North Pennines nectar-feeder survey 2014

This is a summary of the final report produced by Andy Jukes, Conops Entomology Ltd, on behalf of the North Pennines AONB Partnership.

Summary of key points

1. It is important to retain as wide a range of flower species and flower types as possible in order to retain the diversity of insect pollinators.

2. Availability of lots of flowers of a similar type, especially over a long flowering season, provides nectar and pollen to a range of species which target that type of flowers. When this is coupled with a range of flower types (i.e. shallow flowers and deep flowers) at a single site, the result is a strong flower resource which can support a diverse invertebrate community.

3. Hoverflies were the most obvious pollinating group of invertebrates on the flower-rich banks.

4. Habitat connectivity is important. The presence of the rare moss carder bee (*Bombus muscorum*) in Upper Teesdale indicates that the flower-rich banks in this area are functionally connected. For this and many other species to persist, at least the current extent of diverse, flower-rich habitat needs to be retained.

5. All the species recorded of high conservation interest are associated with wetland habitats of varying types. This reinforces the value of the wetland elements of the flower-rich banks and the importance of retaining the wet character of them for this suite of species.

6. Landscape mosaics are important – the close proximity of one natural feature to another. The moorland snipefly (*Symphoromyia crassicornis*), which prefers damp ground near to streams, exemplifies this. The loss of or homogenisation of these habitat features would ultimately result in the loss of invertebrate and other biodiversity.

Introduction

The North Pennines Area of Outstanding Natural Beauty (AONB) supports 40% of the remaining flower-rich upland hay meadows in the UK. Some of the most flower-rich parts of these meadows are on steep, uncut banks. The aim of this survey was to investigate the importance of these areas for nectar-feeding invertebrates. The objectives of the survey were:

- To establish baseline data on the species diversity of nectar-feeding invertebrates found in a range of flower-rich banks and other botanically diverse patches of grassland in upland hay meadows in the North Pennines.
- To establish which plant species within the flower-rich banks act as key food plants and how this may change throughout the spring and summer.
- To identify any management measures which would improve the value of flower-rich banks for nectar-feeding invertebrates.

- To identify any management measures in habitats *other than flower-rich banks* which would benefit the species identified during the surveys, for example, a need for bare soil, tussocky grasses or abandoned rodent burrows.

Methods

The following insect groups were covered by the survey:

- Bees and wasps (Aculeate hymenoptera)
- Hoverflies (Syrphidae)
- "Larger" Brachycera (soldierflies, horseflies, stiletto flies, snipeflies etc)
- Butterflies and day-flying moths (Lepidoptera)
- Fruitflies (Tephritidae)
- Leaf beetles (Chrysomelidae)
- Soldier beetles (Cantharidae)
- Weevils (Curculionidae)
- Click beetles (Elateridae)
- True bugs (Heteroptera)
- Grasshoppers and crickets (Orthoptera)

Ten sites were surveyed and each was visited five times between April and August 2014. Eight sites were in Teesdale and two were in Allendale. Sites were selected because surveys undertaken by the North Pennines AONB Partnership had found them to be some of the most botanically diverse banks in hay meadows in the North Pennines.

Two sampling methods were used at each site on each visit:
1. **Sweep netting**. A ten minute sweeping sample was undertaken at four locations per site.
2. **Spot-sampling of flowers**. Flower visits by nectar-feeders were observed and recorded for a ten minute period at four locations per site.

Results

Seasonal changes

The flower-rich banks have a long flowering season from April through to September. This period also covers the season for the main groups of invertebrates that use the banks for nectar and/or pollen.

April

Few plants were flowering in the early season (primroses, early flowering globeflowers, lesser celandine, cowslips and where there was scrub, willows). Because of this and the low temperatures, few pollinators were recorded. The main species were peacock butterflies, the small hoverfly *Platycheirus albimanus* and early emerging queen bumblebees, particularly the buff-tailed bumblebee (*Bombus terrestris*). Willow scrub was found to attract many different bumblebee species including the only record of the mountain bumblebee (*Bombus monticola*). Willows provided foraging for other pollinators and illustrate the value of this plant to early emerging species. Although scrub could be detrimental to the flower-rich banks owing to increased shading, where it is in small amounts and on the edges of the banks, it should be seen as an asset.

May

Spring reaches its peak in May and on the banks there were many plants in flower and a wide range of species and flower types. Deep corolla flowers (long tube-like flowers) such as bluebells were the most abundant flowers on many of the banks. Bluebells were visited by bumblebee queens, butterflies such as green-veined white and a few hoverflies, most noticeably the very long tongued *Rhingia campestris*. This hoverfly was common on all the banks and especially so where there was adjacent cattle grazing as their larvae feed on the organic matter of dung.

May also sees the main flush of buttercup-type (Ranunculaceae) flowers including marsh marigold (*Caltha palustris*) and creeping buttercup (*Ranunculus repens*). These flowers are flat and shallow and are easily accessible to small pollinators or those with short tongues. Almost all of the small hoverfly species recorded preferentially selected these buttercup-type flowers in May and also well into summer when there was an even greater range of flat flowers like tormentil (*Potentilla erecta*) to diversify the foraging. The Nationally Local species *Platycheirus scambus* (restricted to damp grasslands) was often found on these flowers. One species synonymous with buttercups is the common grassland hoverfly *Cheilosia albitarsis*. This species of hoverfly was most abundant on the flower-rich banks in the early part of the year when there were the most buttercups in flower. Other useful flowers at this time of year included wood crane's-bill (*Geranium sylvaticum*) which, being a shallow, flat flower was utilised by many of the hoverflies and some of the bumblebees like the small garden bumblebee (*Bombus hortorum*).

Platycheirus scambus

May saw a rise in specialist species, including the Nationally Scarce hoverfly *Cheilosia pubera*. This hoverfly was only found at one location and is known to forage from marsh marigold but was recorded from water avens (*Geum rivale*) in this survey, the reputed larval foodplant for this marshy habitat-associated species. This scarce hoverfly may be present at other flower-rich banks in the area, especially those with good abundances of both marsh marigold and water avens.

A number of non-pollinators were recorded that are equally dependant on the banks including the old pasture and unimproved meadows click beetle *Ctenicera pectinicornis* - a spectacular metallic beetle with long feathery antennae. This beetle is Nationally Scarce and therefore an asset to the area. Even scarcer is the Red Data Book 2 marsh marigold leaf beetle (*Hydrothassa hannoveriana*). As its name suggests, it is a beetle that lives on marsh marigolds. Although the plant itself is common the beetle is not. The reason for this may be owing to the management of these sites. Low inputs, low disturbance, a high water table and very good connectivity to other similar sites may be some of the reasons for the very strong populations of this beetle across many of the sites in Teesdale.

Hydrothassa hannoveriana – Marsh marigold leaf beetle

June

This time of year is the peak of invertebrate activity and diversity. This is because it is the overlap between spring species and summer species and day length is at its peak, maximising nectar and

pollen foraging opportunities for day-flying insects. There was a very wide range of flower types and species. As a result, the flower-rich banks were at their richest at this time.

This month saw the first records of the moss carder bee (*Bombus muscorum*), one of the flagship species of the flower-rich banks. It is a very scarce species nationally but in Teesdale was found on five banks suggesting a strong local population (none were found in Allendale). The bee was found to forage from a number of flower species on the banks, but yellow vetchling (*Lathyrus pratensis*) was the most frequently visited in June. It is important to maintain the extent of the network of flower-rich banks as this species forages over a wide area and will need all of them to maintain the healthy colonies in the North Pennines AONB.

The chimneysweeper moth (*Odezia atrata*) was one of the most conspicuous species on the banks at this time of year. It was found on almost all the banks, where it is associated with pignut (*Conopodium majus*) and is an old or established meadows and pasture species.

Hydrothassa marginella leaf beetle

The specialists in June included a range of flies and beetles that are not directly pollinators but depend on the flower-rich banks because of their low disturbance and sensitive management. The moorland snipefly *Symphoromyia crassicornis*, for example, is extremely localised in its national distribution and has probably been lost from many areas due to the draining and disturbance of land. Also found in quite high numbers was the leaf beetle *Hydrothassa marginella* which was often swept from marsh marigold.

July

High summer and the meadows adjacent to the banks were cut so foraging for nectar-feeders was limited to these flower-rich oases. In this month the bumblebees reached peak activity and colony size. There was also a shift in flower types. Tall summer perennial flowers like knapweed (*Centaurea nigra*), thistles (*Cirsium* species), meadowsweet (*Filipendula ulmaria*) and devil's-bit scabious (*Succisa pratensis*) started to dominate the swards over the shorter, early-season flowers and much of the foraging moved across with them.

The large, conspicuous hoverfly *Sericomyia silentis* (a bog breeding hoverfly species) was common along the banks at this time of year feeding on thistles and was very partial to devil's-bit scabious from late July onwards. Some of the spring hoverfly species also peaked again in July with a second brood. The colourful, damp-loving *Platycheirus granditarsus* - shiny black with red blotches on its abdomen - was a common species for much of the year on the banks and in July it was particularly visible on tormentil flowers and occasionally on wild angelica (*Angelica sylvestris*). Being a small hoverfly, it prefers these open, flat flower types.

July also saw two glimpses of the dark green fritillary (*Agrynnis aglaja*) in Teesdale. This large butterfly feeds from thistles and knapweed and the larvae eat a range of violets including common dog violet (*Viola riviniana*) and marsh violet (*Viola palustris*). It is a localised species and not seen often as it flies very fast and low over grasslands, marshes and moorlands.

August

Cattle were grazing many of the sites in August and, as a result, the flowering plants were reduced to very low levels. There was still activity on the banks, though at some sites it was minimal. Small hoverflies persisted as they could forage from low-growing tormentil that was often left by the cattle. Where there was heavy poaching and grazing on the banks, the sward height and structure was reduced so that even these small pollinators disappeared.

However, where some taller flowers were left (mainly devil's-bit scabious and meadowsweet), bumblebees and hoverflies would congregate around them but numbers were lower than in July. *Sericomyia silentis* and the *Eristalis* hoverflies were the most numerous and frequent pollinators in August with sporadic records of bumblebees. Butterflies including the green-veined (*Pieris napi*) and small white (*Pieris rapae*) were common in some localised places, especially in sheltered sunny spots.

Even in August new species were found. The late summer and autumn specialist hoverfly *Arctophila superbiens* was seen in both Teesdale and Allendale*. A. superbiens* is another species that likes damp ground, particularly at woodland fringes or glades. This carder bee-mimicking hoverfly foraged mainly from devil's-bit scabious.

Species recorded

Table 1. Breakdown of all the species recorded on the banks.

	Site: Teesdale☐ Allendale ☐									
Family of insect	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Hoverflies	22	27	15	25	23	22	18	23	21	24
Beetles	10	12	12	20	18	14	9	18	11	6
Butterflies and day-flying moths	7	6	5	6	6	5	9	7	7	7
Bumblebees	11	5	5	5	6	5	5	3	6	6
Other flies	4	3	5	4	7	4	4	5	4	7
True bugs	3	3	3	4	7	3	2	4	3	5
Miscellaneous	0	0	0	0	0	0	0	0	1	0
Other bees and wasps	1	0	3	0	0	0	0	2	0	0
Total pollinators and bank-dependant insects	58	56	48	64	67	53	47	62	53	55

Table 2. Breakdown of the number of species recorded across all sites.

Species group	**Number of species recorded**
Hoverflies	54
Beetles (different families)	49
Bugs	17
Butterflies and day-flying moths	14
Bumblebees	11
Soldier beetles	8
Leaf beetles	7
Mining bees	3
Others	14

Table 3. Species of high conservation interest

NERC Act Section 41 species, Red Data Book species and other species of interest			
Scientific name	**Common name**	**UK Status**	**Sites**
Bombus cryptarum	"Cryptic" white-tailed bumblebee	Unknown (local)	4
Bombus magnus	"Upland" white-tailed bumblebee	Unknown (local)	4
Bombus monticola	Mountain bumblebee	Localised to upland areas	1
Bombus muscorum	Moss carder bee	NERC Act Section 41 species of principal importance	1, 2, 6, 7,10
Cheilosia pubera	A hoverfly	Nationally Scarce – adults visit water avens in base-rich fens and marshes.	10
Coenonympha pamphilus	Small heath butterfly	NERC Act Section 41 species of principal importance	2
Ctenicera pectinicornis	A click beetle	Nationally Scarce "A"- a species associated with unimproved meadows	2, 4, 6
Eristalis rupium	A hoverfly	Highly localised - this hoverfly is a northern speciality species, favouring wet, marshy areas with plentiful flowers.	2, 6, 7, 9
Hydrothassa hannoveriana	Marsh marigold leaf beetle	Red Data Book 2 – associated with marsh marigold	1, 2, 4, 6, 7
Prasocuris junci	Brooklime Leaf Beetle	Local, very localised in northern England	8
Symphoromyia crassicornis	Moorland snipefly	Localised to high quality wet upland areas, often near to streams.	4, 10
Trichopsomyia flavitarsis	A hoverfly	Highly localised species associated with rushes	1, 2, 6
Zacladus geranii	Meadow crane's-bill weevil	A local southern species, becoming scarce in the north of England	2, 4, 5, 8, 10

All the species recorded of high conservation interest are associated with wetland habitats of varying types. The moss carder bee and the moorland snipefly are also biased to upland areas and wet sites. This reinforces the value of the wetland elements of the flower-rich banks and the importance of retaining the wet character of them for this suite of species.

Bombus muscorum (moss carder bee) on common knapweed

Analysis and interpretation

Flower types and attractiveness

There are three main flower types that dominate the swards on the flower-rich banks. These are open, flat flowers, represented by buttercups, stitchworts, speedwells and tormentil, the thistles and thistle-like flowers, especially knapweed, and the deep to very deep flowers like betony, vetches, trefoils and bluebells. Most of the hoverflies, being small and having short tongues, like the open, flat buttercup-type flowers. Creeping buttercup, meadow buttercup and marsh marigold are

especially favoured by spring and early summer hoverflies. Later in the year, tormentil is highly favoured by very small hoverflies like *Sphaerophoria* and *Neoascia* species. Larger hoverflies are less fussy and can forage from a wider range of flowers including the large, deeper flowers including the thistles and knapweed. Species such as *Sericomyia silentis*, *Volucella bombylans* and the honeybee-mimicking *Eristalis* hoverflies favour these larger flowers, partly due to them being deep flowers, perhaps with greater nectar rewards, but also because these insects are quite heavy so may find it difficult to land on a small delicate flowers such as tormentil or speedwells. The exception to this is *Rhingia campestris* which has an exceptionally long tongue and can acquire nectar from the deepest of flowers including bluebells.

Volucella bomblylans (bumblebee mimic) on wood crane's-bill

After the hoverflies, the bumblebees are the second most obvious pollinating group on the flower-rich banks and include both long and short-tongued species. Having a range of flower types on a site means that bumblebee species with different tongue lengths can occupy the same site at any one time. Examples of non-competitive species include the early bumblebee (*Bombus pratorum*), which has a short tongue, and the small garden bumblebee (*Bombus hortorum*) that has a very long tongue.

Specialisation in foraging from a specific flower species is limited to specialists such as *Cheilosia albitarsis* which only forages from buttercups. The foraging preference for most of the invertebrates largely depends on a number of factors. One of these is the "optimal time" to visit a flower. The optimal time can be: a season, such as when the flower has fully opened; a week, when the pollen is mature and the time of day. Nectar and pollen availability is regulated by plants and environmental factors so that they do not compete with other flowers for the pollinator services of the flower-visiting invertebrates. The changing state of flowers releasing nectar and pollen results in changing behaviours of invertebrates using the flowers and the banks throughout a day, week and season.

The physical attributes of different insect pollinators (body size, tongue length) enable them to co-exist at a single site. This coupled with the role plants play in regulating nectar and pollen means it is important to retain as wide a range of flower species and flower types as possible. This variation and diversity of flowers in turn leads to a diverse nectar-foraging resource of invertebrates attracted to the banks to live, feed and breed.

Another key factor is flower abundance. High densities of flowers or "super abundances" are of great benefit to invertebrates. The plant species itself is not necessarily important; putting specialist invertebrates to one side, it is the type or shape of flower that is important. Availability of lots of flowers of a similar type, especially over a long flowering season, will help provide nectar and pollen to a range of species which target that type of flowers. When this is coupled with a range of flower types (i.e. shallow flowers and deep flowers) at a single site, the results is a strong flower resource, which many of the flower-rich banks sampled during this survey have.

Flower-rich banks and hydrology

Although the banks are on slopes and some of them are quite steep, many are wet. This wetness and particularly the movement of surface and near-surface waters results in an interesting fauna.

Chrysogaster solstitialis – a hoverfly found in wetter habitats

Due to the overall high water table and movement of water through the slopes, elements of the banks are more closely associated with wetland marshes and fen assemblages than dry grassland assemblages. There are many examples of species that live and breed on the banks that would not be there if it weren't for their wet character. The hoverfly *Eristalis rupium* is a honeybee-mimicking hoverfly that is very localised in its national distribution. Like many of the wetland species found on the banks, it is probably restricted in Teesdale and Allendale due to modernisation of farming methods and the need for more improved dry land for stock rearing elsewhere. *E. rupium* likes marshy places with lush vegetation and lots of flowers, summarising succinctly the character of many of the banks. *Trichopsomyia flavitarsis* is another indicator species, this time a tiny black and yellow hoverfly. *T. flavitarsis* likes fen-type habitats with jointed rush in which its larvae develop alongside the gall-forming psyliid *Livia juncorum*. It may use other species of rush too. There are many more species found on the banks associated with very particular wetland niches such as seepages, slow water movement, muddy bare ground (from poaching), gullies or wet ditches. The inability (or desire) to manage and improve these banks in the past has enabled complex niches and interrelationships to develop between the habitat and associated invertebrates. These bog, mire and fen invertebrate species are also associated with sites that have high abundances of flowering plants, for example *Eristalis rupium* and the moss carder bee.

Invertebrate Species-habitat Information System (ISIS)

The Invertebrate Species-habitat Information System (ISIS) computer application can be used to identity important assemblages of invertebrates by inputting species lists. The data for Teesdale was combined for this purpose because many of the sites are believed to be inter-related owing to their comparatively close proximity. All invertebrate species are assigned a score depending on their rarity (Fowles *et al.* 1999). Using these scores, an overall rarity score is derived for each Broad Assemblage Type (BAT). Fifty six species (42%) of the species recorded are associated with the Grassland & Scrub Matrix Broad Assemblage Type and the combined rarity score for these is 136. Twenty four species (18%) of the species recorded are associated with the Permanent Wet Mire Broad Assemblage Type and the combined rarity score for these is 167. This analysis shows that the species recorded from the surveys that are associated with the permanent wet mire have higher specificity and ecological value than those associated with the grassland and scrub matrix.

The ISIS analysis highlights the importance of hydrology to the banks and the need to manage the water that passes through them. Draining or culverting adjacent land would impact these slopes and should be avoided to retain and maintain the integrity of the flower-rich banks.

Female white-tailed bumblebee on meadowsweet

Management of the flower-rich banks

The current management of the banks appears to be minimal, being grazing from late July/August.

Given that there are many flower-foraging species using the banks that may be sensitive to disturbance pressures, the banks do not appear to be managed unsympathetically. The advice concerning management would therefore be to retain the current regime and methods employed. Some banks do have fewer species associated with them than others or lack species associated with the more niche situations. This may be due to over or under-grazing, the aspect of the bank (cool north-facing), surrounding land management or other reasons not immediately obvious from this study. Without further assessment it would be difficult to conclude a specific reason. The most likely reason though is that some sites are naturally drier than others. As most of the scarce and high fidelity species (niche specialists) have been found to prefer wet sites, it would be expected that the drier sites would yield fewer species of value and not score as highly as those with a wetter character.

There are a few potential issues that may become problematic in the future relating to meadowsweet along some of the banks. This plant is tall and dominant in late summer, out-competing other flowers. Although it has lots of flowers, its range of pollinators was relatively small and it also has no high fidelity species associated with it (flower-dependent species). A wider range of flowers would be of greater benefit than a mono-stand of meadowsweet.

Bombus hypnorum – Tree bumblebee on willow

Willow scrub is present on or near to a few of the banks. This is a vital resource in early spring before other plants are in flower. As a resource it should be recognized as of value but its extent should be monitored. It should not be on the bank but should occupy the periphery and in a position where it does not shade the adjacent flower-rich swards. Ideally it should be on the northern side of banks where it would not interfere with sunlight penetration.

Once the hay meadows are cut in July, the flower-rich banks are one of few local flower resources still useful to the local pollinator species. Where banks are in isolation from one another, extending the flowering resources would be advisable and can be done through retaining a margin around the field boundary. In this way the foraging resource is increased in area and also extended in time, enabling later summer species to still find sufficient resources through August and into early September.

Management to avoid/monitor

Over or under-grazing are both issues of concern to invertebrates, as both would affect the floral composition, the structure of the swards and level of trampling. The ideal sward is one that is diverse in flower species and flower types and is a complex range of heights from short to tall. It is this range of flowers and structures that gives the banks their diversity of invertebrate species. Maintaining this is important and monitoring the effect of grazing is required to ensure that this is being maintained. Should the sward structure reduce, then an adjustment in grazing may be required. The limited trampling is not thought detrimental to the sites but in fact opens up small muddy hollows that are ideal breeding locations for some of the wetland hoverflies. However, this too should be periodically monitored and in very wet years grazing should be minimized on the slopes to prevent the creation of too much bare and disturbed ground.

Ancillary habitats and features of value

The flower-rich banks are not features in isolation. They are part of the landscape and consequently are affected by and affect the surrounding land and the species composition of it. Bumblebees are noted for their wide-ranging foraging across a landscape. They move between sites as particular flower species come into flower, release nectar and the pollen ripens. This is one aspect of the bumblebee's lifecycle that is important, the other is nesting. The banks are lush and provide suitable nesting for many species of bumblebee. In some situations however the vegetation is too dense and casts too much shade. Surrounding land may provide more optimal nesting for bumblebee species such as the buff-tailed bumblebee and the white-tailed bumblebees.

The common hoverfly *Rhingia campestris* is a frequent visitor to the banks and pollinates flowers such as bluebells, wood crane's-bill and devil's-bit scabious. Its larvae, however, live in organic matter, specifically cow dung. It is therefore dependant on nearby grazing livestock for breeding. Woodlands are a useful and important resource for some of the nectar-feeding invertebrates on the banks. There are species that will nest or breed in woodlands such as *Xylota sylvarum* (a deadwood breeding hoverfly) but which need to venture out of the woodland to sunlit areas in order to find suitable nectar. *Arctophila superbiens* (the carder bee-mimicking hoverfly) is also more commonly associated with damp, wooded landscapes but needs flowers to feed on.

The interrelationship between the many different habitat types of the North Pennines AONB is important and all contribute to the diverse nectar-feeding resource of invertebrates.

Metapopulations

The suite of species recorded on all the flower-rich banks surveyed is broadly similar. Most of the species will breed on or adjacent to the sites and feed from the super abundance of flowers on the banks. This does not happen in isolation though and there is highly likely to be interactions between separate populations of species across different sites. These interactions between populations from different sites create a strong landscape scale population. The way in which it does this is through genetic mixing (inter-population breeding). If a site were isolated and the individuals from that site had no choice but to mate with one another, over time the gene pool would shrink and any problematic mutations would become more apparent in the population. This would eventually cause a reduction in individuals and a greater chance of the population being lost either due to susceptibility to disease, parasites or environmental factors like drought or cold. Populations interacting between different sites reduces this risk.

Eristalis sp. on common knapweed

For example, a long, hot, dry summer may desiccate some sites making breeding and subsequent recruitment of new adults difficult. If this occurred on an isolated site, the species could become extinct in the area. However, where there are sites in close proximity to one another, locations where species were lost due to the drought, which are normally the smaller vulnerable ones, can be re-populated in optimal years by individuals from other nearby, often larger sites where they survived the drought. Likewise, in optimal years where all species on sites have done well, high abundances of individuals are

more likely to migrate and find new sites. This is how colonisation of new sites occurs and with more sites in sensitive land management, it would be possible to increase the distribution of some of the North Pennines AONB's rare invertebrates.

In the modern, fractured landscape where semi-natural sites are becoming more isolated and on which wildlife depend, metapopulations are becoming increasingly important. The sensitive management and retention of the open flowery banks of the North Pennines is therefore not only important to the individual species of that bank but to the overall integrity of the wider landscape population of that species: the metapopulation.

Species group summary

There were 177 different pollinator or flower-associated species recorded from the flower-rich banks. Given that this study only covered ten sites totalling 11.57 ha of habitat and therefore a very small fraction of the North Pennines AONB's total area, this is a relatively high density of species. The list of pollinators is also not exhaustive and there are undoubtedly more pollinator species to be found on the banks and this study does not include all known pollinator species or groups. The broad fly group "Musciodea" that includes houseflies and greenbottles were not included in the study due to time and cost restraints. If this group were included, the total would be much higher. However, the total does serve to illustrate how important the flower-rich banks are to local pollinators and those invertebrates dependant on flower-rich places. Even small sites were found to be of value and it is important to place as much emphasis on these small sites as it is to protect the larger sites as they perform an equally important ecological function.

Fifty four of the species recorded were hoverflies. This is a good total, given the similarity of sites studied and therefore high replication between the sampling locations. Only the beetles were close in terms of species totals but this very large group includes many different families whereas the hoverflies is a single group.

Ringlet butterfly on thistle

The number of butterflies is also quite strong, again given the relative similarity between sites. This included one "species of principal importance" the small heath, although this was rare and only seen on a single occasion. The most frequent butterflies were the whites, especially the small white and green-veined white, which have more than one brood in a season. The peak for butterfly activity was July when the meadow brown and ringlet were present on the banks along with the white butterflies and others such as small tortoiseshell and dark green fritillary.

Surprisingly, mining bees were very few on the banks and were only recorded from a single site which has small areas of bare ground on the slopes in which the bees nest. The other sites did not have any solitary bees as the ground is predominantly too damp and vegetation too lush to support ground nesting species. This was also the reason why just a single grasshopper species was recorded from the banks (the common green grasshopper, *Omocestus viridulus*).

Bumblebees were broadly frequent on all banks but it was mainly the common carder bee that was most frequently seen. The heath bumblebee (*Bombus jonellus*), mountain bumblebee (*B. monticola*), “cryptic” white-tailed bumblebee (*B. cryptarum*), “upland” white-tailed bumblebee (*B. magnus*) and tree bumblebee (*B. hypnorum*) were all seen on just a single occasion or at a single site. All other species recorded were seen on at least two occasions or more than one site. Habitat connectivity is important for bumblebees. The presence of the rare moss carder bee (*Bombus muscorum*) in Upper Teesdale indicates that the flower-rich banks in this area are functionally connected. For this and many other species to persist, at least the current extent of diverse, flower-rich habitat needs to be retained.

The other families recorded were in much smaller numbers but did include some interesting species. The Moorland snipefly (*Symphoromyia crassicornis*) was one such species of interest. It prefers damp ground and often near to streams. This single species serves to reinforce the importance of landscape mosaics - the close proximity of one natural feature to another. Areas where woodland meets grassland and stream meets lush marginal vegetation or moorland meets the flower-rich banks are of high conservation importance. Loss of or the homogenisation of these features erodes the relationship between them and the fauna of the area, which would ultimately degrade biodiversity.

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Globeflower bank in Teesdale © Andy Jukes