CONFERENCE OF COLLEGES
SUSTAINABILITY WORKING GROUP

BIODIVERSITY AUDIT RESULTS

NOVEMBER 2021

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Front cover images:

(Top) Earthworm count at Somerville College. Photo credit: Jack Evans

(Bottom) Tree measuring at St Edmund Hall. Photo credit: Alex Grant

Background

Participating colleges[1] took part in this biodiversity audit pilot during 9th and 10th week in Trinity Term 2021. Building on existing citizen science methodologies baseline data was collected on different land cover types, trees, birds, insects and earthworms. The methodologies were 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 and Professor Tim Barraclough of the Department of Zoology, Joel Footring, Katey Fisher, Amelia Jeffery, Abigail Barker and Tom Badenhorst from NatCap Research Ltd.

[1] 18 colleges took part in the pilot across 29 sites: Balliol, Kellogg, Lady Margaret Hall, Lincoln, Magdalen, Mansfield, Merton, New College, Somerville, St Anthony's, St Catherine's, St Edmund Hall, St Hilda's, St Hugh's, St John's, Trinity, University College and Wolfson. Not all colleges were able to complete all elements of the audit, often because staff and students were having to isolate due to of covid-19. 16 colleges completed each element of the pilot (land cover, birds, earthworms, insects and trees).

Estimated Biodiversity Assets: Wolfson College

Asset	**Quantity**	**Unit**
Total site area	14.27	ha*
Carbon storage		
Estimated total carbon stored in vegetation	434.20	tonnes
Land cover		
Area of trees	3.30	ha
Area of mowed lawn	1.38	ha
Area of wetlands and water meadows	0.28	ha
Area of herbaceous borders and flower beds	0.03	ha
Area of meadow and uncut grass	4.03	ha
Area of water	0.93	ha
Other	4.33	ha
Trees		
Total trees recorded	475	count
Species richness	128	No. of species
Birds		
Total abundance	74	count
Species richness	49	No. of species
RSPB Birds of Conservation Concern: Red	7	No. of species
RSPB Birds of Conservation Concern: Amber	8	No. of species
RSPB Birds of Conservation Concern: Green	27	No. of species
Earthworms		
Soil-feeding	22	No. of worms
Deep-living	0	No. of worms
Surface-feeding	4	No. of worms
Insects		
Total abundance	1,394	count
Flies - *Diptera*	1,008	count
Beetles (including ladybirds and weevils) - *Coleoptera*	132	count
Hymenoptera (including ants, bees and wasps) - *Hymenoptera*	730	count

*1 hectare (ha) = 2.47 acres

Land Cover:

As indicated in Fig. 1 the majority of landcover on the Wolfson College site is composed of meadow and uncut grass (in the Meads) and trees, with relatively few areas of herbaceous borders and/or flower beds.

Landcover	Area (ha)
Trees	3.30
Mowed lawn	1.38
Wetlands and water meadows	0.28
Herbaceous borders and flower beds	0.03
Meadow and uncut grass	4.03
Water	0.93
Other	4.33
Total	14.27

Table 1. Asset register of estimated land cover types

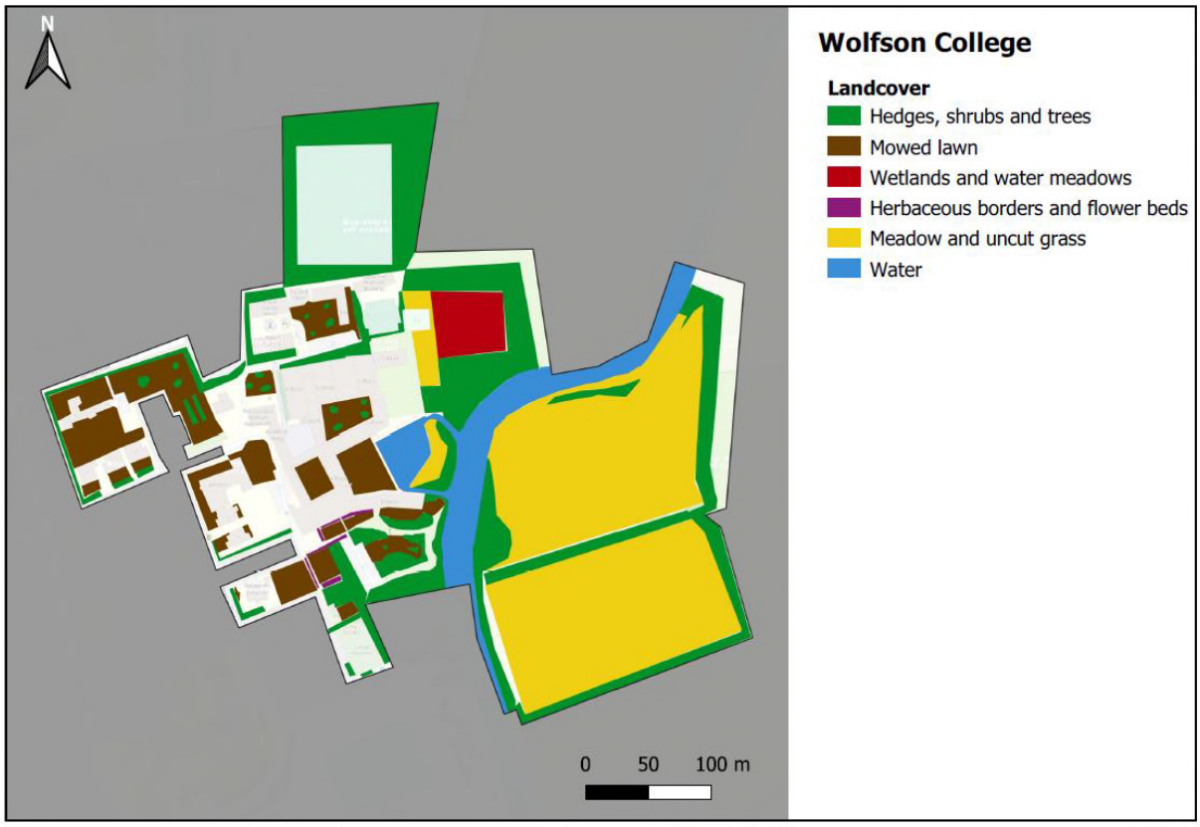

Figure 1. Land cover map.

Carbon storage:

The estimated amount of accumulated carbon (tonnes) that is stored in the different landcover types on the Wolfson 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]	3.30	428.18	98.61
Mowed lawn	1.38	1.38	0.32
Wetlands and water meadows	0.28	0.56	0.13
Herbaceous borders and flower beds	0.03	0.06	0.01
Meadow and uncut grass	4.03	4.03	0.93
Water	0.93	0.00	0.00
Total	9.94	434.20	

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

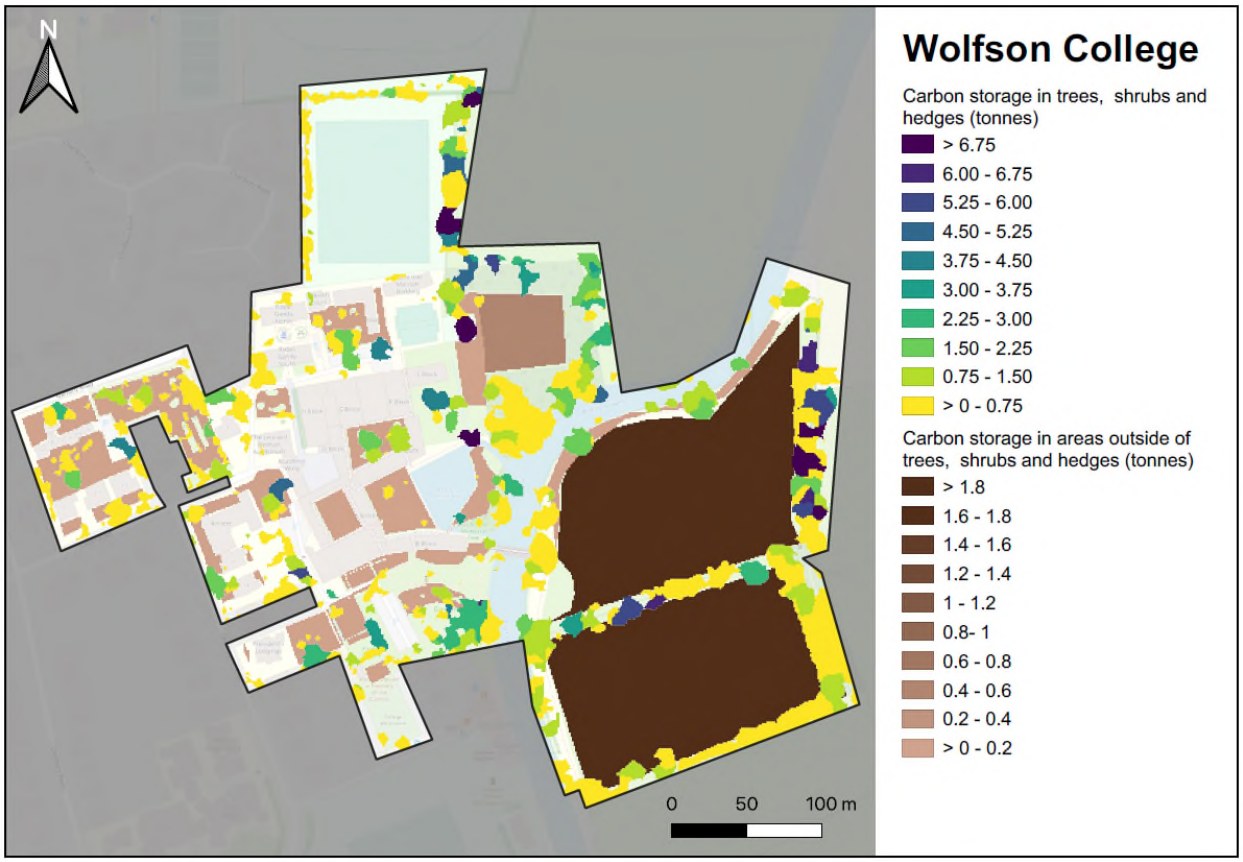

Figure 2. Map indicating the spatial distribution of carbon stored by the different landcover types on the Wolfson site.

[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 Wolfson college site is detailed in Figure 3. Similar to carbon storage, the greatest drawn-down each year is from the trees on the college site.

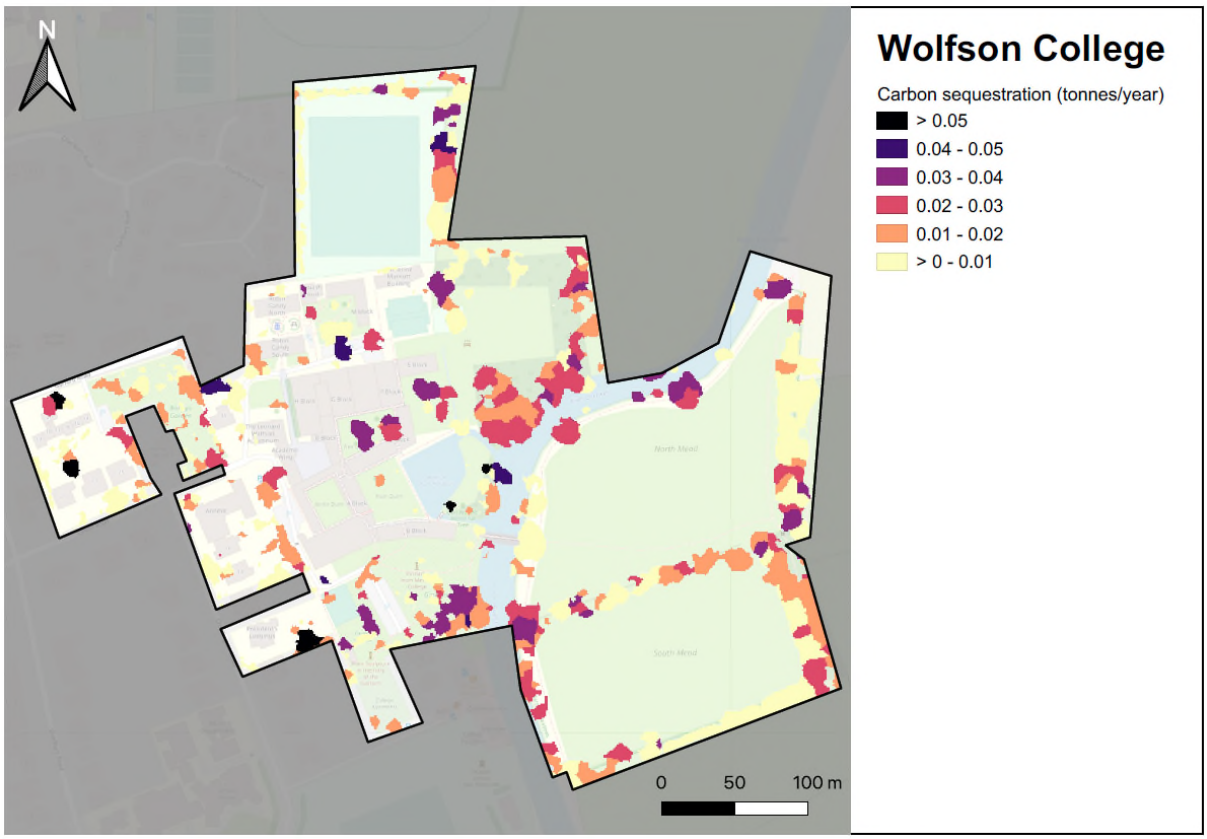

Figure 3. Map indicating the spatial distribution of carbon sequestered (tC/yr) by the different landcover types across the Wolfson site.

Insects:

In the Wolfson College insect audit, pan traps were placed at four sites in the grounds as follows:

Site (what3words)	Traps
jets.zoom.during	blue, yellow
slang.exit.effort	blue, yellow
chips.sage.person	blue, yellow
silks.pile.curve	blue, yellow

As indicated in Table 3, a total of 1,394 insects were collected from the pan traps with the majority comprising parasitoid wasps and flies. 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 with large numbers of parasitoids at a site usually indicating 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.

Of all the sites sampled, the allotments at Wolfson College were one of the richest for pollinating bees and wasps.

	Abundance
Total number of insects*	1,394
Rank among colleges (1-20)	3rd
Coleoptera (Beetles)	
Ladybirds	2
Weevils	3
Other beetles	127
Diptera (Flies)	
Hoverflies	22
Other flies	986
Hymenoptera (bees, wasps)	
Pollinating bees and wasps	77
Parasitoid wasps	153

Table 3. Abundance and categories of insects obtained from the insect traps on the Wolfson site.
*NB. This total includes counts of insects in categories not indicated in the table.

Birds:

The audit of birds (song and visual identification) on the Wolfson site was undertaken over three days as detailed in Table 4. 49 different bird species were identified (Table 5) of which 42 are of conservation concern – seven of these are of highest conservation concern. Of all colleges surveyed, Wolfson identified the fifth largest range of bird species.

DAY 1	
College and site:	Wolfson, Main Site
Location of survey (what3words reference):	rocks.moment.aware
Date of survey:	20th June 2021
Time of survey (from- until):	4.30-9.30am
DAY 2	
College and site:	Wolfson, Main Site
Location of survey (what3words reference):	love.fade.held
Date of survey:	19th June 2021
Time of survey (from- until):	4.30-6.00am
DAY 3	
College and site:	Wolfson, Meads
Location of survey (what3words reference):	gallons.whips.royal
Date of survey:	26th June 2021
Time of survey (from- until):	4.30 to 6.00am

Table 4. Bird survey times and locations – Wolfson College

Species	**Count**	**RSPB Birds of Conservation Concern Status**
Barn Swallow	1	
Barnacle Goose	1	Amber
Black Headed Gull	1	Amber
Blackbird	1	Green
Blackcap	1	Green
Blue Tit	2	Green
Canada Goose	10	
Carrion Crow	1	Green
Coal Tit	1	Green
Collared Dove	1	Green
Common Chaffinch	2	
Common Chiffchaff	3	Green
Coot	1	Green
Cuckoo	1	Red
Dumock	1	
Goldcrest	1	Green
Goldfinch	1	Green
Grasshopper Warbler	1	Red
Great Spotted Woodpecker	1	Green
Great Tit	1	Green
Green Woodpecker	1	Green
Grey Heron	2	Green

House Martin	1	Amber
House Sparrow	1	Red
Jackdaw	1	Green
Jay	2	Green
Kestrel	1	Amber
Kingfisher	1	Amber
Long Tailed Tit	2	Green
Magpie	2	Green
Mallard	3	Amber
Moorhen	3	Green
Mute Swan	2	Amber
Nuthatch	1	Green
Pied Wagtail	1	Green
Raven	1	Green
Red Kite	2	Green
Robin	1	Green
Rook	1	Green
Rose-Ringed Parakeet	2	
Skylark	1	Red
Song Thrush	1	Red
Starling	1	Red
Swift	1	Amber
Tree Creeper	1	
Whitethroat	1	Green
Wood Pigeon	2	Green
Wren	1	Green
Yellow Wagtail	1	Red
Grand Total	**74**	

Table 5. Summary of bird species[3]

[3] The complete RSPB list of birds of conservation concern can be viewed on the RSPB summary leaflet or in the full article published in British Birds at: http://britishbirds.co.uk/wp-content/uploads/2014/07/BoCC4.pdf

Earthworms:

17 colleges completed earthworm surveys across 26 sites. Locations of the Wolfson College surveys are outlined in Table 6.

College and site	Date and time of survey	Soil pit 1 (what3words location)	Soil pit 2 (what3words location)
Main Site, Bishop's Gardens	24th June 2021 - 2.30pm	digs.bolt.dimes	digs.bolt.dimes
Meads	24th June 2021 - 3.30pm	orders.facing.sweep	lamp.list.moment

Table 6. Earthworm survey times and locations – Wolfson 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 one of three categories:

Soil feeding (*endogeic*) earthworms – 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.

Deep living (*anecic*) earthworms – 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.

Surface feeding (epigeic) earthworms – 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.

Across all college sites a total of 356 earthworms were identified with soil-feeding worms accounting for 65%, surface-feeding 21% and deep-living 14%. No earthworms were found at 10 of the soil pits. The majority of earthworms found at the Wolfson sites were soil feeding (Table 7).

Location	Deep living	Soil Feeding	Surface Feeding
Bishop's Garden, Main site	0	15	0
Meads	0	7	2

Table 7. Earthworm results – Wolfson College

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 counts

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 across 9th and 10th week. 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.

Insect counts

Sampling took place in June-July at 58 sites across 20 colleges (2-6 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 18,078 insects were sampled. By some distance, the greatest abundance of insects was recorded at *University College's* Sports Grounds.

The most abundant insects were flies (>75% 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 (18% of all insects). Of these, >75% 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 Balliol College (Masters' Garden). The other main group were pollinating bees and wasps: across colleges, the greatest numbers were found in *Wolfson College* (allotments), *Somerville College* (Fellows' Garden) and *Exeter College* (Rector's Garden).

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, caddisflies, damselflies, earwigs and moths and butterflies.

In addition to abundance of different groups, the number of different species in each group was also recorded. However, these two measures were found to be very strongly correlated; for that reason, the results for each college are for abundance data only. 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 during the sampling period.

Worm counts

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.

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