Biological Recording Company

sapperton wilder

Baseline Earthworm Survey Report

Keiron Derek Brown

Version 2

2 August 2024

Acknowledgements

Earthworm Surveys

The author would like to thank those that contributed to the earthworm surveying that contributed to this report:

Mary Alexander
Madeleine Bunting
Susan Cook
Mally Findlater
Chris Lambourne
Iona MacInnes
Nell Maydew
Fred Miller
Charlie Nash
Chenie Prudhomme
Finn Roweth
Stuart Roweth

Earthworm Identification

The author would like to thank those that contributed to the earthworm identification that contributed to this report:

Katie Ling
Sheila Warbus

Contents

This report was produced by the Biological Recording Company and funded by Beowulf Rewilding Ltd.

Suggested citation: Brown, K.D. (2024) Sapperton Wilder Baseline Earthworm Survey Report [Version 2]. London: Biological Recording Company

Introduction

The Sapperton Wilder is a regenerative farming experiment to test improving biodiversity and socioeconomic returns from marginal Cotswold land. The site was previously intensively farmed arable land.

The site is divided intro 3 blocks, which are further divided into a total of 19 fields (see Figure 1). A further 3 fields are used as control sites at other farms within Gloucestershire.

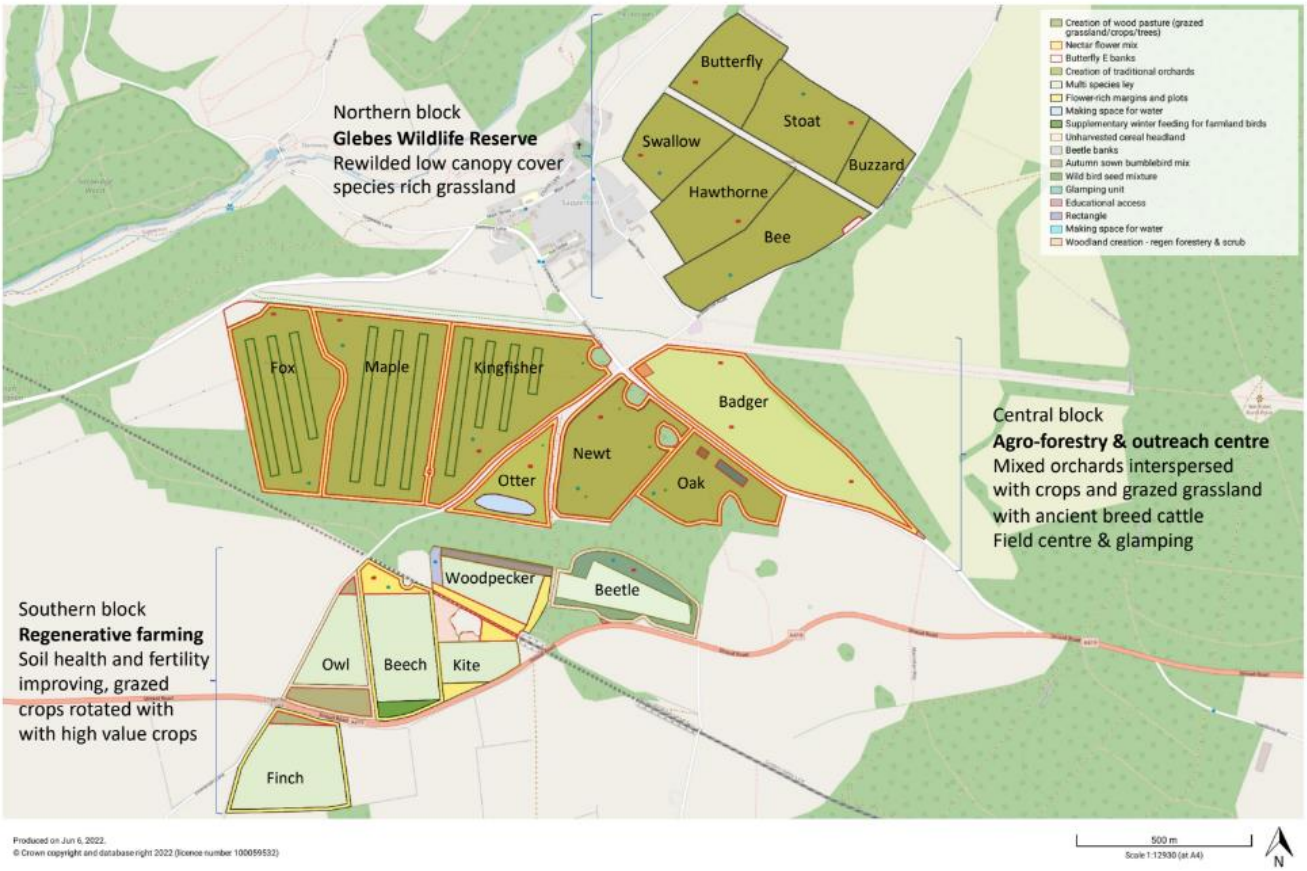

Figure 1: Land use map illustrating the location of the 3 blocks and 19 fields contained within the Sapperton Wilder experiment.

The Biological Recording Company was commissioned in April 2023 to assist in undertaking a baseline survey of the sites involved in the Sapperton Wilder experiment in Gloucestershire prior to the beginning of experimental treatments across the study site. This surveying was repeated in 2024 and will be continued on an annual basis with the results of the surveys published through this report.

Earthworms are widely regarded to be of great ecological importance, with different ecological categories of earthworm contributing to soil processes and resulting in a number of ecosystem services (see Figure 2) (Keith & Robinson, 2012).

Understanding earthworm populations across the experiment site and how they are impacted post-treatment will be important for measuring the impact of the various treatments being applied.

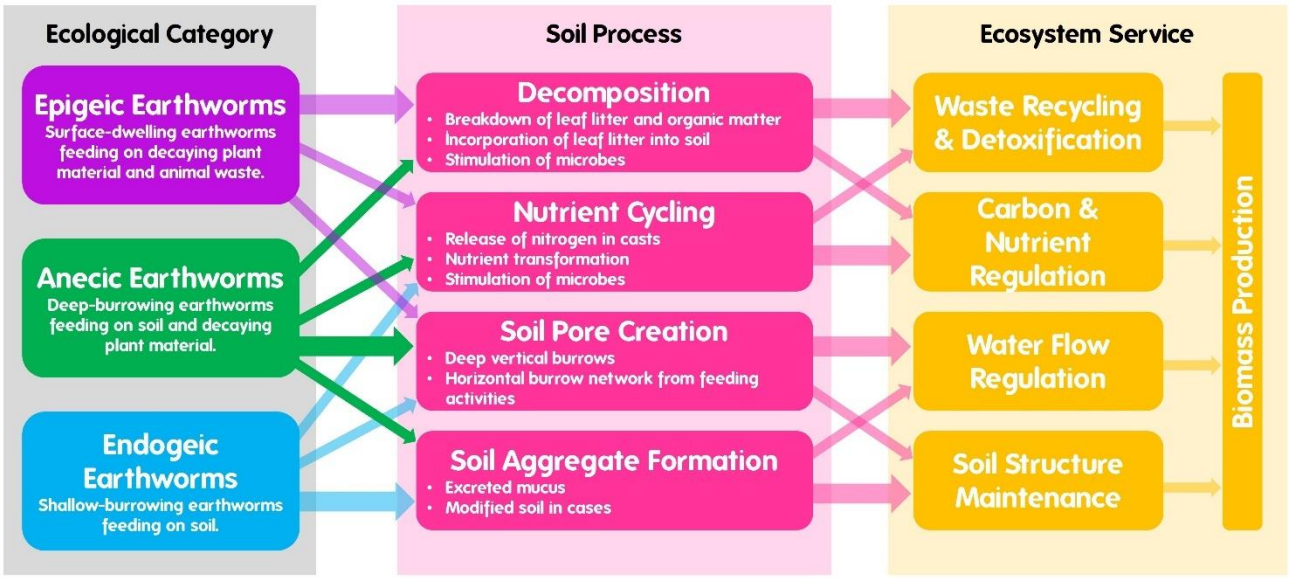

Figure 2: Earthworm ecosystem services adapted from (Keith & Robinson, 2012).

Earthworm Survey Methodology

The survey involved undertaking small-scale soil pit surveys within each of the 19 fields involved in the experiment and at 3 control sites, totalling 22 soil pit survey locations. At each sample site a random point was selected within the target field and 5 soil pits were excavated, following the National Earthworm Recording Scheme guidance on soil pit sampling and the 'NERS 5 pit protocol' (Brown, Earthworm Recorders Handbook [Version 8], 2019).

For each soil pit:

1. A soil pit measuring approximately 25cm by 25cm was excavated to a depth of around 10cm was excavated. Always check the empty pit to make sure no earthworms are in the bottom or sides!
2. The soil excavated from the pit was placed on a sorting tray and the pit was checked for any earthworms.
3. Any adult earthworms that were found in the soil were removed and collected into a labelled sample tube.
4. Any juvenile earthworms that were found were returned to the soil pit and the total number of earthworms returned to the soil were recorded.
5. The soil was returned to the pit once the contents has been sorted and compacted down to avoid leaving a hole or uneven surface that people could trip over.

For each site:

1. 5 replicate soil pit excavations were completed, all within the same 100 m OS grid square.
2. A Soil Pit Survey Form was completed, recording the sampling date, name of the field and location (e.g., Beetle Field, Sapperton Wilder), name of the lead surveyor (recorder name), 6-figure OS grid reference, habitat, number of soil pits sampled and any other notes regarding the sampling site.
3. All earthworm specimens were examined and identified where possible using a microscope the Key to the Earthworms of the UK & Ireland (2nd Edition). Where specimens were not originally identified by Keiron Brown, they were checked and species determination verified by Keiron Brown.
4. The total number of unidentified earthworms was calculated by adding the number of unidentifiable specimens from the sample tubes to the number of specimens returned to the soil in the field.
5. The data for each site was submitted to the National earthworm Recording Scheme via the Soil Pit Survey form on iRecord. All records have since been accepted to the National Earthworm Recording Scheme and have passed the National Earthworm Recording Scheme verification protocol (Brown, Verification, 2022).

Limitations of the survey methodology

1. Soil conditions can vary greatly within a single site and are known to have a significant influence on earthworm populations. It is therefore recommended that more than 5 sample points per site are surveyed to gather robust data to inform any conclusions regarding earthworm abundance and diversity at any given location. The budget and capacity for this baseline survey were limited so it was decided to opt for a lower number of replicates per field in order to gather data on each of the 19 Sapperton Wilder fields and 3 control fields.

2. Weather can be another important factor as it has a direct impact on soil conditions, particularly soil moisture. These surveys were undertaken after an unusually dry spring and the soil was noticeably dry. Repeating the survey during a period following wet weather is likely to result in greater abundance and possibly greater species diversity results.

3. Soil pit surveying is effective for extracting soil-dwelling species, particularly endogeic species from the top layers of soil and can easily be standardised and used to gain good qualitative data for research. However, as a sampling method it is biased towards soil-dwelling species (particularly endogeic species) and less effective than mustard sampling for extracting deep-burrowing anecic species.

Survey Results

During 2023 a total of 887 individual earthworms were recorded across the 22 sample sites (744 from the 19 Sapperton Wilder sites). Of these specimens, 219 were identifiable to species level. During 2024 a total of 2,491 individual earthworms were recorded across the 22 sample sites (2,147 from the 19 Sapperton Wilder sites), with 574 identified to species level. A detailed breakdown of the survey results by sample site and year can be found in **Table 1**.

During 2023 the total number of earthworms recorded at a single site ranged from 15 (Stoat field, Northern block) to 76 (Newt field, Central block). The total number of earthworms recorded from the control sites varied even more greatly, from 8 (Conventional Control 2) to 98 (Regen Ag Control). There was an obvious rise in the total number of earthworms in 2024, with the most individuals recorded ranging from 55 (Beech field, Southern block) to 226 (Swallow field, Northern block).

During 2023 the lowest species diversity recorded was a single species present at a site, and this was the case across 8 different sites (with representatives in all blocks and two out of three of the control sites). The highest species diversity recorded in 2023 was 5 earthworm species from Newt field (Central block) and the Regen Ag Control site. Species diversity increased across a large proportion of sites during 2024 (12 of the 19 Sapperton Wilder sites and 2 of the 3 control sites), with species diversity of 6 earthworm species recorded from 4 sites (across the Northern and Central blocks).

A total of 9 different earthworm species were recorded across the sites out of a total of 31 species known to occur in the UK. **Table 2** and **Table 3** present the earthworm species data by site for 2023 and 2024 respectively. All of the species detected at the control sites were also detected at multiple sites within the experiment. 7 of the 9 species recorded are classed as very common or common, 1 is regarded as uncommon and 1 species is regarded as rare (see **Table 4Table 4**). All of the species recorded have a low habitat specificity and widespread UK distributions.

Allolobophora chlorotica was by far the most recorded species across both the experiment and control sites (over 70% in both 2023 and 2024). This endogeic (shallow-burrowing and feeding on soil) species is the most common species of earthworm within the UK and accounts for 10.7% of all earthworm records submitted to the National Earthworm Recording Scheme. It is known to be disturbance tolerant and commonly recorded in large numbers in agricultural soils.

Table 1: Summary details for earthworm soil pit surveying by site and year.

		2023				2024			
		Sampling Date	Grid Reference	Total Earthworms	Species Diversity	Sampling Date	Grid Reference	Total Earthworms	Species Diversity
Northern Block	Butterfly	23/05/2023	SO951036	24	2	11/04/2024	SO952034	134	6
	Stoat	23/05/2023	SO953034	15	3	09/04/2024	SO954032	111	3
	Buzzard	17/05/2023	SO955032	27	2	09/04/2024	SO955032	76	2
	Swallow	23/05/2023	SO949034	38	2	11/04/2024	SO951034	226	6
	Hawthorne	23/05/2023	SO951033	35	1	10/04/2024	SO953033	181	4
	Bee	24/05/2023	SO953031	31	1	10/04/2024	SO955032	118	3
Central Block	Fox	17/05/2023	SO938028	49	4	12/04/2024	SO938028	149	6
	Maple	17/05/2023	SO941027	36	1	12/04/2024	SO940029	108	3
	Kingfisher	17/05/2023	SO944025	46	4	12/04/2024	SO943027	92	6
	Otter	22/05/2023	SO946023	31	3	18/04/2024	SO946025	82	1
	Newt	20/05/2023	SO947023	76	5	17/04/2024	SO947025	123	3
	Oak	20/05/2023	SO950024	52	2	16/04/2024	SO950025	143	4
	Badger	17/05/2023	SO949027	26	3	16/04/2024	SO949027	95	4
Southern Block	Finch	30/05/2023	SO937015	42	2	22/04/2024	SO938016	143	2
	Owl	24/05/2023	SO941018	54	1	22/04/2024	SO940021	95	5
	Beech	20/05/2023	SO942018	39	1	17/04/2024	SO941021	55	5
	Kite	20/05/2023	SO943019	55	2	23/04/2024	SO945019	59	2
	Woodpecker	20/05/2023	SO943021	42	1	17/04/2024	SO946021	57	2
	Beetle	20/05/2023	SO947021	26	2	17/04/2024	SO946021	100	1
Control Sites	Regen Ag Control	27/05/2023	SP062195	98	5	13/04/2024	SP062195	168	3
	Conventional Control 1	29/05/2023	SO036014	37	1	22/04/2024	SO935014	107	2
	Conventional Control 2	27/05/2023	SO987034	8	1	13/04/2024	SO987034	69	3

Table 2: Numbers of earthworms sampled at each sample site by species during the 2023 sampling period.

2023		Species									
		Allolobophora chlorotica	*Aporrectodea caliginosa*	*Aporrectodea longa*	*Aporrectodea rosea*	*Lumbricus castaneus*	*Lumbricus rubellus*	*Lumbricus terrestris*	*Murchieona muldali*	*Satchellius mammalis*	Unidentified
Northern Block	Butterfly	2			1						21
	Stoat	2	1		1						11
	Buzzard	12			1						14
	Swallow	8								1	29
	Hawthorne	6									29
	Bee	14									17
Central Block	Fox	9			5	1				3	31
	Maple	7									29
	Kingfisher	4	2	1	1						38
	Otter	7	4	1							19
	Newt	19	1	2		1				1	52
	Oak	6			2						44
	Badger	7			1					1	17
Southern Block	Finch	10	1								31
	Owl	2									52
	Beech	5									34
	Kite	3	1								51
	Woodpecker	1									41
	Beetle	5	2								19
Control Sites	Regen Ag Control	24	7	1	6					2	58
	Conventional Control 1	11									26
	Conventional Control 2	3									5
TOTAL		**167**	**19**	**5**	**18**	**2**	**0**	**0**	**0**	**8**	**668**

Table 3: Numbers of earthworms sampled at each sample site by species during the 2024 sampling period.

2024		Species									
		Allolobophora chlorotica	*Aporrectodea caliginosa*	*Aporrectodea longa*	*Aporrectodea rosea*	*Lumbricus castaneus*	*Lumbricus rubellus*	*Lumbricus terrestris*	*Murchieona muldali*	*Satchellius mammalis*	Unidentified
Northern Block	Butterfly	24			5		1	1	2	1	100
	Stoat	21			2				8		80
	Buzzard	1							14		61
	Swallow	29	1		5	1			2	3	185
	Hawthorne	20			4			1	21		135
	Bee	16			1				4		97
Central Block	Fox	33		2	4	2			1	1	106
	Maple	26			1				1		80
	Kingfisher	20		2	3			1	2	2	62
	Otter	18									64
	Newt	22			2			1			
	Oak	31			4	5				1	102
	Badger	17			4				5	1	68
Southern Block	Finch	24							4		115
	Owl	8	2		1	1		2			81
	Beech	6	1		2			1	2		43
	Kite	14	1								44
	Woodpecker	9			3						45
	Beetle	19									81
Control Sites	Regen Ag Control	17			1				13		137
	Conventional Control 1	24	6								77
	Conventional Control 2	3			6				4		56
	TOTAL	**402**	**11**	**4**	**48**	**9**	**1**	**7**	**83**	**9**	**1819**

Table 4: Summary of distribution, habitat and rarity statuses. Taken from UK Earthworm Provisional Conservation Status Assessment Report (in prep).

Species	Distribution	Habitat	Rarity
Allolobophora chlorotica	Widespread	Low	Very common
Aporrectodea caliginosa	Widespread	Low	Very common
Aporrectodea longa	Widespread	Low	Common
Aporrectodea rosea	Widespread	Low	Common
Lumbricus castaneus	Widespread	Low	Common
Lumbricus rubellus	Widespread	Low	Common
Lumbricus terrestris	Widespread	Moderate	Common
Murchieona muldali	Moderately widespread	Moderate	Rare
Satchellius mammalis	Moderately widespread	Low	Uncommon

Aporrectodea caliginosa is an endogeic species and was the second most recorded species in 2023 and accounted for 8.7% (19 individuals across 8 sites). However, in 2024 it was much less abundant and accounted for just 1.9% of identifiable adults (11 individuals across 5 of the 22 sites). Like *A. chlorotica*, it is often abundant at sites where it occurs and classed as very common. It is also known to be disturbance tolerant and often recorded in large numbers from agricultural soils.

Aporrectodea longa is an anecic (deep-burrowing and feeding on soil and above ground decaying plant material) species. Although it was only detected at 4 sites in 2023, it is likely that it is widespread across the site as juvenile anecic earthworms were noted in many of the samples during 2023 but could not be identified as they were juvenile or damaged. It is regarded as a common species and found in a wide range of habitats (including agricultural soils).

Aporrectodea rosea is another endogeic species and is considered common. It consisted of around 8% of total adult earthworms in both 2023 and 2024. It is also considered disturbance tolerant and found in a wide range of habitats, including agricultural soils.

Lumbricus castaneus is commonly found in both the soil and above-ground microhabitats, making it difficult to categorise within any of the ecological categories. It is regarded as a common species and found in a wide range of habitats (including agricultural soils). It was recorded in small number during both 2023 and 2024.

Lumbricus rubellus is also is commonly found in both the soil and above-ground microhabitats, making it difficult to categorise within any of the ecological categories. It is regarded as a common species and is thought to have the lowest habitat of all UK earthworm species. It was detected for the first time in 2024, with a single individual found at a single site (Butterfly Field, Northern Block).

Lumbricus terrestris is the largest species of UK earthworm and was detected for the first time in 2024, with 1-2 individuals recorded across 6 sites (two from each block). It is a deep-burrowing species that creates middens at the entrances to its burrows and is known to feed on soil throughout the soil profile as well as surface material (such as leaf litter). It is a common species and often found in agricultural soils, though can be particularly susceptible to tilling.

Murchieona muldali is considered a rare species of earthworm and appears to have a preference for farmland habitats, particularly field margins. It is a small endogeic species that lives within the soil and feeds on soil. It can be easy to overlook due to its small size and pale/indistinct appearance. It was detected for the first time in 2024, but recorded across a range of sites (both in Sapperton Wilder and at 2 of the 3 control sites). In 2024 it accounted for 14.6% of total adult earthworms.

Satchellius mammalis is another species that is found in both the soil and above-ground microhabitats though it is often classed as epigeic based on its colour and size). It is regarded as uncommon due to the known distribution being more patchy than common species.

Conclusions

Both abundance and species diversity were highly variable across the experiment area and the control sites, making it difficult to make any conclusions regarding the current health of individual sample sites based on earthworm populations.

The species diversity across the whole site was relatively low as just 9 species were recorded, and all of the species were recorded are known to have a low habitat specificity and 7 of the species are regarded as widespread and either very common or common (with just a single species regarded rare that is known to have a preference for agricultural environments).

Earthworm populations can be highly sensitive to soil moisture and it should be noted that the first year of surveying was particularly dry. Annual changes in earthworm communities is to be expected so it is recommended that surveying is continued over a number of years to gather a more robust baseline dataset before any analysis is conducted.

In order to detect changes over time, surveys should be conducted at a minimum of once per year at the same time each year. Sampling in both spring and autumn/winter will help reduce the impact of anomalous results due to weather conditions and help reduce the impact of natural seasonal variation in earthworm populations.

Bibliography

Brown, K. D. (2019). *Earthworm Recorders Handbook [Version 8].* London: Earthworm Society of Britain. Retrieved from https://www.earthwormsoc.org.uk/handbook

Brown, K. D. (2022). *Soil Pit Survey Form [Version 1].* 2022: Earthworm Society of Britain. Retrieved from https://www.earthwormsoc.org.uk/SoilPitSurveyForm

Brown, K. D. (2022). *Verification*. Retrieved from Earthworm Society of Britain: https://www.earthwormsoc.org.uk/verification

Carpenter, D., Sherlock, E., Jones, D. T., Chiminoides, J., Writer, T., Neilson, R., . . . Eggleton, P. (2012). Mapping of earthworm distribution for the British Isles and Eire highlights the under-recording of an ecologically important group. *Biodiversity Conservation, 21*, 475-485. doi:10.1007/s10531-011-0194-x

Eggleton, P., Inward, K., Smith, J., Jones, D. T., & Sherlock, E. (2009). A six year study of earthworm (Lumbricidae) populations in pasture woodland in southern England shows their response to soil temerature and soil moisture. *Soil Biology & Biochemistry, 41*, 1857-1865. doi:10.1016/j.soilbio.2009.06.007

Jones, D. T., & Eggleton, P. (2014). *Earthworms in England: distribution, abundance and habitats (Natural England Commissioned Report NECR145).* Natural England. Retrieved from http://publications.naturalengland.org.uk/publication/5174957155811328

Keith, A. H., & Robinson, D. A. (2012). Earthworms as Natural Capital: Ecosystem Service Providers in Agricultural Soils. *Economology Journal, 2*, 91-99. Retrieved from https://nora.nerc.ac.uk/id/eprint/15994

Sherlock, E. (2018). *Key to the Earthworms of the UK and Ireland* (2nd ed.). Shrewsbury: Field Studies Council.

Sims, R. W., & Gerard, B. M. (1999). *Earthworms. Synopses of the British Fauna (New Series)* (Vol. 39). London: Linnean Society of London.