

PTES Final Report

The collateral gains for biodiversity on sites managed for a European Protected Species, the Large Blue butterfly, *Maculinea arion* in the UK

Background and Introduction

During research into the ecology of the Large blue in the 1970s, on the last remaining British site in Dartmoor, Professor Jeremy Thomas began monitoring the effect of managing habitats designed specifically for the Large Blue on a suite of other species, many which were also nationally rare. Unfortunately the Large Blue *Maculinea arion* became extinct in the UK in 1979.



Large Blue – Sarah Meredith

This project measured the impact of targeted management for the Large blue on (intrinsically-richer) calcareous grassland communities. Following successful introductions in Dartmoor, the butterfly now has been re-established on formerly-degraded, restored traditional limestone grasslands in Somerset and the Cotswolds.

Aims

1. Learn how to identify and survey a range of indicator insect species including Lepidoptera, ants and bee flies.
2. Monitor a suite of species, on a Large blue butterfly site in Dartmoor.
3. Monitor a suite of species, on Large blue butterfly sites in Somerset and the Cotswolds.
4. Collect and collate historical data collected by third parties in all three regions
5. All data will be analysed during autumn 2014 and be made available for publication.

Methods

On the sites in Dartmoor I carried out monitoring following pre-determined and established protocols, namely: timed counts of butterflies, bee flies, wood ants and beetles across the sites and assessing the abundance of key indicator plant species in permanent quadrats.

On the limestone sites in Somerset and the Cotswolds I used the same protocols to monitor a range of similar and different rare species. In addition historical data was collected for the sites from a variety of sources including: the national Butterfly Monitoring Scheme, County Environmental Records Centres and by talking to local experts.

Results

The Large blue – *Maculinea arion*

This butterfly was first recorded as a British species in 1795 and, even then, was considered a rare insect. Due to the loss of suitable habitat, the endemic subspecies of Large Blue became extinct in the British Isles in 1979, the last site being on Dartmoor in Devon (UK Butterflies 2015).



The Large blue was re-introduced back to UK in 1983 on a site in Dartmoor and the first re-introduction in Somerset was in 1992 where the butterfly still flies today. Three further introductions were carried out on sites in the Polden Hills but the most encouraging part in Somerset has been the Large blue's natural spread to 20 or so nearby conservation sites (see figure 1), some which now support high densities similar to the re-introduction sites (Thomas and Lewington 2010).



Figure 1: Distribution of Large blue sites in the Polden Hills

The Large blue butterfly is classified as Near Threatened (NT) on the IUCN Red List and is classified as Endangered in the UK (previously Extinct in the UK, re-introduced 1983). It is fully protected under Schedule 5 of the Wildlife and Countryside Act, 1981 and Listed under Annex IV of the EC Habitats Directive and Appendix II of the Bern Convention (Arkive 2015).

I have been monitoring Large blue populations in Somerset and the Cotswolds since 2010 through timed counts and egg counts. Figure 2 shows the egg population on Polden Hills Site 4 since the Large blues re-introduction in 2000.

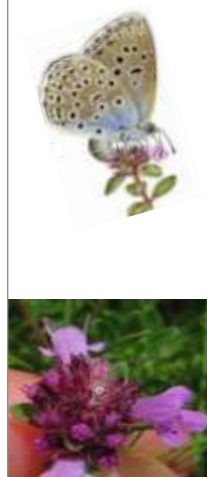
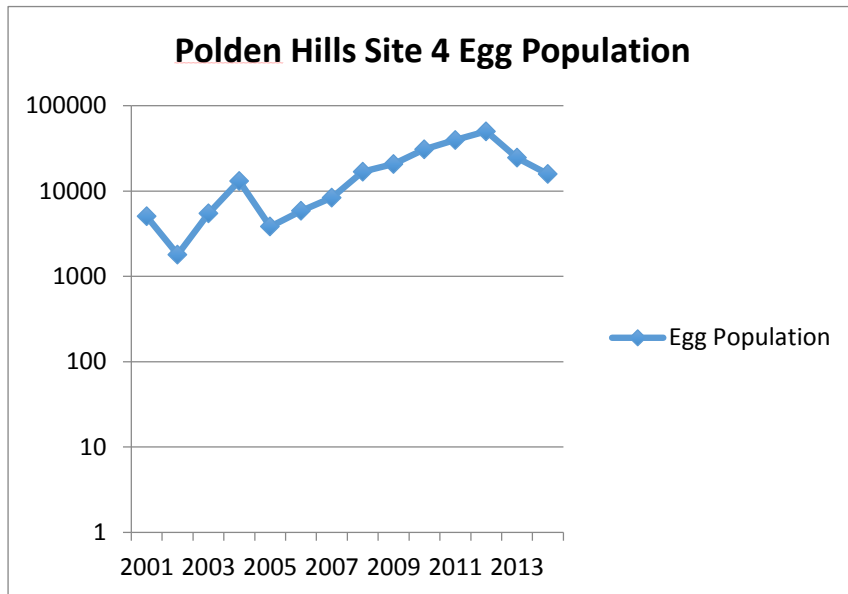


Figure 2: Large blue egg population since 2001

The Large blue egg population on Polden Hills Site 4 has been increasing steadily since 2005, due to correct grazing regimes and scrub management but have fallen over the past 2 years, through work funded by Oxford University and NERC I have been looking at phenology of the food plant and butterfly along with weather data and ground temperatures. This work has helped explain why populations in Somerset have fallen even though management of the sites continues to be excellent. In 2012 many of the sites in the Poldens were at carrying capacity and extreme weather events had a significant impact.

Figure 3 shows the increase in the Large blue egg population since re-introduction on Cotswolds Site 1 in 2011. The phenology and temperature work has also been carried out in the Cotswolds and has helped to show that weather extremes are less evident here and populations were nowhere near carrying capacity.

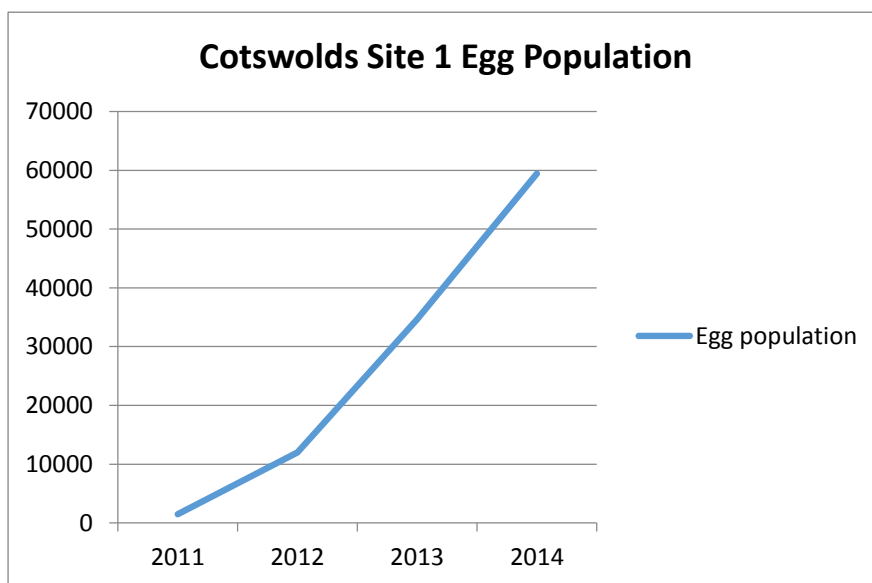


Figure 3: Large blue egg population since 2011

Ant Surveys

Ants play a crucial role within the Large blue life cycle, with the Large blue caterpillars spending 10 months of the year within the ant nests of *Myrmica sabuleti*. This is a parasitic relationship with the caterpillar eating the ant grubs, thus when managing a site for Large blues you have to manage for the ants.

Ant surveys (spring or autumn) identify the different ant species present on site and how colonies of *Myrmica sabuleti* are responding to the management prescriptions. The sward height during the spring and autumn months is critical to ensure the heat-loving ant gets the temperature required to allow maximum foraging time. The sward needs to be grazed tightly between February and late April and again between September and December as ground temperature is a product of turf height. Figure 4 shows historically how *Myrmica sabuleti* has responded to turf height and the affect this has on a Large blue population.

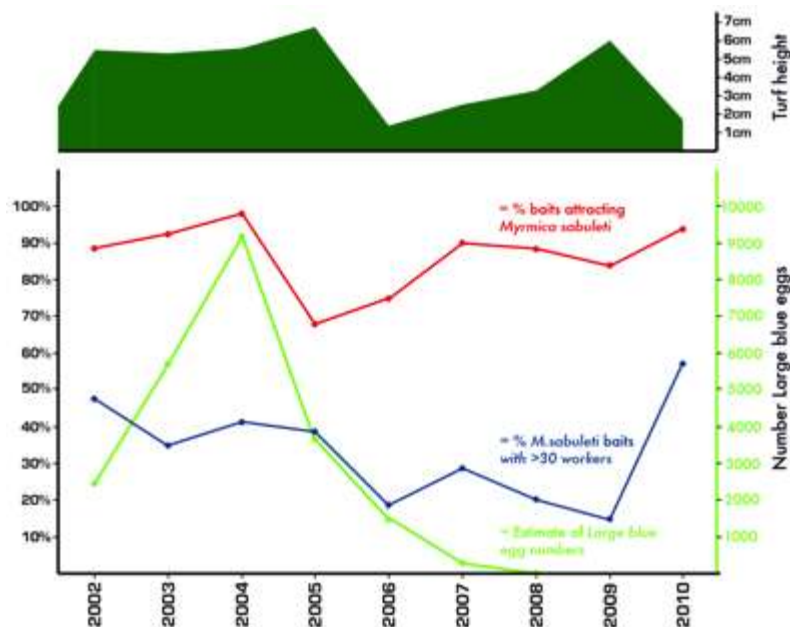


Figure 4: Historical data showing the relationship between turf height and *Myrmica sabuleti*

As turf height increases the percentage of *Myrmica sabuleti* attending baits decreases showing a decline in the number of colonies across the site, if turf height remains high over a period of time this will result in *Myrmica sabuleti* being lost from the site.

By learning to identify ants in the field and record numbers present on baits this allows advisors to alter management advice within specific areas of a site when required. Results enable maps to be produced showing the percentage of *Myrmica sabuleti* attending baits. Figure 5 shows an example of a map produced during the 2013 season; key sites where Large blues are present are baited each year and ant surveys take place on possible re-introduction sites to determine whether the ant colonies are able to support a Large blue population.



Figure 5: An example of an ant distribution map produced in 2013

The hypothesis behind ant surveys is if an egg laying Large blue female picks any random thyme or marjoram plant on a site what is the probability that it will be within the foraging range of *M.sabuleti*? So if the results show that 90% of the baits laid have *M.sabuleti* attending then there is a 9 in 10 probability that *M.sabuleti* will find a Large blue caterpillar and 1 in 10 will go into down in a nest of the wrong species of ant such as *Myrmica scabrinodis*. A presence of 60% and above of *Myrmica sabuleti* across a site will potentially support a population over a number of years, this knowledge along with other key aspects (food plant distribution, grazing levels, size and aspect of the site) help determine and identify re-introduction sites.

Identifying ants in the field is a highly skilled task and takes time and determination to learn, there are only a hand full of people in the country that are able to identify ants in the field. Different ant species are present within different areas of the country and these all need to be learnt so a true picture can be presented.

Somerset

Within the Polden Hills landscape, there are 10 key populations and another 12 sites where Large blues have been present (over a number of years) but have yet to establish sustainable populations. All these sites are surveyed regularly in relation to ant populations and maps are produced showing how the ants are responding to the management prescriptions.

Within this project 2 sites have been used as a case study showing how *Myrmica sabuleti* have increased in response to positive management, one of these sites supports a key population whereas the other supports Large blues periodically.

Table 1 shows the different ant species present within the Polden Hills with figure 6 showing ant surveys being undertaken. To identify the different *Myrmica* species in the field, you have to look at the antennae of the *Myrmica* species under an x20 hand lens, which highlights the distinguishing features of each species.

Species
<i>Myrmica sabuleti</i>
<i>Myrmica scabrinodis</i>
<i>Myrmica schencki</i>
<i>Myrmica rubra</i>
<i>Myrmica ruginodis</i>
<i>Lasius niger</i>
<i>Lasius alienus</i>
<i>Lasius flavus</i>
<i>Formica cunicularia</i>

Table 1: Ant species identified in the Polden Hills 2013 - 2014



Figure 6: Ant surveys being undertaken 2013 - 2014

Polden Hills Site 1

This site was created in 2004 after engineering works undertaken by Network Rail with advice from Professor Jeremy Thomas (University of Oxford) and David Simcox (CEH), the creation of this site was done with the Large blue in mind, food plant was seeded within a limestone flower mix. This site is adjacent to one of the key Large blue populations that has been present since 1992, during mid-summer *Myrmica* nests produce winged males and queens which embark on their nuptial flights. Whilst the males die, the now fertile queens shed their wings and look for new nest sites. This means this species has the ability to colonise new suitable habitat very quickly. It was predicated that queens would quickly find the newly created site and establish colonies, figure 7 shows how in reality this occurred.

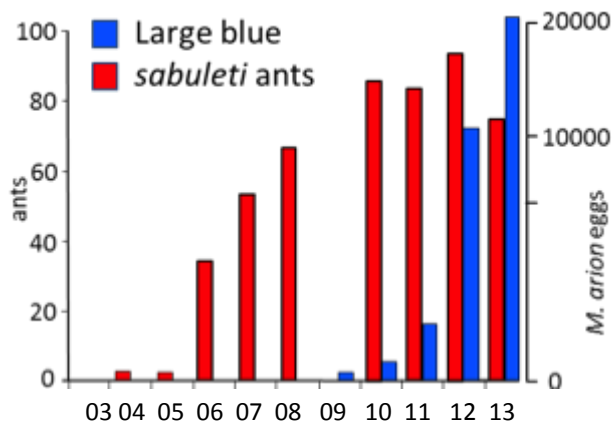


Figure 7: Colonisation of Polden Hills site 1 by *M.sabuleti*

Myrmica sabuleti did quickly colonise the site and Large blues then established themselves in 2009 and continue to fly today.

Polden Hills Site 2

This is a site within the Polden Hills that being restored from conifer plantation to limestone grassland over a 20-year period. Trees were removed and management occurred that enabled the limestone flora to recover, grazing was introduced and recently intensified to ensure conditions are suitable for Large blues. Over the past 5 years *M.sabuleti* has flourished under this management and we can show (Figure 8 and 9) that the *M.sabuleti* populations are now strong enough to support a sustainable Large blue population.



Figure 8: 2013 ant map showing percentage of *M.sabuleti* across the site

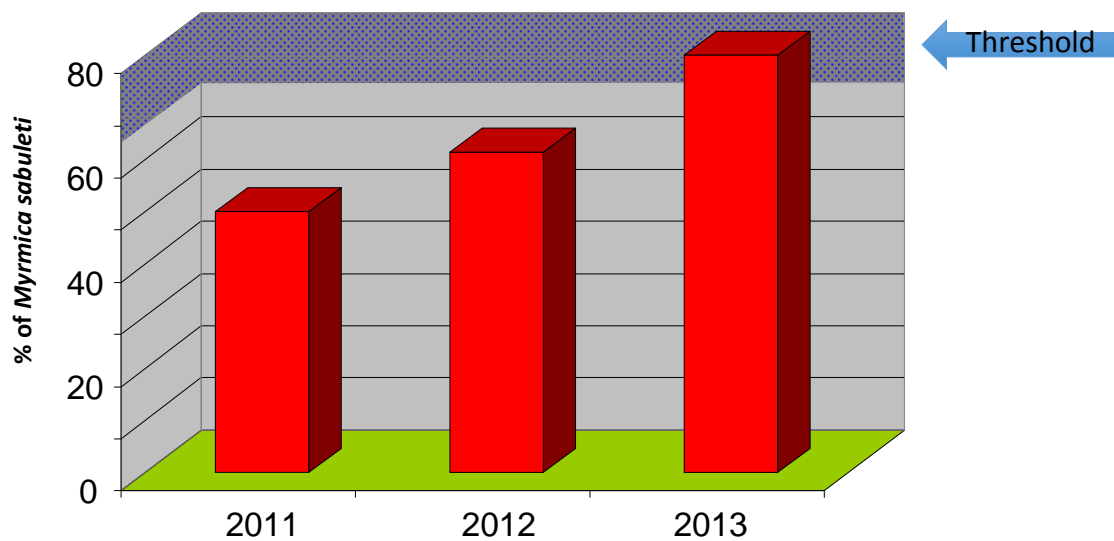


Figure 9: Increase of *Myrmica sabuleti* at Polden Hills site 2.

Cotswolds

In the Cotswolds there is a network of limestone grassland sites (10 sites) that are being managed with the Large blue in mind. Currently 3 of these sites have the Large blue flying on them, hopefully this will increase to 4 sites in 2015. Recent re-introductions have been taking place since 2010 and the Large blue has been flying successfully since 2011, 60 years since it became extinct in the Cotswolds.

As in the Polden Hills ant surveys have been crucial in providing information about the suitability of a site and whether a sustainable Large blue population could be supported. Within the Cotswolds different ant species are present to the Polden Hills, table 2 shows the species that have attended ant baits.

Species
<i>Myrmica sabuleti</i>
<i>Myrmica scabrinodis</i>
<i>Myrmica lobicornis</i>
<i>Myrmica schencki</i>
<i>Myrmica rubra</i>
<i>Myrmica ruginodis</i>
<i>Lasius niger</i>
<i>Lasius alienus</i>
<i>Lasius flavus</i>
<i>Formica cunicularia</i>

Table 2: Ant species identified in the Cotswolds 2013 -2014

Cotswolds Site 1

The Large blue was re-introduced to this site in 2010 and Large blues have flourished over the past 3 years. Historical data before this project started showed that *M.sabuleti* were in good numbers to support a sustainable Large blue population.

This is a unique site in that both Wild Thyme and Marjoram are present in high densities across the site (figure 10 shows the distribution of both food plants). During this project I had the opportunity to look at new areas of habitat across the site where traditionally Large blues wouldn't have been able to utilise but due to climate change *M.sabuleti* is now able to colonise and survive.

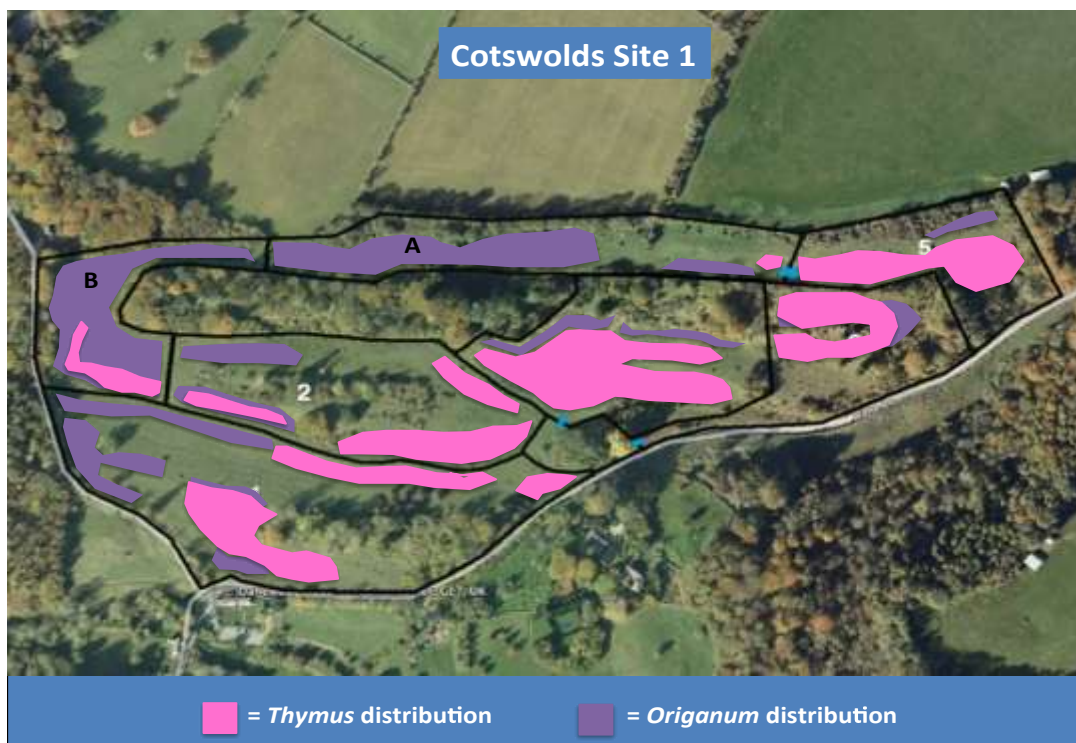


Figure 10: Distribution of Thyme and Marjoram across Cotswolds Site 1



Ant surveys were undertaken in area A and B of the site, this area was not assumed to be potential breeding area when the Large blue was re-introduced in 2010 as *M.sabuleti* had not been present in sufficient numbers over the previous 10 years (Figure 11 shows the habitat in more detail). Historical data from Somerset showed that *M.sabuleti* was extending in new habitat areas.

If the ant surveys produced good results from the *M.sabuleti* point of view then management advice for this area of site would alter, such as increase in grazing pressure, more extensive grazing and removal of some scrub.

Ant baits were placed under or close to Marjoram and the results were outstanding, 95% of the baits attracted *M.sabuleti* and the numbers of individual ants attending were high showing that not only were there populations present but big colonies that could support the Large blue over a period of time.



Figure 11: Large blue habitat

These results have now allowed that the correct management practices to be put into place to ensure sustainable *M.sabuleti* populations can thrive.

Other species benefiting from Large blue management

Cotswolds Site 1

Cut-leaved germander - *Teucrium botrys*

This species declined in the UK after the 1930s, and is currently known from just six sites (figure 12) in the south of England, having disappeared from another nine. Five out of the six known UK populations occur within Sites of Special Scientific Interest (SSSIs), and two sites are managed by local Wildlife Trusts; they therefore receive a degree of protection. Cut-leaved germander is classified as Vulnerable in Great Britain and fully protected under Schedule 8 of the Wildlife and Countryside Act, 1981.

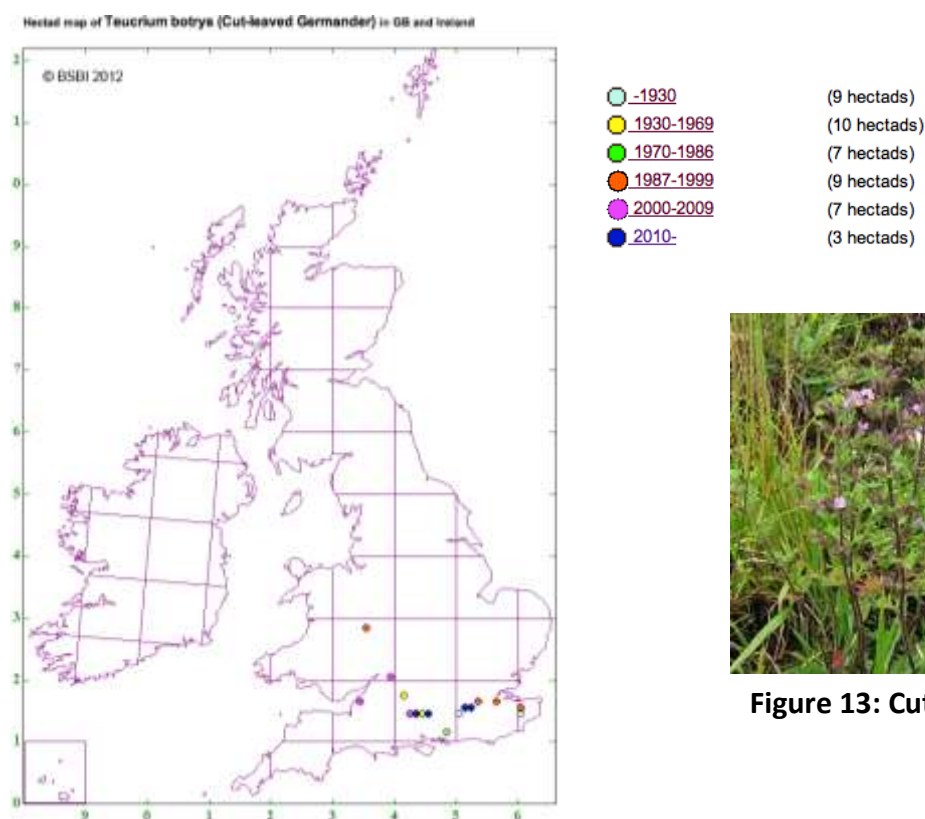


Figure 13: Cut-leaved germander

Figure 12: Distribution of Cut-leaved germander in the UK (BSBI maps 2015)

Cut-leaved germander is characteristic of open, disturbed sites and usually occurs on fairly bare soil (figure 13). It is very tolerant of drought but not shade. The seeds are heavy, and fall close to the parent plant, so the species is not a very good coloniser of new suitable habitats

Cut-leaved germander is present at Cotswold Site 1 and has been expanding across the site over the past few years. It was once confined to a 2m x 2m patch which is now unsuitable but in spring 2010 a dewpond was created, to help facilitate extensive grazing, at the top of the site. This disturbance allowed the right conditions to enable seeds with the existing seed bank to germinate. Since 2010 the plant has been thriving with up to 45 plants being recorded, in 2014 the plant was recorded in a new part of the site away from the dewpond where scrub clearance and a fire had occurred (figure 14). Increased grazing pressure for the

Large blue now also ensures that the right conditions for Cut-leaved germander are present keeping the sward short and open.



Figure 14: Cut-leaved germander discovered in a new location July 2014

In 2014 one Frog orchid and two Fly orchids were recorded on the site for the first time since 2008 (figure 15 shows the different orchid species present on Large blue sites, appendix 1 shows other species that have benefited from Large blue management), Green-winged orchid continues to make an impressive display each year with over 600 being recorded in half an hour in 2013 and 2014.



Figure 15: Orchid species present on sites managed for Large blues

Cut-leaved Selfheal - *Prunella laciniata*

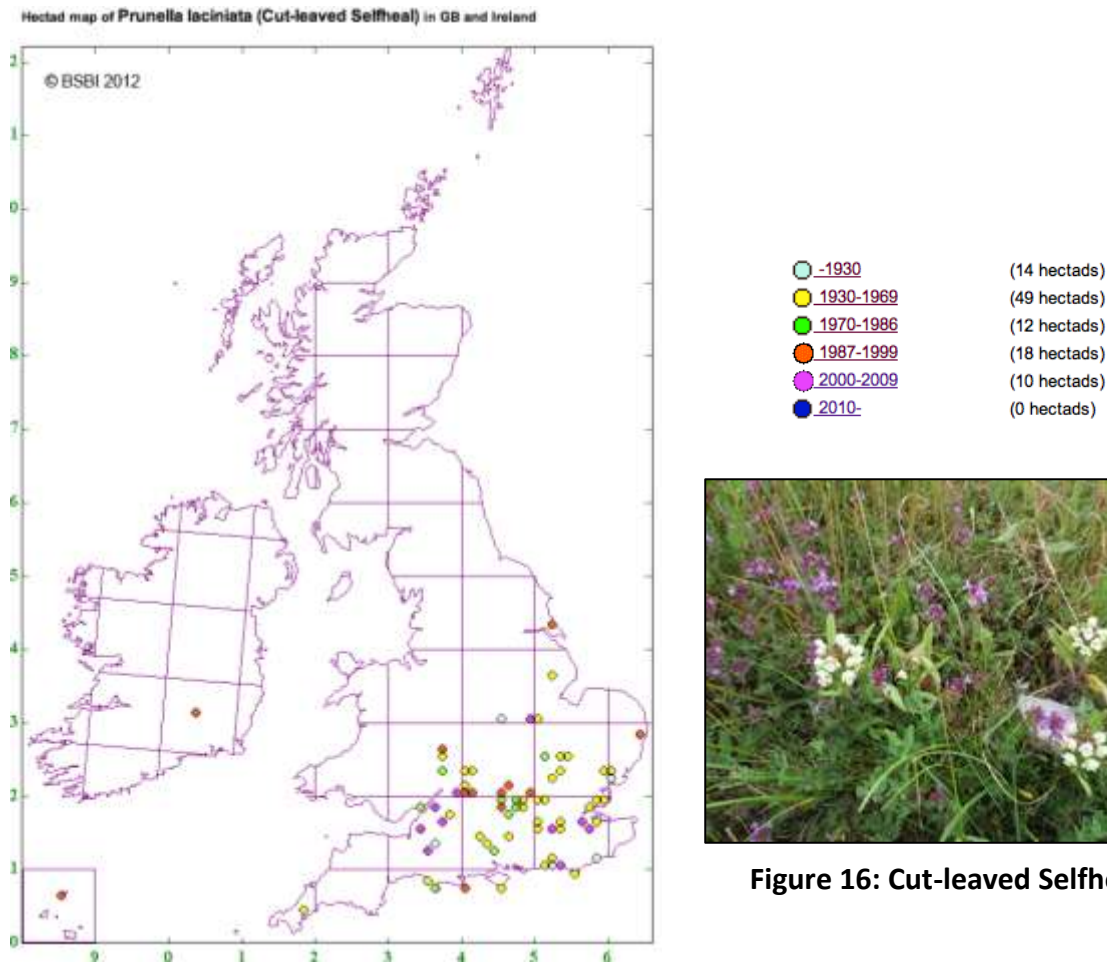


Figure 16: Cut-leaved Selfheal

Figure 17: Distribution of Cut-leaved Selfheal in the UK (BSBI maps 2015)

Cut-leaved Selfheal (figure 16), *Prunella laciniata*, is present on Cotswolds site 1 and was first recorded in 2004, it is nationally rare (figure 17) and was first described as a British plant from Somerset by James W. White in 1906. It can also be found on Polden Hills site 3 where the Large blue has been flying since 1992, Cut-leaved Selfheal was first discovered here in 1966 and in the same year it was discovered that it had hybridized with Selfheal, *Prunella vulgaris*, this hybrid, *Prunella x intermedia*, is still present today and unlike many sites in Somerset today Cut-leaved Selfheal and the hybrid exist side by side (Figure 18). The hybrid is believed to contribute to the disappearance of *P. laciniata*, the species being “hybridised out of existence”. At Cheddar and Polden Hills site 3, however, the species has persisted alongside the hybrid, for around a century in the case of the Cheddar population (Crouch, H.J. 2015).



Figure 18: *Prunella x intermedia* present on Polden Hills site 3 in 2014

Not only have the floral species benefited from Large blue management, other butterfly species have responded well on the site. Figure 19 shows how the number of species recorded across the site has increased since Large blues were re-introduced in 2010.

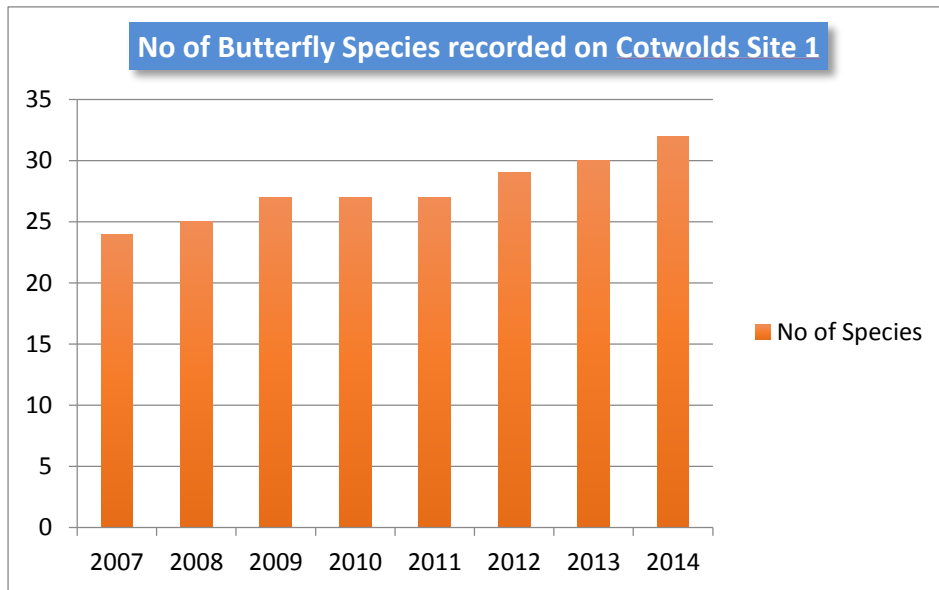


Figure 19: Number of butterfly species present on Cotswold Site 1

$P = <0.001$; $R\text{-sq} = 97.6\%$

This shows statistically that there is a highly significant trend of increasing numbers of butterfly species over the study period at Cotswold site 1.

Cotswolds site 2

The Large blue was re-introduced to Cotswold Site 2 in 2010, the same year as Cotswold site 1, this is the only site in the UK that has Adonis blue, Chalkhill blue, Small blue, Brown Argus, Common blue, Holly blue and Large blue flying on it (figure 20), this is 7 out of the 8 blues present in the UK.



Figure 20: Six of the seven blues to found flying on Cotswolds site 2

In 2011 Fly orchids appeared for the first time in living memory after clearance of scrub and mature trees, as with Cotswold site 1 grazing pressure was increased to ensure the right conditions were present for the Large blue. The Fly orchid is now well distributed across the site with up to 30 to 35 plants being present in 2013 and 2014, in both these years the Fly orchid appeared in new areas of the site but also continued to show a strong presence in existing areas. In 2013 a Wasp orchid was discovered and Bee orchids are present in good numbers across the site.

Dartmoor

Since the early 1970's sites in Dartmoor have been managed with the Large blue in mind, other key Biodiversity Action Plan (BAP) species on these sites include Pearl-bordered fritillary, Small Pearl-bordered fritillary, High Brown fritillary, Grayling, Tiger beetle, Wood ant and Western beefly. Professor Jeremy Thomas and David Simcox have monitored these species over a 40-year period, this has allowed relative changes in populations to be monitored closely. Through this project I undertook surveys of all these species, initially learning how to identify them and then carry out time counts during their flight periods. Figure 21 and 22 shows the results of the monitoring over the past 40 years in relation to when targeted management for Large blues started.



Pearl-bordered fritillary



Small Pearl-bordered fritillary



Western beefly



Tiger beetle

Relative changes (log scale) in BAP butterfly species' numbers at Hembury following the start of targeted management for the Large blue on sites X, Y & W (data for Hembury Castle not plotted)

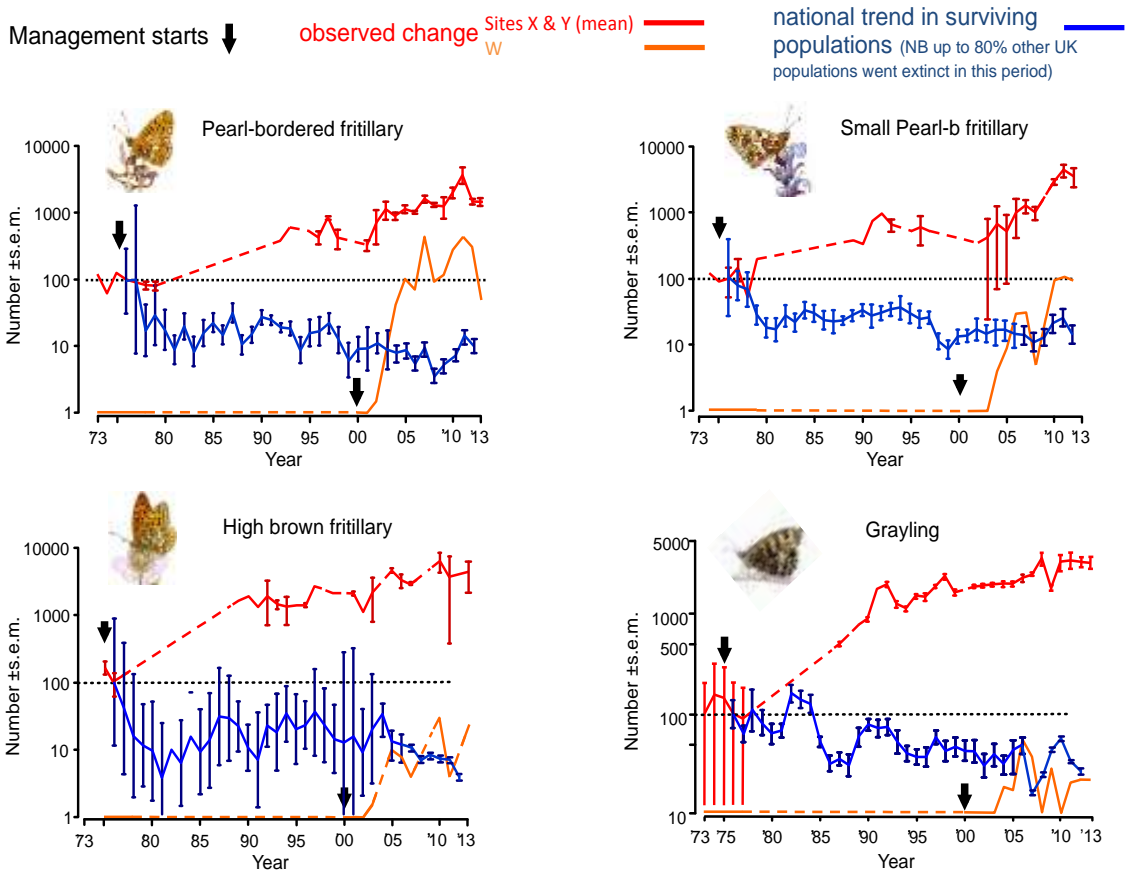


Figure 21: Results of Dartmoor surveys on Lepidoptera over a 40-year period

Targeted conservation for *Maculinea arion*: impacts on (a) Tiger beetle, (b) Wood ant, (c) Western beefly

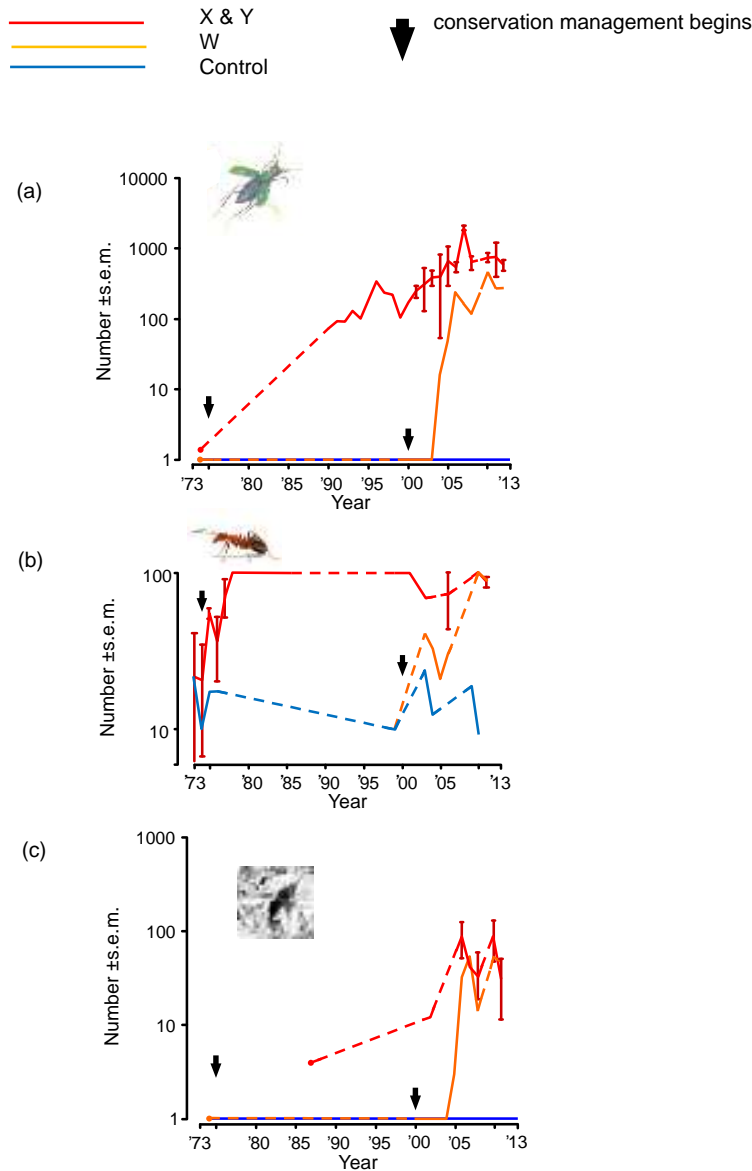


Figure 22: Results of Dartmoor surveys on Tiger beetle, Wood ant and Western beefly over a 40 year period

These results show that as targeted management for Large blue started on these Dartmoor sites the other rare BAP species flourished and are going against the national declining trend. By having a 40-year data set this allows a true picture to be seen for these species and puts into context how a species can decline one year but bounce back the following year.

Pale heath-violet - *Viola lactea*

Pale heath-violet (figure 23) is a species of humid heathland and grass heath (including the culm grasslands), favouring areas with short vegetation and considerable bare ground created by burning, grazing or incidental disturbance

This heathland species had already experienced a severe decline prior to 1930, but this has continued and it has disappeared from much of its former range relatively recently, particularly in SE England. Pale heath-violet is extinct in Kent, Surrey, Middlesex and Buckinghamshire and there are no recent records from Gloucestershire. Figure 24 shows the distribution since the 1900's.

It is classified as 'Vulnerable' in The Vascular Plant Red Data List for Great Britain 2005 due to the magnitude of the decline in its range and area of occupation (population size reduction of $\geq 30\%$ over the last 10 years (JNCC 2015)) and it is a Nationally Scarce species.

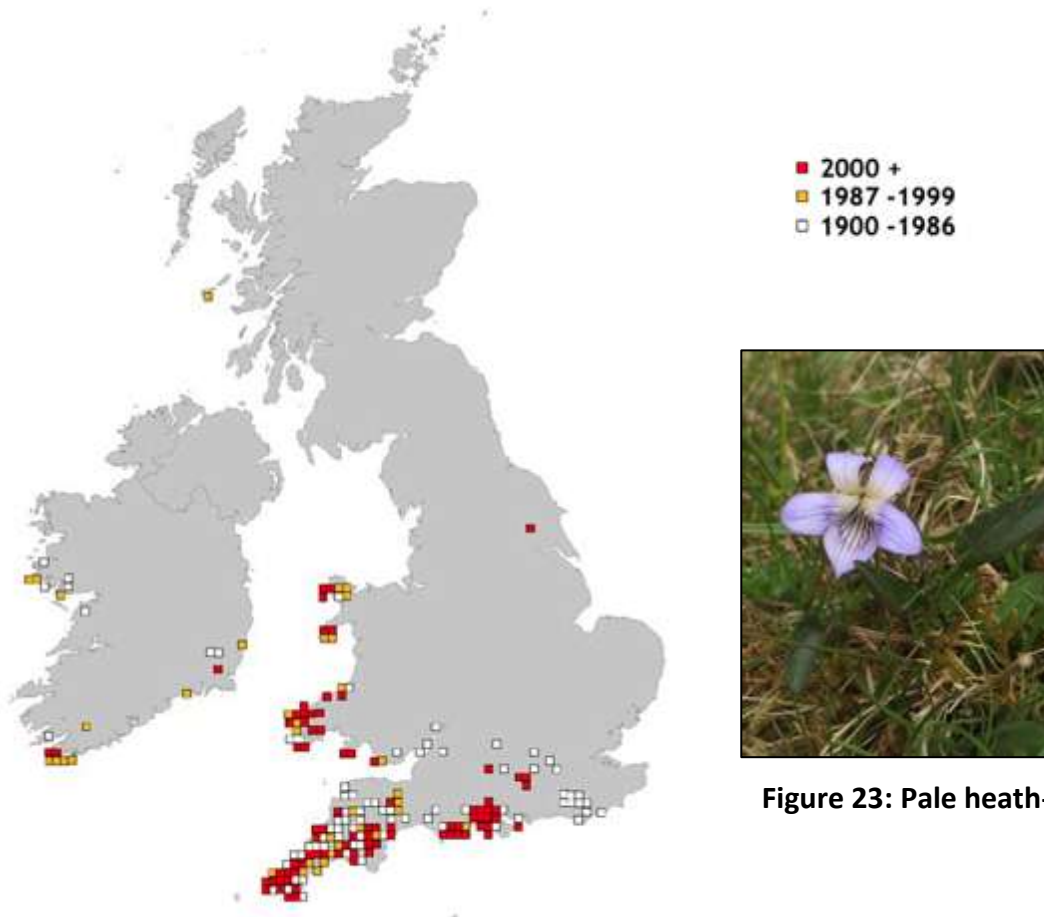


Figure 23: Pale heath-violet

Figure 24: Distribution of Pale heath-violet in the UK (Plantlife 2015)

Pale heath-violet is present on the Dartmoor sites and like the Lepidoptera and other insect species this plant species has benefited from targeted Large blue management. Results show that over the 40-year monitoring period Pale heath-violet has increased 60 fold across the site (figure 25) and plant species by m^2 have increased (figure 26). Increased grazing pressure and burning of older stands of gorse have ensured that there is a short sward length with areas of bare ground for seed germination.

Seeds of pale dog-violet can remain viable within the seed bank for decades (albeit often in

small quantities), so any efforts to maintain and reinstate burning and grazing on heathland are likely to benefit the species and may result in the reappearance of lost populations (Plantlife 2015).

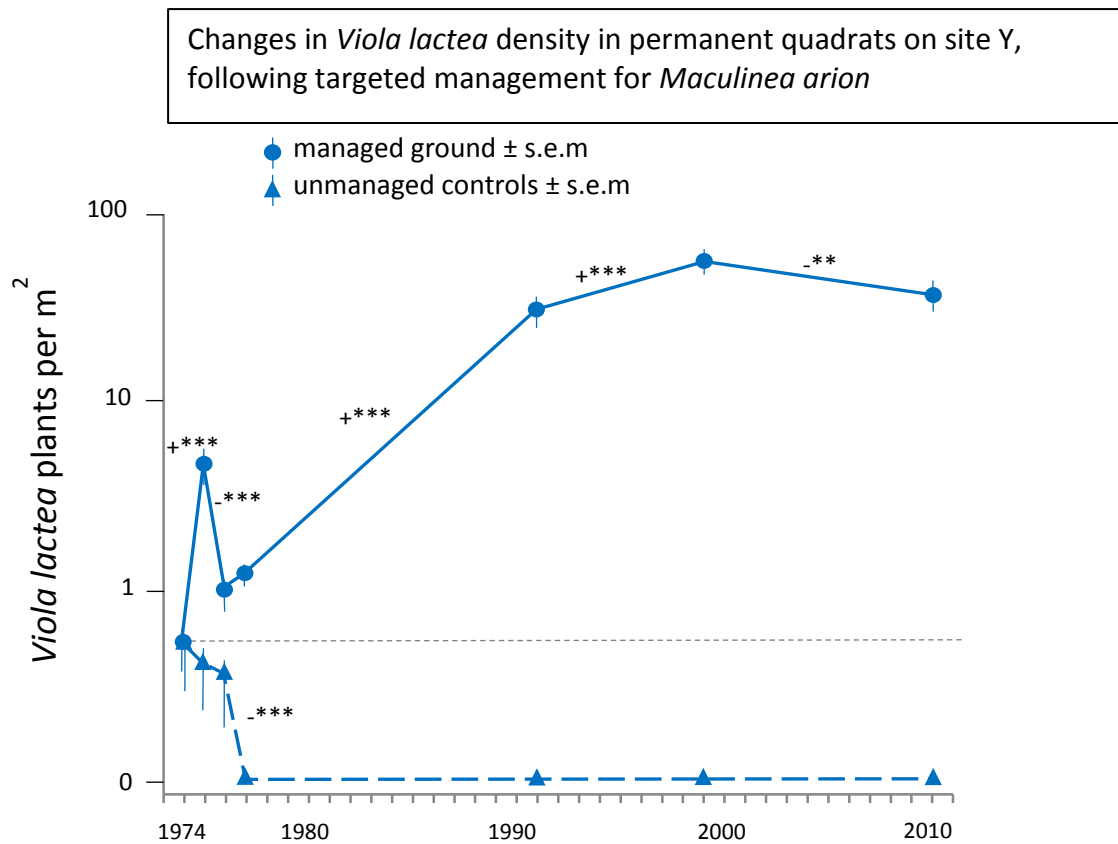


Figure 25: Increase in *Viola lacetea* since 1974 on site Y in Dartmoor

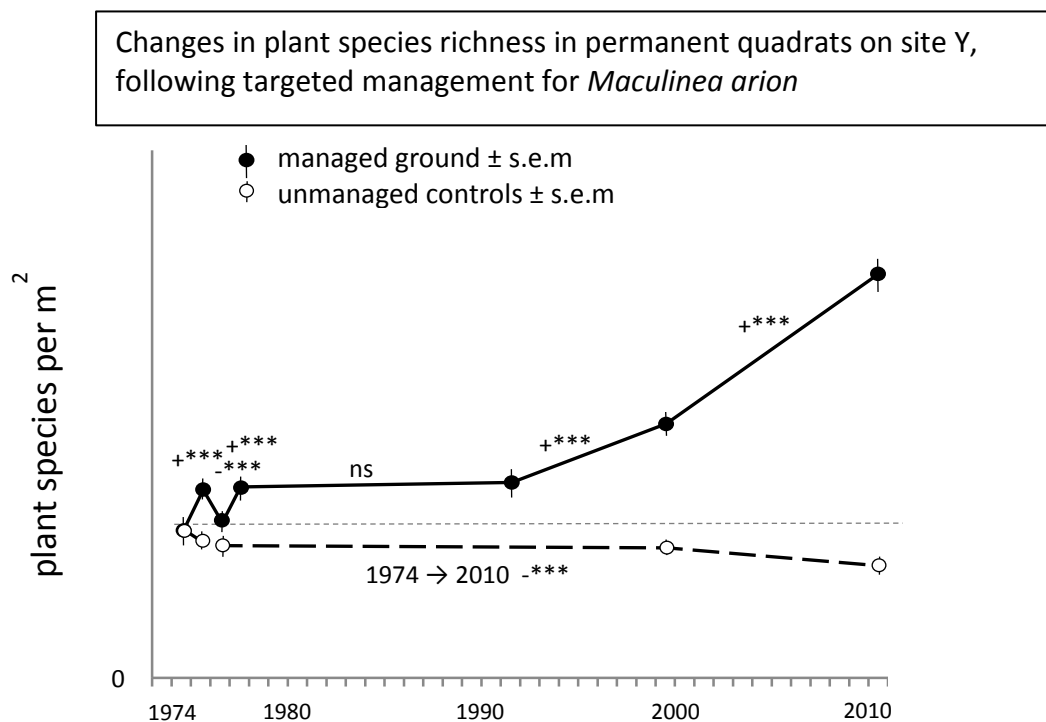


Figure 26: Increase in plant species per m² since 1974 on site Y in Dartmoor

Conclusions

Through this project I have been able to show the benefits of managing sites for Large blues, with many other species increasing in number and distribution on Large blue sites. Managing for the Large blue is not just single species management, a whole suite of flora, Lepidoptera and other insects' benefit.

This is encouraging when thinking to the future, as hopefully when further sites within the Polden Hills and Cotswolds landscape are included into the Large blue project many other rare species will flourish as they already have on the sites that have been looked at during this project.

This project has also shown the importance of long data sets and having the ability to look back and analyse how certain species have fared such as Tiger beetle in Dartmoor or Pale heath-violet, this allows the monitor, manage, monitor approach to be taken, letting science guide conservation management.

References

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Appendix 1



Other species benefiting - Dartmoor



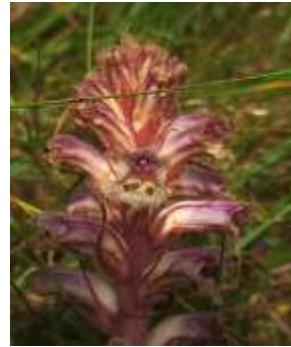
A selection of other species in Dartmoor benefiting from Large blue management



Other species benefiting - Cotswolds



A selection of other floral species in the Cotswolds benefiting from Large blue management



Other species benefiting - Somerset



A selection of other floral species in Somerset benefiting from Large blue management