CONFERENCE OF COLLEGES
SUSTAINABILITY WORKING GROUP

BIODIVERSITY AUDIT RESULTS

NOVEMBER 2022

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Front cover images: (Top) Tree measuring at Somerville College. Photo credit: Jack Evans
(Bottom) Orchids at Christ Church. Photo credit: Malcolm McCulloch

Background

Participating colleges[1] took part in this biodiversity audit pilot during Trinity Term 2022. Building on existing citizen science methodologies baseline data was collected on different land cover types, trees, birds, insects and earthworms. The methodologies are designed to be repeated so that in subsequent years the metrics can be re-measured to help indicate trends.

This report provides a detailed dashboard of your college results, which can serve as your biodiversity baseline. Your college may next decide to set targets against this data, for example in bringing about a % increase in overall biodiversity or one feature (e.g. insects/birds) sometimes referred to a net biodiversity gain. There are many actions your college may wish to undertake in order to enhance biodiversity including, for example, those outlined in the CEH Biodiversity toolkit. Suggestions in here include planting wildflowers, hedgerows, native trees and shrubs; reduced mowing, reduced hedgerow cutting and retaining some scrub to create a mosaic of different habitats even in small spaces; creating structures for insects to shelter in during winter, as well as bee nesting sites, hedgehog 'houses' and 'highways', ponds and rain gardens; installing bat and bird boxes, compost bins and water butts; and reduced use of herbicides and pesticides.

Acknowledgements

Thanks to all participating staff and students who volunteered to complete the college audits. With particular thanks to the following individuals for their time and support in developing the methodologies, producing resources and completing analysis of the data: Dr Jonathan Green, Keiran Storer and Professor Tim Barraclough of the Department of Zoology, Katey Fisher, Amelia Jeffery, Abigail Barker and Tom Badenhorst from NatCap Research Ltd.

[1] 8 colleges took part in the 2022 audit. Not all colleges were able to complete all elements of the audit.

Estimated Biodiversity Assets: Somerville College

Main Site and Sportsground

Asset	2022 Data	2021 Data	Unit
Total site area	2.21	2.21	ha*
Carbon storage			
Estimated total carbon stored in vegetation	20.36	20.90	tonnes
Land cover			
Area of trees	0.09	0.18	ha
Area of mowed lawn	0.44	0.43	ha
Area of wetlands and water meadows	0.00	0.00	ha
Area of herbaceous borders and flower beds	0.14	0.01	ha
Area of meadow and uncut grass	0.04	0.01	ha
Area of water	0.00	0.00	ha
Other	1.49	1.58	ha
Trees			
Total trees recorded	98	87	count
Species richness	40	35	No. of species
Birds			
Total abundance	54	52	count
Species richness	20	12	No. of species
RSPB Birds of Conservation Concern: Red	2	1	No. of species
RSPB Birds of Conservation Concern: Amber	6	2	No. of species
RSPB Birds of Conservation Concern: Green	12	8	No. of species
Earthworms			
Soil-feeding	2	1	No. of worms
Deep-living	0	0	No. of worms
Surface-feeding	3	1	No. of worms
Insects			
Total abundance	684	469	count
Flies - *Diptera*	237	332	count
Beetles (including ladybirds and weevils) - *Coleoptera*	41	64	count
Hymenoptera (including ants, bees and wasps) - *Hymenoptera*	215	181	count

*1 hectare (ha) = 2.47 acres

Landcover:

As indicated in Figures 1 the majority of landcover on the Somerville College sites is composed of mowed lawn, herbaceous borders and flower beds. As outlined in table 1 there has been an increase in the area of herbaceous borders and flower beds at the Somerville site since 2021, and a reduction in the number of trees.

	2022	2021
Landcover	Area (ha)	Area (ha)
Trees	0.09	0.18
Mowed lawn	0.44	0.43
Wetlands and water meadows	0.00	0.00
Herbaceous borders and flower beds	0.14	0.01
Meadow and uncut grass	0.04	0.01
Water	0.00	0.00
Other	1.49	1.58
Total	2.21	2.21

Table 1. Asset register of estimated land cover types across Somerville main site

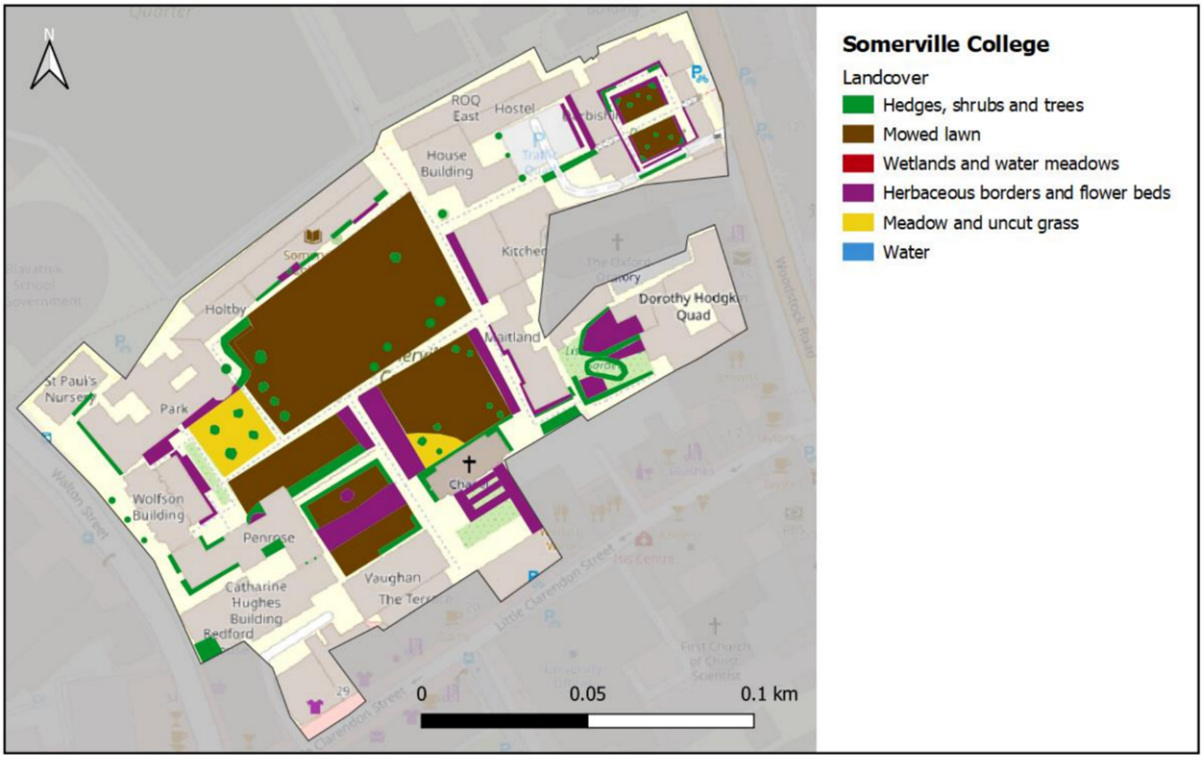

Figure 1. Land cover map – Somerville main site

Carbon storage:

The estimated amount of accumulated carbon (tonnes) that is stored in vegetation biomass (trunk, branches, leaves and roots) on the Somerville site is detailed in Table 2. These results indicate that the trees on the site currently store the greatest amount of carbon (in trunk, branches, leaves and roots).

	Carbon Stocks		
Landcover	Area (ha)	Total (tonnes of carbon)	% of total
Trees[2]	0.09	19.60	96.26
Mowed lawn	0.44	0.44	1.00
Wetlands and water meadows	0.00	-	-
Herbaceous borders and flower beds	0.14	0.28	2.00
Meadow and uncut grass	0.04	0.04	1.00
Water	0.00	-	-
Total	0.72	20.36	100

Table 2. Register of carbon stored in vegetation – Somerville College

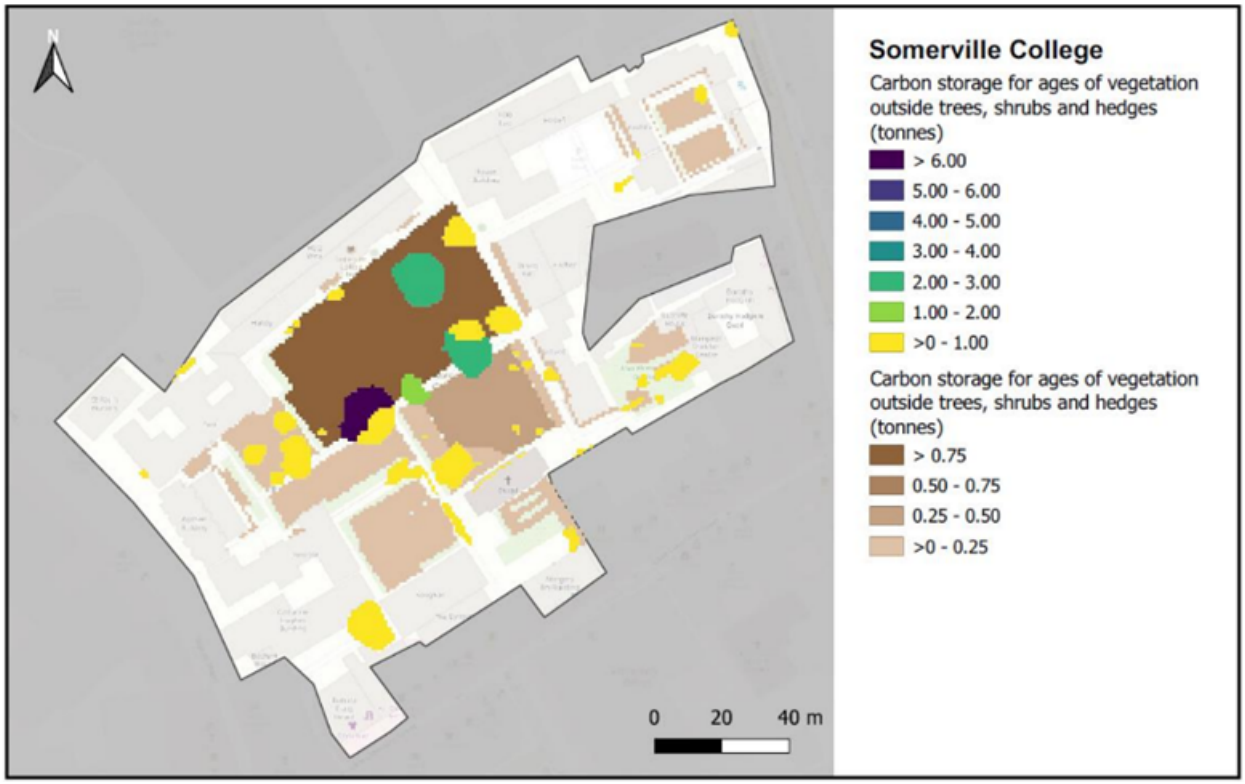

Figure 2. Map indicating the spatial distribution of carbon stored by the different landcover types on the Somerville main site

[2] Please note that the tree carbon storage values have been calculated based on the trees that were measured and reported in your college tree survey. Where surveys were incomplete, reported carbon will be less than the true storage.

Carbon sequestration:

The estimated amount of carbon (tC/yr) being drawn down from the atmosphere by the vegetation each year and stored as woody biomass at the Somerville main site is detailed in Figure 3. Trees on the main site account for all of the annual drawn-down.

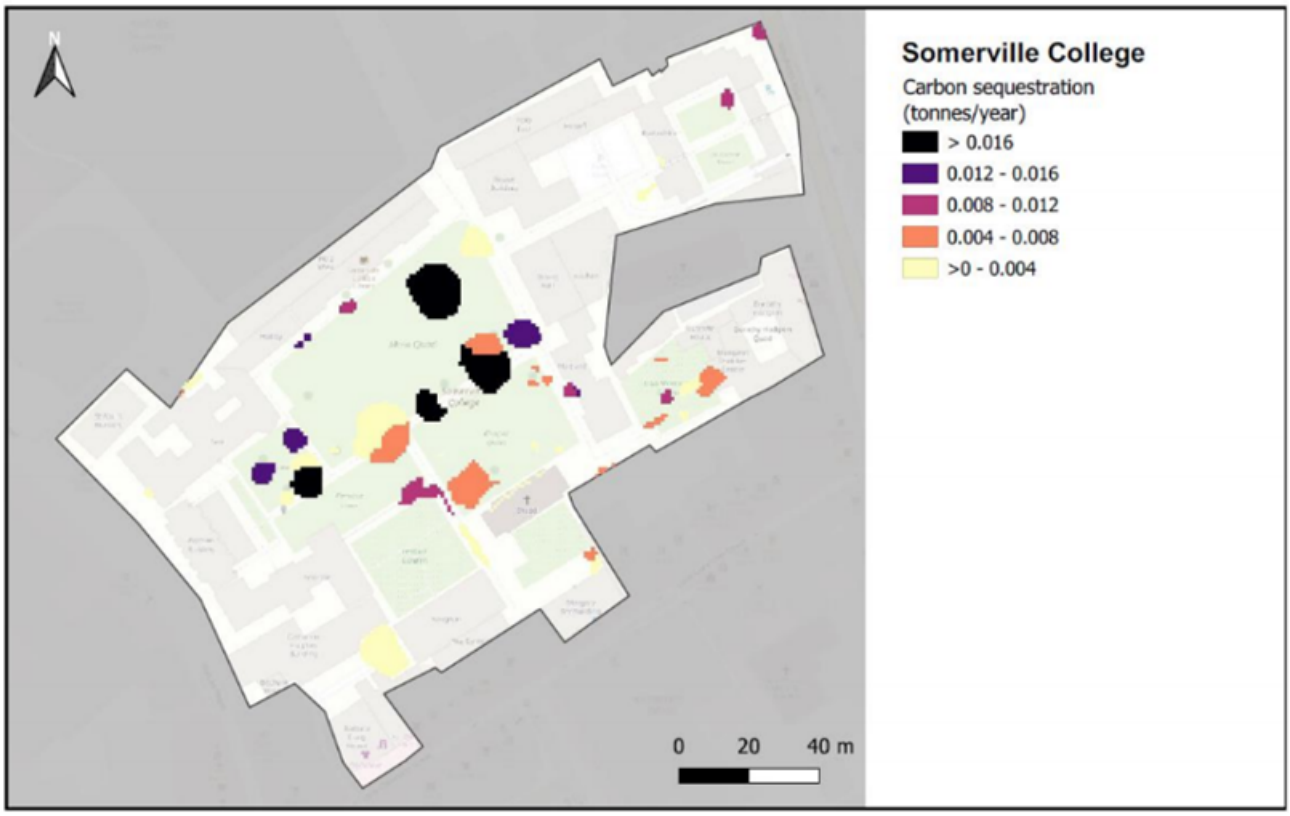

Figure 3. Map indicating the spatial distribution of carbon sequestered (tC/yr) by the different landcover types across the Main site

Insects:

Sampling took place in June-July 2022 at 24 sites across 8 colleges (2-4 sites per college). The selected sites encompassed a range of habitats, including flower beds, meadows, allotments and sports grounds. The pan traps that were used specifically target insects that visit flowers: some may visit flowers for nectar, while others may eat other parts of the plant (e.g. leaves, pollen). A total of 7801 insects were sampled across all sites. In the Somerville survey, pan traps were placed at two locations in the main site as follows:

Site (what3words location)	**Pan traps used**
cars.tribal.copy	blue, white, yellow
hoot.famed.speaks	blue, white, yellow

	Abundance 2022	**Abundance 2021**
Total number of insects*	684	469
Rank among colleges (1-8)	4th	
Coleoptera (Beetles)		
Ladybirds	0	0
Weevils	5	40
Other beetles	36	24
Diptera (Flies)		
Hoverflies	3	3
Other flies	234	329
Hymenoptera (bees, wasps)		
Pollinating bees and wasps	37	121
Parasitoid wasps	178	60

Table 3. Abundance and categories of insects obtained from the insect traps on the Somerville site.
*** NB. This total includes counts of other insects besides the ones shown in the table.**

The Somerville sampling sites in 2022 were the same as those used in 2021. A higher abundance of insects were identified this year, but there was a decrease in the number of pollinating bees and wasps. Some variation is likely to reflect differences in weather over the sampling periods. As indicated in Table 3, in total 684 insects were collected from the pan traps in 2022 with the majority comprising flies and parasitoid wasps.

The flies comprised a large number of species, including species that feed on carrion, plants, fungi and other insects. Parasitoid wasps parasitise other insects and spiders: the mother lays an egg inside a host, and the developing offspring consumes the internal organs of the host while it is still alive. Most parasitoids are specific to a single host species: large numbers of parasitoids at a site therefore indicate a high diversity of other insects, and spiders. By regulating host populations, many parasitoid wasps play an important role in pest control. The flies identified at the site comprised a large number of species, including those that feed on carrion, plants, fungi and other insects. For further interpretation of these results, please read the supplementary material at end of the document.

In addition to data on abundance for specific groups, the overall abundance of insects is given together with a college ranking. This ranking corrects for the fact that colleges varied in the number of sites that were sampled, as well as the number of traps. However, the ranking is designed to give only a

very rough indication of differences in insect abundance across colleges and there are important caveats. For instance, totals for certain colleges may be strongly driven by abundance at a single site, or else might be associated with specific habitat features (for example, where sampling occurred on short grass (i.e. on sports pitches) or else near to water (ponds or streams), this tended to yield high numbers of flies).

Birds:

The audit of birds (song and visual identification) took place across the Somerville main site as detailed in table 4.

DAY 1	
Site	Somerville Main site
Location of survey (what3words reference):	torn.sounds.crib (Fellows garden) most.exile.raved (Main Quad) civil.clocks.field (Main Quad)
Date of survey:	26 July 2022
Time of survey (from- until):	04:30-06:00
DAY 2	
Site	Somerville Main site
Location of survey (what3words reference):	torn.sounds.crib (Penrose lawn) most.exile.raved (Main Quad) blues.granged.grin (Chapel Quad) runs.tribe.kinds (Lisa Monoprio Garden)
Date of survey:	29 July 2022
Time of survey (from- until):	05:30-06:30

Table 4. Bird survey times and locations at the Somerville site

Approximately every six year the Royal Society for the Protection of Birds (RSPB) publish a report on *Birds of Conservation Concern* in coalition with the UK's leading bird conservation and monitoring organisations, which reviews the status of all regularly occurring birds in the UK, Channel Islands and Isle of Man. Each type of bird is assessed and put on the Green, Amber or Red List depending on the level of concern. The latest version (BoCC5) was published in 2021[3], and results from the college bird survey have been compared to these lists.

- Red – birds on the red list are in most urgent need of conservation. It includes some rare birds such as hen harriers and capercaillie, but also familiar birds like house sparrows and starlings, which have suffered significant declines.
- Amber – the Amber list highlights birds whose conservation status is of moderate concern. In the latest report, the Amber list increased from 96 to 103 species. This is because they either showed an improvement in status and moved off the Red list, or showed a deterioration in numbers, moving from Green to Amber.
- Green – These are the birds which are not showing moderate or severe declines and do not fit into either of the categories above.

As summarised in table 5 a total of 20 bird species were identified during the Somerville survey – eight more species than were identified in the 2021 survey. The 2021 survey was carried out approximately one month earlier in the summer (24 and 29 June) than the 2022 survey which may have impacted the results.

[3] The complete Birds of conservation concern (BoCC 5) can be viewed on the RSPB summary leaflet or in the full article published in British Birds at: https://britishbirds.co.uk/sites/default/files/BB_Dec21-BoCC5-IUCN2.pdf

	survey results 2022	survey results 2021
Total number of species identified	20	12
Red	2	1
Amber	6	2
Green	12	8

Table 5. Comparison of bird species identified at Somerville College 2021 - 2022

Species	Count	RSPB Birds of Conservation Concern Status
Carrion Crow	1	Green
Common Chiffchaff	2	Green
Common Wood-Pidgeon	8	Amber
Eurasian Blackbird	6	Green
Eurasian Blue Tit	3	Green
Eurasian Bullfinch	1	Amber
Eurasian Collared-Dove	4	Green
Eurasian Jackdaw	4	Green
Eurasian Magpie	6	Green
Eurasian Wren	1	Amber
European Robin	1	Green
European Starling	1	Red
Goldcrest	1	Green
Great tit	2	Green
House sparrow	1	Red
Lesser Black-backed Gull	4	Amber
Rock Pigeon	1	Green
Rook	1	Amber
White Wagtail	2	Green
Yellow-legged Gull	4	Amber
Grand Total	**54**	

Table 6. Summary of bird species identified at Somerville College 2022

Earthworms

Seven colleges completed earthworm surveys across ten sites. Table 7 details the locations of the Somerville survey. The same locations were used for both the 2021 and 2022 surveys.

College and site:	Somerville, Main Site
Date of survey:	26 July 2022
Location of soil pit 1 (what3words reference)	civil.clocks.fields
Location of soil pit 2	slices.homes.resort

Table 7. Earthworm survey times and locations – Somerville College

Earthworms maintain soil quality, increasing soil fertility and carbon storage ability by mixing in dead plant material, air and water. The earthworms were categorized into three categories:

Soil feeding (*endogeic*) – These live and feed in the top 20cm of soil, rarely coming to the surface. They make horizontal burrows as they feed on the soil, which help mix air into the soil and improve drainage. There are eight species in the UK.

Surface feeding (*epigeic*)– These do not make burrows but live on or near the surface of the soil and eat dead leaves, breaking them down into compost. This decomposition of organic material at the soil surface increases nutrient transformation and helps to stimulate activity of microorganisms. This is the largest group of earthworms in the UK, with 12 species.

Deep living (*anecic*) – This type of earthworm makes deep vertical burrows into which they pull leaves to eat during the night, locking carbon into the soil. Their feeding activity modifies the soil structure through the creation of their vertical burrows and increases macro-porosities, aeration, and water infiltration into the deeper soil. There are only three species of deep-living earthworms in the UK.

Across all sites a total of 122 earthworms were identified with soil-feeding worms accounting for 63%, surface-feeding 36% and deep-living 1%. 22 soil pits were dug and examined across the colleges – no earthworms were found in 5 of the soil pits.

Five earthworms were identified at the Somerville sites (Table 8) – three more than in 2021. Unfortunately the survey results provide statistically insignificant variation to offer conclusive results. All of the worms were found in a soil pit dug in an area of vegetable bed with moist loam soil.

Type of Earthworm	**2022 Count**	**2021 Count**
Soil-feeding	2	1
Deep-living	0	0
Surface-feeding	3	1

Table 8. Quantity and type of earthworms identified at Somerville sites

Looking at the headline results across all ten sites, the highest abundance of worms were identified in areas of woodland (48%), followed by lawn (20%). Based on the results, earthworms prefer moist soils - three quarters of the worms identified were found in moist soils, and of these 80% were in loam soils. The fewest worms (three in total) were found in clay soils. It is worth noting that there was a heat wave during mid-July when several colleges were undertaking the earthworm survey, which will have impacted soil moisture and therefore the number of worms identified.

Supplementary Material

Methodologies employed:

Estimating carbon storage and sequestration

Colleges were provided with a set of landcover maps for their sites. Colleges identified six different categories of land cover (water; mowed lawn; meadow and uncut grass; wetlands and water meadows; herbaceous borders and flower-beds; hedges, shrubs and trees) which were recorded directly onto the maps using a simple colour code.

Tree species and circumference were measured as part of the survey conducted by members of the college community. Tree diameter was then calculated from tree circumference. Tree height was obtained for each measured tree using the National Tree Map. This data was then processed in i-Tree Eco, software that uses allometric equations from the scientific literature to predict carbon storage and sequestration. These values were then assigned to each respective tree in order to produce the final map outputs. Additional carbon stock values for non-woody vegetation were taken from 'Carbon Storage and Sequestration by Habitat 2021 (NERR094)'. The landcovers retrieved were modified grassland for mowed lawn, wetlands, nursey and horticulture for herbaceous borders and flower beds, lowland meadows for meadows and uncut grass, and standing open water and canals.

The tonnes of carbon per hectare and the landcover areas were used to calculate the tonnes of carbon for each landcover using QGIS.

Bird survey

Each college was provided with a map of random sample locations across their site, generated by ArcGIS based on the size of the site. Each college chose random sample locations to complete bird surveys at over three mornings. Locations of the survey were recorded using the what3words app. Participants used the BirdNET app to identify birds from their song and the Merlin Bird ID app to help identify species that were visible but not calling.

Worm survey

Each college was provided with a map of random sample locations across their site, generated by ArcGIS based on the size of the site. Earthworm surveys were completed at two of the random sample locations. Following the methodology of the 'Earthworm Watch' from the Natural History Museum and Earthwatch Institute, participants dug a 20x20cm square pit to 10cm deep at each sample location then counted and recorded earthworms and information about soil properties. At each site data was gathered from two soil pits with different areas of habitat e.g. flowerbed/lawn. The number of earthworms were recorded before and after mustard water was added to the soil; the mustard water encourages earthworms to the surface, helping to identify deep-living worms.

Insect survey

Sampling took place in June-July at 24 sites across 9 colleges (2-4 sites per college). The selected sites encompassed a range of habitats, including flower beds, meadows, allotments and sports grounds. The pan traps that were used specifically target insects that visit flowers: some may visit flowers for nectar, while others may eat other parts of the plant (e.g. leaves, pollen).

Headline Results (across all colleges)

A total of 7801 insects were sampled. By some distance, the greatest abundance of insects was recorded at *Wolfson College's* South Meadow.

The most abundant insects were flies (71% of all insects). Flies were sorted into hoverflies and other flies. Larvae of many hoverflies eat aphids and are important in pest control, while adults are important pollinators. The remaining flies comprised a large number of species, including species that feed on carrion, plants, fungi and other insects.

After flies, the next most abundant group was the bees and wasps (19% of all insects). Of these, 88% were parasitoid wasps, which parasitise other insects and spiders: the mother lays an egg inside a host, and the developing offspring consumes the internal organs of the host while it is still alive. Most parasitoids are specific to a single host species: large numbers of parasitoids at a site therefore indicate a high diversity of other insects, and spiders. By regulating host populations, many parasitoid wasps play an important role in pest control. Across all sites, the greatest numbers of parasitoids were found in *Wolfson College*'s South Meadow. The other main group were pollinating bees and wasps: across colleges, the greatest numbers were found at the main sites of *Somerville College* and *St Hilda's College*.

The third largest group was the beetles, totalling 4% of all insects. Among the beetles sampled were ladybirds, which prey on aphids and play an important role in pest control, together with weevils, leaf beetles and pollen beetles, all of which feed on plants.

In the breakdown of results for each college, abundances are given for these three groups (beetles, flies, and bees and wasps). However, small numbers of other groups were also recorded, including true bugs, damselflies, earwigs and moths and butterflies. In addition to data on abundance for specific groups, the overall abundance of insects for each college is given, together with a ranking for each college. This ranking corrects for the fact that colleges varied in the number of sites that were sampled, as well as the number of traps. However, the ranking is designed to give only a very rough indication of differences in insect abundance across colleges and there are important caveats. For instance, totals for certain colleges may be strongly driven by abundance at a single site, or else might be associated with specific habitat features (for example, where sampling occurred on short grass (i.e. on sports pitches) or else near to water (ponds or streams), this tended to yield high numbers of flies). Some variation across colleges is also likely to reflect differences in weather over the sampling period.

Finally, for those colleges that participated in the survey in 2021, abundances of insects sampled in the two years are compared. While this gives a very rough indication as to whether insect numbers have increased, decreased or remained constant, with differences in the precise sites sampled and substantial differences in weather between the two years (which strongly affects insect abundance and movement), some caution is required when comparing years.

References and further reading

Many of the methods that were followed have been used for academic research elsewhere. You can read further details in the following publications and websites:

Birds

BirdNET: A deep learning solution for avian diversity monitoring. Kahl *et al.,* 2021

Drivers of avian species richness and community structure in urban courtyard gardens, Biroli *et al.,* 2020. This is existing data on birds in Oxford colleges from an undergraduate project.

Earthworms

Soil health pilot study in England: Outcomes from an on-farm earthworm survey, Stroud, 2019

Earthworm Watch is a collaboration between Earthwatch Institute (Europe) and the Natural History Museum in London. Further information about the research behind their survey is available on the Earthworm Watch website.

Insects

Optimising coloured pan traps to survey flower visiting insects. Vrdoljak & Samways, 2012.

Measuring bee diversity in different European habitats and biogeographical regions, Westphal *et al.* 2008

Trees

i-Tree Tools for assessing and managing forests and community trees: Resources and Overview

Camden i-Tree Inventory Report