Bilberry bumblebee *Bombus monticola* *C.Edmondson*

Beewalk Report 2019

Bumblebee monitoring in hay meadows across the Yorkshire Dales and Forest of Bowland AONB

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View across the transect at Myttons Farm, Slaidburn, June 2019, CE

1. Introduction

Bumblebees, and in fact many pollinators, have been declining in numbers over the last few decades. Driven by many contributing factors, such as modern farming practices, higher use of pesticides throughout the world, climate change and loss of habitat. Bumblebees are a good "indicator" species, to determine the quality of foraging habitat present for pollinating insects.

The remnant traditional hay meadows of the Yorkshire Dales and Forest of Bowland have had support from the 'Hay Time', 'Meadow Links', 'Networks for Nectar' (N4N), 'Wild Flowers for the Meadows', and this years' "Hay Time Rescue" projects of Yorkshire Dales Millennium Trust (YDMT) and Forest of Bowland Area of Outstanding Natural Beauty (AONB), for restoration projects to improve their floral diversity. These traditional species rich hay meadows are a vital resource for pollinators in the countryside. Since 2006 our projects have undertaken restoration works on more than 700 hectares, aiming to increase the area of traditional hay meadow by 70% over the remnant 1,000 hectares in the region. The most common restoration method has been transferring green hay from nearby donor sites, enhanced by locally sourced seed in some meadows (St. Pierre 2016, Robinson 2015).

The Bumblebee Conservation Trust (BBCT) initiated a citizen science project 'Beewalk' in 2010 to collect much needed diversity and abundance data of bumblebee populations across the country. YDMT incorporated the 'Beewalk' scheme into these meadow restoration projects through 'A Buzz in the Meadows' in 2015 as a means of monitoring the success of the hay meadow restoration in terms of forage habitat for pollinators. Additional sites were added in the Forest of Bowland AONB in 2016. This has enabled the capture of 6 seasons' bumblebee foraging data to date.

2. Methodology

The study area for the 2019 bumblebee monitoring in these hay meadows included 59 transects over 19 sites across the Yorkshire Dales and Forest of Bowland AONB (fig.1). Sites were surveyed between mid-June and the end of July 2019 to encompass the flowering times for meadow flora, emergence times of bees and the cutting of the hay crop at the end of July.

Training on the methodology of transects and bumblebee identification was given for 'Beewalk' volunteers prior to the start of the data collection period, including a sample transect to monitor the ability of the volunteers at the end of the training. Transects for this study were walked by 29 volunteers.

Hay meadow transects are ideally walked on 4 to 6 occasions from mid-June to the end of July (when the hay is cut). All bumblebee species observed within 2m either side and up to 4m ahead of the surveyor were recorded, whilst walking at a slow pace, between 09.00h and 18.00h, on days with no rainfall, wind speed less than 10 ms-1 and minimum temperature of 13°C; i.e. favourable conditions for bumblebee foraging and following The BBCT Beewalk protocol (BBCT, 2019).

Weather conditions were recorded to ensure data collection fell within the required parameters. Transects passed through different meadow types so each was subdivided into sections accordingly.

The workers of the white-tailed bumblebee *Bombus lucorum* and buff-tailed bumblebee *Bombus terrestris* are notably difficult to separate in the field and therefore, in common with other field-based bumblebee studies (e.g. Goulson *et al.,*2014), they were recorded as a single taxon. Unidentified bumblebees are included in the data analysis simply as bumblebee *Bombus,* but is excluded from species richness data analysis. A small number of cuckoo bumblebees were recorded but also excluded from the data analysis.
Where a bumblebee was recorded on a flower, the plant species was also recorded to provide information on bumblebee foraging habits across the hay meadows. Those seen flying were recorded as "In flight".
Due to sections of transects differing in length, the count on each section was converted to bumblebees per 1,000 metres of transect. This enabled the count data to be comaparable across transect sections and habitats.

The meadows were categorised as follows for comparison between habitat types:

Ancient (*n* = 39): Traditional hay meadows that have been maintained by a management regime of one hay cut per annum at the end of July or later, low stock grazing in autumn and spring, and no inorganic fertiliser treatment. This category includes some semi-improved grassland.

Modern (*n* = 4): Agriculturally improved hay meadows, usually cut once per annum, with organic and/or inorganic fertiliser treatment, and more intensive grazing in autumn through to spring; some may have remnant hay meadow species, often in refuges on the field margins which escape management. Some meadows in this category are permanent pasture. This category is also used to provide a baseline survey for meadows identified for future restoration.

Pasture (*n=3*): Permanent pasture usually grazed by sheep for most of the year. Some pasture with lighter grazing can be floristically diverse.

Restored (*n* = 13): Previous agriculturally improved hay meadows that have been restored and now managed as per Ancient meadows. Restoration methods varied across the meadows according to what was locally practicable, most commonly using green hay. Following the pre-treatment of restoration sites with crop removal and harrowing, green hay was collected from nearby donor meadows during late July to August (some of which are included in the "Ancient" meadows for this study), then transported and spread within an hour to avoid heating the crop. The transfer rate ranged from 1 ha donor:3 ha restored, to 1 ha donor:5 ha restored. In most sites the flora successfully established but occasionally seed, again harvested from nearby meadows, was added to enhance species richness and abundance in the following year (Robinson 2015, St. Pierre 2016). The year of restoration ranged from 1992 to 2016 but the majority (*n* = 10) were surveyed only one to three years post-treatment.

All records were entered into the BBCT online Beewalk dataset. The data were then collated and analysed in Microsoft Excel, from the raw data provided by Dr. Richard Comont at BBCT.

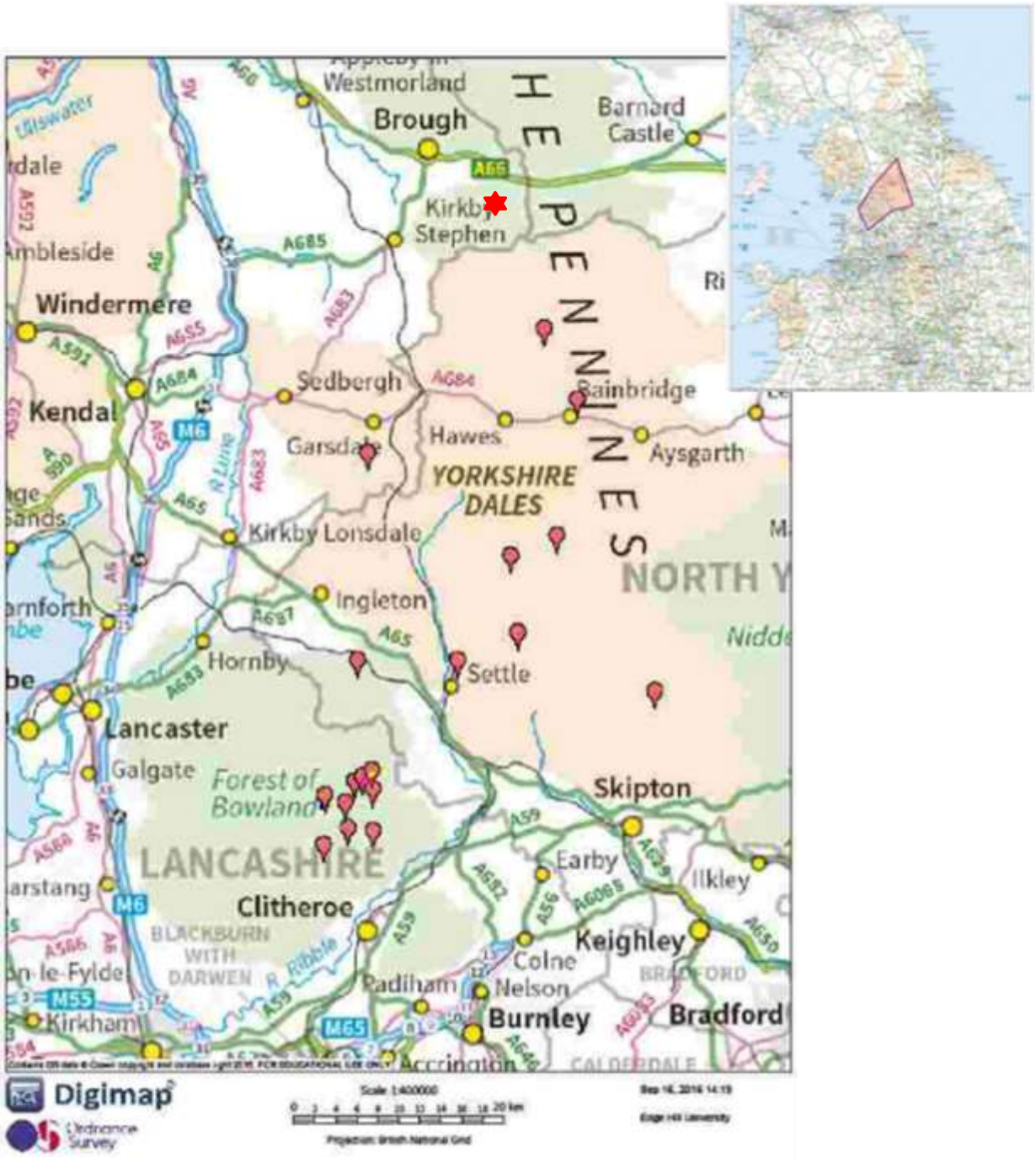


Figure 1. Bumblebee survey sites across the Yorkshire Dales and Forest of Bowland AONB shown at markers. 2019 additional transect shown at ✸

Inset: overall survey location within the UK (Digimap, 2016).

3. Results

3.1 Abundance

The total number of bumblebees recorded across all the sites surveyed, including three cuckoo species, unidentified bumblebees and those in flight, was 2,110. This equated to 39 bumblebees per 1000m of 53680m transect surveyed.

The site with the highest number of bumblebees per 1000m recorded in 2019 was Muker meadows in Swaledale, North Yorkshire, an Ancient hay meadow site. Dent meadows, in Dentdale; and Myttons Farm in the Forest of Bowland meadows, both Ancient meadow sites; also recorded high numbers per 1000m. Tenant Gill Farm in Malham; an Ancient meadow site, and Yockenthwaite meadows; a mixed Modern and Ancient site, recorded the lowest numbers (fig.2).

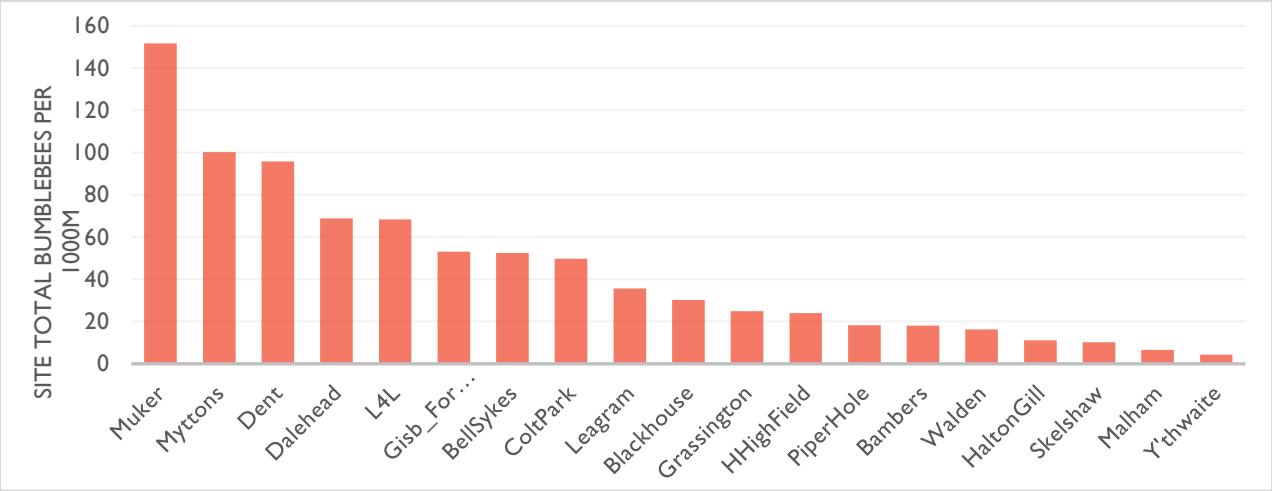


Fig.2: Total bundance of bumblebees. per 1000m of transect recorded across all sites (n=16) surveyed June to July 2019 in Forest of Bowland AONB and Yorkshire Dales

3.2 Abundance of each species

A total of 11 different species were recorded (white & buff -tailed separated) across all sites.

All seven of the more widespread and common bumblebee species were recorded (Goulson *et al*., 2005), in addition to mountain or bilberry bumblebee (rare and declining). Three widespread and common cuckoo species were also recorded. No heath bumblebee (a localised heathland specialist) were recorded in 2019. The grouped white/buff *B. lucorum/terrestris* were the most abundant (Table 1).

Table1: Bumblebee species recorded across hay meadows (N=59) in the Yorkshire Dales and Forest of Bowland AONB; surveyed June to July 2019.

Common name	***Scientific name***	**Average no. per 1000m of transect**	**Total no. recorded 2019** *(Sum of bumblebees per 1000m on each site section rounded to nearest .5)*
White-tailed bumblebee	*B. lucorum*	28.02	2182
Buff-tailed bumblebee	*B. terrestris*		
Common carder bee	*B. pascuorum*	3.58	227
Red-tailed bumblebee	*B. lapidarius*	0.76	55
Tree bumblebee	*B. hypnorum*	1.10	58
Garden bumblebee	*B. hortorum*	0..35	21
Early bumblebee	*B. pratorum*	0.52	36
Mountain or bilberry bumblebee	*B. monticola*	0.34	20
Gypsy cuckoo	*B. bohemicus*	0.04	1
Field cuckoo	*B. campestris*	0.04	1
Forest cuckoo	*B. sylvestris*	0.04	1

3.3 Distribution across meadow types

The Ancient meadows showed a higher mean number of bumblebees recorded per 1000m of transect surveyed *(>55%)*; with Restored meadows having a lower proportion (>28%), Modern meadows having the lowest mean abundance at 4.35 (<6%) (fig.3).

The majority of species were most abundant in the ancient meadows, with the exception of the gypsy cuckoo bee, which was only recorded in pasture at Piper Hole in Westmorland, where most of the cuckoo bees were recorded. Bilberry bumblebees were recorded in pasture at Colt Park meadows in North Yorkshire, Ancient meadows at Muker, and Myttons. They were recorded across a total of seven flower species including clovers, crane's-bill and yellow-rattle, suggesting that they are able to forage across a wide variety of habitats.

The charts below (figs.4a, b &c) show how the different species are distributed across each habitat. The white and buff-tailed combined are shown at 4a, the cuckoo species at 4b, with the remainder at 4c

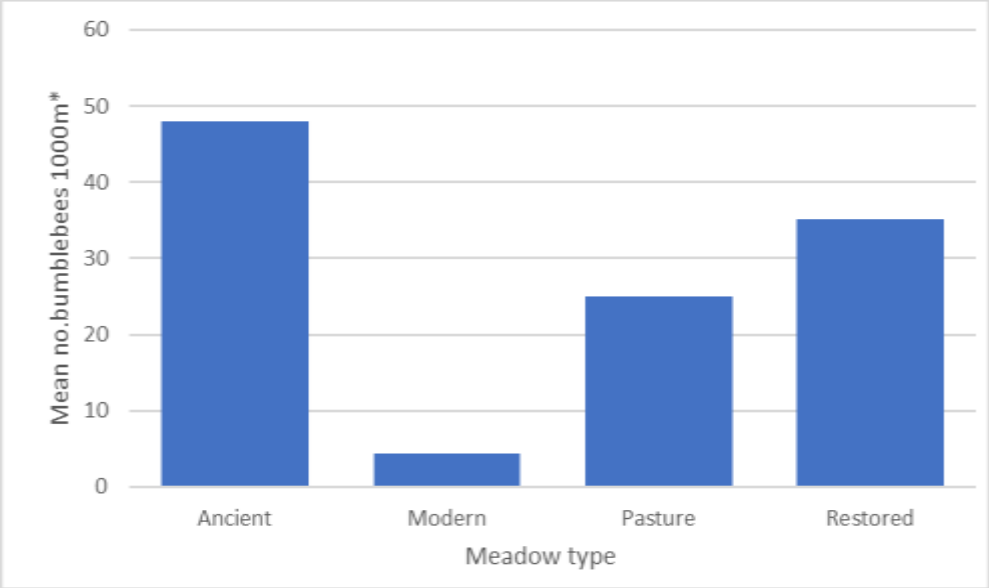
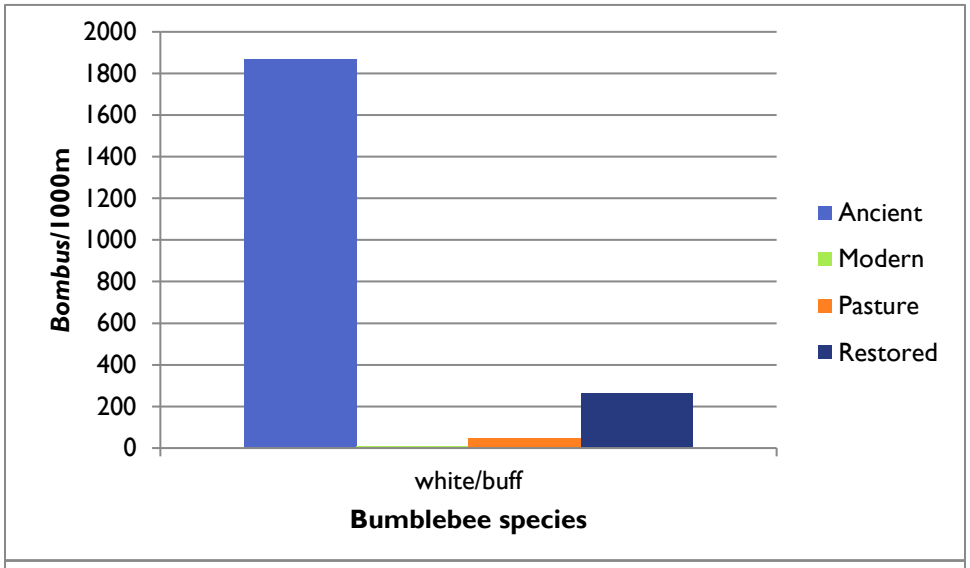
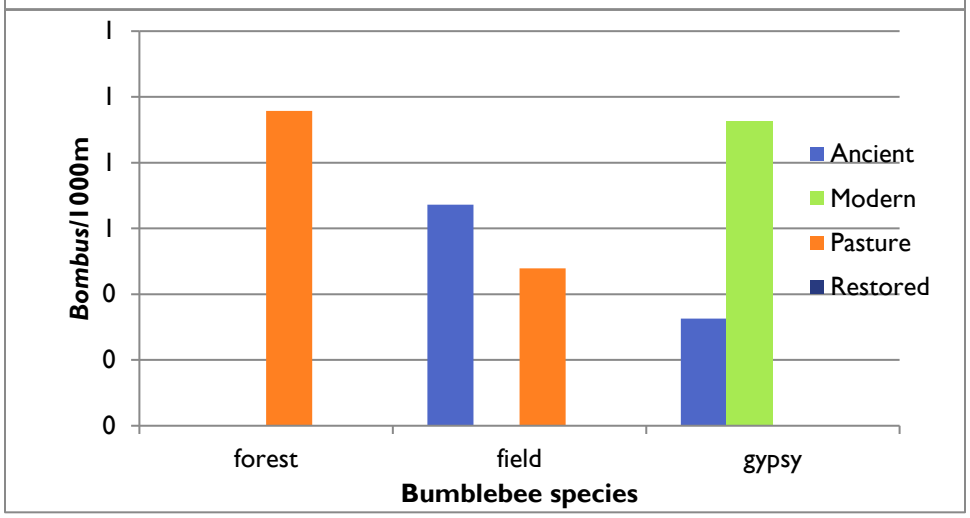


Fig. 3: Mean abundance of bumblebees per 1000m of transect, recorded across three hay meadow habitats: Ancient, Modern, Pasture and Restored (N=59), surveyed June to July 2019 in Forest of Bowland AONB and Yorkshire Dales.





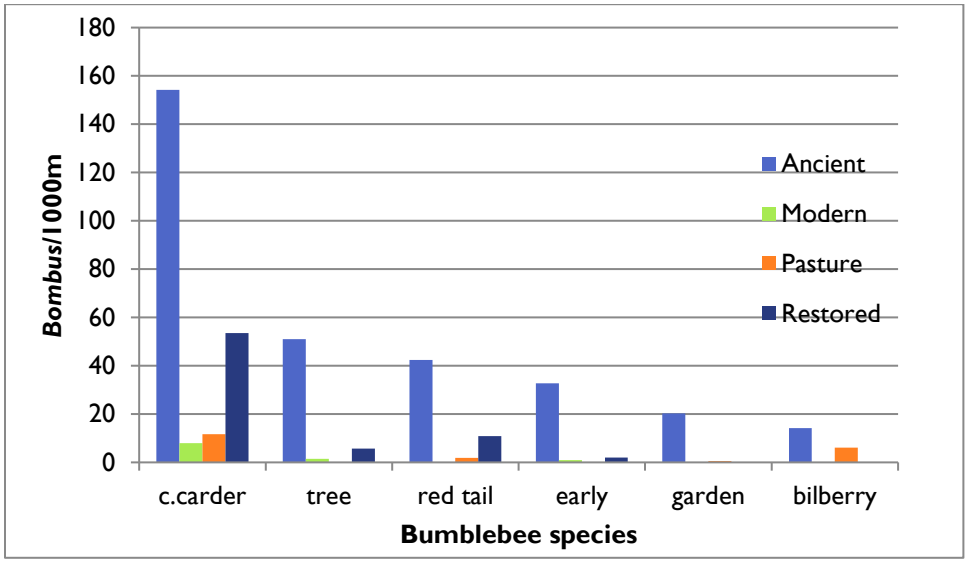


Fig.4a, 4b & 4c: Numbers of bumblebee species recorded per 1000m of transect across four types of meadow; 'Ancient', 'Modern' and 'Restored' in the Yorkshire Dales and Forest of Bowland AONB; surveyed June to July 2019. Note the differing scale of the two charts. White/buff=combined count of white and buff-tailed bumblebees, c.carder=common carder bee, field=field cuckoo bee, gypsy=gypsy cuckoo bee. Note the different scales between charts.

3.4 Diversity of species

The number of individual species recorded varied across the sites, ranging from one to ten in total. Eleven species were recorded across all the sites (white & buff-tailed separated). No heath bumblebees (*B.jonellus*) were recorded in 2019. The greatest diversity of species was at Piper Hole, whereas Bambers recorded only white & buff-tailed (fig.5). The individual site reports are included at Appendix 1.

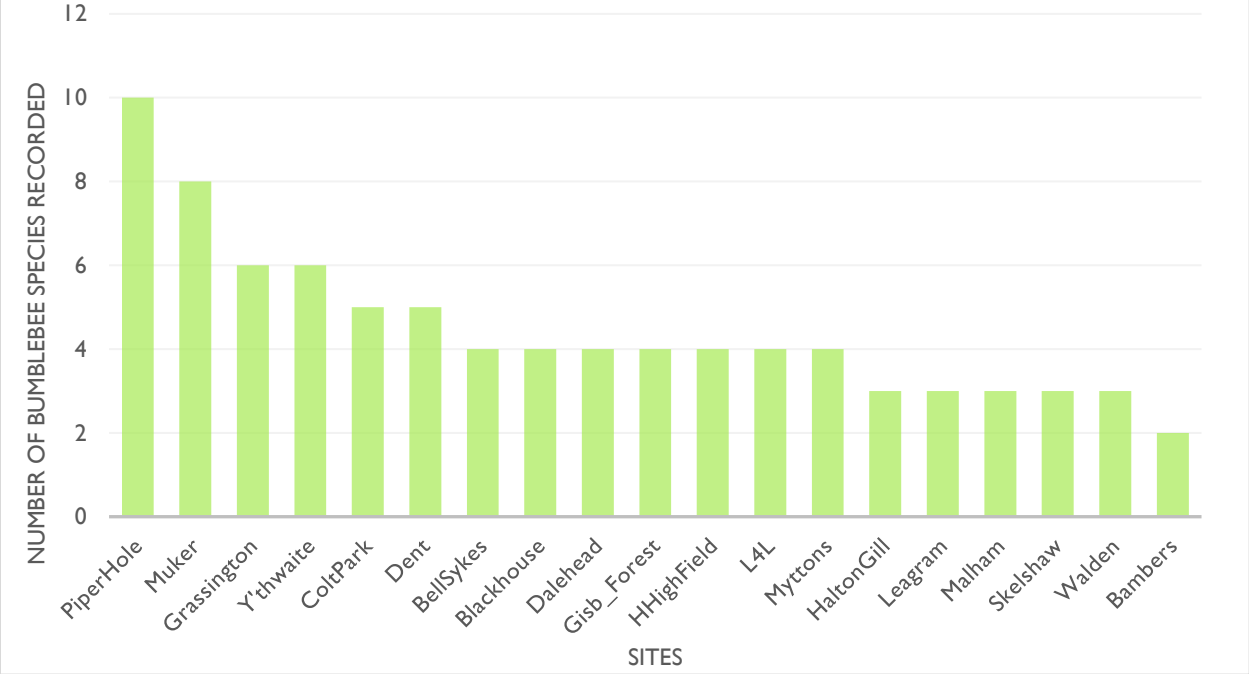


Fig.5: Number of different bumblebee species recorded at each site (N=19) across hay meadows (N=59) in the Yorkshire Dales and Forest of Bowland AONB; surveyed June to July 2019.

Nine different species were recorded across the ancient meadows, 7 species were recorded in the restored meadows. modern meadows recorded fewest species, with some sites having "in flight" bumblebees only, and therefore no actual species recorded. Some of the transects through pasture recorded up to 7 species of bumblebee.

All species are early to mid-season emerging species (Goulson *et al.*, 2008) therefore by mid - June, workers of these species would be actively foraging and accordingly can be concluded that a representative proportion of the population was recorded.

3.5 Floral visitation

Yellow rattle *Rhinanthus minor* accounted for 35% of the twelve most visited flowers, with a similar percentage of visits to red clover (*Trifolium pratense*) *(29%).* Clovers species added together accounted for 40% of the top bumblebee visits to flowers, a greater proportion than in previous years. Together these three species total 75% of *all* visits. The 12 most visited species accounted for almost 95% of all species visited, (*n*=32), as shown in figure 6.

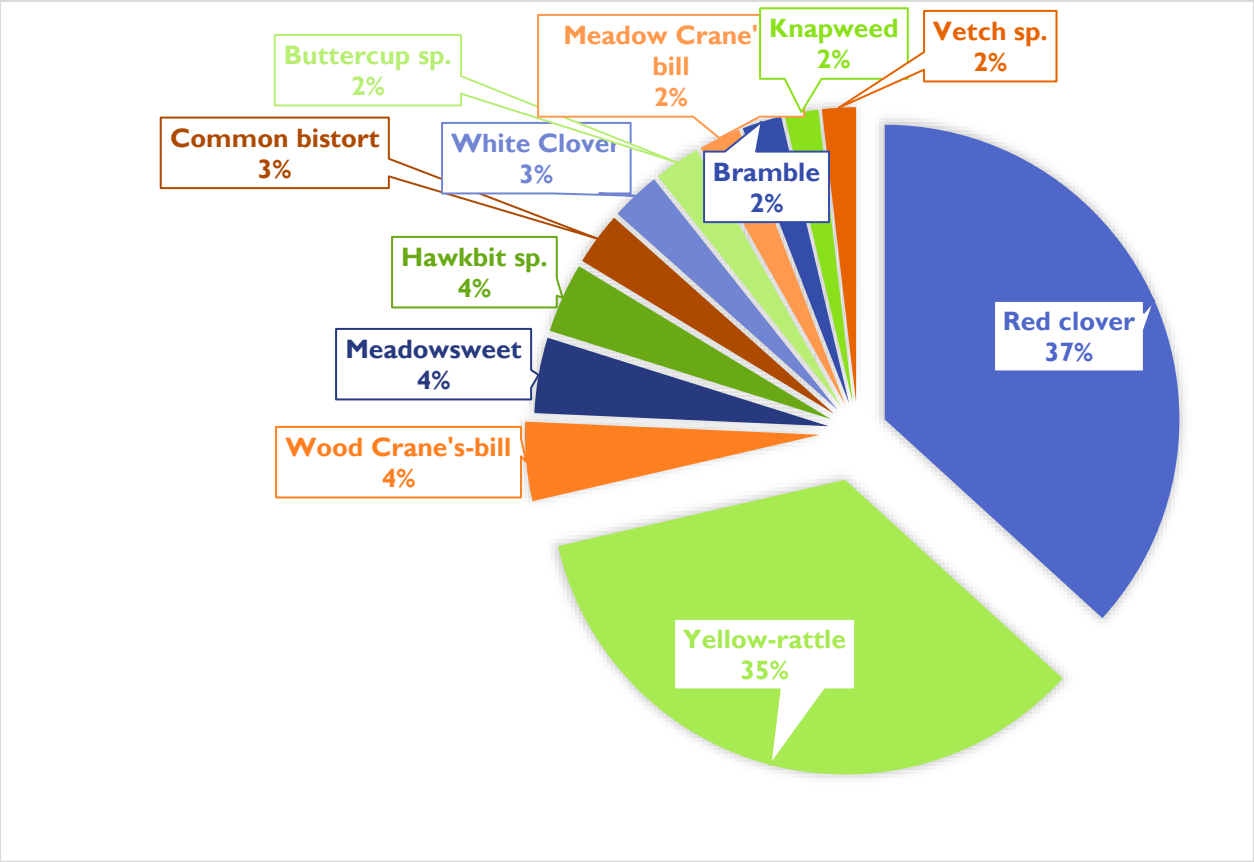


Fig.6: *Flora visited by Bombus spp. as percent of top 12 floral species visited, recorded in hay meadows in the Yorkshire Dales and Forest of Bowland AONB, June to July 2019.*

Yellow rattle and clovers were, as in previous years, the most visited species in both the ancient and restored meadows. Visits to common knapweed were more dominant in the restored meadows compared to those in the ancient meadows, again as in previous years, but these visits were much lower in number than previously recorded. As shown in figure 7, the diversity of species visited was higher in the Ancient meadows, and with the exception on common knapweed and hawkbit species, were also greater in number.

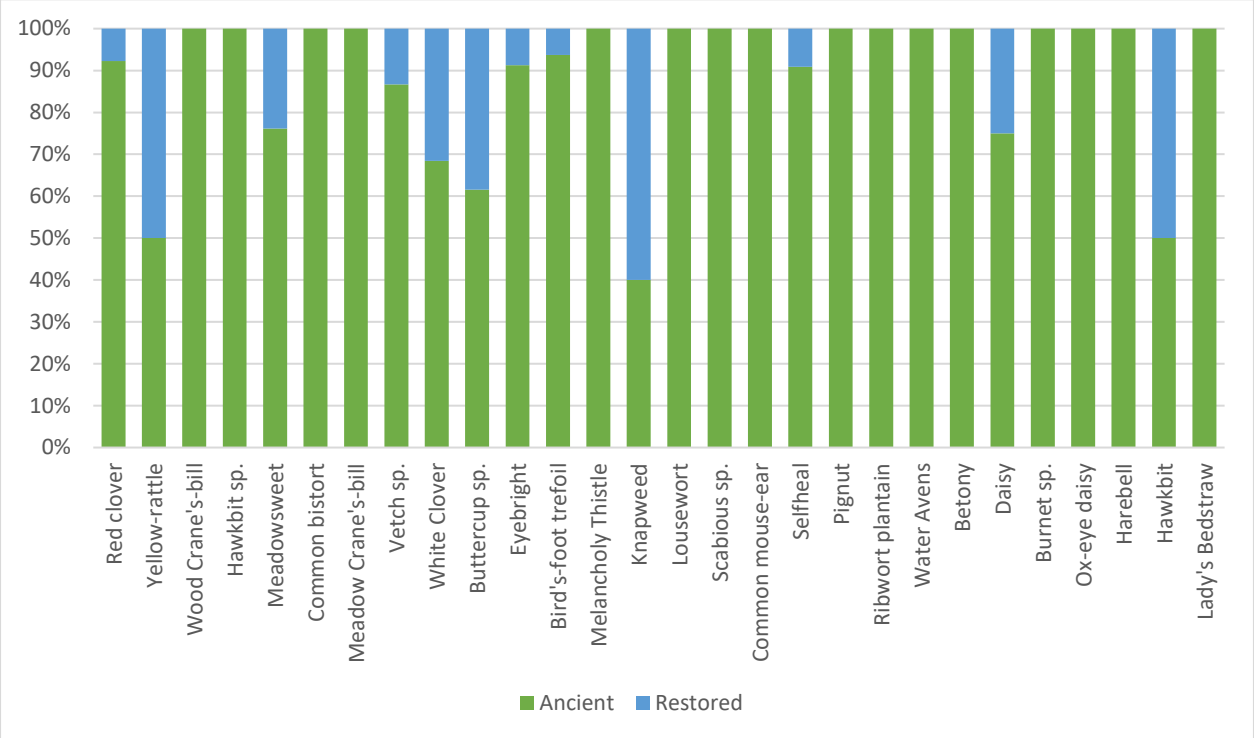


Figure 7: *The 27 most common floral sp. as visited by bumblebees in hay meadow types; ancient, and restored; surveyed June to July, in the Yorkshire Dales and Forest of Bowland AONB, 2019, shown as a percentage of the number of visits recorded.*

The proportion of bumblebee visitations to the two species of clover; red *Trifolium pratense* and white *Trifolium repens;* differed across the habitats. In all meadows the proportion of red clover visited was significantly greater than white clover (the opposite to the previous year) (fig 8). Visits to both clover species were greater in Ancient meadows.

The numbers of floral visits are taken from the raw data i.e. actual numbers of flower visits recorded, as opposed to the bumblebee numbers which are recorded per 1000m of transect surveyed.

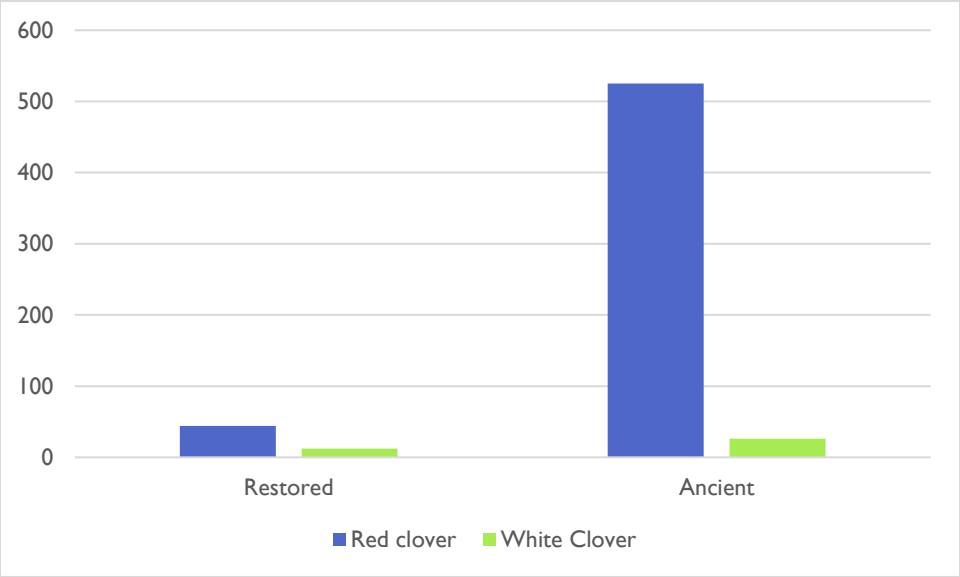


Fig .8: *Comparison of bumblebee visits to red and white clover in two hay meadow types; Ancient and Restored; surveyed June to July, in Yorkshire Dales and Forest of Bowland AONB, north England, 2019.*

4. Comparing data from 2016-2019

2019 saw an increase in the length of transects surveyed, and a new site added in Westmorland, Cumbria at Pier Hole Farm, however we had fewer volunteers than in the past which meant that some sites had very few visits. The weather in 2019 was very wet and windy compared to previous years, with lower mean temperatures. These factors can skew the data; less visits translate to a smaller snapshot of the numbers foraging at those sites. Overall, the numbers recorded were lower than in previous years.

4.1 Bumblebee abundance

The data are comparable with the findings from 2016 (Edmondson *et al*, 2017), and 2017 (Edmondson *et al,* 2018), with the bumblebee abundance and number of species being much lower in the modern and pasture versus both the restored and ancient meadows.
Comparing the abundance of bumblebees recorded per 1000m transect over four years of surveys, the overall abundance had shown a minor increase to 2018, with a dip in 2019 to below previous numbers recorded – *(2016=43.95; 2017=46.8; 2018=47; 2019=39.31).*
Focusing on the abundance of each species, they varied considerably between the species, although the numbers for each species had been reasonably consistent across the previous three years of surveying (fig.9); e.g. white/buff tailed bumblebees have been recorded in the greatest number every year, and most other species were recorded in similar numbers in previous years, despite the radical changes in seasons we have experienced in recent years.

This year the buff/white-tailed aggregated species' numbers were almost double those recorded in previous years (table 2). However, the anomaly can be assigned to the high number recorded

at Muker meadows – 1066.70 per 1000m of transect. Garden, early and bilberry bumblebee numbers were higher in 2019 than 2018, but still lower than 2016.

Common carder bee numbers have fluctuated greatly over the last four years; numbers were greater in 2018 than 2016, but were less numerous in 2019. Red-tailed bumblebee numbers have been consistent until 2019, when there were less than usual recorded, coinciding with a decrease in visits to common knapweed recorded, a usual favourite for this species. Looking at the timing of the site visits, a greater proportion of visits were carried out in June in 2019, no doubt due to the weather. Common knapweed flowers later in the season, which is the likely cause of the lower recordings.

Other possible reasons for the fluctuation in abundance across all species may be due to the variation in the actual sites visited – not all sites are surveyed each year, and therefore the habitat surveyed will vary from year to year. In addition, the surveys may be weighted from one month to the other as in this year, 2019; volunteers' time and conflicting weather constraints may also skew the data as one does not always coincide with the other.

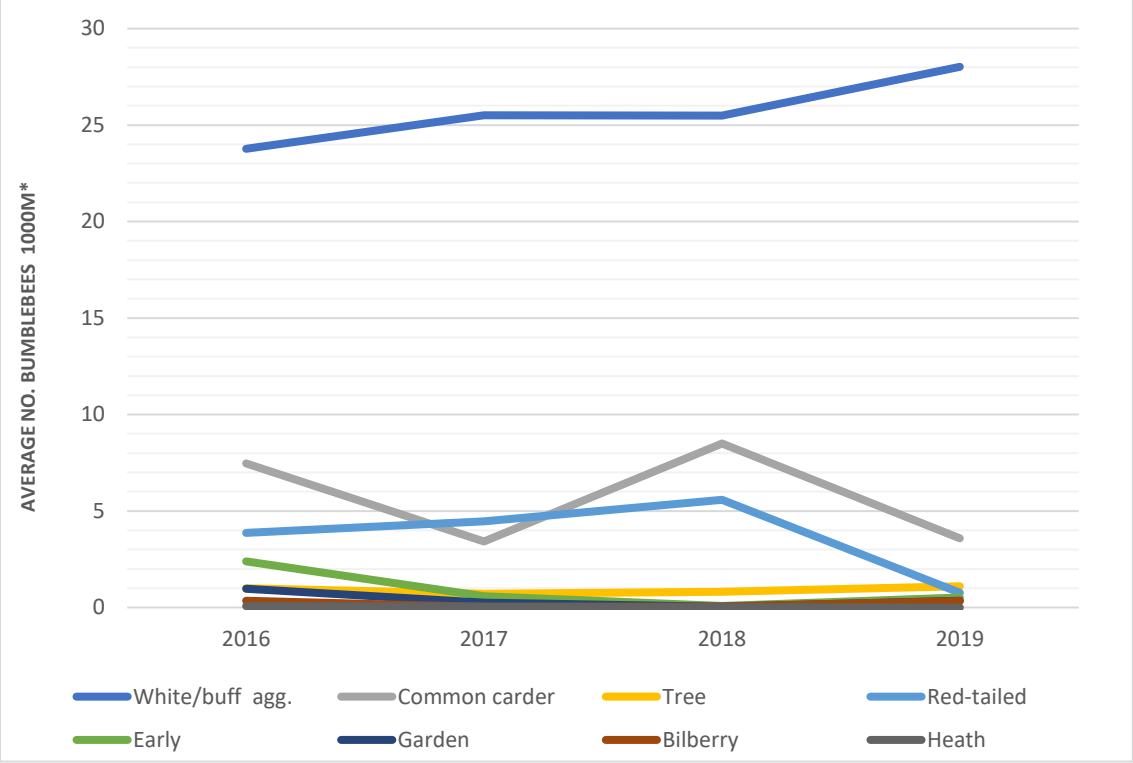


Fig.9: *Comparison of mean abundance of each bumblebee species recorded across hay meadows in the Yorkshire Dales and Forest of Bowland AONB; surveyed June to July 2016-2019.*

Common carder bee foraging on red clover. Numbers of this species were down in 2019.

Red-tailed bumblebee foraging on common knapweed. Records of both bumblebee and flower species were down in 2019.

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4..2 Comparing meadow types and sites 2016 -2019

When comparing the data from the last four years, the numbers fluctuate year to year. There is no determinable pattern when looking at each year since restoration, other than the consistently higher numbers of foraging bumblebees in all the restored meadows over the modern, agriculturally improved meadows, with most being comparable or sometimes greater than those in the ancient, traditionally managed meadows in each year surveyed (fig.10). However, in 2019 the abundance in the meadows that have had restoration work were lower than previous years, and discernibly lower than the "Ancient" meadows.

One factor that most likely accounts for this is the fact that the meadows undergoing restoration work in 2018 were not part of the "Beewalk" scheme in 2019. In the 2016-2017 study (Edmondson *et al*, 2017), one stand-out result was the greater number of bumblebees foraging in the meadows restored the previous year, probably due to the boost in yellow-rattle and clover in those meadows. Climate has an influence on available foraging habitat – the mild wet winter of 2018 meant that the grass species grew throughout the season, shading out many flowering species before they had chance to grow – reducing the availability of surveyors to spot the bumblebees, and also the available forage.

There is an overall downward trend from 2016 – 2019, but further data is needed to form a definitive conclusion on the trend.

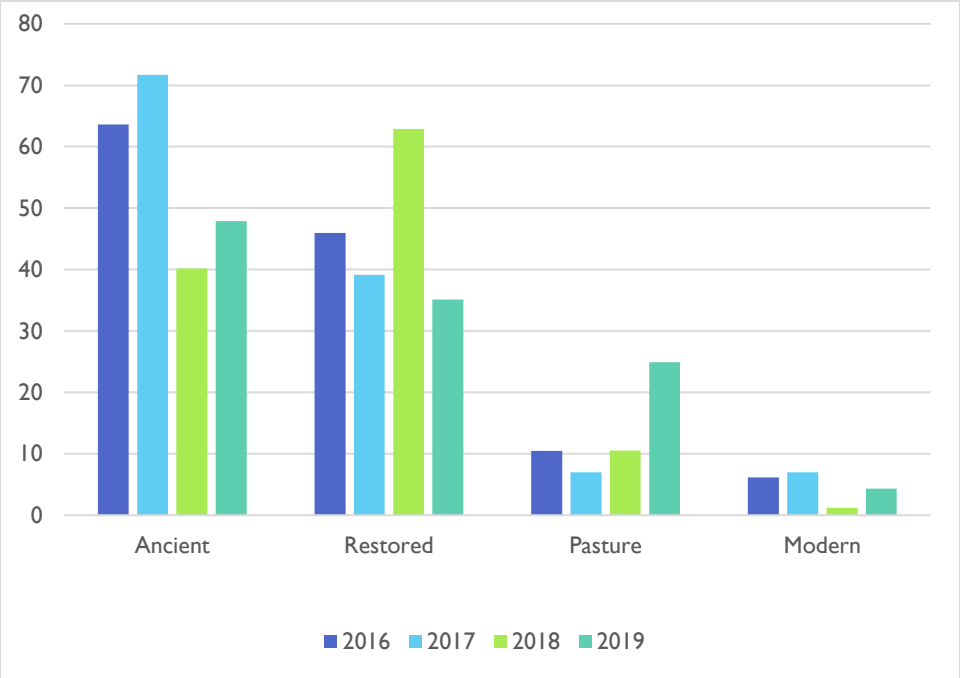

Fig.10: Comparison of mean number of bumblebees recorded by year, across meadows in the Yorkshire Dales and Forest of Bowland AONB; surveyed June to July 2016-2019.

There is fluctuation in species abundance from site to site in the years from 2016 to 2019. Some show a steady decrease from 2016, whereas some show a slight increase or decrease (Table 2). Sites with a marked decrease from 2016 are Halton Gill, Malham, Skelshaw and Yockenthwaite. (All individual site reports are included at Appendix 1).

Table 2: Comparison of bumblebee abundance by year in all sites surveyed in 2019, recorded across hay meadows in the Yorkshire Dales and Forest of Bowland AONB; surveyed June to July 2016-2019. Sites undergone restoration from 2016-2017 are highlighted green. Sites with a # were not surveyed that year.

	Total number of bumblebees recorded per 1000m transect			
Site	**2016**	**2017**	**2018**	**2019**
Bambers	28.50	40.30	132.01	37.59
Bell Sykes	514.24	466.66	113.49	303.12
Blackhouse	84.24	147.81	61.88	62.66
Colt Park	#	51.10	386.00	202.72
Dale Head	56.89	33.53	42.91	68.86
Dent	227.88	234.58	379.51	295.75
Gisburn Forest	66.09	71.69	43.25	53.06
Grassington	201.44	266.46	115.00	123.20
Halton Gill	145.49	111.62	149.68	47.87
Higher High Field	#	11.67	16.30	23.97
L4L	#	18.63	229.81	68.32
Leagram	0	95.62	96.77	35.71
Malham	#	149.47	23.00	21.59
Myttons	462.86	248.79	155.52	209.99
Muker	#	#	#	1212.63
PiperHole	#	#	#	71.40
Skelshaw	149.58	91.21	79.09	19.14
Walden	145.99	439.43	#	75.48
Yockenthwaite	281.22	240.83	109.49	40.44

4.2 Floral visitation

The data on bumblebee visits to flowers has its limitations as there is no reference to the abundance i.e percentage cover, species diversity or phenology of flowers across the habitats. In addition, due to the varying levels of plant identification skills of the volunteers, some species were aggregated as, for example, 'thistle' or 'vetch'. However, it does show which species are of greatest importance to the foraging bumblebees.

As in the previous years' data there are three species visited in a much greater proportion than all other recorded flowers visited. The dominance of clover *Trifolium* spp. was equivalent to that in previous years, with red clover being the most commonly visited across all meadow types.

These favoured flowers are likely to be the species providing the best nectar and pollen, in terms of quantity and quality (Baude *et al*. 2016), but they might also be visited often because they are most abundant in the meadows. Clovers are recognised as a significant source of nectar in grasslands (Baude *et al*. 2016) and were found to be a dominant source of pollen collected by bees in the study by Wood *et al*. (2015).

Using the bumblebee visits as a guideline it would appear that in 2019 the Restored meadows were not as florally diverse as in previous years. However, there was a greater dominance of grass species in most of the meadows in 2019, and compounded by the variables previously mentioned, this may not have been the case – simply that the species visited were the most readily available at that point in time.

5. Conclusions and next steps

The greater abundance and diversity of the bumblebees in the restored meadows, compared to the modern meadows, demonstrates the increase in foraging habitat in the meadows where restoration work has been carried out. In addition, the presence of the majority of floral species in the restored meadows most commonly visited by bumblebees, suggests that the restoration work has effectively transferred the bumblebees favoured flora.

The comparable bumblebee abundance and species numbers with the ancient meadows also shows that overall, the restored meadows are supporting the foraging bumblebee numbers that would be expected in a florally diverse, traditionally managed meadow – in other words the restoration work has been successful in terms of effectively expanding the available food resource for this valuable and vulnerable pollinator.

There is a defined boom and bust in the numbers foraging in recently restored meadows, mainly attributable to the flush of yellow rattle in the first couple of years following the seeding or green hay transfer. This seems to even out over the next couple of years.

The few sites where there has been a steady decline in numbers would benefit from further investigation as to the causes. It could be number of factors: e.g change in meadow management, changes in nearby land management, including building development, leading to loss of nesting habitat. Climate change and increased pollution can also have a greater effect on more fragile habitats and ecosystems.

It is difficult to draw any solid conclusions from the clover visitation data without floral coverage data to reference, but the dominance of white and red clover in the restored and ancient meadows, and the contrasting to the previous years' data would suggest that the coverage of the two clover species had changed in the two meadow types. Alternatively, the cold wet weather could have played a part in the phenology or nectar production of the plants themselves meaning bumblebee foraging availability had changed.

Typical nesting site in grassland for the white & buff tailed bumblebee. Photo courtesy of BBCT.

A common carder bee visiting yellow rattle. Photo C. Edmondson 2018.

A study by Edge Hill University MSc student Hillary McGuire in 2019 in the Forest of Bowland meadows showed a connection between the most frequently visited plant species and their abundance in those meadows. The greater abundance of bumblebees in the Ancient meadows later in the season was attributed to greater abundance of later flowering species. This offers an insight as to whether they are the most preferred species or merely the most abundant – or both, and adds some conviction to the floral data collected through the Beewalk project. Current and future meadow restoration projects aim to increase the numbers of later flowering species in the meadows via plug planting and late cut green hay transfer, which will help to address this difference, and extend the foraging season for bumblebees in those meadows.

Longer term study will provide more insight into the bumblebee foraging preference of floral species, in addition to floral species abundance.

The fluctuations each year in the abundance of bumblebee species could also be related to changes in the surrounding landscape, in addition to the changes in individual meadow management regimes such as cutting dates etc. The availability of nesting sites in the surrounding landscape will also have an impact on the numbers of bees foraging in the area.

Further research into nest abundance, or suitable nesting habitat, in association with the meadow types would assist in explaining the difference in bumblebee numbers across the florally diverse meadows, such as Svenson *et al*., 2000. An assessment of the wider surrounding landscape of each site, in conjunction with nesting preference of each species would also add further understanding of the use of the meadows in relation to the landscape, and possibly contribute to location choice for future restoration projects.

FUNDING

- ‘A Buzz in the Meadows’ was funded by Ernest Cook Trust, Tanner Trust, D’Oyly Carte Charitable Trust, Banister Charitable Trust, Sylvia and Colin Shepherd Charitable Trust, Martin Wills Wildlife Maintenance Trust, Sir Ralph Verney Memorial Trust and the Frognal Trust.

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- The Forest of Bowland AONB ‘Haytime’ project was funded by Lancashire Environment Fund, YDMT and the Forest of Bowland AONB. The work continues into 2019 with a new project 'Hay Time Rescue', funded by Lancashire Environment Fund, YDMT and the Forest of Bowland AONB.

- The Yorkshire Dales ‘Haytime’ was funded by:
  Yorkshire Dales National Park Authority, Countdown 2010, YDNPA Sustainable Development Fund (managed by YDMT), Tubney Charitable Trust, Nidderdale AONB Sustainable Development Fund, YDMT supporters, Friends of Nidderdale AONB, S & C Shepherd Charitable Trust, D’Oyly Carte Charitable Trust, Lady Mary Bell’s Charity, John Spedan Lewis Foundation, David Morgan Rees, The Tanner Trust, Frognal Trust, Upper Wharfedale Field Society.

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- 'Wildflowers 4 the Meadows' was funded by Lancashire Environment Fund, YDMT and the Forest of Bowland AONB

- The 2018 & 2019 ‘Beewalk’ projects were funded by YDMT, Forest of Bowland AONB, and Peoples Postcode Lottery, in recognition of the value of continuous monitoring and data collection.

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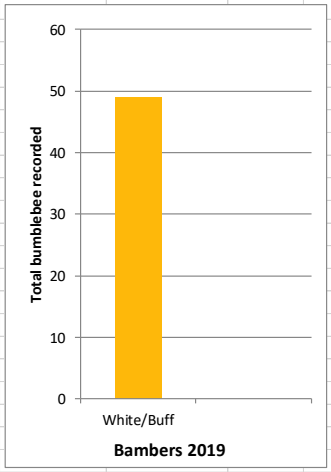
Appendix 1. Individual site reports and maps

Bambers 2019

Flower	No. of BB visits
Yellow-rattle	24
In flight	20
Vetch sp.	2
Clover	1
Grass	1
Selfheal	1
Total	**49**

Bambers	2016	2017	2018	2019
Total bumblebees	55	72	175	49
Total species	6	5	6	1
Average temp	18	n/a	20	18
No. visits	4	4	6	3
Total m transect	905	905	905	905
Bumblebees per 1000m	**15.2**	**19.9**	**23.86**	**18.05**

Section	White/Buff
BB1	32
BB2	17
	49

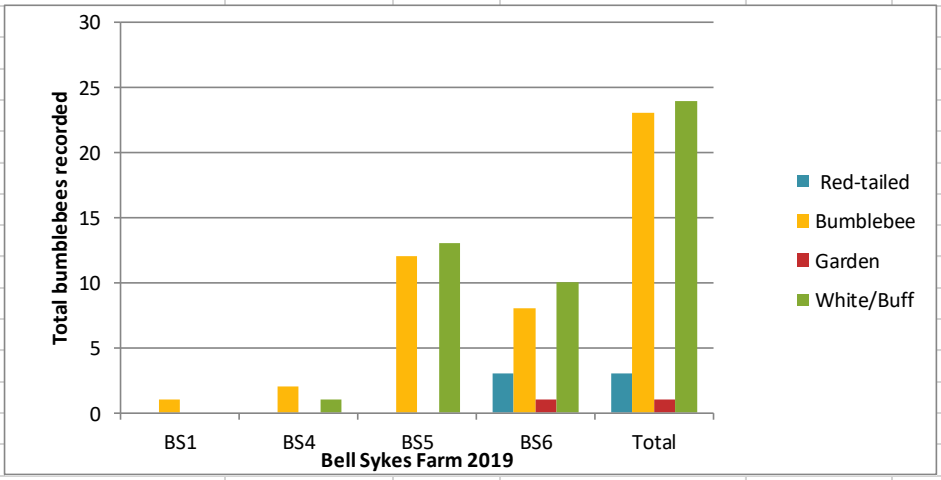


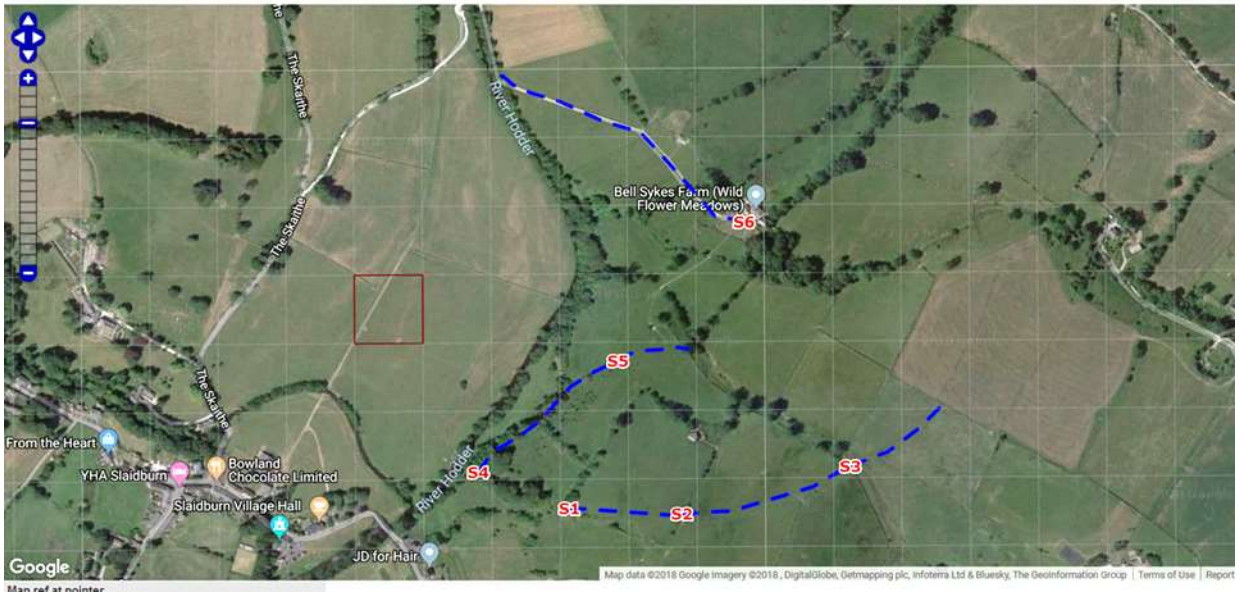
Bell Sykes 2019

Flower	No. of BB visits
Meadowsweet	30
In flight	12
Clover	5
Knapweed	2
Meadow Crane's-bill	1
Yellow-rattle	1
	51

Bell Sykes	2016	2017	2018	2019
Total bumblebees	547	635	175	51
Total species	8	7	6	4
Average temp	16.2	17.6	20	23
No. visits	5	5	6	1
Total m transect	1383	1222	1222	1222
Bumblebees per 1000m	79.1	104	23.86	41.73

Section	Red-tailed	Bumblebee	Garden	White/Buff	Total
BS1	0	1	0	0	1
BS4	0	2	0	1	3
BS5	0	12	0	13	25
BS6	3	8	1	10	22
Total	**3**	**23**	**1**	**24**	**51**



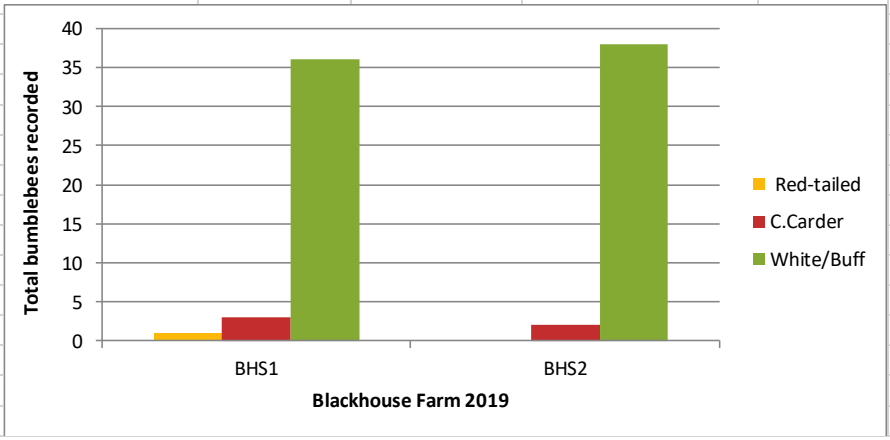


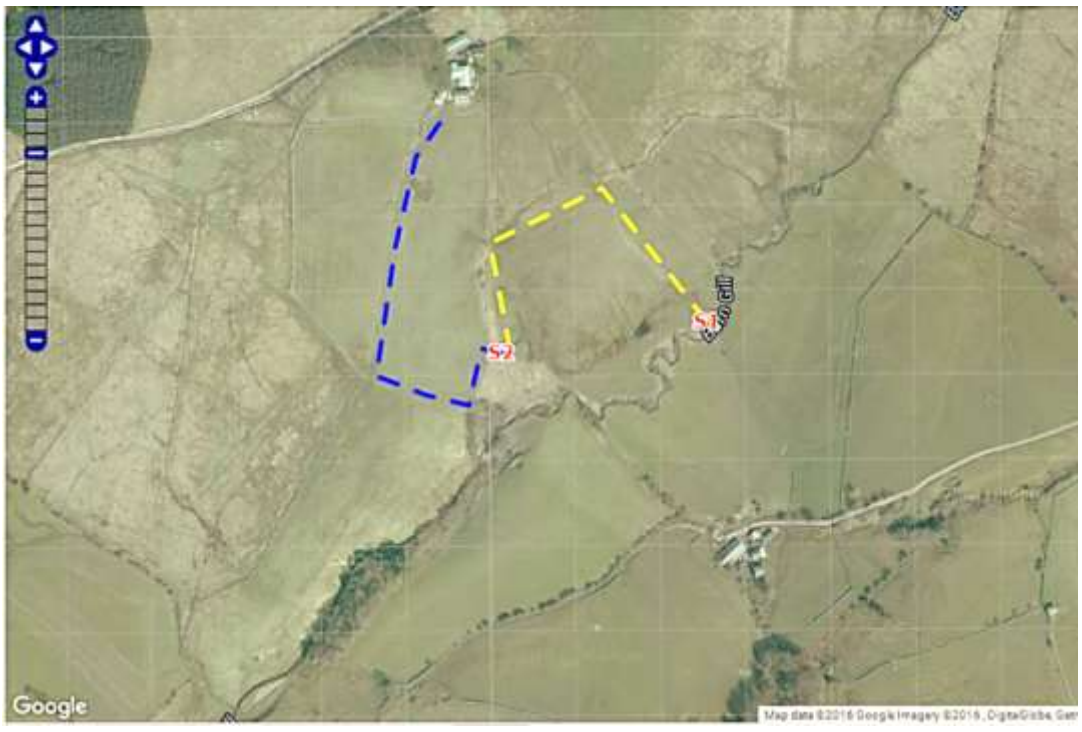
Blackhouse 2018

Flower	No. of BB visits
Yellow-rattle	46
In flight	8
White Clover	7
Meadowsweet	5
Knapweed	4
Bird's-foot trefoil	3
Red clover	3
Eyebright	2
Buttercup sp.	1
Ribwort plantain	1
Total visits	80

Blackhouse	2016	2017	2018	2019
Total bumblebees	211	215	47	80
Total species	6	4	4	4
Average temp	19.3	19.75	24	13.7
No. visits	6	4	2	3
Total m transect	885	885	885	885
Bumblebees per 1000m	**39.7**	**60.7**	**26.55**	**30.13**

Row Labels	Red-tailed	C.Carder	White/Buff
BHS1	1	3	36
BHS2		2	38
	1	**5**	**74**



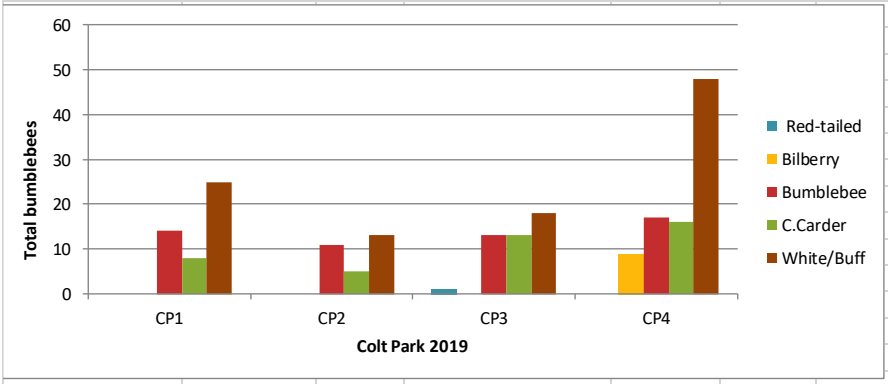


Colt Park 2019

Flower	No. of BB visits
Yellow-rattle	103
In flight	62
Red clover	40
Common mouse-ear	2
White Clover	2
Hawkbit	1
Selfheal	1
	211

Colt Park	2017	2018	2019
Total bumblebees	51	581	211
Total species	7	6	5
Average temp	-	18	16.9
No. visits	6	7	5
Total m transect	848	848	848
Bumblebees per 1000m	**10**	**97.88**	**49.76**

Colt Park	Red-tailed	Bilberry	Bumblebee	C.Carder	White/Buff	
CP1			14	8	25	
CP2			11	5	13	
CP3	1		13	13	18	
CP4		9	17	16	48	
Total	**1**	**9**	**55**	**42**	**104**	**211**

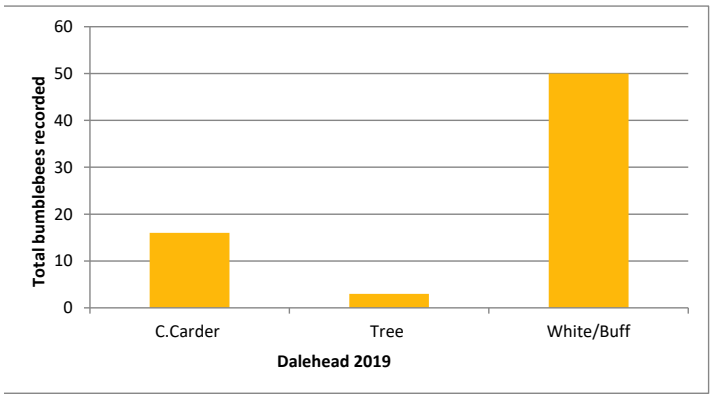


Dalehead 2019

Flower	No. of BB visits
Yellow-rattle	14
Red clover	13
Lousewort	12
In flight	11
Ribwort plantain	5
Selfheal	5
Water Avens	3
Bird's-foot trefoil	2
Meadowsweet	2
Vetch sp.	1
White Clover	1
Total	**69**

Dalehead	2016	2017	2018	2019
Total bumblebees	57	28	43	69
Total species	6	5	5	4
Average temp	15.3	16.8	20	15
No. visits	6	5	6	6
Total m transect	167	167	167	167
Bumblebees per 1000m	**56.9**	**33.5**	**42.9**	**68.86**

C.Carder	Tree	White/Buff	Grand Total
16	3	50	69

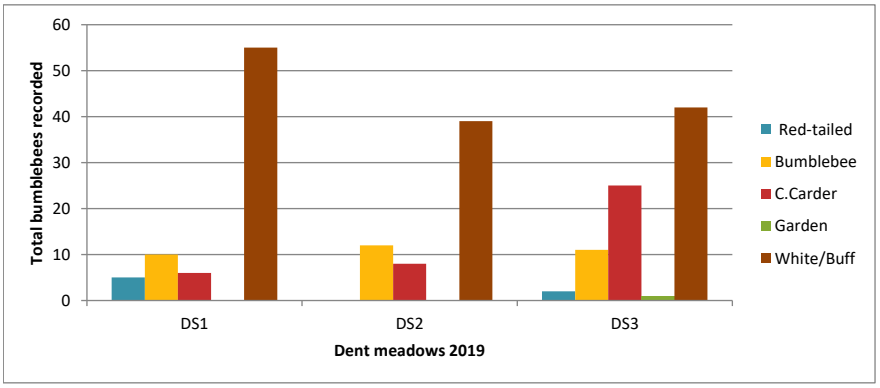


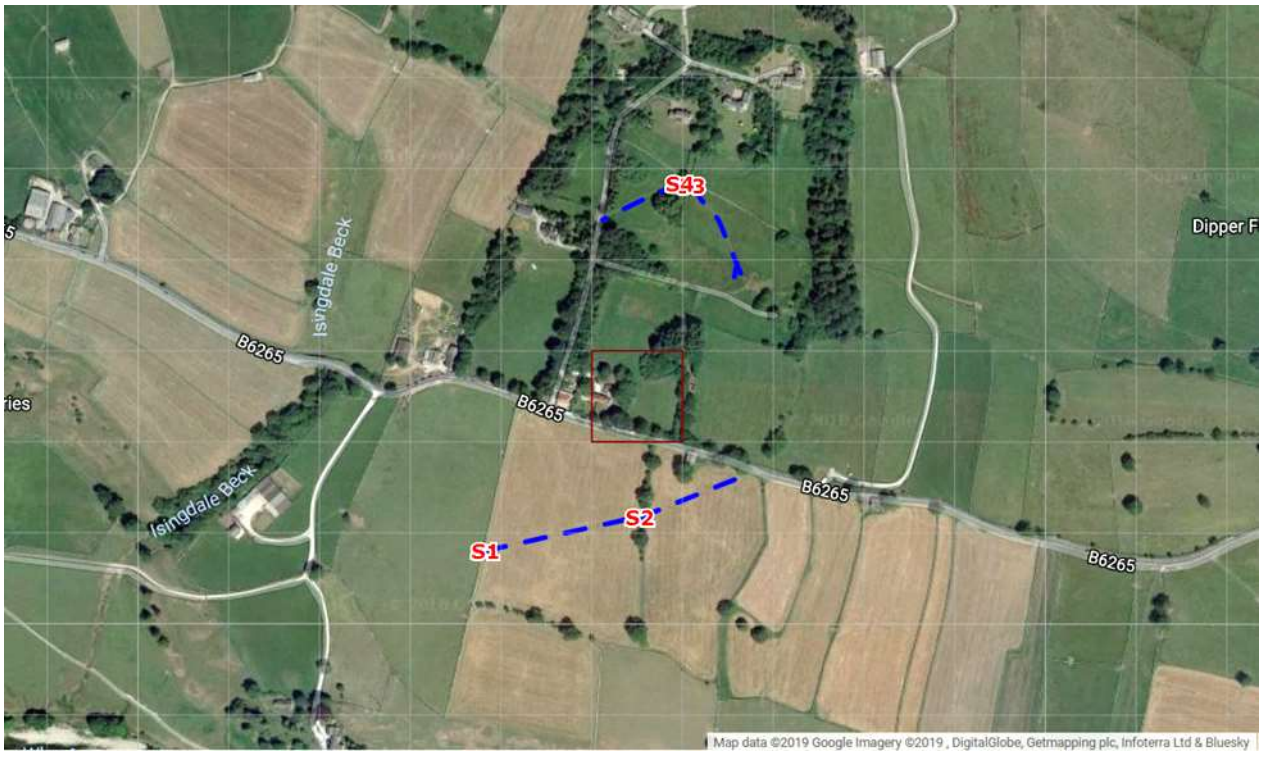
Dent 2019

Flower	No. of BB visits
Yellow-rattle	58
In flight	50
Red clover	47
Common bistort	36
Hawkbit sp.	9
White Clover	6
Knapweed	4
Eyebright	3
Buttercup sp.	2
Pignut	1
Total	**216**

Dent	2016	2017	2018	2019
Total bumble	133	141	294	216
Total species	6	5	4	5
Average tem	16.5	16.2	20	16.75
No. visits	6	6	4	6
Total m trans	446	376	376	376
Bumblebees	**49.7**	**62.5**	**195.48**	**95.74**

Section	Red-tailed	Bumblebee	C.Carder	Garden	White/Buff	Grand Total
DS1	5	10	6		55	76
DS2		12	8		39	59
DS3	2	11	25	1	42	81
Total	**7**	**33**	**39**	**1**	**136**	**216**



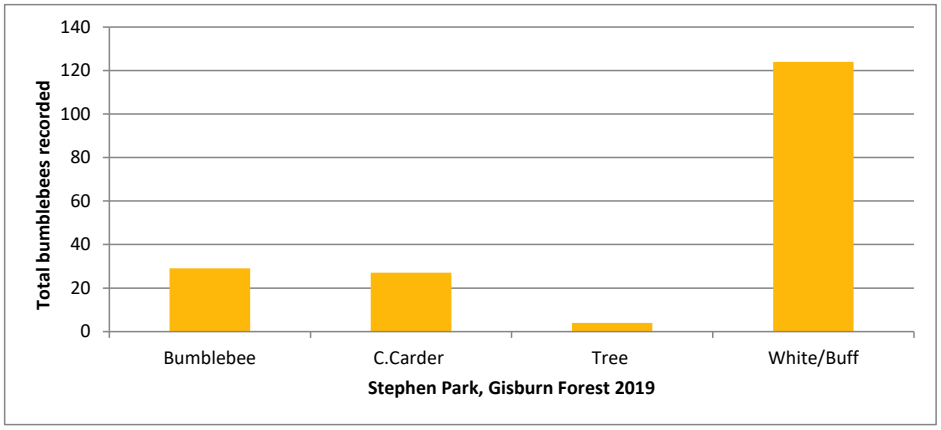


Stephen Park, Gisburn Forest 2019

Flower	No. of BB visits
Yellow-rattle	113
In flight	36
Buttercup sp.	11
Red clover	11
Bramble	5
White Clover	3
Eyebright	2
Vetch sp.	2
Clover	1
Total	**184**

Stephen Park	2016	2017	2018	2019
Total bumblebees	464	166	125	184
Total species	10	4	3	4
Average temp	14	18.5	17.25	18
No. visits	5	4	4	6
Total m transect	1706	578	578	578
Bumblebees per 1000m	**54.4**	**71.8**	**54.07**	**53.06**

Bumblebee	C.Carder	Tree	White/Buff	Grand Total
29	27	4	124	184

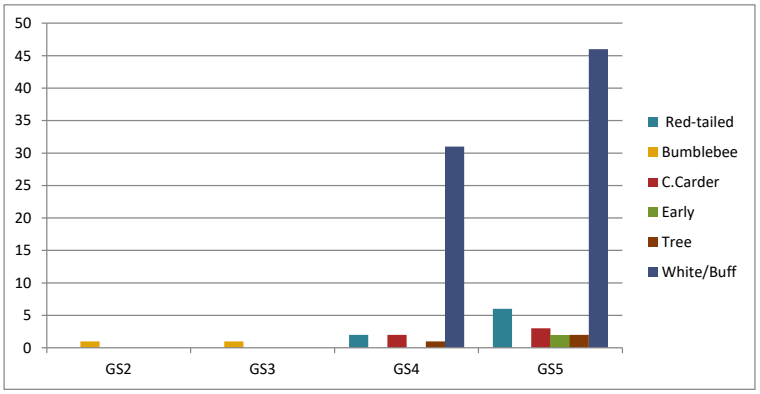


Grassington 2019

Flower	No. of BB visits
Hawkbit sp.	14
Red clover	13
Bird's-foot trefoil	11
Eyebright	11
Scabious sp.	11
In flight	9
Yellow-rattle	7
Betony	4
Clover	3
Selfheal	3
Burnet sp.	2
Buttercup sp.	2
Knapweed	2
Ox-eye daisy	2
Water Avens	2
Pignut	1
Total	**97**

Grassington	2016	2017	2018	2019
Total bumblebees	127	174	69	97
Total species	7	10	5	6
Average temp	16.6	18	21.5	17
No. visits	6	6	6	7
Total m transect	636	636	636	636
Bumblebees per 1000m	**33.3**	**45.6**	**18.08**	**21.78**

Section	Red-tailed	Bumblebee	C.Carder	Early	Tree	White/Buf	Total
GS2			1				1
GS3			1				1
GS4	2			2		1	31	36
GS5	6			3	2	2	46	59
Total	**8**	**2**	**5**	**2**	**3**	**77**	**97**

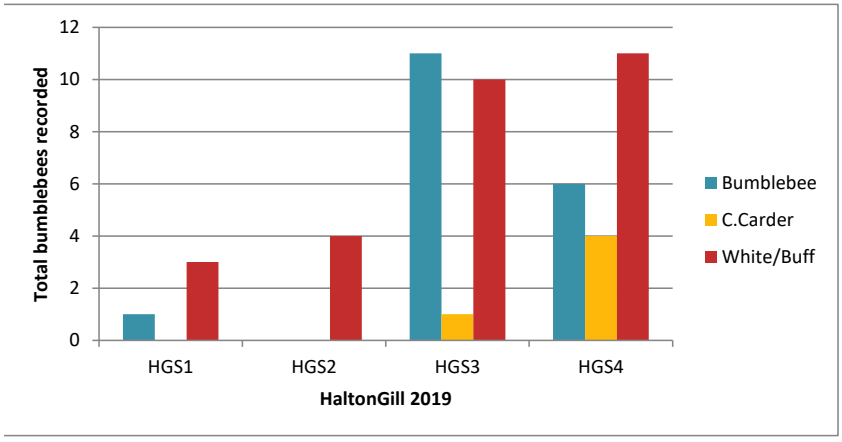


Halton Gill 2019

Flower	No. of BB visits
Yellow-rattle	19
In flight	18
White Clover	5
Daisy	4
Clover	3
Red clover	1
Unidentified f	1
Total	**51**

Halton Gill	2016	2017	2018	2019
Total bumblebees	118	83	102	51
Total species	7	6	6	3
Average temp	15	16	18.5	15
No. visits	5	6	6	5
Total m transect	917	917	917	917
Bumblebees per 1000m	**25.7**	**18.1**	**18.54**	**11.12**

Section	Bumblebee	C.Carder	White/Buff	Total
HGS1	1		3	4
HGS2	0		4	4
HGS3	11	1	10	22
HGS4	6	4	11	21
Total	**18**	**5**	**28**	**51**

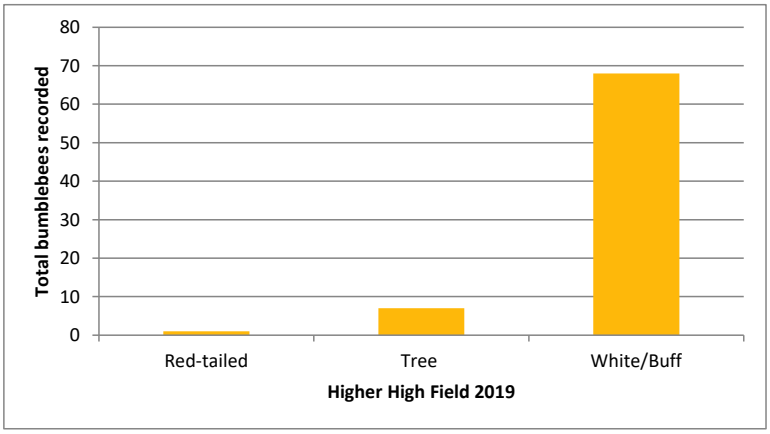


Higher High Field 2019

Flower	No. of BB visits
Yellow-rattle	33
Red clover	20
Vetch sp.	14
Meadow Crane's-bill	5
Buttercup sp.	1
Knapweed	1
Meadowsweet	1
White Clover	1
Total	**76**

Higher High Field	2017	2018	2019
Total bumblebees	37	62	76
Total species	5	5	4
Average temp	15	17.25	18
No. visits	6	5	5
Total m transect	634	634	634
Bumblebees per 1000m	**9.7**	**19.55**	**23.97**

Section	Red-tailed	Tree	White/Buff	Total
HHF1	1	7	68	76
Grand Total	**1**	**7**	**68**	**76**

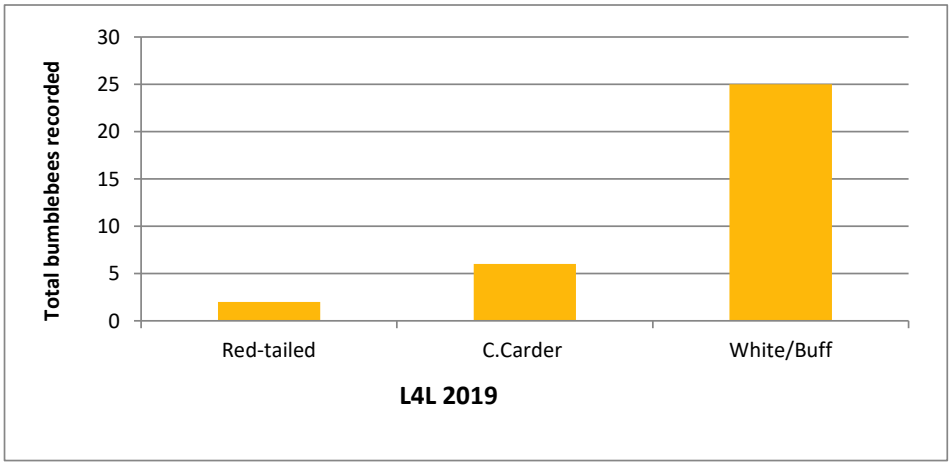


Life4life meadow 2019

Flower	No. of BB visits
Yellow-rattle	11
Cow parsley	8
Knapweed	7
Red clover	4
Buttercup sp.	1
Himalayan balsam	1
Stitchwort	1
Total	**33**

Life4life	2017	2018	2019
Total bumblebees	18	185	33
Total species	3	6	4
Average temp	19	20.4	18.6
No. visits	4	5	3
Total m transect	161	161	161
Bumblebees per 1000m	**28**	**216.4**	**68.32**

	Red-tailed	C.Carder	White/Buff	Grand Total
L4L	**2**	**6**	**25**	**33**

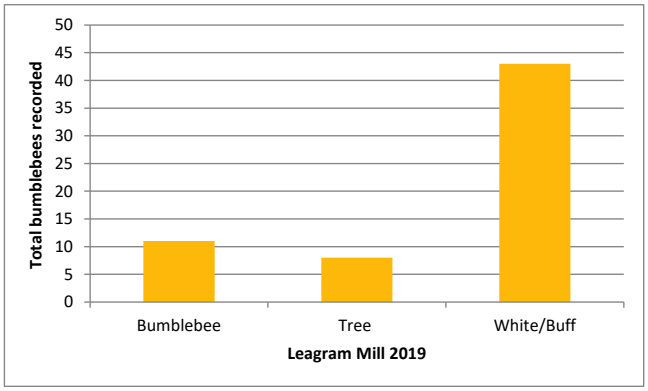


Leagram Mill 2019

Flower	No. of BB visits
Bramble	30
Meadowsweet	14
Knapweed	9
Yellow-rattle	4
In flight	3
Buttercup sp.	2
Total	**62**

Leagram Mill	2016	2017	2018	2019
Total bumblebeess	N/A	186	168	62
Total species	N/A	8	5	3
Average temp	N/A	21	20.5	18
No. visits	N/A	4	4	4
Total m transect	N/A	434	434	434
Bumblebees per 1000m	**N/A**	**107**	**96.77**	**35.71**

Site	Bumblebee	Tree	White/Buff	Grand Total
LS1	11	8	43	62

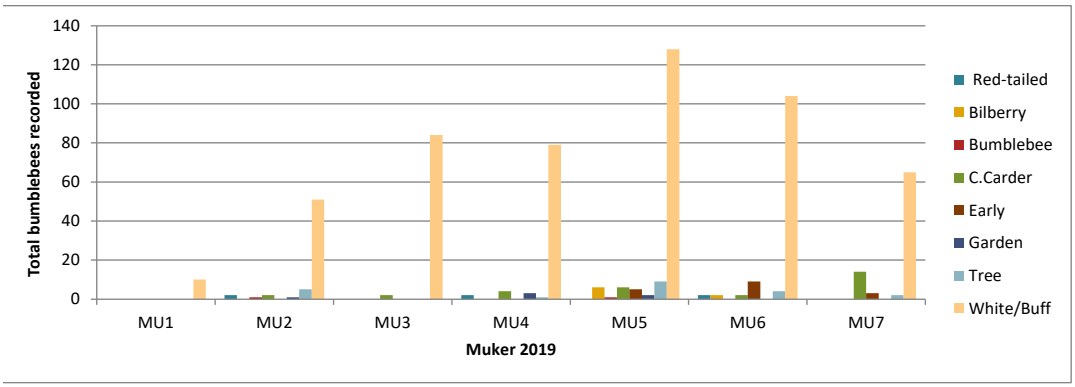


Muker 2019

Flower	No. of BB visits
Red clover	381
Yellow-rattle	72
Wood Crane's-bill	67
Meadow Crane's-l	23
In flight	15
Buttercup sp.	12
Common bistort	11
Common mouse-e	10
Hawkbit sp.	6
Pignut	4
Eyebright	3
Vetch sp.	2
White Clover	2
Harebell	1
Lady's Bedstraw	1
Meadowsweet	1
Total	**611**

Muker	2019
Total bumblebees	611
Total species	4
Average temp	18
No. visits	2
Total m transect	479
Bumblebees per 1000m	**100.2**

Site section	Red-tailed	Bilberry	Bumblebee	C.Carder	Early	Garden	Tree	White/Buf	Grand Total
MU1				0				10	10
MU2	2			1	2		1	5	51	62
MU3					2				84	86
MU4	2				4		3	1	79	89
MU5		6		1	6	5	2	9	128	157
MU6	2	2			2	9		4	104	123
MU7					14	3		2	65	84
Grand Total	**6**	**8**		**2**	**30**	**17**	**6**	**21**	**521**	**611**

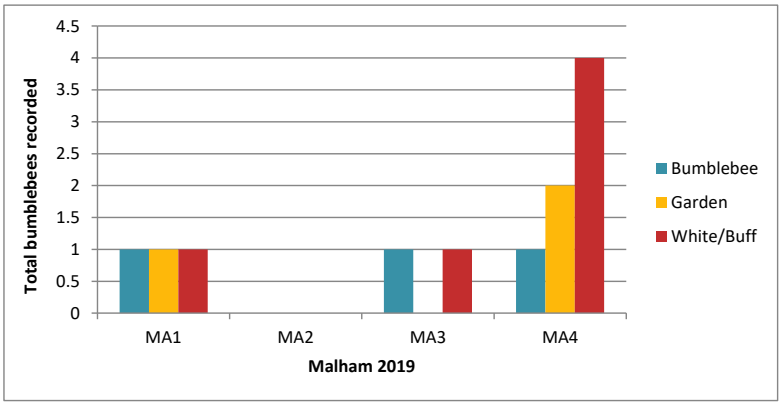


Malham 2019

Flower	No. of BB visits
Yellow-rattle	6
In flight	3
Red clover	2
Eyebright	1
	12

Malham	2016	2017	2018	2019
Total bumblebees	23	117	19	12
Total species	3	3	2	4
Average temp	17	19	19	18.5
No. visits	2	5	6	3
Total m transect	612	612	612	612
Bumblebees per 1000m	**18.8**	**38.23**	**5.17**	**6.53**

Section	Bumblebee	Garden	White/Buff	Grand Total
MA1	1	1	1	3
MA2	0			0
MA3	1		1	2
MA4	1	2	4	7
Total	**3**	**3**	**6**	**12**

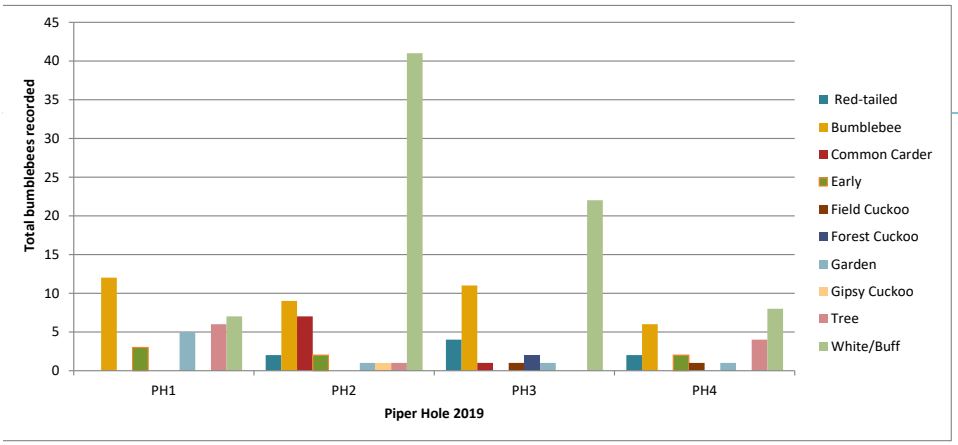


Piper Hole 2019

Flower	No. of BB visits
Buttercup sp.	5
Hawkbit	1
In flight	26
Meadow Crane's-bill	8
Meadowsweet	1
Melancholy Thistle	14
Red clover	37
Unidentified flower	17
Vetch sp.	1
White Clover	15
Wood Crane's-bill	3
Yellow-rattle	35
Total	**163**

Piper Hole	2019
Total bumblebees	163
Total species	10
Average temp	13.4
No. visits	6
Total m transect	1492
Bumblebees per 1000m	**18.9**

Site section	Red-tailed	Bumblebee	Common Carder	Early	Field Cuck	Forest Cuc	Garden	Gipsy Cucko	Tree	White/Buff	Total
PH1		12		3			5		6	7	33
PH2	2	9	7	2			1	1	1	41	64
PH3	4	11	1		1	2	1			22	42
PH4	2	6		2	1		1		4	8	24
Total	**8**	**38**	**8**	**7**	**2**	**2**	**8**	**1**	**11**	**78**	**163**

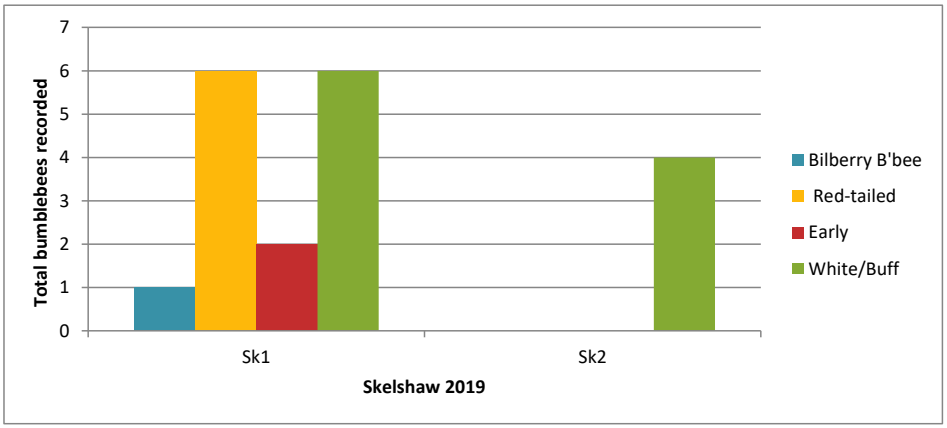


Skelshaw 2019

Flower	No. of BB visits
Meadowsweet	2
Red clover	6
White Clover	5
Yellow-rattle	6
Total	**19**

Skelshaw	2016	2017	2018	2019
Total bumblebees	433	170	107	19
Total species	9	5	6	5
Average temp	17	20	20	20
No. visits	5	5	3	2
Total m transect	885	633	633	885
Bumblebees per 1000m	97.85	53.7	56.35	10.73

Section	Bilberry B'bee	Red-tailed	Early	White/Buff	Grand Total
Sk1	1	6	2	6	15
Sk2				4	4
Total	**1**	**3**	**1**	**2**	**19**

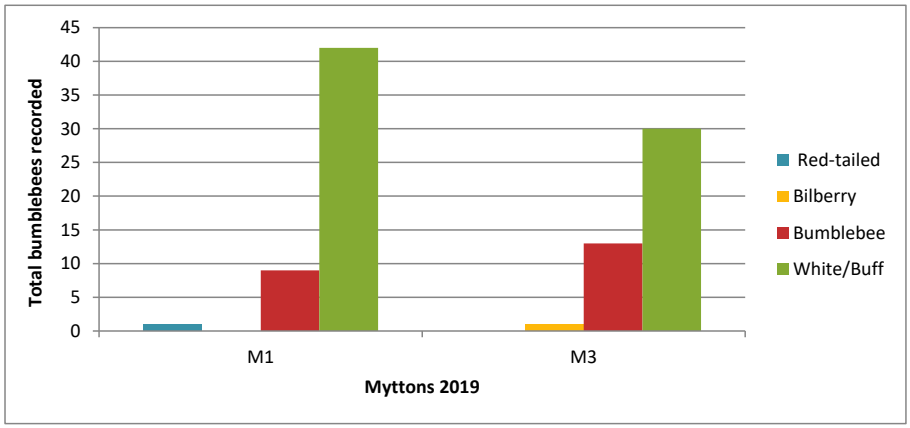


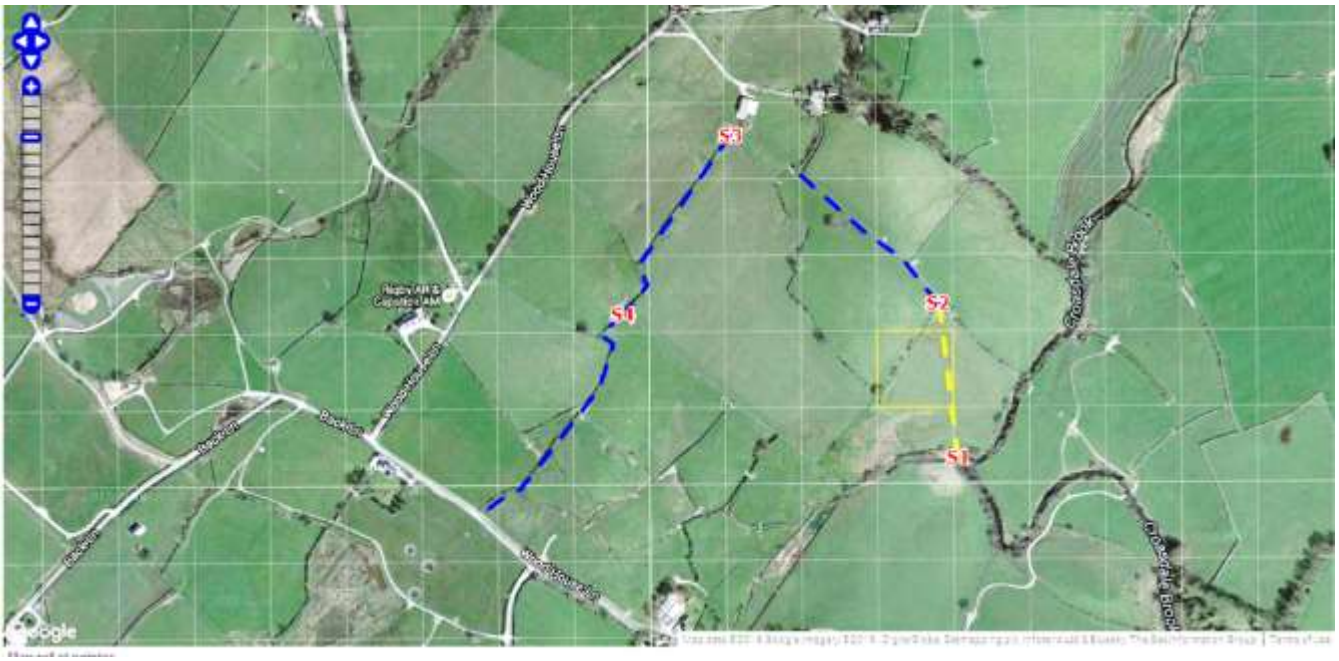
Myttons 2019

Flower	No. of BB visits
In flight	30
Hawkbit sp.	29
Meadowsweet	12
Red clover	11
Vetch sp.	8
Yellow-rattle	5
Knapweed	1
	96

Myttons	2016	2017	2018	2019
Total bumblebees	662	288	110	96
Total species	9	5	6	4
Average temp	17	19	19.7	18
No. visits	5	5	3	2
Total m transect	1084	479	479	479
Bumblebees per 1000m	**122.1**	**120.25**	**76.54**	**100.2**

Section	Red-tailed	Bilberry	Bumblebee	White/Buff	Grand Total
M1	1		9	42	52
M3		1	13	30	44
Total	**1**	**1**	**22**	**72**	**96**



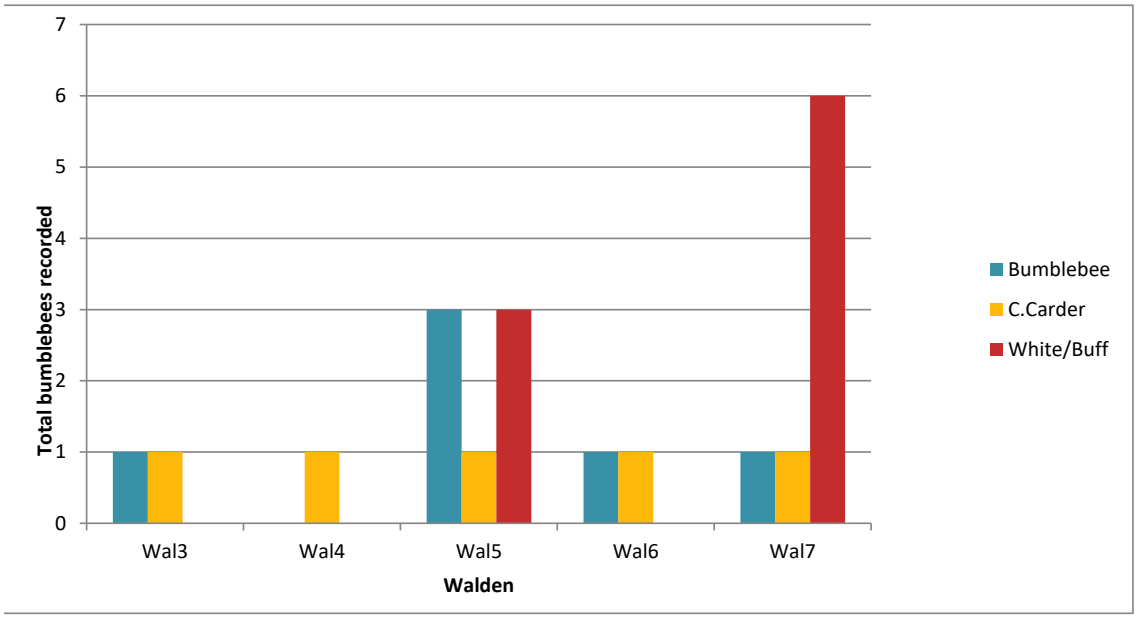


Walden 2019

Flower	No. of BB visits
Buttercup sp.	4
In flight	6
Red clover	9
Yellow-rattle	1
Total	**20**

Walden	2016	2017	2018	2019
Total bumblebees	133	203	#	20
Total species	6	4	#	3
Average temp	17	18	#	17
No. visits	4	5	#	2
Total m transect	911	1007	#	614
Bumblebees per 1000m	**36.5**	**40.3**	#	**16.3**

Site section	Bumblebee	C.Carder	White/Buff	Total
Wal3	1	1		2
Wal4		1		1
Wal5	3	1	3	7
Wal6	1	1		2
Wal7	1	1	6	8
	6	**5**	**9**	**20**



Yockenthwaite 2019

Flower	No. of BB visits
Eyebright	2
Hawkbit sp.	4
In flight	5
Red clover	1
Selfheal	3
Tormentil	1
White Clover	1
Yellow-rattle	3
Total	**20**

Yockenthwaite	2016	2017	2018	2019
Total bumblebees	160	97	44	20
Total species	6	6	7	6
Average temp	17	23	22.25	18.4
No. visits	5	5	4	6
Transect length	942	942	942	942
Bumblebees per 1000m	**33.9**	**20.6**	**11.68**	**3.53**

Section	Bumblebee	C.Carder	Early	Gipsy Cu	Tree	White/Buff	Total
Yoc1	0						0
Yoc2	0						0
Yoc3	0	1			1	1	3
Yoc4	0					2	2
Yoc5	1					2	3
Yoc6	0						0
Yoc7	0	1		1			2
Yoc8	0	2	1			6	9
Yoc9	0				1		1
Total	**1**	**4**	**1**	**1**	**2**	**11**	**20**