


Glasgow's Buzzing final project report

September 2014

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Saving the small things that run the planet

Summary

Wildflower species-rich grasslands created and enhanced through this project have provided vital important habitat for invertebrates, especially pollinating insects as well as other wildlife. Over 13 hectares of wildflower meadow across 13 parks have benefitted through this project and have provided 'stepping stones' for wildlife across Glasgow.

During this pollinator survey, a total of 66 species of invertebrate were recorded across seven parks (Kelvingrove Park, Pollok Country Park, Bellahouston Park, Victoria Park, Botanic Gardens, Alexandra Park and Auchinlea Park). A total of 139 species of invertebrate have been recorded during the project and as only a very limited amount of time is spent during each survey, this highlights just how important these sites are for invertebrates.

All of the meadow areas surveyed for this study and the meadow at Linn Park were enhanced during the final year of this project. Volunteers helped to plant wildflower plug plants and sow Yellow rattle seed and a diverse mix of native wildflower seed was also sown.

On project completion, it is recommended that the wildflower meadows continue to be created, enhanced, and expanded. This will further benefit wildlife, especially pollinating insects that have been experiencing significant declines across the UK, by providing foraging habitat and will also provide additional areas that will act as stepping stones across the city of Glasgow to allow the movement and mixing of individuals and species.

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1. Introduction

A massive 97% (over 3,000,000 hectares) of flower-rich grassland have been lost in the UK since the 1940's through agricultural intensification to produce more home-grown food, and through wider development of housing, transport infrastructure and industry. These flower-rich areas are vital habitats for a range of wildlife species, particularly pollinating insects such as bees, butterflies and hoverflies (Figure 1). The loss of wildflower meadows across the UK has resulted in a massive decline in pollinators as well as other invertebrate species. Over 250 species of pollinating insects in the UK are in danger of extinction and are on the UK Biodiversity Action Plan (UKBAP) priority species list.

Figure 1. Buff tailed bumblebee (*Bombus terrestris*) foraging on Common knapweed (*Centaurea nigra*) at Auchinlea Park.

Eighty percent of plants need insects for pollination and without these plants we would not have the air we breathe and the food we eat. Pollinators are thought to be responsible for one in every three mouthfuls of the food that we eat and it is estimated that 84% of crops in the European Union (valued at £12.6 billion per annum) rely on insect pollinators. In the UK, pollination of agricultural crops by insects is valued at more than £400 million. National reports in the press stress the importance of honeybees in food production but wild bees and other insects are even more important as they are adapted to pollinate a much wider range of plants. With the recent decline in pollinating insects, there is evidence that insect pollinated plants are also declining and at a faster rate than wind and water pollinated plants.

Buglife has joined forces with Land and Environmental Services - Glasgow City Council (LES-GCC) to transform mown grassland in urban areas into colourful and wildlife-rich wildflower

meadows across Glasgow. These wildflower meadows will not only provide habitat for invertebrates but will also provide food and nesting areas for a range of other wildlife such as birds, amphibians and small mammals. In Glasgow, wildflower meadows are a Local Biodiversity Action Plan priority habitat. This project started in May 2011 and is funded by the Landfill Communities Fund.

2. Pollinator surveys

During each year of the project, Buglife have undertaken surveys to record invertebrates, focusing on pollinating insects within the meadows. These surveys have occurred before and after meadow creation and enhancement.

At the end of year three of the project, surveys have occurred at seven parks; including three from years two and three of the project (Pollok Country Park, Bellahouston Park and Victoria Park), one from year one and three (Kelvingrove Park) and three from year three (Botanic Gardens, Alexandra Park and Auchinlea Park) and these final surveys allowed for three years of surveys to be completed at Pollok Country Park, Bellahouston Park, Kelvingrove Park and Victoria Park and two years of surveys at Botanic Gardens, Alexandra Park and Auchinlea Park.

Invertebrate surveys concentrated on pollinating insects such as bees and wasps (Order Hymenoptera), hoverflies (Family Syrphidae, Order Diptera) and butterflies and moths (Order Lepidoptera). Other invertebrate species found during the survey were also recorded.

2.1 Method

Invertebrates were surveyed during a single visit to each park. The surveyor walked a transect across the park using direct observations and a sweep net to survey for invertebrates, concentrating on pollinating insects such as bees, butterflies and hoverflies. The surveys were undertaken during dry and warm days in August at a similar time to previous pollinator surveys (Table 1).

Table 1. Date each park was surveyed for pollinators and grid references of meadows surveyed for each of the seven parks.

Park Name	Grid Reference	Date Surveyed
Alexandra Park	NS619657	05/08/2014
Auchinlea Park	NS666662	05/08/2014
Bellahouston Park	NS545635	13/08/2014
Botanic Gardens	NS566676	05/08/2014
Kelvingrove Park	NS568663, NS569663	05/08/2014
Pollok Country Park	NS557619, NS548620	13/08/2014
Victoria Park	NS539671	05/08/2014

2.1.1 Sweep nets

Sweep nets were used to collect invertebrates from vegetation, particularly from flower heads (Figure 2). The net was swept over vegetation in a figure of eight for 1 minute in a transect across a site. Specimens collected in this way were either put into a pot with 70% ethanol to be identified later or if they could be identified by the surveyor at the park the specimen was later released.

Figure 2. A sweep net is used to collect invertebrates on vegetation especially pollinating insects on flowers.

2.1.2 Direct observations

Identification of several species of bees, wasps, butterflies, moths and hoverflies were made through direct observation of specimens visiting flowers or in flight during a site survey. Sweep nets were sometimes used to aid in identification of a species which could then be released. Other species identified through direct observations included grasshoppers (Order Orthoptera), and some beetles (Order Coleoptera).

2.2 Results

A total of 66 species of invertebrate were recorded during this survey; this includes six that were identified to genus and a further two that were identified to family level. Hoverflies made up the greatest number of species recorded across the seven parks as a total of 17 species were identified (Figure 3); four other species of fly were identified and these are included in 'other species'. There were 10 species of bees, wasps and ants recorded and six species of butterfly and moth (Figure 3). Some of the other invertebrate species recorded across the seven parks included beetles: 12 species, true bugs (Order Hemiptera): 11 species

and mayfly: one species (Figure 3). A complete list of invertebrate species recorded can be found in Appendix 1.

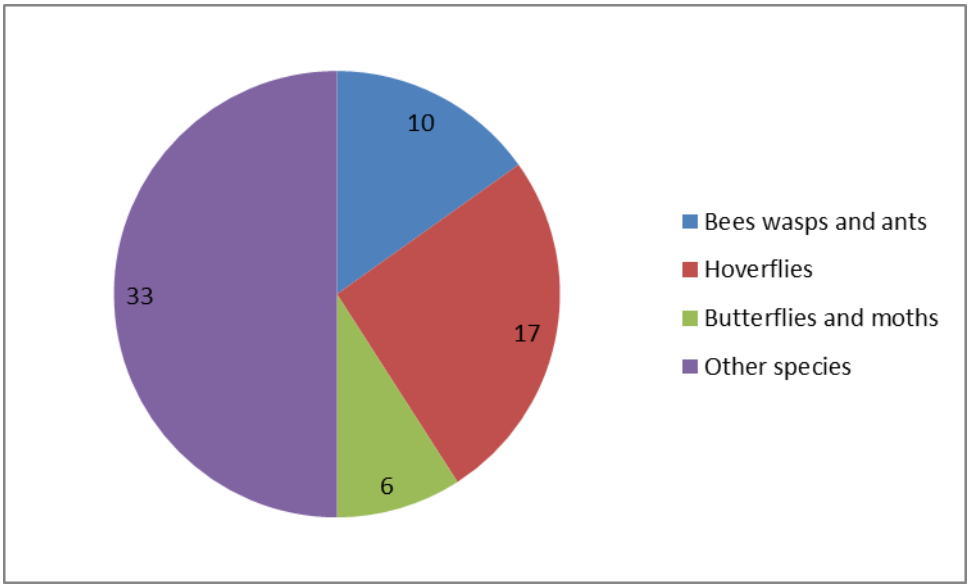

Figure 3. Total number of pollinator species recorded across the seven parks in Glasgow including bees, wasps and ants, hoverflies and butterflies and moths; the category 'other species' includes all other invertebrates and flies that are not hoverflies.

Alexandra Park had the greatest number of invertebrate species recorded during this year's survey with a total of 30 species (Figure 4). The fewest number of invertebrates were recorded at Bellahouston Park and Botanic Gardens that both had a total of 18 species (Figure 4). Kelvingrove Park had the greatest number of species of hoverfly and bees, wasps and ants with a total of nine species for each (Figure). The lowest number of hoverfly species was recorded at Victoria Park with a total of four species (Figure 4). Botanic Gardens had the lowest number of bees, wasps and ants recorded with only four species (Figure 4). No species of butterfly or macro moths were recorded from Bellahouston Park (Figure 4).

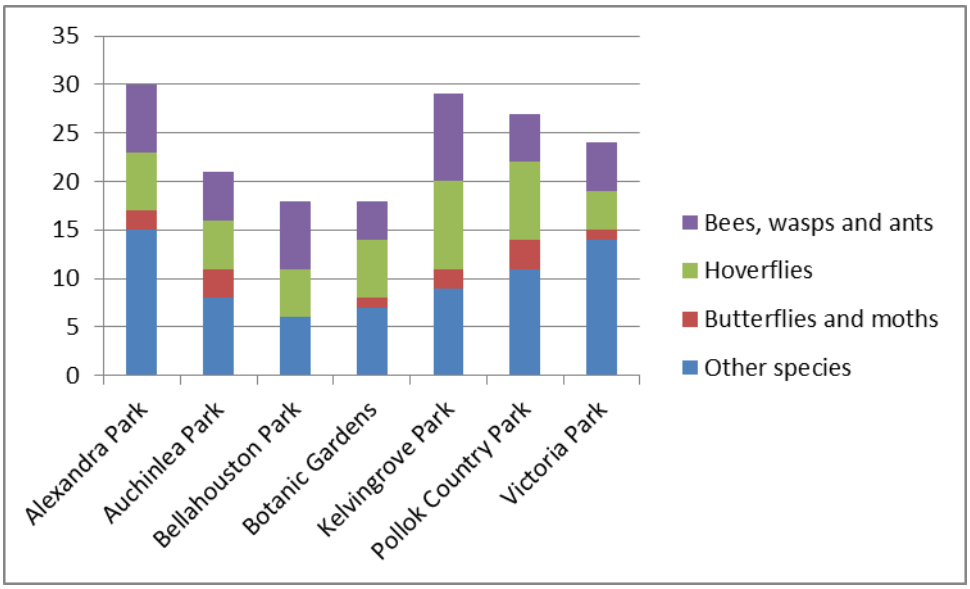

Figure 4. Graph showing the total number of bees, wasps and ants; hoverflies; and butterflies and moths; and all other invertebrate species (including flies that are not hoverflies) recorded at each of the seven parks surveyed in Glasgow.

Four of the parks surveyed during this year have been surveyed in two previous years (Bellahouston Park, Kelvingrove Park, Pollok Country Park and Victoria Park) (Figure 5). Of these four parks, Kelvingrove Park had the total highest number of invertebrates with 43 species and this includes two species that were only recorded in year one of the project, 12 species in year two only and 15 species in year three only, a further two species were recorded in each year of the project and 12 species over two years (Figure 5). A total of 42 species were recorded at Pollok Country Park over the three years of the project with an additional 11 species recorded during this survey (Figure 5). Victoria Park had a total of 34 species and Bellahouston Park a total of 32 species (Figure 5).

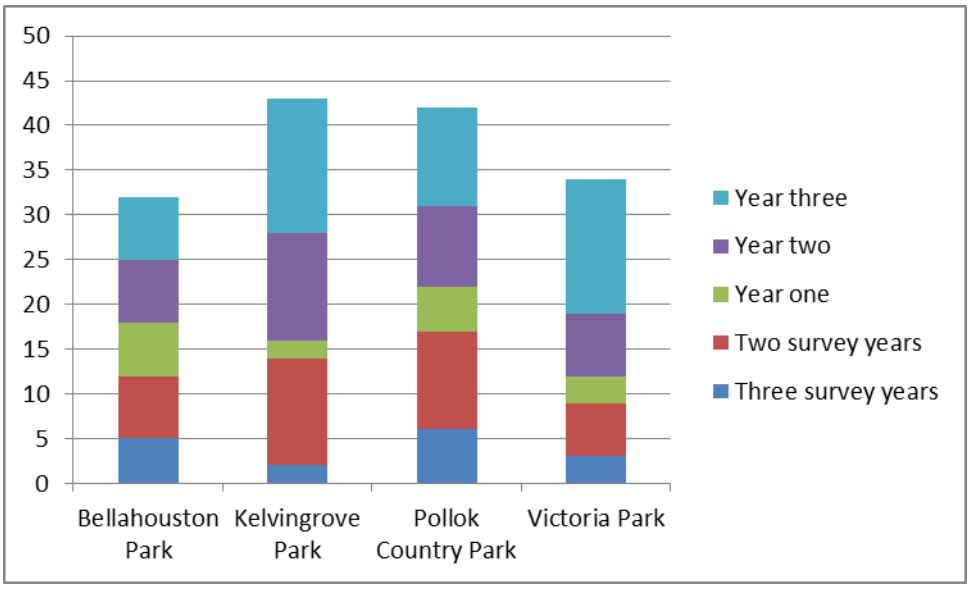

Figure 5. Total number of species recorded at four parks surveyed over three years of the project (Bellahouston Park, Kelvingrove Park, Pollok Country Park and Victoria Park); graph shows species recorded during year one, year two, year three, during two years of the survey and during all three years.

The remaining three parks, Alexandra Park, Auchinlea Park and Botanic Gardens, were surveyed at the start of year three of the project (Glasgow's Buzzing: pollinator survey year 3) and at the end of year three for this study (Figure 6). Of these parks, Alexandra Park had the highest number of invertebrates recorded over the two surveys with a total of 38 species (Figure 6); a total of 11 species were recorded during both surveys at this park, eight species were recorded only at the start of year three of the project and 19 species at the end of year three of the project (Figure 6). Auchinlea Park had a total of 31 species and Botanic Gardens had 25 species (Figure 6).

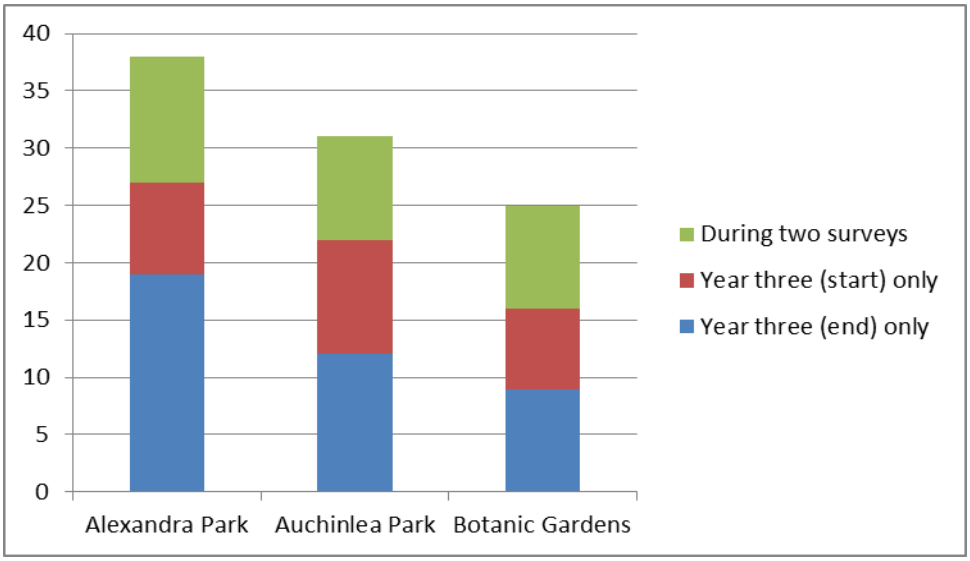

Figure 6. Total number of species recorded at parks surveyed over two years (Alexandra Park, Auchinlea Park and Botanic Gardens); graph shows species recorded at the start of year three only, the end of year three only and during the two surveys.

2.2.1 Total species recorded over the project

Over the three years of the project a total of 139 species of invertebrate have been recorded (Figure 7); this includes 14 species recorded during this years survey. The invertebrate order with the highest number of species recorded over the project is flies with 33 species and this includes 29 species of hoverfly (Figure 7). A total of 27 species of true bug were recorded, 24 species of beetle and 20 species of butterfly and moth (Figure 7). Several smaller orders had only 1 species recorded each including harvestman (Order Opiliones), earwig (Order Dermaptera), mayfly (Order Ephemeroptera), lacewing (Order Neuroptera), stonefly (Order Plecoptera) and a snail (Phylum Mollusca); these were included in one group under small orders (Figure 7).

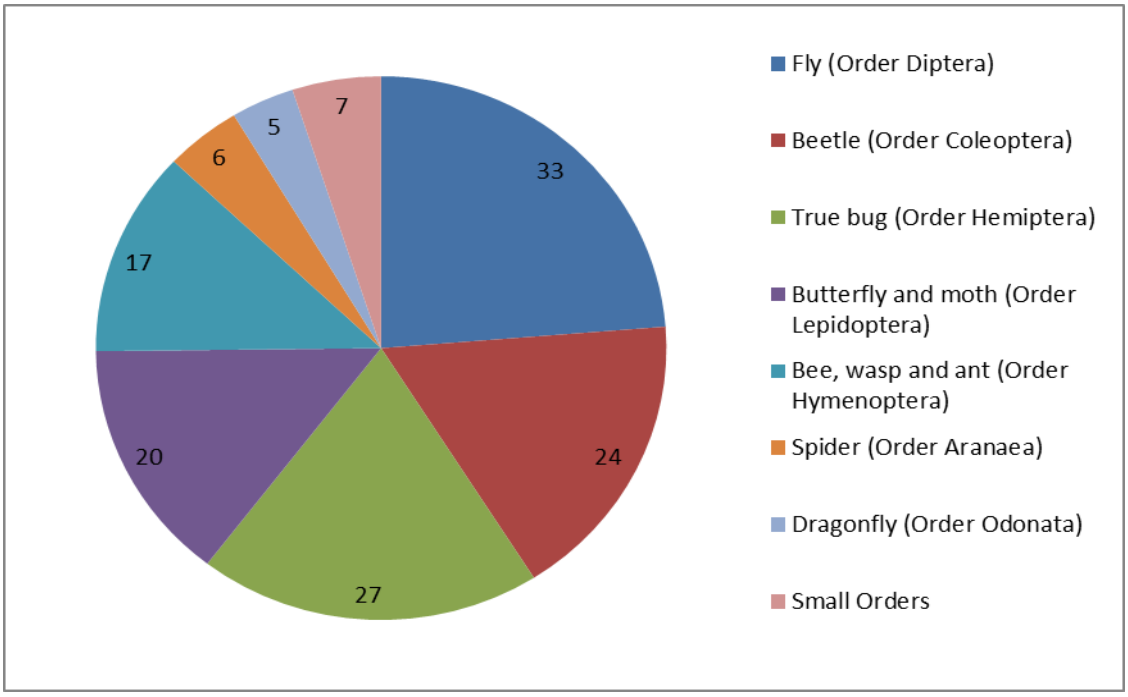

Figure 7. Total number of invertebrate species collected from each order during the three year pollinator survey. Small orders includes harvestman, grasshopper, lacewing, mayfly, snail, stonefly and earwig where one species was recorded from each group.

Over the four pollinator surveys, 22 species of invertebrate were recorded during every year, 16 species were recorded over three years and 32 species over two years (Figure 8). Of unique species each year, six were recorded in year one, 15 in year two, 33 at the start of year three and 17 at the end of year three (Figure 8).

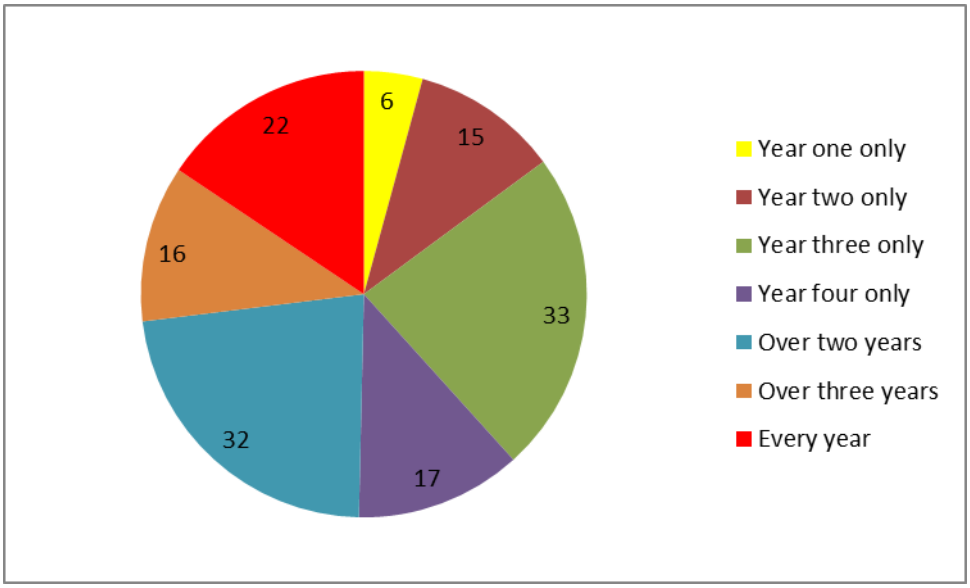

Figure 8. Graph showing the number of invertebrates recorded every year of the project, over three years, over two years and the numbers recorded only in year one, two, three and four of the project.

2.3 Discussion

This year in Scotland, the winter was mild and the spring and summer have been fairly warm and dry. It is thought that this has helped to boost some populations of invertebrates as well as helping some species recolonize sites they have previously been lost from.

Many pollinating insects such as bumblebees and some hoverflies were seen in far larger numbers this year than during the pollinator surveys in 2011 and 2012 when the overall summer weather was wetter and cooler (see Glasgow's Buzzing: pollinator surveys year one and year two). Butterflies were seen in fewer numbers during this year's survey, although this may be due to the fewer number of parks that were visited (Figure 9).

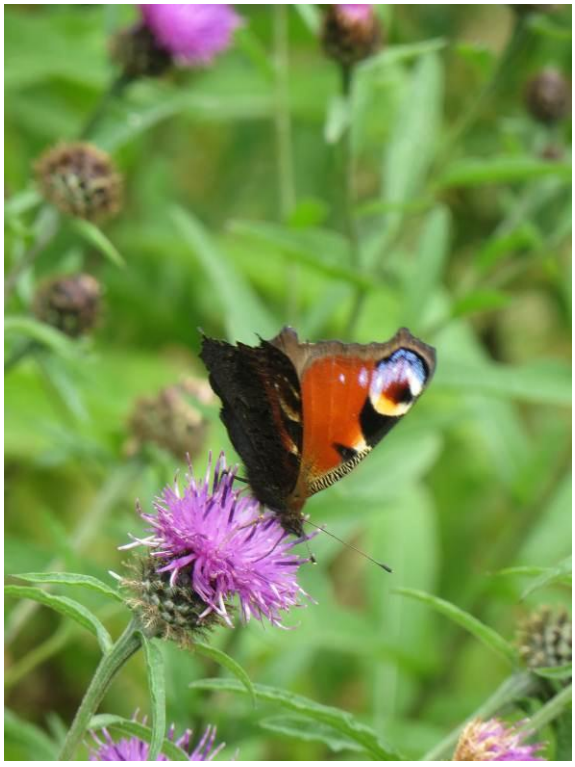

Figure 9. Butterflies such as this Peacock butterfly (*Inachis io*) were seen in far lower numbers in this years survey.

During this pollinator survey a total of 66 species of invertebrates were recorded during across the seven parks. This is lower than the previous year when a larger number of sites were surveyed (totalling 13 parks) and a total of 103 species were recorded; although, it is higher than surveys from year one of the project in August 2011 when 55 species were recorded across seven parks and from year two of the project in August 2012 when 57 species were recorded across eight parks.

Altogether, 17 species of hoverfly where recorded during this survey including several that have been recorded in previous years such as the Chequered hoverfly (*Melanostoma scalare)* and Drone fly (*Eristalis tenax*) as well as others that have previously not been recorded including *Eupeodes luniger* and the sawfly mimic the Gold-belted hoverfly (*Xylota segnis*). The Marmalade hoverfly (*Episyrphus balteatus*) and the Lesser banded hoverfly (*Syrphus ribesii*) were recorded from almost every park surveyed and were often seen in large numbers.

Bumblebees and wasps were seen at every park visited and often in high numbers, especially in parks where the meadows had plenty of wildflowers such as Common knapweed (*Centaurea nigra*). A total of 10 species of bees, wasps and ant were recorded across the seven parks. As with the previous years survey (see Glasgow's Buzzing: pollinator survey year 3) the Common carder bee (*Bombus pascuorum*) and Buff tailed bee (*Bombus terrestris*) were identified as being the most frequently seen species of bumblebee and both were recorded at all seven parks. Red tailed bee (*Bombus lapidarius*) and White tailed bee (*Bombus lucorum*) were recorded at most of the parks surveyed and were also very abundant (Appendix 1). Other bees recorded during this year's survey that have been recorded in previous years include the solitary mining bee *Colletes daviesanus* (Figure 10), that was observed foraging on flowers at Alexandra Park, Bellahouston Park and Kelvingrove Park and the solitary parasitic bee *Sphecodes geoffrellus* that was again recorded foraging on Ragwort (*Senecio jacobaea*) at Alexandra Park and Kelvingrove Park.

Figure 10. The solitary bee *Colletes daviesanus* foraging on an Oxeye daisy (*Leucanthemum vukgare*) at Bellahouston Park.

Very few butterflies were seen and no macro moths were recorded during this year's survey. As already mentioned, this may be due to the fewer number of parks visited and some of the parks were surveyed early in the morning when the air temperature was low. Of the five species of butterfly recorded only one individual was seen of Small copper (*Lycaena phlaeas*), Red admiral (*Vanessa atalanta*) and Large white (*Pieris brassicae*). Only one species of micro moth the grass moth Agriphila tristella was identified to species, although grass moths were seen in abundance at every meadow visited.

Altogether 12 species of beetle were recorded during this year's survey and includes the rove beetles *Stenus cicindeloides* and *Stenus similis* that were swept from grassland within

Victoria Park; *S. cicindeloides* has previously been recorded at Hogganfield Park (Glasgow's Buzzing: pollinator survey year 3) and *S. similis* has previously been recorded at Cranhill Park (Glasgow's Buzzing: pollinator survey year 2) and Linn Park (Glasgow's Buzzing: pollinator survey year 3). Ladybirds are important pollinators and four species were recorded this year including 2-spot (*Adalia bipunctata*), 10-spot (*Adalia decempunctata*), 7-spot (*Coccinella septumpunctata*) and Cream spot ladybird (*Calvia quatuordecimguttata*).

This year, the highest number of invertebrate species was recorded from Alexandra Park with a total of 30 species. This is higher than what was recorded at this park at the start of year three when 19 species were recorded. The wildflower meadow at Alexandra Park has large expanses of grass and this project has helped to enhance this area through the planting of wildflower plug plants, the sowing of a diverse seed mix and the sowing of Yellow rattle (Rhinanthus minor) seed (see section 3.7). Where there are flowers present at this park a high number of bumblebees, hoverflies and other pollinators were observed foraging. These wildflowers will continue to provide important foraging habitat for pollinating insects on completion of this project and the sowing of native wildflowers and Yellow rattle that have enhanced wildflower species diversity within the meadows.

A total of 38 invertebrate species have been recorded at Alexandra Park during pollinator surveys at the start and end of year three of the Glasgow's Buzzing project. Eleven species were recorded in both years including the Thick legged hoverfly (*Syritta pipiens*) and the parasitic solitary bee *Sphecodes geofrellus*. This year a total of 19 species were recorded that hadn't been recorded in the previous survey including Red tailed bumblebee and the lacewing *Micromus variegatus*. This highlights not only the importance of wildflower meadows for pollinating insects and other invertebrates but also how these surveys which involve only a single site visit identify a limited range of species utilising these habitats.

The lowest number of invertebrates recorded during this year's survey was at Bellahouston Park and Botanic Gardens with 18 species identified. This is higher than the number recorded in surveys at the start of year three with 15 species identified at Bellahouston Park and 16 species at Botanic Gardens.

During the previous year's pollinator survey at Bellahouston Park the wildflowers were very small in height and the surveyor identified that the meadow must have been cut at some point over the spring or summer. The meadow at this park this year looked a lot healthier and the wildflowers were taller and denser and this explains the higher number of invertebrates recorded during this year's survey. This meadow has been surveyed over three years of the project (year two and the start and end of year three) and a total of 32 species have been recorded. No butterflies have been recorded at this meadow during the entire project although the macro moths Large yellow underwing (*Noctua pronuba*) and Chamomile shark (*Cucullia chamomillae*) and the micro moth *Agriphila tristella* and other grass moths have been seen. It is not known why butterflies have not been recorded foraging at this meadow as a diverse range of wildflowers are present including Field scabious (*Knautia arvensis*) and Red clover (*Trifolium pratense*), it may be that when the surveyor has visited the site that butterflies were not present at that time. On reaching the meadow during this survey, a Goldfinch (*Carduelis carduelis*) was observed foraging from

Common knapweed and several others were heard from the nearby trees and indicate the importance of wildflowers for other wildlife such as seed loving birds.

A range of wildflowers are present within the meadow at Botanic Gardens and include Hogweed (*Heracleum sphondylium*) and St. John's wort (*Hypericum perforatum*) that provide important foraging habitat for many pollinating insects. A total of 25 species of invertebrate have been recorded over the two surveys from meadows at Botanic Gardens. The meadows appear to be particularly important for hoverflies such as the Tapered dronefly (*Eristalis pertinax*) and Gold-belted hoverfly and for the lacewing *Micromus variegatus* and the Blue-winged olive mayfly (*Serratella ignita*). Only four species of Hymenoptera were recorded during this year's survey including three species of bumblebee and the Common wasp (*Vespula vulgaris*). It was noted by the surveyor that many of the wildflowers present had already set seed and a lot of the bumblebees were seen foraging on a Lime tree (*Tilia* species). Broad-leaved helleborine orchids (*Epipactis helleborine*) were also recorded from the meadows at Botanic Gardens.

A total of 31 species of invertebrate have been recorded over the two survey years at the small wildflower meadow at Auchinlea Park. This year's survey recorded 21 species including Common green grasshopper (*Omocestus viridulus*) and several Peacock butterfly (*Inachis io*) that were not recorded in the previous survey. The meadow at this park is very diverse in wildflower species with dense clumps of Common knapweed and patches of Cow parsley (*Anthriscus sylvestris*) and Meadow vetchling (*Lathyrus pratensis*). Yellow rattle seed has been sown into the meadow to help preserve wildflower species diversity.

At Kelvingrove Park there are several wildflower meadows and this year's survey focused on those adjacent the University of Glasgow and Park Quadrant where a total of 29 species of invertebrate were recorded. Over the three survey years, 43 species of invertebrate have been recorded at this park and this includes the Common carder bee and the Common wasp that were recorded during every survey. During this year's survey, the highest number of hoverflies and bees, wasps and ants was recorded from this park and highlights how important the meadows within Kelvingrove Park are for pollinators. The dense area of Common knapweed within the meadow opposite the University of Glasgow is incredibly important for a wide range of species such as the Dead head hoverfly (*Myathropa florea*) and *Sphecodes geoffrellus* as well as the fruit fly *Chaetostomella cylindrica* which feeds on this particular species of wildflower (Figure 11). This park is well used by residents and visitors to the area and a number of large events are held here each year.

Figure 11. The wildflower meadow at Kelvingrove Park with dense stands of Common knapweed that were covered in bumblebees and hoverflies.

A total of 34 species have been recorded across the three years at Victoria Park and includes the Marmalade hoverfly, Chequered hoverfly and Common carder bee that were recorded each year. This meadow has open swards of grassland that is shaded by mature trees and a denser sward in open areas with Common knapweed, Yellow rattle and Germander speedwell. Broad leaved helleborine orchids have been recorded from within the meadow. Surveys this year recorded 24 species of invertebrate and included eight species of beetle such as the rove beetle *Tachyporus chrysomelinus* and ground beetle *Loricera pilicornis*. The lowest number of hoverflies was recorded from this park with a total of four species that included a species of Drone fly (*Eristalis* species) and *Platycheirus* species.

The two wildflower meadows at Pollok Country Park are completely different. The meadow close to Pollok House has areas with Meadow cranesbill (*Geranium pratense*) and Devils-bit scabious (*Succisa pratensis*) and an area previously identified as being wet has established Yellow flag iris (*Iris pseudacorus*), Purple loosestrife (*Lythrum salicaria*) and Sneezewort (*Achillea ptarmica*) that have previously been planted as plug plants. This meadow is incredibly important for the butterflies Green veined white (*Pieris napi*) and Small copper. The other meadow adjacent the Burrell Collection is wet with lots of Soft rush (*Juncus effusus*) and also Greater birds foot trefoil (*Lotus pedunculatus*) and Creeping buttercup (*Ranunculus repens*). The species collected from these two meadows have been combined into one list and this year a total of 27 species were recorded and included the Thick-headed fly (*Conops quadrifasciatus*) that parasitises bumblebees and the leaf hopper *Cicadella viridis*. Over the three surveys a total of 42 species of invertebrate have been recorded from Pollok Country Park and this includes six species that were recorded each year such as the Common wasp and the Common banded hoverfly.

Pollinator surveys over the project lifetime have recorded a total of 139 species of invertebrates. Surveys focused on pollinating insects and include 33 species of fly, of which 29 are hoverfly, 20 species of butterfly and moth and 17 species of bees, wasps and ants, all of which are very important pollinators of wildflowers. Over the project, 27 species of true bug were recorded and indicates the meadows importance not only for pollinating insects but also those that feed on the plants themselves. A large number of different species of beetle were recorded over the three years with a total of 24 species; this includes 5 individuals that could only be identified down to genera or family. Other groups were found in much smaller numbers including lacewings with one species (*Micromus variegatus*) and stonefly with one species (*Nemoura cinerea*).

It was expected that over the project a number of species would be recorded at several of the parks and over more than one year, especially pollinators. Twenty two species of invertebrates were recorded during each of the four pollinator surveys and includes many that are very common and widespread such as 7-spot ladybird and the Tiger hoverfly (*Helophilus pendulus*). A further 16 species were recorded over three of the pollinator surveys including Red darter (*Sympetrum striolatum*) and Large white butterfly and 32 species were recorded over two pollinator surveys including the grass bug *Stenodema calcarata* and the Dead-head hoverfly. A number of unique species were recorded each year such as the Cream-spot ladybird recorded this year at Botanic Gardens and a Red admiral seen flying during this survey from the meadow at Pollok Country Park.

The creation and enhancement of wildflower meadows through this project has created important habitat and significantly improved species diversity in several of the parks in Glasgow. These surveys have highlighted how important these meadows are for invertebrates, especially pollinating insects but also other wildlife.

3. Habitat creation in final year of Glasgow's Buzzing

During the final year of the project, wildflower meadows have been enhanced at several parks through the sowing of wildflower seed and the planting of plug plants. Seed has been sown using a power harrow that removed the top layer of vegetation before the seed was sown using a scarifier. The seed mix was the same mix that has been used in previous years of the project and includes at least 20 wildflower species of known Scottish origin. With the help of volunteers from The Conservation Volunteers, Hidden Gardens, Scottish Agricultural College, Shawlands Academy and members of the public, wildflower plug plants have been planted into meadows at several of the parks.

Yellow rattle, a hemi-parasite of grassland has been sown in small patches at several meadows across Glasgow. Yellow rattle will reduce the growth of fine grasses as it feeds on their roots and this will aid in helping to improve species diversity within the meadow.

The meadows have continued to be cut once and lifted, leaving some areas uncut for over-wintering invertebrates and other wildlife. By cutting the meadow once, this will help to reduce competition by reducing nutrients to discourage vigorous species to allow wildflowers to thrive. The cutting is timed so that the wildflowers have seeded and the light

and space within the meadow provides the conditions for the wildflowers to spread. This will ultimately create a healthier meadow and also help in improving wildflower species diversity providing a wide range of food plants for pollinating insects. Once cut, the grass cuttings are baled and taken away by a local farmer to be either used as hay for his cattle or to be composited.

3.1 Linn Park

There are a variety of habitats present at Linn Park including woodland and open grassland as well as riparian along the White Cart Water that flows through the park. There is already a well established meadow to the south of this park that this project has previously identified as being important for a range of invertebrate species and has since been expanded in size to create further habitat. Another meadow to the north of the park, adjacent to Linn Park Golf Club house, was created during year two of the project by leaving the area uncut and this has allowed wildflowers already present to develop. This area has been enhanced during the final year of the project through the planting of over 700 wildflower plugs by volunteers from Scottish Agricultural College and Shawlands Academy. Wildflower species planted into this meadow include Oxeye daisy (*Leucanthemum vulgare*), Cat's ear (*Hypochaeris radicata*) and Common knapweed.

Pollinator surveys didn't occur at the end of year three of the project at Linn Park, as three years worth of surveys had already occurred. A total of 55 species of invertebrate have been identified from the meadows at Linn Park including several that are new to Glasgow such as the leaf beetle *Galeruca tanaceti* observed foraging on Common knapweed and the leafcutter bee *Megachile centuncularis*.

3.2 Pollok Country Park

Glasgow's largest park has several well visited tourist attractions including Pollok House, Burrell Collection and the highland cattle. The surrounding grounds are also visited by a number of local residents and visitors to the area. A variety of habitats are present across the park including woodland, open grassland, ponds and the White Cart Water that provide homes for a wide range of wildlife species.

Two of the wildflower meadows present at this park have been enhanced through the planting of wildflower plug plants. Both of the meadows have very different plant communities. The meadow adjacent the Burrell Collection is very wet for most of the year and is dominated by Soft rush. The other area that was enhanced through this project by Pollok House is not as wet and a wide range of wildflowers are present including Meadow cranesbill and Purple loosestrife. It was this meadow that has had more enhancements during the final year of the project. Over 200 wildflower plug plants have been planted into this meadow by volunteers from the Hidden Gardens and members of the public and included Cowslip (*Primula veris*), Common sorrel (*Rumex acetosa*) and Sneezewort (Figure 12).

Figure 12. Volunteers helping plant wildflower plug plants at Pollok Country Park © Cath Scott.

The meadow areas at this park have been identified as being important for a wide range of invertebrate species. A total of 42 species of invertebrate have been identified during this project including the Thick-legged hoverfly and the Blue winged olive mayfly which was resting in the grassland. Further wildflower plug planting will provide more foraging habitat for pollinators as well as a home for species that rest in the meadows.

3.3 Bellahouston Park

This park is located south of Glasgow city centre and is used for a number of large events that are set up in the area of amenity grassland along the south of the park. Several large attractions are associated with this park including the victorian walled garden, Charles Rennie Mackintosh's House for an Art Lover and a ski slope.

The meadow area created through this project is to the south west of the park and a diverse range of wildflowers are present and include Yarrow (*Achillea millefolium*), Common knapweed and Oxeye daisy. During this project the meadow was due to be increased in size although it was noticed during the start of year three of the project that it had been cut at some point in the spring and summer (see Glasgow's Buzzing: pollinator survey year 3). During the final pollinator survey the meadow looked healthy although it has been cut to be smaller in size.

A total of 32 species of invertebrates have been recorded within this meadow at Bellahouston Park and Gold finches have been observed foraging from Common knapweed. No butterflies have been recorded at this park although the diverse range of wildflowers is important for other pollinators such as Red tailed and Common carder bumblebees and Marmalade hoverfly.

3.4 Victoria Park

Located in the west end of Glasgow, this park is well known for its formal floral displays and carpet bedding and for Fossil Grove that houses fossilised tree trunks. The wildflower meadow created during year two of the project involved leaving an area uncut under trees at the west of the park alongside Victoria Park Drive South. The change in cutting regime within this area allowed wildflower species already present within grassland including Greater plantain (*Plantago major*) and Lesser celandine (*Ranunculus ficaria*) to develop and flower providing foraging habitat for bumblebees and hoverflies within the park.

A range of wildflowers have been planted into the meadow as plug plants and includes Common bird-foot trefoil (*Lotus corniculatus*), Ragged robin (*Lychnis flos-cuculi*) and Yarrow. Yellow rattle seed has also been sown throughout this meadow (Figure 13). Since being left uncut, Broad-leaved helleborine have been recorded within the wildflower meadow.

Figure 13. Yellow rattle seed at Victoria Park.

Through the pollinator surveys a total of 34 species of invertebrate have been recorded. This meadow has been identified as being particularly important for Chequered hoverflies with many males seen patrolling the meadow and a range of beetles including the rove beetles *Stenus cicindeloides* and *Stenus similis* as well as the ground beetle *Loricera pilicornis* and the 2-spot ladybird.

3.5 Kelvingrove Park

This large park in the heart of the west end of Glasgow is well used by local residents for walking, running and cycling as well as for a number of events such as the Glasgow Mela festival and by tourists visiting Kelvingrove Art Gallery and Museum which is adjacent the park.

Several wildflower meadows are within this park, including opposite Kelvingrove Art Gallery and Museum and the University of Glasgow as well as a meadow to the north east of the park adjacent Park Quadrant and Park Terrace. During the final year of the project the meadow adjacent the University of Glasgow has been enhanced through the planting of wildflower plug plants of a range of wildflower species including Cuckooflower (*Cardamine pratensis*), Meadow cranesbill and Cowslip. Yellow rattle seed has also been sown into this meadow to promote species diversity.

A further area managed for pollinating insects is the 'Butterfly Garden' to the south east of the park and this is managed by volunteers from the RSPB and The Conservation Volunteers.

Surveys at this park have recorded 43 species of invertebrates from within the meadows and have highlighted there importance for a range of pollinating insects including the parasitic solitary bee *Sphecodes geofrellus* and the Dead head hoverfly.

3.6 Botanic Gardens

Glasgow Botanic Gardens are renowned for its architecturally impressive glasshouses and extensive temperate and tropical plant collections. A range of habitats are present within Botanic Gardens including woodland and cut grassland as well as open wildflower meadows.

The wildflower meadows present within the Botanic Gardens include a range of species such as Herb bennet (*Geum urbanum*) and Hogweed. During the final year of the project, wildflower plug plants have been planted into one of the wildflower meadow areas to enhance it further for invertebrates and other wildlife. Broad leaved helleborine orchids are present within the wildflower meadow areas. Surveys within the meadows have identified 25 species of invertebrate including Gold-belted hoverfly and the planthopper *Javesella pellucida*.

3.7 Alexandra Park

This popular park to the east of Glasgow is known for its stunning views and beautiful floral displays. The large wildflower meadow within this park has been enhanced through this project with the sowing of a diverse wildflower seed mix and Yellow rattle. The diverse seed mix has been sown with the use of a power harrow that removed the top layer of vegetation and a scarifier that then raked the ground while sowing the seed; a total area of 1 hectare has been sown with this method.

It has been identified by the surveyor during pollinator surveys that this meadow must be very well established as a wide range of invertebrate species were recorded and where flowers were present such as Ragwort and Common knapweed a high number of pollinators where seen. A total of 38 species of invertebrate were recorded within the meadows over the two surveys and include the Thick headed fly and the parasitic solitary bee *Sphecodes geofrellus* that were recorded in both surveys.

3.8 Auchinlea Park

At the edge of Easterhouse on the outskirts of Glasgow, this park is well known for its a-listed buildings, Provanhall and Blochairn House. The park is well known for being important for wildlife with its formal walled garden, extensive shrub and herbaceous plantings, as well as woodland gardens and a bog garden that is a recognised site for nature conservation. The wildflower meadow that is adjacent the large shopping centre The Fort was enhanced during this project through the planting of wildflower plugs by volunteers from Easterhouse TCV Green Gym. Species planted included Ladies bedstraw (*Galium verum*), Meadow buttercup (*Ranunculus acris*) and Ragged robin (Figure 14).

Figure 14. Common carder bee and Buff tailed bee foraging on Common knapweed at Auchinlea Park; this area was enhanced by the planting of native wildflowers by volunteers from TCV Easterhouse Green Gym.

The pollinator surveys at this park have identified 31 species of invertebrate including Common green grasshopper, Peacock butterfly and Large white butterfly. While out planting the plug plants, the volunteers from Easterhouse TCV Green Gym recorded an 14 species of invertebrate, eight of which were not recorded during pollinator surveys at this park including the Dock leaf beetle (*Gastrophysa viridula*), Common earwig (*Forficula auricularia*) and a caterpillar of the Grey dagger moth (*Acronicta psi*) (see Glasgow's Buzzing: pollinator survey year 3).

4. Conclusion and recommendations

Over the three years of the Glasgow's Buzzing project, over 13 hectares of wildflower meadow have been created and enhanced across 13 parks through the sowing of a diverse wildflower seed mix, planting of plug plants and the sowing of Yellow rattle seed. An

additional 10 hectares have benefitted from a change in cutting regime which has further enhanced wildflower meadow areas.

Since their creation and enhancement, these wildflower meadows have been identified through pollinator surveys as being important for a range of invertebrates as well as small mammals, birds and amphibians. A total of 139 species of invertebrate have been recorded during the project and includes at least 17 that are new to Glasgow such as the distinctive leaf beetle *Galeruca tanaceti* found on Common knapweed at Linn Park and the solitary parasitic bee *Sphecodes geoffrellus* recorded foraging on Ragwort at Alexandra Park and Kelvingrove Park. During this pollinator survey, a total of 66 species of invertebrates were recorded across the seven parks (Pollok Country Park, Bellahouston Park, Kelvingrove Park, Botanic Gardens, Victoria Park, Alexandra Park and Auchinlea Park).

Over the project, a very limited period of time was spent at each site during a pollinator survey and only a small fraction of species utilising the meadows would have been recorded, although, the high total number of invertebrates recorded over the project indicate that even for such a limited amount of time a wide range of species were recorded including many pollinating insect.

The wildflower meadows created and enhanced through this project will act as important 'stepping stones' across Glasgow and will allow the movement and mixing of individuals and species. It is recommended that the wildflower meadows across Glasgow continue to be planted with native species of wildflower through plug plants and seed sowing. This will provide further foraging habitat for pollinating insects as well as for other wildlife. The sowing of Yellow rattle seed into areas dominated by grass, especially fine grasses, will further enhance these areas by reducing grass growth and providing habitat for wildflower species to grow and set seed. It is also recommended that new meadow areas are created and those existing expanded to provide additional wildlife areas and habitat corridors between the parks and across Glasgow.

It is important that the wildflower meadows are cut and lifted once a year to reduce nutrients and grass growth and promote the development of wildflowers. Whilst cutting the meadows, it is also important to leave areas long for over-wintering species of invertebrate and other wildlife, particularly small mammals and birds. The area left uncut can be rotated every year to prevent grasses dominating and the area becoming rank and the sowing of Yellow rattle into the areas left uncut will help to reduce vigorous grass growth.

Appendix 1: Complete list of invertebrate species recorded at each park during pollinator surveys in year three of the Glasgow Buzzing project.

Scientific name	Common name	Alexandra Park	Auchinlea Park	Bellahouston Park	Botanic Gardens	Kelvingrove Park	Pollok Country Park	Victoria Park
Aranaea	**Spider**							
Meta species	Long jawed spider							●
Xysticus species	Crab spider	●						
Coleoptera	**Beetle**							
Adalia bipunctata	2-spot ladybird			●				●
Adalia decempunctata	10-spot ladybird			●				
Aleocharinae	Rove beetle	●	●					●
Apionidae	Weevil			●				●
Calvia 14-guttata	Cream-spot ladybird				●			
Coccinella septumpunctata	7-spot ladybird	●	●	●				●
Longitarsus luridus	Flea beetle					●		
Loricera pilicornis	Ground beetle							●
Rhagonycha fulva	Red soldier beetle	●				●		
Stenus cicindeloides	Rove beetle							●
Stenus similis	Rove beetle							●
Tachyporus chrysomelinus	Rove beetle							●
Diptera	**Fly**							
Chaetostomella cylindrica	Fruit fly					●	●	
Conops quadrifasciatus	Thick headed fly	●					●	
Episyrphus balteatus	Marmalade hoverfly	●	●	●	●	●	●	●

Scientific name	Common name	Alexandra Park	Auchinlea Park	Bellahouston Park	Botanic Gardens	Kelvingrove Park	Pollok Country Park	Victoria Park
Eristalis pertinax	Tapered dronefly				●	●		
Eristalis species	Dronefly							●
Eristalis tenax	Dronefly	●	●	●		●	●	
Eupeodes luniger	Lunar hoverfly					●		
Helophilus pendulus	Tiger hoverfly		●			●	●	
Melanostoma mellinum	Hoverfly				●			
Melanostoma scalare	Chequered hoverfly				●		●	●
Myathropa florea	False dronefly					●		
Palloptera trimacula	Fly							●
Platycheirus albimanus	Pale-footed hoverfly					●		
Platycheirus granditarsus	Hoverfly						●	
Platychierus species	Hoverfly	●						●
Scathophaga species	Yellow dung fly				●			
Sericomyia silentis	Common bog hoverfly		●	●		●		
Sphaerophoria species	Hoverfly	●					●	
Syritta pipiens	Thick-legged hoverfly	●		●			●	
Syrphus ribesii	Common banded hoverfly	●	●	●	●	●	●	
Xylota segnis	Gold-belted hoverfly				●			
Ephemeroptera	**Mayfly**							
Seretella ignita	Blue winged olive				●	●	●	

Scientific name	Common name	Alexandra Park	Auchinlea Park	Bellahouston Park	Botanic Gardens	Kelvingrove Park	Pollok Country Park	Victoria Park
Hemiptera	**True bug**							
Anthocoris nemorum	Flower bug		●	●	●		●	●
Aphrophora alni	Alder spittlebug	●						
Cicadella viridis	Leaf hopper						●	
Javesella pellucida	Plant hopper				●			
Lygus rugulipennis	Tarnished plant bug	●		●			●	
Philaenus spumarius	Common froghopper	●	●			●	●	
Plagiognathus arbustorum	Plant bug	●	●			●	●	●
Plagiognathus chrysanthemi	Plant bug	●						●
Stenodema calcarata	Grass bug	●					●	●
Stenodema laevigata	Grass bug	●	●		●	●	●	
Stygnocoris sabulosus	Plant bug		●			●		
Hymenoptera	**Bees, wasps and ants**							
Apis mellifera	Honey bee			●		●		
Bombus lapidarius	Red tailed bumblebee	●	●	●		●	●	●
Bombus lucorum	White tailed bumblebee		●	●	●	●	●	●
Bombus pascuorum	Common carder bee	●	●	●	●	●	●	●
Bombus terrestris	Buff tailed bumblebee	●	●	●	●	●	●	●
Colletes daviesanus	Solitary bee	●		●		●		
Myrmica ruginodis	Red ant					●		

Scientific name	Common name	Alexandra Park	Auchinlea Park	Bellahouston Park	Botanic Gardens	Kelvingrove Park	Pollok Country Park	Victoria Park
Sphecodes geofrellus	Solitary bee	●				●		
Vespula germanica	German wasp	●						
Vespula vulgaris	Common wasp	●	●	●	●	●	●	●
Lepidoptera	**Butterfly and moth**							
Agriphila tristella	Grass moth	●				●		
Inachis io	Peacock butterfly		●					
Lycaena phlaeas	Small copper						●	
Pieris brassicae	Large white		●					
Pieris napi	Green veined white	●	●		●	●	●	●
Vanessa atalanta	Red admiral						●	
Neuroptera	**Lacewing**							
Micromus variegatus	Lacewing	●			●		●	
Odonata	**Dragonfly**							
Sympetrum striolatum	Common darter	●						
Orthoptera	**Grasshopper**							
Omocestus viridulus	Common green grasshopper	●	●			●		