Report

footprint ECOLOGY

Results of the Hazeley Heath Grazing Trial

Sophie Lake, John Underhill-Day,
Chris Panter & Rob McGibbon

Forest Office
Cold Harbour
Wareham
Dorset BH20 7PA
Tel/Fax: 01929 552444
info@footprint-ecology.co.uk

connecting wildlife and people

www.footprint-ecology.co.uk

Date: 24th March 2015
Version: FINAL
Recommended Citation: Lake, S., Underhill-Day, J., Panter, C. and McGibbon, R. (2015) Results of the Hazeley Heath Grazing Trial (Footprint Ecology/Hart District Council/RSPB)

Front cover photo: John Collman

Summary

This report summarises the results of monitoring carried out during the Hazeley Heath grazing trial. The monitoring programme was set up to demonstrate the effectiveness and appropriateness of grazing at Hazeley Heath, its compatibility with recreational use and to help determine whether it is acceptable to stakeholders.

Small numbers of cattle were introduced to two temporary grazing enclosures during the summer months between 2010 and 2014. During this time, visitor surveys were carried out, plus various surveys to monitor overall site condition, vegetation, invertebrates, birds and small mammals.

Over 500 visitor surveys carried out during 2010, 2011, 2012 and 2014 suggested that the majority of visitors to Hazeley Heath were local, and that the most frequent activity undertaken was dog walking, with walking, horse-riding and cycling also undertaken. The majority of respondents (around 75%) were positive about grazing on Hazeley Heath and would be happy to see wider-scale grazing. However, a proportion of the visitors (up to 35%) avoided grazed areas, and changed their route to do so. By 2014, most respondents said they would prefer to keep electric fencing, with self-closing gates (but note that responses for the relevant questions were only recorded for a small proportion of respondents).

The grazing trial was set up under two main constraints - the limitations imposed by the site's status as registered common land, and the need to continue mechanical restoration and maintenance management during the period of the trial. It was not therefore possible to follow an ideal experimental design and a number of factors need to be taken into account when interpreting the results. These include the lack of replicates as the enclosures and adjacent ungrazed land were of different vegetation types (use of replicates would have allowed extrapolation of the results to other areas of the site), different types and areas of mechanical management carried out in grazed plots and adjacent ungrazed plots, occurrence of wildfire, and variation in the grazing regime resulting in lighter grazing pressure than initially intended. For every species group surveyed, it should be kept in mind that possible differences due to the presence of absence of grazing may have been over-ridden or conflated by varying mechanical management and intrinsic differences in the vegetation.

Both ungrazed and grazed areas remained in unfavourable condition at the end of the trial, although the ungrazed area at Mattingley was described as improving in 2014, and the grazed area at Hartley-Wintney was described as favourable for the first time in 2013. On both grazed and ungrazed areas, the number of individual targets that were met was greater in 2014 than in 2009. Differences between grazed and ungrazed areas in the various targets assessed through condition monitoring suggest that the overall height and cover of grasses, sedges and rushes and the cover of bracken was generally less on the grazed sites. No other clear patterns were evident.

Vegetation monitoring using paired quadrats inside and outside of the grazed plots suggested that the richness of heathland plant species might be greater in grazed areas, but this was not statistically significant. Observations suggested that the sward height was generally lower in grazed quadrats.

The abundance of young birch and gorse varied according to site. Any overall patterns are likely to have been obscured by the variability of the vegetation between quadrats.

Invertebrates were monitored through regular butterfly transects and through timed searches for invertebrates. Butterfly monitoring indicated that populations of the heathland specialist silver-studded blue were probably larger in the grazed plots. Numbers of grayling, another heathland species, were also slightly greater in grazed areas. Timed searches for invertebrates in 2014 indicated that the number of invertebrate species was consistently lower in grazed areas compared to ungrazed areas when considering total species, number of rare species and number of species within individual taxonomic groups. However, half of the species were associated with open areas, while the remainder were associated with open areas with scrub, woodland edge, open woodland and trees, shrubs in open areas or closed woodland. Examination of the requirements of species in relation to grazing levels revealed large numbers of species associated with ungrazed or moderately grazed conditions. The relative proportion of these species in grazed and ungrazed areas suggests that grazing has influenced invertebrates, with a slightly greater proportion of species generally associated with grazed swards in the grazed areas compared to ungrazed areas.

Breeding bird populations were monitored each year for seven species of particular interest, including Dartford warbler, nightjar and woodlark. No clear patterns were found in the average number of pairs of each species before and after grazing was introduced. The low numbers of breeding pairs and over-riding impact of mechanical management may have obscured any potential differences between grazed and ungrazed areas.

Reptiles were monitored using artificial refugia. Results at the end of the trial suggested that there was a significantly higher probability of encountering grass snake in grazed areas and a significantly higher probability of encountering slow worm in the ungrazed plots. The numbers of common lizard appeared to have declined very substantially in both grazed and ungrazed plots.

An analysis of the costs of mechanical management and grazing are presented. Over the five year period, mechanical management costs totalled £18,490 while grazing costs (including a ranger) totalled £28,945. Grazing cost included infrastructure, the cost of which would be spread over 10 years if grazing continued; the total cost per year for grazing would then be around £5292. Comparison between the grazing and mechanical management costs is not meaningful, as heathland sites require some mechanical management and ranger time whether grazing is carried out or not.

Contents

Acknowledgements

This report was commissioned by Hart District Council (HDC) and RSPB. Our thanks go to Leigh Neville at HDC and Mike Coates and Izzy Morgan at RSPB for their help and guidance. Mike Edwards, John Collman, Dave Braddock and Giles Groome kindly provided additional information.

1. Introduction

Background to Hazeley Heath Grazing Trial

1.1 Hazeley Heath covers 177ha of common land in Hartley Wintney and Mattingley parishes. It is designated as a Site of Special Scientific Interest (SSSI)[1] for its heathland plant communities which include dry heath on well-drained slopes and ridges, wet heath on shallower slopes, and valley mire over peat on low-lying ground with impeded drainage. Hazeley Heath also falls within the Thames Basin Heaths Special Protection Area (SPA)[2], designated for the presence of nightjar, woodlark and Dartford warbler. This site also supports areas of grassland, secondary woodland, scrub and bracken, and has a history of extensive disturbance as a result of military activities, sand and gravel extraction and subsequent use for land-fill. A fuller description of the site can be found in Edgar (2004) and Atkins (undated), which also provides an outline of the process undertaken to secure a consensus on management of the site.

1.2 Cessation of traditional management (including grazing) of Hazeley Heath during the 20th Century resulted in the development of secondary woodland and scrub across much of the site, and recent management has aimed at restoring some of these areas to heathland. Grazing is now widely used on lowland heathland sites to help maintain heathland and increase structural and species diversity (e.g. Lake, Bullock & Hartley, 2001; Newton *et al.* 2009). Grazing management at Hazeley Heath has been the subject of much discussion, and a grazing trial was proposed and carried out between 2010 and 2014 (see Offer *et al.* 2008 for further details). The objects of the trial were:

1. To demonstrate the effectiveness of grazing by domestic livestock in securing the appropriate management of the heathland habitats of Hazeley Heath (both established areas and those in the process of restoration from secondary woodland and/or scrub) in order to meet the condition requirements set out by Natural England.
2. To demonstrate that grazing by domestic livestock is compatible with the conservation of the Annex I bird species breeding on Hazeley Heath (Dartford warbler, nightjar and woodlark).
3. To demonstrate that grazing by domestic livestock would be compatible with recreational uses of Hazeley Heath including access by walkers and horse riders.
4. To determine whether grazing by domestic livestock is acceptable to stakeholders with interests in the future management of Hazeley Heath.
5. To determine the considerations that would need to be taken into account if wider grazing of Hazeley Heath were to be pursued as a management tool (following completion of the trial and agreement of stakeholders).

1.3 This report considers the results of monitoring instigated as part of the grazing trial in order to meet objectives 1-3.

---

[1] http://designatedsites.naturalengland.org.uk/SiteDetail.aspx?SiteCode=S1000926&SiteName=hazeley%20heath&countyCode=&responsiblePerson=

[2] http://jncc.defra.gov.uk/page-2050-theme=default

1.4 The report is structured by taxa to avoid lengthy complex sections on methods and results. So for example, there are individual chapters on vegetation, invertebrates, birds, reptiles, and also visitor questionnaires. Each chapter includes a succinct section on methods, a discussion of results and a summary box. There is an additional chapter reviewing costings and another outlining future considerations. Throughout the report, the area of Hazeley Heath that falls within Mattingley parish is referred to as Mattingley and the area within Hartley Wintney parish as Hartley Wintney. Grazing enclosures are referred to as grazed areas, and the unmarked "control" plots as ungrazed areas.

Available data and constraints

1.5 Table 1.1 summarises the data sets available. All data have been considered within this report, with the exception of the dragonfly data, which concentrated on pools within one area only, and the small mammal survey, in which no records were made from the relevant areas.

Table 1.1: Data available from the Hazeley Heath trial.

	2009	2010	2011	2012	2013	2014	
Visitor data							
On-site visitor questionnaire		✓	✓	✓		✓	RSPB/HDC
Vegetation							
Condition monitoring		✓	✓	✓	✓	✓	John Collman
Botanical surveys – year prior to trial and year 4	(2008)				✓		Chris Hall
Fixed-point photography	✓	✓	✓	✓	✓	✓	John Collman
Invertebrate data							
Butterfly surveys		✓	✓			✓	Volunteers
Dragonfly surveys					✓		Stuart Croft & Rachel Jones
Invertebrate surveys	✓			✓		✓	Mike Edwards, Peter Hodge, Andy Phillips
Reptiles							
Reptile surveys	✓	✓	✓			✓	Craig Boorman Leigh Neville, Dave Braddock
Breeding birds							
Notable breeding bird surveys	✓	✓	✓	✓	✓	✓	John Collman
Small mammals							
Small mammal survey			✓				Deborah Whitfield & Tiki Leggett

1.6 The practicalities of management at Hazeley Heath and the need for ongoing restoration work meant that there were a number of constraints to the trial that should be taken into account

when interpreting the results. These included physical differences between Hartley Wintney and Mattingley; initial differences between grazed and ungrazed plots; differences in mechanical management undertaken; and differences in events outside of the site managers' control such as wildfire. Key considerations are listed in Table 1.2.

Table 1.2: Constraints to the grazing trial.

Constraint	Mattingley	Hartley Wintney	Constraint
Differences between Mattingley and Hartley Wintney	Includes significant areas where secondary woodland was cleared that are now dominated by European gorse. Other areas are predominantly humid heath although there are some open areas of dry heath.	Predominantly humid heath with areas of purple moor-grass dominated mire.	The two sites cannot be used as replicates in the analysis of grazed vs ungrazed treatments.
Differences between grazed and ungrazed areas	Ungrazed area includes a dry gravelly ridge with seepage systems at its base	Grazed area was more homogenous and in better condition at the start of the grazing trial	Comparison between grazed/ungrazed should be made with caution
Mechanical management	Differences in tree felling and scrapes	Scrapes, "cut and collect" and scattered tree felling were carried out in the ungrazed areas only during the trial	Differences between grazed/ungrazed areas may be due to differences in mechanical management
Unforeseen events	A wildfire in July 2010 burned half the ungrazed area.	Wildfire on the ungrazed area in 2012.	Differences between grazed/ungrazed areas may be due to uncontrolled burns
	The grazier was not always able to supply the desired number of stock throughout the planned grazing period each year		Lighter overall grazing pressure than desired
Existing grazing/browsing pressure	Deer known to be present on site	Deer known to be present on site	The electric fencing around the grazed areas may have discouraged deer, resulting in reduced deer pressure within the "grazed" areas compared to "ungrazed" areas.
Time span of project	Five years	Five years	Relatively short time span for changes to occur as a result of light, summer only grazing

2. Visitors

Methods

2.1 Visitor questionnaires were carried out in 2010, 2011, 2012 and 2014. The same questions were largely used each year, although there were some differences in the data recorded.

Results

2.2 A total of 505 questionnaires was completed. The results are summarised in Table 2.1. Note that not all respondents answered each question. In 2010 (possibly in other years), all members of groups were interviewed, which might lead to a bias in the results, as group members are more likely to give the same answer. Questions differed between years. Survey dates and times were not available, but may also have influenced the results.

Table 2.1: Questionnaire results from Hazeley Heath 2010 and 2014. "-"indicates that the question was not recorded in that year (questions varied between years). (%) indicates the percentage of respondents who gave that reply. *Question re-phrased as "does (not) walk…" in 2014.

Number (percentage of those who answered the question)	2010	2011	2012	2014
No. of visitors interviewed	317	44	110	34
Respondents who visit regularly (at least once a week)	114 (36%)*	-	74 (74%)	29 (85%)
Locals	-	-	69 (69%)	26 (74%)
Walkers	87 (27%)	-	35 (32%)	4 (12%)
Dog walkers	168 (53%)	-	60 (55%)	25 (74%)
Horse riders	19 (6%)	-	4 (4%)	6 (18%)
Cyclists	17 (5%)	-	7 (6%)	0
Other activity	26 (8%)	-	4 (4%)	1 (3%)
No. of dogs	133	-	73	-
Dogs off lead	114 (94%)	-	44 (60%)	-
Happy to/does walk* through grazed plot	-	33 (77%)	70 (70%)	15 (44%)
Not happy to/does not walk* through grazed plot	-	7 (16%)	30 (30%)	12 (35%)
Depends/sometimes	-	3 (7%)	0	7 (21%)
Respondent changed route to avoid grazed area	-	7 (16%)	16 (53%)	-
Did not change route to avoid grazed area	-	36 (82%)	14 (47%)	-
Sometimes changes route to avoid grazing	-	1 (2%)	-	-
Do you feel dog fouling is a problem? Yes	-	-	43 (42%)	-
Not a problem	-	-	38 (37%)	-
Could be worse	-	-	21 (21%)	-
Prefers wooden stock fencing	-	16 (36%)	-	-
Does not prefer wooden stock fencing	-	1 (2%)	-	-
No preference	-	27 (61%)	-	-

Number (percentage of those who answered the question)	2010	2011	2012	2014
Are you in favour of/happy with wider scale grazing?	-	33 (79%)	83 (83%)	24 (71%)
Are you against/unhappy with wider scale grazing?	-	7 (17%)	7 (7%)	8 (24%)
No preference	-	2 (3%)	1 (1%)	-
Unsure	-	-	9 (9%)	1 (3%)
Positive about grazing trial	131 (81%)	36 (84%)	78 (78%)	-
Negative about grazing trial	12 (7%)	5 (11%)	7 (7%)	-
Neutral about grazing trial	19 (12%)	2 (5%)	15 (15%)	-
Not aware of grazing trial	-	-	-	2 (6%)
Aware of trial, but not reasons behind it	-	-	-	21 (62%)
Aware of trial and reasons behind it	-	-	-	11 (32%)
Important to look after the wildlife of Hazeley Heath	-	-	-	34 (100%)
Not important to look after the wildlife of Hazeley Heath	-	-	-	0

2.3 The majority (74-85%) of visitors interviewed were regular, visiting at least once a week (the figure was substantially lower in 2010, but "regular" was not defined).

2.4 Data from 2014 show that a similar proportion of visitors (69-74%) were local (e.g. from Hartley Wintney) while 18% were from nearby places such as Fleet and Winchfield. Ten of the 26 local visitors interviewed om 2014 were from the nearby police college

2.5 Most visitors were dog walkers (varying from 53 to 74% depending on the year). Horse riders formed 4-8% of visitors, and walkers 12-27%. The site was also used by cyclists (0-6%) and by people undertaking other activities (e.g. a family day out).

2.6 The number of dogs off the lead dropped from 94% in the first year of the trial to 60% in 2012 (it was not recorded in 2014).

2.7 The number of visitors who were happy to walk through the grazed plot was 74% in 2010. In 2014, the number who did walk through the grazed area (the wording of the question changed) was 44%. This figure apparently included people whose route happened not to take them through the grazed area in addition to those deliberately avoiding the grazed area.

2.8 There was a notable difference between 2011 and 2012 in the percentage of the subset of visitors who were not happy to walk through the grazed plot who changed their route to avoid the grazed areas - 16% and 53% respectively (but note the difference in sample size between these years).

2.9 The majority of visitors were positive about grazing on Hazeley Heath (79-84%) with 12-15% neutral and the remainder negative. The percentage of visitors who would be happy to see wider-scale grazing on Hazeley Heath peaked in 2012 at 84% and dropped to 70% in 2014. The number who were unsure was highest in 2012.

2.10 Preferences about infrastructure were recorded in 2011 (see Table 2.1) and in greater detail in 2014 (see Table 2.2). In 2014, responses to the three questions concerning infrastructure were notably few in number and the number varied between questions, and so actual numbers are given in the text in addition to percentages. In 2011 most respondents had no preference about the types of fencing (61%) while 36% preferred wooden stock fencing. In 2014, most respondents (11, 61%) preferred to keep electric fencing. However, the questionnaire for 2014 included the option no fencing, which four (22%) preferred, while post and wire stock fencing was preferred by three (17%) but wooden fencing was not given as an option. In 2014, 10 (71%) preferred to keep the existing self-closing gates. Eleven respondents (58%) preferred to keep the existing cows, while five (26%) preferred no livestock and three (16%) preferred ponies. More information was requested by six respondents (60%). This included information on the cattle and the dates they would be on site, routes for horse riders, and two requests for information about road building unrelated to the grazing project.

Table 2.2: Responses to questions regarding grazing-related infrastructure at Hazeley Heath in 2014.

Infrastructure change	No (%) of respondents who answered
Fences	
Keep electric fence	11 (61%)
Post and wire stock fence	3 (17%)
No fence	4 (22%)
Other comment	0
Gates	
Keep self-closing gates	10 (71%)
Non self-closing grates	0
Cattle grids	0
No gates	4 (29%)
Other	0
Livestock	
Keep current cows	11 (58%)
Different breed of cow	0 (0%)
Use ponies	3 (16%)
No livestock	5 (26%)
Other	0
Information	
Keep current info	4 (40%)
More info	6 (60%)
Less info	0
What would you like info about?	0

2.11 In 2014, respondents were given the opportunity to comment about heathland grazing. Comments from five respondents were recorded and included the observation that dogs and cattle don't mix; that there needed to be more awareness about when cattle were on site; that self-closing gates were easiest for horse riders together with a request to keep gates to a minimum; a preference for no grazing; that the grazing was fine provided it was working, together with thanks for the good work and concern over tree-felling, and that the grazing was fine as it didn't affect the respondent but that dogs were the main issue.

Visitor surveys – summary

- 505 visitor questionnaires were completed overall during 2010 and 2014 (none in 2013). Questions varied a little between years, as did survey effort. The number of responses in 2009 was over 9 times greater than in 2014. In 2009, all members of groups were interviewed, rather than just one, leading to a possible bias in the data. These factors should be kept in mind when making comparison between years.
- Between 78% and 84% of respondents were positive about the grazing trial, with a variable percentage of negative or neutral respondents. Between 71% and 83% were happy with potential wider-scale grazing.
- The percentage of respondents who were "happy" to walk through the grazed areas (2010 only) was 77%.
- The percentage of respondents who said that they "walked through" the grazed plot (2014) was 44%. Those who did not gave a variety of reasons including the presence of cattle and that their route did not take them through the grazed area.
- Most respondents were local (although the percentage varied between years) and dog walking was the most frequently recorded activity. Other activities included walking, horse riding and, in some years, cycling. The percentage of dogs off leads apparently declined between 2010 and 2012.
- Responses about infrastructure were low in number, but indicate that, in 2014, most respondents preferred to keep the existing fencing and self-closing gates. Most (58%) preferred to keep the existing livestock (rather than ponies or no livestock)
- The majority of the small number of responses about information provision in 2014 concerned increased information, often specifically information about when livestock would be on site. Requests were also made for information about routes suitable for horse-riders.

3. Vegetation

Condition assessment

Methods

3.1 Vegetation monitoring was carried out annually and was based on JNCC's Common Standard Monitoring Guidance for Lowland Heathland[3] (JNCC 2004, see also Collman 2014). This involves following transects across the habitat area being monitored, taking measurements at regular intervals and averaging these for the whole area. It provides an assessment of the "condition" of the area, particularly taking into account the vegetation structure and plant community composition. Results are useful in giving an overall impression of the site, but more detailed analysis is not possible without the underlying data. These reports were therefore used qualitatively, although summary data for 2014 are presented and are considered in the context of changes since 2009 under grazed and ungrazed treatments where possible.

Results

3.2 The current condition assessment and changes since 2009 according to the condition assessment summary sheets are given in Table 3.1. Note that these are different in their details from the condition assessment carried out by Natural England for the site in 2014[4], which covered the entire site, not just the areas within the trials, and concluded that relevant compartments were in "unfavourable recovering" condition. Additional data that were available summarised for all five years and more detail on individual changes are presented in the following figures and tables.

[3] http://jncc.defra.gov.uk/pdf/CSM_lowland_heathland.pdf

[4] http://www.sssi.naturalengland.org.uk/special/sssi/reportAction.cfm?report=sdrt13&category=S&reference=1000926

Table 3.1: The condition status of grazed and ungrazed areas at Mattingley and Hartley Wintney in 2014 and key changes since 2009 based on the condition assessment summary forms. Changes have been categorized as positive or negative, but this is relative (e.g. an increase in purple moor-grass may be negative if it is at the expense of a more diverse sward, but could also be the short-term result of recent tree or scrub clearance). Text in **bold** indicates that the change has resulted in a corresponding change in whether or not a specific condition assessment target is met. Additional data recorded are shown in the following series of figures.

Area	Status (change in overall status since 2009)	Reason why favourable status was not attained	Positive change	Negative change	Management and other factors
Mattingley ungrazed	Unfavourable 'improving' (improved from unfavourable)	Low frequency of flowering plants on wet heath	Increase in dwarf shrubs Decrease in tree cover and gorse Decrease in tussockiness of purple moor-grass Increase in grasses, sedges, rushes.	Decrease in bare ground Increase in area of Purple moor-grass	Felling, scraping, mowing and scrub control carried out, (half the area affected by accidental fire in 2010)
Mattingley grazed	Unfavourable (no change)	Low % cover of bare ground	**Reduction in sward height**	**Decrease in area of bare ground** Slight increase in tree/gorse cover Increase in purple moor-grass cover Decrease in dwarf-shrub cover	Grazing, felling (it is suggested that the cattle spent a disproportionate amount of time on an area of grass where felling had taken place over the winter).
Hartley Wintney ungrazed	Unfavourable (no change)	Too much tall, tussocky purple moor-grass. Low occurrence of desirable herbs, particularly on wet heath	**Decrease of bare ground to within appropriate limits** **Improvement in balance of heather growth-types and frequency of species** **Increase in grasses, sedges and rushes**	Decrease in dwarf shrub cover **Increase in purple moor-grass tussocks and cover**	Scraping, mowing, bracken-spraying also tree-felling although not on transect, accidental fire.
Hartley Wintney grazed	Unfavourable (no change from 2009, but was favourable in 2013).	Heather structure inadequate. Purple moor-grass sward too high (just) Desirable herb frequency low on dry heath.	Decrease in purple moor-grass **Increased frequency of heather species on wet heath**	Decrease in bare ground	Grazing, some scrub control and tree-felling between 2009 and 2012 and scrub clearance in the last winter season.

Mattingley

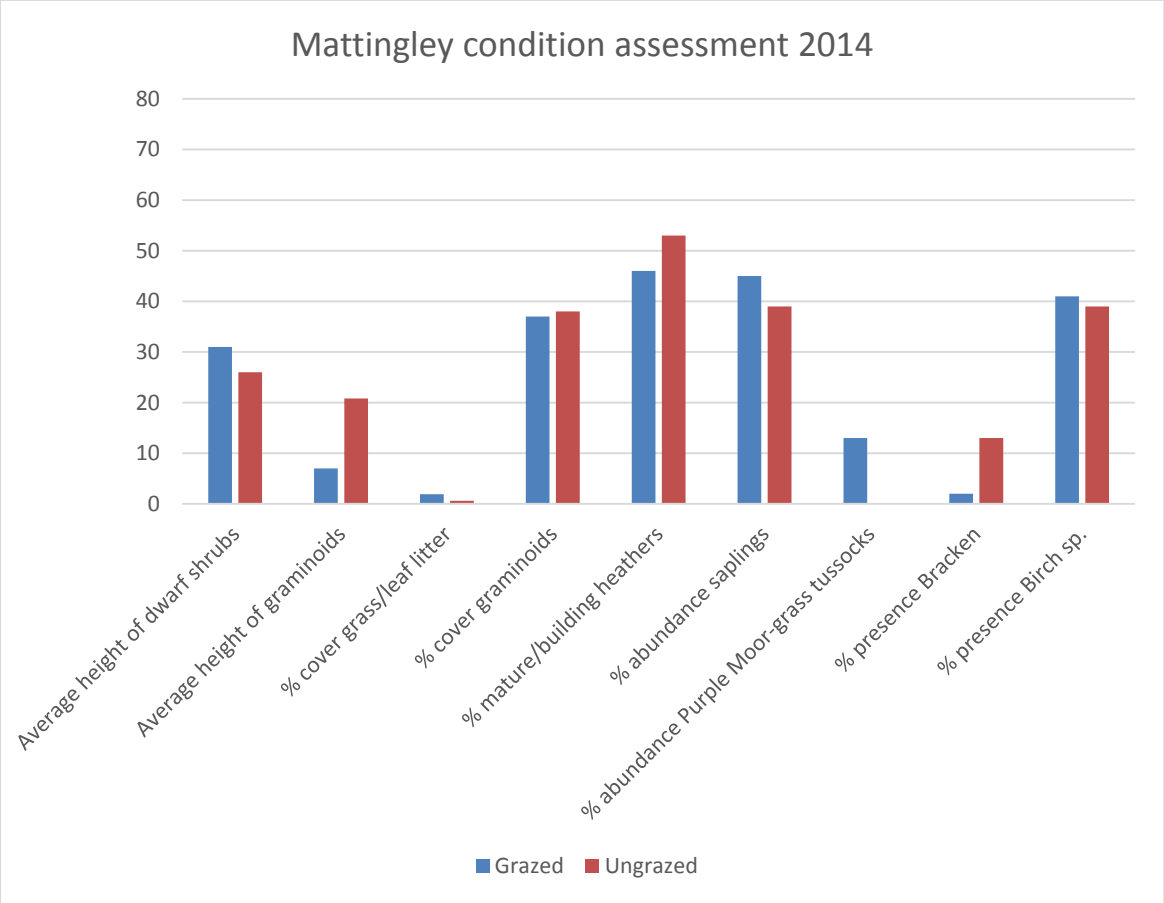


Figure 1: Averaged results from condition monitoring in the grazed area and adjacent ungrazed area at Mattingley in 2014. Available data do not allow the addition of error bars which would indicate the statistical significance of any differences.

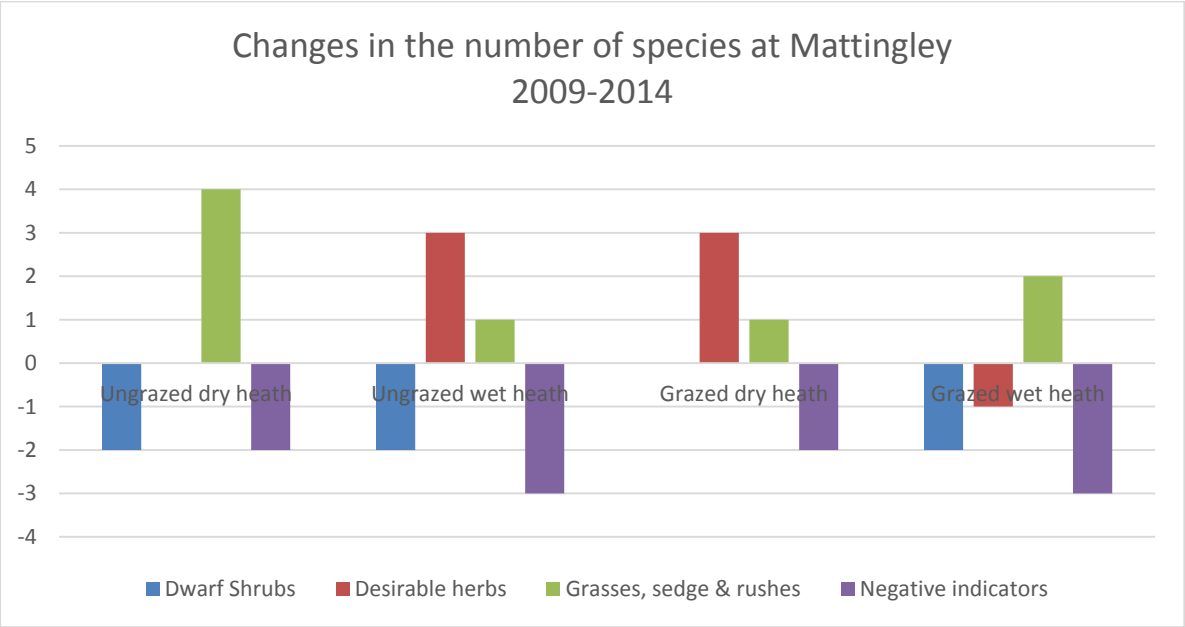


Figure 2: Changes in the number of species within particular plant groups in the grazed area and adjacent ungrazed area at Mattingley in 2014.

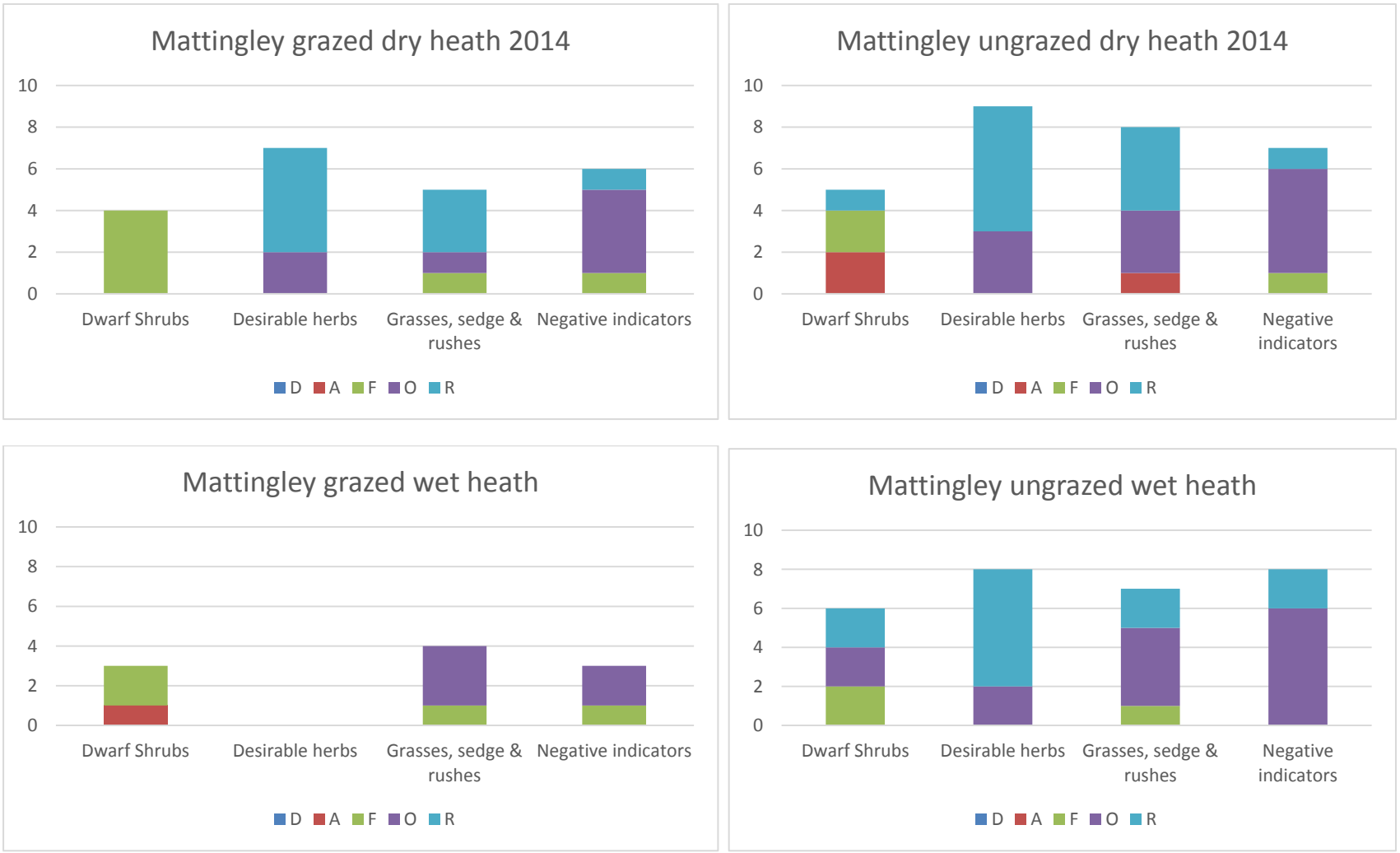


Figure 3: Results for species abundance targets from condition monitoring in the grazed and adjacent ungrazed dry and wet heath at Mattingley in 2014. D – dominant, A – abundant, F – frequent, O – occasional, R – rare.

Table 3.2: The criteria for which favourable condition was met (M) or which failed to meet favourable condition (F) at Mattingley in 2010 (the first year for which these data are summarised) and 2014. ↑ - increase, ↓ - decrease, ≈ - more or less equal. Note that the changes cannot be tested for their statistical significance, i.e. it is not possible to determine whether apparent differences are meaningful or are likely to be due to chance variation.

Mattingley	Ungrazed			Grazed		
	2009	2014	Actual change	2009	2014	Actual change
Bare Ground	M	M	↑+	M	F	≈
Trees/scrub	M	M	↓	M	M	↑
Dwarf shrubs	M	M	↑	M	M	↓
Gorses	M	M	↓	M	M	↑
Purple moor-grass and Wavy Hair-grass	M	M	variable^	M	M	↑
Heather structure	M	M	variable	M	M	≈
Sward Height	M	M	≈	F	M	↓
Heather structure diversity	M	M	variable	M	M	≈
Desirable herbs	F	F	↑x	F	M	↑*
Grasses, sedges and rushes	M	M	↑	M	M	↑
Negative indicator species	M	M	variable	M	M	↓

*Dry heath only, declined on wet heath; +Wet heath only, declined on dry heath; xwet heath only; ^area increased, tussocks decreased

3.3 The **ungrazed** area at Mattingley was assessed as remaining in unfavourable condition due to the low frequency of flowering plants on the wet heath. However, overall, condition was considered to be improving. Positive factors include the increase in the area of bare ground on wet heath (although the area of dry heath decreased), due to the creation of scrapes; a decline in the percentage of tree cover (due to felling work and a fire), and a corresponding increase in the percentage cover of dwarf shrubs (particularly pioneer phase) and purple moor-grass (although the purple moor-grass was less tussocky). The area of gorse also decreased slightly

3.4 There was a reduction in the number of negative indicator species present on the dry heath, although one of these had risen to “frequent” in abundance. However, on the wet heath, there was an increase in number (by two species), although all were occasional or rare. On the wet heath, there was also an increase in the number of dwarf shrub species (by two), although abundance declined, and in increase (by five) in flowering plant species. There was an increase in the number of grasses, sedges and rushes from one to seven species, which mostly showed a higher abundance in 2014 than in 2009

3.5 After five years of seasonal cattle grazing, the **grazed** area also remained in unfavourable condition, in this case due to the low percentage cover of bare ground. Overall condition may be declining. The area of bare ground was 0.8% on dry heath, although it had risen to 1.2% on wet heath (1% being the threshold for favourable condition; in 2009 the percentage cover was given as ~1%). All other criteria regarding structure and composition were met, but there was a decline in the cover of dwarf shrubs and a corresponding increase in the cover of gorse and

probably also purple moor-grass (the cover on wet and dry heath was differentiated in 2014 but not 2009). However, there was an overall decrease in the height of purple moor-grass.

3.6 The number of dwarf scrub species had declined on wet heath, and there were no longer any abundant dwarf shrub species on the dry heath. However the number of desirable herbs had increased on the dry heath (by three species) as had grasses, sedges and rushes (by one species), which had also increased (by two species) on the wet heath. The loss of a single desirable herb on the wet heath meant that none were recorded. The number of negative indicator species had declined on both heath types.

3.7 It is noted that, at Mattingley, the two areas were not comparable in terms of condition before the trial started: the control area failed to meet favourable condition status in 2009 because one target (for flowering plants) was not met, whilst the area to be grazed failed to meet favourable condition status because the sward was too high, in addition to the lack of flowering plants. At the end of the trial, the ungrazed area still failed to meet the criteria for desirable herbs. The grazed area met the criteria for a favourable sward and numbers and frequency of desirable herbs, but the area of bare ground had declined sufficiently for it to fail on this element.

Hartley Wintney

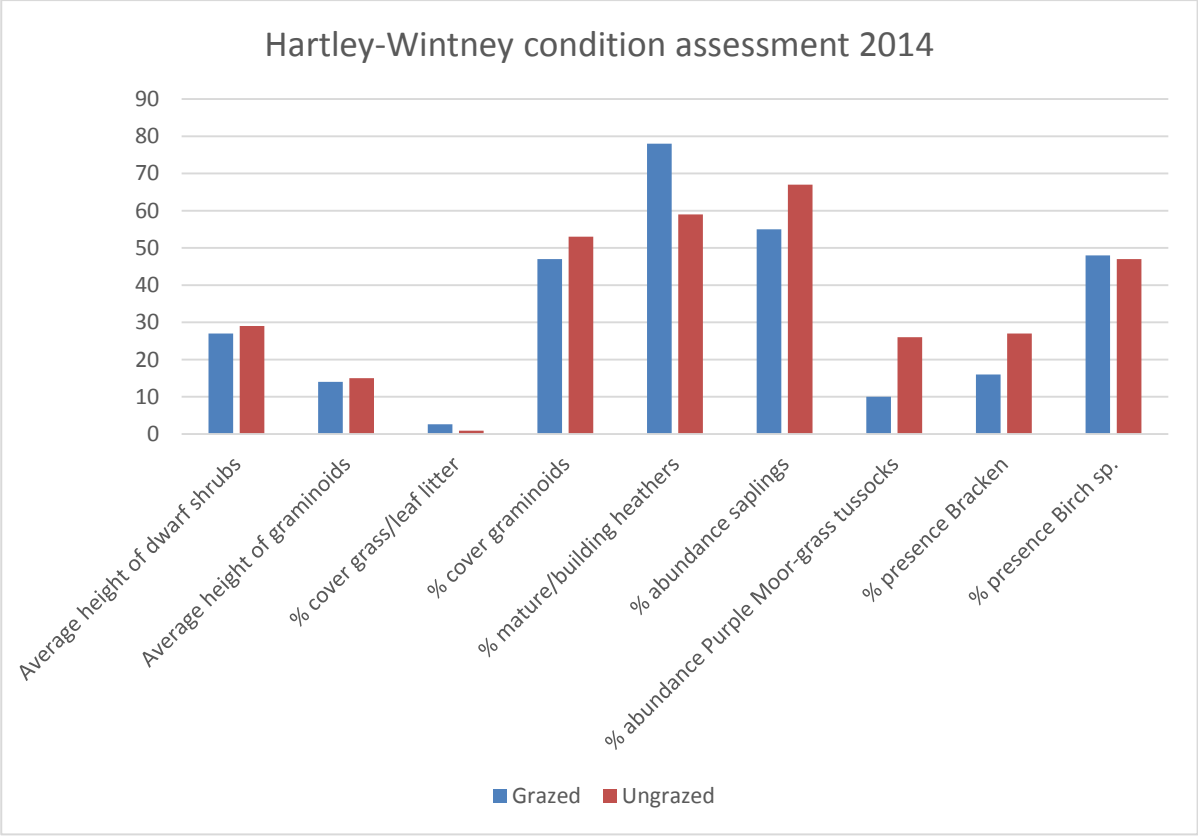


Figure 4: Averaged results from condition monitoring in the grazed area and adjacent ungrazed area at Hartley Wintney in 2014 using all summed data available. Available data do not allow the addition of error bars which would indicate the statistical significance of any differences.

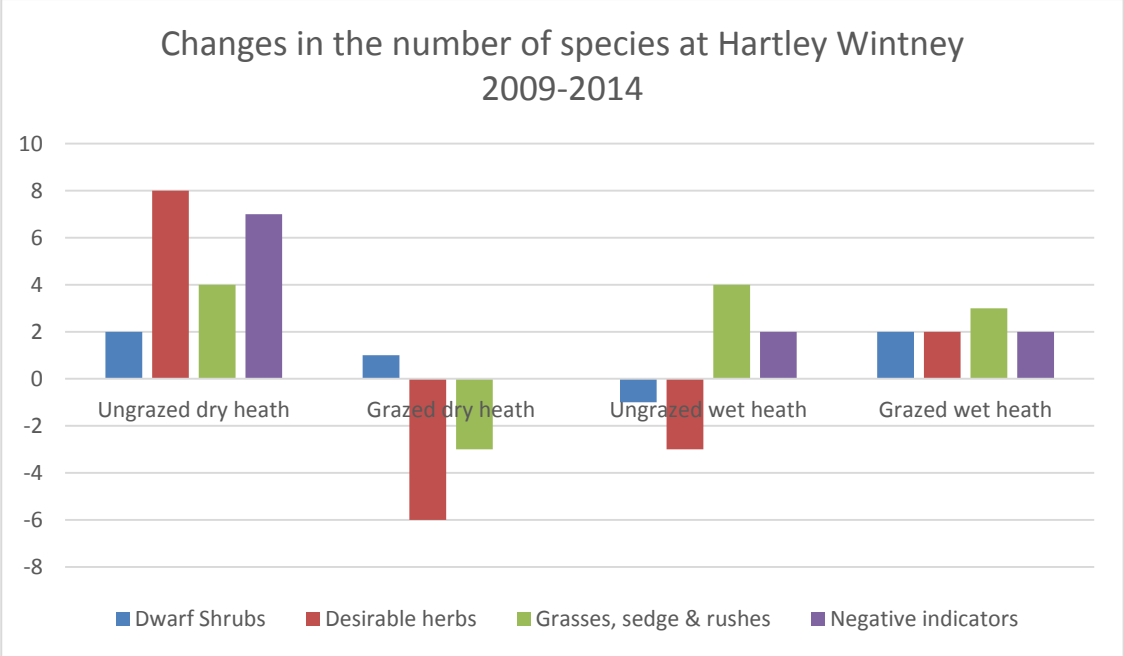


Figure 5: Changes the number of key taxa between 2009 and 2014 in grazed and ungrazed dry and wet heath at Hartley Wintney (note there were some discrepancies in the data for grazed dry heath in 2009).

3.8 Results from the condition monitoring at Hartley Wintney are shown graphically in Figure 4 - Figure 6. Available data do not allow the addition of error bars which would indicate the statistical significance of any differences. It should remembered that the start point of each area was also different.

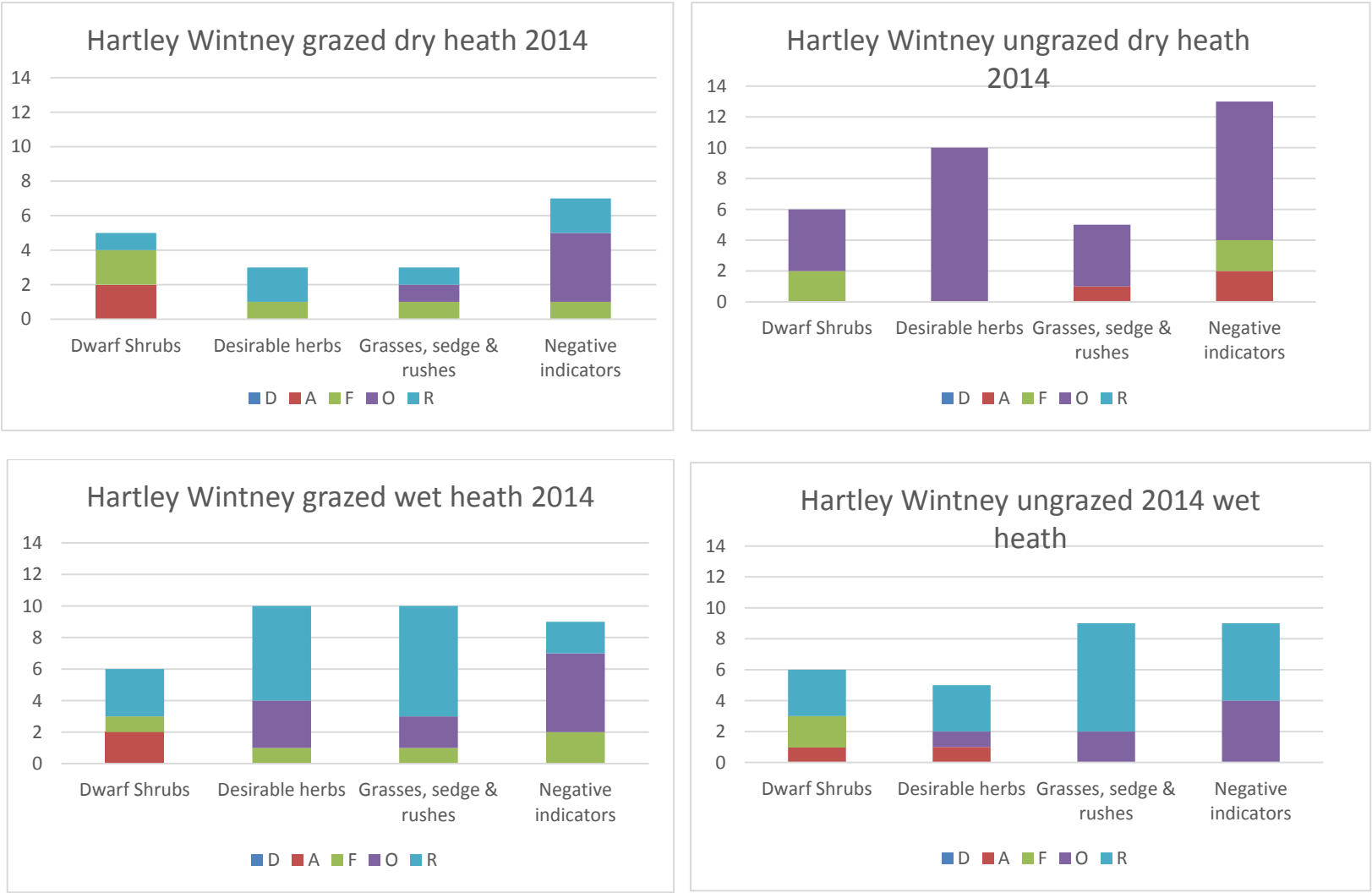


Figure 6: Results for species abundance targets from condition monitoring in the grazed and adjacent ungrazed dry and wet heath at Hartley Wintney in 2014.

Table 3.3: The criteria for which favourable condition was met (M) or which failed to meet favourable condition (F) at Hartley Wintney in 2010 (the first year for which these data are summarised) and 2014. ↑ - increase, ↓ - decrease, ≈ - more or less equal. Note that the changes cannot be tested for their statistical significance, i.e. it is not possible to determine whether apparent differences are meaningful or are likely to be due to chance variation.

Hartley Wintney	Ungrazed			Grazed		
	2009	2014	Actual change	2009	2014	Actual change
Bare Ground	F	M	Variable*	M	M	↓
Trees/scrub	M	M	≈	M	M	≈
Dwarf shrubs	M	M	↓	M	M	↑
Gorses	M	M	≈	M	M	≈
Purple moor-grass and Wavy Hair-grass	M	F	↑[+]	M	M	↓
Heather structure	F	M	↑	F[5]	F	↑
Sward Height	F	F	↑	M[6]	F	≈^
Heather structure diversity	F	M	variable	F	M	↑
Desirable herbs	F	F	↑	F	F	variable
Grasses, sedges and rushes	F	M	↑	M	M	↑
Negative indicator species	M	M	variable[x]	M	M	↑

* Increased on wet heath, decreased on dry heath (both beneficial changes according to common standard monitoring protocol); [+]Increase in tussocks not area; [x]notable increase in birch.^ change from 59-61% tipped into unfavourable.

3.9 As at Mattingley, the Hartley Wintney **ungrazed** area remained in unfavourable condition at the end of the grazing trial, although it was considered to be probably improving. It failed to meet both criteria for purple moor-grass (too much tall and tussocky grass) and for the abundance of desirable herbs (there were just enough species, but their frequency was too low). The cover of birch had increased (and is reaching the upper limit for meeting the target) and the area of dwarf shrubs had decreased. However, the balance of different heather growth phases, frequency of heather species and number and frequency of grasses, sedges and rushes had both improved sufficiently for the criteria for these targets to be met.

3.10 The **grazed** area was also in unfavourable condition in 2014, although it had achieved favourable condition in 2013, and in 2014 the wet heath was considered to be "fine" in the overall assessment. In 2014, the dry heath failed meet the criteria for heather structure and desirable herbs on dry heath and the sward height (combined for wet and dry) also exceed the target. Of these three targets, only sward height was favourable in 2009, scraping inside the target range with 1% to spare. An increase of 2% meant that the criterion was just exceeded in

[5] The survey suggests that heather growth-phase criteria were met. However, the lack of representation of all growth phases and the clear dominance of building/mature heather on wet heath would indicate that the criteria were not met for this target.

[6] This target was recorded as unfavourable. However the criterion for this target is that <60% of Purple Moor-grass should be <20cm, so the recorded figure of 59% means the target was just attained.

2014. However, on the positive side, the cover of dwarf shrubs had increased, including the frequency of heather species on wet heath, and the cover and tussockiness of purple moor-grass had decreased. The variation in heather structure had improved on wet heath, but on dry heath an increase in building/mature heather at the expense of pioneer heather meant that that the criteria were not met overall. The low frequency of desirable herb species on dry heath meant that the criterion for this target was not met (although it was met in some of the intervening years). The cover of birch remained within the range for favourable condition, but by a much smaller margin.

Condition assessment - summary

- The condition of areas both grazed and ungrazed areas remained unfavourable. However, the condition of the ungrazed heath at Mattingley is considered to be improving and the grazed wet heath at Hartney-Wintney very nearly met favourable condition targets. Overall, a greater number of individual targets were met in 2014 than in 2009 on both grazed and ungrazed areas.

- Despite the similarity in the overall condition, differences were observed between grazed and ungrazed areas (it is stressed that the statistical significance of these results cannot be tested, and differences may lie within the range that would be expected by chance). These differences varied between the two sites.

- At Mattingley, the height of grasses and cover of bracken was lower in the grazed area than the ungrazed area. The height of dwarf-shrubs, cover of purple moor-grass tussocks and abundance of saplings was greater in the grazed area. On ungrazed dry heath the number of dwarf shrub species had declined and that of desirable herbs remained constant, while on grazed dry heath dwarf shrubs had remained constant and desirable herbs had increased, and the number of negative indicators had decreased to a greater extent. The number of grasses, sedge and rushes had increased more on ungrazed dry heath. In contrast, on wet heath, the key difference was in the number of desirable herbs, which increased on ungrazed wet heath and decreased on grazed wet heath.

- At Hartley Wintney, sward height, cover of grasses, saplings, bracken and purple moor-grass tussocks were lower in the grazed area. Cover of building/mature heather was higher. However, on dry heath, ungrazed areas saw an increase in plant species numbers (including negative indicator species) while grazed dry heath saw a decline. In contrast, on wet heath, the main apparent difference was in the number of dwarf shrubs and desirable herbs, which had increased on grazed area but decreased on the ungrazed area.

- These apparent difference may be due to the presence of absence of grazing, the start point of the vegetation and the vegetation type, and the extent and diversity of mechanical management undertaken (which was greater on ungrazed areas), and the interactions between these factors. Differential deer browsing may also have occurred if the electric fencing discouraged deer from entering the grazed enclosures.

Botanical surveys

Methods

3.11 Botanical surveys were carried out in 2008 before the grazing trial started and in 2013 (Hall 2009; Hall 2013; Hall 2014). Data from 2008 were obtained through a different methodology and cannot be used to provide baseline data. In 2013, plant abundance (in most but not all cases) was recorded from paired quadrats situated one on either side of the fence line. The 2013 raw data available include abundance ratings or counts of shoots for selected species only, and have been compiled by compartment (total data for each quadrat were not provided). The quadrats were situated in a diversity of conditions (dry or wet heath which had undergone a variety of different managements or experienced wild fire). Some sward height observations are presented in the reports, but underlying data were not provided. The nature of the data available allowed differences in summary statistics of the mean number of species per area to be explored (other data presented in summarised form in the report could not be tested statistically).

Results

3.12 The results from the two sites reflect the difference between them and are therefore considered separately, although the overall trends are in most cases similar.

Mattingley

3.13 A higher number of species were recorded from grazed quadrats than from their ungrazed counterparts, but this difference was not statistically significant (paired t-test, P>0.05). The difference is greater if only heathland species are considered, but is still not statistically significant due to the variation between quadrats. Results are summarised in Table 3.4 and Figure 7.

Table 3.4: The total number of species and number of heathland species per quadrat in grazed and ungrazed areas at Mattingley. Averages are not presented because of the variable quadrat sizes (the likelihood of encountering species changes with area).

Quadrat	Heathland type	Management	All species	Heathland species	Quadrat area
Grazed					
2	Recently cut-over humid heath	Turf-stripping	15	12	16
4	Recently cut-over humid heath	Turf-stripping	16	13	16
6	Reversion from secondary birch wood	Felling	23	12	16
8	Reversion from secondary birch wood	Felling	10	5	16
10	Purple moor-grass dominated heath	Outside small grazing exclosure	19	13	70
Ungrazed					
1	Recently cut-over humid heath	Turf-stripping	14	12	16
3	Recently cut-over humid heath	Turf-stripping	15	11	16

Quadrat	Heathland type	Management	All species	Heathland species	Quadrat area
5	Reversion from secondary birch wood	Felling	10	3	16
7	Reversion from secondary birch wood	Felling	7	2	16
9	Purple moor-grass dominated heath	Within small grazing exclosure	15	7	70

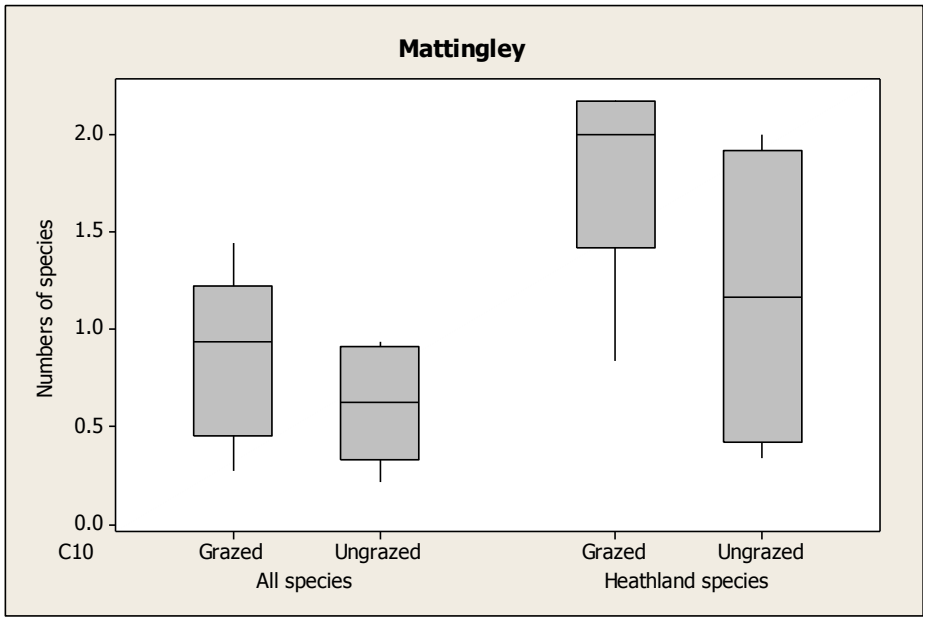


Figure 7: The difference in higher plant species numbers in grazed and ungrazed plots at Mattingley. Boxes show the interquartile range, whiskers (vertical lines) the upper and lower quartiles, and the horizontal line the median value.

3.14 The monitoring report (Hall, 2013) suggests from observation that, for the quadrats in the area that was recolonizing following turf stripping, the ungrazed area had a thicker layer of litter and taller sward. Similarly, on the area reverting from secondary birch woodland, the grass canopy was thicker in the ungrazed area, although a greater number of woody species meant that the sward was higher in the grazed area even though the grassy component was shorter. The sward within the exclosure was dominated by tall tussocks of purple moor-grass, while the grazed area outside was more open with space between tussocks.

3.15 Smaller heathland or acid grassland species were generally only found in grazed quadrats, and included tormentil *Potentilla erecta*, thyme-leaved speedwell *Veronica serpyllifolia*, heath speedwell *V. officinalis*, cat's-ear *Hypochaeris radicata* and sheep's sorrel *Rumex acetosella*. However, heath bedstraw *Galium saxatile* was only recorded in one ungrazed quadrat.

3.16 Counts of "young birch" suggested that, at the woodland reversion site, it was notably more abundant in the grazed area (although generally shorter). Gorse seedlings were also reported to be more abundant here. Birch and other tree species were however more abundant in the ungrazed enclosure than the adjacent grazed areas.

Hartley Wintney

3.17 The mean number of species recorded from grazed quadrats was slightly greater than that from ungrazed quadrats. However, this difference was not statistically significant (paired t-test, P>0.05). Similarly, the mean number of heathland species in grazed areas was slightly greater than that in ungrazed areas, but again difference was not significant (paired t-test, P>0.05). Data are summarised in Table 3.5 and shown in Figure 8. (Note difference in quadrat size).

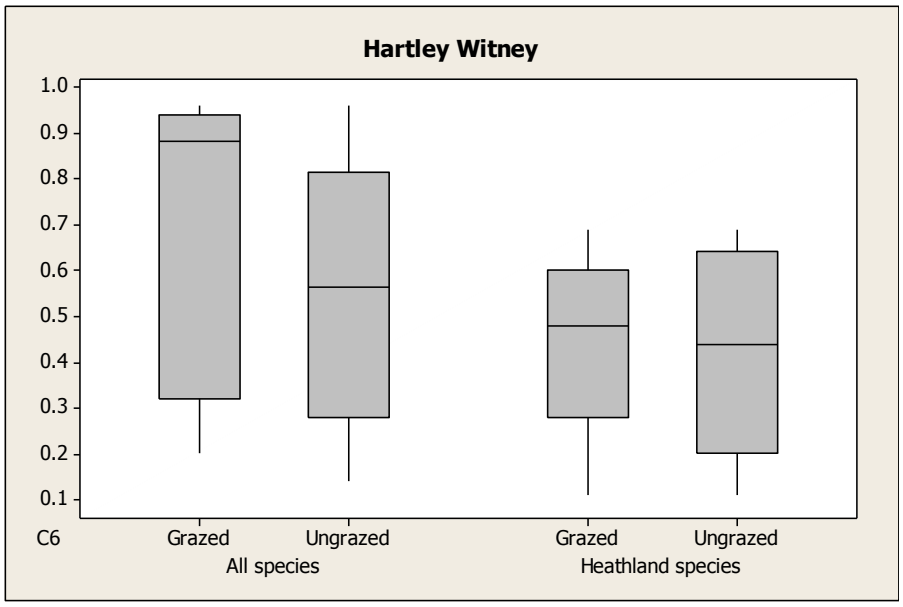


Figure 8: The difference in higher plant species numbers in grazed and ungrazed plots at Hartley Wintney. Boxes show the interquartile range, whiskers the upper and lower quartiles, and the horizontal line the median value.

Table 3.5: The total number of species and number of heathland species per quadrat in grazed and ungrazed areas at Hartley Wintney (averages are not present because of varying quadrat sizes).

Quadrat	Heath type	Management	All species	Heathland species	Quadrat size
Grazed					
2	restored dry heath	Tree-felling, litter scraping, bracken spraying	24	12	25
4	restored dry heath	Tree-felling, litter scraping, bracken spraying	23	15	25
6	dry heath		8	7	25
8	wet heath	Unplanned fire	8	7	16
10	mire	Strimming & raking	15	11	16
12	rank mire		22	12	25
14	restored dry heath	Tree-felling	20	11	100
Ungrazed					
1	restored dry heath	Tree-felling, litter scraping, bracken spraying	15	12	25
3	restored dry	Tree-felling, litter scraping, bracken	24	16	25

Quadrat	Heath type	Management	All species	Heathland species	Quadrat size
	heath	spraying			
5	dry heath		7	5	25
7	wet heath	Unplanned fire	9	7	16
9	mire	Strimming & raking	13	11	16
11	rank mire		11	8	25
13	restored dry heath	Tree-felling	14	11	100

3.18 The report (Hall 2014) includes a more subjective assessment of sward height, which was considered to be lower in the grazed quadrat of each pair. This was particularly notable in the wetter quadrats, particularly those within rank valley mire. Here the overall number of species in the grazed quadrat was double that of the ungrazed quadrat, although many of these were not heathland or mire species. This increase was thought to be due to the greater area of bare ground (e.g. between tussocks) in the grazed quadrat. Heathland and mire species included creeping bent *Agrostis stolonifera,* common yellow-sedge *Carex viridula* ssp *oedocarpa (Carex demissa),* star sedge *Carex echinata,* bulbous rush *Juncus bulbosus,* compact rush *Juncus conglomeratus* and soft rush *Juncus effusus,* while heath spotted-orchid *Dactylorhiza maculata* was only recorded from one of the ungrazed quadrats.

3.19 On dry heath, heathland and mire species only present in grazed quadrats were creeping bent *Agrostis stolonifera*, glaucous sedge *Carex flacca*, common mouse-ear *Cerastium fontanum*, heath-grass *Danthonia decumbens*, sharp-flowered rush *Juncus acutiflorus*, toad rush *Juncus bufonius*, bulbous Rush *Juncus bulbosus*, Soft rush *Juncus effusus*, annual meadow-grass *Poa annua*, procumbent pearlwort *Sagina procumbens*, germander speedwell *Veronica chamaedrys* and squirreltail fescue *Vulpia bromoides*. Species only present in ungrazed quadrats included green-ribbed sedge *Carex binervis*, heath bedstraw *Galium saxatile*, creeping soft-grass *Holcus mollis*, compact rush *Juncus conglomeratus* and the moss juniper haircap *Polytrichum juniperinum.*

3.20 Hall (2013) notes that 'only 30 of [herbaceous and dwarf shrub] species were recorded in the ungrazed sites (62%) whereas nearly all (44 species or 92%) were recorded in at least one grazed site.'

3.21 An assessment of birch colonization, estimating the number and height within grazed and ungrazed quadrats, suggests that there were almost twice as many young birch trees on the ungrazed quadrats as the grazed quadrats. Young birches were generally taller in the ungrazed quadrats, while birches in the grazed quadrats were generally shorter and had been browsed by cattle or deer.

Botanical surveys – summary

- The number of species (per area) was slightly greater in grazed than ungrazed quadrats at both sites, although this difference was not statistically significant. The difference is marginally more pronounced if only heathland species are considered, and several species were recorded only from grazed areas.
- Observations suggested that the sward height was generally lower in grazed quadrats.
- Young birch was generally smaller and less abundant in grazed quadrats. However, in the area cleared from secondary woodland at Mattingley, young birch and gorse seedlings were reported to be more abundant in the grazed area than in the ungrazed area.
- The variability between pairs of quadrats and the small number of replicates should be kept in mind when considering these results in the context of the potential impact of grazing on the site as a whole.

4. Invertebrates

Butterflies

Methods

4.1 Butterfly transects were set up at Mattingley and Hartley Wintney. The number of different species observed within sections were recorded in 2010, 2011 and, for Mattingley only, 2014.

4.2 The transect routes within grazed and ungrazed plots were of different lengths (the grazed plot transect was longer than the ungrazed plot transect at Mattingley and shorter at Hartley Wintney, resulting in a different recording effort between the two areas, and in 2014 a new additional transect route was followed at Mattingley. The sections were also of different lengths, therefore it is not possible to make a robust comparison between grazed and ungrazed areas. A significantly greater effort was put into the survey in 2010 (8-9 visits between June and August) compared to 2011 (3 visits in May), while 22 were undertaken at Mattingley only in 2014. In 2010, data were compiled for the season, so data from individual transect counts were not available. These factors make the comparison of changes between years grazed and ungrazed areas difficult. A separate survey was carried out for silver-studded blues on seven occasions in June and July 2014, covering sections of the old and new Mattingley transects.

Results

4.3 A summary of the records of different species is given in Table 4.2 and 4.2, but note that the recording effort was different in each case. Specific data on weather conditions were not available for 2010-11. Conditions were generally favourable in 2014.

4.4 Of particular interest are records for the heathland specialist silver-studded blue, which requires short, sparse swards dominated by cross-leaved heath. Records were very scarce in May 2011 (transects were undertaken in May and the main flight period for this species is June to August), but in 2010 and 2014 there was a marked difference between grazed and ungrazed areas. For example, 72 records were made from the grazed transect sections and 25 from the ungrazed transect at Mattingley in 2014, and 30 records from the grazed and 14 from the ungrazed transects at Hartley Wintney in 2010. This difference probably over-rides that due to varied recording effort (which was greater in the grazed area of Mattingley but the ungrazed area of Hartley Wintney). However, this difference cannot be attributed to cattle grazing with any confidence, due to the variability of other factors including habitat. Edwards (2012) suggests that the high number of Silver-studded blues in the north–west corner of Mattingley is probably due to the heavily rabbit-grazed sward. Data from the silver-studded blue survey in 2014 are from transect sections of different lengths, making comparison between grazed and ungrazed areas difficult, but could be standardised once section lengths are available.

4.5 Grayling is another heathland specialist, and numbers were notably higher in the grazed plots (80 versus 14 in the ungrazed area at Mattingley in 2014). A wide difference is also seen in the numbers of gatekeeper and ringlet at Hartley Wintney, which are much greater in the ungrazed area. The section of the transect which contributed most of these records runs along

the southern wooded boundary, which provides suitably sheltered, woodland-edge habitat for these species, neither of which are typical of open heathland habitat.

4.6 Available national trends suggest a slight overall increase in silver-studded blue between 2003 and 2013, with a 130% increase in 2013 following on from the particularly poor weather conditions in 2012. Grayling shows a 25% increase since 2003 and a 47% increase between 2012 and 2013 (although the longer term trend is again negative).

Table 4.1: The total number of species and number of heathland species per transect in grazed and ungrazed areas at Hartley Wintney. Comparison in changes in over time should be made with caution due to differences and timing in survey effort. Direct comparison between grazed and ungrazed in any one year is not valid due to unquantified differences in transect length and habitat.

Hartley Wintney	Grazed		Ungrazed	
Species	June-Aug 2010	May 2011	June-Aug 2010	May 2011
Small Skipper	10	0	21	0
Large Skipper	7	0	24	1
Brimstone	1	0	2	1
Large White	7	0	7	2
Small White	0	2	0	0
Purple Hairstreak	0	0	1	0
Small Copper	1	0	4	0
Common Blue	0	0	2	0
Holly Blue	0	2	0	0
Silver-studded Blue	30	0	14	0
White Admiral	0	0	2	0
Red Admiral	1	0	3	1
Peacock	0	0	1	0
Comma	4	0	2	0
Silver-washed Fritillary	0	0	1	0
Speckled Wood	1	0	1	0
Marbled White	1	0	7	0
Grayling	4	0	1	0
Gatekeeper	19	0	71	0
Meadow Brown	10	0	23	0
Ringlet	11	0	105	0
Small Heath	1	0	0	0

Table 4.2: Butterfly records from transects undertaken at Mattingley. Comparison in changes in over time should be made with caution due to differences and timing in survey effort. Direct comparison between grazed and ungrazed in any one year is not valid due to unquantified differences in transect length and habitat.

Mattingley	2010	2011	2014	2010	2011	2014	2014
	Grazed	Grazed	Grazed	Ungrazed	Ungrazed	Ungrazed	New ungrazed
Small Skipper	6	1	252	4	0	123	270
Large Skipper	20	0	26	16	0	10	37
Clouded Yellow	0	0	4	0	0	0	0
Brimstone	0	0	17	0	0	2	30
Large White	31	0	15	5	1	3	36
Small White	1	3	7	0	2	1	10
Green-veined White	0	0	1	0	0	0	7
Orange-tip	0	0	0	0	0	0	16
Green Hairstreak	0	0	1	0	0	2	0
Purple Hairstreak	1	0	14	0	0	2	0
Small Copper	9	0	7	4	0	1	5
Common Blue	6	0	4	1	0	3	9
Silver-studded Blue	45	0	72	0	3	25	34
Holly Blue	0	0	2	0	0	0	3
White Admiral	0	0	6	0	0	3	0
Red Admiral	0	0	22	2	0	8	31
Painted Lady	0	0	2	0	0	0	4
Small Tortoiseshell	0	0	23	0	0	5	31
Peacock	0	0	34	0	0	8	57
Comma	0	0	4	0	0	1	24
Silver-washed Fritillary	2	0	24	2	0	11	71
Speckled Wood	24	2	73	32	1	34	104
Wall	0	0	0	0	0	2	0
Marbled White	0	0	16	0	0	0	34
Grayling	4	0	80	2	0	14	80
Gatekeeper	104	0	213	105	0	73	280
Meadow Brown	26	0	249	23	0	92	255
Ringlet	12	1	64	5	0	24	102
Small Heath	1	1	0	0	2	0	0
Purple emperor	0	0	4	0	0	1	0

Other invertebrates

Invertebrate sampling methods

4.7 General invertebrate surveys were carried out in 2009 before grazing was introduced and in 2012 and 2014. The methodology was different in 2009 in terms of the areas surveyed, and so are not used for comparative purposes here. The results for 2012 are written up in Edwards (2012). Specific information on weather conditions is not given, but overall 2012 was a poor year for invertebrates (e.g. Brereton *et al.* 2014).

4.8 The survey comprised a fixed-time search of the grazed and ungrazed areas of Hazeley Heath. The time period, survey dates and specific weather conditions were not available at the time of writing for 2014 but will be available in the report of the survey when this is finalized.

Analysis methods: guild classification

4.9 Invertebrates records were examined to explore any difference between grazed and ungrazed areas in the proportions of species requiring conditions associated with grazed heathland. The approach used guild classification.

4.10 Species were first grouped according to their requirements into “guilds”. Guilds operate irrespective of habitat, as a species with similar requirements (e.g. bare ground) may occur in a wide range of habitats. Guilds focus on the underlying requirements of a species in terms of vegetation structures or processes. This methodology follows the guild approach used during Biodiversity Audits (Dolman, Panter & Mossman 2012). This approach, first applied in the Breckland heathland region (Dolman, Panter & Mossman 2010), has since been refined through worked examples in other regions. These focused on scarce species but here we extend the classification to include all species.

4.11 This approach groups species based on their requirements for vegetation structures such as sward height, the presence of bare ground, and nectar sources etc. Guilds are created by examination of species accounts from a wide range of sources including the Invertebrate Site Register, red data book accounts, atlases and websites. The classification focused on the life-cycle stage at which conservation management can be targeted; for example the aquatic larval stages of dragonflies were taken into accounts, as adults are much more mobile and less habitat specific. Fully aquatic species were not included in analysis, those associated with wet areas were included.

4.12 The final classified species list consisted of 525 species. It was not possible to assign some species to a guild due to their extremely broad or uncertain requirements. This was particularly the case for species that are extremely common and widespread, and this were omitted. Some species were assigned to hydrological-successional group, but not assigned any further to a final vegetation structure guild.

4.13 It is acknowledged that although this methodology of coding species is applied consistently and objectively, it is nevertheless subjective and if repeated independently different management guilds may result.

4.14 The guilds relating to vegetation structures were interpreted for their relevance to grazing levels as follows:

- Grazing and disturbance: Species within this group are associated with areas of bare ground and short vegetation. Management for these species would require some physical disturbance to create bare ground (e.g. mechanical disturbance, trampling along paths or by animals) and grazing or regular cutting to maintain the short sward.
- Grazing - high: Species are associated with short vegetation and plants which prevail in short, grazed swards. Stocking density needs to be relatively high to create sufficiently large areas of short swards. It includes species directly associated with grazing stock e.g. dung feeders.
- Grazing - moderate: Species which exist in a medium height sward but will be lost if grazing levels are too high. It includes species associated with the tussocks and sward mosaics that are often created by a moderate grazing pressure over a wide area. This includes species associated with heather, as grazing at the correct density should maintain a mosaic of heather structure and diversity.
- Ungrazed: Species associated with tall grasses, rank vegetation and flower-rich areas (not tolerant of grazing). This includes those associated with detritus from tall vegetation, mature heather etc., but not generalist detritivores. Typically grazing is limited to that done by wild animals e.g. deer and rabbits.
- Ungrazed (disturbed): Species are found in ruderal communities, including on brownfield and arable. Species benefit from regular physical disturbance to the soil, and are often associated with grazing-intolerant plants.
- Juxtaposition: Species associated with the juxtaposition of bare ground and tall vegetation or flower rich areas. These species often exist in small areas and their requirements can be met by grazed and disturbed areas near to areas which are ungrazed and support flower-rich vegetation.

Results: sampling effort

4.15 In total, 647 invertebrate species were recorded across ungrazed and grazed areas at Hazeley between 2001 and 2014 (Table 4.3). There was a good representation of taxonomic groups with a slight bias towards bees, wasps, and spiders. Lower number of beetles, flies and particularly moths were recorded.

Table 4.3: The number of species from different taxonomic groups recorded across both grazed and ungrazed areas.

Taxonomic group	Number of species	Number of rare species
Spiders (Araneae)	66	9
Harvestmen (Opiliones)	1	0
Damsel and Dragonflies (Odonata)	13	0
Crickets and Grasshoppers (Orthoptera)	11	4
Earwigs (Dermaptera)	2	1
Cockroaches (Dictyoptera)	1	1

Taxonomic group	Number of species	Number of rare species
Lacewings and allies (Mecoptera, Megaloptera, Neuroptera)	1	0
True bugs (Hemiptera)	80	2
Butterflies and moths (Lepidoptera)	46	6
Beetles (Coleoptera)	156	17
True flies (Diptera)	126	9
Bees, Wasps and Ants (Aculeate Hymenoptera)	140	22
Sawflies and Ichneumon Wasps (Other Hymenoptera)	4	0
Total	647	71

4.16 The survey effort appeared to be variable across years (Figure 4.1), with the number of species recorded in years prior to 2014 roughly half of those recorded in 2014. In addition, recording of different taxonomic groups was variable, with no recording of spiders prior to 2012.

4.17 Acknowledging these constraints and that sufficient time needs to be allowed for any effects of grazing to be noticeable, analysis was restricted to the 2012 and 2014 surveys. This meant that, from the list of the 525 species able to be categorised during the guild process, 452 species were used.

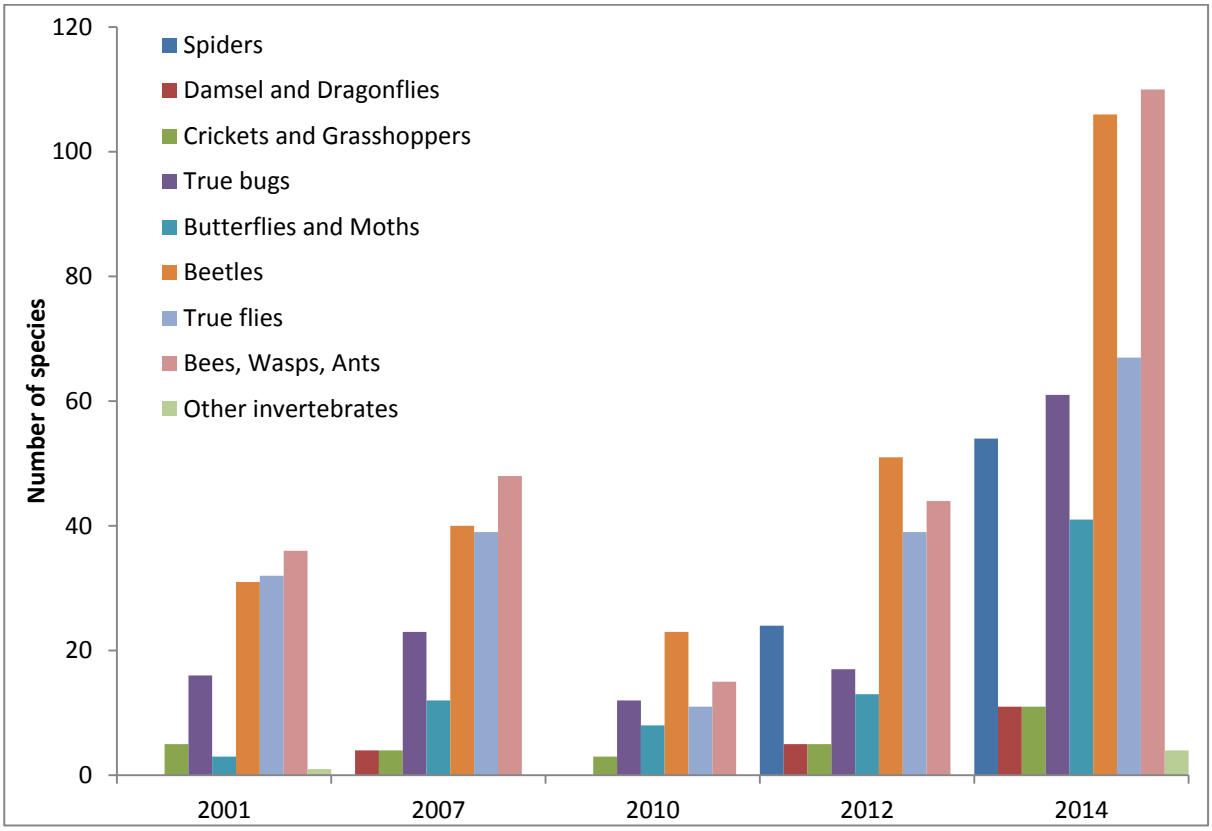


Figure 4.1: Number of species recorded from each taxonomic group across the five sampling years.

Species totals

The number of species that were only found in grazed areas (242) was lower than the number found only in found only in ungrazed areas (381) across taxonomic groups (

4.18 Table 4.5). Species numbers in grazed areas were also lower when considering only designated species (32 in grazed areas compared to 61 in ungrazed areas). Interestingly, the only group with similar numbers of unique species in both grazed and ungrazed areas was spiders, which is unexpected given that many are associated with mature heather, gorse, broom or tall grasses.

Table 4.5: Number of species recorded only in the grazed areas, only in ungrazed areas and recorded in both grazed and ungrazed areas, separated by taxonomic group.

Taxonomic group	Recorded only in grazed areas	Recorded only in ungrazed areas	Recorded in both grazed and ungrazed areas
Spiders (Araneae)	12	16	28
Crickets and Grasshoppers (Orthoptera)		3	8
Cockroaches (Dictyoptera)		1	
True bugs (Hemiptera)	13	26	24
Butterflies and moths (Lepidoptera)	7	12	20
Beetles (Coleoptera)	18	61	36
True flies (Diptera)	13	33	21
Bees, Wasps, Ants, Sawflies and Ichneumon Wasps (Hymenoptera)	8	58	34
Total (452)	71	210	171

Guild classification

4.19 Examination of the assigned guilds, using just the canopy cover gradient, shows that half the species (51%) recorded were associated with exclusively open areas (Table 4.6). The remaining half were associated with open areas with some scrub or tree cover, or closed woodlands/scrub. These proportions of species remain roughly similar when considering only rare species and those only recorded in the grazed or ungrazed areas. The numbers of species associated with woodland and scrub are not surprising given the small, isolated nature of the site - a result of heathland habitat fragmentation and edge effects (Webb 1989).

Table 4.6: Numbers of species associated with different canopy cover configurations.

Canopy cover	Number of species
Open areas (no canopy cover)	229
Open areas with scrub/scattered scrub	58
Scrub cover	7
Open woodland (including wood pasture configurations)	40
Tree or shrub cover (any amount, open with scattered shrub or tree to closed canopy)	66
Closed canopy woodland or scrub	8
Variety (species occur in open areas and closed canopy)	44
Total	452

Species requirements

4.20 From species accounts key requirements can be identified and comments made on the important elements required. Vegetation elements in open areas frequently include the presence of heather, a wide range of grasses, scrub such as gorse and broom, yellow composites and crucifers. Also noted was the importance of bare ground, in both the dry, sandy areas, but also in damp or wet areas. The juxtaposition of areas of bare ground and flower-rich areas was noted as very important, due to the many bees and wasps recorded. In wooded areas or scrub, many associations were reported with birch and oak, and occasionally pine. In woodland-edge the combination of deadwood and flower-rich areas, such as umbels and dead stems is important.

4.21 With specific reference to grazing on site, six species were strongly associated with the availability of dung. However the presence of these species was variable and they were recorded on both the grazed and ungrazed plots.

Grazing guilds

4.22 Species recorded in 2012 and 2014 were examined in relation to their requirements for grazed habitat. Analysis was based on species associated with all levels of canopy cover, but excluded arboreal/ foliage feeders, and considered only those for which the ground vegetation was important.

4.23 In Figure 4.9, the various guilds are depicted based on their requirements for different degrees of grazing pressure and disturbance. In most guilds the number of species was greater in the ungrazed than the grazed areas, but in the guild requiring grazing and disturbance, the number of species was slightly greater in the grazed areas. The relative proportions of species associated with different guilds varied little between the ungrazed and grazed areas. However, there was a slightly greater proportion of 'juxtaposition' species in ungrazed areas (due to a higher number of foraging aculeates). When considering only designated species, the pattern is similar, except that the higher number and proportion species of grazing and disturbed guilds is more notably higher in grazed areas and the number and proportion of species within the 'disturbance – ungrazed' is also higher.

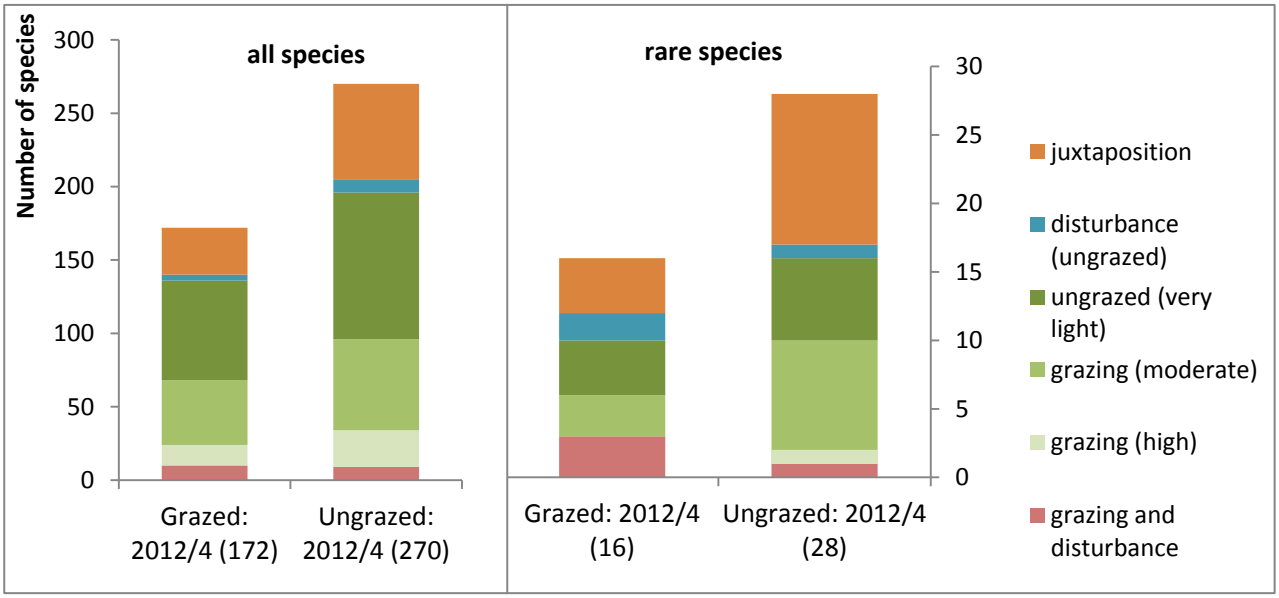


Figure 4.9: The number of species assigned to groups based on their recorded requirements for different grazing and disturbance regimes, recorded in grazed and ungrazed areas in 2012 and 2014. Numbers in brackets indicate the total number of species.

Individual taxa

4.24 Further examination of the guilds was conducted using single taxonomic groups, as each taxa has its own associated vegetation structures. For example, spiders are mostly associated with tall vegetation and bees, wasps and ants with the juxtaposition of bare ground and flower-rich areas. Figure 4.10 and Figure 4.11 illustrate the differences between selected taxonomic groups. Within each taxon, the relative proportions of species associated with different vegetation structures remained fairly similar between grazed and ungrazed areas. There is a slight increases in the proportion of flies associated with 'grazing' and of beetles associated with 'disturbance and grazing' in grazed areas, and an increase in flies association with 'disturbance (ungraze)' in ungrazed areas. Otherwise proportions remain roughly similar between the ungrazed and grazed areas within individual taxa. As one of the groups most associated with ungrazed areas, the proportion of spiders was not different between grazed and ungrazed which might have been expected.

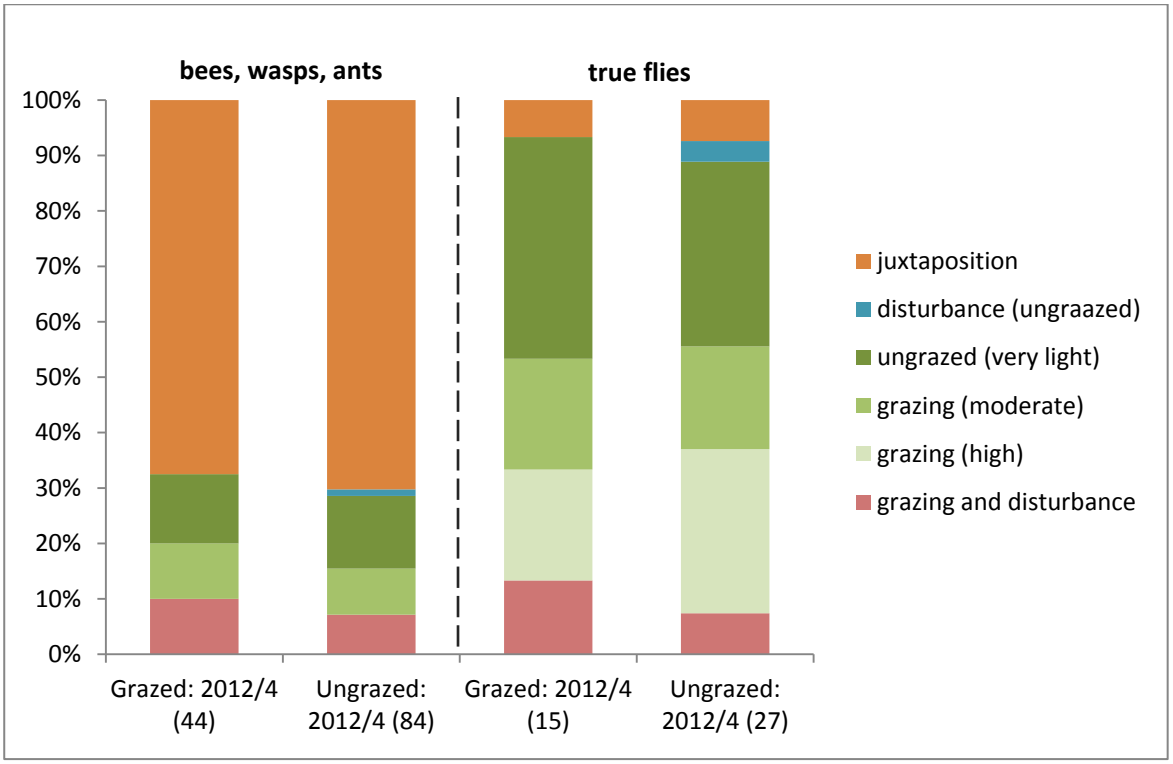


Figure 4.10: The proportion of species associated with different grazing and disturbance requirements recorded from grazed and ungrazed areas, shown for bees, wasps and ant, and true flies. Numbers in brackets indicate the number of species.

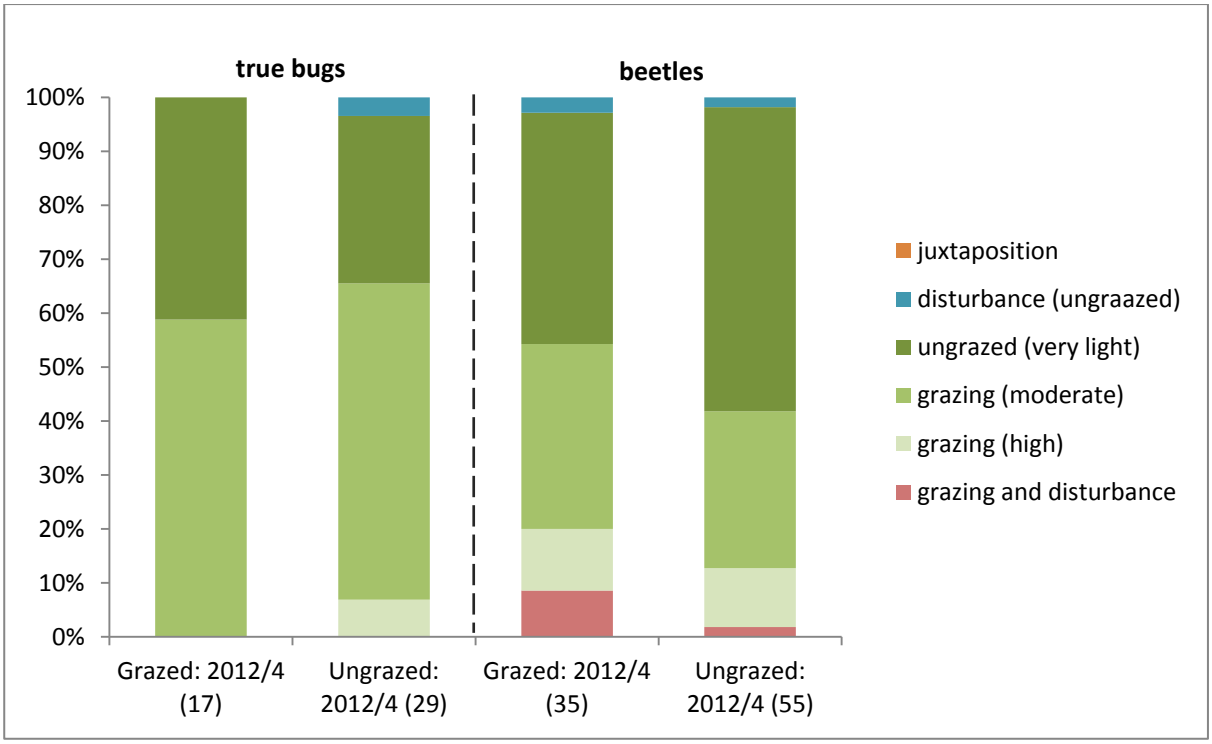


Figure 4.11: The proportion of species associated with different grazing and disturbance requirements recorded from grazed and ungrazed areas, shown for hymenoptera and diptera. Numbers in brackets indicate the number of species.

Invertebrate surveys – summary

- The number of silver-studded blue butterflies was notably greater in grazed areas of Hartley Wintney and particularly Mattingley in 2010 and 2014 (but recording effort differed). Numbers of the other specialist heathland butterfly, grayling, were also greater on grazed areas although numbers were very small. While cattle-grazing is likely to help create the short sward required by these species, differences may also be due to other localised factors (such as rabbit grazing)
- Constraints include the different survey effort (different length transects and transect sections) between areas and across years for butterflies.
- The overall number of invertebrate species was consistently lower in grazed areas compared to ungrazed areas. The number of rare species and the number of species within individual taxonomic groups were also lower.
- Half of the species recorded were associated with open areas, while the remainder were associated with open areas with scrub, woodland edge, open woodland and trees, shrubs in open areas or closed woodland.
- Examination of the requirements of species in relation to grazing levels shows large numbers of species associated with ungrazed or moderately grazed conditions. The proportion of these species in grazed and ungrazed areas suggests there have been effects of grazing on invertebrates with a slightly greater proportion of species generally associated with grazed swards in the grazed areas compared to ungrazed areas.
- Overall, weather was particularly poor in 2012, but comparison is made between grazed and ungrazed areas rather than between years.

5. Reptiles

Methods

5.1 Reptiles were monitored in 2010, 2011 and 2014 through a survey of artificial refugia (i.e. tin sheets, which provide cover and protection from predators and therefore attract reptiles). The survey methodology broadly follows that set up in 2009 (Boorman 2010) before grazing was introduced, although the numbers of tins and their placement varied, as did the experience of surveyors. Twenty-four tins were set out in grazed and ungrazed areas of both Mattingley and Hartley Wintney and were checked up to ten times between April and September. Records were also made of reptiles encountered on the route between tins. Some tins were lost (e.g. as a result of fire) and recording effort varied between years.

5.2 Results from refugia were interpreted by using binary logistic regression to consider the probability of each reptile species being present or absent under a tin in grazed and ungrazed areas. Presence or absence, rather than total number was used, because the presence of more than one of a particular species may be due to social interactions (e.g. the presence of one individual attracted others).

5.3 Data from 2009 were used to provide a base line, although caution should be used in interpreting any differences between 2009 and subsequent years due to the different methodologies. In 2009, 58 refugia were used. Forty-nine of these were laid out in a systematic manner over the site (roughly one per hectare). An additional nine were used in areas identified as being of particular suitability for reptiles, six in the grazed area, and three in the ungrazed area. These were removed from the analysis as they were split unequally between grazed and ungrazed areas. Visual observations of reptiles recorded away from tins were not included within the analysis due to the likely variation in survey effort. In most cases, no difference were found between Mattingley and Hartley Wintney, and therefore the data for the two areas are generally considered together to maximize the sample size.

Results

5.4 No sand lizards or smooth snakes were recorded. The presence/absence of adder, slow worm, grass snake and common lizard in grazed and ungrazed areas in 2009, 2010 and 2014 is shown in Table 5.1.

Table 5.1: The presence or absence of reptiles recorded under refugia in grazed and ungrazed areas. Highlighted cells indicate where the probability of encountering a reptile is significantly different between grazed and ungrazed areas.

Grazing	No. of tin checks	% of tin check with one or more reptiles present (total number of tin checks with one or more of the species present)			
		Adder	Slow Worm	Grass Snake	Common Lizard
2009 (before grazing)					
Grazed	79	**Appendix 2**0	50.63 (40)	8.86 (9)	50.63 (40)
Ungrazed	69	0	49.27 (34)	4.34 (6)	57.97 (40)
2010 (1st year of grazing)					
Grazed	113	0.88 (1)	25.66 (29)	1.77 (2)	7.96 (9)
Ungrazed	101	3.96 (4)	23.76 (24)	7.92 (8)	9.9 (10)
2014 (5th year of grazing)					
Grazed	95	6.32 (6)	24.21 (23)	10.53 (10)	1.05 (1)
Ungrazed	92	8.70 (8)	39.31 (36)	2.17 (2)	0

5.5 In 2009, there was no statistically significant difference between areas that would be grazed and control areas that would remain ungrazed in terms of the probability of encountering one or more of a given species of a reptile under a refuge tin (see Appendix 2 for test results). No adders were recorded under tins, but 29 were observed on site.

5.6 In 2010, the year when grazing was introduced, there was again no statistically significant difference found. The numbers of grass snake and also adder were slightly higher in the ungrazed area but were generally low (see Appendix 2 for test results).

5.7 In 2014, the probability of encountering slow worms was significantly greater in ungrazed areas than in grazed areas. Conversely, the probability of encountering a grass snake was significantly greater in grazed areas than ungrazed areas. A significant pattern was not found for adder or common lizard.

5.8 Differences between sites and tins and potential interactions between species were explored using the 2010 and 2014 data. In 2010, the probability of encountering slow worms at Mattingley was significantly lower than at Hartley Wintney, whereas the probability of encountering common lizards was greater at Mattingley. At Mattingley, the probability of encountering common lizards was significantly greater in the grazed area than the ungrazed area. There were no significant differences in 2014.

5.9 Overall differences between 2009 and subsequent years need to be viewed with caution due to differences in the methods and surveyors. However, the overall decline in the number of common lizards and increase in number of adders during the period is particularly notable (see Figure 5.1 and 5.2). In 2009, lizards were the most common species recorded with 80 encountered under tins and 144 observed away from tins, while in 2014, only one was recorded at a tin and 23 near tins. No records were made of adders at tins in 2009, five in

2010 and 14 in 2014. There is a significant difference in the proportion that each species contributed to overall records between 2009 and 2014 (Chi-Sq = 85.271, DF = 6, P-Value = 0.000).

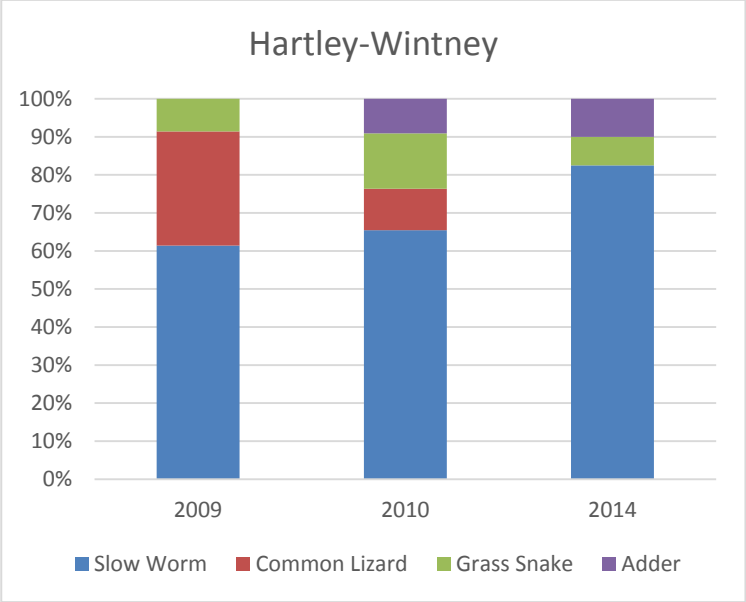


Figure 5.1: The proportional difference between years in the presence/absence of each reptile species under artificial refugia at Hartley Wintney.

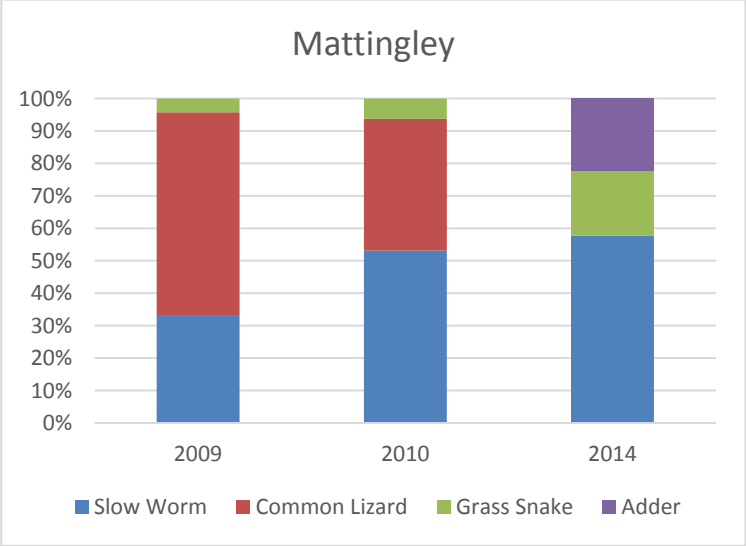


Figure 5.2: The proportional difference between years in the presence/absence of each reptile species under artificial refugia at Mattingley.

Reptile surveys – summary

- Base-line data from 2009 show little variation between grazing and control areas in terms of the probability of encountering reptiles at artificial refugia.
- There were no statistically significant differences between grazed and ungrazed areas in 2010, although the number of adder records was higher in ungrazed areas.
- In 2014, the probability of encountering one or more slow worms at artificial refugia was significantly higher in ungrazed areas, while the probability of encountering one or more grass snakes was significantly higher in grazed areas.
- Overall, numbers of reptiles changed markedly between years with an apparent substantial overall decline in common lizards and an increase in adders.
- Constraints include the difficulties in reliably estimating reptile numbers - variability between sites in the detectability of reptiles is known to be an issue (e.g. Sewell *et al.* 2013), and methods for detecting reptiles rely more heavily on field craft than those for some other taxa. In addition, it is not possible to determine whether changes observed between grazed and ungrazed areas were attributable to grazing or other habitat management differences.
- Differences between years may have also reflected winter survival, breeding success in previous years and immigration or emigration into or out of the study area.

6. Birds

Methods

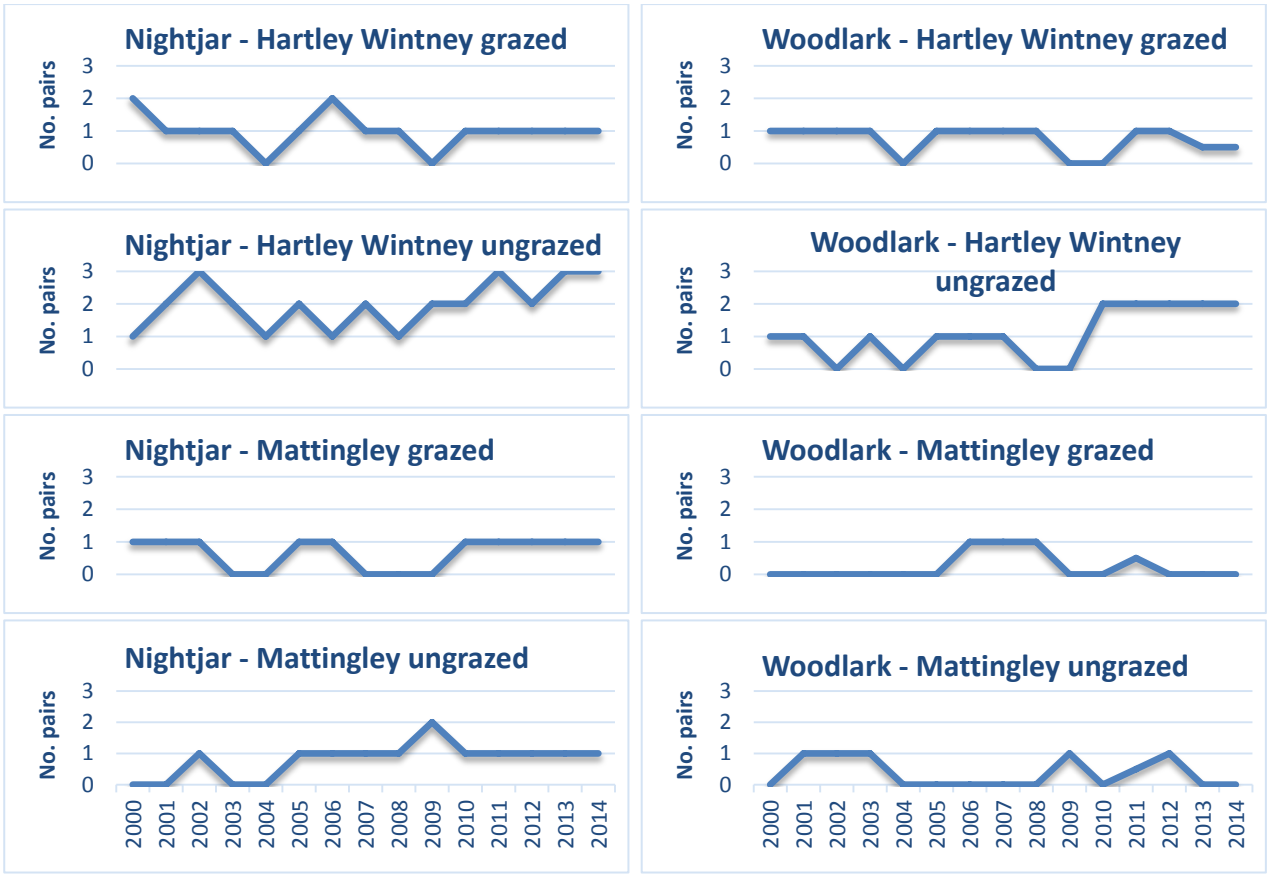
6.1 Breeding birds survey data are available from 2000-2014. Counts were made of breeding pairs as indicated by consistent sightings of singing males in the same area of the Heath over the period April – June (Collman 2009). The data were mapped, allowing a breakdown according to grazing treatment even for data collected before the grazing trial was planned.

6.2 Data were examined for any apparent differences before and after grazing, on both grazed and ungrazed plots using a Mann-Whitney test (to examine the equality of the medians of the two groups in each case). More detailed trend analysis was not possible due to the relatively high number of zero records per grazing treatment per year.

Results

6.3 For all species, no significant difference were found in the median population size before or after grazing was introduced on either the grazed on ungrazed plots. Data are summarised in Figure 12 (see figure heading for constraints).

6.4 In some cases changes in the number of breeding pairs between years has been attributed to over-riding factors such as cold weather (e.g. the decline in breeding Dartford warbler after 2009) and tree clearance (e.g. increase in woodlark in the ungrazed areas of Mattingley in 2010) (Collman 2014b).



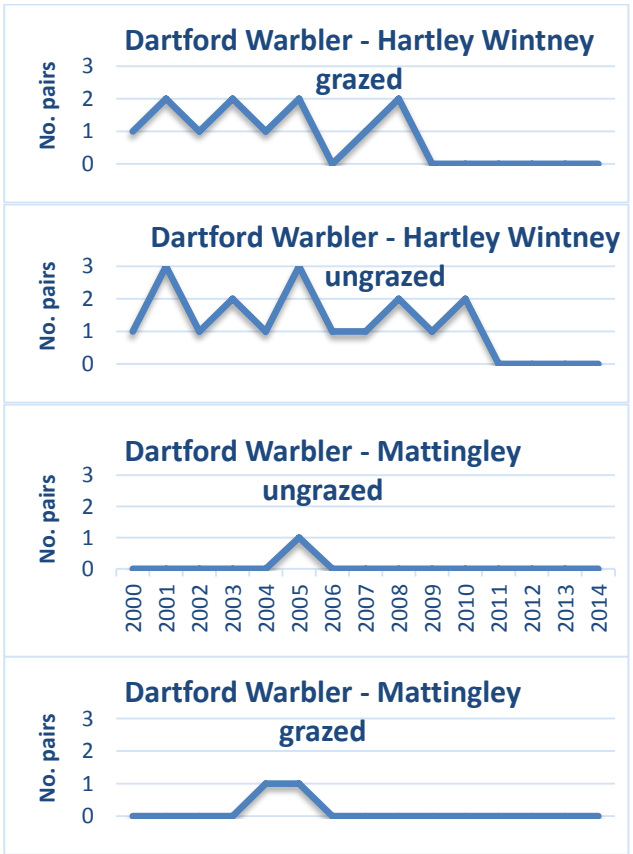
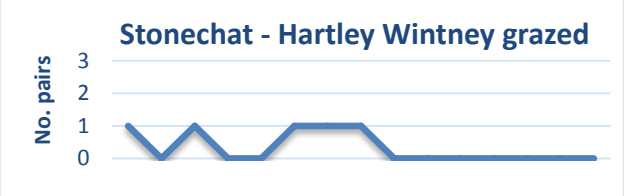


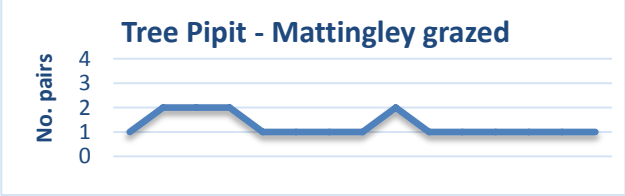
Figure 12. Changes in the number of breeding pairs of Annex 1 species Nightjar, Woodlark and Dartford Warbler in grazed and ungrazed areas of Mattingley and Hartley Wintney between 2000 and 2014. Cattle grazing was introduced in 2010 to the grazed areas (cont'd overleaf). Note that direct comparison of numbers between areas (and therefore treatments) is not valid due to their different sizes. In some cases there was also difficulty where territories overlapped the fence between grazed and ungrazed area. The normal constraints of different mechanical management between grazed and

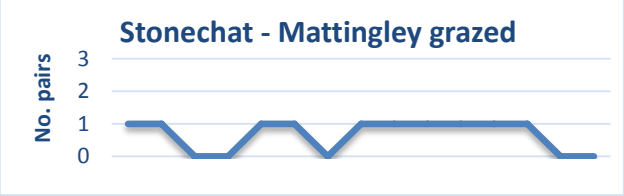

Tree Pipit - Hartley Wintney grazed
No. pairs
0
1
2
3
4

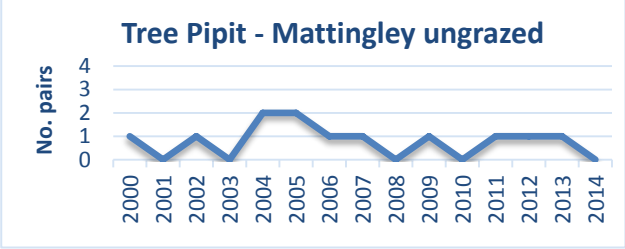

Stonechat - Hartley Wintney grazed
No. pairs
0
1
2
3

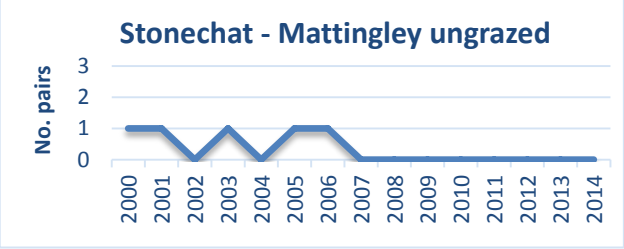

Tree Pipit - Hartley Wintney ungrazed
No. pairs
0
1
2
3
4


Stonechat - Hartley Wintney ungrazed
No. pairs
0
1
2
3

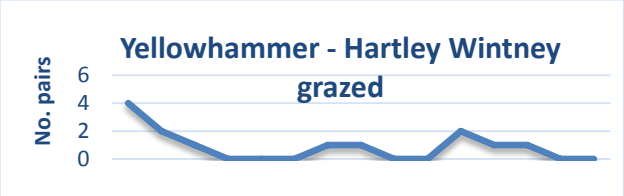

Tree Pipit - Mattingley grazed
No. pairs
0
1
2
3
4


Stonechat - Mattingley grazed
No. pairs
0
1
2
3


Tree Pipit - Mattingley ungrazed
No. pairs
0
1
2
3
4
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014

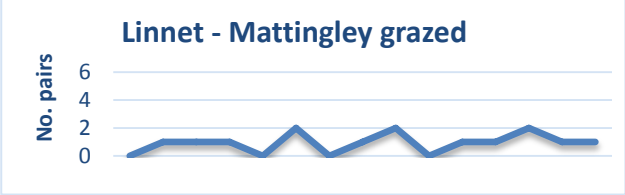

Stonechat - Mattingley ungrazed
No. pairs
0
1
2
3
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014

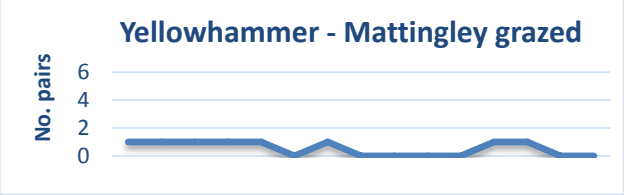

Linnet - Hartley Wintney grazed
No. pairs
0
2
4
6

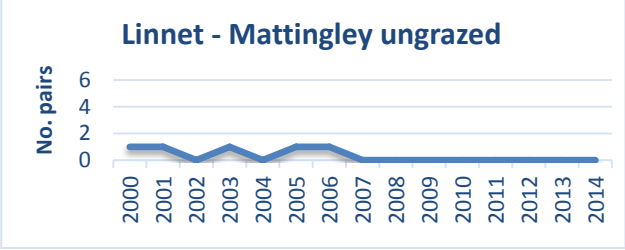

Yellowhammer - Hartley Wintney grazed
No. pairs
0
2
4
6

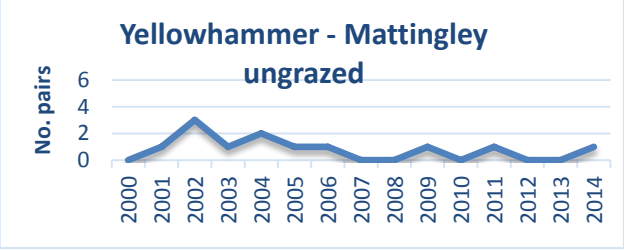

Linnet - Hartley Wintney ungrazed
No. pairs
0
2
4
6


Yellowhammer - Hartley Wintney ungrazed
No. pairs
0
2
4
6


Linnet - Mattingley grazed
No. pairs
0
2
4
6


Yellowhammer - Mattingley grazed
No. pairs
0
2
4
6


Linnet - Mattingley ungrazed
No. pairs
0
2
4
6
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014


Yellowhammer - Mattingley ungrazed
No. pairs
0
2
4
6
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014

7. Analysis of management costs during the period of the grazing trial

Management operations other than grazing

7.1 The data presented in Table 7.1 were provided by Hart District Council (HDC) for the area in its management, which includes a grazed compartment and control areas. The operations listed (and described below) are standard heathland management practices used on the majority of heathland sites, whether grazed or not. It is likely that all will be needed on parts of the site in the future in order to maintain and diversify existing heathland areas or as part of a process of restoring areas of heathland which have been lost to tree cover. However, some (e.g. tree felling) are restoration techniques that would not be needed once restoration is complete and management enters a maintenance phase.

7.2 It is not possible to use these figures to give more than a very broad indication of future management costs. Indeed, it will be seen that for given operations, costs were variable, reflecting differences in the scale or difficulty of the work in different areas. Very small treatment areas tend to have a relatively high unit cost. For these reasons a range for cost per hectare over the trial period is also given in Table 7.1.

Table 7.1: Operations carried out by HDC with costs. Note that tree-felling/woodland removal is a restoration operation, and should not be needed on an ongoing basis for maintenance management

Operation	Amount	Cost (ex VAT)	Cost per ha	Cost per ha range
Cut and collect mowing	1.68ha	£4690	£2792	£2500-3750
Turf/litter scraping	0.51ha	£2270	£4451	£2333-6000
Scrub management	2ha	£5153	£2577	£1500-3653
Tree felling/ woodland removal	1.04ha	£4650	£4471	£3600-13750
Bracken spraying	2ha	£1727	£863	£687-1040

7.3 ***Cut and Collect mowing*** is most often used on areas of medium height heather or tall grass and sometimes on young scrub. It is useful for diversifying the structure of vegetation on a ‘coarse scale’ (in contrast to grazing which delivers 'finer scale’ structural variation). It is also a way of re-setting the heather cycle to early growth heather and so revitalising heather stands and the plant and animal communities dependent upon them. It can be used to create fire breaks and access routes. Grazing trial experience shows this to be a useful moderately expensive treatment on suitable accessible areas with potential for wider application on site, though likely to be needed less within grazed areas.

7.4 ***Turf/litter scraping*** removes surface organic matter and reduces nutrients. Usually it is done down to a level that exposes dormant heather seed, which can then regenerate. Consequently it is often used to restore heather on areas which once supported heather but may now be dominated by other vegetation such as bracken or even be under mature woodland. Like cutting, scraping diversifies heathland structure but also exposes bare ground, which is of great value to a wide range of heathland invertebrates, reptiles and even birds such as woodlark. Regular creation of small-scale scrapes of just a few square metres can be worthwhile. As the data from the trial show, this is an expensive operation and disposal of the

stripped material is often difficult so it tends to be used sparingly and in carefully selected areas. This technique must also to be used with care to avoid damage to archaeological or cultural surface features. However it will be a valuable, albeit minor, component of future site management.

7.5 ***Scrub management*** is a regular and necessary operation on nearly all heathland areas. Sites vary in the character of their scrub but on southern heaths birch, pine and gorse are the main species. Left unmanaged, scrub is a great threat to heathland and usually succeeds to some form of woodland, although it also has considerable ecological value. Scrub management aims to prevent it taking over open heath yet seeks to maintain its presence, ideally with diversity in its age. Scrub management techniques range from cutting with hand tools through power tools to larger scale cut/collect machinery. Herbicides are also used on regrowth from cut stumps, in targeted spot-spraying and using weed-wiping techniques. As shown in the trial, this is a moderate-cost technique that is essential to maintain heathland so will feature as an important element in future management of the site, though possibly at reduced levels where grazing limits scrub development.

7.6 ***Tree felling/woodland removal*** can be used to restore heathland on areas from which it was lost to tree cover some considerable time before. It may be followed by scraping or disturbance of the litter layer to encourage heathland regeneration. This is an expensive process and is planned strategically so that it adds area on the margins of existing open heathland. It is especially valuable if it creates links between formerly isolated open areas. If sufficient resources are available, there is considerable potential to increase the open heathland area on Hazeley Heath through restoration from tree cover. Once restoration is complete, it should not be needed on an ongoing basis.

7.7 ***Bracken spraying*** has been extensively used in heathland management for several decades. By far the most commonly used chemical for control has been Asulam (Asulox), which if used at the right rates on heathland, specifically targets bracken with negligible effect on other species. Recently Asulox has been withdrawn from use in the EU but has been available year by year on 'emergency approval' in the UK. An approval is in place for 2015. An alternative, more expensive, treatment is Glyphosate (Roundup) which has a further disadvantage in being a broad spectrum herbicide so is not suitable as a spray for controlling bracken where it is scattered in other vegetation. There are mechanical means of bracken control such as cutting, crushing or rolling but these are only suitable for dense stands on relatively flat ground and can potentially harm wildlife such as breeding nightjar. Bracken tends to be patchy in its occurrence on heathland and the need to control it is consequently localised. On Hazeley Heath, this is an operation that will need to continue in scattered areas across the site.

Grazing management

7.8 Data in Table 7.2 are from the Hazeley Heath grazing trial. They relate to an area of about 9ha in which cattle were seasonally contained within electric fencing. Whilst the trial has demonstrated the value of grazing, costings for the grazing element cannot be extended from the trial area to the whole site for practical reasons.

7.9 Firstly there are considerations of scale. The trial covers only a small proportion of the site and the status of Hazeley Heath as registered common land precludes (without Planning Inspectorate consent) more than 10 hectares or 10%, whichever is less in any registration unit, being enclosed within a fence over a 6 month period annually. If kept at its current scale, even if the electric fencing were moved twice in the summer grazing season (with a heavy associated labour requirement), this would mean a given area would wait years for repeat grazing, so negating any useful effects.

7.10 With consent under the Commons Act 2006, the system could be scaled up to cover substantially more of the site. However, there are also considerations of robustness and dependability as electric fencing components are not long lasting and can quickly be rendered ineffective by vegetation shorting the system so need constant checking. Such fencing is also very susceptible to vandalism or theft - both more likely with larger scale operations. Rather than electric fencing, some form of stock fencing is thus indicated as the best practical long-term option to provide dependable livestock control. This would have very different costs for erecting the infrastructure but would share with the trial a need for supervision by a Ranger. However, managing grazing would in most cases only be a small proportion of the total job. Grazier payments would reflect the arrangements made with the grazier who would be selected on ability to provide the right type of livestock in the right number at the right time.

Table 7.2: Grazing costs incurred 2010-2014

Item	Cost (ex VAT) over 5 years	Notes	Equivalent likely annual payment for 6 months grazing
Fencing materials and equipment	£4785	Expected lifespan 10 years	£478.5
Fencing labour	£4819	One-off capital costs	£963.8*
Grazing Trial Ranger	£15,000	Approx., based on 1 ranger at £12/hr for 9 hrs/wk for 6 months of the year. Year round grazing would cost £5616 per year	£3000
Grazier payments	£4250	Annual payment of £850 for 4 cattle for 6 months	£850
Grazier transport	£100	One off payment, unlikely in future if grazing continues	£0

*Spread over the five years of the project. Would depend on labour needed.

A balance in management operations.

7.11 The mechanical operations, spraying and grazing that have been used in the trial are not alternative ways of achieving the goal of well managed heathland. Rather, they are contributing elements of good heathland management. Grazing can produce effects that are not achievable by mechanical techniques – structural diversity on a fine scale, selective control of potentially dominating species such as purple moor-grass and reduced scrub establishment and growth. Other management practices cannot provide the diversity created by selective grazing and habitat use, dunging, or trampling and poaching (Lake, Bullock & Hartley, S. 2001).

However, grazing rarely delivers everything and usually needs to be supplemented by scrub and bracken control. Cut/collect can also add to structural diversity under a grazing regime or encourage grazing in particular parts of the site. Creation of scrapes of various sizes can add more diversity. Restoration of heathland after removal of tree cover can be assisted by grazing but often also requires scrub and bracken management.

7.12 Access for mechanical management needs to be considered. For example, on the northern end of Hazeley Heath there are some areas where mechanical management is either very difficult or not practical due to topography and ground conditions. In these areas, grazing by livestock may be the only suitable option**.**

8. Considerations that would need to be taken into account if wider grazing of Hazeley Heath were to be pursued as a management tool

8.1 If a grazing scheme in the longer term over the whole or a major part of the common remains a possibility which the managers wish to pursue and if this involves any form of fencing or other structures then it would require the consent of the Planning Inspectorate (PI).

8.2 Under the Commons Act 2006, there is a prohibition on carrying out any works on common land, without the consent of the appropriate National Authority, which, for these purposes, is now the Planning Inspectorate. In considering such an application, the PI may take into account a wide range of primary considerations including

- The interests of persons having rights over the land
- The interests of the neighbourhood
- The public interest
- Any other matter considered to be relevant

8.3 The public interest includes:

- Nature conservation
- The conservation of the landscape
- The protection of public rights of access
- The protection of archaeological remains and historic interest features.

8.4 The PI strongly advises that public consultations are undertaken into any proposals in accordance with "A Common Purpose"[7] . This would normally involve two stages:

i) A full public consultation, using all reasonable methods to obtain the views of stakeholders on the management options for Hazeley heath. This first consultation will seek views on all management options and will:

- Be independent, impartial and objective
- Be open and transparent
- Treat all parties and their views equally and fairly
- Be thorough and cover all issues and options
- Make it clear that no pre-determined outcomes have been decided upon

Given the consultation work that has already been undertaken, this could take the form of a one-day drop in event to which stakeholders are invited.

ii) A second consultation looking at preferred solutions arrived at in the light of the views obtained during the first consultation, the practicalities and costs and the views of the statutory bodies and consultees including Natural England. This consultation should follow the

[7] A Common Purpose. A guide to community engagement for those contemplating management on common land. Natural England. 2012

same practices and principles as the first, except that now a number of preferred options will have been chosen as a possible way forward.

8.5 These consultations would require the production of information which might include a full options appraisal, a shorter background paper and a leaflet. It is also possible to seek views via a questionnaire which can be a good way of systematically getting and analysing people's views. However this should be carefully designed by an expert and if properly worded, can tease out a great deal of information and opinion in a logical and organised way.

8.6 An administrator may be needed to keep a careful record of all communications, details of the consultation methods, copies of all consultation documents, dates of events etc.

8.7 Once key decisions are made and the consultation documents prepared then the consultation would need to be publicised. Ways to do this could include putting posters up on the site and elsewhere, press releases, newsletters, letters to individuals and local and national organisations. All these communications would contain details of planned consultation events.

8.8 Once the first consultation is finished, then a report and analysis would be needed and decisions made on how to take forward the management of the site. In most case this would involve a second consultation on preferred options. Procedures for advertising the consultation and seeking views could follow a similar path to the first consultation.

8.9 Once the second consultation is completed, then a final decision would need to be made on future management of the site, and if this involves the construction of works on the common it will require an application to PINS.

8.10 During the consultations every effort should be made to reach a consensus without the need for the Inspector to call a public inquiry, but that if this is not successful and an inquiry is held, then the applicant would need to show that steps have been taken to advertise and conduct an open and honest consultation.

8.11 Finally, consultations take time. From start to submission of an application can take between one and three years with an average of twelve months.

8.12 If the chosen options require an application to the Planning Inspectorate (PI) for structures on the Commons, then the third stage will be the preparation of an appropriate application with supporting maps, evidence and documentation. Depending on the responses received to the application, the PI may determine the application or hold a local hearing or inquiry

9. Conclusions

9.1 Although the desired endpoint has not yet been reached, there is evidence to suggest that grazing is shifting the heathland habitat at Hazeley Heath in the right direction. Five years is a relatively short time span in terms of monitoring the effects of grazing on lowland heathland. Lowland heathland plant communities can be slow to respond to light seasonal grazing, and changes in vegetation structure are likely to occur before changes in species composition (e.g. Lake 2002). However, there was some indication that grazing was having a positive impact on plant communities at Hazeley Heath by the end of the trial (see p13, 22, 27), particularly on the wet heath. There were differences between Mattingley and Hartley-Wintney and none of the differences were statistically significant (or could not be tested)

9.2 The indication of an increase in species diversity and decrease in purple-moor grass on wet heath at Hartley-Wintney is backed up by studies of the impact of reintroducing grazing to wet heath from other sites. For example, three years of cattle grazing on wet heath at Arne in Dorset resulted in an increase in species diversity on wet and humid heath (Lake, 2002), while at other sites in Purbeck species such as petty whin *Genista anglica* and pale butterwort *Pinguicula lusitanica* reappeared following the reintroduction of grazing at sites where they were thought to have been lost. Similarly, after five years grazing, overall species diversity increase on wet heath at Folly Bog in Surrey (Groome 2011), with a significant increase the frequency and/or cover of mosses, including lustrous bog-moss *Sphagnum subnitens,* compact bog-moss S. *compactum* and soft bog-moss *S. tenellum*, and in common cotton-grass *Eriophorum angustifolium* and tormentil *Potentilla erecta*.

9.3 The primary conservation objective for grazing wet heath is generally the reduction of purple moor-grass (e.g. Wright & Westerhoff 2001). There are a number of studies from wet heath and valley mire which suggest that grazing can achieve this (see Lake, Bullock & Hartley, 2001) . However, success is likely to be dependent on grazing intensity - it is considered that a biomass off take of at least 33% is needed before a reduction in purple moor-grass is seen, as below this level grazing stimulates more growth than it removes (e.g. Grant *et al.* 1996), and achieving an adequate off take level should be considered if grazing is continued at Hazeley Heath.

9.4 At Hazeley Heath, the impact on dry heath was less apparent, although there was an indication that smaller heathland or acid grassland species were more abundant in grazed areas. Data on the impact of grazing on lowland dry heath from other sites are more limited. There is a substantial body of literature from the uplands, but most of this deals with grazing in an agricultural context, often on sites that are over-grazed by sheep. On lowland dry heath, the objective of grazing is usually to diversity the structure of the heather swards, and to contribute to the control of invasive scrub and tree seedlings. Preliminary data from Chobham Common (presented at the 2015 National Heathland Conference, to be published in the conference proceedings) suggested that grazing was causing a more diverse heath structure at this site.

9.5 The assessment at Hazeley was partly based on Natural England's condition assessment protocol. This approach will pick up gross changes, but the of broad size classes in deciding whether features meet targets mean that many changes will not be reflected in the overall assessment. This is not a problem specific to Hazeley Heath, for example, significant positive changes resulting from grazing were recorded at Folly Bog (Groome, 2011), but this was only reflected in the attainment of the condition assessment target for the frequency of desirable herbs following grazing, not the target for purple moor-grass. If grazing is continued at Hazeley Heath, it is recommended that a suitable number of replicated plots are used to record percentage cover of plant species. Monitoring for other groups should also be carefully designed, and where possible should provide data compatible with that collected as part of the trial.

9.6 The priorities of the trial were:

- ***To demonstrate the effectiveness of grazing by domestic livestock in securing the appropriate management of the heathland habitats of Hazeley Heath (both established areas and those in the process of restoration from secondary woodland and/or scrub) in order to meet the condition requirements set out by Natural England***
  Prior to the trial, mechanical management had been carried out at Hazeley Heath for 15 years, and had not resulted in favourable condition status being attained. Although the site remained in unfavourable condition at the end of the grazing trial, the Hartley-Wintney grazed area was in favourable condition for the first time in year 4 of the trial, and the wet heath was very nearly so in 2014. It is likely that this positive trend would continue with ongoing grazing.

- ***To demonstrate that grazing by domestic livestock is compatible with the conservation of the Annex I bird species breeding on Hazeley Heath (Dartford warbler, nightjar and woodlark).***
  At the end of the trial, there was no evidence to suggest that grazing had a negative impact on Annex I birds species breeding on Hazeley Heath

- ***To demonstrate that grazing by domestic livestock would be compatible with recreational uses of Hazeley Heath including access by walkers and horse riders.***
  The majority of public opinion was positive about cattle grazing at Hazeley Heath and about the possibility of extending the grazing. No official complaints were received about the livestock or infrastructure and no accidents or incidents with dogs were reported.

10. References

Atkins (undated) *Hazeley Heath Management Plan: Completion of Consultation Process Outcome D: Outline Management Plan*. Hampshire Heathland Project.

Boorman, C. (2010) The Distribution of the Four Common British Reptile Species on Lowland Heathland and Their Associated Vegetation Communities.

Brereton, T., Botham, M.S., Middlebrook, I., Randle, Z., Noble, D.G. & Roy, D.B. (2014) *United Kingdom Butterfly Monitoring Scheme Annual Report 2013.* Centre for Ecology and Hydrology and Butterfly Conservation.

Collman, J. (2009) The Significant Breeding Birds on Hazeley Heath.

Collman, J. (2014a) Hazeley Heath Grazing Trial. Summary of Results of VCA monitoring after the 5th Year.

Collman, J. (2014b) Hazeley Heath Grazing Trial: Breeding Bird Occurrence in 2014.

Dolman, P.M., Panter, C. & Mossman, H.L. (2010) Securing biodiversity in Breckland: guidance for conservation and research. *First Report of the Breckland Biodiversity Audit. University of East Anglia, Norwich*.

Dolman, P.M., Panter, C.J. & Mossman, H.L. (2012) The biodiversity audit approach challenges regional priorities and identifies a mismatch in conservation. *Journal of Applied Ecology*, **49**, 986–997.

Edgar, P. (2004) *Hazeley Heath Management Plan. October 2004 – September 2009*. Unpublished report for Hart District Council.

Edwards, M. (2012) *Entomological Report and Assessment of the Impact of Grazing on Insects at Hazeley Heath, 2012*. Unpublished report for Hampshire County Council, Hart District Council.

Grant, S.A., Torvell, L., Sim, E.M., Small, J.L. & Armstrong, R.H. (1996) Controlled grazing studies on Nardus grassland: Effects of between-tussock sward height and species of grazer on Nardus utilization and floristic composition in two fields in Scotland. *Journal of Applied Ecology*, **33**, 1053–1064.

Groome, G. (2011) *Colony Bog to Bagshot Heaths: Assessment of the Impacts of Grazing on Valley Mire and Wet Heath at Folly Bog, Surrey*. Report for Surrey Wildlife Trust.

Hall, C. (2009) A Botanical Survey of Hazeley Heath (South) (Hart District Council-owned Compartments).

Hall, C. (2013) Monitoring of Hazeley Heath (Mattingley) Grazing Trial.

Hall, C. (2014) Monitoring of Hazeley Heath (Hartley Wintney) Grazing Trial.

JNCC. (2004) *Common Standards Monitoring Guidance for Lowland Heathland*. Joint Nature Conservation Committee, Peterborough.

Lake, S. (2002) *The Role of Livestock in the Conservation of Lowland Heaths.* PhD Southampton University.

Lake, S., Bullock, J. & Hartley, S. (2001) *Impacts of Livestock Grazing on Lowland Heathland in the UK*. English Nature, Peterborough.

Newton, A., Stewart, G.B., Myers, G., Diaz, A., Lake, S., Bullock, J. & AS, P. (2009) Impacts of grazing on lowland heathland in North-west Europe. *Biological Conservation*, **142**, 935–947.

Offer, D., Mycock, J., Collman, J., Green, A. & Morrisson-Price, P. (2008) *Hazeley Heath Grazing Trial Proposals*. Hazeley Heath Interim Management Committee.

Webb, N.R. (1989) Studies on the invertebrate fauna of fragmented heathland in Dorset, UK, and the implications for conservation. *Biological Conservation*, **47**, 153–165.

Wright, R.N. & Westerhoff, D.V. (2001) *New Forest SAC Management Plan.* English Nature, Lyndhurst.

11. Appendix 1: Visitor Survey questions

2012 Questions:

1) How often do you visit the heath?
2) Why do you use Hazeley Heath? (user groups)
3) Where have you come from and how did you get here?
4) How do you feel about dog fouling?
5) Are you happy to walk through the grazing plot?
6) If not, did you often walk through the plot previous to grazing?
7) Have you changed your walking route to avoid going through the grazing plot?
8) Why are you unhappy to walk through the grazing plot?
9) **If** at the end of the 5 year trial it was discovered that grazing had significant positive benefits for the wildlife of the heath and helped towards protecting it's SSSI and SPA status, would you be happy for wider scale grazing to take place?
10) In general are you for or against the grazing on Hazeley Heath?

Surveyor to complete:

11) How many dogs?
12) Are they on leads?
13) Are they under control?

12. Appendix 2: Reptile tests

Results from binary logistic regression.
2009

Predictor	Coef	SE Coef	Z	P	Odds Ratio
Grass snake 2009 (grazed/ungrazed) Log-Likelihood = -46.882, G = 1.226, DF = 1, P-Value = 0.268					
Constant	-3.45225	0.383904	-8.99	0.000	
Ungrazed	-0.742440	0.696949	-1.07	0.287	0.48
Common lizard 2009 (grazed/ungrazed) Log-Likelihood = -206.409, G = 0.360, DF = 1, P-Value = 0.548					
Constant	-1.54756	0.174124	-8.89	0.000	
Ungrazed	0.148846	0.247976	0.60	0.548	1.16
Slow worm 2009 (grazed/ungrazed) Log-Likelihood = -197.432, G = 0.038, DF = 1, P-Value = 0.845					
Constant	-1.54756	0.174124	-8.89	0.000	
Ungrazed	-0.0500409	0.256288	-0.20	0.845	0.95

2010

Predictor	Coef	SE Coef	Z	P	Odds Ratio
Slow worm 2010 (grazed/ungrazed) Log-Likelihood = -44.223, G = 0.816, DF = 1, P-Value = 0.366					
Constant	-1.85630	0.480885	-3.86	0.000	
Grazed	0.512563	0.579933	0.88	0.377	1.67
Slow worm 2010 (grazed/ungrazed) Log-Likelihood = -37.922, G = 0.001, DF = 1, P-Value = 0.969					
Constant	-1.85630	0.480885	-3.86	0.000	
Grazed	0.0237165	0.613392	0.04	0.969	1.02
Grass snake 2010 (grazed/ungrazed), Log-Likelihood = -8.700, G = 2.001, DF = 1, P-Value = 0.157					
Constant	-23.8732	15231.6	-0.00	0.999	
Grazed	20.5410	15231.6	0.00	0.999	1 8.33348E+08

2014

Predictor	Coef	SE Coef	Z	P	Odds Ratio
Adder 2014 (Grazed/ungrazed) Log-Likelihood = -49.560, G = 0.383, DF = 1, P-Value = 0.536					
Constant	-2.35138	0.369998	-6.36	0.000	
Grazed	-0.345502	0.561060	-0.62	0.538	0.71
Slow worm 2014 (Grazed/ungrazed) Log-Likelihood = -114.160, G = 4.845, DF = 1, P-Value = 0.028					
Constant	-0.441833	0.213623	-2.07	0.039	
Grazed	-0.699339	0.320939	-2.18	0.029	0.50
Grass Snake 2014 Grazed/ungrazed) Log-Likelihood = -41.602, G = 5.917, DF = 1, P-Value = 0.015					
Constant	3.80666	0.714919	-5.32	0.000	
Grazed	1.66660	0.789224	2.11	0.035	5.29

Addition tests where results were significant at P<0.05

Predictor	Coef	SE Coef	Z	P	Odds Ratio
Slow worm 2014 by site, Log-Likelihood = -117.576, G = 4.423, DF = 1, P-Value = 0.035					
Constant	-0.835322	0.199564	-4.19	0.000	
Mattingley	-0.688174	0.333871	-2.06	0.039	0.50
Common Lizard 2014 by site, Log-Likelihood = -61.693, G = 4.893, DF = 1, P-Value = 0.027					
Constant	-2.93563	0.418942	-7.01	0.000	
Mattingley	1.09386	0.514422	2.13	0.033	2.99
Common Lizard by grazing at Mattingley only,Log-Likelihood = -37.922,G = 0.001, DF = 1, P-Value = 0.969					
Constant	-1.85630	0.480885	-3.86	0.000	
Grazed	0.0237165	0.613392	0.04	0.969	1.02