UK Pollinator Monitoring Scheme

Annual Report 2023

UK Centre for Ecology & Hydrology

JNCC

POMS

UK Pollinator Monitoring Scheme

Welcome

This is the second annual report of the UK Pollinator Monitoring Scheme (PoMS), providing an overview of survey coverage and highlighting progress during the 2023 season. The report documents ongoing analyses of trends in different insect pollinator groups from PoMS data collected by dedicated volunteers between 2017 and 2022, and includes news and updates from the partnership.

PoMS aims to understand how insect pollinator populations are changing across the UK through implementing two large-scale surveys: the Flower-Insect Timed Count (FIT Count) and the 1 km square survey. These surveys use a combination of volunteer and professional recorders to collect and process data on the abundance and species distribution of flower-visiting insects from a wide range of habitats across the UK. The UK PoMS partnership is coordinated by UKCEH, further details are provided on page 45.

We welcome feedback on any elements of this report or on other types of article you would like to see in future.

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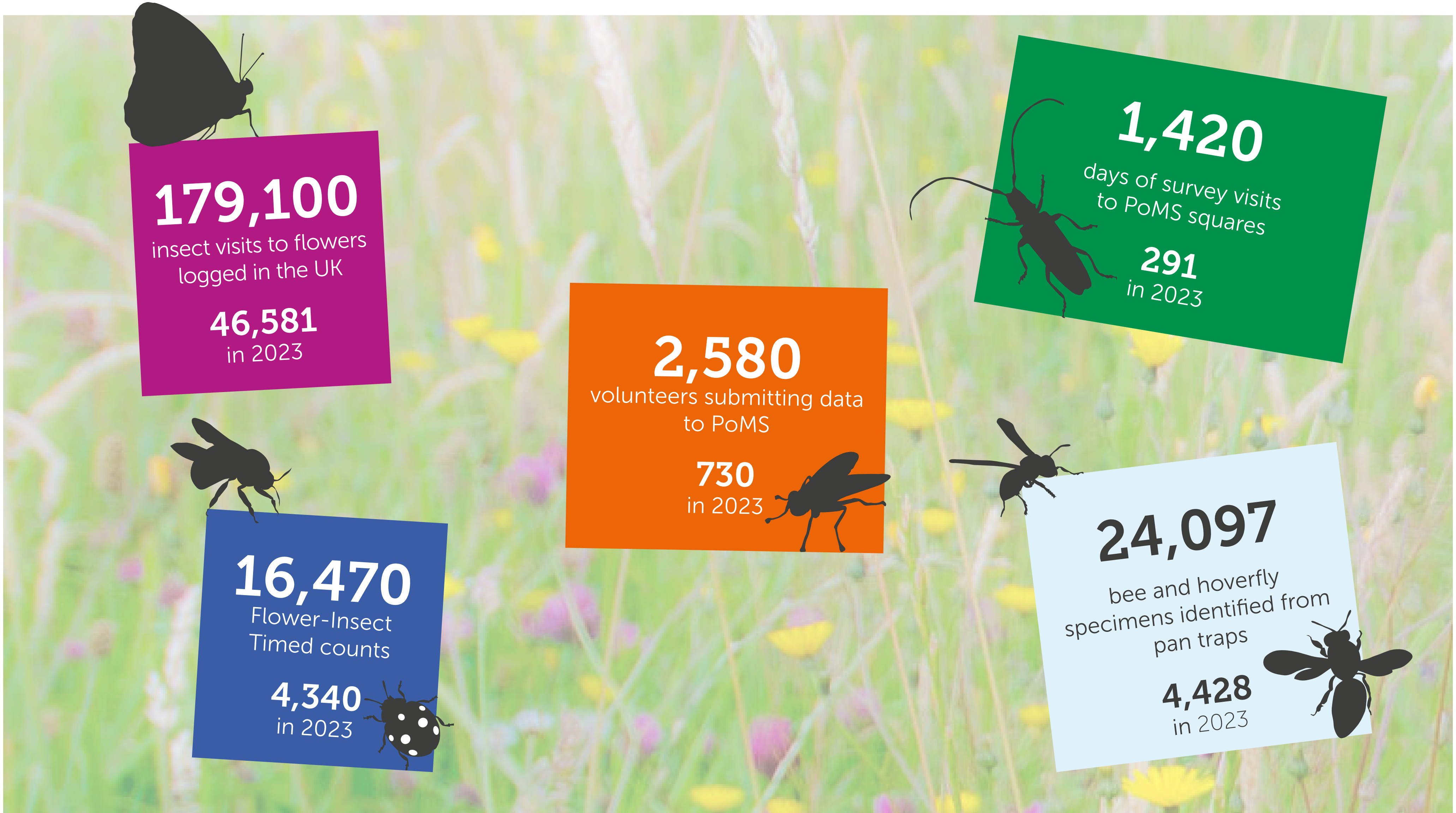
This report can be downloaded from: https://ukpoms.org.uk/reports.

Contents

References to publications and websites are indicated with hyperlinks like this [1] and are listed on pages 43-44

Front: Yellow-clubbed Glasswing hoverfly, *Scaeva selenitica* © Steven Falk

Back: FIT Counting. © Miranda Bane



Alan Lawlor © UKCEH

PoMS in numbers

In each box, the first value is for all years (2017-2023) whilst the second value is for 2023

Latest news from UK PoMS

Claire Carvell, Chris Andrews and Martin Harvey (UKCEH) provide a round-up of PoMS activities during the past year and look forward to the 2024 season.

The **UK Pollinator Monitoring Scheme (PoMS) has continued to thrive during 2023**, with a record year seeing our highest coverage to date for both the FIT Count and 1 km square surveys. We welcomed Buglife (the Invertebrate Conservation Trust) to the partnership, which sees PoMS aligned with the set of other long-term UK-wide biodiversity monitoring schemes [1] that are collectively supported by JNCC, UKCEH, and a range of non-governmental organisations. Working with Buglife helps us to promote our shared interests in the conservation and further understanding of a whole range of insects, beyond the more 'conspicuous' groups such as bumblebees and butterflies. Already Buglife have led a number of excellent outreach events that included an introduction to FIT Counts. Read more on these and other partner-led activities in "PoMS on Tour" and sign up to our news updates [2] including upcoming events.

As PoMS is a relatively young scheme, the **data** and any emerging trends are not yet sufficiently developed to contribute to "official statistics" or indicators in the way that survey results from the longer-running UK biodiversity monitoring schemes do. However, the team is continuing to **develop analytical approaches** and metrics which we hope will, in due course, contribute as indicators that can be used widely to set priorities and inform conservation action – these are presented in more detail on pages 18-23.

Meanwhile, PoMS is already making an **impact on both policy and research** agendas, at UK level and beyond. During 2023 the House of Commons Science, Innovation and Technology Committee (SITC) held an inquiry into insect decline and UK food security. Several members of the PoMS partnership were invited as expert witnesses to the inquiry and we welcome the recently published report [3], which includes recommendations to sustain long-term insect monitoring and fill data gaps, and recognises the key role of amateur entomologists and citizen science.

PoMS is contributing more widely to the research agenda on **DNA barcoding** under a new partnership with the BIOSCAN project [4]. Read more in our feature article on pages 27-32. Further, we are continuing to share **species records for bees and hoverflies** with the recording schemes and societies and to prepare updated PoMS datasets for open publication via the UKCEH Environmental Information Data Centre [5],[6]. As in previous years, a few rare or localised species have been sampled on PoMS survey squares in 2023, including the Yellow-clubbed Glasswing hoverfly (*Scaeva selenitica*) featured on this reports' front cover. Further details are given on pages 24-26.

We are always keen to hear from researchers interested in making use of PoMS data. Recently, PhD student **Kwaku Peprah Adjei** published a paper [7] in which he combined data from the PoMS pan trap survey (which contains species-level presence-absence data) together with FIT Count data (which contains counts of insect groups) to better estimate the alpha diversity of bumblebees, hoverflies and solitary bees. Alpha diversity is one metric that helps us to measure the diversity of species in a community. The resulting "integrated" model estimated alpha diversity more precisely than data from the models fitted to each individual dataset.

Of course, the extensive survey coverage and data collection achieved by PoMS would not be possible without the considerable efforts of our volunteers. Prompted by a request from JNCC for some figures relating to **volunteer contributions to PoMS**, Chris and Martin took a look at our latest data. They used the FIT Counts submitted both as 'public' counts and from the 1 km squares to differentiate between volunteers contributing to the two PoMS surveys, and excluded contributions from any staff team members. Notwithstanding a few potential issues from the early years with individuals entering counts from multiple participants, or using multiple usernames, the figures are quite impressive!

To date, 2,580 individual volunteers have submitted FIT Count data and of those, 2,505 took part in public FIT Counts and 117 were involved in 1 km square surveys. Some 42 volunteers undertook both public and 1 km square surveys. The total number of participating volunteers on the public FIT Count reached 730 in 2023, albeit remaining lower than the peak of 851 in 2021. 2021 likely saw increased participation in part due to the launch of the FIT Count app, and to COVID-19 guidance restricting people to garden and open space activities. The contribution of 1 km square volunteers shows steady growth across the years, with 58 volunteers submitting data in 2023.

The PoMS team welcomed Miranda Bane and Fiona Montgomery in 2023 to support surveys across the 22 PoMS 1 km squares in Scotland. Sam and Arianna joined as volunteers, and are pictured here setting up a pan trap station.

We wanted to take part in PoMS because it felt like an opportunity to contribute to something important outside of our own research. We both love and study insects, and wanted to get to know and respect our local busy pollinators. We have loved looking after our own wee square. The terrain and weather can be difficult in Scotland, but we've loved being out for a whole day on the hills and have learned so much about native flowering plants.

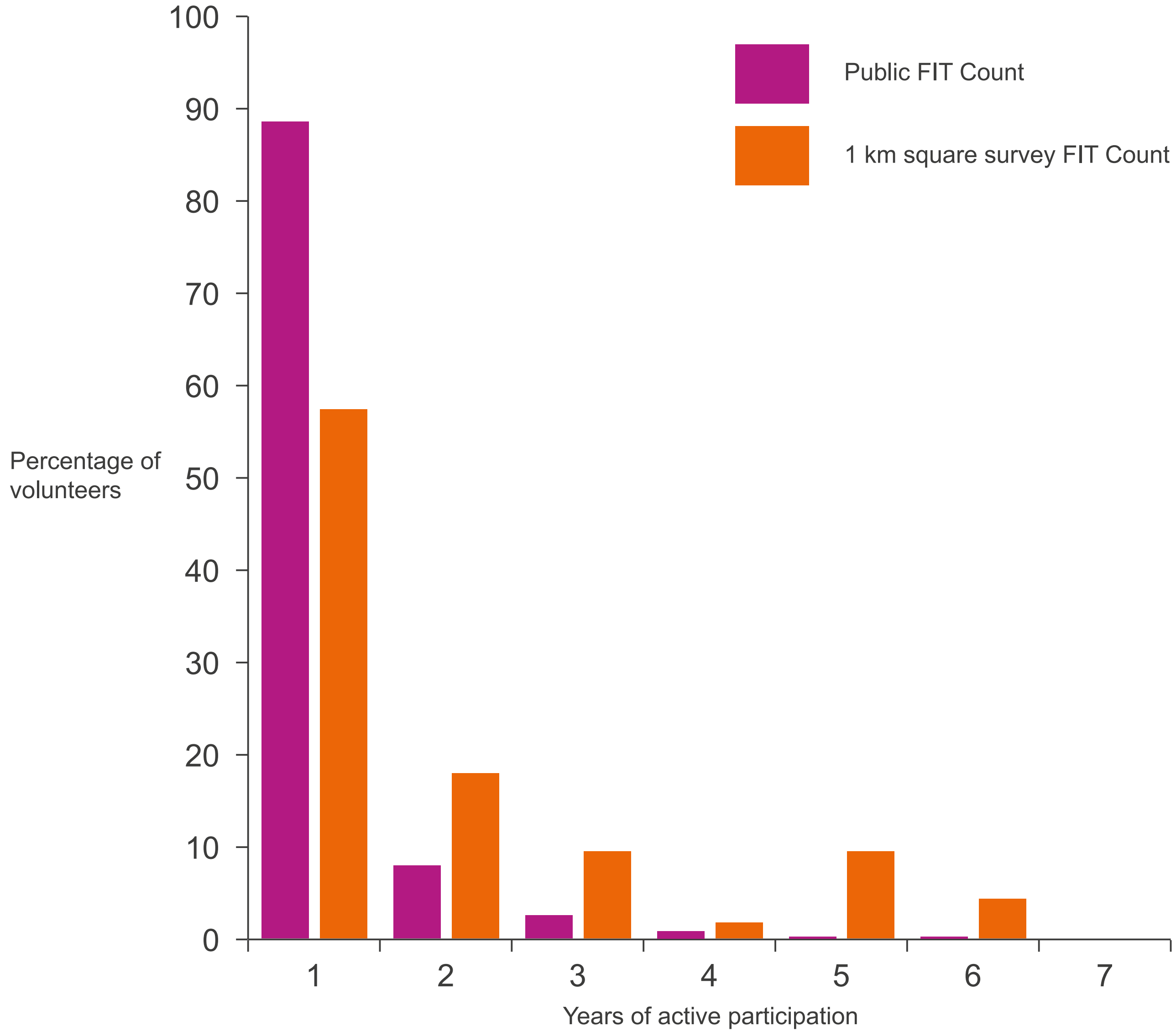
- *Sam Rogerson and Arianna Chiti, 2023*

© Miranda Bane

Of the volunteers taking part in public FIT Counts to the end of 2023, 88% undertook surveys in only a single year, with an additional 8% undertaking surveys on two separate years (Figure 1). The remaining 4% undertook FIT Counts in three or more years. By contrast 1 km square volunteers were much more likely to remain involved over multiple years, with only 57% being involved for a single year. A further 18% undertook surveys on two separate years, with the remaining 25% undertaking surveys for three or more years.

Overall, the year-to-year retention rate of volunteers has remained relatively steady across the seven years of PoMS to date. For public FIT Counts the overall year-to-year retention rate is 24.3%, ranging from 18.1% to 30.8%. By comparison, the year-to-year retention rate of 1 km square volunteers is much higher at 67.5% (46.7 – 85.2%). This higher retention rate likely reflects the higher level of additional training needed to undertake a 1 km square survey, and perhaps the greater sense of attachment that our smaller group of 1 km volunteers feel to their allocated squares and mentors. We'd really like to better understand how to encourage people who do FIT Counts to stay involved in future years. If you have any thoughts or ideas on this, please get in touch. We hope that the recently introduced "PoMS projects" [8] feature in the FIT Count app will help to encourage this. Read about the projects feature on pages 36-37 and get in touch with PoMS if you would like to know more.

Figure 1. The percentage of volunteers submitting PoMS FIT Counts in one or more years



Flower-Insect Timed Counts

Flower-Insect Timed Counts (FIT Counts) are simple systematic surveys collecting data on abundance of flower visitors across a variety of habitats and plant groups. Here, Robin Hutchinson, Claire Carvell and Martin Harvey (UKCEH) summarise coverage to date and highlight the fantastic contribution volunteers are making to this survey.

FITCount

FIT Counts were developed with the aim of encouraging a wide range of people to get involved in pollinator monitoring, whilst also generating data on flower visitation and plant-pollinator interactions that is not being collected by any other existing scheme. The recorder spends **10 minutes** counting the insects that visit the flowers of a chosen flower species within a **50 cm quadrat** (ideally from our list of 14 target flowers, although other flowers can be used). Information on flower abundance and habitats surrounding the FIT Count quadrat, and the weather, is also collected to help explain variation in the insect data and explore the effects of changes in these other variables over time, where the data allows.

FIT Count resources include survey guidance, a recording form, insect and flower guides, 2-minute video guides, online forms for data capture and the mobile app that was launched in 2021. All are available in both English and Welsh through the PoMS website.

Overall, since 2017 a total of 16,470 FIT Counts have been submitted, representing an incredible 2,745 hours of observation and **179,100 flower-insect interactions!** Thanks are due to all the recorders who submitted counts from all corners of the UK. This year we have produced a series of plots showing the cumulative increase in counts coming in each month over the season, and shared these via the PoMS e-newsletters. Counts during 2023 overtook those from 2022 during May and continued to reach our highest total to date, 4,340 FIT Counts by the end of September (Figure 2).

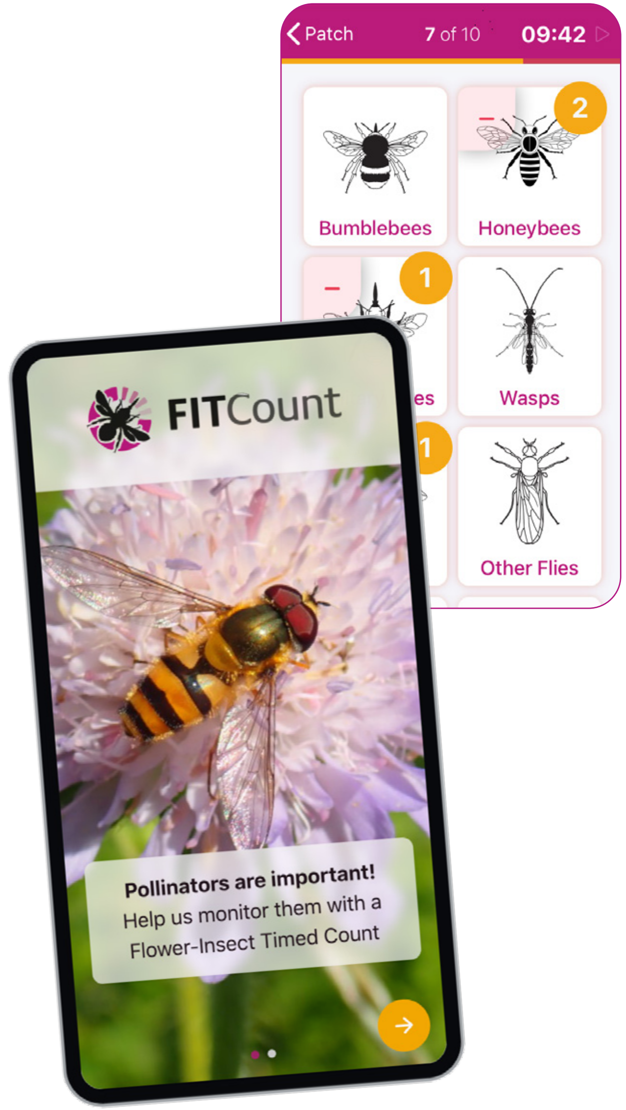
Martin Harvey © UKCEH

Counting insects on White Clover during a FIT Count training event

Detail	Years	England	Scotland	Wales	N Ireland	Total UK*
Total number of FIT Counts	2017 - 2023	12,438	2,062	1,326	629	16,470
	2023	3,500	405	272	158	4,340
Number of FIT Counts submitted by the public	2017 - 2023	11,149	1,087	662	509	13,419
	2023	3,294	240	154	98	3,790
Number of FIT Counts on 1 km square surveys	2017 - 2023	1,289	975	664	120	3,051
	2023	206	165	118	60	550
Insect visits to flowers logged	2017 - 2023	143,217	18,742	12,232	4,824	179,100
	2023	38,546	3,408	3,042	1,549	46,581
Total number of recorders (1 km and public)	2017 - 2023	1,490	210	134	68	1,870
	2023	454	73	46	28	595
Total number of public recorders	2017 - 2023	1,457	190	118	62	1,799
	2023	432	62	37	24	549

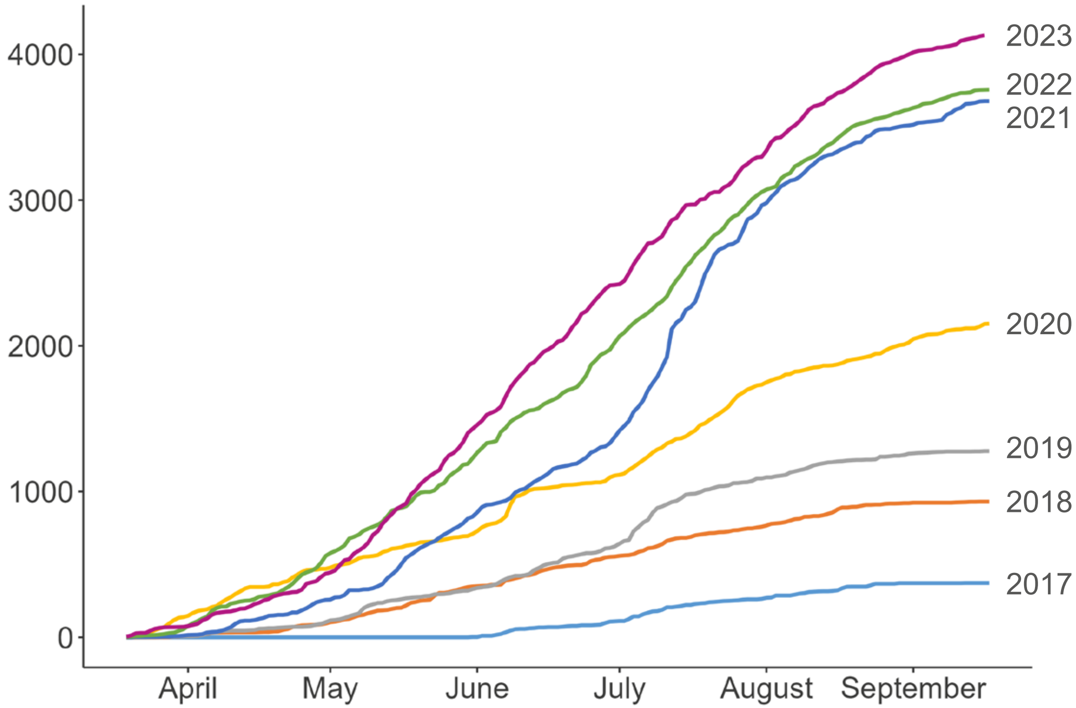
Table 1. Summary of survey coverage and uptake of Flower-Insect Timed Counts submitted to UK PoMS

Note: The FIT Count was launched to 'the public' in 2018 and runs every year between 1st April and 30th September. FIT Counts have also been carried out as part of the PoMS 1 km square survey protocol since 2017. *Totals for the UK in Table 1 are often higher than the summed total number of counts or insects across all four countries due to a few FIT Counts being undertaken in squares directly on country borders, and not being assigned to a country. The number of recorders in Table 1 is based on the user accounts registered via the FIT Count app and PoMS website. Note that while data for 2023 are shown to provide information on survey coverage from the last year, these data are still subject to further final processing and hence minor adjustments may be required prior to data publication.



The FIT Count app was launched in 2021 with English and Welsh languages, and is available to download from Google Play or the App Store

Figure 2. Cumulative total number of FIT Counts submitted each year, shown through the season from April to September



Note: Chart based on data from all FIT Counts submitted from the UK and Isle of Man between 1 April and 30 September from 2017 to 2023. PoMS data is subject to review and totals shown here may differ from our published datasets and reports.

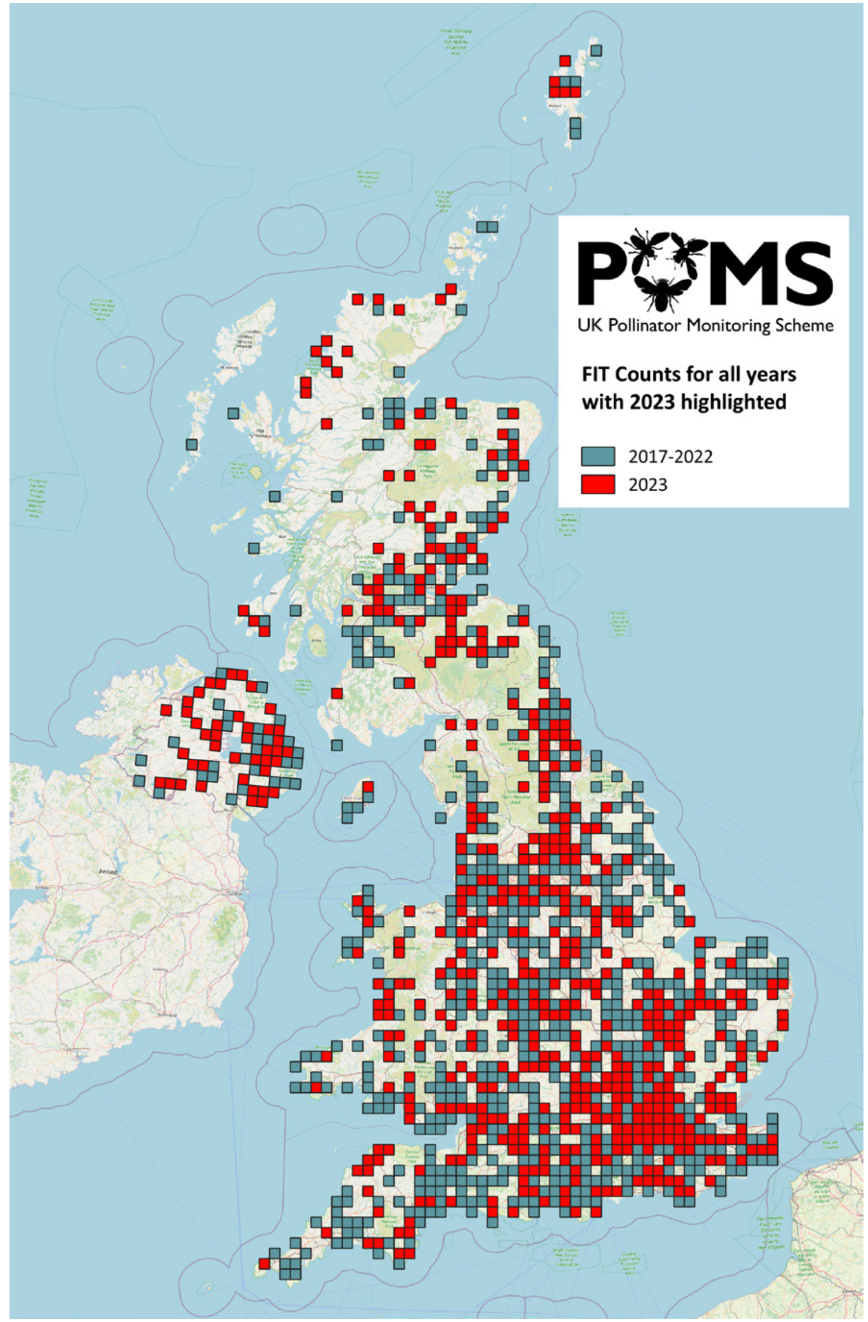


Figure 3. Map showing the location of 10 km squares in which one or more FIT Counts have taken place since 2017 (both submitted by the public and on 1km square surveys). Counts from 2023 are shown in red

While PoMS has seen a steady increase in FIT Counts year on year in England, the map and chart in Figures 3 and 4 highlight the scope to increase coverage in Scotland, Wales and Northern Ireland for future years. Records from the mobile app now constitute around 60% of all public FIT Counts (remaining steady compared to 58% in 2022), which should help widen the reach of this citizen science survey. Read more about the introduction of our new local projects feature on pages 36-37, continuing in 2024, which will also support the recruitment of new volunteers.

Insects, habitats and target flowers

A series of interactive charts has been set up on the PoMS website [9] to showcase the FIT Count data by target flower. Comparing these data to last year, the same flowers remained popular with recorders as Buttercup, Lavender and Ragwort received the most FIT Counts (Table 2). While this table once again demonstrates the high number of insect visits typically seen on Ivy and Hogweed, it also highlights the value of different flowers for different pollinator groups. We continue to encourage FIT Count recorders to submit all completed counts, even where no insects are seen, and to select from across the suggested list of target flower types where possible. Nevertheless, more counts were conducted on 'other' flowers from 2020 onwards than on any individual target flower (39% of all public counts), reflecting the high proportion of FIT Counts in gardens and low number of common horticultural species in the target flower list.

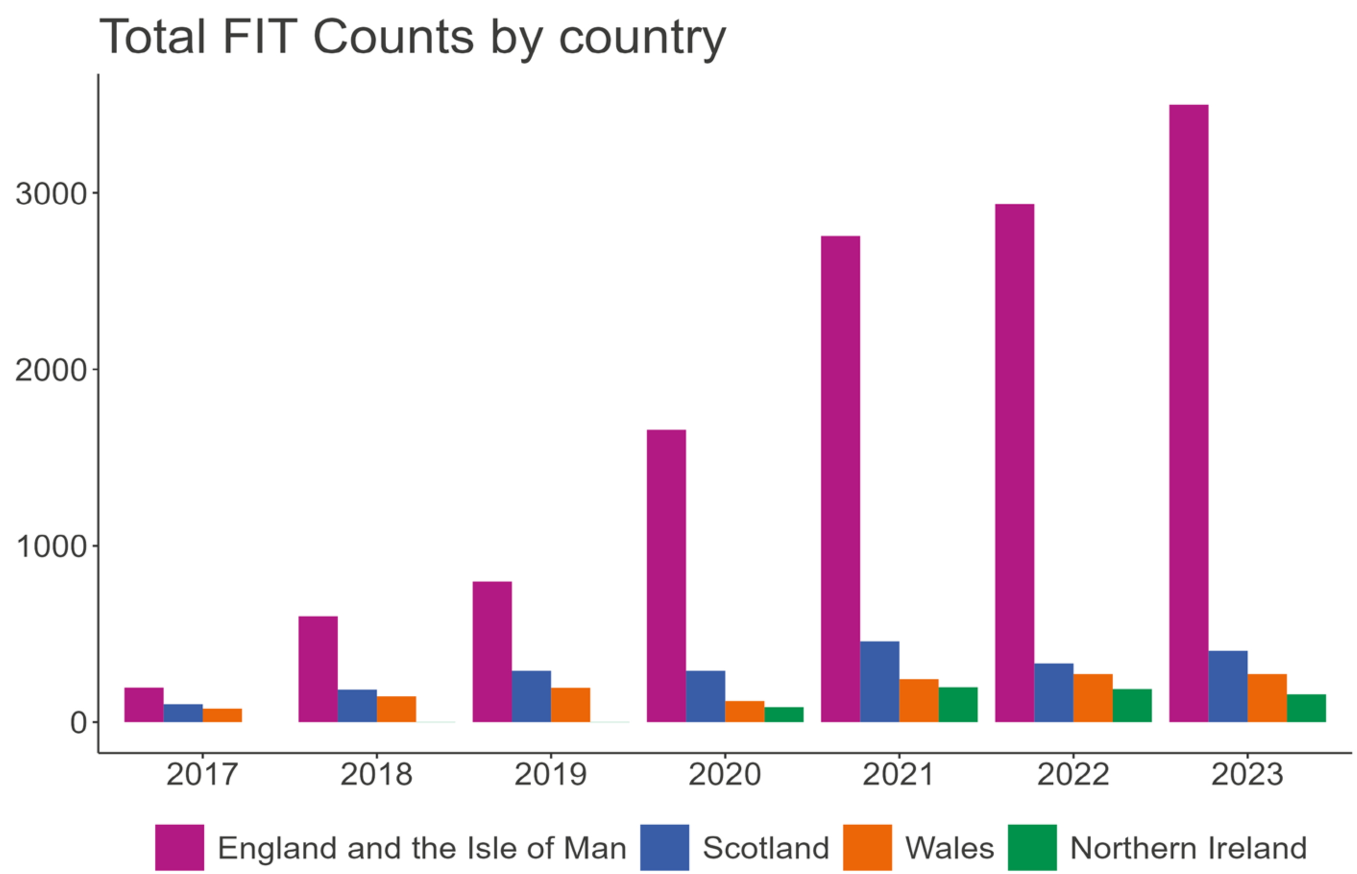


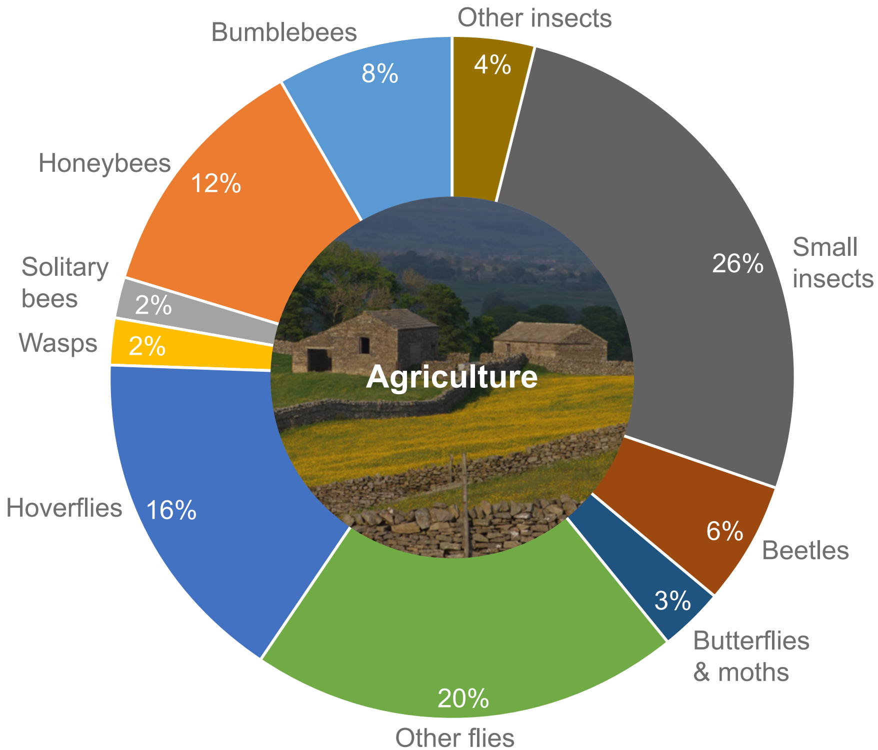
Figure 4. FIT Counts have shown a steady increase in uptake each year, with 4,340 counts submitted in 2023

We can also look at how visiting insect numbers and communites differ across different habitat types. The overall average number of insects per FIT Count does not vary greatly between habitats. Counts in agricultural habitats have the highest average number (12 insects per FIT Count), and counts within urban habitats have the lowest (10 insects per FIT Count) (Table 3). However, FIT Counts in each habitat show a different composition of insect groups. In agricultural environments, 'other' flies and the small insects (under 3mm) make up 46% of the visiting insects. In gardens, honeybees and bumblebees account for 45% of the insects seen during counts (Figure 5).

Of course, the target flowers being counted in each habitat will also affect the insect groups seen, with garden flowers such as Lavender being more popular with the social bees and providing important sources of nectar and pollen when these may be less readily available in agricultural areas. Through the developing modelling work (pages 18-23), we can take flowers and habitats into account at the same time.

Table 2. Summary of FIT Count results by target flower, showing the average total number of insect visits per 10-minute count across all years of the survey (2017-2023)

Target flower	Total insects	Total counts	Average per 10-min count	Most common insect visitors
Ivy *Hedera helix*	5,442	238	23	Other flies; honeybees
Hogweed *Heracleum sphondylium*	13,348	614	22	Small insects; other flies
Bramble (Blackberry) *Rubus fruticosus* agg.	10,242	683	15	Honeybees; bumblebees
Buddleja *Buddleja davidii*	9,042	655	14	Honeybees; bumblebees
Knapweeds (Common or Greater) *Centaurea nigra* or *scabiosa*	11,792	817	14	Bumblebees; hoverflies
Thistle *Cirsium* or *Carduus*	13,985	971	14	Small insects; other flies
Lavender (English) *Lavandula angustifolia*	14,879	1,056	14	Bumblebees; honeybees
Ragwort *Jacobaea/Senecio* species	13,406	1,031	13	Hoverflies; other flies
Hawthorn *Crataegus monogyna* or *laevigata*	2,396	309	8	Other flies; small insects
Heathers *Calluna* or *Erica* species	1,669	250	7	Other flies; small insects
White Dead-nettle *Lamium album*	1,425	256	6	Bumblebees; small insects
White Clover *Trifolium repens*	4,806	813	6	Small insects; bumblebees
Dandelion *Taraxacum officinale* agg.	5,723	943	6	Small insects; other flies
Buttercup *Ranunculus* species	7,316	1,295	6	Other flies; small insects



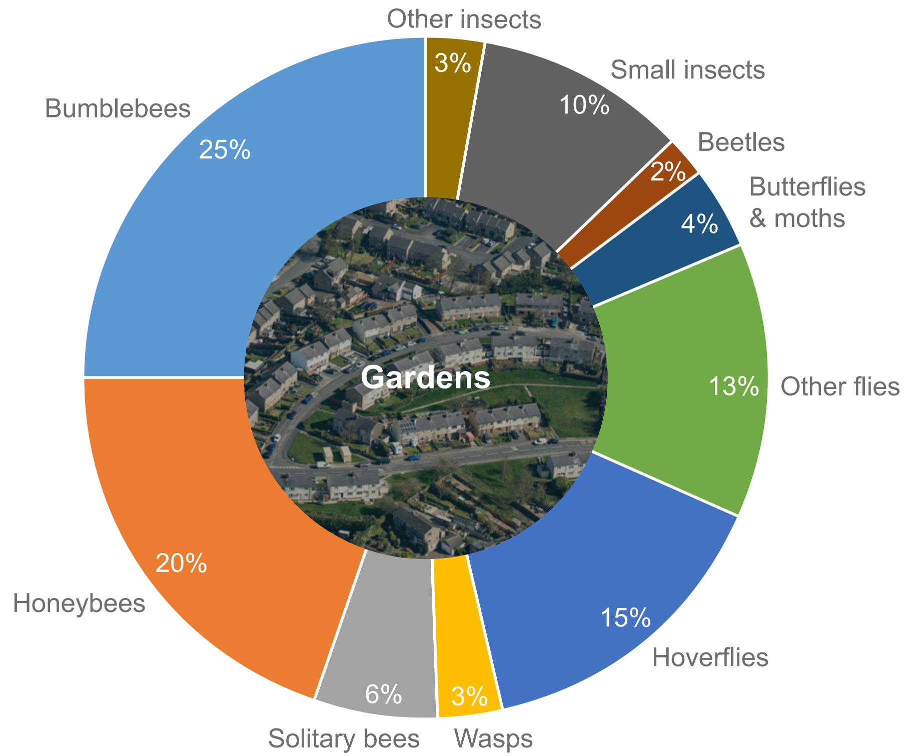


Figure 5. Insects counted in two habitat types, agricultural and gardens, showing the proportion from each group across all years of the survey (2017-2023)

Table 3. Summary of FIT Count results by habitat type, showing the average total number of insect visits per 10-minute count across all years of the survey (2017-2023)

Note: These figures are derived from the raw data.

Habitat type	Total insects	Total counts	Average per 10-min count	Most common insect visitors
Agricultural	21,924	1,863	12	Small insects; other flies
Garden	69,858	6,207	11	Bumblebees; honeybees
Semi-natural	67,648	6,231	11	Small insects; other flies
Urban	10,603	1,099	10	Small insects; bumblebees; hoverflies

The PoMS 1 km square survey

The PoMS 1 km square survey is a systematic survey of pollinators and floral resources from a core set of sites across the UK. It generates species-level data for bees and hoverflies using pan traps, providing new records of occupancy and distribution, as well as data to detect changes in abundance of key groups across a range of insect taxa. Here, Claire Carvell, Martin Harvey and Robin Hutchinson (UKCEH) summarise coverage to date.

This survey was set up in 2017 across 75 randomly selected 1 km squares in Great Britain, stratified to represent the relative cover of agricultural and semi-natural land use in each country [10]. In 2021, squares were set up in Northern Ireland to expand the overall network to 95 squares (Figure 6). Sampling is conducted on up to four visits from May to September each year by a combination of volunteers and PoMS team surveyors. The 'one-person-one-day' protocol was designed to be implemented by non-experts and involves setting out five pan trap stations (each with three bowls painted UV-bright yellow, blue and white, mounted at vegetation height and filled with water) along a diagonal of each square for six hours. During this time the surveyor collects data on floral resources (number of flowers within a 2m radius of the trap station) and habitats surrounding the pan traps and undertakes at least two FIT Counts. Collected samples are sent back to UKCEH for sorting and identification, and surveyors enter their other survey data online via the PoMS website.

Pan trap stations can be located in a variety of habitats, but are always set in the same position within a site on each survey visit, and attached to meet the height of surrounding vegetation

Photos (all @UKCEH)
Left, top and bottom: Claire Carvell
Left, middle: Nadine Mitschunas
Right: Miranda Bane

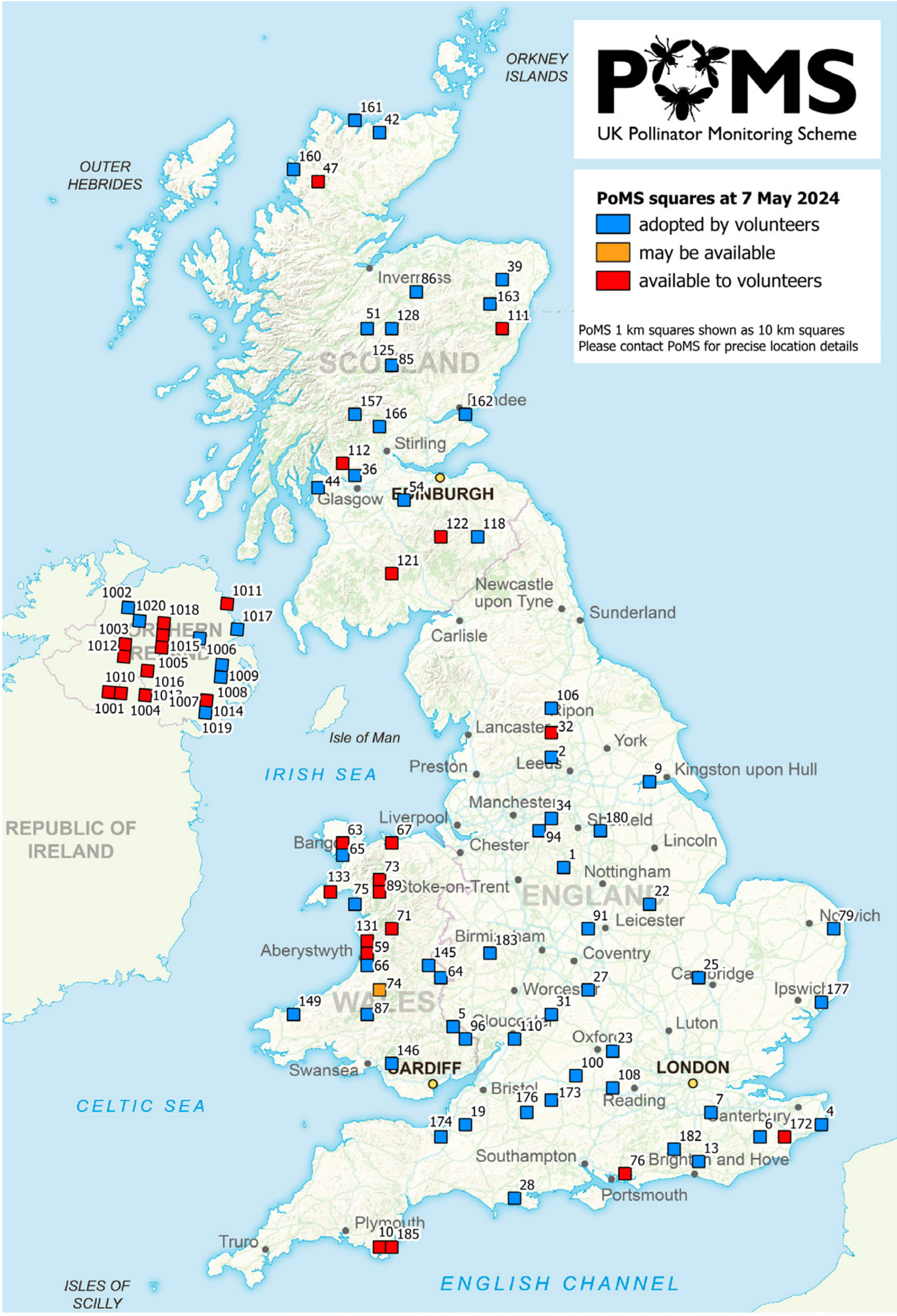


Figure 6. Location of 1 km square survey sites across the UK. Surveys on 'available' squares in red are covered by the PoMS survey team each year until they are adopted by volunteers. We are extremely grateful to the landowners who allow access for PoMS surveys, and to the volunteers who undertake them. Each year they receive a bespoke report which lists the bee and hoverfly species sampled and the flowering plants spotted in their 1 km square

Survey coverage 2017-2023

Since 2017, a total of 1,420 survey visits have been made, typically covering around 70 PoMS 1 km squares per year but increasing to 92 squares in 2023 with expansion of the network in Northern Ireland (Table 4). Survey effort has generally reflected the number of squares set up in each country (36 in England, 22 in Scotland, 17 in Wales, now 20 in N Ireland). Surveys were suspended from April to early July 2020 due to the restrictions imposed during the COVID-19 pandemic, but recovery has been excellent with an average of 3.2 visits per square achieved in 2023. Over the years, the number of volunteers adopting squares has increased steadily with 61% of the 95 squares having a trained volunteer surveyor in 2023 (see our report on levels of volunteer retention in the *Latest News* section). Several of the more remote PoMS squares remain available across Scotland, Wales and Northern Ireland (Figure 6), and we encourage anyone interested to get in touch for further information on what's involved.

Table 4. Coverage of the PoMS 1 km survey and samples processed from 2017-2023

Note: Figures for 2023 are shown to provide information on survey coverage from the last year, but may be subject to minor changes following final processing and data cleaning.

Detail	Year	England	Scotland	Wales	Northern Ireland	Total UK
Number of 1 km survey days	2017	59	35	33	NA	127
	2018	94	32	22	NA	148
	2019	108	62	64	NA	234
	2020	54	24	12	NA	90
	2021	119	61	57	6	243
	2022	119	76	60	32	287
	2023	128	69	58	36	291
Number of squares surveyed	2017	36	19	17	NA	72
	2018	33	17	15	NA	65
	2019	33	21	17	NA	71
	2020	32	18	11	NA	61
	2021	33	18	15	5	71
	2022	34	21	17	13	85
	2023	36	21	17	18	92
Number of samples processed (One sample is from three bowls at a pan trap station)	2017	295	175	165	NA	635
	2018	465	156	110	NA	731
	2019	540	305	313	NA	1,158
	2020	270	120	60	NA	450
	2021	593	305	284	30	1,212
	2022	591	364	296	157	1,408
	2023	628	328	278	169	1,403
Bee & hoverfly taxa identified	2017-2023	235	140	173	68	266

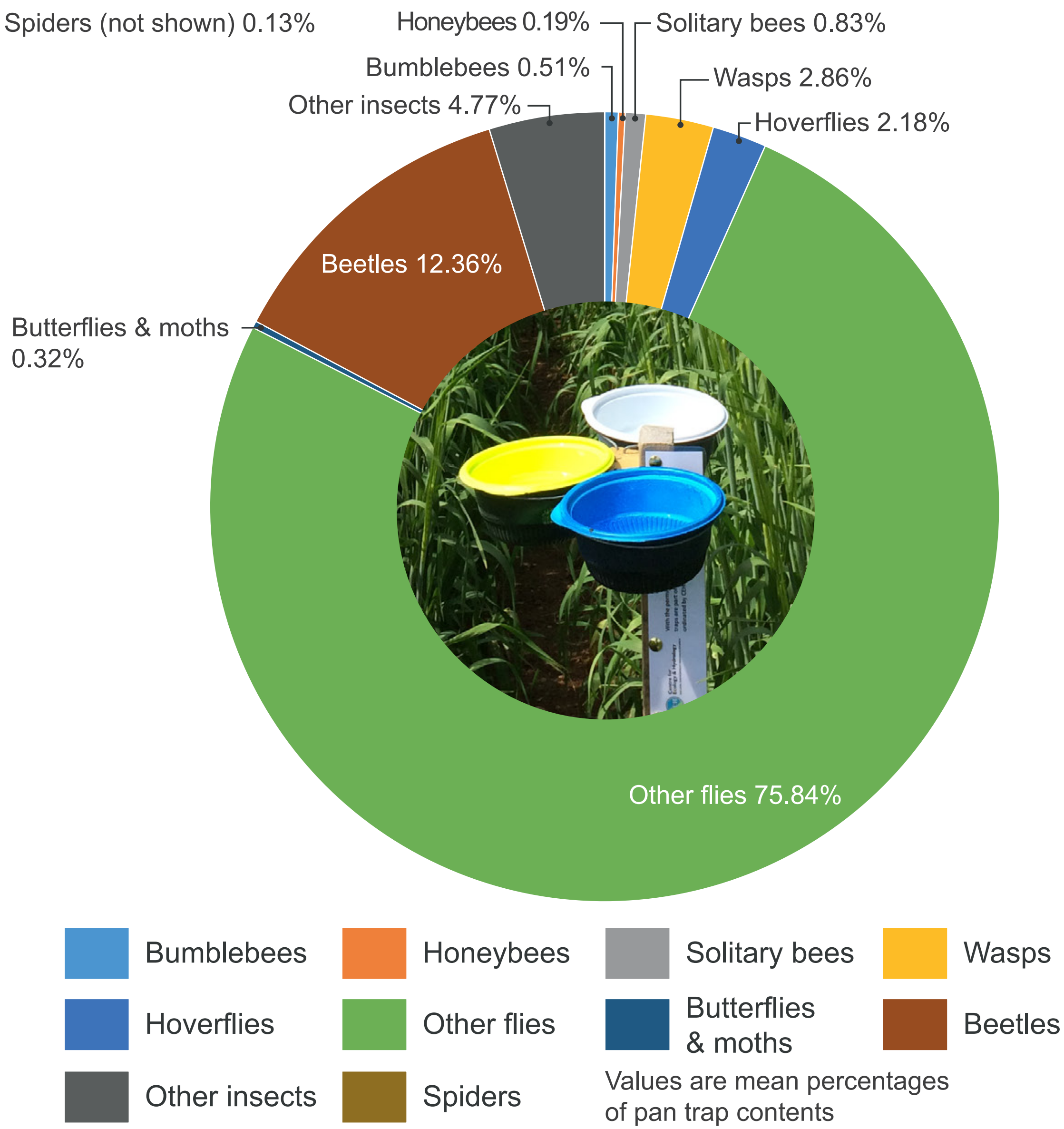


Figure 7. Average composition of a PoMS pan trap, taken from 5,594 samples collected across the UK between 2017-2022

What's in a pan trap?

The PoMS pan trapping protocol has been carefully designed to minimise the number of insects caught, while still getting a representative sample of the community at the site, and sampling enough individuals to measure changes over time [11]. Typically the traps catch three to four individual bees and/or hoverflies per set of three pans during a 6-hour survey, though these numbers vary considerably depending on factors including location and time of year.

Insects from the PoMS 1 km square samples are stored in small tubes of alcohol and returned (Freepost) to the UKCEH labs for processing and curation. This includes a full count of all insects sampled in the pan traps, broken down by species group. All bees and hoverflies are then identified to species level by expert taxonomists, while other groups are stored as 'by-catch' for potential future identification. A key aim of the UK PoMS partnership is to expand taxonomic capacity and skills in the identification of pollinators, to enable future monitoring efforts to continue and expand (see our feature article on DNA barcoding research on pages 27-32).

The pie chart (Figure 7) shows the average composition of a PoMS pan trap sample by insect group. Note the large proportion of 'other' non-hoverfly flies, making up on average 76% of a sample, with the bees and hoverflies making up only around 4% of a typical sample. Nevertheless, between 2017 and 2022, a total of 9,245 bees and 10,424 hoverflies were sampled and processed, belonging to nearly 250 species. These represent the spread of species that we would typically expect to find across the sampled areas of the UK, including some interesting finds that are described on pages 24-26.

This year we have taken a look at the typical numbers of species being detected in the pan traps across the 95-site PoMS network. Table 5 shows the average number of bee and hoverfly species per pan trap, per year, within squares in each country, with +/- standard errors (between 2017 and 2022). We find that typically more bee species than hoverfly species are sampled in pan traps in England, whereas there are more hoverfly species sampled per trap in Scotland and Northern Ireland, with numbers of species per group in Wales being fairly similar. Note that the figures shown here for Northern Ireland are not included in our statistical analyses in the next section, due to being based on reduced survey effort of one to three visits per square in 2021 and 2022 only (see Table 4, page 15), although these initial surveys appear to have sampled relatively high numbers of hoverfly species.

Looking at the total number of species recorded in each square on each year of PoMS to date, the square with the highest number of bee species recorded in a given year was on the Welsh borders, with 30 bee species sampled during the four surveys of 2022. Close behind was a PoMS square bordering National Trust estate in Kent where 27 bee species were sampled during 2019. The square with the highest number of hoverfly species recorded in a given year was in Aberdeenshire, with 26 hoverfly species sampled during only three surveys in 2018. Again close behind, 25 species of hoverfly were sampled in 2018 from a square in Shropshire. Clearly these numbers are dependent on survey effort in each square, emphasising the importance of achieving all four survey visits where possible. Regardless of their diversity, all squares are equally as important in their capacity to help us understand changes in pollinator numbers over time.

	England	Scotland	Wales	Northern Ireland*
Bee species	5.46 +/- 0.14	2.7 +/- 0.14	4.34 +/- 0.24	2.06 +/- 0.16
Hoverfly species	3.69 +/- 0.14	4.51 +/- 0.25	4.98 +/- 0.3	7.63 +/- 0.91

Table 5. Average number of bee and hoverfly species per pan trap station in each country, with +/- standard errors (2017–2022). Note: The standard error is a measure of uncertainty that indicates how far the sample mean (average) of the data is likely to be from the true population mean. *squares in N Ireland received only one to three sampling visits in 2021 and 2022, in comparison to typically three or four visits per square, per year for the other countries

Claire Carvell © UKCEH

Above: PoMS taxonomists carry out detailed examinations to identify all bee and hoverfly specimens from the pan traps , cross-checking a proportion of each others' IDs for quality assurance

Below: Bee and hoverfly specimens from pan traps, individually coded and ready for identification

Nadine Mitschunas © UKCEH

Six-year results from PoMS

PoMS surveys continue to provide a growing dataset that will enable us to study the abundance and species richness of pollinating insects through time across the UK. However, the current six-year time series is still too short to detect trends with sufficient confidence. Insect populations are notoriously variable between years, driven by a wide range of factors, hence while our results to date suggest no strong changes in either direction for most insect groups, it is important to consider this as an extended baseline rather than an initial trend. Claire Carvell and Francesca Mancini provide an update on the analytical work going on behind the scenes.

With five years of data from the public FIT Count survey and six years from the 1 km square survey, we are able to undertake statistical analyses that will give an indication of changes in different pollinator groups over time. As with any large-scale biodiversity monitoring survey, ensuring robust results requires sufficient data throughout the recording period together with an understanding of variation around any trends (often shown by a 95% confidence interval). Here we report on the results for Great Britain using the data generated from England, Scotland and Wales between 2017 and 2022, for the more commonly recorded insect groups in each of the PoMS surveys. Although nearly all data from 2023 are available, they are still going through cleaning and quality assurance pipelines and are not ready to be included in the analysis.

Helen Bostock © RHS

A FIT Count survey - recorders collect information on environmental factors such as flower abundance, habitat type and weather conditions during the survey which can be included in models to account for variation in insect numbers

Modelling the data and interpreting graphs

Insect numbers can vary for many different reasons, including local and seasonal weather or other environmental factors. Changes in these variables can make it difficult to detect a temporal trend in number of pollinating insects. We use statistical models to account for variation in insect numbers due to some of the more local environmental factors measured on PoMS surveys and derive robust estimates of temporal trends in insect abundance.
We model data from the 'public' FIT Counts, 1 km square FIT Counts and pan trap surveys separately and we include the following variables: year; month; site; flower count in the

quadrat and flower structure of the target flower (categorised as open or closed, for FIT Counts) or total flower count and species richness of plants in flower around the pan trap, broad habitat type, wind speed and amount of sunshine during the survey (see the *technical details* box below).

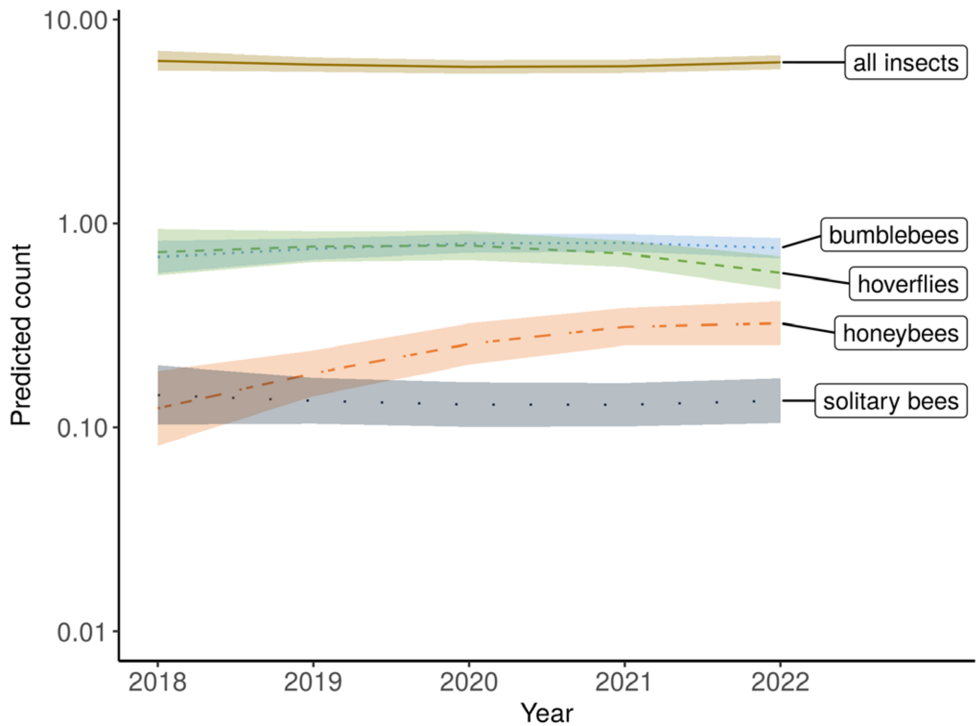
Graphs are plotted showing the counts (or species richness) estimated by the model (on the y axis) for each year (the x axis). Each graph shows the trend in average number of insects or number of species counted per survey as a line and the associated uncertainty as shaded areas (95% confidence interval).

Overall, we see pollinator numbers fluctuating across the PoMS time series to date (Figure 8 a-d, pages 20-21). One notable difference between this year's data and that presented in our last annual report is an apparent decline in 2022 for hoverfly and total insect counts in both the FIT Count and 1km square surveys, and for hoverfly species richness from the pan traps. It is most likely that these patterns reflect the extremely hot, dry summer weather experienced in 2022 which we would expect to have impacted the flies more than the bees due to their greater dependency on water or damp areas for certain stages of the lifecycle. However, given the large uncertainty and high inter-annual variability typical of insect numbers, we should be cautious about interpreting these plots in terms of overall declines or increases over this five or six-year period. As we collect more data in the next few years we will be able to detect longer-term trends in insect numbers beyond annual fluctuations.

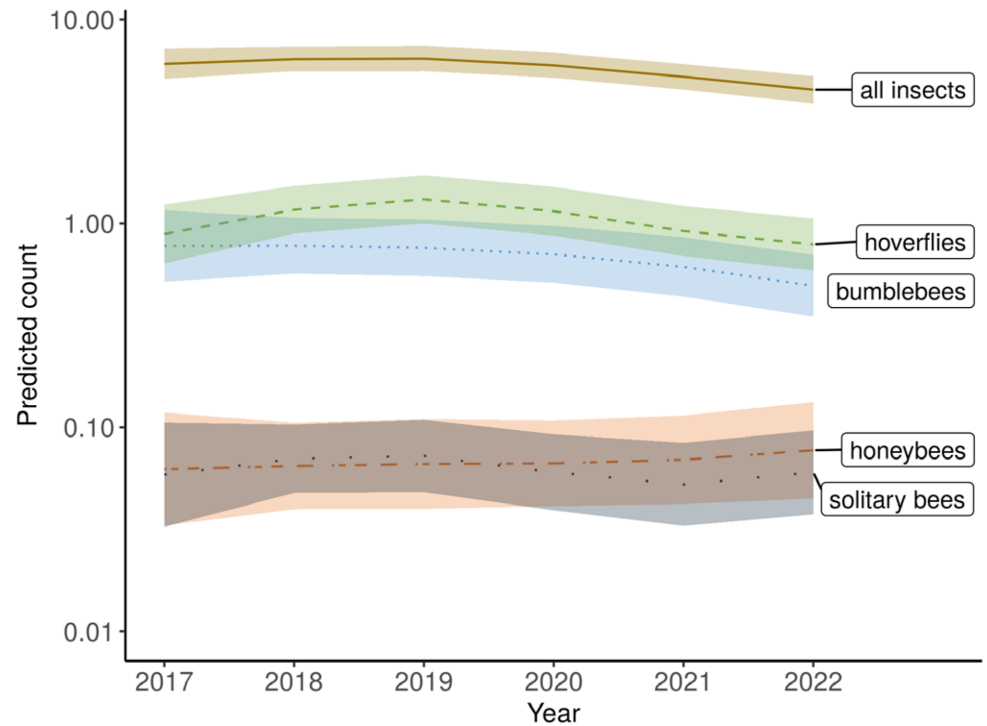
Estimated counts from the FIT Counts (Figure 8 a-b) show, as last year, the relative numbers of bumblebees, hoverflies and solitary bees to be similar between the public and 1 km square surveys. This suggests that despite the lower overall levels of expertise in insect group identification among the public FIT Count recorders, and the large proportion of counts carried out in gardens, they are capturing a similar picture of the flower-visiting insect community to those counts carried out in the wider countryside across the 1 km square network.

The technical details

We use generalised linear mixed models with a negative binomial distribution to model counts and/or species richness of different insect groups. The effect of year is modelled as a natural spline with two degrees of freedom for the public FIT counts (only five years of data) and three degrees of freedom for the 1km FIT Counts and pan trap data. We include a random effect for site for FIT Counts and a nested random effect for pan trap station within 1 km square for the pan tap data, to account for between site variation in insect numbers that is not accounted for by the variables in the model. The counts presented in the plots are estimated marginal means from the final model, which are averaged over all levels of the categorical variables in the model and weighted by the number of observations within each level, with continuous variables kept at the mean.



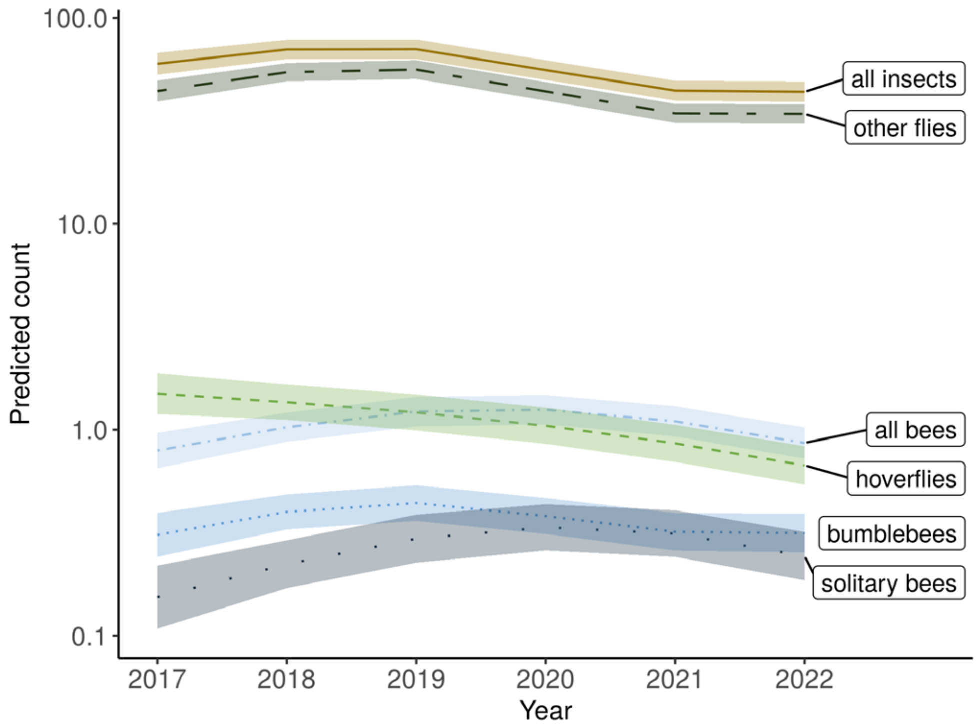
a) Insect abundance per 10-minute count from the public FIT Counts



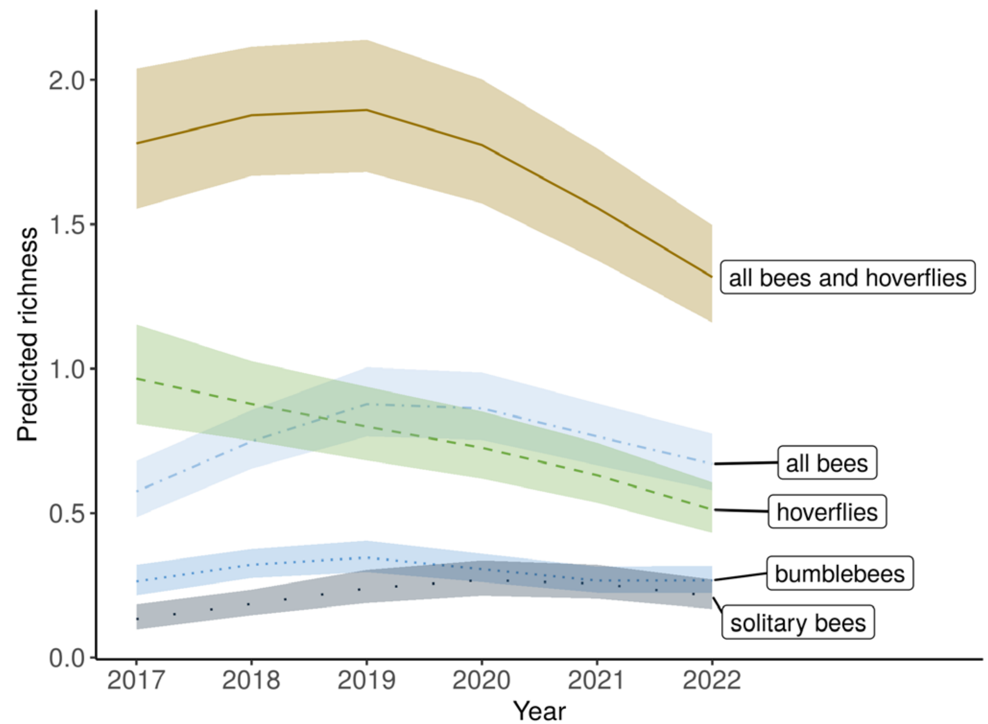
b) Insect abundance per 10-minute count from the 1 km square FIT Counts

Figure 8 a,b. Results showing predicted counts from statistical models on PoMS FIT Count datasets between 2017/2018 and 2022

Note: Where predicted counts are shown, numbers on the y axis represent the predicted number of insects per FIT Count, plotted on a log-10 scale to allow presentation of the overall trend alongside trends for each insect group. The associated uncertainty around the trend (the 95% confidence interval) is shown as shaded areas.



c) Insect abundance per pan trap station per survey visit



d) Richness of bee and hoverfly species per pan trap station per survey visit

Figure 8 c, d. Results showing predicted counts and species richness (number of bee or hoverfly species) from statistical models on PoMS pan trap datasets between 2017 and 2022

Note: Where predicted counts are shown, numbers on the y axis represent the predicted number of insects per trap station, plotted on a log-10 scale to allow presentation of the overall trend alongside trends for each insect group. Species richness is plotted on a normal scale. The associated uncertainty around the trend (the 95% confidence interval) is shown as shaded areas.

Emerging effects of explanatory variables

Some patterns of interest emerged from the environmental variables included in our initial four or five-year models and the majority of these have been maintained with the additional year of data, suggesting that these measures collected by PoMS volunteers will prove important in interpreting the results.

From FIT Counts:

- The number of floral units in a FIT Count quadrat has a positive effect on number of insects seen, across all groups, with this effect being more notable on the public FIT Counts.
- Overall, more insects (and hoverflies in particular) are recorded visiting 'open' structure flowers, such as Hogweed and Bramble, than 'closed' structure flowers, but bumblebee numbers are higher on 'closed' flowers with long flower tubes, such as Lavender and Dead-nettle.
- Insects in all groups tend to be more abundant on 'public' FIT Counts in garden habitats than in countryside locations, but this pattern was not consistently shown from counts in PoMS 1 km squares.
- More insects are counted on FIT Counts where the quadrat is 'entirely in sunshine' and when there is just a light wind, and fewest where the quadrat is entirely shaded and/or in windier conditions.
- Flower patches that are more or less isolated from other flowers tend to have lower numbers of insect visitors on FIT Counts than those patches that are within a larger patch of flowers.

From PoMS pan traps:

- The number of insects sampled does not appear to be significantly affected by the number of flowers (measured as floral units) within a 2m radius of the pan trap, however the total number and species richness of bees, and of bumblebees, is positively related to the flower richness (number of plant species in flower) around the pan trap.

A bumblebee feeding on a large patch of Hemp-agrimony (*Eupatorium cannabinum*)

- Overall insect abundance and abundance of bumblebees and hoverflies in the pan traps increased through the season to a peak in August. For the solitary bees, abundance and richness were highest in May, gradually decreasing towards September, as we would expect given that many solitary bee species have spring flight periods.
- Our models suggest that there are differences in abundance of some insect groups sampled in pan traps in 1 km squares dominated by agriculture vs squares dominated by semi-natural habitats. Further research will explore the extent of these differences.

What's next

A key goal for PoMS is to see the data and trends become an important part of the evidence base that helps us understand how, where, and why pollinator populations are (or are not) changing. This will take time not only because of the need to look beyond annual fluctuations, but because of the need for some important development tasks that we are working on together with the PoMS Steering Group:

1. The modelling methods we are using to produce trends are provisional. We hope to get them published in an academic scientific journal over the next year to give extra credibility to what we find. We are also keen to ensure that these outputs are useful and interesting to volunteers and others taking part in PoMS, so will be happy to receive any feedback on the way PoMS results are presented.
2. We are looking to refine what kinds of trend metrics and statistics to report, to show how pollinators are changing, for example the percentage change in abundance or species richness per survey at insect group level or using a composite measure for "total pollinators", or both of these.
3. We need to better understand the statistical 'power' of the PoMS dataset and analyses to detect changes. A very gradual increase or decrease will generally require a lot of data over a long period of time, whereas an abrupt change will be more obvious. We are currently analysing how well the PoMS datasets will be able to pick up different sizes of change, and at what spatial and temporal scales.

Jens Holm, unsplash.com

Species highlights from the PoMS 1 km square survey

The PoMS 1 km survey uses pan traps to record insects in a consistent way, gathering quantitative data on species abundance for hoverflies and bees. The survey is not designed to focus on rare species, but it is always interesting to find the occasional unusual species among the more widespread ones. Here, Martin Harvey (UKCEH) highlights four of the rarer species from the 1 km square surveys in 2023.

Dark Copperback hoverfly, *Ferdinandea ruficornis*

This hoverfly is a handsome dark copper colour, with reddish legs and antennae. It is a scarce species nationally, and prior to 2023 had never been found in the PoMS 1 km squares. In 2023 it was found at square 71, in Montgomeryshire, mid-Wales. Previous Welsh records for this species have been along the north coast and the border with England, so the PoMS record extends the range a long way into mid-Wales.

The Dark Copperback is one of a small number of hoverflies with larvae that are associated with sap runs on old trees. Its larvae filter out yeasts and bacteria from the sap runs and feed on these. In some locations there is an association with a rare moth, the Goat Moth, that has caterpillars that bore into tree stems and can trigger sap runs as a result. However, the fly is also found in areas where Goat Moth is not present.

Most of the PoMS square 71 consists of open hillside grassland, but there are woodlands nearby and a scattering of trees and scrub within the square, so it is possible that Dark Copperback is breeding nearby, but further recording is needed to confirm that.

Male Dark Copperback hoverfly, *Ferdinandea ruficornis*

Note: The square numbers mentioned in the species accounts refer to the numbers shown on the 1 km square survey map, see page 14.

Yellow-clubbed Glasswing hoverfly, *Scaeva selenitica*

This is a much more widespread hoverfly than the Dark Copperback, but is quite localised and not recorded all that often. It is particularly associated with conifers, and has larvae that feed on some of the aphids that are found on pine and spruce trees. The adult hoverflies visit flowers (including Hogweed and other white umbellifers) and may be found in more open areas.

This hoverfly is known to be a migratory species. There may be a resident population in the UK, but additional individuals regularly migrate from continental Europe. Some fascinating experiments have been carried out by Richard Massy (University of Exeter) and colleagues, available in an open access research paper [12]. This research has shown that in autumn, when Yellow-clubbed Glasswing is migrating southwards, it is able to judge the position of the sun as it moves through the day and use this to maintain a southerly flight direction. If the flies are kept in an environment where the light is artificially managed to so that 'daylight' hours are shifted to be six hours later than they would be under natural conditions, the hoverflies end up flying in a more westerly direction, strongly suggesting that they are basing their choice on the position of the sun rather than other cues such as the time since daybreak.

Yellow-clubbed Glasswing has been recorded twice by the PoMS 1 km square surveys, once in 2019 in square 69 in Cardiganshire, and again in 2023 at the same Welsh square that produced the record of Dark Copperback.

© Steven Falk

Female Yellow-clubbed Glasswing hoverfly, *Scaeva selenitica*

Tormentil Mining Bee, *Andrena tarsata*

A small, dark solitary bee that is quite widespread, but has declined in parts of its range and is listed as a priority species. As its name suggests, it is closely associated with Tormentil flowers, from which it collects most of the pollen it needs to feed its larvae. It will visit other flowers for nectar as well. Tormentil is associated with heathlands, moorlands and acid grassland, and the bee is most frequently found in such habitats in northern and western parts of Britain.

This species has now been recorded three times during the PoMS 1 km square surveys. The first was in 2019 from square 146, south Wales, and then in 2023 it was recorded from square 87 in Carmarthenshire, Wales, and from square 157, in Perthshire, Scotland.

A detailed review of conservation for Tormentil Mining Bee has been produced by the Species Recovery Trust [13], and a factsheet is available from Buglife [14].

© Steven Falk

Male Tormentil Mining Bee, *Andrena tarsata*

Downland Furrow Bee, *Halictus eurygnathus*

The Downland Furrow Bee nests in burrows in the ground, and the adult bees visit flowers of Greater Knapweed (*Centaurea scabiosa*) for pollen, and can also be seen on other knapweeds and scabiouses. Elsewhere in Europe it is known to play a role in the pollination of Lucerne crops, and in orchards. In the UK it is a species of chalk grasslands, and is a very rare species in the UK. It used to be found in several southern coastal counties in England, but went unrecorded for about 50 years until it was rediscovered by Steven Falk in 2003, on the South Downs in Sussex.

The PoMS records also come from the South Downs, at square 13 in East Sussex. Single individuals have been recorded in years 2019, 2022 and 2023. More information is available on the BWARS website [15].


© Steven Falk

Female Downland Furrow Bee, *Halictus eurygnathus*

Hidden secrets: DNA barcoding of PoMS specimens

Since establishing the PoMS scheme in 2017, we have been undertaking complementary research to understand the value of newly emerging techniques in molecular DNA barcoding for identifying the many specimens and species (both plant and insect) captured in pan trap surveys. Here, Claire Carvell introduces the research teams behind this work, discusses some of its initial findings and outlines its future potential.

PoMS has made significant headway in expanding the range of pollinating insect groups covered by systematic annual monitoring at national scale in the UK. Samples are being obtained and archived from regions and habitats that may never have been surveyed to this extent across the 95-site network of 1km squares. As we have reported, all the bees and hoverflies are identified to species level, but for the thousands of other insects sampled (often making up around 90% of the pan trap contents), our current taxonomic capacity and funds mean we are only able to identify these to 'group' level to look at changes in overall abundance over time.

DNA barcoding is a method of specimen identification using short, standardized segments of DNA [16]. DNA can be extracted from individual insects by harvesting a small sample of tissue such as a leg, or extracted from 'bulk' samples of multiple specimens, to reveal not only the identity of the insects therein, but also any associated plant pollens or other organisms. Environmental DNA or "**eDNA**" refers to DNA shed by organisms and sampled in the environment. Often this will be soil, water or air, but eDNA can also be sampled from insect traps, or the gut or faeces of an animal. DNA extracts are 'amplified' and fed into a **sequencing** platform, translating the unknown sample into the sequence that represents its DNA barcode. Every species has its own barcode, just as every person has their own fingerprint. These DNA barcodes can be compared to a **reference library** to find a match and provide an ID. The IDs are often referred to as operational taxonomic units (**OTUs**), describing groups of individuals that share the same DNA sequence, even if it is not always possible to assign a definitive species.


Claire Carvell © UKCEH

Specimens awaiting identification in the lab at UKCEH Wallingford – most are identified following a short period of drying before being returned to ethanol to preserve their DNA quality

While the technologies used for DNA barcoding have continued to develop and radically extend the way we monitor insect biodiversity, there remain several gaps and opportunities, for example in our understanding of a) the potential and practicality of applying DNA barcoding to samples collected and archived using different methods; b) how to interpret the resulting data and c) the extent of the reference libraries for understudied insect groups such as those sampled via PoMS. If DNA-based identification protocols can be developed and applied to the samples generated by PoMS and other long-term insect monitoring schemes, this would offer a powerful way to broaden biomonitoring and cover some of the 'dark taxa' that are often understudied but highly diverse, and play key roles in ecosystem functioning.

Since 2019, two projects have been awarded to UKCEH and partners to further our understanding of the potential for DNA barcoding techniques as new tools to address these research gaps. Both projects have been funded by the Defra **DNA Centre of Excellence**, with the support and guidance of Paul Woodcock at JNCC for which we are extremely grateful. Both have taken advantage of the site infrastructure and extensive sample archive generated by PoMS.

The first project was led by PoMS partner **Alfried Vogler** and postdoc **Huaxi Liu** at the Natural History Museum, London. As well as focussing on DNA from the sampled insects, we wanted to understand more about the potential to **analyse pollen grains** associated with the insect specimens and thus develop a better picture of **plant-pollinator interactions** over time and space. The project had four core aims, and here we outline these together with a summary of the findings against each one.

1. Develop methods for plant DNA extraction and identification from insect specimens sampled in pan traps, both via ingested pollen (in gut samples) and via the insects' body surface

We found that extraction of pollen from the guts of both bee and hoverfly specimens produced sequenceable DNA in 94.5% of cases. This was much more successful than 'surface' samples of pollen (Figure 9) extracted from the specimen submerged in extraction buffer, which was only successful in 11.0% of cases. This could be explained by the fact that few pollen grains remain attached to the specimens that have been captured within the water-based pan trap and then transferred to 70% ethanol for transport and storage. Some key further questions remain: such as how long do pollens persist in the gut contents of larval and adult insects? We would also need to establish the precise link between pollen intake and pollination in order to understand how well gut pollens represent interactions with flowers that likely result in pollination.

© Kay Wilson

Figure 9. Research led by the NHM tested whether DNA extraction methods could detect different pollens remaining on the body surface or within the guts of bees and hoverflies sampled in PoMS pan traps, or within the pan trap preservation fluid

2. Test the possibility of obtaining plant DNA directly from the preservation fluid following pan trap sampling

We tested the preservative ethanol from 100 samples across 18 PoMS sites surveyed in 2018 and found that extraction produced sequenceable DNA in virtually all cases. Sequencing identified 186 operational taxonomic units (OTUs) classified as 'Streptophyta', the major group of green plants that includes the flowering plants. However, the majority (>70%) of these OTUs could be identified to family level only based on the available DNA barcode reference dataset for plants, and lack of resolution in the molecular outputs. This method would not permit pollen sequences to be assigned to a single insect specimen, but may enable a rapid, non-destructive test for the set of flowering plants visited by pollinators at the level of whole trap stations or sites.

3. Assess pollinator communities and their associated plant DNA from PoMS sites across Great Britain to establish differences between agricultural and semi-natural sites and between the two main pollinator groups, bees and hoverflies

We tested 1,217 specimens from 41 PoMS sites and applied a **high-throughput method** (one that is capable of sequencing multiple DNA molecules in parallel) known as "individual illumina barcoding" (previously developed by the NHM team in collaboration with PoMS [17]) for identification of the bees and hoverflies, as well as the above method for amplification of plant DNA from their guts. This revealed 531 OTUs representing the flowering plants, and 1,085 barcodes representing a species of Hymenoptera (bees) or Diptera (flies) which were in close agreement with the classical taxonomy carried out on those specimens. Interestingly, these protocols revealed some potential cross-contamination, possibly from specimen mixing in the pan traps, indicated by the detection of various flower-visiting Coleoptera and other non-target groups.

Interaction networks constucted using the bee and hoverfly species (from 954 specimens) and the plant families in their associated gut pollens revealed some interesting patterns from within PoMS squares dominated by agricultural versus semi-natural habitats (see the example in Figure 10).

Overall there were examples of both generalist and specialist pollen feeding behaviour shown across the bee and hoverfly species, though of course the analysis at plant family level may hide a greater variety of pollen types representing species within those. We noted the great variety of plant families represented in specimens of the most dominant insects in particular; the most common species sampled within the semi-natural sites (from a total of 234 specimens) was *Lasioglossum calceatum* (Common Furrow-Bee) which (along with several other species) showed a preference for plants in the Ranunculaceae but signalled interactions with several other plant families (Figure 10). In contrast, the most common species sampled within agricultural sites (from 720 specimens) was *Episyrphus balteatus* (Marmalade Hoverfly) which (along with several other species) showed a preference for plants in the Asteraceae, but again with individuals showing associations with many other plant families.

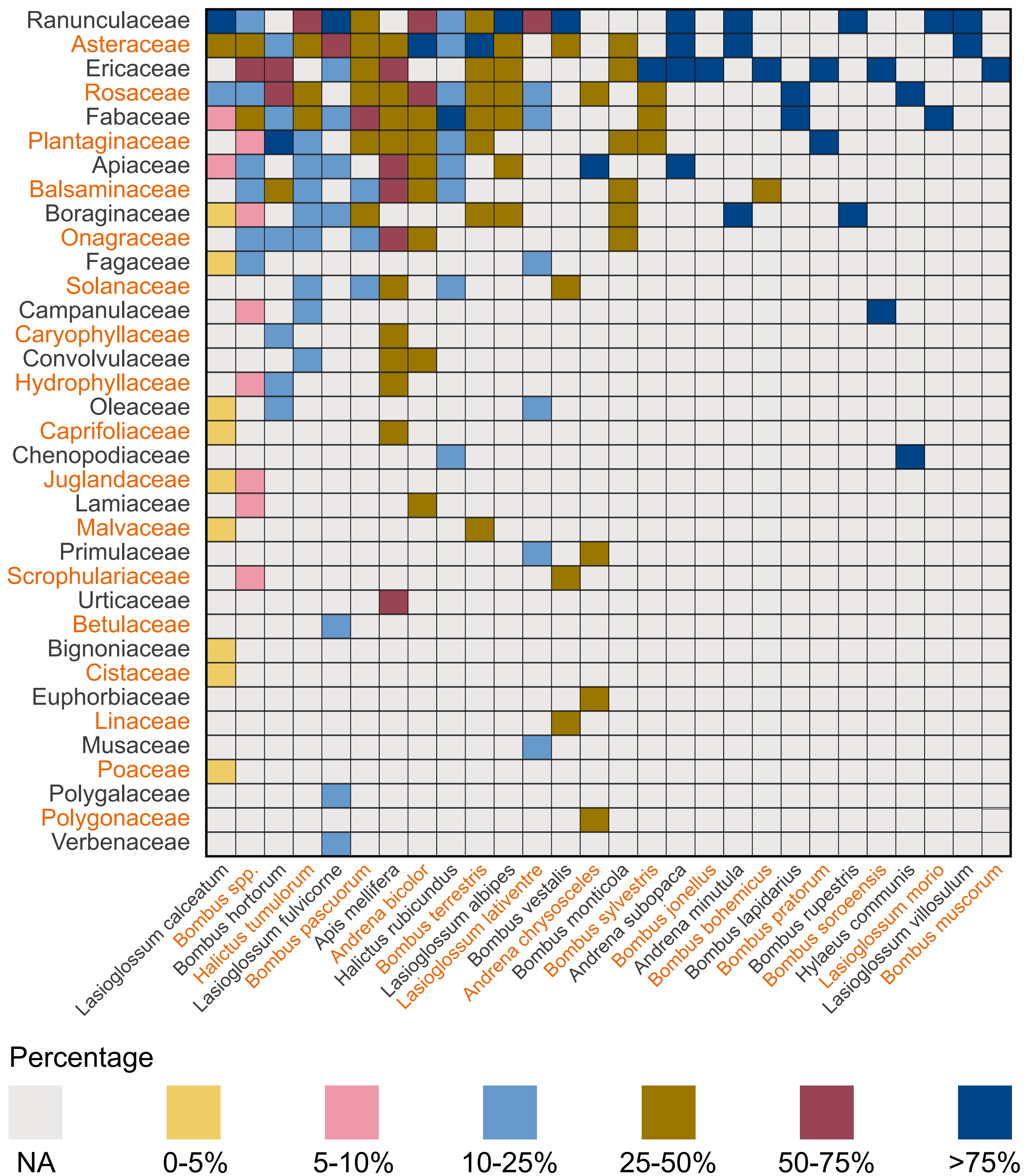


Figure 10. Matrix showing the relative frequency of plant family pollens in the guts of bees sampled in semi-natural PoMS squares in 2018. Plant families are ordered from top to bottom according to the overall frequency with which they were encountered across all sampled sites, and the insects are ordered from left to right based on the highest to lowest number of linked plant families present. Generalist species are located in the leftmost columns and specialists are found towards the right. Figure redrawn from that in Liu et al (2021), unpublished report to Defra

4. Establish the power of using the 'by-catch' of the large number of other insects obtained from pan trap sampling for UK biodiversity assessment and biomonitoring

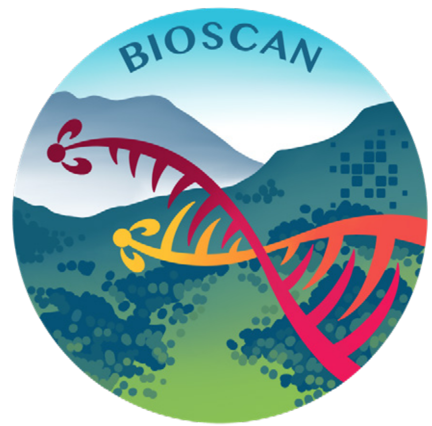
The 'by-catch' representing all non-bee and non-hoverfly specimens from PoMS pan traps are routinely counted at insect group level, but here we applied a non-destructive DNA extraction and '**metabarcoding**' approach (allowing for the simultaneous barcoding of many taxa within the same sample) to 206 of these mixed samples. The results based on more than 900 OTUs showed that most species in the PoMS by-catch were **non-syrphid Diptera** (flies, at 76%), followed by the Coleoptera (beetles) and Lepidoptera (moths), agreeing with our initial counts. Communities were strongly structured ecologically and geographically, communities from Scotland appearing different from those collected in England and Wales. The diversity of insects represented within the pan trap by-catch may offer a novel route for revealing differentiation between local communities geographically or ecologically, and may provide a suitable tool for assessing environmental change across the UK, alongside patterns of species-level abundance or occupancy in the target pollinator taxa (bees and hoverflies).

This study established DNA barcoding methods as a potentially powerful approach to study complex insect communities and their interactions with plants, as a sensitive measure of environmental quality and change through time. The full project report [18] is likely to be published by Defra during 2024.

The second project involves a new partnership with scientists **Mara Lawniczak**, **Jemma Salmon** and **Lyndall Pereira** at the Wellcome Sanger Institute in Cambridge. They are leading the BIOSCAN-UK project [4], using DNA barcoding to study the genetic diversity of one million flying insects from across the UK over a five year period. BIOSCAN are obtaining insect specimens primarily from a network of malaise traps, set monthly and plated by project partners across the country. However, recognising that the PoMS sample archive provides an additional source of material, we are conducting a pilot to investigate whether the BIOSCAN pipeline provides a reliable, cost-effective molecular protocol for DNA-based identification of insects from pan trap samples.

We selected pan trap samples dating from 2017 to 2022 from four PoMS squares (two in England, one in Scotland and one in Wales). These were then individually transferred to 96-well plates provided by BIOSCAN under their established standard operating procedure, with all

A large proportion of the PoMS sample by-catch is made up of flies other than hoverflies (classed as 'other flies' in the PoMS FIT Count). This example shows a mating pair of flies in genus *Lucilia*, one of several similar species that are often referred to as 'greenbottles'



the small insects going in whole and just three legs from one side of each larger insect being removed and plated in the wells (Figure 11). In total, we plated 9,296 insects (including bee and hoverfly specimens and all the by-catch) from 31 PoMS survey visits across the six years.

The specimen plates are with the BIOSCAN team and at the time of writing, are undergoing high-throughput non-destructive DNA extraction and barcoding of individual specimens. The resulting sequence data will be analysed to tell us whether the 6-year PoMS archive samples are of sufficient DNA quality for use with the protocols developed by BIOSCAN, to compare their results with our traditional taxonomy, and to consider potential next steps for making DNA-based analysis an operational part of PoMS. The project also hopes to contribute significantly to filling gaps in the Barcode of Life Data System (BOLD), a unique and expanding reference library of DNA barcodes.

As ever, it has been the sample sorting and processing, and meticulous plating, labelling, extraction and cataloguing of specimens that has consumed many hours on these projects and been critical for their success. For this we have to thank Nadine Mitschunas and Ellie Grove at UKCEH Wallingford and Huaxi Liu at the NHM. We would also like to thank Daniel Read, head of the molecular ecology group at UKCEH for overall advice and guidance.

Claire Carvell © UKCEH

Claire Carvell © UKCEH

Figure 11. Under the project partnership with BIOSCAN-UK 9,296 insects have been plated for DNA barcoding (including bee and hoverfly specimens and all the by-catch) from 31 PoMS survey visits across four sites and six years. The image above shows the diversity of size classes of insect found in just one pan trap set. The image below shows a 96-well plate filled with insect specimens or legs from the larger individuals, ready for the BIOSCAN DNA barcoding pipeline

A volunteer's view from the field

PoMS volunteer Enid Forsyth shares reflections on her first PoMS survey with team member Miranda in "Craigierig: Diary of Adventure". We very much hope this will be one of many!

It's 7am and I'm off down Edinburgh's Morningside Road - bound for deepest Border country. Stakes, pan traps, water, ethanol and paperwork all packed – as are gargantuan amounts of food, drinking water, boots, gaiters, rain gear, a change of clothes and boot disinfectant. We have an outbreak of bird flu in Red Grouse here in Scottish Borders and I don't want to be spreading anything when I leave the site…

After Peebles I take the back-road to Traquair but not before Lee Pen hurls into view as I round a bend. I've been lucky enough to be in the company of Black Grouse and Red Squirrels when on her paths. On down to St Mary's Loch, then head up, just beyond Cappercleuch, to Meggethead and Craigierig. Don't you just love these names? Crisp hill air fills my lungs as I step out. This is my destination and although it is a bit cloud-bound there is a hint of colour from the east. I have breakfast, feeling the cool damp air and slight breeze, as I wait for Miranda, Pollinator Ecologist and my mentor and buddy for the day.

Boots on, equipment divvied up, and we're off up the track to the east of the farm that occupies the survey square. I've been building up my glutes since a silly headlong fall into a bog a couple of months back but it's my lungs that tell me I haven't been doing elevated stuff

© Miranda Bane

Enid at 'pan trap five' on her PoMS square for a while. There's a lot of up-hill and down-hill in this 1km square but after a bit I get into my stride. At the second gate we climb over the stile and I remember we saw a fully bleached-out roe-buck skull, in all nature's brilliant design, right beside the gate on the first survey of the year. We set up pan trap two nearby – 160 spikes of *Calluna vulgaris* and fifty flowers of *Potentilla erecta* in the 2m radius of this trap - before we head up the hilly moorland in deep springy heather to do pan trap one. Clouds of pollen take off as our boots disturb it. Then at pan trap one 8,400 spikes of *C. vulgaris* and six of *Erica tetralix*. We're at around 450 metres just below Craigierig's summit so we get a good view.

Now the real hard trek begins. Back down the hill we go, over the burn and rise fairly steeply up to pan trap three's location on Cauldstane rig. It takes us an hour to get there, but the views are glorious when we stop to drink some water. Sixteen *E. tetralix* spikes here and 2,500 of *C. vulgaris*. Back down the rig, over Craigierig Burn and a pull up towards Hunter Hill. We've just set up pan trap four when we see a hill buggy way down below us. And then I realise it's on the way up to us. The local gamekeeper and forester throws us a smiley hello and we chat. Then he realises we have a fair haul up Hunter Hill to our final destination so he offers us a lift. We accept with alacrity. He promises to go slowly over the bumps – there are loads of them – and we hold on for dear life but love every minute of the exhilarating ride. Now the end is in sight. We head over the shoulder and there, far below in its bright-blue hue, is Megget Reservoir. Glorious. Pan trap five feels almost suburban by comparison in its H18 glory of agriculturally improved/re-seeded/heavily fertilised grassland (PoMS provides a list of habitat classifications to assign to the 2m radius around each trap, each coded H with a number). Pan traps one to four are in H12 acid bog/mire and H23 wet and dry heathland /dry heather moorland habitats. Very different. But on this 'improved' land at pan trap five there are no flowers in the 2m radius. As well as classifying the local habitat at each pan trap we also take the air temperature, calculate the cloud cover and wind speed. For some reason this appeals to the nerd in me and I feel grounded and even more connected.

© Miranda Bane

Miranda Bane enjoying her first season supporting PoMS surveys across Scotland

Then we descend, very steeply and backwards, holding on to the high-grade sheep fencing, onto the track and back to the cars. We're off to the café at Loch o' Lowes – just south of St Mary's Loch - to fuel up, sun ourselves and relax until the second round. A couple of hours later we do the exact same circuit and collect up the haul of insects in the pan traps, filter them through gauze, place the gauze and insects in the sample tubes and euthanise them in ethanol, pack up the pans, holders and stakes. And descend to our day's end. Pan traps one to four were all intact but the fifth had had a visitor or visitors – sheep had drunk all the contents from the white pan and some from the yellow.

But in addition to setting up the traps and collecting in the harvest we also did four FIT Counts: two on a patch of grassland and two in the heart of heather moorland. We each set up our 50cm quadrats in the more sheltered valley between the hilltops and sat down to observe the squares for exactly ten minutes and record the number of insects from various groups that landed on the flowers. Very few target flowers on this species-poor landscape of sheep-browsed grassland and heather moor. And of course, without an abundance of target flowers we observed only a few insects landing on the few flowers within our squares. A sad reminder that this is an upland desert. But when I think about the work we have just done, I realise the importance of gathering data in just such landscapes.

The insect tubes were packed-up and sent to the labs in Wallingford the day after the survey and I still have to enter the data onto the PoMS website. I will enjoy this desk-bound job as it gives a chance for reflection.

After a full hill-day on Thursday, the endorphins are still racing round on Sunday as I write this... What joy! As this was the last survey of the 2023 season, I am looking forward to seeing the results from the pan traps for Craigierig's kilometre square. I feel honoured to have been part of this year's surveys. Thank you PoMS for giving me the chance to be 'one of the gang'. Vive les insectes!

P.S. On the road home, a Brown Hare canters across the tarmac and a mile further on a Stoat races across the track. The end of a fine day!

© Miranda Bane

View across one of the more northerly PoMS squares in Scotland

FIT Counts: the new projects feature

Every FIT Count that you send in via the PoMS website or FIT Count app makes a contribution to the monitoring of pollinators at a national level. But FIT Counts are increasingly being carried out by local projects who are using them as part of their work to conserve pollinators, and engage people with watching and recording the insects involved. We have always wanted to support such groups and last year we were able to add a new option into the FIT Count recording page and app to help with this.

The new “PoMS projects” feature allows you to link your FIT Count to a particular project that you are taking part in. This is intended for local groups who may want to gather the results of FIT Counts from multiple people who have counted pollinators at a particular location, or for projects that may span multiple locations but want to be able to group together the FIT Count results from their volunteers or participants.

In summer last year we trialled the projects with four partners:

- Kent’s Plan Bee
- Kingston University Biodiversity
- RHS Plants for Pollinator Counts
- The Bradley Bug Project

FIT Counts were contributed by participants in all of these projects, and the resulting data has been passed on to the project organisers. We expect some new projects to be added to the list in 2024, and the first of these is already in place, for the Pollinating London Together project.

The RHS’s Plants for Pollinator Counts project is using data collected through FIT Counts to inform their RHS Plants for Pollinator lists, available to gardeners and designers to help highlight the best pollinator-friendly flowers. The sizeable living plant collections in RHS gardens and accessibility of the app as a recording tool are a great match for this project, making the most out of the plant-pollinator interaction information and allowing it to be used by volunteers at Wisley and Hyde Hall. The project hopes to be rolled out to the remaining RHS gardens in 2024.

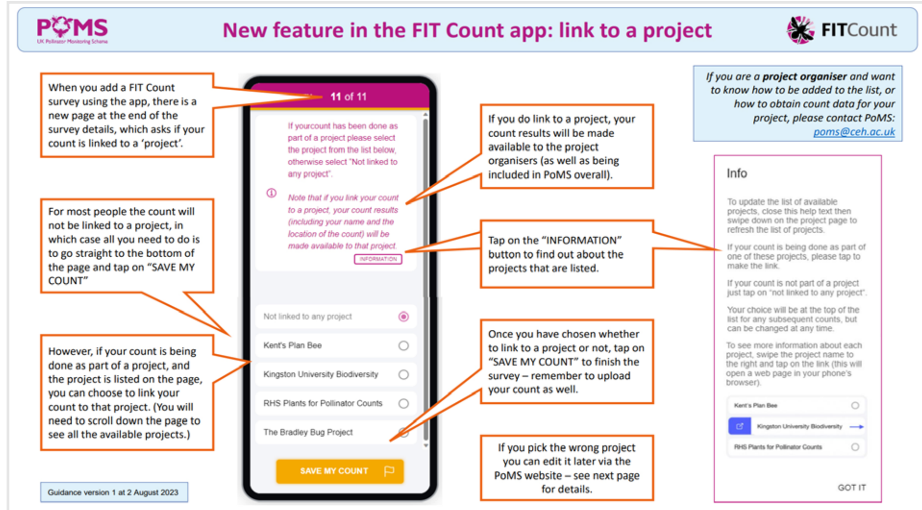
- *Helen Bostock, Senior Wildlife Specialist, RHS, 2024*

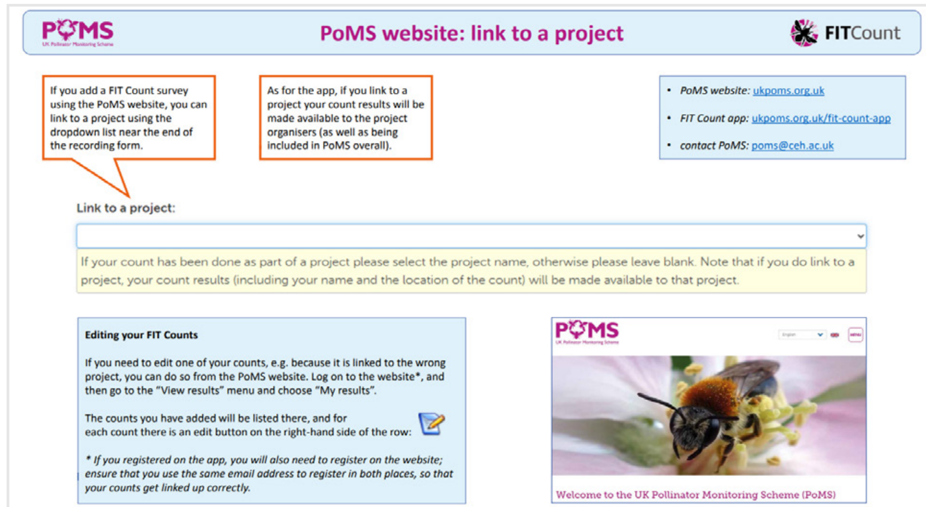
When you carry out your FIT Count, you can choose to link your count to one of these projects, if there is one that is relevant to you (it is entirely optional). If there is a project that you are part of, and you choose to make the link, this is what happens:

- Your count results (including your name as recorder, and your location) will be available to the local project for them to download and include in their own analysis and reporting
- Your email address is not passed on, but some projects may have their own mailing lists that you can choose to join
- Your results will still contribute to the national monitoring scheme

For a guide to how the project links work, go to the PoMS website, and in the main menu choose **Taking part** and then **NEW: PoMS projects** [8].

If you are a project organiser and want to know how your project could be added to the list, or how to obtain count data for your project, please contact PoMS.





We've produced a handy guide to using the new *PoMS projects* feature of the FIT Count app

Pollinator monitoring in Northern Ireland

Conor Bush, Scientific Officer with the Northern Ireland Environment Agency (NIEA) shares how our partners within DAERA have been supporting and carrying out PoMS surveys in Northern Ireland.

In the summer of 2021, the first pollinator monitoring scheme surveys took place in Northern Ireland with five of the initial ten 1 km squares surveyed. During 2022 we expanded the network to 20 squares across the country, with 18 of these being surveyed in 2023. It has been great to see a positive change year on year with more volunteers and NIEA staff wanting to get involved with the surveys and each reporting back how much they have enjoyed being a part of PoMS. For 2024 we are aiming to increase the number of surveys conducted to reach the target of four survey visits per square. (see Figure 6 on page 14 for the map of square locations).

You can hear from one of our volunteers, **Hannah Fullerton, conservation officer for Buglife**, on their experience of the PoMS surveys:

Q. Why did you want to take part in PoMS?

A. I began my own site pan trapping because, during my placement year with NIEA, I helped to introduce the UK PoMS 1km square survey to NI and felt it would be a very effective survey for finding trends in pollinator populations.

Q. Tell us a bit about your square

A. My square is a lovely little area in Carryduff surrounded by lovely people who are always interested in having a chat and hearing about the insects in their backyard as well as a few inquisitive animals, including a horse and some sheep.

© Michelle Larkin

Pan traps on heathland in County Wexford, Ireland

Q. What do you enjoy most about the surveys?

A. It is great to get out into nature and feels good to be gathering valuable data. It is tricky sometimes to get the best weather for the surveys in Northern Ireland as it can be wet and cold even in summer, but it is worth it to look through all the interesting solitary bees, moths, and hoverflies that have come into the traps, and especially exciting to receive the report of species found in my square once the identifications are complete.

All-Ireland Pollinator Plan

The All-Ireland Pollinator Plan is an Island-wide attempt to address pollinator declines in both Ireland and Northern Ireland. Implementation of the Plan is coordinated by the **National Biodiversity Data Centre (NBDC)** and we have asked **Dr. Úna FitzPatrick** to let us know a bit more about it:

> "In publishing the first All-Ireland Pollinator Plan (AIPP) in 2015, Ireland became one of the first countries in Europe to address pollinator declines, and the Plan has since gained international acclaim. The first AIPP was developed from the grass roots up, to ensure we have an island that's better for biodiversity; better for pollinators; better for us; and better for future generations. It is a shared action plan. Together, we can collectively take steps to restore our pollinator populations to healthy levels. A 15-member all-island steering group provide oversight of the All-Ireland Pollinator Plan. The Plan is managed by the National Biodiversity Data Centre, who oversee the implementation. In the first phase we wanted to ensure that everyone understood what pollinators need, and what simple, evidence-based actions they can take to help. Extensive guidelines were developed for everyone from farmers to councils, communities, businesses, schools, sports clubs and gardens. These are all freely available at www.pollinators.ie. Tracking the impact of the shared actions is an important part of the Plan. The NBDC launched a bumblebee monitoring scheme in 2012, FIT Counts in 2019, and set up a scheme that is equivalent to UK PoMS in 2022. Currently 40 sites are being monitored, using similar methodologies. This may allow analyses across Britain and Ireland in the future."

2024 FIT Count County competition

In 2024 DAERA and NBDC will be running a competition to have North and South Ireland compete to complete the highest number of FIT Counts. This will be calculated per county in both the North and South of Ireland to see which county can complete the most FIT Counts and take the title as the most active surveyors! To get involved download the FIT Count app now and get out recording between April and September.

Find out more or get involved

For any further information or if you are interested in volunteering in Northern Ireland please use the contact page here: https://ukpoms.org.uk/contact/contact_poms_ni.

PoMS on tour

PoMS has made links with a wide range of people and organisations over the years, and we aim to encourage and support pollinator monitoring wherever possible. Through the year in 2023 we attended some great events to help get the message across.

March

- Thanks to Thames Valley Environmental Records Centre for hosting a PoMS workshop, led by Robin Hutchinson and Claire Carvell, as part of their annual recorders' conference just prior to the start of the FIT Count season. A similar workshop was held in March 2024.

April and May

- Richard Dawson led FIT Count workshops for the Nature isn't Neat project in Abergavenny and Gwent.
- Richard was also the tutor for the Discovering Bees online course, provided by Field Studies Council. This included carrying out FIT Counts as part of the course and is running again in 2024.
- Entomologists from the RHS and Royal Entomological Society (RES) carried out FIT Counts in the stunning RES garden at the Chelsea flower show. Read more about this activity and the RES garden.

June

- Claire and Martin were invited to speak about PoMS, and about recording and monitoring flies in particular, at the online Scottish Pollinator Conference. Read more about all the talks on the fabulous Scottish Pollinators blog site.

Claire Carvell © UKCEH

Rachel and Bex leading the pollinators session with farmers and attendees at Groundswell 2023

Claire Carvell © UKCEH

Farmers and attendees at Groundswell 2023 trying out FIT Counts on the herbal ley mix which was buzzing with bees and other pollinators

- Richard led a training event for PoMS in Northern Ireland, covering both FIT Counts and the 1 km square surveys to help support the roll-out of PoMS in the country. A combination of indoor and outdoor sessions gave the participants (including staff from NIEA and DAERA) practical experience of carrying out PoMS surveys. Feedback was positive with all saying they now felt confident to carry out the surveys.
- Wider members of the PoMS team were at Groundswell, the regenerative agriculture festival. Rachel Richards (Buglife) and Bex Cartwright (BBCT) hosted a session "Counting pollinating insects on your farm" with support from Claire and Catherine Jones (previously Farm Wildlife). Around 35 farmers and other event attendees were introduced to the FIT Count, then all had a go on a herbal ley mix which was buzzing with bees and small pollinators. Specimens of solitary bees, hoverflies and bumblebees were also caught and passed round before being released.
- The Buglife team held up to 30 events across the UK through the summer linking with FIT Count surveys. Highlights in June included an event with 13 Denbighshire Council Rangers, training staff on how to undertake FIT Counts so they could then train others and use the surveys in their work. Two training days were held with English Heritage at Witley Court, Worcestershire, on managing habitat for invertebrates and included FIT Count training. Catch up with the great variety of outreach events planned by Buglife for the coming season.

July

- FIT Count workshops with community groups in Scotland were led by Miranda Bane as part of the Hidden Gardens Glasgow initiative.
- In England, the Royal Horticultural Society hosted a pollinator day at Hyde Hall, attended by Claire, Nadine Mitschunas and Robin for PoMS. RHS staff and volunteers enjoyed trying out FIT Counts and considering how they could help inform plant choices for the 'Plants for pollinators' list.


Rachel Richards © Buglife

Happy FIT Counters on an uncut road verge at a Buglife training event with Denbighshire Council


Rachel Richards © Buglife

FIT Count training led by Buglife with English Heritage in the formal gardens at Witley Court, Worcestershire

August

- Thanks to the House of Tongue on the North coast of Scotland for inviting PoMS to their Open Garden day and Pollinator Extravaganza. This was co-led by Miranda (PoMS) with input from other organisations including Bumblebee Conservation Trust, Plantlife, Species on the Edge, Nature Scot and North Sutherland Wildlife Group.
- Also in Scotland, Miranda and Charlotte Rankin (previously of Buglife) led workshops for community groups in Peebles and Tweedmuir, combining an introduction to FIT Counts with sessions on pollinator-themed art.

October and November

- Robin led events for local groups in Oxfordshire as part of Community Action Groups.
- Miranda presented an update on PoMS for the Dipterists Forum Annual Meeting, held at the National Museum of Scotland in Edinburgh.

Alongside the above events, most of which the PoMS team at UKCEH directly participated in, more than 80 pollinator-themed events and workshops featuring our surveys were run by PoMS partners: British Trust for Ornithology, Buglife, Bumblebee Conservation Trust and Butterfly Conservation. Many thanks to all who led, helped and attended!

Further afield, the PoMS team has been supporting development of national-scale pollinator monitoring efforts in South America and Europe. With the recent launch of the FIT Count app in Portugal by researchers on the PolinizAÇÃO project, this brings the list of countries using the FIT Count app to nine, building a unique picture of flower-visiting insect communities across the globe. Go to the "Settings" page of the app to find the range of countries and languages available this season.

Colleagues on the EU SPRING project (Strengthening Pollinator Recovery through INdicators and monitoring) have produced a fantastic set of resources and training materials under a new Pollinator Academy, to help address the growing demand for fast access to taxonomic knowledge. The Pollinator Academy offers a learning platform with integrated taxonomic tools and information on European pollinators, and is well worth a look.

Helen Bostock © RHS

FIT Counts with RHS staff and volunteers at Hyde Hall, Essex

© RES

Doing a FIT Count at the RHS Chelsea Flower Show

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Thank you

The UK PoMS Partnership

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The members of the PoMS Steering Group in 2023 were Paul Woodcock and Azra Gordy (JNCC), Pauline Campbell (DAERA), Elias Scheuermann and Stephanie Maher (Defra), Athayde Tonhasca and Jim Jeffrey (NatureScot), Kathleen Carroll (Welsh Government), Una Fitzpatrick (All-Ireland Pollinators Plan), Fiona Highet (Science and Advice for Scottish Agriculture).

The UK PoMS team

Martin Harvey is the PoMS co-ordinator at UKCEH and the first point of contact for queries via the poms@ceh.ac.uk email. Claire Carvell is the project manager for PoMS, also based at UKCEH Wallingford and responsible for strategic direction, overseeing delivery of the surveys, data management and reporting, and liaising with JNCC and other partners. Nadine Mitschunas leads the field team with Chris Andrews and Angus Garbutt, and Francesca Mancini leads on statistical analysis of PoMS data, with Robin Hutchinson working on data management and communications. Other UKCEH team members are Nick Isaac, Lucy Ridding, Marc Botham and Helen Roy, and our partners are represented by Richard Comont (BBCT), Richard Fox and Rachael Conway (BC), Dawn Balmer and Rob Jaques (BTO), Rachel Richards (Buglife), Conor Bush (DAERA), Rowan Edwards (Hymettus), Mike Garratt and Simon Potts (Reading University), Bill Kunin (Leeds University) and Alfried Vogler (Natural History Museum).

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PoMS

UK Pollinator Monitoring Scheme

UK Pollinator Monitoring Scheme (2024).
The UK PoMS Annual report 2023
UK Centre for Ecology & Hydrology and
Joint Nature Conservation Committee

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The UK PoMS partnership

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JNCC

Bumblebee Conservation Trust

Butterfly Conservation
Saving butterflies, moths and our environment

BTO
Birds Science People

Hymettus

Natural History Museum

University of Leeds

University of Reading

buglife

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