

Bio4Ag Toolbox Indicators: pollinators

Background

Many pollinator species are in decline due to arable intensification, habitat loss and fragmentation. The abundance and diversity of pollinators is critical to ecosystem functioning, crop productivity, farm income and consumer access to nutritious food. Declining insect pollinator numbers results in disrupted plant-pollinator networks and lower pollination rates, seriously affecting the productivity of insect-pollinated crops: the annual global economic value of insect pollination is estimated at \$153 billion. Pollinator diversity is also crucial for the survival of native plant species, particularly rare and declining species. Rare plants share pollinators with more common plant species, the latter providing insects with a continuity of nectar and pollen resources over the season. The arable cropped area, largely mono-cropped with little or no understorey flora, makes up ca. 20% of the total UK land area and therefore represents a massive, currently underutilised, opportunity for reversing the declines in flowering plants and the pollinating insects upon which they depend.



Integrated cropping strategies

At the Centre for Sustainable Cropping, we aim to design a cropping system that can maintain yields with less reliance on agrochemical inputs by promoting soil health and arable biodiversity. As part of this integrated strategy, management options to enhance the diversity and abundance of insect pollinators focus on three main targets. First, field margins are sown with a diverse wildflower mix to provide continuity and diversity of resources for a wide range of different pollinator groups during periods of cultivation when the in-field area is disturbed. These margins are multifunctional, providing, in addition to pollinator resources, buffers alongside water courses and semi-natural habitats to reduce agrochemical pollution and retain nutrients within the field boundaries. Second, targeted in-field weed management aims to maintain a presence of broad leaved, beneficial weed species at around 10% ground cover. This is sufficient to attract pollinators into the cropped area of fields and provide additional resources from a wider range of broadleaved plant species while remaining below crop competition thresholds. Finally, IPM strategies including biofortification, pest and disease forecasting and threshold monitoring minimise reliance on crop protection chemicals and reduce the risk of unintended consequences of pesticides for beneficial insects.



Results from the CSC

Pollinator insects were sampled using 9 sets of 3 coloured pan traps within the cropped area of each field half (integrated and conventional management) across 6 crops in June 2017, 2018, 2020, 2021, 2023 and 2024. Most of the pollinators sampled were honeybees (525 specimens), followed by bumblebees (344 specimens) with solitary bees occurring less frequently (52 specimens). Overall, numbers were significantly greater in the integrated cropping systems than in conventionally managed crops ($p = 0.003$) with the largest differences occurring in winter oilseed and spring barley where integrated management had a large impact on in-field weed abundance. Kendal rank correlation coefficient showed significant positive association between pollinator number and weed density (dicot weeds $p = 0.002$, species richness $p < 0.001$) across crops and treatments.

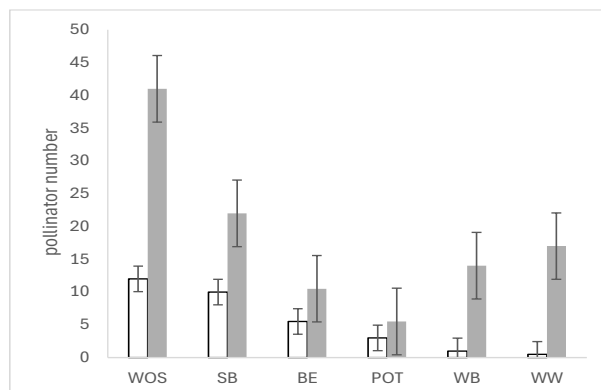


Figure 1. Mean number (and SE) of pollinating insects sampled in June (2017-2024) in integrated (open) and conventional (shaded) crop systems across the six crops (WOS winter oilseed rape, SB spring barley, BE beans, POT potato, WB winter barley and WW winter wheat). Kruskal-Wallis $H = 8.8$, $p = 0.003$, on mean overall rank of 29.2 (conventional) and 43.8 (integrated).

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How to measure pollinators: sampling strategies

Insect pollinators include a wide range of taxonomic and functional groups including Diptera (especially hoverflies), Hymenoptera (honeybees, bumblebees and solitary bees), Lepidoptera (butterflies and moths) and Coleoptera (pollen beetles). Due to their long co-evolutionary history, this broad diversity is reflected in a similar range of form and function in the plant floral resources that they feed on. However, this presents a challenge for accurate monitoring. All insect sampling methods are biased towards certain groups over others, depending on how well the method matches the insect's life-history strategy, activity pattern and foraging technique.

The following describes two simple strategies, that can provide reasonably cost-effective and representative data to show relative differences in pollinator diversity across habitats:

1. Transects walks: non-destructive surveys, giving opportunity for additional information on which plant species are foraged.
2. Pan traps: destructive sampling but providing a broader picture of flying insect communities active in a habitat.

Transect walks

Equipment: Record sheet and ID guides. Recommended:

<https://www.bumblebeeconservation.org/bumblebee-species-guide/>

<https://butterfly-conservation.org/butterflies/identify-a-butterfly>

Timing: Monthly, if possible, between May and August, depending on weather conditions.

Location: Two field margins and two tramlines into the cropped area of each field to be surveyed.

Sampling procedure:

1. Carry out surveys between 10:00 and 16:00 when the temperature is above 13°C with at least 60% clear sky and above 17°C in any sky conditions, apart from heavy rain and strong wind.
2. At each field, record date, time, weather conditions and crop growth stage.
3. Start a minimum of 10m along the field margin from a corner or gateway.
4. Walk slowly along the field margin for 100m aiming to cover the transect distance in about 5 minutes.
5. As you walk the transect, record all bees (bumble bee colour types, honeybees, solitary bees) and butterflies (species) that are actively foraging or resting on plants within 2m of the crop edge into the field margin. Don't record individuals that are just flying past.
6. Repeat for the same distance and time, walking along a tramline perpendicular to the surveyed margin into the cropped area of the field.
7. Repeat steps 4-6 for the field margin/crop area on the opposite side of the field.

Bumblebees



Large, furry bees; mainly black with yellow banding; often with white, buff or red tail.

Honeybees



Slender with furry thorax but otherwise smooth; brownish with stripey abdomen.

Solitary bees



Small and highly variable in furriness, stripiness and colour; if it's not a bumble or honeybee, but is definitely a bee, it is probably one of these!

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How to measure pollinators: pan trapping

Equipment for set-up:

9 sets of 3 pan-traps: 20 cm diameter plastic bowls painted with UV reflective paint (white, UV blue, and UV yellow); 27 stakes/pan trap stands, with attachment for the 3 bowls, set at a height level with crop canopy flowering height; 100ml per trap of dilute Teepol® detergent (1 cap to 5 L of water)



Examples of pan-trap sets composed of three bowls placed on their support. Different materials can be used: a plastic tray and an iron bar (pan-trap set on the left image), metal straps and a cane (middle image), a wood support and stake (right image). The height of the bowls must be equal or slightly higher than the average vegetation height.

Equipment for collection:

27x 20cm squares of muslin, tea strainer/sieve, paint brush, plastic pot to drain water into, 27 ziplock plastic bags labelled with field and location.

Timing: Twice a year depending on weather conditions – spring (May) and summer (June/July).

Weather conditions for sampling:

- relatively sunny day (no more than 75% of cloud cover)
- a minimum temperature of 13°C if the sky is clear (less than 50% cloud)
- a minimum temperature of 15°C if the sky is cloudy (cloud cover more than 50%, but not more than 75%)
- wind speed under 5 on the Beaufort scale

Location: Set traps at 9 locations in each field: 3 sets of the three coloured dishes, spaced equidistantly along 3 tramlines into the field.

Sampling procedure:

1. At each field, record date, time, weather conditions and crop type and growth stage.
2. At each of the locations, install the pan trap stand at crop canopy height, with one bowl of each colour, white, blue and yellow.
3. Fill each bowl with teepol solution (approx. 100 ml).
4. Set all traps by 10am and leave until 4 pm before collecting them in.
5. From 4pm, record the collection time for each field, and collect samples as follows:
 - a) Place muslin square into sieve and place sieve over collecting pot. Pour samples from all three bowls through sieve, emptying out excess water as necessary.
 - b) Ensure that all insects from each bowl are in the muslin and use the brush to pick out any remaining specimens.
 - c) Fold muslin gently in half and place in the labelled Ziploc bag, seal.
 - d) On return to the lab, place all samples in a -20°C freezer until processing

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Pan trap sorting and identification

1. Take sample bags from the freezer and leave to defrost at room temperature for an hour
2. For each sample, remove the muslin square from the bag and open on a white tray.
3. With a pair of forceps, pick out all specimens and group by taxa in separate shallow dishes containing a thin covering of 70% ethanol.
4. Count and record the number of individuals in each taxa.
5. Place specimens in a sample tube willed with ethanol diluted with water to 70%,
6. Label each tube with the date, field name and sample ID.
7. Ensure lids are tight and store tubes somewhere cool for future reference.

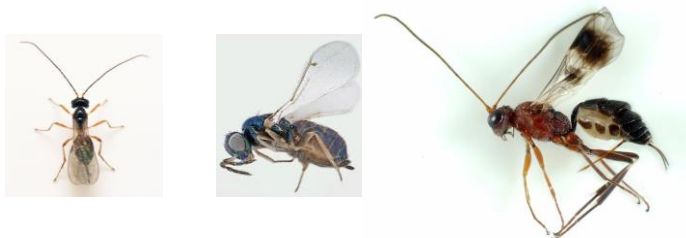
Identification

Level of taxonomic identification will depend on available expertise and specific purpose of the survey. Here's a useful guide for beginners: <https://www.nhm.ac.uk/content/dam/nhmwww/take-part/identify-nature/beginners-uk-invertebrate-id-guide.pdf>

At a simple level, try to record the following the number of insects in each of the following groups –

Parasitic wasps (Hymenoptera, Apocrita)

Tiny to medium sized wasps with a narrow waist and two pairs of wings, long antennae



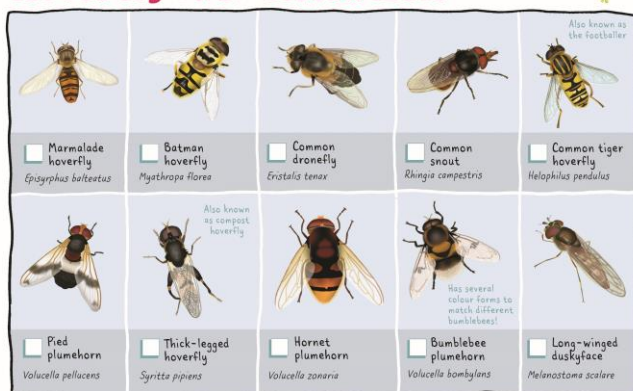
Diptera (Hoverflies)

Single pair of wings with a vein that runs around the outer edge, no waist, short antennae. Variable in colour and size but can be stripey or bee mimics. www.wildaboutgardens.org.uk

Bees divided into
Bumblebees
Solitary bees
Honeybees



Hoverfly identification



www.wildaboutgardens.org.uk

Hoverflies can be difficult to identify. This is a rough guide to some common species.

Useful links

- <https://csc.hutton.ac.uk>
- https://csc.hutton.ac.uk/resource/Handbook_of_indicators_v1.pdf
- Natural history museum invert ID guides: <https://www.nhm.ac.uk/content/dam/nhmwww/take-part/identify-nature/beginners-uk-invertebrate-id-guide.pdf>
- UK pollinator monitoring scheme background information: <https://ukpoms.org.uk/>
- UK pollinator monitoring scheme, Flower Insect Timed (FIT) counts <https://ukpoms.org.uk/fit-counts>
- CEH pollinator monitoring guide [New guide to monitoring pollinators in your community | UK Centre for Ecology & Hydrology](#)
- Bumblebee conservation trust, Bee identification guide [Identifying Bumblebees - Bumblebee Conservation Trust Bumblebee identification tips](#)
- Butterfly ID guides: <https://butterfly-conservation.org/butterflies/identify-a-butterfly>