Biological Recording Company

Cranborne Chase

Earthworm Survey Report

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Produced for

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as part of the Chalk & Chase Landscape Partnership

CHASE & CHALKE LANDSCAPE PARTNERSHIP

Cranborne Chase National Landscape

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Contents

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1 Introduction

The UK is home to 31 different species of earthworm, which can be broken down into groups based on their morphology, ecology and behaviour.

Traditionally this has been by ecological category based on their morphology using three poles on a triangular scale:

- Anecic earthworms make permanent vertical burrows in soil. They feed on leaves on the soil surface that they drag into their burrows. They also cast on the surface, and these casts can quite often be seen in grasslands. Some anecic earthworm species also make middens (piles of casts) around the entrance to their burrows. Anecic species are the largest species of earthworms in the UK. They are darkly coloured at the head end (red or brown) and have paler tails.
- Endogeic earthworms live in and feed on the soil. They make horizontal burrows through the soil to move around and to feed and they will reuse these burrows to a certain extent. Endogeic earthworms are often pale colours, grey, pale pink, green or blue. Some can burrow very deeply in the soil.
- Epigeic earthworms live on the surface of the soil in leaf litter, deadwood, dung and compost. These species tend not to make burrows but live in and feed on the leaf litter. Epigeic earthworms are also often bright red or reddy-brown, and sometimes even stripy.

Earthworms were selected as an indicator of general soil biodiversity health as they 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 (**Figure 1**) (Keith & Robinson, 2012).

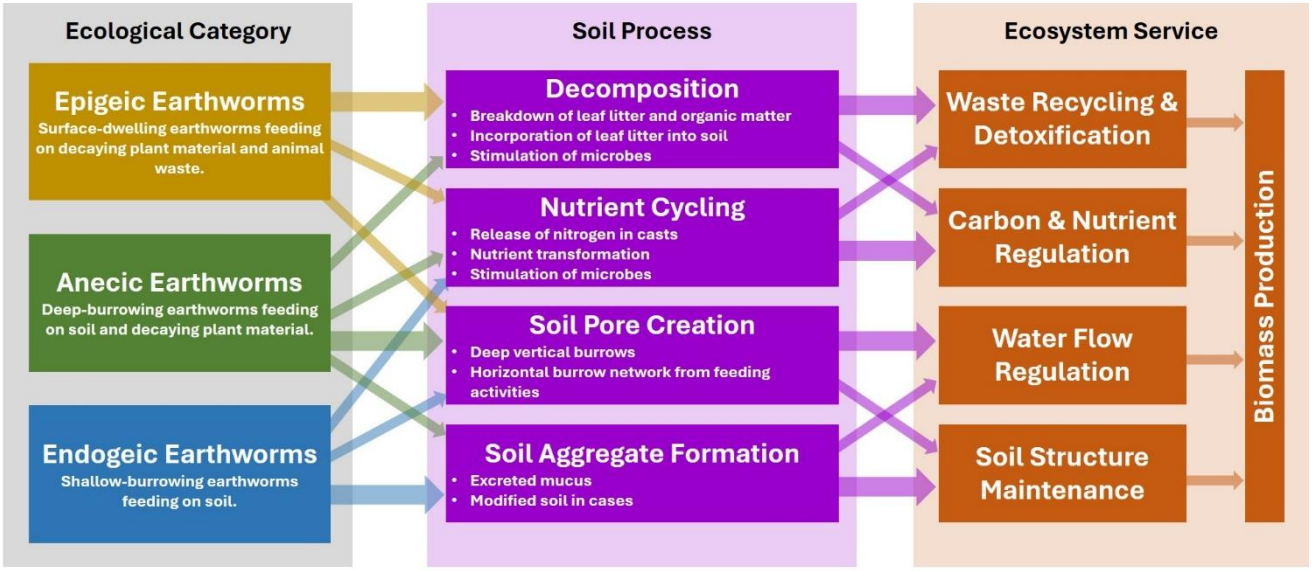


Figure 1: Earthworm ecosystem services adapted from Keith & Robinson 2012.

More recently, earthworms have been categorised into one of 6 functional groups based on their bioturbation behaviour as illustrated in **Figure 2** (and including an additional intermediate grouping) (Capowiez, Marchán, Decaëns, Hedde, & Bottinelli, 2044).

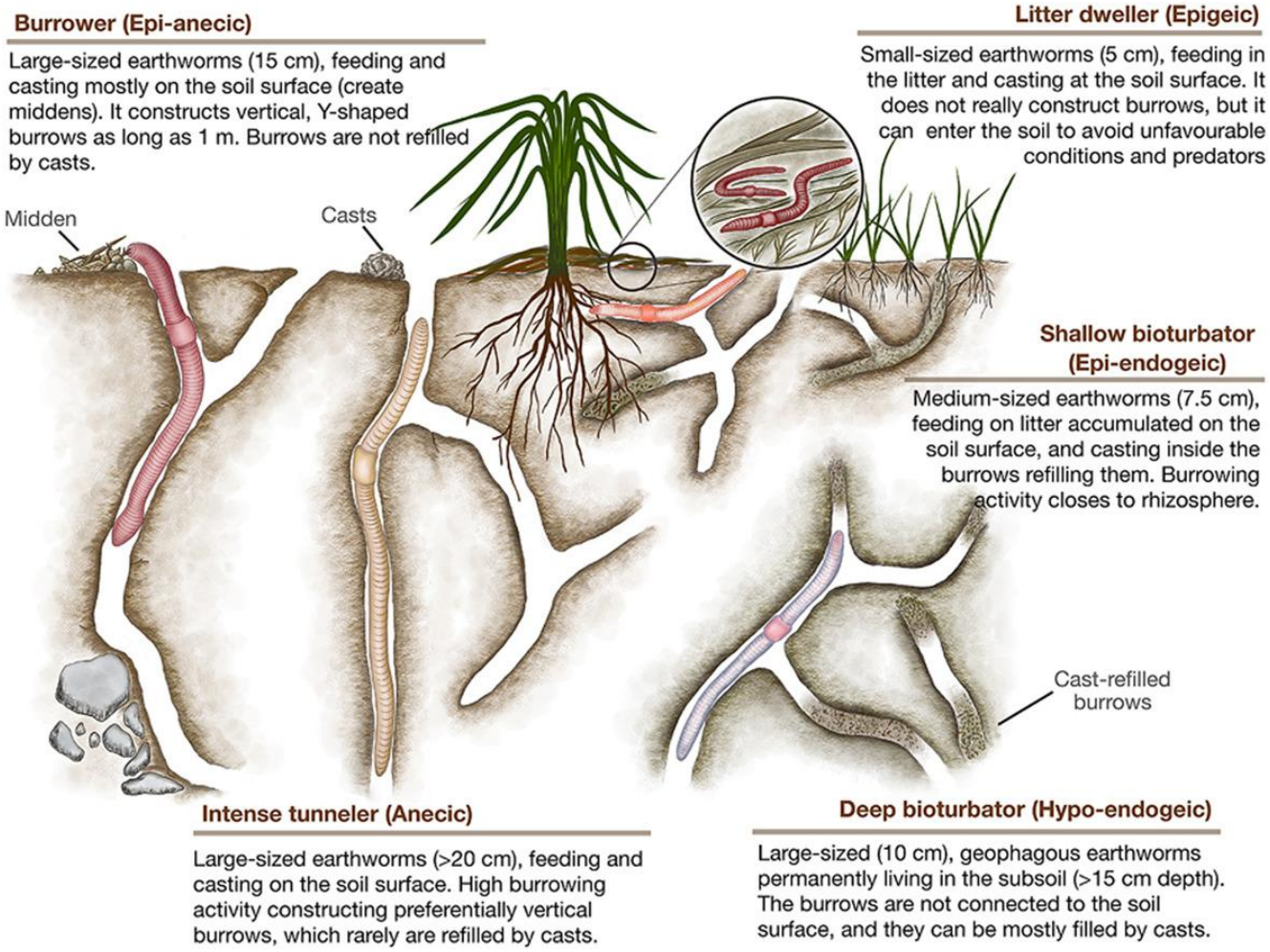


Figure 2: Earthworm Functional Groups taken from Capowiez et al (2024).

The 'Nurturing Nature' project focuses on the distinctive flora and fauna of the Chase & Chalke Landscape Partnership area.

- To engage new volunteers with training, biodiversity monitoring, mentoring and practical action.
- To improve understanding of biodiversity in the Cranborne Chase and Chalke Valley area, and to set a new baseline of information about the landscape which will inform priorities for action.
- To promote the importance of this landscape, and the species that rely upon it, as well as to raise awareness of risks to the habitats of the landscape.

The Biological Recording Company was commissioned by the Wiltshire and Swindon Biological Records Centre to deliver:

1. Middleton Down Earthworm Survey: One Earthworm Sampling Day at Middleton Down on Cranborne Chase to engage local volunteers with earthworm recording and generate and generate new earthworm records.
2. Arable Sites Earthworm Survey: Two Earthworm Sampling Days across agricultural sites on Cranborne Chase with the aim of comparing earthworm communities in arable soils and other habitat features.

2 Earthworm Survey Methodology

The survey consisted of two components:

1. Middleton Down Earthworm Survey (April 2023)
2. Arable Sites Earthworm Survey (May 2024)

2.1 Middleton Down Earthworm Survey

This survey involved searching a wide range of above and below-ground habitats for earthworms at Middleton Down Nature Reserve on 25 April 2023.

1. Any adult earthworms that were found were collected into a labelled sample tube for each different location, sampling method and habitat.

2. Biological recording forms were completed for each record, including the following information: sampling date (i.e. 25/04/2023), name of the location (i.e. Middleton Down Nature Reserve), name of the recorder, 6-figure OS grid reference, habitat, sampling method and any other notes relevant to the record.

3. All earthworm specimens were examined and identified where possible using a microscope the Key to the Earthworms of the UK & Ireland (2nd Edition).

4. The data for each record was submitted to the National Earthworm Recording Scheme via 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).

5. An Earthworm Site Species List was generated using the data and this information is reported in the Results section of this report.

Figure 4: Hand-sorting of excavated soil for earthworms by volunteers. Image: Anna Cooper.

Figure 3: Hand-sorting of excavated soil for earthworms by volunteers. Image: Anna Cooper.

2.2 Arable Sites Earthworm Survey

The survey involved undertaking 8 soil pit survey transects across four farms (see **Table 1**). At each farm 1 transect was located within a spring barley field (arable habitat) and 1 transect was located in a nearby alternative habitat (such as hedgerow or grassland).

Table 1: Details of soil pit sample sites surveyed for earthworms in this study.

Transect	Location	Habitat	Survey Date	Grid Reference
SB1	South & Burts Farm	Arable (spring barley)	02/05/2024	ST967147
SB2	South & Burts Farm	Hedgerow	02/05/2024	ST966148
MY1	Myncen Farm	Arable (spring barley)	02/05/2024	ST969143
MY2	Myncen Farm	Grassland (wildflower meadow)	02/05/2024	ST972143
CP1	Chalk Pyt Farm	Arable (spring barley)	03/05/2024	SU032263
CP2	Chalk Pyt Farm	Grassland (chalk downland)	03/05/2024	SU031265
MA1	Manor Farm	Arable (spring barley)	03/05/2024	SO007264
MA2	Manor Farm	Grassland (unmanaged)	03/05/2024	SU009265

At each sample site a random point was selected within the target habitat and 5 soil pits were excavated, following the National Earthworm Recording Scheme guidance on soil pit sampling and the 'NERS 5 pit protocol'. For the linear hedgerow habitat, the soil pits were taken at roughly 2 metre intervals along the base of the hedgerow. (Brown, Earthworm Recorders Handbook [Version 8], 2019)

Figure 5: Hand-sorting of excavated soil for earthworms by earthworm recorders. Image: Michael New.

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 was recorded.

5. The soil was returned to the pit once the contents had been sorted and compacted down to avoid leaving a hole or uneven surface that people could trip over.

Figure 6: Hand-sorting of excavated soil for earthworms. Image: Anna Rebmann.

For each site:

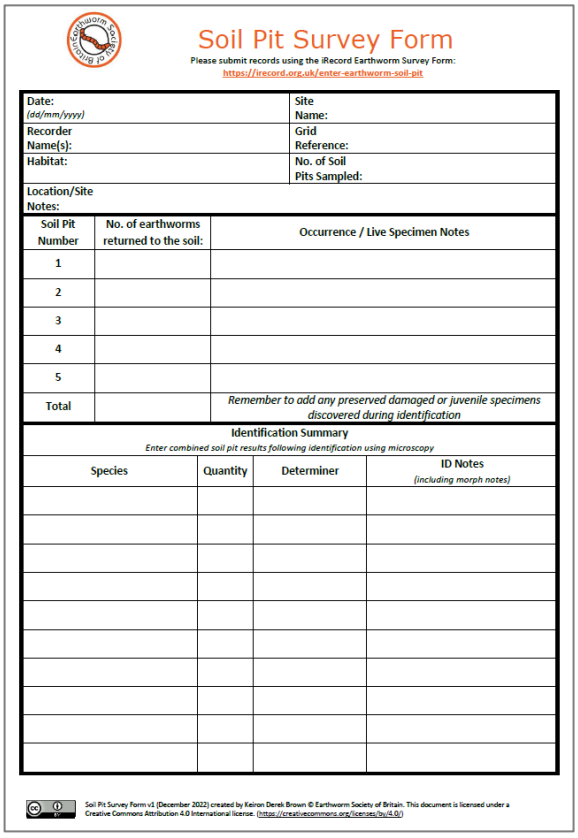
1. 5 replicate soil pit excavations were completed, all within the same 100 m OS grid square.

2. A Soil Pit Survey Form was completed for each transect, recording the sampling date, name of the farm, 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).

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).



Soil Pit Survey Form

Please submit records using the iRecord Earthworm Survey Form:
https://irecord.org.uk/enter-earthworm-soil-pit

Date: *(dd/mm/yyyy)*	Site Name:
Recorder Name(s):	Grid Reference:
Habitat:	No. of Soil Pits Sampled:
Location/Site Notes:	

Soil Pit Number	No. of earthworms returned to the soil:	Occurrence / Live Specimen Notes
1		
2		
3		
4		
5		
Total		*Remember to add any preserved damaged or juvenile specimens discovered during identification*

Identification Summary

Enter combined soil pit results following identification using microscopy

Species	Quantity	Determiner	ID Notes *(including morph notes)*

Figure 7: Soil Pit Survey Form used to record sample site details and number of unidentified earthworms returned to the soil. Image: Earthworm Society of Britain.

3 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 survey were limited so it was decided to opt for a lower number of replicates per site in order to gather data on a larger number of sites.

2. Weather can be another important factor as it has a direct impact on soil conditions, particularly soil moisture. Survey results may need to be taken in context with seasonal and annual weather cycles.

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.

4 Arable Sites Earthworm Survey Results

A detailed breakdown of the survey results by sample site can be found in **Table 2**.

Table 2: Earthworm survey totals and species diversity by transect.

Transect	Adults Total	Unidentified Total	Total Earthworms	Species Diversity
SB1	17	26	43	3
SB2	10	76	86	6
MY1	26	71	97	1
MY2	14	76	90	6
CP1	4	14	18	2
CP2	15	32	47	3
MA1	10	37	47	3
MA2	21	63	84	5
TOTAL	117	395	512	8

Both earthworm abundance and earthworm species diversity were analysed using paired sample t-tests to investigate if significant differences occurred between the data collected in arable habitats and the data collected in the neighbouring habitat at the same farm site.

The following hypotheses were tested:

Null hypothesis (H_0): There is no difference between the means of the two groups.

Alternative hypothesis (H_1): There is a significant difference between the means.

4.1 Earthworm abundance

The highest earthworm abundance recorded at a single farm was 187 earthworms. This site also had the highest abundance in both the arable habitat (97) and neighbouring habitat (90). The lowest earthworm abundance recorded at a single farm was 65 earthworms. This site also had the highest abundance in both the arable habitat (18) and neighbouring habitat 47).

The values recorded for earthworm abundance across arable and neighbouring habitats is presented in the box plots within **Figure 8**. Earthworm abundance in arable habitats appeared to be much more variable than in neighbouring habitats.

The data was analysed using a paired sample *t*-test to establish if there was a statistically significant difference between the earthworm abundance in arable habitats and the neighbouring habitat. The statistical analysis presented in **Box 1** indicates that that **there is no statistically significant difference between the two sets of values** (*p*-value = 0.1074).

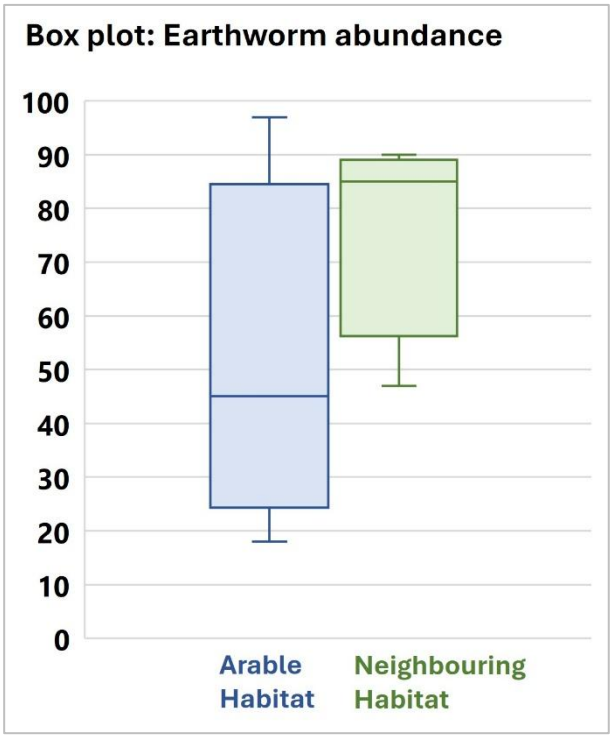


Figure 8: Box and whisker plots of earthworm abundance values. (n = 4)

Paired t-test results: Earthworm abundance

Null hypothesis (H_0): There is no difference between the means of the two groups.
Alternative hypothesis (H_1): There is a significant difference between the means.

p-value and statistical significance:

- *p*-value = 0.1074
- Given that the p-value is significantly higher than the common significance levels (0.05, 0.01, or 0.001), we fail to reject the null hypothesis. This means that **there is no statistically significant difference between the two sets of values**.

Confidence interval:

- The mean of 'Arable' minus 'Neighbouring habitat' = 0.60
- 95% confidence interval of this difference: From -61.16 to 10.16

Intermediate values used in calculations:

- *t*-statistic = 2.2755
- Degrees of freedom = 3
- Standard error of difference = 11.206

Review of data:

Group	Arable	Neighbouring habitat
Mean	51.25	76.75
Standard deviation	33.09	19.99
Standard error of the mean	16.54	9.99
n	4	4

Box 1: Paired sample *t*-test output for earthworm abundance data of arable versus neighbouring habitat. (*n* = 4) (*p*-value = 0.1074).

4.2 Earthworm species diversity

A total species diversity of 8 species was recorded across the four farms. Three of the four farms had an overall species diversity of 6 species. The lowest species diversity recorded was at Chalk Pyt Farm was 3 species. Transects varied in species diversity from 1 to 6 species.

The values recorded for earthworm species diversity across arable and neighbouring habitats is presented in the box plots within **Figure 9**.

The data was analysed using a paired sample *t*-test to establish if there was a statistically significant difference between the earthworm abundance in areas cleared of leaves and areas where the leaves were left. The statistical analysis presented in **Box 2** indicates that that **there is a statistically significant difference between the two sets of values** (*p*-value = 0.0486).

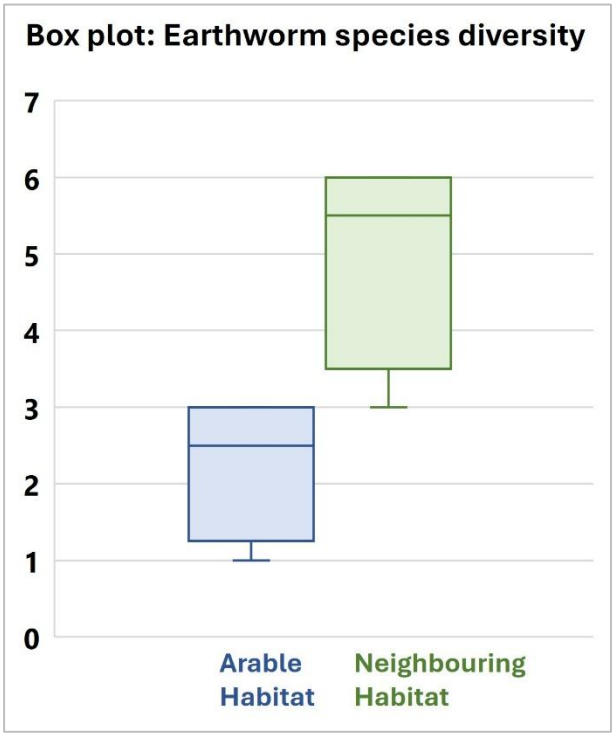


Figure 9: Box and whisker plots of earthworm species diversity values. (*n* = 4)

Paired t-test results: Earthworm species diversity

Null hypothesis (H_0): There is no difference between the means of the two groups.
Alternative hypothesis (H_1): There is a significant difference between the means.

p-value and statistical significance:

- *p*-value = 0.0486
- Given that the p-value (0.049) is slightly below the standard significance level of 0.05, we reject the null hypothesis. This suggests **that there is a statistically significant difference between the species diversity in "Arable" and "Neighbouring habitat" in this dataset**.

Confidence interval:

- The mean of 'Arable' minus 'Neighbouring habitat' = 0.20
- 95% confidence interval of this difference: From -0.84 to 1.24

Intermediate values used in calculations:

- *t*-statistic = 3.2205
- Degrees of freedom = 3
- Standard error of difference = 0.854

Review of data:

Group	Arable	Neighbouring habitat
Mean	2.25	5.00
Standard deviation	0.96	1.41
Standard error of the mean	0.48	0.41
n	4	4

Box 2: Paired sample t-test output for earthworm species diversity data of arable versus neighbouring habitat. (*n* = 4) (*p*-value = 0.0486).

5 Earthworm Species Composition

A total of 715 individual earthworms were recorded across the 5 sample sites. Of these specimens, 229 were identifiable to species level.

73 species occurrence records were submitted to the National Earthworm Recording Scheme, where they were shared locally (via Wiltshire & Swindon Biological Records Centre), nationally (via the National Biodiversity Network Atlas) and internationally (via the Global Biodiversity Information Facility).

The Middleton Down Earthworm Survey resulted in 44 new earthworm species occurrence records, with 11 species of earthworm recorded on the site. The Arable Sites Earthworm Survey resulted in a further 29 new earthworm species occurrence records, with 8 species of earthworm recorded across the 4 farms.

A total of 12 species of earthworm were recorded across the various sampling days that were undertaken in Cranborne Chase National Landscape. **Table 3** presents the species of earthworm recorded during the Nurturing Nature project alongside earthworms recorded at Coombe Bissett Nature Reserve as part of the Action For Insects project by Wiltshire Wildlife Trust.

Table 3: List of earthworm species recording across Cranborne Chase National Landscape sites.

Species	Coombe Bissett	Middleton Down	Chalk Pyt Farm	Manor Farm	Myncen Farm	South & Burts Farm
Allolobophora chlorotica	X	X	X	X	X	X
Aporrectodea caliginosa	X	X	X	X		X
Aporrectodea longa	X	X				
Aporrectodea rosea	X	X	X	X	X	X
Dendrobaena hortensis		X				
Lumbricus castaneus		X		X		X
Lumbricus festivus	X	X				
Lumbricus rubellus		X			X	
Lumbricus terrestris	X				X	X
Murchieona muldali		X				
Octolasion cyaneum		X		X	X	X
Satchellius mammalis		X		X	X	

Data accessed from National Earthworm Recording Scheme datasets on 21/10/2024 (Brown, Ashwood, & Calloway, Earthworm Research Records (UK). Earthworm Society of Britain. Occurrence dataset, 2024) (Brown, National Earthworm Recording Scheme (UK). Earthworm Society of Britain. Occurrence dataset, 2024).

Details of the predicted functional group, distribution. Habitat specificity and rarity are provided in **Table 4** (Brown, UK Earthworm Provisional Conservation Status Assessment Report, in prep).

The Middleton Down earthworm survey includes the first records *of Dendrobaena hortensis*, *Lumbricus castaneus*, *Murchieona muldali* and *Octolasion cyaneum* submitted to the National Earthworm Recording Scheme within Vice County 08 South Wiltshire.

Dendrobaena hortensis and *Murchieona muldali* are both considered rare species within the UK.

Table 4: Summary of earthworm species recorded within this survey.

Species	Functional group (ecological category)	Distribution	Habitat specificity	Rarity
Allolobophora chlorotica	Shallow bioturbator (Epi-endogeic)	Widespread	Low	Very common
Aporrectodea caliginosa	Shallow bioturbator (Epi-endogeic) [2]	Widespread	Low	Very common
Aporrectodea longa	Intense tunneler (Anecic) [2]	Widespread	Low	Common
Aporrectodea rosea	Shallow bioturbator (Epi-endogeic) [2]	Widespread	Low	Common
Dendrobaena hortensis	Litter dweller (Epigeic) [2]	Restricted	High	Rare
Lumbricus castaneus	Litter dweller (Epigeic)	Widespread	Low	Common
Lumbricus festivus	Burrower (Epi-anecic) [3]	Moderately widespread	Moderate	Uncommon
Lumbricus rubellus	Litter dweller (Epigeic)	Widespread	Low	Common
Lumbricus terrestris	Burrower (Epi-anecic)	Widespread	Moderate	Common
Murchieona muldali	Shallow bioturbator (Epi-endogeic) [3]	Moderately widespread	Moderate	Rare
Octolasion cyaneum	Deep bioturbator (Hypo-endogeic)	Widespread	Low	Common
Satchellius mammalis	Litter dweller (Epigeic)	Moderately widespread	Low	Uncommon

[1] Species is non-native in the UK. [2] Functional group estimated by author instead of using group established by Capowiez et al (2024). [3] Functional group estimated by author as not established in Capowiez et al (2024).

6 Conclusions

The earthworm surveying that occurred within the Nurturing Nature generated new species occurrence records for the Cranborne Chase National Landscape, including 4 new species of earthworm for Vice County 08 South Wiltshire and records of two species considered rare. 14 earthworm recorders took part in a survey of Middleton Down Nature Reserve and four farms engaged with the Arable Sites Earthworm Survey.

The results of the Arable Sites Earthworm Survey indicate that there is no significant difference in earthworm abundance between arable soils and the soils of neighbouring habitats. However, the limited surveys that were undertaken during this project indicate that there may be a significant difference in earthworm species diversity between arable soils and neighbouring habitats. The author of this report therefore urges caution when using overall earthworm numbers as an indicator of soil health and condition without also considering species diversity.

Earthworms remain relatively under-recorded across Cranborne Chase and there is a need to undertake further sampling and local naturalist engagement in order to better understand these important ecosystem engineers.

7 Bibliography

Ashwood, F., Brown, K. D., Sherlock, E., Keith, A. M., Forster, J., & Kevin, R. B. (2024). Earthworm records and habitat associations in the British Isles. *European Journal of Soil Biology, 122*, 103642. doi:10.1016/j.ejsobi.2024.103642

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

Brown, K. D. (2024). National Earthworm Recording Scheme (UK). Earthworm Society of Britain. Occurrence dataset. United Kingdom.

Brown, K. D. (in prep). *UK Earthworm Provisional Conservation Status Assessment Report.* Natural England.

Brown, K. D., Ashwood, F., & Calloway, K. (2024). Earthworm Research Records (UK). Earthworm Society of Britain. Occurrence dataset. United Kingdom.

Capowiez, Y., Marchán, D., Decaëns, T., Hedde, M., & Bottinelli, N. (2044). Let earthworms be functional - Definition of new functional groups based on their bioturbation behaviour. *Soil Biology and Biochemistry, 188*, 109209. doi:10.1016/j.soilbio.2023.109209

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.