

**Comparisons of butterfly diversity at three
calcareous grasslands within Torbay.**

Steven Mayers : Liverpool John Moores University & Paignton Zoo
Environmental Park.

Natasha de Vere: Paignton Zoo Environmental Park.

steven.mayers@paigntonzoo.org.uk

natasha.devere@paigntonzoo.org.uk

Abstract

Torbay is home to the majority of calcareous grasslands within Devon. There are a number of important sites including Clennon Hill (Paignton) which is within the grounds of Paignton Zoo Environmental Park. The site is owned and managed by the Zoo's parent organisation the Whitley Wildlife Conservation Trust. This study compares the vegetation and butterfly diversity between Clennon Hill and two other calcareous grasslands in Torbay: Berryhead and the Grove.

- All sites were found to be CG3b communities within the National Vegetation Classification (Rodwell 1992), however detrended correspondence analysis shows that each site is floristically distinct.
- Clennon Hill has significantly greater plant species richness but plant diversity is similar across the three sites.
- The Grove has significantly greater butterfly species richness but butterfly diversity is similar across the three sites.
- The abundance of the larval food-plant, *Festuca ovina* in the grassland proper was negatively correlated with the abundance of adult meadow brown and gatekeeper butterflies.
- In the edge habitat the abundance of several butterfly species and nectar food-plants were correlated including a negative relationship between gatekeepers and bramble.
- The relationships found suggest the importance of a mosaic of habitat types for butterflies, containing both their larval food-plants along with areas of scrub for shelter and nectar.

Introduction

Calcareous grasslands are plagioclimax plant communities in which lime-loving plants are characteristic (pH 7.0 – 8.4). Calcareous grasslands are generally low-nutrient areas with exceptionally high plant diversity. The area of the UK covered by calcareous grassland has been declining rapidly in recent decades. The greatest threat to calcareous grasslands in the UK and Europe is fragmentation and destruction caused by under-grazing, over-grazing, agricultural intensification and urban and industrial intensification (Steffan-Dewenter, 2002). Many calcareous grasslands are now granted protection by a SSSI, NNR, AONB or CWR status, however a great deal of damage has been done. It is estimated there are 40,000-50,000 ha of calcareous grasslands remaining in the UK (ukbap.org.uk). According to Berkshire HAP (2001) between 1930 and 1984 97% of unimproved grasslands in England and Wales were lost. Furthermore in Worcestershire alone between 1980 and 1991/2 28% of the remaining unimproved grasslands were damaged and 37% lost. The loss of these grasslands has had an effect on the associated wildlife; particularly butterflies. Bourn (2002) found that butterflies are more greatly affected by habitat changes than any other order of insects. There are 59 butterfly species native to the UK, 27 of these are associated with calcareous grasslands, including 3 of conservation concern (JNCC 1992).

There are very few calcareous grasslands within Devon, they are only found in isolated areas in southern parts of the county including Plymouth and Torbay (Torbay Local BAP, 1998). Torbay is a borough of south Devon and the home of Paignton Zoo Environmental Park. Within the zoo grounds is an area of calcareous grassland which is considered to be the second most important in the borough. The site is owned and managed by the zoos parent company the Whitley Wildlife Conservation Trust (WWCT). Members of the WWCT are active members of the steering group for the local Biodiversity Action Plan which considers calcareous grasslands to be a priority habitat.

Aims and objectives

- Classify vegetation composition of three calcareous grassland sites.
- Compare butterfly and plant species richness, diversity and abundance both within and between sites.
- Relate vegetation composition to butterfly abundance, richness and diversity within and between sites.
- Recommend possible methods of improving butterfly abundance and diversity through vegetation management.

Methodology

Site descriptions

Clennon Hill is an unimproved west-facing calcareous grassland covering approximately 4500m². It is surrounded by scrub and young trees, predominately ash (*Fraxinus excelsior*). The site is grazed by pygmy goats. Berryhead is located on top of a steep sea-cliff and contains a large area of calcareous grassland. An area of approximately 2400m² was sampled for the current study. It is surrounded by stone walls and has very little scrub. The Grove site is composed of two woodland glades separated by approximately 80m of woodland. The first is approximately 104m², the second covers approximately 750m². Like Clennon Hill it is surrounded by scrub and young trees predominately ash (*Fraxinus excelsior*).

Vegetation Survey

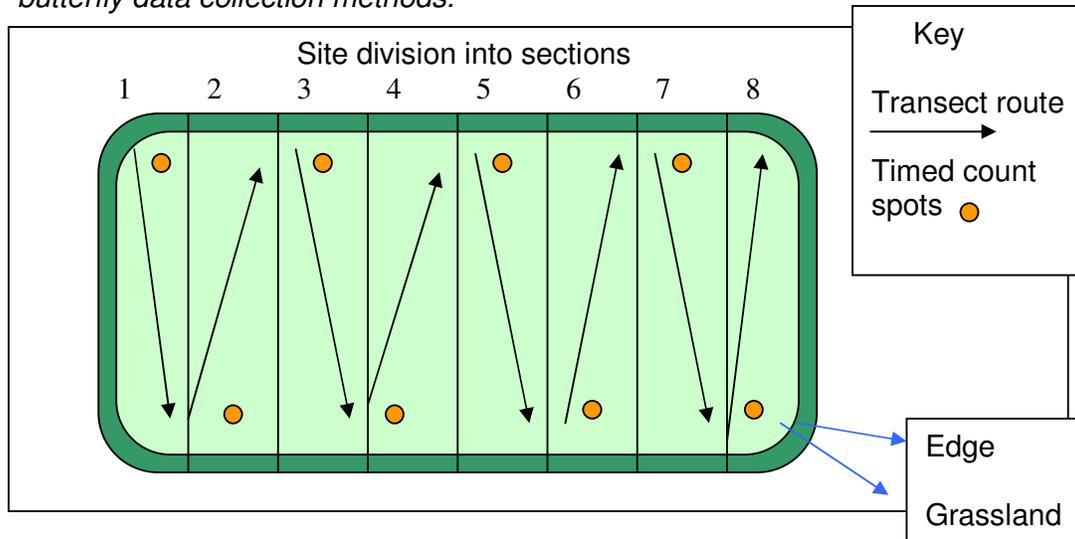
As two of the three grassland sites are essentially woodland clearings they are surrounded by scrub; this edge habitat was surveyed separately from the grassland proper. Each site was divided into 8 equal-sized sections. The 8 sections of the sites correspond to the division of the site for butterfly monitoring (figure 1). This allows within and between site comparisons of butterfly presence and vegetation. Within each section 10 quadrats were placed randomly; 5 50x50cm quadrats have been surveyed in the grassland during August 2004 and 5 2x2m will be surveyed in the edge habitat during August 2005. All plant species within the quadrats and their percentage cover were recorded.

Butterfly Survey

Data was gathered using two methods; set transects (or Pollard Walk technique) and timed counts. The transects are approximately 400m long in total, the same length at each site. These were walked weekly and the number of butterfly species and individuals within a 5m radius counted.

Timed counts involve standing at set points on a site (in this case one point per section) again noting all butterflies that come within a 5m radius. The routes are divided into 8 sections in order to find out if any particular areas of the sites are particularly species rich or poor (figure 1).

Figure 1: Schematic diagram showing division of sites into sections and butterfly data collection methods.



The data collection was split between two years. The first half was collected between 19th July until 27th September 2004. In 2005 the collection began 4th April until the 12th of July. This will give a complete set of data for the 26 weeks of the butterfly season and follows the recommendations of the Butterfly Monitoring Scheme (<http://bms.ceh.ac.uk>).

The criteria for carrying out transect and timed count surveys are:

- Conduct between 10.30am and 16.00pm.
- Temperature at least 13°C with less than 60% cloud cover, or at least 17°C if there is 100% cloud cover.
- The wind speed must not be greater than F4 on the Beaufort Scale and it must not be raining.
- Butterflies, caterpillars and pupae seen within 5m ahead, left or right of the observer are counted.

Data analysis

- Rodwell (1992) and MAVIS Plot Analyser v.1 (Smart 2000) were used to assign sites to National Vegetation Classification communities. In order to see how these sites were related to each other detrended correspondence analysis was used to produce an ordination plot. The program DECORANA (default settings) was used within the package Community Analysis 2.15 (Pisces Conservation 2003).
- The plant and butterfly species diversity were calculated using Simpson's Index. The similarity of the sites to each other in terms of both species richness and diversity was tested with One-Way ANOVA and post-hoc Bonferroni tests; both conducted in SPSS v12.

- To investigate a possible relationship between butterfly and plant abundance and diversity within sites Pearson correlation analysis was conducted in SPSS v12.

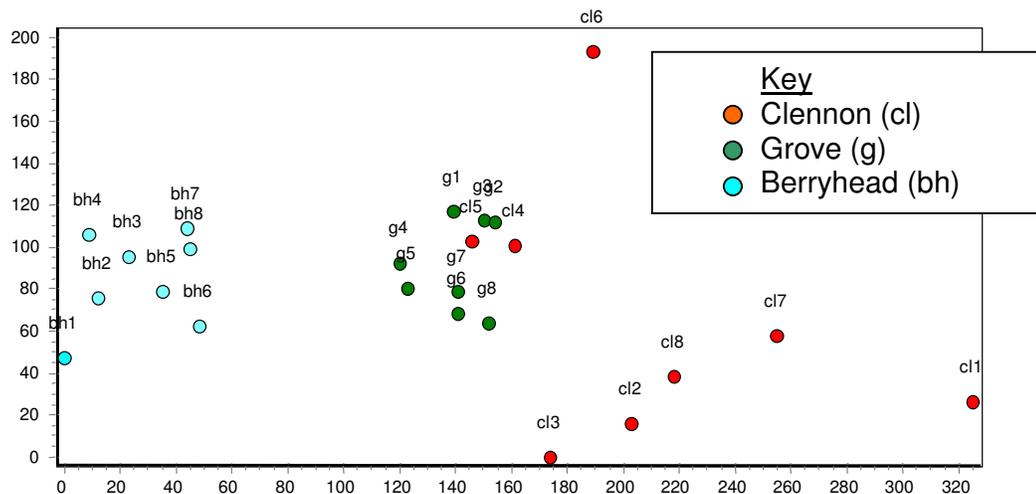
Results

Plants

All three sites correspond with the same National Vegetation Classification (NVC) community CG3b *Bromus erectus* with *Centaurea nigra* (Rodwell 1992). No *Bromus erectus* was found however in any of the sites. This may indicate that the calcareous grasslands in Torbay do not closely conform to those in other areas of the country.

Figure 2 shows an ordination plot for all three sites with each point representing one section within the grassland. It shows that although the sites correspond to the same NVC community they are none the less distinct from each other. The ordination plot shows that the Grove and Berryhead form discrete clusters suggesting relatively homogenous but distinct vegetation within each. Clennon Hill on the other hand has greater heterogeneity between the sections.

Figure 2: Detrended correspondence analysis plot of vegetation for each site section within the Grove Berryhead and Clennon Hill.



Figures 3 and 4 show the difference in plant species richness (figure 3) and diversity (figure 4) between the three sites. Clennon Hill has significantly higher plant species richness ($F = 10.365$, $P = 0.02$) but there is no significant difference between the three sites in terms of species diversity ($F = 0.555$, $P = 0.582$). This may be due to higher levels of variation in diversity within each site.

Figure 3: Mean plant species richness between sites, Grove, Berryhead and Clennon Hill.

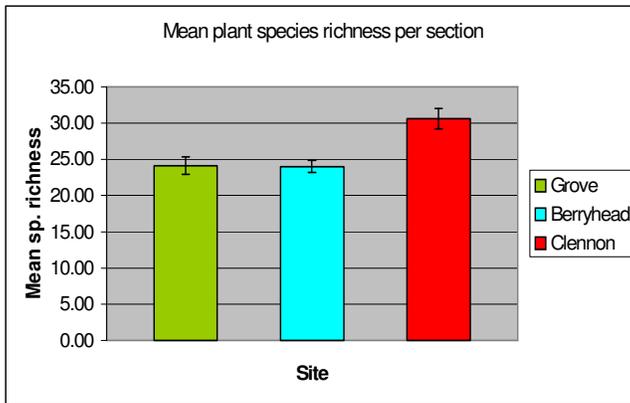
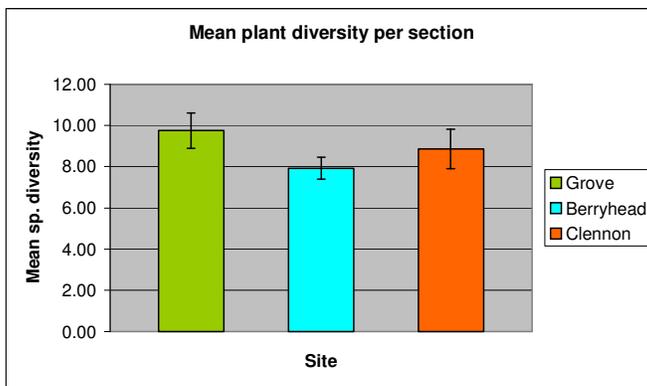


Figure 4: Mean plant diversity between three sites: Grove, Berryhead and Clennon Hill.



Butterfly results

Figures 5 and 6 show butterfly richness (figure 5) and diversity (figure 6) between the three sites. The Grove has the greatest species richness, significantly higher than that of Berryhead ($F = 8.717$, $P = 0.002$) and Clennon ($F = 8.717$, $P = 0.027$). However, there is no difference between the sites in terms of butterfly diversity.

Relationship between butterflies and plants on the grassland proper

To investigate any relationships between plant and butterfly diversity Pearson correlation analysis was conducted for each site. Butterfly data from 19/7/04 – 30/9/04 showed a significant negative correlation between butterfly diversity and plant diversity at the Grove site ($r = 0.716$, $P = 0.046$) (Figure 5). The full butterfly data from 04-05 showed no correlation ($r = 0.227$, $P = 0.589$) however this relationship was investigated further. Butterfly abundance and percentage cover of their larval foodplants were tested for a relationship using Pearson correlation and negative correlations were found between both the gatekeeper and meadow brown butterflies and their food-plant *Festuca ovina* (Figure 6 and 7).

Figure 5: Relationship between plant diversity and butterfly diversity in each section of the Grove 7/04-9/04.

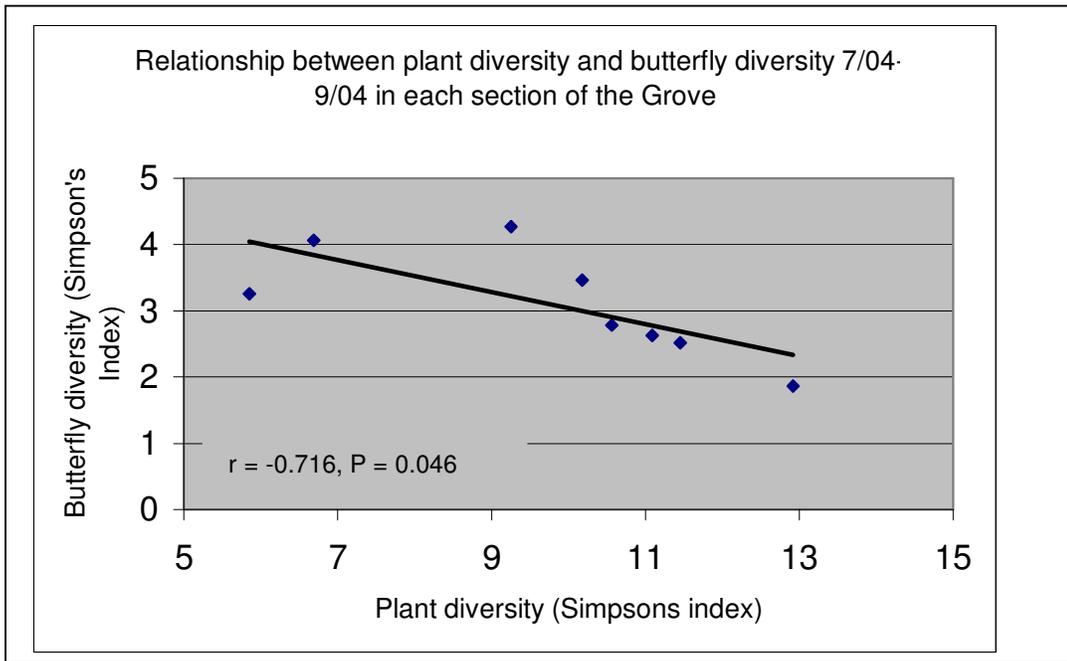


Figure 6: scatterplot showing mean % cover *Festuca ovina* against mean number of meadow browns seen 04-05 in each section of the Grove.

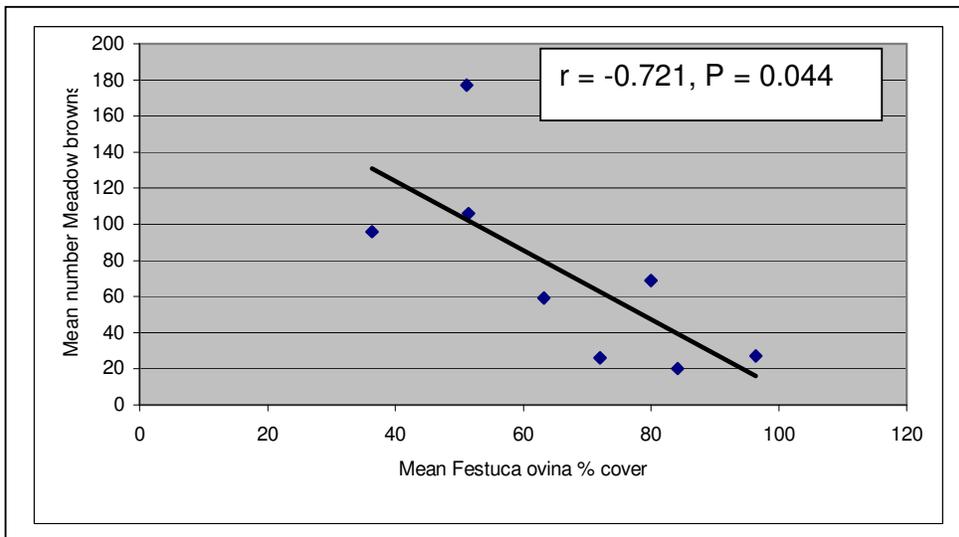
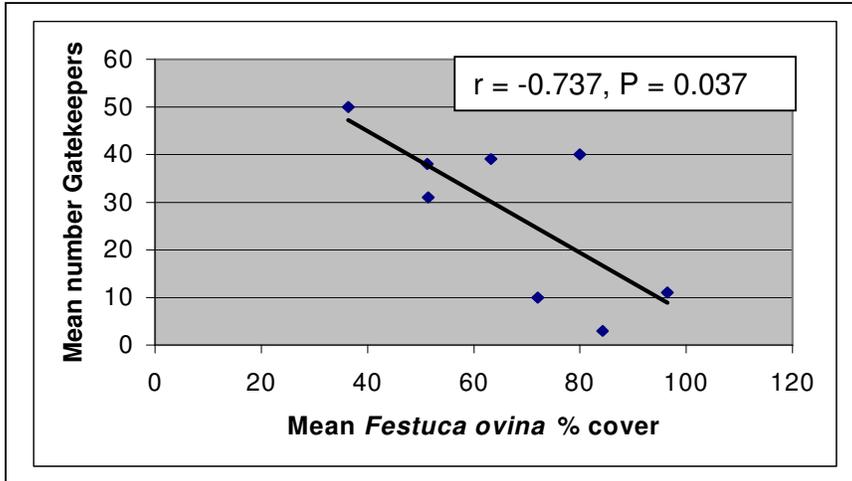


Figure 7: scatterplot showing mean % cover *Festuca ovina* against mean number of Gatekeepers 04-05 seen in each section of the Grove.



Relationship between butterflies and plants in the edge habitat

In order to test the possibility of a relationship between butterfly abundance and nectar-producing plants in the edge habitat a Pearson product-moment correlation test was used. The percentage cover of nectar-producing plant species in the edge habitat and butterfly species abundance was correlated producing several significant results on both the Grove and Clennon Hill (Berryhead has no edge habitat as such and therefore was not surveyed). The Grove has five correlations (figures 9, 10, 11, 12, 13, 14). Two significant negative correlations were found between Gatekeeper and bramble ($r = -0.768$, $P = 0.031$) and Common blue and bramble ($r = -0.725$, $P = 0.042$). Three significant positive correlations were found between Meadow brown and Ivy ($r = 0.753$, $P = 0.031$), Silver-washed fritillary and Stemless thistle ($r = 0.714$, $P = 0.046$) and Silver-washed fritillary and Spear thistle ($r = 0.861$, $P = 0.042$). Four significant correlations were found at Clennon (figures 13, 14, 15, 16). One negative correlation between Common blue and Privet ($r = -0.800$, $P = 0.017$). Three positive correlations were found between Meadow brown and Wild basil ($r = 0.782$, $P = 0.022$), Gatekeeper and Birds-foot trefoil ($r = 0.739$, $P = 0.036$) and Speckled wood and Privet ($r = 0.875$, $P = 0.004$).

Grove butterfly species abundance and edge habitat plants scatterplots

Figure 8: Scatterplot showing mean Ivy % cover against Meadow brown abundance. Grove site.

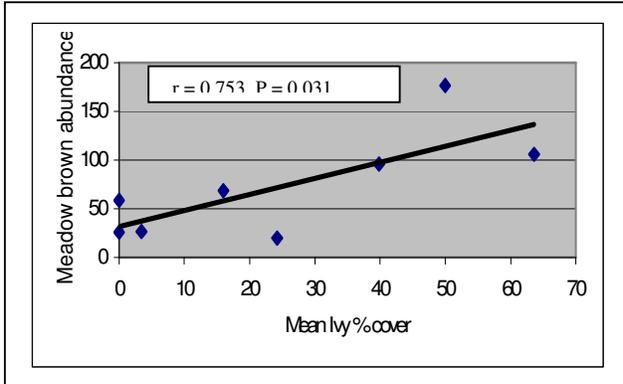


Figure 9: Scatterplot showing mean Bramble % cover against Gatekeeper abundance. Grove site.

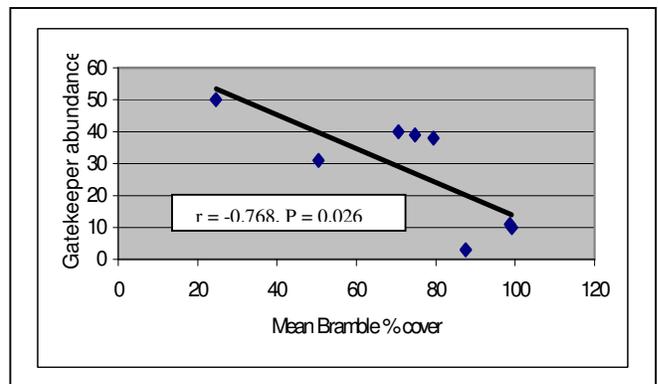


Figure 10: Scatterplot showing mean Stemless thistle % cover against Silver-washed fritillary abundance. Grove site.

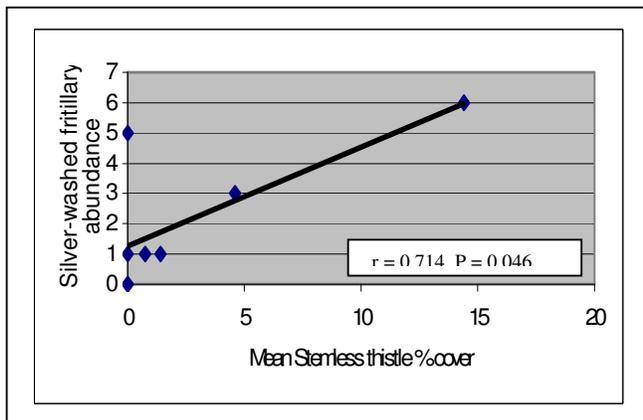


Figure 11: Scatterplot showing mean Spear thistle % cover against Silver-washed fritillary abundance. Grove site.

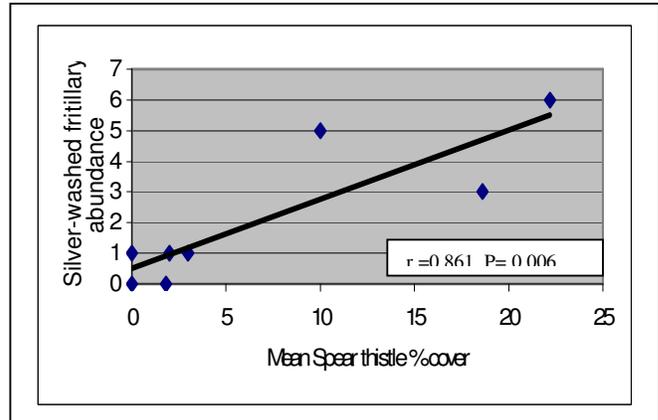
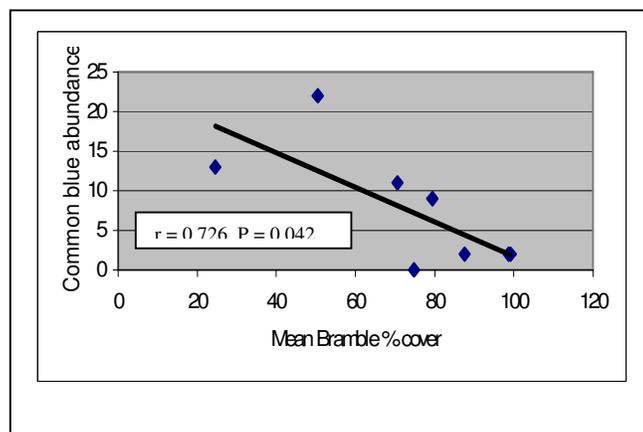


Figure 12: Scatterplot showing mean Bramble % cover against Common blue abundance. Grove site.



Clennon Hill butterfly species abundance and edge habitat plants scatterplots

Figure 13: Scatterplot showing mean Privet % cover against Speckled wood abundance. Clennon Hill site.

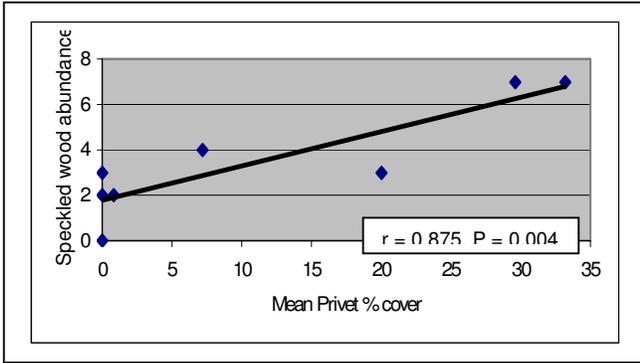


Figure 14: Scatterplot showing mean Privet % cover against Common blue abundance. Clennon Hill site

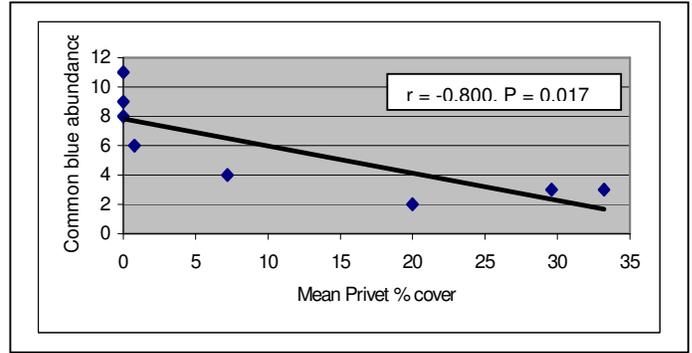


Figure 15: Scatterplot showing mean Birds-foot trefoil % cover against Gatekeeper abundance. Clennon Hill site

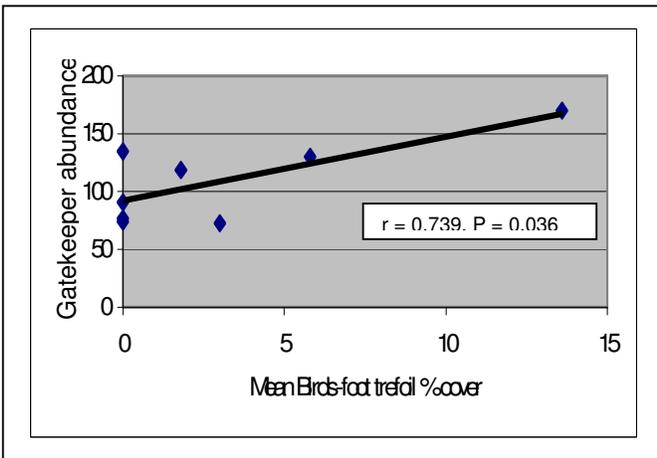
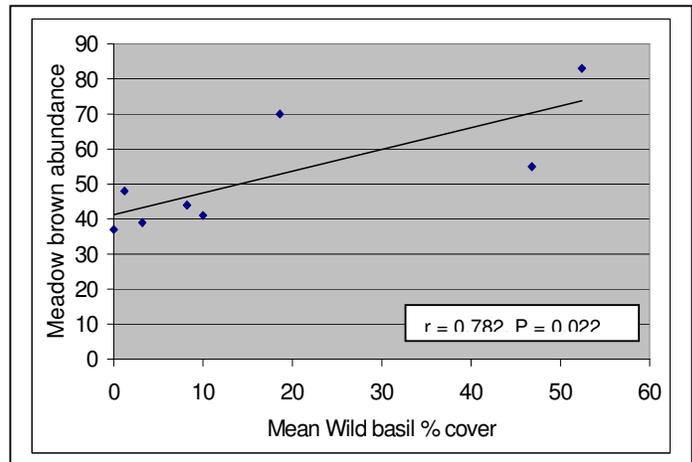


Figure 16: Scatterplot showing mean Wild basil % cover against Meadow brown abundance. Clennon Hill site



Discussion

Berryhead, Clennon Hill and the Grove have similar vegetation types (all have CG3b communities within the National Vegetation Classification (Rodwell 1992)). Clennon Hill has a greater species richness but plant diversity is similar across the three sites. Nevertheless detrended correspondence analysis shows that each site is floristically distinct. All three sites are therefore unique examples of calcareous grasslands within Torbay. All three have high butterfly species richness and diversity. It is therefore important that all three sites are conserved effectively for the plant and butterfly species they contain. The abundance of the food-plant, *Festuca ovina* was negatively associated with the abundance of adult meadow browns and gatekeepers at the Grove site. A possible reason for this negative relationship is congregations of butterflies on nectar-producing plants in the edge habitat where grassland species may be out-competed by scrub species. This was investigated and several relationships were found including bramble negatively correlated with gatekeepers. This is unexpected as it is a known nectar-plant (Thomas 1991) and personal observation has found bramble to be one of the most desirable nectar-plants to this species. However as none of the correlated species from the edge have any (known) particular importance to each other more research needs to be conducted into the nature of these relationships. These relationships suggest the importance of a mosaic of habitat types for butterflies, containing both their larval foodplants along with areas of scrub for shelter and nectar.

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