UK Pollinator Monitoring Scheme

Establishing a UK Pollinator Monitoring and Research Partnership (PMRP)

Progress Report October 2018

Claire Carvell and PMRP partners (October 2018)

A collaborative project funded by Defra, JNCC, the Welsh and Scottish Governments and project partners

www.ceh.ac.uk/pollinator-monitoring

Objectives

To provide a hierarchical approach to monitoring combining expert and non-expert volunteer and professional recording while building capacity through existing partnerships to ensure long-term sustainability (Tasks 1 – 3);

To provide metrics and/or indicators to show how pollinator populations are changing in Great Britain (Tasks 1 and 4);

To establish how pollinator populations are changing in the cropped and non-cropped environment (Task 4-5);

To provide access to monitoring data at full resolution and engage with external research groups and wider stakeholders to facilitate use of the data in research, conservation & survey planning (Tasks 4-5).

These objectives will be delivered under the following Tasks:

Task 1) Improving robustness and our understanding of population trend estimates for bees and hoverflies from opportunistic records across England, Wales and Scotland, and increasing capacity for data flow and record verification.

Task 2) Promoting simple systematic surveys to engage a wide range of volunteers collecting data on abundance and flower visitation rates of pollinators, initially through targeted promotion with project partners.

Task 3) Undertaking new intensive systematic surveys of pollinators and floral resources with a core set of stratified sites across England, Wales and Scotland.

Task 4) Data management, integration and modelling to create metrics or indicators at GB and country level.

Task 5) Establishing a Pollinator Monitoring Research Advisory Group (PMRAG) to help support externally-funded research applications and use project data in research, conservation and survey planning (Specification Part B)

Summary of Progress (January - September 2018)

This report summarises progress on the PMRP project since the last report (dated 29th January 2018). Highlights have included:

- further development of models to estimate trends in species distribution (Task 1);
- GB-level uptake of the FIT count by members of the public to gather widespread data on pollinator abundance and flower visitation (Task 2);
- second year sampling across the PoMS 1km survey site network using a combination of newly recruited volunteers and PoMS team surveyors (Task 3);
- workshop of the PMRAG with 14 invited academics (Task 5); and
- communication about the Pollinator Monitoring Scheme (PoMS) to a variety of audiences.

A summary of activities and preliminary results is given in the text below, followed by Figures and Tables.

Task 1: Strengthening existing opportunistic recording of bees and hoverflies

Task 1.1: Improving robustness and understanding of population trend estimates from opportunistic records

Opportunistic records of bee and hoverfly species are collated by the Bees, Wasps and Ants Recording Society (BWARS) and the Hoverfly Recording Scheme (HRS) and used to estimate trends in the status and occupancy of species over time. Occupancy refers here to the area (number of 1km grid cells across the UK) over which each species was found, hence measures changes in species' distributions.

a) The New Pollinator Indicator

The UK Status of Pollinating Insects Indicator is produced alongside other UK Biodiversity Indicators and funded directly by JNCC (http://www.jncc.gov.uk/page-1824).The first Indicator published in 2015 was based on modelled trends for 213 wild pollinator species. The new Indicator published in August 2018 reported on changes in distribution of **351 bee and hoverfly species** (representing approximately 70% of all species) between 1980 and 2016 (http://jncc.defra.gov.uk/page-6851). Only species for which reliable trends could be estimated were included; hence species with fewer than 50 total records across the time period were excluded from the 2018 Indicator. A lag in submission and collation of hoverfly records means that post 2013 records per year tended to drop off. Therefore, for the composite indicator of average relative change in species' distributions and the trend assessment, hoverfly occupancy estimates post 2013 were held at their value in 2013. Further, bee species were filtered, following expert consultation with BWARS, so that only species considered to pollinate wild plants and/or crops were included (for example, 'cuckoo' species were excluded). The increase in species (since 2015) for which robust trends can be generated has been made possible by an increase in verified records and improvements to the modelling approach. Whether an individual species is increasing or decreasing is defined by its rate of annual change across the time period considered.

Between 1980 and 2016, 14% of the 351 species analysed became more widespread (5% showed a strong increase at above a threshold of +2.8% per annum) and 34% of species became less widespread (13% showed a strong decrease at below a threshold of -2.7% per annum, equating to a decrease in occupancy of -50% over 25 years). As expected, species show considerable variation through time and care is needed when interpreting average trends across species with contrasting ecological traits (see section b). When combined into a composite average trend across all species, occupancy declined by 22% between 1980 and 2016 and the pollinator Indicator was therefore assessed as declining over this period. In the shorter term between 2011 and 2016, the indicator showed a minor increase of 2%, however given the uncertainty, the short-term trend was assessed as 'stable'.

The Indicator is presented separately for bees and hoverflies. Of the 137 wild bee species analysed, a greater proportion of species were declining than increasing, 37% and 20% respectively between 1980 and 2016 (Figure 1). Averaged across bee species, the indicator shows a particularly sharp decline in occupancy between 2006 and 2013, after which it appears to have stabilised, although the bee index in 2016 was estimated 17% lower than in 1980. In contrast, the hoverfly index (Figure 2) shows a gradual decline from 1987 to 2001, after which it remains relatively stable. Similarly to the bee results, of the 214 UK hoverfly species analysed, a greater proportion of species were declining than increasing, 33% and 10% respectively, between 1980 and 2013 (Figure 2).

b) Further understanding trends and patterns of change (including at country level)

Understanding of these trends has been aided by PMRP discussions with scheme organisers where the species-by-species model outputs have been examined in detail (we have developed an online app https://gpowney.shinyapps.io/bee_sdm_app/ to communicate model outputs to the

schemes, and to share their views on the outputs). A parallel exercise to produce a "Red List for the aculeate Hymenoptera", supported by Natural England (currently under final review), has also furthered our understanding of the species-specific trend estimates since it allows for use of multiple approaches to assessing change, along with expert opinion, to inform categories of status or threat.

The UK Indicators are presented at UK level, however under this Task we are using latest updated versions of the BWARS and HRS databases (i.e. the maximum potential number of records) to derive country-level trends for England, Wales and Scotland. Preliminary analyses suggest that country-specific trends are tractable, particularly for widespread species that pass a given 'precision threshold' (indicating a "useable" model for individual species). Only a minority of species pass this threshold for Scotland and Wales. However, composite indicators can include species below this threshold. Country-level trends will be reported fully and discussed in the final report, March 2019.

Further analyses using the modelled trends in species occupancy have been conducted to improve our insight into the key drivers of change and potential implications for pollination services. Working with BWARS and HRS, the CEH team have examined composite trends for species grouped according to various ecological traits or geographical associations; i) bee species known to be dominant crop pollinators (compared with those of other wild bee species); ii) bee and hoverfly species split into four categories based on their distribution patterns at the 10km grid square scale, resulting in upland species, southern species, widespread southern species and widespread species (predominantly hoverflies) iii) sociality, separating eusocial from solitary species. The results have been submitted within a manuscript which is currently under review with Nature Communications: Powney G.D., Carvell, C., Edwards, M., Morris, R., Roy, H.E., Woodcock, B.A., Isaac, N.J.B (in review) "Widespread losses of pollinating insects in Britain".

As with all modelling approaches, the approach we use to estimate trends in species occupancy has several key assumptions, that if not met can lead to unreliable outputs. There is an assumption that the detection sub-model reflects a true representation of the observation (recording) process. There may be examples where this assumption is not met. For example, intense targeted surveys for certain species (e.g. to produce an Atlas) may not be fully accounted for in the detection model, leading to unreliable occupancy estimates for the species in question. Furthermore, strong temporal bias in recording intensity can lead to increased uncertainty in the occupancy estimates in earlier years. Systematic surveys (see Tasks 2 and 3) that are not prone to such biases offer a more robust approach to monitoring and understanding patterns of change in pollinator species or communities.

Task 1.2: Increasing capacity for data flow and record verification

The current capacity for verifying species records within BWARS and HRS is limited by the small number of dedicated volunteer scheme organisers with sufficient taxonomic expertise, and the lack of a clear route by which potential new verifiers can be identified and mentored. BWARS have identified the lack of suitable online tools for training and assessing verifiers as one of the barriers to recruiting more volunteers into the system, especially for building the capacity to verify photographic records.

Through work with Hymettus (project partners and expert entomological consultants) in 2018, we have developed a detailed specification for the data structures needed to implement an **online training tool** that will capture the level of expertise of potential verifiers, allowing them to be matched to the appropriate sets of records to assist with verification. Currently this is in the form of a set of technical outlines for the main program 'loops', plus the structure of the database to support them, setting out the requirements that would allow a system to present records and images for verification, and to store the results from users of the tool.

The next step will be to seek resources to build an online implementation of the tool, in the first instance for the BWARS recording scheme. Such a tool could also be adapted for use as an 'identification quiz' that could be taken by people contributing to the PoMS FIT Count, allowing us to capture information about the reliability of identifications of the broad insect group records in the FIT Count.

By increasing the pool of available verifiers with known taxonomic expertise we will ultimately improve the flow of data available for modelling trends. This system will also provide a clear and more quantitative route for people who wish to increase their identification skills and so contribute to verification at levels that will increase the capacity of recording schemes such as BWARS.

Task 2: Simple systematic survey collecting data on abundance and flower visitation of pollinators

The name **Pollinator Monitoring Scheme – PoMS** describes the two main surveys taking place under Tasks 2 and 3 of the Pollinator Monitoring and Research Partnership.

Flower-Insect Timed Counts - **FIT Counts** - are simple systematic surveys collecting data on abundance of flower visitors across a variety of habitats, and have been developed with the aim of encouraging a wide range of people to get involved in pollinator monitoring. To take part, recorders are asked to spend ten minutes counting all the insects that land on a particular flower species within a 50cm square, recording these to a broad species group (e.g. honey bees; bumblebees; hoverflies; other flies; etc).

The FIT Count protocol and associated supporting resources (survey guidance, survey form, insect and flower guides, 2-minute video guide and online forms for data capture in iRecord) were modified slightly in response to reviews of the 2017 data and made available through the CEH PoMS project webpage[1] in March. FIT Counts were advertised to run between 1st April and 30th September, during which time they were promoted via numerous channels across the UK (see section on Communications activity below).

As well as FIT counts submitted by the wider public (here 'public' FIT counts), FIT counts were carried out as part of the 1km square protocol (Task 3) in order to help calibrate the data and increase sample sizes ('1km' FIT counts). Surveyors (including volunteers) of 1km squares carried out a minimum of two counts per survey visit.

Preliminary Results as at 24th September 2018.

To date (24th September) 535 FIT counts have been submitted to iRecord by 106 members of the public (366 counts in England, 81 in Wales, 80 in Scotland, 7 in the Isle of Man, 1 in Northern Ireland)[2]. See Figure 3 for a map of locations and Table 1 for summary figures on the counts received to date. We are aware of many examples of additional counts that have been conducted but not yet submitted, hence reminders are being sent (via email to registered iRecord users and via Twitter and online webpages to reach others). Given that a total of 2,375 downloads of the FIT count survey guidance have been logged on the CEH webpage (1739 of these being unique), it will be important to understand where interest is not translating into action. A full analysis of the FIT count data will be included with the final project report.

A total of 4,641 insects were counted, at an average of 8.7 insects per 10-minute count. Zero insects were recorded for 53 of the submitted counts, indicating that recorders are still prepared to enter 'data' despite not having observed insect visitors to their target flowers during the count. Further analyses of the data will be conducted, for example with a temporal element and at 1km or 'site' level, to account for some volunteer recorders submitting many counts from the same location, often on the same day (one recorder submitted 55 counts, and another 44 counts, with the overall mean number of counts per recorder being 5). This may

[1] www.ceh.ac.uk/our-science/projects/pollinator-monitoring

[2] As of 19th November, 584 FIT Counts had been submitted by 110 members of the public (with a total of 5,346 insects counted at an average of 9.2 insects per count).

have resulted from our instruction to encourage volunteers to count more frequently at fewer sites rather than only once over many sites.

Target flower species receiving the most counts were Buttercup (48), White Clover (42), Buddleia and Dandelion (both 36), but a majority (198) were conducted on "other" flowers. Gardens were the most popular habitat type in which to conduct FIT counts (249 counts conducted in gardens), followed by “grassland with wild flowers” (130 counts).

Recorders are given the option to upload photos of insects to allow for verification of their group-level identification. To date for 2018, the public FIT counts have produced 1,395 non-zero records of an insect group (i.e. each “record” is a count of an insect group), 226 of which have at least one associated photo, with 297 photos in total. Initial inspection of six of these suggests that their identifications are all correct, but all submitted photos will be checked by the PoMS team to ensure consistency in the data received.

A further 287 FIT counts have been submitted from 58 of the PoMS 1km survey squares (Figure 4), at an average of 5 counts per square (the minimum expected total number of counts per square being 8 if a square is surveyed on four visits) (Table 2).

Task 3: Intensive systematic survey of pollinators and floral resources from a network of 1km squares

Task 3.1: Site selection and stratification

During 2017, access permission was obtained to survey 75 1km squares as part of the PoMS intensive systematic survey. These were distributed as follows: 36 in England, 22 in Scotland (in each case co-locating with squares that were part of the National Plant Monitoring Scheme) and 17 in Wales (co-locating with squares that were part of the Welsh environmental monitoring framework). Letters were sent to all landowners within the final 75-square network in September 2017 to thank them for allowing access for PoMS surveys on their land, and to confirm that they approved continuation of these in 2018. No negative responses were received in this case.

Task 3.5: Volunteer recruitment and training

Initial ‘set up’ and surveys were undertaken by PoMS team surveyors during 2017, this team comprising around nine CEH ecologists from the Wallingford, Bangor and Edinburgh sites and one ecologist/ bee expert based on a short-term contract at the University of Leeds. From February 2018, PoMS project partners worked together to engage volunteers to match with squares local to their area and receive training and mentoring on the PoMS 1km sampling protocol. Approaches to recruitment included featuring PoMS in several national and regional newsletters/ e-newsletters of project partners or wildlife groups (as well as the NFUs British Farmer & Grower magazine), directly contacting relevant Local Record Centres (LERCs), Wildlife Trusts and other interest groups in regions with available squares, and promoting opportunities for involvement in PoMS via partner training and public events. Recruitment continued throughout the summer, with each volunteer surveyor being met at their square by a PoMS team member to conduct the first sampling visit together and hand over equipment.

By mid-September, volunteers had adopted 37 squares (50% of the total; see Figure 5) and had carried out a total of 107 survey visits. See Table 3 for a breakdown by country; a high proportion of squares in England have been adopted, with around half the squares in Scotland and only 3 squares in Wales having a committed volunteer. Two or more volunteers have worked together on at least 7 squares, giving a total of up to 45 volunteer surveyors. Two have regrettably had to drop out due to personal circumstances and the relatively physically demanding nature of the protocol at some sites.

The recruitment process involved individual contact with more than 130 people interested in adopting a square. With 43 committed volunteers, this equates to a recruitment rate of roughly 1 in 3, with the primary reason for lack of retention and commitment being a lack of 1km squares within reasonable travel distance of the volunteers’ home. Project partners are discussing ways to intensify the campaign to recruit volunteers to unallocated squares for 2019.

Task 3.2: Field sampling 2018

The PoMS 1km square protocol involves a set of five pan trap stations (each hosting 3 coloured bowls filled with water) being set out along a diagonal of each 1km square and left for 6 hours, during which time the surveyor collects data on floral resources and habitats surrounding the pan traps and undertakes at least two 10-minute FIT Counts (Figure 4). The protocol is intended to be repeated on 4 survey visits to each square between late April and September.

PoMS team surveyors visited 72 of the 75 squares in 2017 to 'set up' and map sampling locations (Figure 5), and conduced at least one, and in most cases two surveys on each square between June and early September (mean = 1.76 survey visits per square, total 127 survey visits for 2017).

During 2018, a total of 144 survey visits were conducted across 65 PoMS squares (mean = 1.95 visits per square; see Tables 3 and 4). Eighteen squares received the full set of four visits, and 37 squares received at least two visits. Surveys during May and June were primarily focussed towards mentoring volunteers, hence were limited by the number of volunteers coming forward. In July the PoMS team surveyors began filling gaps by surveying those squares not yet adopted, often visiting local wildlife groups during their visit to recruit potential volunteers, and this continued into August and early September.

Surveys in Wales and Scotland were most affected by poor weather conditions in July and August. Furthermore, there were significant delays in accessing most of the Welsh squares until August due to a requirement from the Welsh Government to review landowner permissions on the basis of the new GDPR regulations. In Scotland, two squares proved unsuitable to access or survey due to changes in land-use (eg. livestock movements) and therefore may need to be replaced for future years; two squares were visited but changeable weather prevented sampling and one square in the west of Scotland has yet to be set up for surveying. Consequently, three squares in England, two in Wales and five in Scotland were not surveyed in 2018.

Task 3.3: Links with crop pollination

This Task aims to investigate the potential of data on abundance and diversity of pollinators collected using the PoMS 1km survey protocol to act as a proxy for important crop flower visitors. To test this, additional surveys of crop visitors on a selected focal crop (flowering oilseed rape) were conducted at a subset of squares. Data on UK arable crop coverage at the field scale were extracted from the new CEH 'Land Cover Plus: Crops' map to identify PoMS squares in which oilseed rape was grown. Of the 75 survey squares, 14 contained oilseed rape in 2015 and 2016, and 13 included oilseed rape in 2017. Individual landowners were contacted to confirm which of these were still growing oilseed rape in 2018.

In May 2018 we conducted additional pollinator surveys on six squares in England in which winter oilseed rape was grown. On the same day as the PoMS pan traps were deployed, four transects of 50m x 1m were walked in the same field within the 1km square boundary: two along the edge of the field and two at least 50m from a field edge along a tramline. All insects visiting crop flowers were recorded to group level (as in the FIT Counts) during approx. 10 minutes per transect, followed by counts of open flowers within two 1m quadrats at the start and end of each transect. In three squares, timed free searches were conducted throughout the oilseed field in order to record (and capture where necessary) the species of bee and hoverfly visiting crop flowers. Thus the capacity of recorders to implement a focussed crop pollinator survey as part of the 1km square protocol was investigated and relationships between pollinator abundance and diversity during the PoMS survey and the crop pollinator survey will be compared.

Given that this dataset is limited to six 1km squares, we will investigate the possibility of using additional datasets on oilseed rape visitation held by the University of Reading and CEH to identify likely key pollinators across different regions, and assess their prevalence within the pan trap samples from all PoMS 1km squares containing oilseed rape. A manuscript has also been submitted from the design and testing phase project (WC1101) that includes assessment of the feasibility of different sampling methods for assessing crop pollinators as part of a larger monitoring scheme (O'Connor et al., in review).

Task 3.4: Sample processing and identification

From the total of 631 pan trap samples received in 2017 (all the insects captured at one pan trap station over a 6 hour period), comprising over 50,000 individual specimens, bee and hoverfly species identifications were completed in February. The time taken by taxonomic experts to complete this process averaged at between nine bees per hour to 20 hoverflies per hour. All other captured specimens were

identified to group level (e.g. all non-hoverfly flies as 'other flies'; solitary, social and parasitic wasps; butterflies; moths; sawflies; a group for very small insects <3mm; and 'other insects'), counted and archived in 100% ethanol in their original sample tubes at -20degC for potential downstream analysis. Table 5 summarises the number of specimens generated during 2017 with indicative estimates for 2018 (see January 2018 progress report for more detailed 2017 data summaries).

A total of up to 720 pan trap samples is expected to result from the 144 survey visits carried out during 2018 (missing samples from a few sites due to damage or weather will reduce this total). 80% of these samples have been sorted in the CEH lab, with the bees and hoverflies individually tubed in 99% ethanol and delivered to taxonomic experts for determination to species level.

Preliminary Species data from 2017 PoMS pan trap surveys across 1km squares

In January we reported on mean counts at insect group level from the 2017 pan trap catches. Here we summarise the data at species level. Final verification checks on these 2017 records have just been completed and full analyses will be conducted together with the 2018 data.

A total of 803 bees was caught in pan traps, belonging to 62 species (Table 6). These represent a range of social (*Bombus* and *Apis*) and solitary species, including members of the genera *Andrena*, *Lasioglossum* and *Halictus* (typically ground-nesting and 'mining' bees), and *Hylaeus* (aerial nesting bees). Sixteen species are represented by a single individual and eighteen species by 10 or more individuals. The most commonly recorded bee species was *Apis mellifera* (the honeybee, caught in 32 squares and most prevalent across England), followed by *Bombus lucorum/terrestris* and *Lasioglossum calceatum*. Twelve species are recognised as nationally scarce or notable (e.g. Section 41) species in England, Wales or Scotland. A total of 1300 hoverflies were caught in pan traps, belonging to 70 species or species aggregates (Table 7). Fifteen species are represented by a single individual and 24 species by 10 or more individuals. The most commonly recorded hoverfly species was *Episyrphus balteatus* (often called the marmalade hoverfly, caught in 32 squares but more prevalent in Scotland), followed by *Syrphus ribesii* and *Neoascia podagrica*.

The average number of bee and hoverfly species per square, as sampled on one to two survey visits between June and September, was 12.3, with up to 31 species being recorded in one square. On average, 5.6 bee species and 7.2 hoverfly species were caught per square, and up to 19 and 20 species respectively were sampled in single squares. Overall, these species lists represent the spread of taxa that we would typically expect to sample in pan traps across GB, with the caveat that they may have missed some of the early season solitary bees.

Task 4: Data management, integration and modelling

Data from the public FIT Counts and all data from the 1km square surveys is being stored securely in the Indicia data warehouse at CEH. Data is entered by volunteer recorders and CEH surveyors via forms developed within the iRecord online recording system. These have been set up to match the paper field recording forms, and allow all relevant data and any associated species photographs to be stored securely.

Insect specimen data from the 1km pan trap samples is also being added to the iRecord forms, at species level for the bees and hoverflies and at species-group level for the other insects. This species data is not being made publicly visible within iRecord, so as to respect agreements with landowners. It will be shared via the relevant recording schemes following full verification, for contribution to the wider pool of pollinator occurrence data. Verified species data will be shared at the 1km square resolution with the relevant landowners and current volunteers for each square, as a means of providing feedback, and published on the NBN Atlas following the appropriate data security restrictions.

Data analyses planned for late 2018/ early 2019 (once all data from 2018 has been received) will aim to integrate a) occurrence records (Task 1, including potentially a new set of verified records from the Great British Bee Count) with species-level data from the 1km systematic surveys and others such as the Bumblebee Conservation Trust BeeWalk scheme, and b) abundance data at group and species-level from the public FIT counts and 1km surveys, to derive metrics and/ or indicators that can also be linked with contextual data on land-use, habitat (local floral cover) and other environmental variables.

Task 5: Pollinator Monitoring Research Advisory Group (PMRAG)

The Pollinator Monitoring Research Advisory Group (PMRAG) was established to help identify opportunities to maximise the value of data generated by the PMRP and PoMS surveys; to highlight knowledge gaps and aim to secure external resources to address these needs. A wider stakeholder group (including members of Defra's Pollinator Strategy Advisory Group, the Welsh Task Force for pollinators and Scottish Natural Heritage) was consulted initially during January 2018 to identify overarching priorities for monitoring (in terms of pollinator groups and functions, key drivers and other research gaps). In a workshop on 20th February 2018, 14 invited academics joined project team members to review these priorities and discuss gaps and opportunities that should be a priority for the PMRP in the short-medium term.

When asked which pollinator groups they would consider a priority for monitoring, stakeholders ranked wild bees and hoverflies as the priority taxa, followed by honeybees, butterflies, 'all taxa' and wasps (Table 8). When asked what should be the focus of a monitoring scheme for pollinators, respondents ranked (from high to low priority) common species, wild plant pollinators and effectiveness of interventions as priority focal areas for long-term monitoring, followed by threats and stressors, rare species, crop pollinators, managed pollinators and invasive species (Table 9). Other areas of interest were the contribution of non-floral resources, pollinators in gardens and functionally important species.

The PMRAG workshop identified several common themes that are considered research gaps or needs not currently covered by the PoMS that could be addressed through complementary research or more 'effective' monitoring (See "PMRAG breakout notes collated v3.pdf"). These included better understanding threats and drivers of change, the effectiveness of management interventions (e.g. can benefits outweigh costs?) and the consequences of changing pollinator populations on pollination of crops and wild plants. Others noted involving a wider range of stakeholder and community groups in pollinator monitoring (e.g. gardeners, farmers and growers). Sustaining the 'core' Pollinator Monitoring Scheme at at least the same sampling intensity was seen as a critical long-term activity in order to enable any of these complementary projects to add value; until this is decided progress on new projects is paused.

Publications and Communications activity

The PMRP and PoMS have been presented or communicated through various channels since the January 2018 progress report, including online or in print articles, social media, public events and volunteer training days hosted by PoMS partners and stakeholder groups, as summarised in Table 10.

Together, these 170+ engagement activities have reached an **estimated audience of 550,000 people and more**. This total does not include, for example, webpage views (see below) or TV viewers to the BBC One Scotland 'Landward' programme on which the FIT Count was featured.

Public engagement highlights:

- PoMS stand at three major public events: the Bristol Festival of Nature (9-10 June), Bees' Needs Week (London, 9-13 July) and Countryfile Live (Blenheim Palace, 2-5 August). More than 2,000 children (and a few adults) took part in our 'bee foraging game', transferring ping pong pollen grains between flowers and back to their bucket 'nest', and many thousands were reached on social media through these events.

- Links with Friends of the Earth's Great British Bee Count 2018, including pages on "What happens to the data from the Great British Bee Count?" that features the PoMS (to which professionally verified photographic records from GBBC 2018 can contribute) and "Bee surveys - record bees and help science" featuring the FIT count.
- Blogpost on the "Grow Wild UK" website "Let's count pollinators for Science!". Grow Wild is a national project run from Kew Gardens that connects people with nature and each other by sharing native plants and fungi, transforming spaces and changing lives across the UK. Grow Wild has over 300,000 subscribers and reported 2572 unique readers of our pollinators blogpost, encouraging growers of their seed packs to try a FIT Count.

- Translation of the PoMS poster and FIT Count materials (guidance, form and ID guides) into Welsh, kindly supported by the Growing the Future project, National Botanic Garden of Wales. These resources were used at the Eisteddfod festival (Cardiff), and the Anglesey Show in August.
- Buglife Scotland promoted the PoMS and FIT Counts at 40 workshops and school sessions across Scotland (additional feedback on Buglife activities in England and Wales still to come), and on BBC One Scotland's 'Landward' programme in May.
- The Bumblebee Conservation Trust promoted the PoMS, FIT Counts and 1km surveys at 41 bumblebee ID training days and at numerous talks and events across England and Scotland (additional information on activities in Wales still to come).

Webpage and Social media activity

The PoMS webpage is consistently the 'most viewed' project page on the CEH website and is one of the top-performing pages on the CEH website overall.
Since January 2018, the PoMS webpage has received 18,250 page views (7,954 unique views), with the biggest single days of activity being in mid-March and late April. Downloads of the FIT Count materials were as follows:
FIT survey guidance downloads: 2,375 (1,739 unique)
FIT flower guide downloads: 1,558 (1,145 unique)
FIT insect guide downloads: 1,539 (1,180 unique)
FIT survey form downloads: 1,136 (873 unique)

Two short 'how-to' videos were created and posted on the webpage (and YouTube) in March, providing friendly guidance on conducting a FIT Count and what a 1km survey involves.
The PoMS Twitter account was launched on 16th March 2018 and has attracted a total of 760 followers to date, with more than 350 followers after just three days.

Further plans for PoMS communications

A PoMS newsletter is planned for early 2019, including a summary of results to date, a round-up of events, short blog posts from a selection of keen volunteers (as 'ambassadors' of the scheme) and perhaps a short piece on 'PoMS on holiday' where the FIT Count is being used to monitor insects on native vs alien plants in Cyprus. Consideration is also being given to the most effective ways of meeting with and linking up PoMS survey volunteers in 2019.

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Figures and Tables.

Figure 1. Change in the distribution of pollinating wild bee species (n = 137) in the UK between 1980 and 2016. The shaded region is the 90% credible intervals of the annual occupancy estimates and represents the uncertainty surrounding the annual estimates. The solid line illustrates the rescaled indicator value. The proportion of pollinating wild bee species in each trend category is based on the mean annual change in occupancy over both a) the long-term (1980-2016) and b) the short-term (2011-2016).

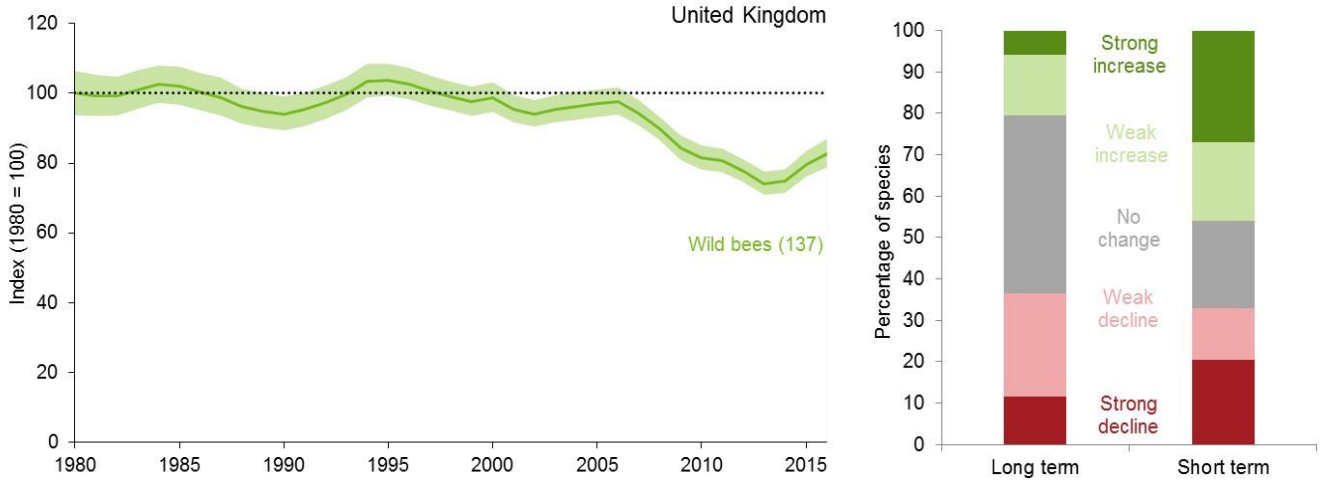
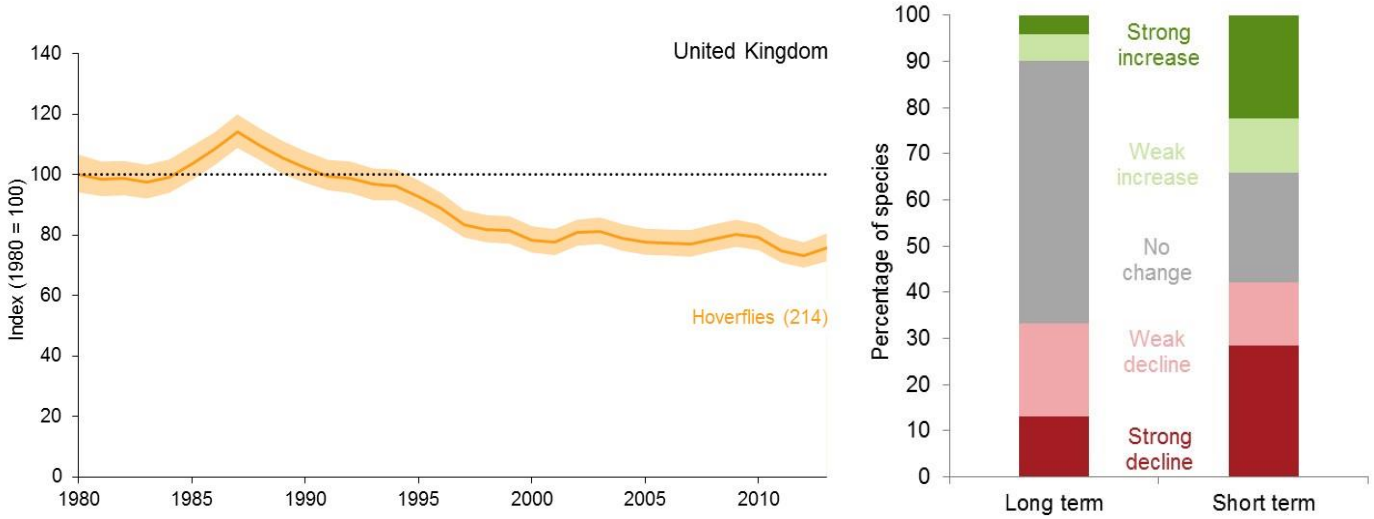


Figure 2. Change in the distribution of hoverfly species (n = 214) in the UK between 1980 and 2013. The shaded region is the 90% credible intervals of the annual occupancy estimates and represents the uncertainty surrounding the annual estimates. The solid line illustrates the rescaled indicator value. The proportion of hoverfly species in each trend category is based on the mean annual change in occupancy over both a) the long-term (1980-2013) and b) the short-term (2008-2013).



Figures taken from Powney, G. D., Harrower, C., Outhwaite, C., & Isaac, N. J. B. (2018). UK Biodiversity Indicators 2018: D1c Status of pollinating insects. Technical background document. JNCC/ Centre for Ecology and Hydrology, UK.

Figure 3. Map showing locations of the 535 Flower-Insect Timed Counts (FIT Counts) carried out by members of the public since 1st April 2018 and submitted to iRecord as at 24th September 2018.

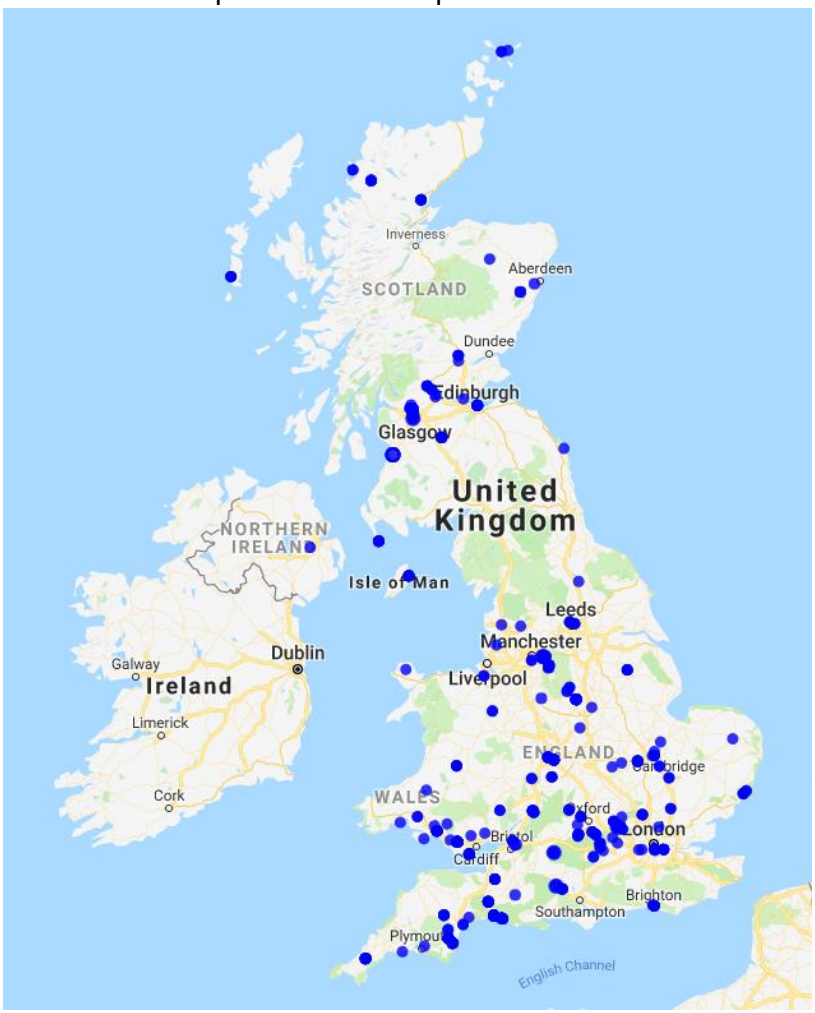
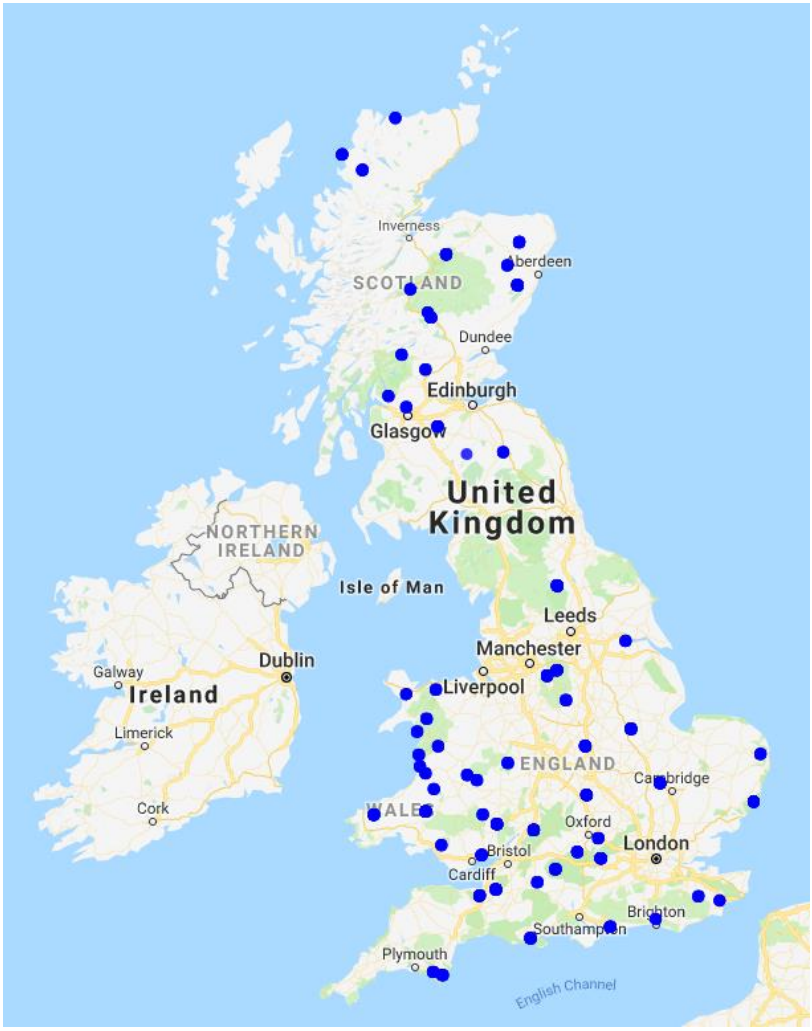


Table 1. Summary of FIT Counts submitted to iRecord by members of the public as at 24th September 2018

Country	Number of FIT Counts submitted	Number of volunteer recorders submitting counts	Mean (max) number of FIT Counts per recorder	Total insects counted	Mean insects per 10-min count
England	366	73	5 (55)	3,442	9.4
Wales	81	9	9 (44)	295	3.6
Scotland	80	22	3.6 (11)	814	10.2
Isle of Man	7	1	7	79	11.3
Northern Ireland	1	1	1	11	11.0
UK TOTAL	535	106	5	4,641	8.7

Figure 4. Left - Map showing locations of the 61 PoMS survey squares for which data has been submitted to iRecord since 1st April 2018 (as at 24th September 2018).

Right - Example of a PoMS 1km survey square map on agricultural land. Target notes are used along with GPS locations to help volunteers re-locate sampling points and alert them to any hazards.



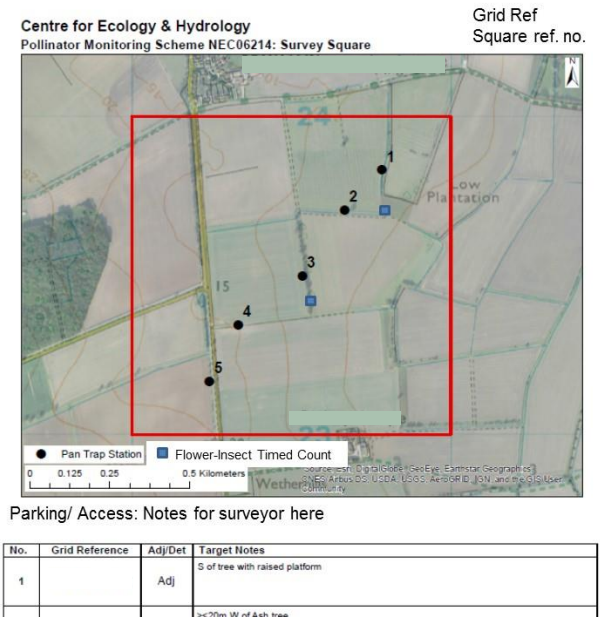


Table 2. Summary of FIT Counts and pan trap surveys submitted to iRecord by 1km square surveyors (including volunteers) as at 24th September 2018

Country	Number of 1km squares with FIT Counts submitted	Number of FIT Counts submitted	Mean (max) number of FIT Counts per 1km square	Number of 1km pan trap surveys submitted
England	27	133	5 (14)	70
Wales	15	65	4 (27)	22
Scotland	16	89	6 (12)	29
UK TOTAL	58	287	5	121

Figure 5. Current allocation of PoMS 1km squares to volunteers.

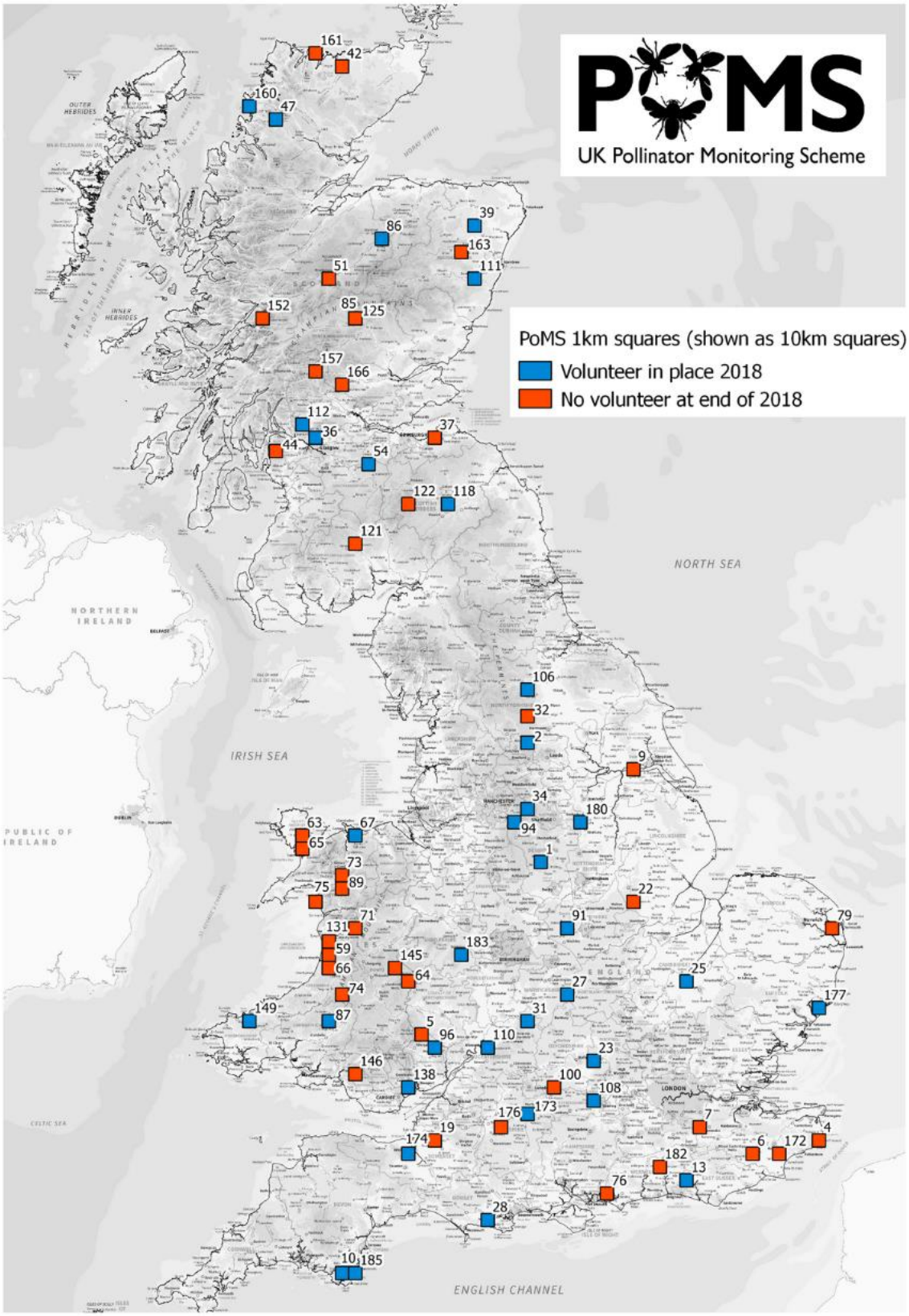


Table 3. Summary of PoMS 1km square surveys conducted by volunteers and CEH PoMS team in 2018

*two or more volunteers surveyed together on at least 7 squares.

† includes initial visits with a CEH team mentor

**one square in the west of Scotland has yet to be set up for surveying

*** one volunteer in England was already trained and provided with equipment during 2017.

Country	Number of PoMS 1km squares	Squares surveyed in 2018	Squares with trained volunteers 2018 *	Total volunteer survey visits 2018†	Total CEH-volunteer mentoring visits	Total CEH-only survey visits	2018 Total survey visits
England	36	33	24	74	23***	18	92
Wales	17	15	3	10	3	12	22
Scotland	21**	17	10	23	10	7	30
UK TOTAL	74	65	37	107	36	37	144

Table 4. Summary of PoMS 1km square surveys by month and submitted to iRecord as at 24th September 2018. Note "August" surveys continued up to mid-September.

	Total number of survey visits 2018					
Country	May	June	July	August	Mean survey visits per square 2018	Number of 1km surveys submitted to iRecord
England	20	19	27	26	2.56	70
Wales	2	3	2	15	1.29	22
Scotland	4	7	5	14	1.43	29
UK TOTAL	26	29	34	55	1.95	121

Table 5. Summary of specimens and stored samples from PoMS squares to date (max per year calculated on the basis of all 75 squares being surveyed four times).

	2017 actual	**2018 estimates**	**Max per year**
Number of 1km squares surveyed	72	65	75
Total samples (6hr pan traps)	631	720	1,500
Total specimens	50,353	57,455	118,980
Bee specimens to species	803		1,920
Hoverfly specimens to species	1300		3,060
Total by-catch individuals	48,250		114,000
Average total insects per survey, per square	396.6		397
Average bees and hoverflies per survey	16.6		17
Average by-catch insects per survey	380.0		380
% bees and hoverflies	4.2%		0
% by-catch	95.8%		1
Approx # ethanol samples for pollen screening	0	720	1,500

Table 6. Provisional list of bee species recorded from pan traps in the 2017 survey of PoMS 1km squares (final QA still underway). * = nationally scarce or notable species in England, Wales or Scotland. Note the Red List for Hymenoptera is currently being revised. *Bombus terrestris* and *B. lucorum* workers cannot always be reliably separated, hence are often recorded as a species aggregate.

Family	Taxon name (species)	Number of PoMS records 2017
Andrenidae	*Andrena (Andrena) fucata*	2
Andrenidae	*Andrena (Andrena) lapponica*	1
Andrenidae	*Andrena (Euandrena) bicolor*	7
Andrenidae	*Andrena (Melandrena) cineraria**	2
Andrenidae	*Andrena (Melandrena) nigroaenea*	1
Andrenidae	*Andrena (Melandrena) thoracica*	2
Andrenidae	*Andrena (Micrandrena) minutula*	2
Andrenidae	*Andrena (Micrandrena) semilaevis*	1
Andrenidae	*Andrena (Micrandrena) subopaca*	2
Andrenidae	*Andrena (Oreomelissa) coitana*	4
Andrenidae	*Andrena (Ptilandrena) angustior*	2
Andrenidae	*Andrena (Simandrena) dorsata*	2
Andrenidae	*Andrena (Trachandrena) haemorrhoa*	2
Andrenidae	*Andrena (Zonandrena) flavipes*	8
Apidae	*Anthophora (Clisodon) furcata*	1
Apidae	*Apis mellifera*	137
Apidae	*Bombus bohemicus*	3
Apidae	*Bombus campestris*	3
Apidae	*Bombus hortorum*	45
Apidae	*Bombus hypnorum*	4
Apidae	*Bombus jonellus*	3
Apidae	*Bombus lapidarius*	45
Apidae	*Bombus lucorum/terrestris*	102
Apidae	*Bombus monticola**	16
Apidae	*Bombus pascuorum*	58
Apidae	*Bombus pratorum*	3
Apidae	*Bombus rupestris**	2
Apidae	*Bombus sylvestris*	12
Apidae	*Bombus terrestris*	26
Apidae	*Bombus vestalis*	6
Apidae	*Nomada marshamella*	1
Apidae	*Nomada ruficornis*	1
Colletidae	*Colletes (Colletes) similis*	1
Colletidae	*Hylaeus (Hylaeus) communis*	8
Colletidae	*Hylaeus (Lamdopsis) dilatatus*	1
Colletidae	*Hylaeus (Prosopis) confusus*	2
Colletidae	*Hylaeus (Prosopis) pectoralis*	16
Colletidae	*Hylaeus (Spatulariella) hyalinatus*	1
Halictidae	*Halictus (Halictus) rubicundus*	16
Halictidae	*Halictus (Seladonia) tumulorum*	26

Halictidae	*Lasioglossum (Dialictus) cupromicans*	2
Halictidae	*Lasioglossum (Dialictus) leucopus*	4
Halictidae	*Lasioglossum (Dialictus) morio*	18
Halictidae	*Lasioglossum (Dialictus) smeathmanellum**	3
Halictidae	*Lasioglossum (Evylaeus) albipes*	5
Halictidae	*Lasioglossum (Evylaeus) calceatum*	76
Halictidae	*Lasioglossum (Evylaeus) fratellum*	4
Halictidae	*Lasioglossum (Evylaeus) fulvicorne**	12
Halictidae	*Lasioglossum (Evylaeus) malachurum**	42
Halictidae	*Lasioglossum (Evylaeus) minutissimum*	3
Halictidae	*Lasioglossum (Evylaeus) parvulum*	2
Halictidae	*Lasioglossum (Evylaeus) pauxillum**	10
Halictidae	*Lasioglossum (Evylaeus) villosulum**	6
Halictidae	*Lasioglossum (Lasioglossum) laevigatum*	1
Halictidae	*Lasioglossum (Lasioglossum) lativentre*	7
Halictidae	*Lasioglossum (Lasioglossum) leucozonium*	16
Halictidae	*Lasioglossum (Lasioglossum) zonulum*	10
Halictidae	*Sphecodes crassus**	1
Halictidae	*Sphecodes ephippius*	1
Megachilidae	*Megachile (Megachile) ligniseca*	1
Megachilidae	*Osmia (Chalcosmia) leaiana*	1
Megachilidae	*Osmia (Osmia) bicornis**	1

Table 7. Provisional list of hoverfly species recorded from pan traps in the 2017 survey of PoMS 1km squares.

Family	Taxon name (species)	Number of PoMS records 2017
Syrphidae	*Anasimyia transfuga*	1
Syrphidae	*Chalcosyrphus nemorum*	1
Syrphidae	*Cheilosia albitarsis sens. lat.*	4
Syrphidae	*Cheilosia bergenstammi*	1
Syrphidae	*Cheilosia fraterna*	2
Syrphidae	*Cheilosia illustrata*	1
Syrphidae	*Chrysotoxum bicinctum*	4
Syrphidae	*Chrysotoxum festivum*	2
Syrphidae	*Dasysyrphus albostriatus*	7
Syrphidae	*Epistrophe grossulariae*	2
Syrphidae	*Episyrphus balteatus*	138
Syrphidae	*Eristalinus aeneus*	1
Syrphidae	*Eristalinus sepulchralis*	18
Syrphidae	*Eristalis abusivus*	7
Syrphidae	*Eristalis arbustorum*	31
Syrphidae	*Eristalis horticola*	5
Syrphidae	*Eristalis intricarius*	3
Syrphidae	*Eristalis nemorum*	12
Syrphidae	*Eristalis pertinax*	26
Syrphidae	*Eristalis rupium*	1
Syrphidae	*Eristalis tenax*	53
Syrphidae	*Eumerus ornatus*	1
Syrphidae	*Eumerus strigatus*	3
Syrphidae	*Eupeodes corollae*	87
Syrphidae	*Eupeodes latifasciatus*	8
Syrphidae	*Eupeodes luniger*	27
Syrphidae	*Ferdinandea cuprea*	29
Syrphidae	*Helophilus hybridus*	4
Syrphidae	*Helophilus pendulus*	50
Syrphidae	*Helophilus trivittatus*	1
Syrphidae	*Leucozona glaucia*	1
Syrphidae	*Melanogaster hirtella*	19
Syrphidae	*Melanostoma mellinum*	56
Syrphidae	*Melanostoma scalare*	9
Syrphidae	*Meliscaeva auricollis*	1
Syrphidae	*Meliscaeva cinctella*	8
Syrphidae	*Myathropa florea*	13
Syrphidae	*Neoascia podagrica*	97
Syrphidae	*Neoascia tenur*	4
Syrphidae	*Pipizella viduata*	5

Syrphidae	*Platycheirus*	2
Syrphidae	*Platycheirus albimanus*	54
Syrphidae	*Platycheirus clypeatus*	2
Syrphidae	*Platycheirus granditarsus*	24
Syrphidae	*Platycheirus manicatus*	17
Syrphidae	*Platycheirus peltatus*	1
Syrphidae	*Platycheirus peltatus agg.*	6
Syrphidae	*Platycheirus rosarum*	2
Syrphidae	*Platycheirus scutatus sens. lat.*	4
Syrphidae	*Rhingia campestris*	86
Syrphidae	*Scaeva pyrastri*	5
Syrphidae	*Sericomyia lappona*	8
Syrphidae	*Sericomyia silentis*	17
Syrphidae	*Sphaerophoria*	14
Syrphidae	*Sphaerophoria fatarum*	2
Syrphidae	*Sphaerophoria interrupta*	2
Syrphidae	*Sphaerophoria philanthus*	1
Syrphidae	*Sphaerophoria scripta*	4
Syrphidae	*Sphegina clunipes*	1
Syrphidae	*Syritta pipiens*	9
Syrphidae	*Syrphus rectus/vitripennis agg.*	23
Syrphidae	*Syrphus ribesii*	114
Syrphidae	*Syrphus torvus*	9
Syrphidae	*Syrphus vitripennis*	45
Syrphidae	*Volucella bombylans*	6
Syrphidae	*Volucella inanis*	1
Syrphidae	*Volucella inflata*	4
Syrphidae	*Xanthogramma pedissequum sensu strictu*	1
Syrphidae	*Xylota jakutorum*	4
Syrphidae	*Xylota segnis*	89

Summary of results from PMRAG consultation on research gaps and priorities

(led by the University of Reading team)

The consultation survey was sent to wide stakeholder group including members of Defra's Pollinator Strategy Advisory Group (PASG), the Welsh Task Force - Action Plan for Pollinators, Scottish Natural Heritage and organisations involved in pollinator conservation.

We received 22 responses in total with several individuals answering on behalf of the organisations they work for. The specific questions asked, the responses obtained including summaries and the additional comments are provided below.

Table 8. Which pollinator groups should be a priority for monitoring?

Respondents were asked to rank the top three where 1 was the most important. For analyses, the most important (rank 1) were given a score of 3, the second most important (rank 2) a score of 2, and so on and all the non-scored columns given a score of zero. Where replies had extra ranks beyond 3, a score of 0.5 was given

	Wild bees	Honey bees	Wasps	Hover-flies	Butter-flies	All the above taxa	Other (please state)
	0	0	0	0	0	3	
	3	1	0	2	0	0	
	0	3	0	0	1	0	
	3	0.5	1	2	2	3	
	2	3	0	0	1	0	
	3	0.5	0.5	2	1	0	
	3	0	0	2	1	0	
	3	0	0	1	2	0	
	2	3	0	0	1	0	
	2	0	0	3	0	0	All Lepidoptera incl. moths
	3	0	0	0	2	1	
	3	1	0	2	0	0	
	3	0	0	2	0	1	
	3	0	0	2	0	0	Other flies
	2	0	0	0	0	3	Under recorded groups / flower visiting Diptera
	3	2	0	1	0	0	
	3	0	0	1	2	0	
	3	1	0	2	0	0	
	3	2	0	1	0	0	
	3	0	0	2	1	0	
	3	0	0	0	2	0	Non syrphid Diptera
	3	0	0	2	0	1	
MEAN	**2.50**	**0.75**	**0.06**	**1.23**	**0.73**	**0.55**	
RANK	**1**	**4**	**6**	**2**	**3**	**5**	

Table 9. What should be the focus of a monitoring scheme?

Respondents were asked to rank the top five by adding 1, 2, 3, 4 and 5 to the table below, where 1 is the most important. For analyses, the most important (rank 1) were given a score of 5, the second most important (rank 2) a score of 4, and so on and all the non-scored columns given a score of zero. Where replies had extra ranks beyond 5, a score of 0.5 was given

	Common species	Rare species	Endemic species	Invasive species	Crop pollinators	Wild plant pollinators	Managed pollinators	Threats stress-ors	Effective-ness of intervent-ions
	3	2	0	0	0	1	0	5	5
	5	0	0	0	4	3	2	0	0
	3	0	2	0	4	1	5	0	0
	4	5	3	0.5	0	2	0	1	0.5
	4	0	3	0	0	1	0	2	5
	3	0.5	2	0.5	0.5	1	0.5	5	4
	3	0	0	0	0	4	0	5	5
	5	0	4	0	0	3	0	2	1
	5	0	0	0	0	4	2	3	1
	2	1	0	0	0	0	0	4	5
	4	5	0	0	2	3	0	0	1
	4	3	0	0	1	2	0	5	0
	4	5	0	0	2	3	0	0	1
	5	4	0	0	0	3	2	0	1
	4	1	0	0	0	0	0	5	3
	0	0	0	0	3	2	1	5	4
	5	3	0	0	0	4	0	1	2
	0	1	0	0	5	4	0	2	3
	4	0	0	0	5	1	2	0	3
	3	0	0	0	0	4	0	0	5
	4	0	0	0	0	5	2	3	0
	0	0	0	0	5	5	0	4	4
MEAN	**3.36**	**1.39**	**0.64**	**0.05**	**1.43**	**2.55**	**0.75**	**2.36**	**2.43**
RANK	**1**	**5**	**8**	**9**	**6**	**2**	**7**	**4**	**3**

Table 10. Summary of communication and engagement activities at which the PoMS has been promoted since January 2018.

Type of engagement activity	Number of events/ articles	Approx. audience reached
Article in print	11	83100
Article online	16	332400
E-newsletter / news item	2	19110
Major Twitter/FB activity	10+	112000
Media radio or TV	2	?
Meeting attended/ talk	24	987
Public event/ festival	14	5202
Training event	94	1242
Volunteer activity day	7	46