Impact of enhancing the environmental performance on wildlife and ecosystem services

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Pollinator Demonstration Farm 2019/2020

We have now almost finished our third and final year at Lochend of Barra the Soil Association Scotland's Pollinator demonstration farm. This project has explored the impact of wildlife enhancement on farmland biodiversity. Lochend of Barra was paired with West Fingask, an adjacent farm that did not undergo any major environmental improvements (our control farms). This experiment was also replicated in Midlothian on the AHDB's monitor farm Prestonhall. In 2017, baseline monitoring was conducted to obtain information on beneficial insects and their ecosystem services. In 2018 and 2019, floral-rich field margins were planted at the environmental improvement farms and follow up monitoring was conducted. The results of this study are presented in this report. We are indebted to the farmers who have worked closely with us, allowing us access to their farms and providing essential feedback. Over the course of this research we have provided placements for a total of 12 undergraduate students who have gained important skills in conducting ecological surveys and identifying many species of plants and insects.

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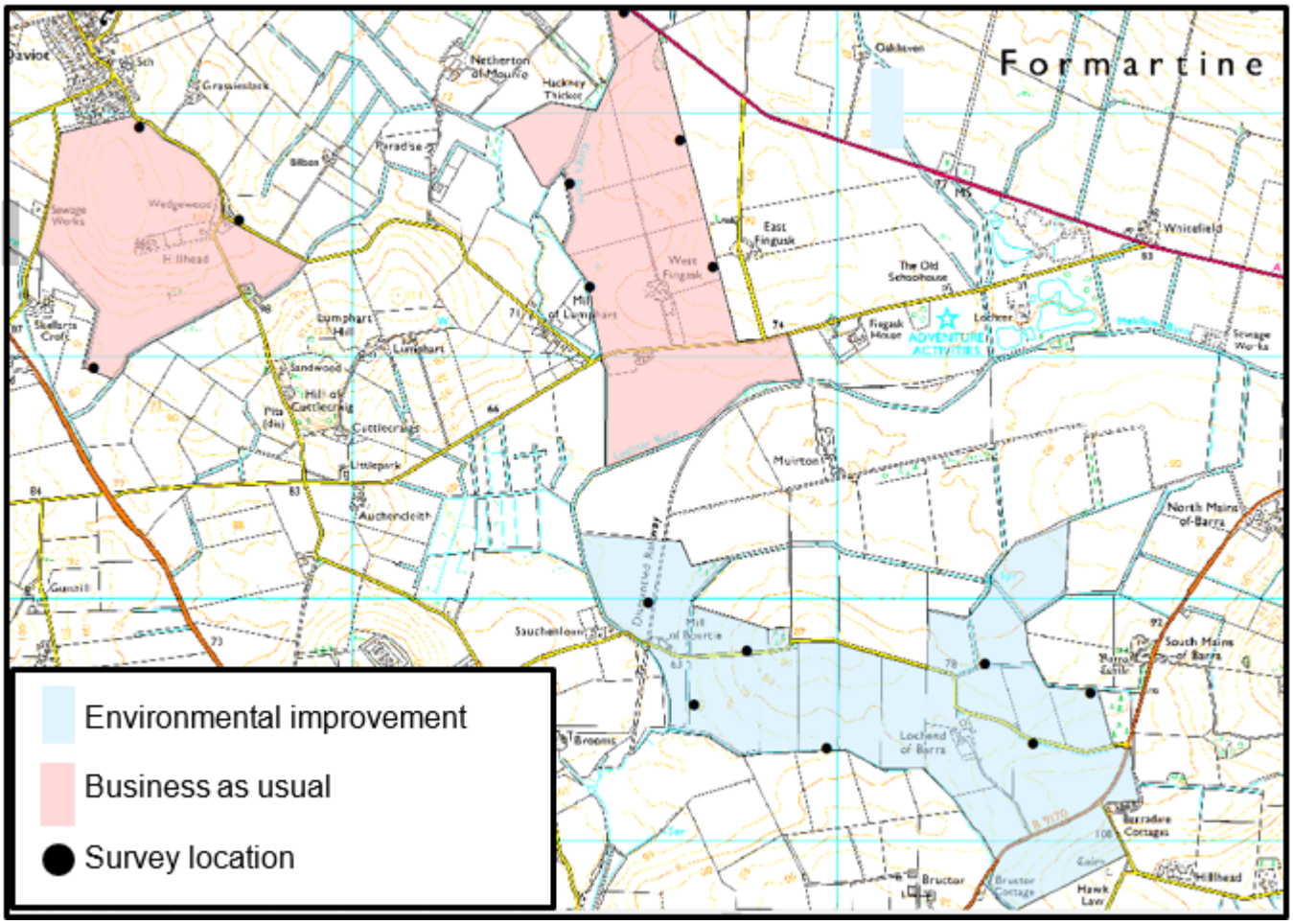
Experimental Design and survey methodology

In Aberdeenshire, two farms were selected for this experiment. These farms were both intensively managed arable farm near Inverurie, Aberdeenshire. The Soil Association's Pollinator Demonstration Farm, Lochend of Barra, was our environmental improvement monitor farm, and this farm was paired with West Fingask, a farm which did not undergo any environmental improvements over the study period and was thus our "Business as Usual" farm (Figure 1). To try and reduce impacts of environmental change at Lochend of Barra influencing biodiversity at West Fingask these farms were over 1km apart.

At each farm seven survey locations were established and at each survey location sampling was conducted in the field margin and the field centre. Beneficial insects were surveyed using insect pan traps and transect walks. As different insect species are attracted to different trap colours, a combination of blue, white and yellow pan traps were used to survey as a wide a range of species as possible. We monitored activity rates of aphid predators (e.g. ladybirds, spiders and lacewings) using aphid bait cards (Figure 5). At each survey site, four aphid bait cards were placed for a 48-hour period in the field centre and field margin. Each bait card had ten aphid attractors and on collection, the number of aphids eaten by predators was counted as a measure of predator activity.

Figure 1. Map highlighting the two study farms in Aberdeenshire and the seven survey locations on each farm.

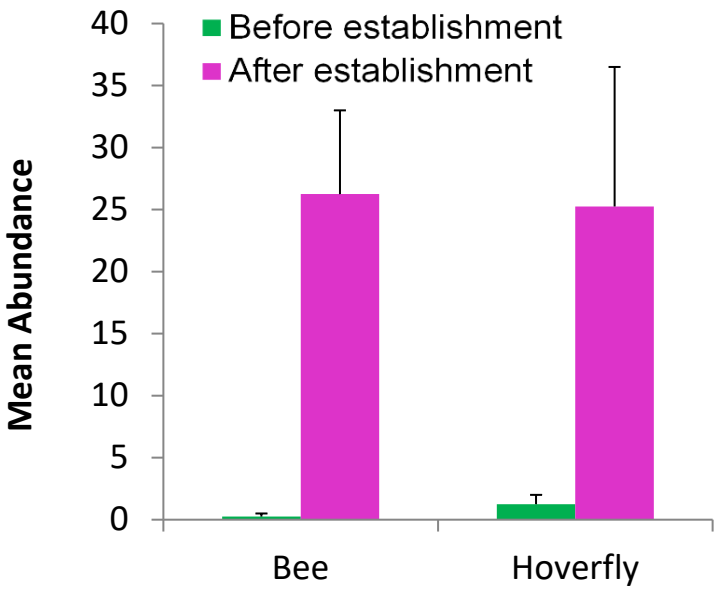


Pollinators recorded in transect walks

Pollinators observed in transect walks tended to increase from May until August. We will therefore focus these results on the August transect walks when pollinator populations were at their highest and our floral-rich margins were in full bloom.

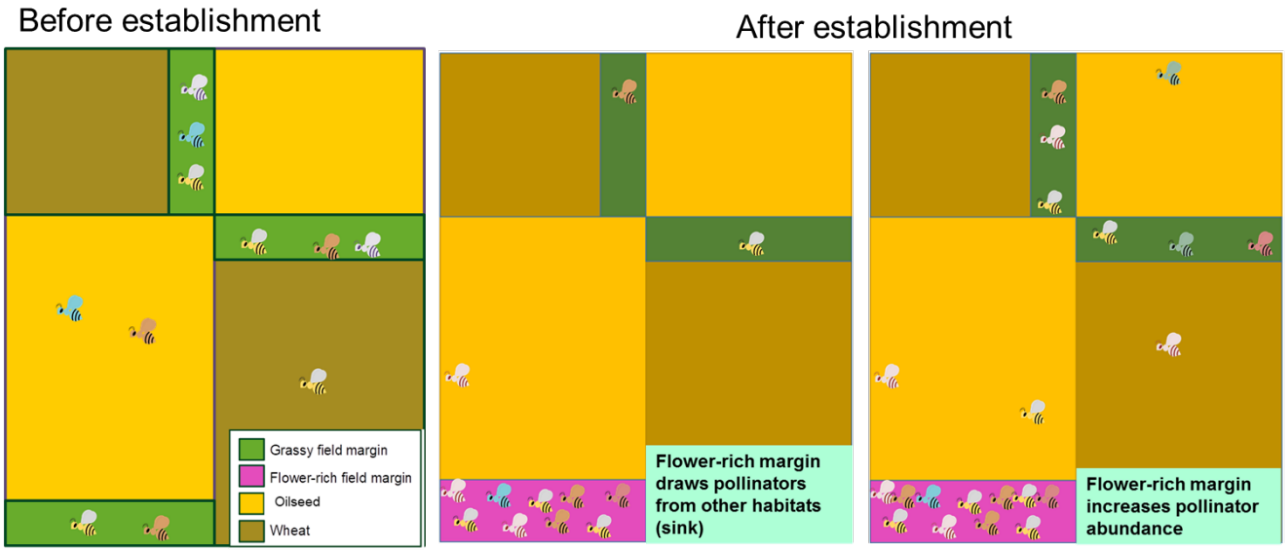
Our experimental design focussed on exploring how pollinator populations responded to environmental improvement at the farm level. The data does, however, provide the opportunity to explore how pollinators responded to planting flower-rich margins at the field level. The abundance of both bumblebees and hoverflies foraging in field margins increased in fields that were planted with flower-rich seed mixtures (Figure 2).

Figure 2: *Impact of planting flower-rich field margins on insect pollinators at the field level. Based on Aberdeenshire and Midlothian data in 2017 (i.e. before floral-rich field margins were planted) and 2018 and 2019 (i.e. after floral-rich field margins were planted)*



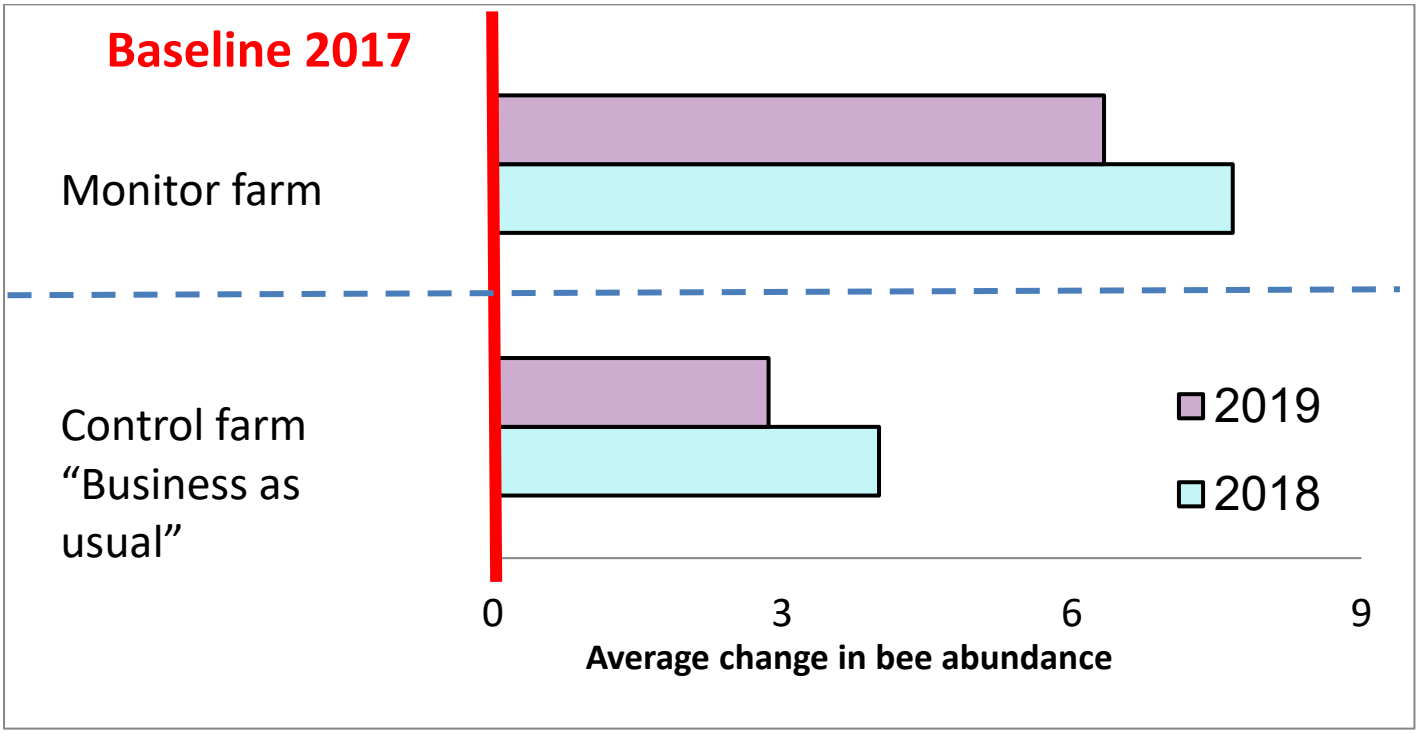
An increase in pollinators in flower-rich margins, however, does not necessarily prove that the pollinator populations at the farm level were increasing. It is possible that pollinators are simply redistributing themselves and congregating in the flower-rich margins in response to increased forage (see Figure 3). Previous research has indicated that pollinators alter their distribution in response to the availability of floral resources (Cole et al. 2017). To try and determine if pollinator populations were simply congregating in the floral-rich margins (pink in Figure 3), or actually increasing in abundance we explored how populations changed in grassy field margins (i.e. field margins that were not planted with flower-rich seed mixtures: green in Figure 3).

***Figure 3**: Conceptual model of the different ways pollinators may respond to flower-rich margins*



When compared to our 2017 baseline, bumblebees in grassy field margins in Aberdeenshire increased in 2018 and 2019 (Figure 4). This increase occurred in both our Monitor farm and our Business as usual farm indicating that weather conditions were more favourable for bumblebees in 2018 and 2019 than in 2017. When compared to our 2017 baseline data, our environmental improvement farm showed a bigger increase in bumblebee abundance in grassy field margins than our business as usual farm (Figure 4). This does suggests that pollinator populations were not simply redistributing in response to food availability but actually **increasing** as a result of environmental improvement. However, more formal statistical analyses are required before definite conclusions can be drawn.

***Figure 4:** Comparing 2018 and 2019 bumblebee abundance with our 2017 baseline data for **grassy field margins** only. Both Business as Usual and Environmental Improvement farms in Aberdeenshire are shown.*

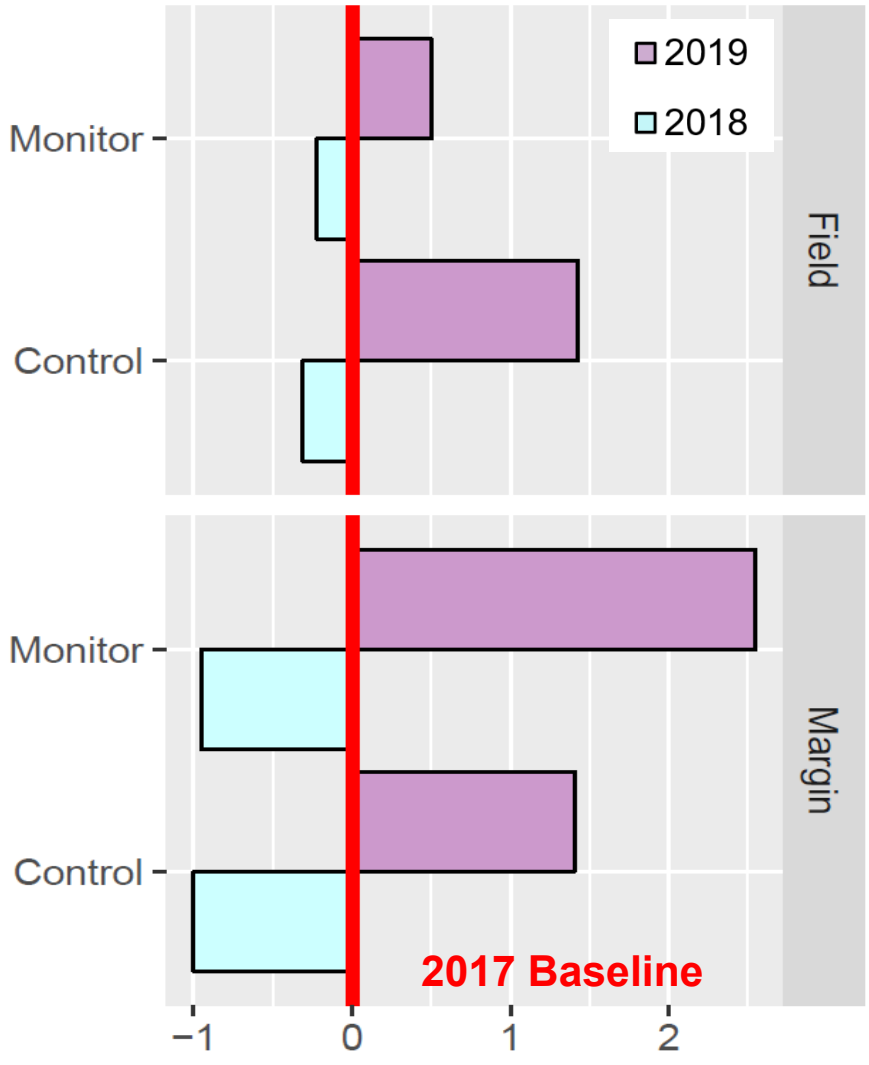


Activity Level of Predatory Insects in Aberdeenshire

The activity of predatory insects, specifically their rate of predation of aphids, was monitored using aphid bait cards. When compared to the 2017 baseline, predation rates in 2018 were lower than 2017, whereas, in 2019 they were higher. In 2018, trends in our control and monitor farms were similar, indicating that predation rates were not yet influenced by environmental improvement (Figure 5). This indicates that either predator activity was lower in 2018 than 2017, or there was a greater availability of prey in 2018 providing predators with an alternative prey source.

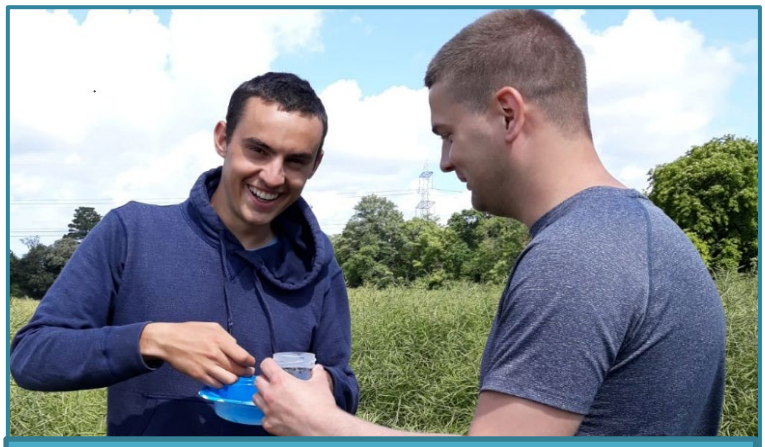
Differences were beginning to emerge between our control (business as usual) and monitor farm in 2019 (Figure 5). When we focus on the results for field margins, we can see that the increase in predation rate was greater in the monitor farm than the control farm indicating that improving field margin habitat increased predation rates in the margin. When we focus on results for the centre of the fields, however, we find a different trend with our control farm showing a greater increase in predation rate than the monitor farm. It is possible that predators were more reluctant to migrate into the field centre when the management of the field margin was more wildlife friendly. There was a lot of variability around these data and more formal statistical tests are required to explore the findings in greater depth.

Fig. 5 *Average aphid predation rates in fields & field margins in the monitor & control farms in Aberdeenshire*



Student internships

SRUC have provided research internships with a total of 12 undergraduate students (four Scottish students and eight French students). The students have worked alongside researchers and participated in all aspects of field work and laboratory work. They have gained key skills in insect and plant identification and surveying techniques alongside data management and analyses.



The internship provided me with a wealth of knowledge, now allowing me to identify a wide array of flowers, and the pollinators who depend on them, such as butterflies, hoverflies and bees. These skills are very sought after from an employer's perspective and will help me stand out when it comes to future employment.

Fraser White, SRUC, Ayr

It was great to increase my identification skills – learning how to identify plants and pollinators. I feel it will enhance my CV increasing my chances of employment in this field.

Leanne Kirkpatrick, SRUC, Ayr

I really enjoyed the outdoor surveying. It really helped me increase my plant and insect identification skills. I really like entomology and doing this work has shown me how important this field of study is. I hope to pursue a future career in ecological research and this work with strengthen my CV.

Romane Darul, ENSAT, France

I enjoyed being outside doing the transect walks because I love to be constantly active and it was great to apply what I have learned in my studies in the real world. It was also great to see more of the Scottish countryside.

Camille Le Carlier de Veslud, ENSAT, France

Knowledge exchange activities

This research has contributed to a wide variety of knowledge exchange activities aimed at a range of stakeholders. Table 1 lists some of these activities.

Table 1: List of knowledge exchange activities this project has contributed to

Stakeholder	Activities
Farmers, land managers	Practical guides • Cole, LJ, McKnight, G. 2018. Practical Guide: Why and how to increase pollinators on your farm. FAS, Edinburgh. Farm meetings • Soil Association Scotland: Profit from Pollination, July 2018, Inverurie • Farm Advisory Service: IPM and beneficial insects, June 2018, Angus • SRUC-AHDB Cereals & Oilseeds Winter Agronomy Roadshow January 2018, Lauder, Scottish Borders, Scone Palace Park, Perth, Inverurie, Aberdeenshire, Old Perth Road, Inverness Videos • Soil Association Scotland: Increasing Pollinators On Arable Farms: Part 1 Habitats • Soil Association Scotland: Increasing Pollinators On Arable Farms: Part 2 Monitoring • Farm Advisory Service: Helping pollinators on your farm • Farm Advisory Service: The benefits of pollinators for oilseed rape
Farmers, Researchers, Policymakers	Workshops • SRUC: Sustainable Agriculture in Scotland: New Research Ideas. January 2018, Kings Building, Edinburgh • SRUC: Innovative Arable and Mixed Farming Systems for a Sustainable Future. October 2019, Oatridge, Midlothian
Policymakers	• Feedback Pollinator Strategy for Scotland: 2018 Progress Report • Feedback Pollinator Strategy for Scotland: 2019 Progress Report • Feedback SNH Terrestrial Invertebrate Strategy • Rural Policy Centre: Recommendations to ensure the CAP post-2020 supports insect pollinators (in preparation)
Researchers	Publications • Cole, L.J., et al. (2020). A critical analysis of the potential for EU Common Agricultural Policy measures to support wild pollinators on farmland. Journal of Applied Ecology. • Cole L., et al. (2019) Farmers and Beekeepers Can Work Together to Deliver Sustainable Pollination, Beefarmer, 12, 11-13. • Breeze, T. et al. (2019) Linking farmer and beekeeper preferences with ecological knowledge to improve crop pollination; People and Nature 1:562–572 • Cole et al. (2018). The potential for nitrogen-fixing crops to deliver foraging resources for insect pollinators, Aspects of Applied Biology 138, 109-114 Presentations • Robertson & Cole The potential for nitrogen-fixing crops to deliver pollinator resources Advances in Legume Science and Practice (March 2018) Jurys Inn, Glasgow • Super-B (March 2018) Kleijn et al. 2018 Factors affecting the implementation of measures mitigating pollination loss. (March 2018) Leiden, The Netherlands.

Table 2: *Pollinator species recorded at Lochend of Barra (2017-2020). Some samples are still to be processed so this list may change.*

Pollinator Group	*Species*	
Bumblebees	*Bombus terrestris*	Buff-tailed bumblebee
	Bombus lapidarius	Red-tailed bumblebee
	Bombus pratorum	Early bumblebee
	Bombus lucorum	White-tailed bumblebee
	Bombus hortorum	Garden bumblebee
	Bombus pascuorum	Common carder bumblebee
Honeybee	*Apis mellifera*	Honeybee
Solitary bees	*Andrena bicolor*	Gwynne's mining bee
	Andrena nigroaenea	Buffish mining bee
	Andrena scotia	Chocolate mining bee
	Lasioglossum calceatum	Slender mining bee
Butterflies	*Pieris rapae*	Small white
	Pieris napi	Green-veined white
	Pieris brassicae	Large white
	Aglais urticae	Small tortoiseshell
	Aglais io	Peacock
	Vanessa cardui	Painted lady
	Anthocharis cardamines	Orange tip
	Lycaena phlaeas	Small copper
	Aphantopus hyperantus	Ringlet
Hoverflies	*C.illustrata*	*N.podagrica*
	C.berganstammi	*Pipiza bimaculata*
	C.pagana	*P.albimanus*
	E.abusivus	*P.manicatus*
	E.arbustorum	*P.peltatus*
	E.balteatus	*P.scutatus*
	E.corollae	*R.campestris*
	E.intricarius	*S.pipiens*
	E.latifasciatus	*Sphaerophoria.spp.*
	E.tenax	*S.pyrastri*
	H.pendulus	*S.ribesii*
	L.lucorum	*S.silentis*
	M.mellinum	*S.vitripennis*
	M.scalare	*V.bombylans*