POMS

UK Pollinator Monitoring Scheme

UK Pollinator Monitoring and Research Partnership (PMRP)

Progress Report January 2020

Claire Carvell and PMRP partners (January 2020)

UK Centre for Ecology & Hydrology · Bumblebee Conservation Trust · Butterfly Conservation · BTO · Hymettus · UNIVERSITY OF LEEDS · University of Reading · Natural History Museum · Department for Environment Food & Rural Affairs · Llywodraeth Cymru Welsh Government · Scottish Government Riaghaltas na h-Alba gov.scot · JNCC Joint Nature Conservation Committee

www.ceh.ac.uk/pollinator-monitoring

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PoMS highlights in numbers (May 2019 – January 2020)

365 species trends estimated for the Status of Pollinating Insects Indicator 2019

3 first country level species trends for England, Scotland and Wales

75 1km survey squares active across England, Scotland and Wales with access permission for PoMS surveys

809 'public' FIT-Counts submitted to iRecord (584 in 2018)

236 PoMS survey visits made to 74 1km squares (147 in 2018)

1180* pan trap samples sorted to insect group level *current estimate

3,255 bee and hoverfly specimens from 2018 identified to species level

61 volunteers matched with 54 1km squares as of October 2019

4 countries beyond GB adopting FIT Counts into new pollinator monitoring schemes

1,313 followers of PoMS on Twitter

UK Pollinator Monitoring Scheme

Introduction and overview of progress

Many insect pollinators are becoming less widespread in Britain and elsewhere and we have a poor understanding of the effect of these changes on the pollination services they provide. This is largely due to the lack of long-term standardised monitoring of their populations. Current evidence for pollinator declines (of most species, aside from butterflies, moths and more recently, bumblebees) is derived from relatively unstructured opportunistic records of species occurrence submitted by volunteer recorders and co-ordinated by the National Schemes and Societies (NSS). These invaluable datasets make it possible to track long-term changes in pollinator distributions at the species level, but provide no direct information on abundance, population size or pollination service.

Through the project "Establishing a UK Pollinator Monitoring and Research Partnership BE0125" (Jan 2017 – April 2019) the PMRP project team established a hierarchical approach combining professional and volunteer involvement and taxonomic scope, through the integration of two new systematic surveys (forming the UK Pollinator Monitoring Scheme, PoMS) with ongoing opportunistic recording. In addition, a Pollinator Monitoring Research Advisory Group (PMRAG) was established to help support externally-funded research applications and use PoMS-derived data in research, conservation and survey planning.

This report summarises progress on the PMRP project since the start of Phase 2 (May 2019 – January 2020)[1]. Phase 2 retains the five core Tasks as outlined below, with elements of the implementation mechanism updated to reflect the second phase of delivery. Overall, progress is on track and in line with planned project Milestones, with 2019 having seen an increase in both public FIT Counts and 1 km square survey visits since 2018, continued recruitment to the volunteer network via PMRP partners and outreach activities, and significant improvements to the data infrastructure and modelling approaches.

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 (T 3-5);

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 are delivered under the following Tasks:

Task 1) Improving robustness and 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) Simple systematic survey (Flower-Insect Timed Counts) to engage a wide range of volunteers collecting data on abundance and flower visitation rates of pollinators across GB.

Task 3) Undertaking new intensive systematic surveys (PoMS 1 km square 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) Maintaining links with the Pollinator Monitoring Research Advisory Group (PMRAG) to help support externally-funded research applications and use project data in research, conservation and survey planning.

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[1] The final report from Phase 1 (2017- 2018 surveys) is still under review and is yet to be published.

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 1 km 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 (https://jncc.gov.uk/our-work/ukbi-d1c-pollinating-insects/).The first Indicator published in 2015 was based on modelled trends for 213 wild pollinator species. The 2019 update of the Indicator describes changes in distribution of **365** bee and hoverfly species. 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 Indicator. Whether an individual species is increasing or decreasing is defined by its rate of annual change across the time period considered.

The increase in species for which robust trends can be generated has been made possible by an increase in verified records and improvements to the modelling approach since 2018. For example, a large addition to the HRS database made it possible to include 14 additional species of hoverfly across the entire time series up to 2016, rather than to 2013 as for the 2018 Indicator. This update has impacted on the modelled long-term and short-term composite trends.

Between 1980 and 2016, **14% of the 365 species analysed became more widespread** (5% showed a strong increase at above a threshold of +2.8% per annum) and **44% of species became less widespread** (20% showed a strong decrease at below a threshold of -2.7% per annum, equating to a decrease in occupancy of -50% over 25 years). Similarly, a greater proportion of species were decreasing than increasing over the short term between 2011 - 2016, with 46% of species decreasing and 38% of species increasing. 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 or **distribution size declined by 31% between 1980 and 2016** and the pollinator Indicator was therefore assessed as **declining** over this period (the equivalent figure from the 2018 Indicator was a decline of 22%). In the shorter term between 2011 and 2016, average occupancy declined by 10% (having shown a minor increase of 2% with the previous 2018 dataset), and the short-term trend was also assessed as declining.

The Indicator is presented separately for bees and hoverflies. Of the 137 wild bee species analysed, a greater proportion of species was declining than increasing, 37% and 20% respectively between 1980 and 2016 (Figure 1). However, a greater number of species were increasing (46%) than declining (33%) in occupancy over the short term. 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 at 17% lower than in 1980.

In contrast to the bees, the hoverfly index (Figure 2) shows a gradual decline from 1987 to 2000, reaching a low of 18% lower than the 1980 value in 2000. The trend was then relatively stable up to 2009, before declining again, ending 39% (90% CIs: 43% to 35% decline) lower than the value in 1980. Of the 228 species analysed, a greater proportion of hoverflies have declined than increased in occupancy over the long- and short term (1980 to 2016: 49% decreased and 10% increased; 2011 to 2016: 54% decreased and 32% increased).

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. 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 have derived country-level trends for England, Wales and Scotland. Initial analyses suggest that country-specific trends are tractable, particularly for widespread species with sufficient records in a given country that pass a given 'precision threshold' (indicating a "useable" model for individual species). The country level indicators are presented in the PMRP final report from Phase 1 (2017- 2018 surveys), still under review, but the preliminary statistics for Scotland and Wales suggest that declines have been less severe than in England.

For 2020, we have begun to look more closely at species-specific model outputs at country level, specifically to assess regional model robustness to known potential causes of bias (e.g. targeted or low levels of recording). We plan to organise a PMRP working group to assess these model outputs in more depth with respect to recorder expertise, data availability and other data sources or modelling approaches, including linking with the integrated model approaches in Task 4.

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 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 of images.

Since May 2019, we have progressed towards a working prototype of the tool within a Docker web server environment to aid in hosting/sharing the tool with other schemes. This will allow potential verifiers to test themselves in the verification of a selected suite of species to customisably defined taxonomic thresholds. Species have initially been selected that are frequently recorded, are possible to identify from photos, but that are often confused with similar species. Included taxa have been expanded through consultation with recording schemes beyond BWARS to include squash bugs and 'green shield bugs', 'brown shield bugs' and orb weaver spiders. Ladybirds are identified as another potential candidate with significant links and outreach, as are numerous species? of hoverflies and links with wasp genera. The next phase from April 2020 will be to work with volunteers (likely to be invited from BWARS members and contacts) to carry out verification on a trial basis using the working prototype, producing objective data and feedback on their ability to correctly identify the set of target species.

Moving to a statistically driven technological approach over a direct-to-person training method (as currently operating within most NSS) provides a way to achieve a far greater coverage for the same initial outlay. 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.
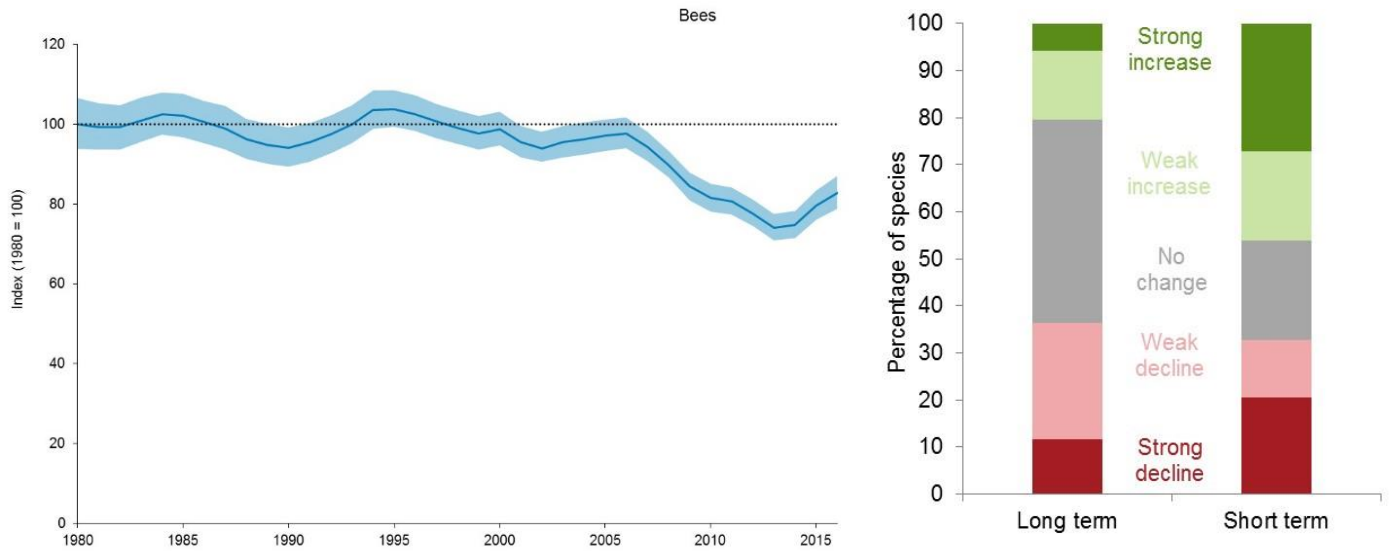
Figure 1. Change in the distribution of pollinating wild bee species (n = 137) in the UK between 1980 and 2016. The shaded region is the 90% credible intervals of the annual occupancy estimates and represents the uncertainty surrounding the annual estimates. The solid line illustrates the rescaled indicator 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).
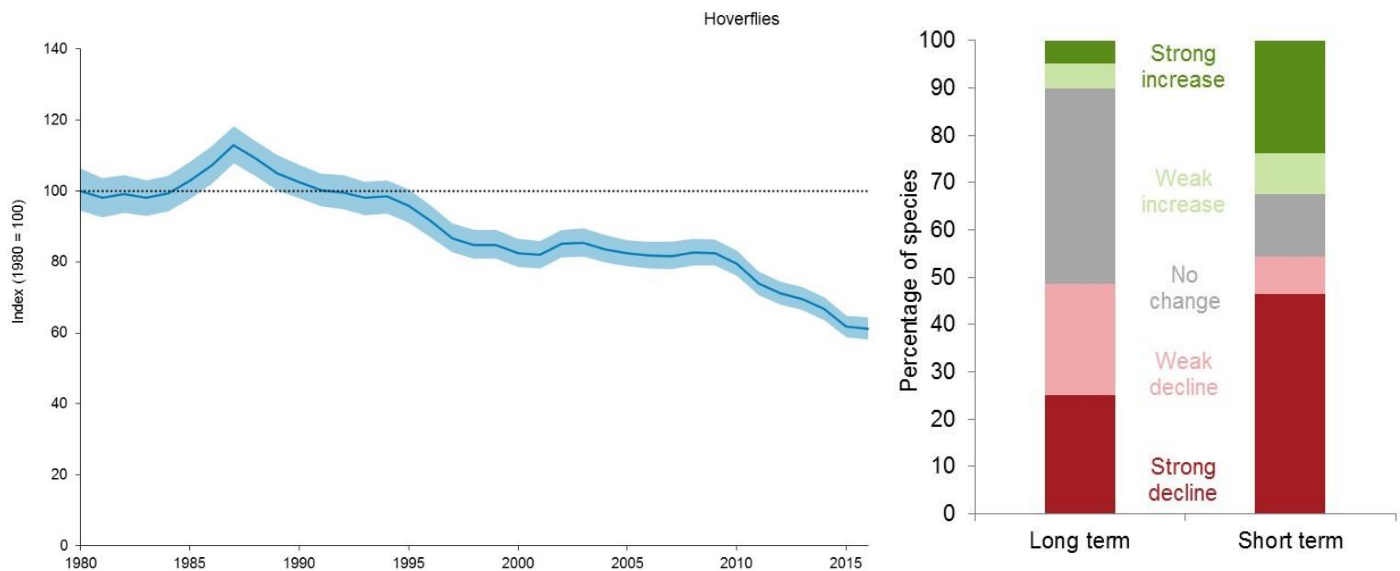

Figure 2. Change in the distribution of hoverfly species (n = 228) in the UK between 1980 and 2016. The shaded region is the 90% credible intervals of the annual occupancy estimates and represents the uncertainty surrounding the annual estimates. The solid line illustrates the rescaled indicator value. The proportion of hoverfly 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).

Figures taken from Powney, G. D., Harrower, C., Outhwaite, C., & Isaac, N. J. B. (2019). UK Biodiversity Indicators 2019: D1c Status of pollinating insects. Technical background document. JNCC/ Centre for Ecology and Hydrology, UK.

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 and plant-pollinator interactions 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 approach, guidance documentation (in English and Welsh), three video guides (also on YouTube) and supporting data infrastructure within iRecord (www.brc.ac.uk/irecord/poms-fit-count) were developed and tested during 2017 and 2018, and based on positive feedback from participants, we have continued with this approach. Promotion during 2019 was made through the PMRP partnership, funders and wider stakeholders via a variety of channels (see list under Task 6).

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

Preliminary Results from 2019 FIT Counts as at January 2020..

A total of 809 FIT counts have been submitted to iRecord by members of the public from 2019. See Figure 3 for a map of locations and Table 1 for a summary comparison with the 2018 counts.

A total of 10,651 insects were counted, at an average of 13.2 insects per 10-minute count (as compared with 5,452 insects from 584 counts in 2018 at an average of 9.3 per count). The relative proportions of insect representing each taxon group in the public FIT counts remained similar between years (Figure 4, pie charts). Bumblebees, honeybees, hoverflies, other flies and 'small' insects were most prevalent, although the average proportion of small insects making up the counts increased in 2019.

Target flower species receiving the most counts in 2019 were Dandelion, Lavender and Buttercup, but as in 2018, a large number of counts were conducted on "other" flowers.

Public FIT Counts GB	2018	**2019**
Number of FIT counts submitted	584	809
Total number of insects counted	5,452	10,651
Mean insects per count	9.3	13.2

Table 1. Summary of FIT Counts submitted to iRecord by members of the public 2018 and 2019

Figures in this table exclude the few counts submitted from the Channel Isles and Northern Ireland, and counts made after the end of September, but include a few counts submitted from the Isle of Man
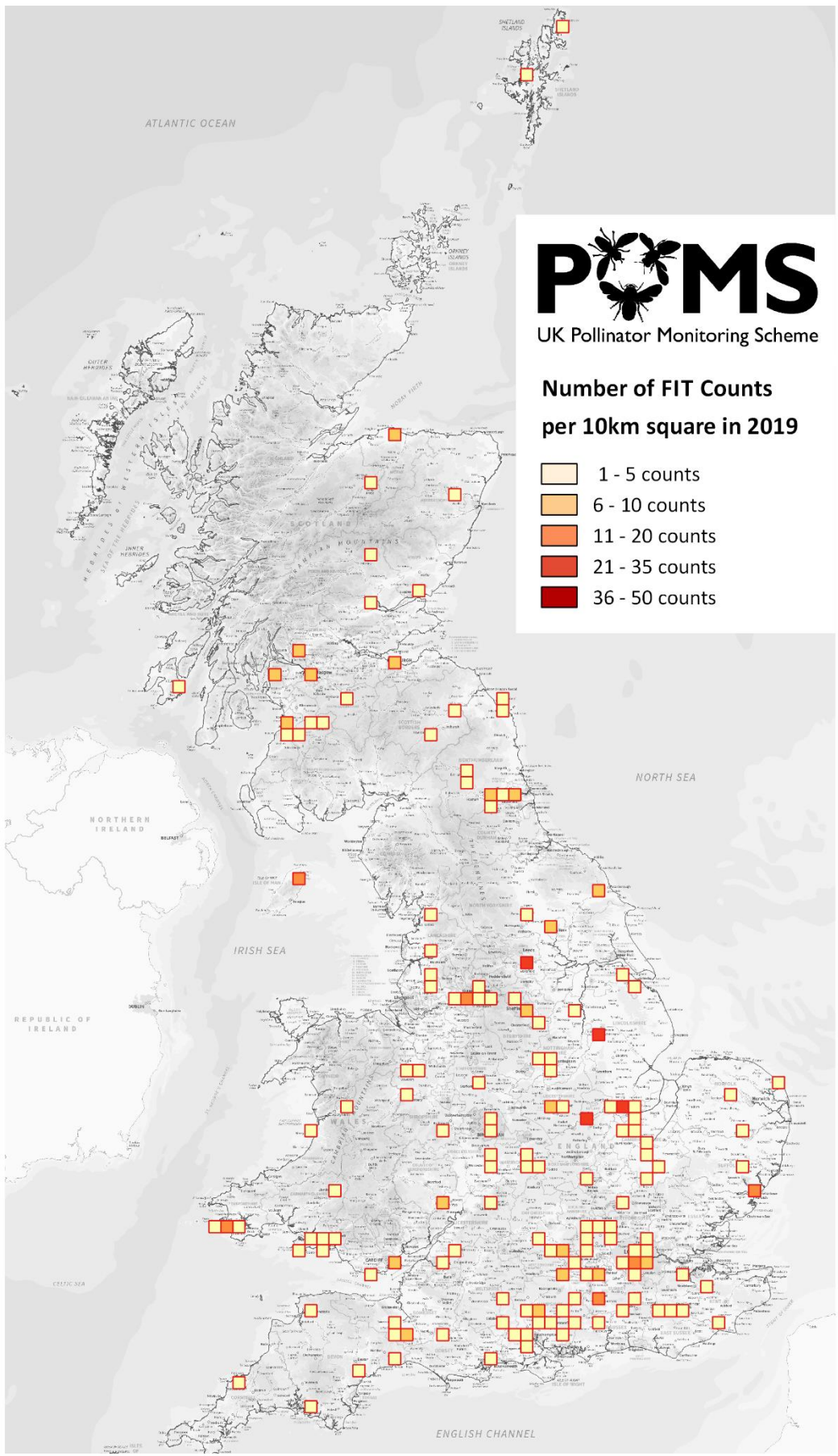
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Figure 3. Map showing locations of the 809 Flower-Insect Timed Counts (FIT Counts) carried out by members of the public from April – September 2019 and submitted to iRecord as at January 2020.
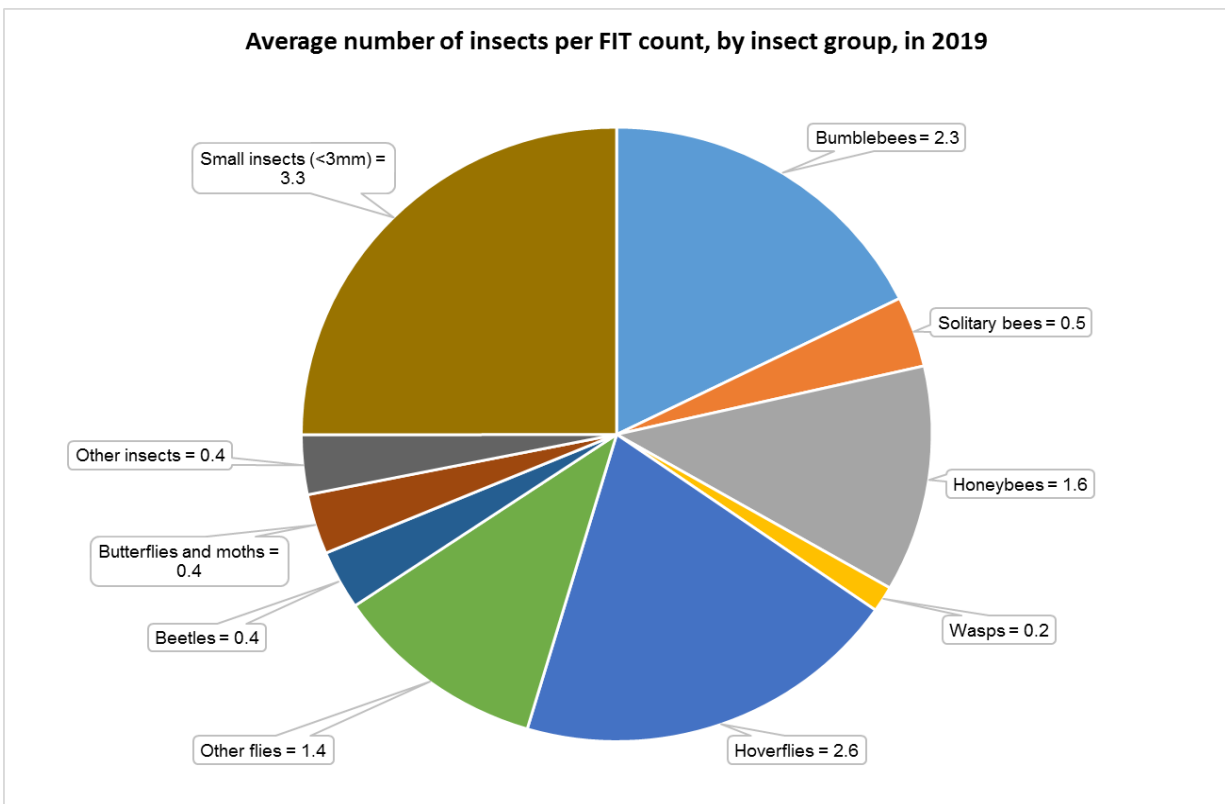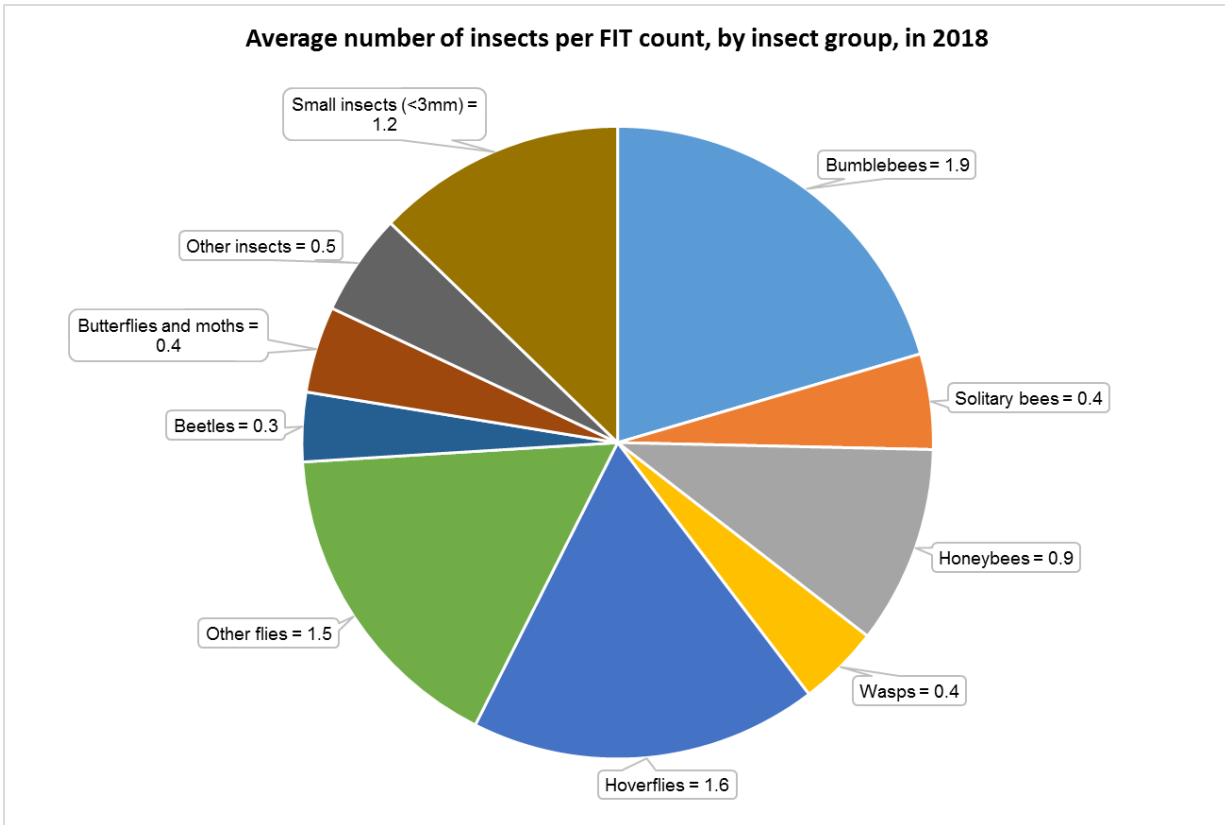
Average number of insects per FIT count, by insect group, in 2018

Small insects (<3mm) = 1.2
Other insects = 0.5
Butterflies and moths = 0.4
Beetles = 0.3
Other flies = 1.5
Hoverflies = 1.6
Wasps = 0.4
Honeybees = 0.9
Solitary bees = 0.4
Bumblebees = 1.9

Average number of insects per FIT count, by insect group, in 2019

Small insects (<3mm) = 3.3
Other insects = 0.4
Butterflies and moths = 0.4
Beetles = 0.4
Other flies = 1.4
Hoverflies = 2.6
Wasps = 0.2
Honeybees = 1.6
Solitary bees = 0.5
Bumblebees = 2.3

Figure 4. Average number of insects per public FIT Count, by insect group, in 2018 and 2019 (data for 2019 still subject to final checking).

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Task 3: PoMS 1 km square surveys: an intensive systematic survey of pollinators and floral resources from a network of 1 km squares

This survey has been set up to monitor the abundance of pollinating insects across a network of 75 randomly selected 1 km squares stratified across agricultural and semi-natural landscapes. All PoMS survey squares in England (36) and Scotland (22) are also included within the National Plant Monitoring Scheme (NPMS www.npms.org.uk), to benefit from co-location with their invaluable long-term data on wild plant species and changes in habitat condition. All survey squares in Wales (17) are part of the Welsh ERAMMP wider environmental monitoring framework.

Task 3.1: Field sampling 2019

The PoMS 1 km 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 1 km 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. The protocol is intended to be repeated on 4 survey visits to each square between late April and September.

During 2019, a total of 236 survey visits were conducted across 74 PoMS squares (mean = 3.1 visits per square, see Table 2). This was a significant improvement on the 2018 survey coverage of 147 visits across 65 squares. 31 squares received the full set of four visits, and a further 29 squares received three visits during 2019. The five part-time PoMS team surveyors who were recruited specifically to fill gaps in survey effort on unallocated squares, as well as recruiting and mentoring new volunteers, were essential for the delivery of this element.

All squares in England and Wales were retained from the first two years of the PoMS survey, with continued access permission from landowners. The square in England from which no 2019 survey data have been received is assigned to a volunteer, but it is not yet certain whether any samples were generated. In Scotland, two squares had proven unsuitable to access due to changes in land-use (eg. livestock movements), and were therefore replaced for 2019 (one of these had not yet been set up or surveyed for PoMS). Two replacement squares were selected as the next available squares within the random tranche of NPMS squares assigned to PoMS during the site stratification exercise, and as sites for which access could be obtained for 2019. As a general principle, squares that are now set up as part of the core PoMS network will only be replaced if absolutely necessary on the grounds of access or safety, given the resources required for set-up and the value of existing survey data needed to detect longer-term trends at these sites.

Country	# PoMS 1km squares	# survey visits			# samples (6hr pan traps)			# squares surveyed			Mean surveys per square			# squares with 4 survey visits		
		2017	2018	**2019**	2017	2018	**2019***	2017	2018	**2019**	2017	2018	**2019**	2017	2018	**2019**
England	36	59	93	113	295	465	565	36	33	35	1.6	2.6	3.1	0	14	16
Scotland	22	35	32	61	175	156	305	19	17	22	1.7	1.5	2.8	0	2	2
Wales	17	33	22	62	165	110	310	17	15	17	1.9	1.3	3.6	0	2	13
GB Total	75	127	147	236	635	731	1180	72	65	74	1.7	1.8	3.1	0	18	31

Table 2. Summary of PoMS 1 km square surveys conducted by volunteers and UKCEH PoMS team 2017 - 2019. *2019 sample numbers are preliminary and subject to data checking.

Task 3.2: Sample processing and identification

All of the ca. 1180 pan trap samples received in 2019 (all the insects captured at one pan trap station over a 6 hour period), have been sorted in the UKCEH lab, and individually tubed bee and hoverfly specimens distributed to a team of three taxonomists for species identification (this is near completion as end January 2020). As in 2018, the determinations of consultant taxonomists will be quality assured by obtaining second opinions on a random subset of specimens during an end of season "lab day" to be hosted at UKCEH in early March, with an additional focus on difficult species or species pairs.

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 99% ethanol in their original sample tubes at -20degC for potential

downstream analysis. These samples have been catalogued within iRecord alongside their respective survey datasets.

Full results of the 2017 and 2018 1 km square surveys and species-level findings from the pan traps are reported in the final report (still under review and in process of translation into Welsh). Here, we feature some **highlight stories on four species** that will be featured in the forthcoming PoMS newsletter.

Broken-belted Bumblebee *Bombus soroeensis*

One of our smaller bumblebees, *Bombus soroeensis* is quite widespread in the Scottish highlands and can still be found in parts of West Wales, but has declined greatly in England, where it is now best known from Salisbury Plain and parts of the North Pennines. The PoMS 1 km surveys recorded this species in five 1 km squares in Scotland, including one in Lanarkshire in August 2018, the first time it has been recorded in this vice-county (according to the maps provided by BWARS and NBN Atlas), and in fact the first time it has been recorded within this entire 100km square (square "NS" within the Ordnance Survey grid system).
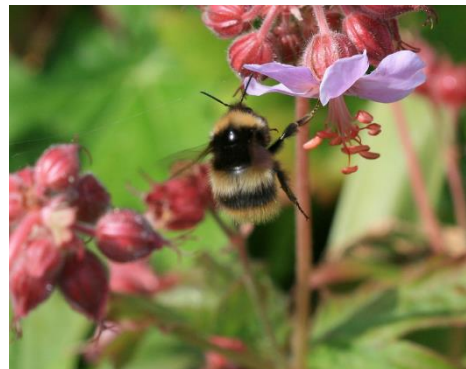
Bombus soroeensis Photo © S. Rae, via Flickr (CC BY)

Pantaloon Bee, *Dasypoda hirtipes*

This attractive solitary mining bee gets its English name from the long hairs that form a striking yellow pollen basket on the hind legs. These hairs also play a role in nest construction, when the females use them to help excavate burrows in the sandy soils in which they nest. The bees visit flowers from the daisy family (Asteraceae), including ragworts and thistles. *Dasypoda hirtipes* is mostly confined to the coasts of the southern half of England and Wales, and is listed as a Nationally Scarce species although it can be very numerous where it does occur. It was recorded from a PoMS 1 km square in East Suffolk in June 2018.

Dasypoda hirtipes Photo © Jeremy Early, via BWARS

### Alder Wood Hoverfly *Xylota abiens*

This is a fairly small hoverfly that is associated with damp, mature woodland, where its larvae develop in the decaying roots of trees such as Beech. Unlike many hoverflies, it rarely visits flowers, and spends more of its time running across leaves in the dappled sun of its woodland habitat. Although it has been found quite widely across England, it is very localised and records show a decline. It is listed as Nationally Scarce. It was found in a PoMS 1 km square in Oxfordshire in June 2018, and has also been identified from the same square in the 2019 pan trap samples, as shown in the picture.

Xylota abiens Photo © Nigel Jones

Marmalade Hoverfly *Episyrphus balteatus*

This is a familiar species in towns, gardens and the wider countryside, and in fact is the most abundant species in the PoMS 1 km square pan trap surveys. It is seen visiting a wide range of flowers, and has larvae that prey on aphids. Numbers within PoMS were especially high in 2018, probably at least in part a result of an influx of migratory individuals. *Episyrphus balteatus* is a resident species in Britain but is well-known for also migrating here from breeding populations further south in Europe.
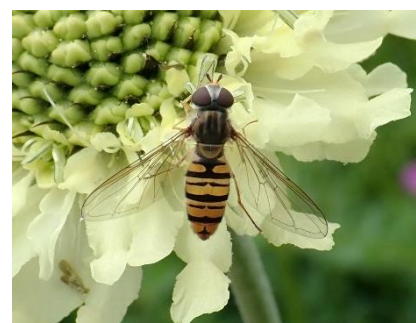
Episyrphus balteatus Photo © Martin Harvey

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Task 3.3: Links with crop pollination

This Task aims to investigate the potential to use data collected using the PoMS 1 km survey protocol to track populations of key crop pollinators. In order to meet our objectives we will utilise a recently developed comprehensive list of important UK crop pollinators for a number of UK crops. We will examine the abundance and distribution of these crop pollinator species from 2019 pan trap data collected in PoMS survey squares. By comparing this with the spatial distribution of different crops based on the UKCEH LCM+Crops maps we will explore possible spatial mis-matches between pollinators and crops and to what extent this varies between crops and regions.

We are currently working with a number of growers on other projects to assess pollination services including in apples, strawberries and raspberries and we will actively encourage our farmers to carry out FIT Count surveys to strengthen our datasets from farmed environments and on crop pollinator groups in particular. We will also explore the potential for farmers to implement FIT Count type surveys in their crops on a regular basis.

In addition with UKCEH and the University of Reading we will contribute existing data on pollinator abundance and effectiveness to help development of a Functional Species Indicator for the UK, to increase our understanding of changing patterns of occurrence in key crop pollinators

Task 3.4: Volunteer recruitment, training and retention

As a citizen science-based structured monitoring scheme with long-term aspirations, PoMS has a clear goal of ensuring that volunteers are well supported and maintaining their interest in order to maximise participation. Communication with volunteers for the PoMS 1 km square survey has continued mainly via a Co-ordinator role based at UKCEH, including via a dedicated PoMS email account. Confirmed volunteers are put in touch with their PoMS team mentor to arrange survey visits and discuss the exchange and replacement of equipment.

As of October 2019, there were 61 trained volunteers allocated across 54 PoMS squares (see map in Figure 5). This is an increase of 11 new volunteers taking up 11 unallocated squares since April 2019 and brings us close to our Milestone target for 2020 of 60 1 km squares allocated with retained volunteers.

On 29th January 2020, we circulated a short feedback questionnaire to all volunteers to check whether they were able to continue with the 1 km square surveys. Within the first week since this communication, we have had responses from 23 of the 2019 volunteers, 17 of which are happy to continue, 4 have said they cannot continue, and 2 have said that things are a little more complicated and have asked to discuss with the PoMS volunteer co-ordinator. This leaves at least 4 squares in England, 10 in Scotland and 10 in Wales with no allocated volunteer. These squares are to be covered by PoMS team surveyors during 2020, alongside the process of recruitment of new volunteers, working alongside our partner and funder organisations to promote the surveys.

To overcome one of the perceived barriers to uptake (travel distance to selected squares), resources were requested to offer expenses (mileage) to volunteers for travel to 1 km squares, administered through the UKCEH non-employee expenses system. This opportunity was communicated to all 1 km volunteers at both the beginning and end of the 2019 season, although only around 4 expenses claims were received through the system.

As a further means of reporting scheme findings to volunteers and receiving feedback, we have organised a PoMS volunteer webinar for late March 2020. This will be open to anyone, including current and potential volunteers, and include talks from team members and a current 1 km square volunteer, and discussion on progress and potential improvements, using the on-line question/chat facility to conduct a moderated Q&A. A recording of the webinar will be made available afterwards.
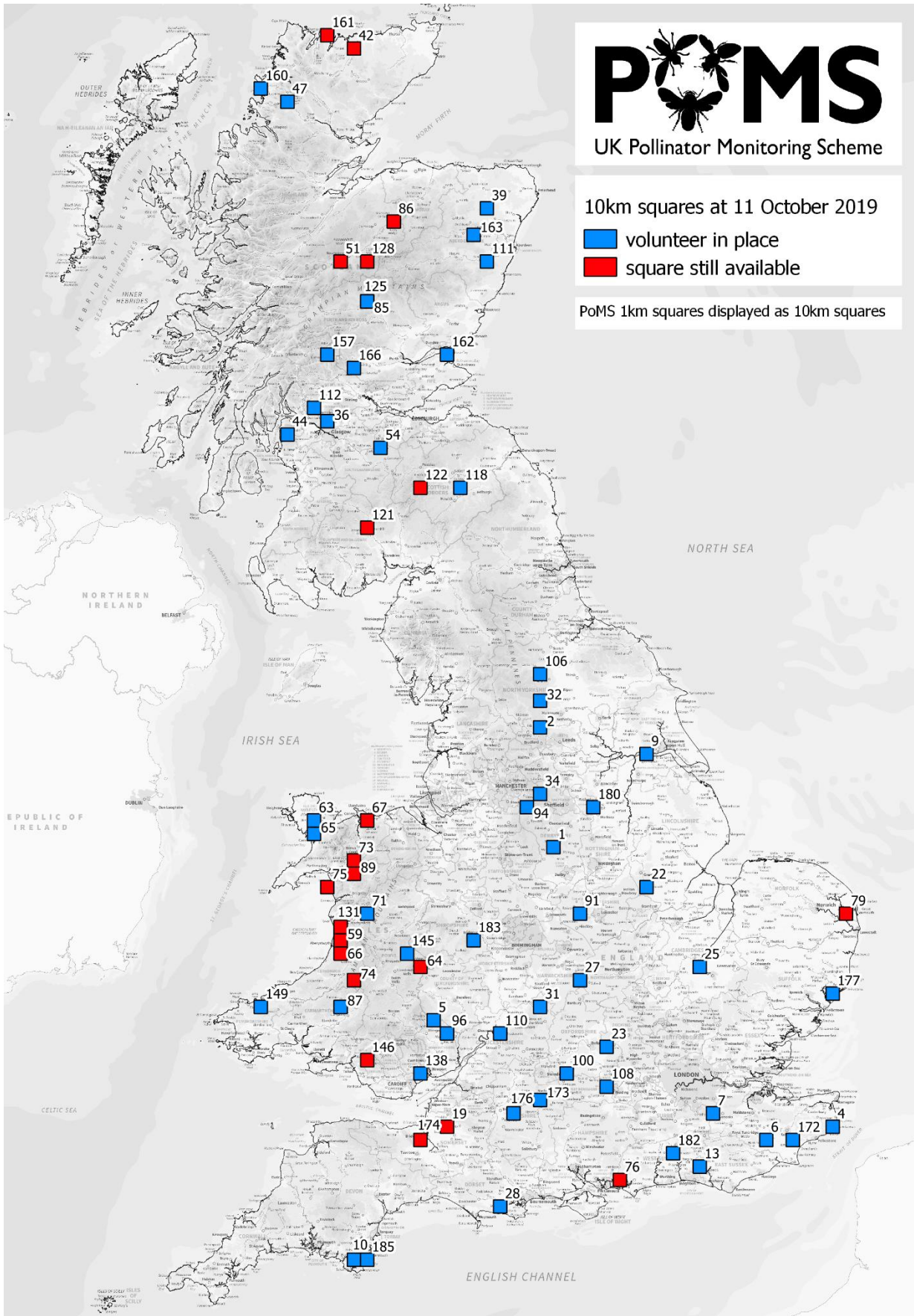
Figure 5. Allocation of PoMS 1 km squares to volunteers, showing position in October 2019.

Note that squares 128 and 162 have been added to the network in Scotland from 2019 to replace lost squares.

Task 4: Data management, integration and modelling

Data from the public FIT Counts and all data from the 1 km square surveys is being stored securely in the Indicia data warehouse at UKCEH. Data is entered by volunteer recorders and UKCEH 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 1 km 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 and the NBN Atlas following full verification, for contribution to the wider pool of pollinator occurrence data. Verified species data will be shared at the 1 km square resolution with the relevant landowners and current volunteers for each square, as a means of providing feedback, before the start of the 2020 survey season.

Full systematic datasets from the 2017 and 2018 surveys are being finalised and metadata prepared for publication under Open Government Licence (and in anonymised form) with the NERC Environmental Information Data Centre.

Under Task 4.2 we are working towards improving the occupancy and integrated models of the Hoverfly Recording Scheme (biological records) and PoMS (systematic survey records) data. At the time of this report we are running the models for all 62 hoverfly species present in both datasets for 2017, although this has remained challenging to implement. We have increased the number of iterations from 200000 to 400000 and are identifying and excluding HRS records with incorrect dates from the models. We expect this to improve the convergence of the models and the precision of the model estimates. Following the hoverflies from 2017 datasets, we plan to run the same integrated model analyses on bee species records from the BWARS database and PoMS pan traps, and on bumblebees specifically from BeeWalk transects for which multiple years' data are now available.

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 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 in 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.

During 2019, new research and stakeholder collaborations have materialised, addressing two of the themes that were considered not currently covered by PoMS: a) incorporation of molecular barcoding techniques and b) exploring more from observational FIT counts, here across a wider geographical reach.

a) <u>Award from the Defra DNA Centre of Excellence for novel DNA barcoding work on PoMS samples</u>

A proposal to develop DNA barcoding approaches for individual bee and hoverfly specimens, pollen carried on sampled insects or suspended in the storage ethanol and whole 'bulk' samples of by-catch material from the PoMS pan traps was developed. This has secured funding until March 2021 and enabled the Natural History Museum to join the Pollinator Monitoring and Research Partnership.

This research project will involve 3 stages:

- Testing three different approaches for sampling pollen DNA from pan trap-derived samples: a) from the surface/ body hairs of the specimen (bees/ syrphids individually tubed in ethanol after sorting in the lab); b) from the gut or nectar crop of the insect (specimens as in a) or c) from the preservative ethanol in which samples are initially stored before lab sorting to pull out the different groups (this ethanol was tubed and archived from all 2018 PoMS samples with this 'eDNA' in mind). New

protocols will be developed to allow for the analysis of pollen types and associations with plant species at the sampled sites.

- Individual and whole-community DNA-based identification for a) individual bees and hoverflies from across all PoMS sites (metabarcoding will target the pollinator specimen, parasites and pathogens and pollen traces on each one) and b) by-catch samples, by metabarcoding of by-catch from the same traps as in a). This will enable the build-up of an extensive barcode library and baseline of insects, parasites and plants for monitoring biotic change.
- Analysis of interaction networks and community composition from the samples in 2, to identify important food sources for pollinators and map the spatial distribution of plant-pollinator-parasite associations.

The work will use a subset of PoMS samples from 2018 and in some cases will be semi-destructive of these, but all DNA extracts will be kept and archived.

b) <u>FIT Counts conducted in Ireland, Jersey, Cyprus and Chile</u>

The FIT Count survey has now been trialled or adopted in several countries as a means of engaging members of the public in pollinator monitoring and conservation, and generating systematic data on pollinator numbers. In all cases, PoMS team members have shared protocols and best practice to ensure standardisation between schemes (although each of these additional schemes is independently funded). This has included:

- A FIT Count pilot across Ireland which is set to continue into 2019 as part of the All-Ireland Pollinator Plan (https://pollinators.ie/record-pollinators/fit-count-progress/)

- FIT Counts conducted on Jersey as part of a student placement supported EarthWatch Europe and subsequent MSc thesis comparing patterns of flower visitation in Jersey and the UK. This collaboration with the Jersey Biodiversity Centre has resulted in a plan to take forward FIT Counts Island-wide in Jersey as part of the Channel Islands Pollinator Project.

- FIT Counts conducted on Cyprus as part of 'PoMSKy' within the Darwin Initiative 'Ris-Ky' project, using FIT Count observations to track invasive plants and insects as well as collect data on flower visitor numbers. Educational resources have been produced, including for schools with a modified 5 minute 'mini-PoMS' count and see their how-to video here https://youtu.be/neKZn5q53cs

- FIT Counts conducted in Chile as part of a pilot with the schools EXPLORA project, under the NERC-funded SURPASS project led by UKCEH.

Publications and Communications activity

The PMRP and PoMS have been presented or communicated through various channels since May 2019, 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 3.

Together, these 70+ engagement activities have reached an **estimated audience of more than 370,000 people**. This total does not include, for example, webpage views (see below) or regular Twitter updates via the PoMS account which now has nearly 1,320 followers.

<u>Webpage and Social media activity</u>

The PoMS webpage is consistently the 'most viewed' project page on the UKCEH website and is one of the top-performing pages on the UKCEH website overall.

Since May 2019, the PoMS webpage has received more than 8,000 page views (7,000 unique views), with days of significant activity being apparent around Bees Needs' Week in July, and other large events in June and July.

Further plans for PoMS communications

A PoMS newsletter is planned for early March 2020, 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 updates on other wider activities.

Type of engagement activity	Number of events/ articles	Approx. audience reached
Article in print	3	1700
Article online	9	174,982
Email to team	4	400
Major Twitter/FB activity	5	200,000+
Media radio or TV	2	1,300+
Meeting attended/ talk	14	600
Public event/ festival	8	630+
Training event	21	300
Volunteer activity day	1	14

Table 3. Summary of communication and engagement activities at which PoMS has been promoted since May 2019.

Acknowledgements