



**Biological  
Recording  
Company**

# Earthworm Image Recognition Project Activity Report

Keiron Derek Brown

Version 3

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- Aidan Keith for providing additional data by sampling and photographing earthworms according to the project protocol outside of project sampling events.
- Emma Sherlock for assisting with the identification and verification of the many specimens that required a second opinion.



Photo 1: Volunteer surveyors at Grove Farm Nature Reserve (London). Image credit: Anna Rebmann.



Photo 2: Volunteer earthworm surveyors at Nant Mill (Wales). Image credit: Keiron Derek Brown.



Photo 3: Volunteer earthworm surveyors at Rothwell Country Park (West Yorkshire). Image credit: Keiron Derek Brown.



Photo 4: Volunteer earthworm surveyors at Sefton Park (Liverpool). Image credit: Peter Brash.

# Project Summary

## Project Timeline

The project commenced in July 2023 and is due to be delivered by the end of March 2024. A summary of project activities and timeline is provided in **Table 1**. The information within this table is updated with each version of this report to reflect the current timeline. A summary of the original project plan can be found in the appendix of this report.

**Table 1: Summary table of project activities and timeline.**

Month	Activities	Status
Jul 2023	Trial photographing earthworms in the field	✓
	Draft protocol for earthworm sampling and photography	✓
	Meet with CEH on 26/07/23 to finalise protocol	✓
Aug 2023	Design Earthworm Sampling Day survey plan and identify sample sites	✓
	Schedule 8 Earthworm Sampling Days across Great Britain	✓
Sep 2023	Promote Earthworm Sampling Days and manage volunteer bookings	✓
	Prepare equipment and consumables for Earthworm Sampling Days	✓
Oct 2023	Delivery of Earthworm Sampling Day Programme 1 (Great Britain) events	✓
	ID of Earthworm Sampling Day Programme 1 earthworm specimens	✓
	Process Earthworm Sampling Day Programme 1 images and submit to CEH	✓
	Submit Earthworm Sampling Day Programme 1 species occurrence records to iRecord	✓
Nov 2023	Schedule 3 Earthworm Sampling Days on farms within Chilterns National Landscape	✓
	Delivery of Earthworm Sampling Day Programme 2 (Chilterns National Landscape) events	✓
Dec 2024	ID of Earthworm Sampling Day Programme 2 earthworm specimens	✓
	Process Earthworm Sampling Day Programme 2 images	✓
	Submit Earthworm Sampling Day Programme 2 species occurrence records to iRecord	✓
Jan 2024	Process live specimen images collected to date	✓
	Confirm uncertain species determinations with Natural History Museum	✓
Feb 2024	Submit updated image library to CEH	✓
	Schedule 3 Earthworm Sampling Days across London	✓
Mar 2024	Delivery of Earthworm Sampling Day Programme 3 (London) events	✓
	Schedule Pilot Workshop with Farmers workshops 1 and 2	
Apr 2024	ID of Earthworm Sampling Day Programme 3 earthworm specimens	✓
	Process Earthworm Sampling Day Programme 3 images and submit to CEH	✓
	Submit Earthworm Sampling Day Programme 3 species occurrence records to iRecord	✓
May 2024	Preparation of workshop content and materials	
Jun 2024	Delivery of Pilot Workshop with Farmers 1	
Jul 2024	Address actions from Pilot Workshop with Farmers 1	
Aug 2024	Delivery of Pilot Workshop with Farmers 2 (liaise with NE and Defra engagement teams)	
Sep 2024	Review of project outputs	
	Delivery of 1-hour webinar to present project challenges and lessons learned	

# Earthworm Specimen Photography Protocol

Earthworms should be photographed in a standard 'white tub' container with the following dimensions: 18 cm length x 11.5 cm width x 7 cm height. The specific units used within this project were purchased from Parkers Packaging Limited: <https://www.parkerspackaging.com/product/1-litre-rectangular-ice-cream-container-lid/>

During sampling it was noted that mobile phone cameras often had difficulty focusing on the earthworm so the protocol was modified in February 2024 to use black containers so that the project could investigate the effectiveness of a white background versus a black background. Ideally, this would have involved the use of a black plastic container with the same shape and dimensions. However, it was not possible to source this product in black so an alternative product was used with the following dimensions: 19.5 cm length x 13.5 cm width x 3.5 cm height. The specific units used for this project were purchased from Deco Dine Limited: <https://decodine.co.uk/categories/814-711-categories-16-oz-rectangular-container-with-lid.html>

Using a standard container for photographing the specimens ensures a consistent background and enables a reference for the size of the specimen.



Figure 1: Details of the standard sampling containers used for the Earthworm Image Recognition Project.

When photographing earthworms for the Earthworm Image Recognition Project:

- The **whole container should appear within the image**. This helps the algorithm estimate the size of the earthworm in comparison to the standard size of the container.
- **Labels and other objects should not be photographed within the container**. Additional objects will be detected by the image recognition technology and create additional admin to remove.
- The **container should be kept clean of debris and soil** as this can also be detected by the image recognition technology. Where necessary, the container should be wiped clean between specimens.
- **Photos should be taken from directly above the container** and not at an angle with care taken not to create shadows in the image.
- **Multiple photos of each specimen should be taken** to account for the constantly changing shape of the specimen as it stretches, contracts and twists. At least one of the photos should have the specimen centrally in the container.



Figure 2: Acceptable and unacceptable examples of photographs for the earthworm specimen photography protocol.

Once photographed, earthworms were collected into labelled tubes of preservative and identified by Keiron Derek Brown using a microscope and the *Key to the Earthworms of the UK and Ireland (2nd ed.)* (Sherlock, 2018). Some specimens were identified by other trusted earthworm recorders and the determinations were all checked by Keiron Derek Brown. Where there was any uncertainty over the species identification, the specimens were submitted to the Natural History Museum (London) to be checked by Emma Sherlock.

Photographs of the specimen were then added to the relevant species folder on the Earthworm Images Google Drive.

## Photography Protocol Issues

A number of factors were noted during sampling that could potentially be problematic for generating suitable images:

- **Precipitation:** Rainy conditions can result in water gathering in the containers and cause issues with glare and reflections.
- **Shadows:** Both the sides of the container and photographer were found to cast shadows over part or all of the image.
- **Soil:** Earthworms are found within the soil, so it was unsurprising that the sampling containers became dirty relatively quickly. This was particularly evident in muddy conditions.
- **Excretions:** Earthworms that have been collected may excrete liquid as a defence mechanism. This can impact the background of the image where containers have been marked and it was noted that this could also change the colour and patterns on the earthworm. For example, *Aporrectodea icterica* is known for having a yellow mottled appearance and it was noted that this appeared to fade out and disappear as specimens excreted mucus from their skin.
- **Photographer inconsistency:** Despite step-by-step instructions and a demonstration, many participants still failed to photograph specimens according to the protocol and a significant proportion of images were discarded (though the actual proportion discarded was not recorded).

# Earthworm Sampling Day Programme

Earthworm Sampling Days are 1-day events where members of the public are invited to participate in earthworm surveys of a site. These events generate earthworm species occurrence records and engage local communities with earthworm research and soil health.

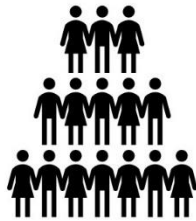
A total of 16 Earthworm Sampling Days were scheduled at sites across England and Wales, covering a variety of habitats. The Earthworm Sampling Day Programme aimed to cover a relatively wide geographic area and sampling sites were selected across a north to south gradient in England, from North Yorkshire to London. One site was also selected in Wales. No sites were selected in Scotland or Northern Ireland due to budget and logistical constraints. Earthworm Sampling Days undertaken in 2023 used the white container in the photography protocol, whereas Earthworm Sampling Days undertaken in 2024 used the black container.

A summary of the Earthworm Sampling Day Programme is provided in **Table 2**.



**16**

Earthworm  
Sampling Days  
delivered



**133**

Earthworm  
Sampling Day  
attendees



**617**

Earthworm  
specimens  
photographed and  
collected



**8,862**

Earthworm  
photographs with  
white background  
generated



**2,341**

Earthworm  
photographs with  
black background  
generated

Table 2: Summary of Earthworm Sampling Days.

Date	Venue	County	Attendees	Specimens	Images
26/09/2023	Paradise Fields	London	7	51	737
10/10/2023	Nant Mill	Denbighshire	5	51	1203
16/10/2023	Woodhouse Farm	North Yorkshire	10	43	1619
21/10/2023	Rothwell Country Park	West Yorkshire	4	34	462
23/10/2023	Erewash Meadows Nature Reserve	Derbyshire	5	43	576
24/10/2023	Erewash Meadows Nature Reserve	Derbyshire	2	17	202
25/10/2023	Woodside Nature Reserve	Derbyshire	10	35	1508
10/11/2023	Chilterns AONB (various farms)	Buckinghamshire	6	36	431
13/11/2023	Chilterns AONB (various farms)	Buckinghamshire	7	39	431
01/12/2023	Chilterns AONB (various farms)	Buckinghamshire	5	17	184
12/12/2023	Kensington Gardens	London	23	47	1514
27/03/2024	Southwood Open Space	London	11	47	337
06/04/2024	Grove Farm Nature Reserve	London	17	43	1309
22/04/2024	Sefton Park	Liverpool	10	47	415
29/04/2024	Paradise Fields	London	3	18	174
22/05/2024	Low Oxque Farm	North Yorkshire	8	49	448

## Earthworm Sampling Day Format and Guidance

Each event started with an introduction to the project by an earthworm specialist and an outline of the event. The earthworm specialist selected the locations and sampling methods for each sampling point, with the aim of maximising the species diversity collected from each sample site.

Volunteers were trained to locate and handle earthworms (Brown, Earthworm Recorders Handbook [Version 8], 2019). Juvenile specimens were returned to the habitats they were found within and adult specimens were photographed by both the earthworm specialist and the volunteers (using their own mobile devices) as per the **Earthworm Specimen Photography Protocol**.

For each sample point, adult earthworms were separated into individual white tubs with a label. Volunteers were instructed to photograph the label and then take multiple images of the earthworm within the tub without the label. The white tubs were lined up with each volunteer moving down the line to enable volunteers to easily keep track of which specimens they had each photographed.



Photo 5: Volunteer earthworm surveyors photographing specimens according to the earthworm specimen photography protocol at Woodhouse Farm (North Yorkshire. Image credit: Keiron Derek Brown.

Photographed specimens were collected for identification by an earthworm specialist at a later date. Each specimen was placed into a tube of preservative alongside the specimen label. Additional details of the biological record (such as date, recorder, grid reference, site name, habitat and sampling method) were recorded on an earthworm recording form.

Following each event, folders were created for each attendee on the Earthworm Images Google Drive and they were invited to submit their images (including the photographs of the labels) to their individual folders, where they were processed by the earthworm specialist (using the label photos as separators for each specimen) following identification of the specimens and sorted into the relevant earthworm species folders.

In addition to specimens collected during the Earthworm Sampling Days, a further 67 specimens were collected for the project and an additional 624 images were generated as a result. This included 36 specimens collected by Aidan Keith and 31 specimens collected by Keiron Derek Brown.



# Training Image Library Summary

This section will summarise the total number of images sourced for each species of earthworm that is known to occur in natural environments in the UK and Ireland.



**650**

Earthworm specimens determined to species level



**21**

Species of earthworm identified



**9**

Species of earthworm yet to be found and photographed



**11,827**

Images of earthworms added to the training library



**35**

Specimens in progress (comprising a total of 352 images)

Table 3: Summary of images uploaded to the training image library by species.

Species	Number of specimens	Number of images
<i>Allolobophora chlorotica</i>	68	1409
<i>Aporrectodea caliginosa</i>	147	2428
<i>Aporrectodea cupulifera</i>		
<i>Aporrectodea icterica</i>	18	322
<i>Aporrectodea limicola</i>	5	31
<i>Aporrectodea longa</i>	68	1442
<i>Aporrectodea nocturna</i>	7	108
<i>Aporrectodea rosea</i>	51	640
<i>Bimastos eiseni</i>	4	63
<i>Bimastos rubidus</i>	26	576
<i>Dendrobaena attemsi</i>		
<i>Dendrobaena hortensis</i>		
<i>Dendrobaena octaedra</i>	7	227
<i>Dendrobaena pygmaea</i>		
<i>Dendrobaena veneta</i>	10	170
<i>Eisenia andrei/fetida agg</i>	20	333
<i>Eiseniella tetraedra</i>	12	143
<i>Helodrilus oculatus</i>		
<i>Kenleenus armadas</i>		
<i>Lumbricus castaneus</i>	67	1136
<i>Lumbricus festivus</i>	10	227
<i>Lumbricus friendi</i>		
<i>Lumbricus rubellus</i>	77	1723
<i>Lumbricus terrestris</i>	15	240
<i>Microsclex phosphoreus</i>		
<i>Murchieona muldali</i>	152	101
<i>Octolasion cyaneum</i>	12	158
<i>Octolasion lacteum</i>	12	196
<i>Satchellius mammalis</i>	8	154
<i>Sparganophilus tamesis</i>		

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