	25.18	0.3986
5	Model 4- *Man.jur* Density	33.59	38.3	-12.79	25.59	0.5223
6	Model 5- Treatment	32.63	36.17	-13.32	26.63	0.3074
	Zyg.fil					
1	Maximal model	44.99	56.77	-12.49	24.99	
2	Model1- Treatment: *Zyg.fil* Desnity	43.03	53.63	-12.51	25.03	0.8383
3	Model 2- Rep	43.03	53.63	-12.51	25.03	1.0000
4	Model 3- Treatment: Rep	38.43	44.32	-14.21	28.43	0.4936
5	Model 4-Block	37.89	42.60	-14.94	29.89	0.2266
6	Model 5-*Zyg.fil* density	38.15	41.68	-16.08	32.15	0.1325

8.4.4 Lepidoptera behaviour on the mown side of the boundary- random effects are individual boundary survey ID

8.4.4.1 Crossing boundaries

8.4.4.1.1 Model iterations

Table 8-38. GLMM for proportion of Lepidoptera crossing boundaries, Model iteration (model), Variables, AIC, BIC, Log-link and deviance of the model and the chi-squared between the model and the previous iteration (Chi p=).

Model	Model iteration cross	AIC	BIC	Log-link	Deviance	Chi p=
	All Lepidoptera					
1	Maximal model	43.84	59.15	-8.919	17.84	
2	Model 1- Treatment: Total Density	41.85	55.99	-8.927	17.85	0.8995
3	Model 2- Rep	41.85	55.99	-8.927	17.85	1.0000
4	Model3- With or Against: Wind Speed	40.27	53.23	-9.135	18.27	0.5193
5	Model 4- Wind speed	38.33	50.11	-9.165	18.33	0.8052
6	Model 5- With or Against	37.81	48.41	-9.905	19.81	0.2237
7	Model 6- Treatment: Rep	37.84	43.73	-13.92	27.84	0.0906
8	Model 7-Total Density	38.17	42.88	-15.08	30.17	0.1269
	Man.jur					
1	Maximal model	37.09	52.4	-5.544	11.09	
2	Model 1- Man.jur Density	37.09	52.4	-5.544	11.09	1.0000
3	Model 2- Block	35.15	49.29	-5.576	11.15	0.8002
4	Model 3- Treatment: Man.jur Density	36.29	48.07	-8.143	16.29	0.0768
5	Model 3- rep	35.15	49.29	-5.576	11.15	1.0000
6	Model 5- With or Against: Wind Speed	35.31	48.27	-6.655	13.31	0.1419
7	Model 6- With or Against	34.54	46.33	-7.272	14.54	0.2663
8	Model 7-Wind speed	33.48	44.08	-7.739	15.48	0.3341
9	Model 8- Treatment: Rep	32.01	37.9	-11	22.01	0.163

10	Model 9- Treatment	30.66	35.37	-11.33	22.66	0.4191
	Zyg.fil					
1	Maximal model	35.87	51.18	-4.935	9.87	
2	Model 1- Treatment: Rep	32.31	45.27	-5.157	10.31	0.8013
3	Model 2- Wind Speed	32.31	45.27	-5.157	10.31	1.0000
4	Model 3- Rep	29.2	39.81	-5.602	11.2	0.6404
5	Model 4- Treatment	27.41	36.83	-5.705	11.41	0.6501
6	Model 5- With or Against	27.68	35.93	-6.840	13.68	0.1320
7	Model 6- With or Against: Wind Speed	26.46	32.35	-8.228	16.46	0.2494

8.4.4.2 Following boundaries

8.4.4.2.1 Model iterations

Table 8-39. GLMM for proportion of Lepidoptera following boundaries, Model iteration (model), Variables, AIC, BIC, Log-link and deviance of the model and the chi-squared between the model and the previous iteration (Chi p=).

Model	Model iteration follow	AIC	BIC	Log-link	Deviance	Chi p=
	All Lepidoptera					
1	Maximal Model	39.92	55.24	-6.962	13.92	
2	Model 1- Treatment: Rep	36.11	49.07	-7.055	14.11	0.9110
3	Model 2- Wind Speed	36.11	49.07	-7.055	14.11	1.0000
4	Model 3- Wind direction: Wind Speed	34.98	45.58	-8.49	16.98	0.2381
5	Model 4- Rep	32.9	41.15	-9.451	18.9	0.3825
6	Model 5- Wind Direction	31.37	38.43	-9.683	19.37	0.4963
7	Model 6- Treatment: Density	30.64	36.53	-10.32	20.64	0.2584
8	Model 7- Density	32.39	37.11	-12.2	24.39	0.0527
	Man.jur					
1	Maximal model	28.69	44.00	-1.345	2.69	
2	Model 1- *Man.jur* density	28.69	44.00	-1.345	2.69	1.0000

3	Model 2- Treatment: *Man.jur* density	25.15	38.11	-1.576	3.152	0.7937
4	Model 3- Wind Direction	23.37	35.15	-1.686	3.372	0.6389
5	Model 4- Treatment:Rep	21.21	30.63	-2.605	5.21	0.3990
6	Model 5- Wind speed: Wind direction	21.21	30.63	-2.605	5.21	1.0000
7	Model 6- Block	17.55	24.62	-2.777	5.554	0.6654
8	Model 7- Rep	23.28	28.00	-7.642	15.28	**0.0077**
	Zyg.fil					
1	Maximal model	28.72	41.68	-3.359	6.718	
2	Model 1- Rep	28.72	41.68	-3.359	6.718	1.0000
3	Model 2- Treatment: Rep	23.58	31.83	-4.791	9.581	0.5809
4	Model 3- Wind speed	21.93	29.00	-4.965	9.929	0.5551
5	Model 4- Wind direction	20.33	26.22	-5.165	10.33	0.5273

8.4.5 Lepidoptera behaviour on both sides of the boundary- random effects are individual survey boundary plot ID and survey period)

8.4.5.1 Crossing boundaries

8.4.5.1.1 Model iterations

Table 8-40. GLMM for proportion of Lepidoptera crossing boundaries, Model iteration (model), Variables, AIC, BIC, Log-link and deviance of the model and the chi-squared between the model and the previous iteration (Chi p=). (model would not allow for interactions so Treatment, Block and Sp density as fixed, plot and rep and random for some groupings).

Model	Model iteration Cross	AIC	BIC	Log-link	Deviance	Chi p=
	All Lepidoptera					
1	Maximal model	45.98	53.05	-16.99	33.98	
2	Model 1- Block	46.26	52.15	-18.13	36.26	0.1314
	Man.jur					
1	Maximal model	35.51	42.57	-11.75	23.51	
2	Model 1- Man.jur Density	34.08	39.97	-12.08	24.08	0.4484
3	Model 2- Treatment	33.34	38.06	-12.67	25.34	0.2612
	Zyg.fil					
1	Maximal model	44.3	51.37	-16.15	32.3	
2	Model 1- Zyg.fil Density	42.76	48.65	-16.38	32.76	0.4954
3	Model 2- Block	41.75	46.47	-16.88	33.75	0.3195

8.4.5.1.2 Minimum Adequate Model

Table 8-41. Minimum adequate model for GLMM for all Lepidoptera, *Maniola jurtina* (*Man.jur*) and *Zygaena filipendulae* (*Zyg.fil*) crossing the boundary of plots. Variable estimate (Estimate), Standard error (Std.Error), z (Decimal Places) and p value (Decimal Places) . Significance p<0.001 ***, p<0.01 **, p<0.05 *, p<0.1>0.05 (*).

Crossing	Variables	Estimate	Std.Error	z	p	
All Lepidoptera	Model 2 overall compared to Null				**0.0007**	***
	(Intercept)	-0.18	0.39	-0.46	0.6483	
	Treatment Mown	-0.76	0.26	-2.91	**0.0036**	**
	Total Density	0.04	0.01	2.94	**0.0033**	**
Man.jur	Null					
Zyg.fil	Model 3 overall compared to Null				0.0679	(*)
	(Intercept)	1.15	0.37	3.09	**0.0020**	**
	Treatment Mown	-1.02	0.50	-2.03	**0.0428**	*

8.4.5.2 Following boundaries

8.4.5.2.1 Model iterations

Table 8-42. GLMM for proportion of Lepidoptera following boundaries, Model iteration (model), Variables, AIC, BIC, Log-link and deviance of the model and the chi-squared between the model and the previous iteration (Chi p=).

Model	Model iteration Follow	AIC	BIC	Log-link	Deviance	Chi p=
	All Lepidoptera					
1	Maximal model	32.09	39.16	-10.04	20.09	
2	Model 1- Block	32.19	38.08	-11.09	22.19	0.1473
	Man.jur					
1	Maximal model	37.18	44.25	-12.59	25.18	
2	Model 1- *Man.jur* density	35.59	41.48	-12.79	25.59	0.5223
3	Model 2- Treatment	34.63	39.34	-13.32	26.63	0.3074
	Zyg.fil					

1	Maximal model	40.43	47.49	-14.21	28.43	
2	Model 1- Block	39.89	45.78	-14.94	29.89	0.2266
3	Model 2- *Zyg.fil* Density	40.15	44.86	-16.08	32.15	0.1325

8.4.5.2.2 Minimum Adequate Model

Table 8-43 Minimum adequate model for GLMM for all Lepidoptera, *Maniola jurtina* (*Man.jur*) and *Zygaena filipendulae* (*Zyg.fil*) following the boundary of plots. Variable estimate (Estimate), Standard error (Std.Error), z (Decimal Places) and p value (Decimal Places) . Significance p<0.001 ***, p<0.01 **, p<0.05 *, p<0.1>0.05 (*).

Follow	Variables	Estimate	Std.Error	z	p	
All Lepidoptera	Model 2 overall compared to Null				**0.0001**	***
	Treatment Mown	1.02	0.30	3.36	**0.0008**	***
	Total Density	-0.06	0.02	-3.54	**0.0004**	***
Man.jur	Null					
Zyg.fil	Model 3 Overall compared to Null				**0.0195**	*
	(Intercept)	-1.92	0.42	-4.55	**<0.0001**	***
	Treatment Mown	1.44	0.53	2.70	**0.0069**	**

8.4.6 Lepidoptera behaviour on the mown side of the boundary- random effects are individual survey boundary ID and survey period

8.4.6.1 Crossing boundaries

8.4.6.1.1 Model iterations

Table 8-44. GLMM for proportion of Lepidoptera crossing boundaries, Model iteration (model), Variables, AIC, BIC, Log-link and deviance of the model and the chi-squared between the model and the previous iteration (Chi p=).

Model	Model iteration crossing	AIC	BIC	Log-link	Deviance	Chi p=
	All Lepidoptera					
1	Maximal model	43.63	55.41	-11.81	23.63	
2	Model 1- Treatment	42.97	53.57	-12.48	24.97	0.2467
3	Model 2- Wind speed	42.97	53.57	-12.48	24.97	1.0000
4	Model 3- Wind direction: Wind speed	41.65	49.90	-13.82	27.65	0.2615
5	Model 4- Wind direction	39.99	47.05	-13.99	27.99	0.5619
	Man.jur					
1	Maximal model	40.20	51.98	-10.10	20.20	
2	Model 1- Wind direction: Wind speed	38.55	49.15	-10.27	20.55	0.5540
3	Model 2- Wind direction	36.60	46.02	-10.30	20.60	0.8261
4	Model 3- Treatment: *Man.jur* density	35.24	43.48	-10.62	21.24	0.4238
5	Model 4- Wind speed	33.83	40.90	-10.91	21.83	0.4413
6	Model 5- Block	32.23	38.12	-11.11	22.23	0.5287
7	Model 6- *Man.jur* Density	33.21	37.93	-12.61	25.21	0.0839
	Zyg.fil					
1	Maximal model	31.20	42.98	-5.60	11.20	
2	Model 1- Wind speed	31.20	42.98	-5.60	11.20	1.0000
3	Model 2- *Zyg.fil* density	31.20	42.98	-5.60	11.20	1.0000
4	Model 3- Treatment: *Zyg.fil* density	30.76	40.18	-7.38	14.76	0.1693

5	Model 4- Wind direction	29.82	38.06	-7.91	15.82	0.3029
6	Model 5- Wind direction: Wind speed	29.85	35.74	-9.92	19.85	0.1332

8.4.6.1.2 Minimum Adequate Model

Table 8-45. Minimum adequate model for GLMM for all Lepidoptera, *Maniola jurtina* (*Man.jur*) and *Zygaena filipendulae* (*Zyg.fil*) crossing the boundary of plots. Variable estimate (Estimate), Standard error (Std.Error), z (Decimal Places) and p value (Decimal Places) . Significance p<0.001 ***, p<0.01 **, p<0.05 *, p<0.1>0.05 (*).

Crossing	**Variables**	**Estimate**	**Std.Error**	**z**	**p**	
All Lepidoptera	Model 5 Overall compared to Null				**0.0005**	***
	(Intercept)	-0.90	0.51	-1.76	0.0778	(*)
	Block Sheltered	1.05	0.39	2.72	**0.0065**	**
	Total Density	0.14	0.04	3.62	**0.0003**	***
	Total Density: Treatment Mown	-0.14	0.03	-4.82	**<0.0001**	***
Man.jur	Model 6 overall compared to Null				**0.0080**	**
	(Intercept)	0.02	0.72	0.03	0.9782	
	Treatment Mown	-2.41	0.83	-2.90	**0.0037**	**
	Man.jur Density	0.22	0.13	1.639	0.1013	
	Model 7 Overall compared to Null				**0.0098**	**
	(Intercept)	0.92	0.48	1.90	0.0578	(*)
	Treatment Mown	-1.66	0.63	-2.64	**0.0083**	**
Zyg.fil	Model 6 Overall compared to Null				**0.0034**	**
	(Intercept)	1.26	0.47	2.69	**0.0071**	**
	Treatment Mown	-2.28	0.59	-3.83	**0.0001**	***
	Block Sheltered	1.62	0.58	2.79	**0.0053**	**

8.4.6.2 Following boundaries

8.4.6.2.1 Model iterations

Table 8-46. GLMM for proportion of Lepidoptera following boundaries, Model iteration (model), Variables, AIC, BIC, Log-link and deviance of the model and the chi-squared between the model and the previous iteration (Chi p=).

Model	Model iteration following	AIC	BIC	Log-link	Deviance	Chi p=
	All Lepidoptera					
1	Maximal model	35.76	47.54	-7.88	15.76	
2	Model 1-Wind speed	35.76	47.54	-7.88	15.76	1.0000
3	Model 2-Wind direction: Wind speed	34.90	44.33	-9.45	18.90	0.2082
4	Model 3-Wind direction	33.37	41.61	-9.68	19.37	0.4963
5	Model 4-Treatment: Density	32.64	39.71	-10.32	20.64	0.2584
6	Model 5- Density	34.39	40.28	-12.20	24.39	0.0527
	Man.jur					
1	Maximal model	32.79	44.57	-6.40	12.79	
2	Model 1- Treatment: *Man.jur* density	30.91	41.51	-6.46	12.91	1.0000
3	Model 2- *Man.jur* density	28.95	38.38	-6.48	12.95	0.8375
4	Model 3- Wind speed	28.95	38.38	-6.48	12.95	1.0000
5	Model 4- Wind direction: Wind speed	26.41	33.48	-7.21	14.41	0.4822
6	Model 5- Block	25.85	31.74	-7.93	15.85	0.2305
7	Model 6- Wind direction	25.56	30.28	-8.78	17.56	0.1906
	Zyg.fil					
1	Maximal model	26.57	38.35	-3.28	6.57	
2	Model 1- Wind speed	26.57	38.35	-3.28	6.57	1.0000
3	Model 2- Wind direction: Wind speed	23.66	33.08	-3.83	7.66	0.5789
4	Model 3- Wind direction	22.13	30.38	-4.07	8.13	0.4923
5	Model 4- Zyg.fil density: Treatment	22.33	29.40	-5.17	10.33	0.1383

8.4.6.2.2 Minimum Adequate Models

Table 8-47. Minimum adequate model for GLMM for all Lepidoptera, *Maniola jurtina* (*Man.jur*) and *Zygaena filipendulae* (*Zyg.fil*) following the boundary of plots. Variable estimate (Estimate), Standard error (Std.Error), z (Decimal Places) and p value (Decimal Places) . Significance p<0.001 ***, p<0.01 **, p<0.05 *, p<0.1>0.05 (*).

Following	Variables	Estimate	Std.Error	z	p	
All Lepidoptera	Model 5 iteration compared to Null				**0.0015**	**
	(Intercept)	-1.3	0.61	-2.01	**0.0441**	*
	Treatment Mown	2.14	0.50	4.28	**<0.0001**	***
	Block Sheltered	-0.93	0.44	-2.13	**0.0334**	*
	Total Density	-0.06	0.03	-1.93	0.0542	(*)
	Model 6 iteration compared to Null				**0.0029**	**
	(Intercept)	-2.05	0.45	-4.59	**<0.0001**	***
	Treatment Mown	2.02	0.49	4.12	**<0.0001**	***
	Block Sheltered	-0.84	0.43	-1.98	**0.0482**	*
Man.jur	Model 7 iteration compared to Null				**0.0847**	(*)
	(Intercept)	-1.79	0.62	-2.87	**0.0041**	**
	Treatment Mown	1.20	0.74	1.63	0.1027	
Zyg.fil	Model 5 iteration compared to Null				**0.0015**	**
	(Intercept)	0.02	0.96	0.02	0.9807	
	Treatment Mown	2.64	0.76	3.46	**0.0005**	***
	Block Sheltered	-1.47	0.65	-2.24	**0.0249**	*
	Zyg.fil Density	-0.27	0.11	-2.62	**0.0089**	**

8.4.7 Measures of micro-climate, weather, nectar resources and vegetation characteristics

8.4.7.1 Micro climate and weather

Table 8-48. Mean (and Standard Error) micro-climate and weather conditions between control and treatment boundary surveys and sheltered and exposed blocks. Results of Student's T test/or Wilcoxon Sum Rank test (W/T=) and significance (p=) and if the values were square -root or log transformed (sqrt and log, respectively).

Measure	Treatment		Stats		Block		Stats	
	Control	Boundary	W/T=	p=	Exposed	Sheltered	W/T=	p=
<u>Micro climate</u>								
Humidity	53.89	54.40	T=-0.1492	0.8828	55.61	52.68	T=-0.8730	0.3925
	2.58	2.22			2.62	2.09		
Temperature	23.67	24.44	T=-0.6039	0.5521	23.92	24.19	T=0.2128	0.8337
°C	0.91	0.90			0.76	1.04		
Wind speed	2.48	1.81	W=82	0.5687	2.17	2.13	W=69	0.8808
(mean km/h)	1.58	1.34			1.59	1.33		
<u>Weather</u>								
Temperature	21.77	22.70	T=-0.8703	0.3936	22.26	22.21	T=-0.0458	0.9640
°C	0.75	0.77			0.54	0.95		
Wind speed	8.00	8.67	W=69.5	0.9073	8.75	7.92	T=-0.4320	0.6701
(Mph)	1.45	1.28			1.23	1.48		
Cloud coverage	34.17	24.17	(sqrt) T=1.0475	0.3036	23.33	35.00	W=95	0.1884
(%)	7.83	8.11			8.10	7.74		

8.4.7.2 Nectar resources and habitat characteristics at the whole survey area level

Table 8-49. Mean (and Standard Error) nectar resources and habitat characteristics between control and treatment boundary surveys and sheltered and exposed blocks comparing whole survey areas. Results of Student's T test/or Wilcoxon Sum Rank test (W/T=) and significance (p=) and if the values were square -root or log transformed (sqrt and log, respectively).

Measure	Treatment		Stats		Block		Stats	
	Control	Boundary	W/T=	p=	Exposed	Sheltered	W/T=	p=
Nectar resourecs								
Lotus corniculatus	7.50	4.25	(sqrt) T=0.5023	0.6215	8.67	3.08	(sqrt) T=-1.7275	0.1005
	2.78	1.35			2.80	0.89		
Medicago lupulina	30.25	19.42	(sqrt) T=1.9575	0.0639	28.75	20.92	(sqrt) T=-1.104	0.2818
	4.40	4.75			5.04	4.36		
Onobrychis viciifolia	19.67	5.67	W=133	0.0005	12.83	12.50	(sqrt) T=0.1924	0.8493
	3.22	1.93			3.63	3.13		
Rhinathus minor	21.42	5.83	(sqrt) T=4.0216	0.0006	15.58	11.67	(sqrt) T=-0.9861	0.3350
	3.64	1.58			3.16	4.01		
Total nectar flowers	84.75	37.08	(sqrt) T=5.1347	<0.0001	71.08	50.75	T=-1.5392	0.1382
	7.85	5.32			9.86	8.79		
Asteraceae	2.50	1.25	W=93	0.2261	2.42	1.33	W=45.5	0.1247
	0.70	0.33			0.61	0.50		
Fabaceae	59.75	29.92	T=3.6216	0.0015	52.58	37.08	T=-1.5706	0.1313

	6.19	5.43			7.73	6.14		
Average nectar flowers	7.06	3.09	(sqrt) T=5.1069	<0.0001	5.92	4.22	(sqrt) T=-1.5488	0.1358
	0.66	0.44			0.82	0.73		
Richness	3.96	3.15	T=2.4049	0.0254	3.68	3.43	T=-0.6295	0.5368
	0.26	0.21			0.31	0.20		
Diversity	3.33	2.53	T=2.6835	0.0136	3.07	2.79	W=66	0.7553
	0.22	0.20			0.28	0.18		
Shannon' Diversity	1.36	1.12	T=2.5189	0.0196	1.26	1.21	T=-0.457	0.6528
	0.06	0.07			0.09	0.06		
Evenness	0.77	0.73	T=0.9518	0.3523	0.75	0.76	T=0.2389	0.8136
	0.03	0.03			0.04	0.03		
<u>Habitat characteristics</u>								
Vegetation density (mean)	22.90	15.79	T=6.3505	<0.0001	21.28	17.41	W=41	0.0780
	0.91	0.65			1.41	0.94		
Vegetation density (CV)	18.76	54.58	T=-16.7858	<0.0001	37.28	36.07	W=61	0.5512
	1.88	1.01			5.99	5.19		

8.4.7.3 Nectar resources and habitat characteristics comparing the un-mown and mown side of the boundary

Table 8-50. Mean (and Standard Error) nectar resources and habitat characteristics between control and treatment boundary surveys and sheltered and exposed blocks comparing the un-mown side of the boundary to the mown side or "mown" for control. Results of Student's T test/or Wilcoxon Sum Rank test (W/T=) and significance (p=) and if the values were square -root or log transformed (sqrt and log, respectively).

	Side of the treatment plot				**Control plots**	
	mown side	**un-mown side**	**T/W=**	**p=**	**"Mown"**	**Un-mown**
Lot cor	1.75	2.50	W=45.5	0.1014	3.92	3.58
	1.19	0.74			1.69	1.40
Med lup	0.50	18.92	W=0	<0.0001	15.67	14.58
	0.26	4.68			3.25	2.32
Ono vic	0.75	4.92	W=24	0.0041	10.17	9.50
	0.39	2.03			1.26	2.67
Rhi min	0.00	5.83	W=12	0.0001	12.42	9.00
	0.00	1.58			3.55	2.39
Total	3.50	33.58	(sqrt) T= -8.2539	<0.0001	45.00	39.67
	1.43	4.36			5.42	5.39
AstTot	0.33	0.83	W=47	0.1098	1.50	0.75
	0.19	0.24			0.66	0.33
FabTot	3.17	32.67	W=0	<0.0001	43.08	38.33
	1.32	4.31			5.50	5.45
Average	0.29	2.80	(sqrt) T=-8.2539	<0.0001	3.75	3.31
	0.12	0.36			0.45	0.45
N1	1.45	2.78	W=16	0.0012	3.53	3.44
	0.20	0.24			0.24	0.24
N2	1.58	2.27	T=-2.2345	0.03965	3.03	2.95

	0.23	0.21			0.21	0.25
H	0.29	0.98	W=16	0.0012	1.24	1.21
	0.12	0.09			0.07	0.06
Evenness	0.52	0.68	W=47	0.9692	0.80	0.78
	0.16	0.06			0.03	0.04
Drop Disc mean	5.89	21.62	(log) T=-19.0983	<0.0001	23.13	22.69
	0.31	0.95			1.12	0.91
Drop Disc CV	16.91	19.49	T=-0.7192	0.4796	19.35	15.86
	2.53	2.56			2.88	1.87

8.4.8 Nectar feeding

Table 8-51 . The number of Lepidoptera/nectar flower interactions for *Argynnis* species, *Goneopteryx rhamni, Maniola jurtina Melanargia galathea, Pieris brassicae, Polyommatus icarus, Thymus sylvaticus* and *Zygaena filipendulae*.

Species	***Arg.sp***	***Gon.rha***	***Man.jur***	***Mel.gal***	***Pie.bra***	***Pol.ica***	***Thy.syl***	***Zyg.fil***	***Grand Total***
Centaurea scabiosa	0	0	16	2	1	0	0	28	47
Knautia arvensis	1	0	7	1	2	0	0	17	28
Leontodon hispidus	0	0	1	0	0	0	0	0	1
Lotus corniculatus	0	0	0	0	0	2	0	0	2
Onobrycis viccifolia	0	1	0	0	0	2	1	3	7
Scabiosa columbaria	0	0	0	0	0	0	0	4	4
Trifolium pratense	0	0	1	1	0	0	0	0	2
Grand Total	1	1	25	4	3	4	1	52	91

8.5 Appendix E (Chapter 6)

8.5.1 Boundary impacts of different matrix types

Table 8-52. Boundary impact (metres) of different matrix land cover types to a generic focal species associated with neutral grasslands target habitat and Broadleaved and Yew woodland target habitat from Eycott *et al.* (2011). Boundary effect used in Fragstats (McGarigal *et al.* 2012) analysis due to the 25m by 25m grid square resolution restriction (boundary impact needed to be in multiples of 25).

	Neutral grassland target habitat		**Broadleaved/yew woodlands target habitat**	
Land Cover Type	**Boundary impact (m) (Eycott *et al.* 2011)**	**Boundary impact (m) used in analysis**	**Boundary impact (m) (Eycott *et al.* 2011)**	**Boundary impact (m) used in analysis**
Broadleaved and Yew woodlands	5	0	0	0
Coniferous Woodland	15	25	20	25
Arable and Horticulture	10	25	50	50
Improved Grassland	8	0	30	25
Neutral Grassland	0	0	15	25
Calcareous Grassland	0	0	15	25
Urban/Suburban	10	25	75	75

8.5.2 Map of Lepidoptera species distribution 4 target grassland species

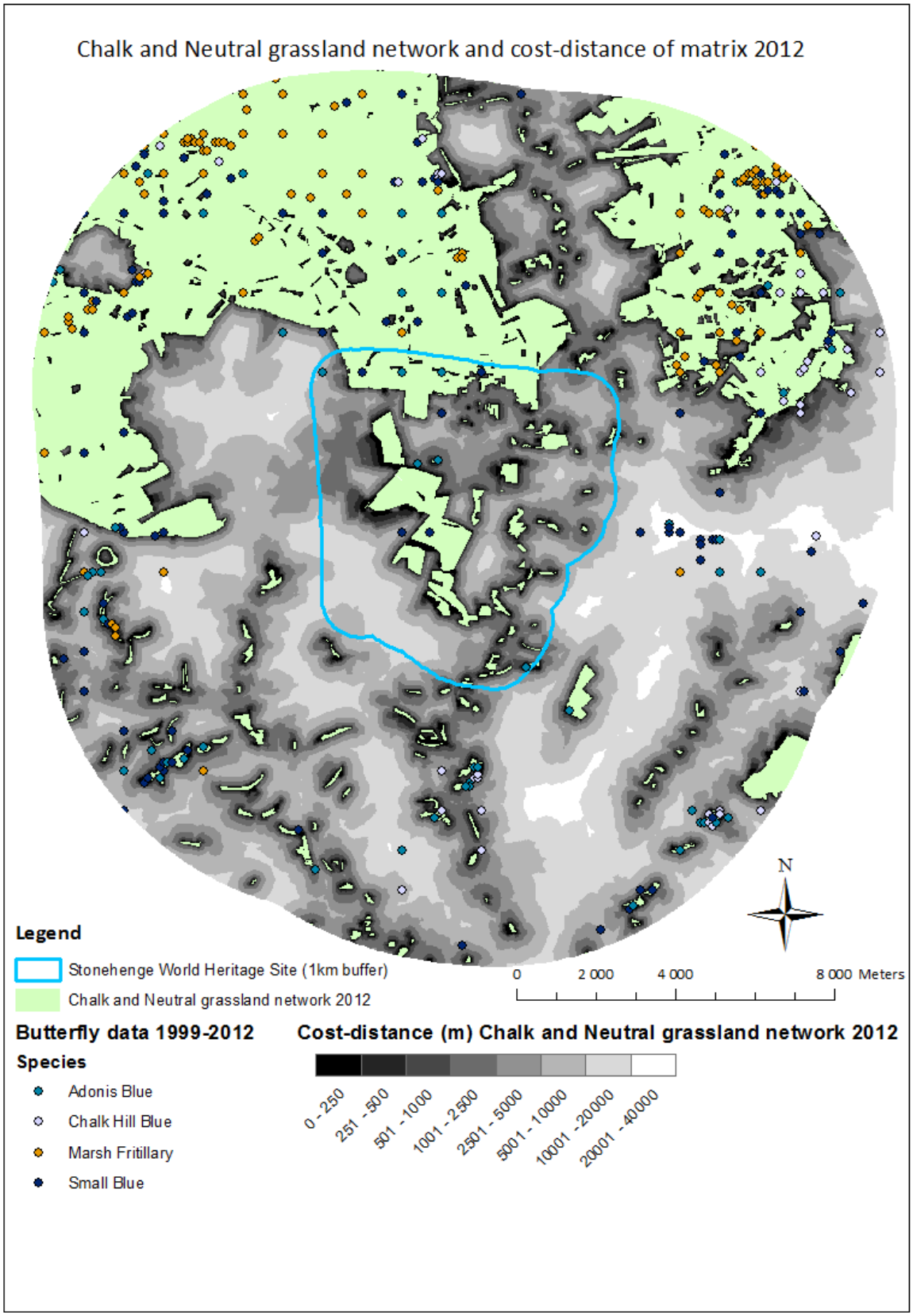

Figure 8-5. Map of the Stonehenge World Heritage Site and the surrounding landscape with locations of sightings of Adonis Blue (*Lysandra bellargus*), Chalkhill Blue (*Polyommatus coridon*), Small Blue (*Cupido minimus*) and Marsh Fritillary (*Euphydryas aurina*) from 1999-2012. Chalk and neutral grassland habitat network and cost-distance matrix in 2012. Cost distance in metres represents the dispersal distance an individual would need to be capable of to reach that matrix patch.

8.5.3 Results of habitat patch and landscape connectivity measures

Table 8-53. Results from habitat patch and network connectivity calculations of re-creation grasslands contributing to the, a) chalk grassland network and to the, b) chalk an neutral grassland network. Measured at the scale of the surrounding landscape with an 8km buffer from the World Heritage Site boundary (Surrounding landscape 8km buffer) that encompasses the many other large expanses of chalk grassland and within the 1km buffer of the World Heritage Site (Stonehenge site 1km buffer). Values in 2000 before the re-creation project started, in 2012 when it was finished and the difference (change). All values 2 decimal places.

	Surrounding landscape (8km buffer)			**Stonehenge Site (1km buffer)**		
Metric	**2000**	**2012**	**Change**	**2000**	**2012**	**Change**
a) Re-creation grasslands adding to chalk grassland network						
Grassland patch characteristics						
Number of patches	301	303	2	28	31	3
Number of patches >2 ha	64	71	7	7	13	6
Total Area (ha)	6730.19	7223.38	493.19	223.94	716.44	492.50
Patch area mean (ha)	22.36	23.84	1.48	8.00	23.11	15.11
Percentage of landscape (%)	16.89	18.12	1.24	4.30	13.77	9.46
Total Core area (ha)	6581.31	7051.00	469.69	206.63	676.06	469.44
Core area mean (ha)	21.86	23.27	1.41	7.38	21.81	14.43
Core area of landscape (%)	16.51	17.69	1.18	3.97	12.99	9.02
No. of disjunct core areas	3183	3198	15	415	432	17
Shape Index mean (>1)	1.58	1.59	0.01	1.59	1.65	0.06
Connectivity						
Nearest neighbour distance (m)	143.60	134.27	-9.33	294.00	185.34	-108.66
Proximity index 2500m	2497.11	2514.94	17.84	71.96	163.21	91.25

Connectance 2500m (%)	8.54	8.52	-0.02	41.27	45.38	4.11
Proximity index 300m	2479.23	2496.60	17.36	68.81	155.72	86.91
Connectance 300m (%)	1.35	1.33	-0.02	6.65	6.65	0.00
b) Re-creation grasslands adding to chalk and neutral grassland network						
Grassland patch characteristics						
Number of patches	247	248	1	48	49	1
Number of patches >2 ha	81	87	6	15	20	5
Total Area (ha)	10763.38	11256.56	493.19	458.13	950.63	492.50
Patch area mean (ha)	43.58	45.39	1.81	9.54	19.40	9.86
Percentage of landscape (%)	27.01	28.24	1.24	8.80	18.27	9.46
Total Core area (ha)	10458.75	10929.56	470.81	409.94	880.38	470.44
Core area mean (ha)	42.34	44.07	1.73	8.54	17.97	9.43
Core area of landscape (%)	26.24	27.42	1.18	7.88	16.92	9.04
No. of disjunct core areas	2433	2445	12	362	376	14
Shape index mean (>1)	1.57	1.58	0.01	1.47	1.53	0.06
Connectivity						
Nearest neighbour distance (m)	219.82	200.53	-19.28	261.01	162.50	-98.52
Proximity index 2500m	1889.52	1900.75	11.22	48.83	95.80	46.96
Connectance 2500m (%)	7.90	8.09	0.19	38.83	43.37	4.54
Proximity index 300m	1838.52	1845.84	7.32	43.33	86.62	43.30
Connectance 300m (%)	0.80	0.82	0.02	3.06	3.51	0.45

Table 8-54. Results from landscape metric calculations considering all habitat patch types of re-creation grasslands contributing to the, a) chalk grassland network and to the, b) chalk an neutral grassland network. Measured at the scale of the surrounding landscape in 8km buffer from the World Heritage Site boundary (Surrounding landscape 8km buffer) that encompasses the many other large expanses of chalk grassland and within the 1km buffer of the World Heritage Site (Stonehenge site 1km buffer). Values in 2000 before the re-creation project started, in 2012 when it was finished and the difference. All values 2 decimal places.

	Surrounding landscape (8km buffer)			**Stonehenge site (1km buffer)**		
Metric	**2000**	**2012**	**Change**	**2000**	**2012**	**Change**
a) Re-creation grasslands adding to chalk grassland network						
Total core area (Ha)	36672.50	36691.38	18.88	4679.94	4699.44	19.50
Landscape						
Number of patches	3398.00	3404.00	6.00	444.00	451.00	7.00
Shannon diversity	1.67	1.68	0.01	1.46	1.62	0.17
Simpson diversity	0.75	0.75	0.01	0.65	0.73	0.08
Shannon evenness	0.65	0.65	0.00	0.61	0.68	0.07
Simpsons evenness	0.81	0.81	0.01	0.72	0.80	0.09
b) Re-creation grasslands adding to chalk and neutral grassland network						
Landscape						
Number of patches	2605.00	2610.00	5.00	387.00	392.00	5.00
Shannon diversity	1.49	1.49	0.01	1.39	1.52	0.13
Simpson diversity	0.71	0.72	0.00	0.65	0.72	0.07
Shannon evenness	0.60	0.60	0.00	0.61	0.66	0.05
Simpsons evenness	0.78	0.78	0.00	0.72	0.80	0.08

8.6 References

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