Environment and Rural Affairs Monitoring & Modelling Programme (ERAMMP)

ERAMMP Document-51:
Field-Survey Handbook (Procedures)
Soil Sampling

Robinson, D.A., Emmett, B.A., Fitos, E. & Keith, A.M.

UK Centre for Ecology & Hydrology

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1.0	Author Team	09/04/2021	Published
2.0.0	Sabine Reinsch	01/05/2023	- added - information on elevated-risk soils - information on sampling in arable fields if soil sampling is disconnected from vegetation survey - soils-specific risk assessment - section on short and compressed cores - information on recording soil samples on the app - updated soil bag label - renamed document to “Soil sampling” – removed the year

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Field-Survey Handbook (Procedures) - Soil Sampling

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Client reference C210/2016/2017

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Approved by Bridget Emmett (UK Centre for Ecology and Hydrology)
James Skates (Welsh Government)

Abbreviations Used in this Document

Comp	Compressed
ERAMMP	Environment and Rural Affairs Monitoring & Modelling Programme
FAB	Field Assessment Booklet i.a. FAB cover sheet on the tablet
GMEP	Glastir Monitoring and Evaluation Programme
O	Organic [as used, this report only]
SQ	Square
UKCEH	UK Centre for Ecology & Hydrology

Abbreviations and some of the technical terms used in this document are expanded on in the programme glossaries: https://erammp.wales/glossary (English & Welsh).

Contents

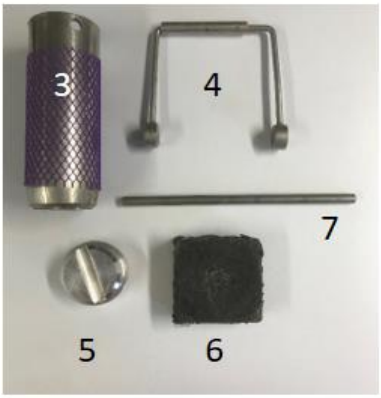
1 SOIL SAMPLING PROCEDURE

1.1 Equipment

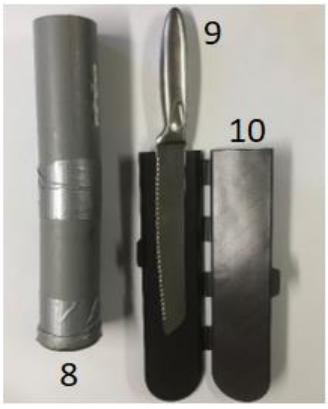
Rucksack or box (1) that can be kept in the van with spares (Figure 1.1.1). Field kit bag (2) to carry the coring device and tools for coring in the field. Main body of the coring device (3) in which plastic cores are inserted. The handle (4) and crossbar (7) are used for extracting the core. The plastic block or equivalent (6) can be placed on top of the metal lid (5) to reduce noise and vibration when driving the core into the ground with the hammer. The knife (9) is used for cutting through roots prior to coring, or for cutting peat cores. We have two types of guard, a magnetic (10) and a plastic (8).

1) Bag for van & spares

2) Bag for field kit



3) Corer
4) Handle
5) Metal cap
6) Hammer block
7) Crossbar



8) Knife guard
9) Knife for peat & roots
10) Magnetic knife guard

Figure 1.1.1 Soil coring equipment

A set of soil sampling tools is provided (Figure 1.1.2): The rulers (11) and (12) can be used to measure the depth from the base of the cross bar to the ground if the core won't go in 15 cm.

A trowel/long handle spoon (13) for sampling unconsolidated material, e.g. sand or gravel (see methods) is provided. Two hammer options 3 lb (14) and a 4 lb (15) hammer depending on user preference. A lever or crowbar (16) to extract cores that are difficult to pull out. Scissors (20) to remove excess grass or vegetation from the surface of the core. An extruder (21) can be used to push out any core that gets stuck in the coring device (3).

11) 30cm ruler
12) 15cm ruler
13) Trowel
14) 3lb hammer
15) 4lb hammer

16) Lever or crowbar
17) Gloves
18) Cloth for cleaning cores
19) Pliers
20) Scissors for cutting grass
21) Extruder for pushing cores out
22) Screwdriver

23) Tape

Permanent marker
24) 2*thin
25) 2*fat

Figure 1.1.2 Soil sampling tools

A collection of trays is provided for easier handling soil cores in the field (Figure 1.1.3): Trays (small or big) for working with loose soil, e.g. sand, soil with lots of stones or wet, boggy, peaty soil – to capture any loose material without contamination.

Figure 1.1.3 Tray for handling the collected soil samples

Cooling equipment is provided to reduce acceleration of soil processes after taking the cores (Figure 1.1.4): Electric Cool Box (28): which should be kept cool by charging whenever the vehicle is being driven (connected to the vehicle lighter socket (27)) or plugged in with the mains cable (26) at the accommodation to keep the samples cool. An extension cable is provided for the more convenient use. (Figures 1.1.4)

26) Mains cable
27) Car cigarette lighter cable
28) Cool box
29) 3 cold blocks

Figure 1.1.4. Cool box and accessories

As part of your soil sampling kit, you will also receive:

- **pre-printed** & **paid-for**, high-endurance envelopes fitting up to three soil cores at a time with two destinations
    - UKCEH Bangor (section 1.3.2)
    - UKCEH Lancaster (section 1.3.3)
- Pre-labelled soil bags in your SQ pack for all X-plots and soil types
- Spare labels to write the square and soil type information on
- Labels for “Elevated Risk soils” (section 1.2.3)
- Bags with white, black and grey plastic cores
- Soil barcode scanner

Table 1.1 *- Packing list for tools*

Tool	✓
Electric Cool Box	
Mains cable and car cigarette lighter cable for cold box	
Extension cable	
Cold blocks (3)	
Corer + metal cap + handle + crossbar + hammer block (heavy and lightweight version)	
Hammer (3 lb)	
Hammer (4 lb)	
Scissors	
Knifes + knife guards	
Wood muddler/Extruder	
Lever/Crowbar	
Trowel/long handle spoon	
Tray (large)	
Ruler (15 cm)	
Ruler (30 cm)	
Pliers	
Screwdriver	
Gloves (or to be purchased individually)	
Cloths	
Tape	
Permanent markers	
Bag/plastic box for van & spares	
Bag for field kit	
Avalanche rod for peat (3 m)	

1.1.1 Soil plastic core samples

In each X-plot three 15 cm cores will be taken (one white (P), one grey (B) and one black (C)).The aperture of the coring device is 50 mm and is slightly narrower than the cores so they slide out in the lab. The X-plot quadrats have four guide lines laid out north, south east and west of a central point. The cores will be taken in line with the **WEST** line out from the centre post of the quadrat. This positions the core 15 cm outside the central 2 m x 2 m quadrat used for vegetation sampling.

Sampling locations in arable fields will differ from previous sampling locations to avoid damage to the crop. If soil samples are taken separately from the vegetation survey, note that "*In arable fields, the plot should be taken as being a 14 m square (estimated not measured), starting 3 metres into the crop (to avoid any edge effect). Access should be made using drill lines where possible and causing minimum disturbance to the crop).*" If soils are taken in an arable field, make a note on the Field Assessment Booklet (FAB) cover sheet.

Sampling procedures for each core are detailed below. If there are problems taking any of the soil samples or a specific comment needs to be made regarding the sampling then a note must be placed in the FAB cover sheet (e.g. "large tree roots - 1st soil core taken 1 m E of centre quadrat"). If there is unusual vegetation, cow pat, boulder etc. move minimum distance to get more homogenous sensible location and record problem in the FAB cover sheet.

1.2 Taking the cores

1.2.1 X-plot sample layout

Location in respect of 2m x 2 m X-plot quadrat (2020-2024 WEST)

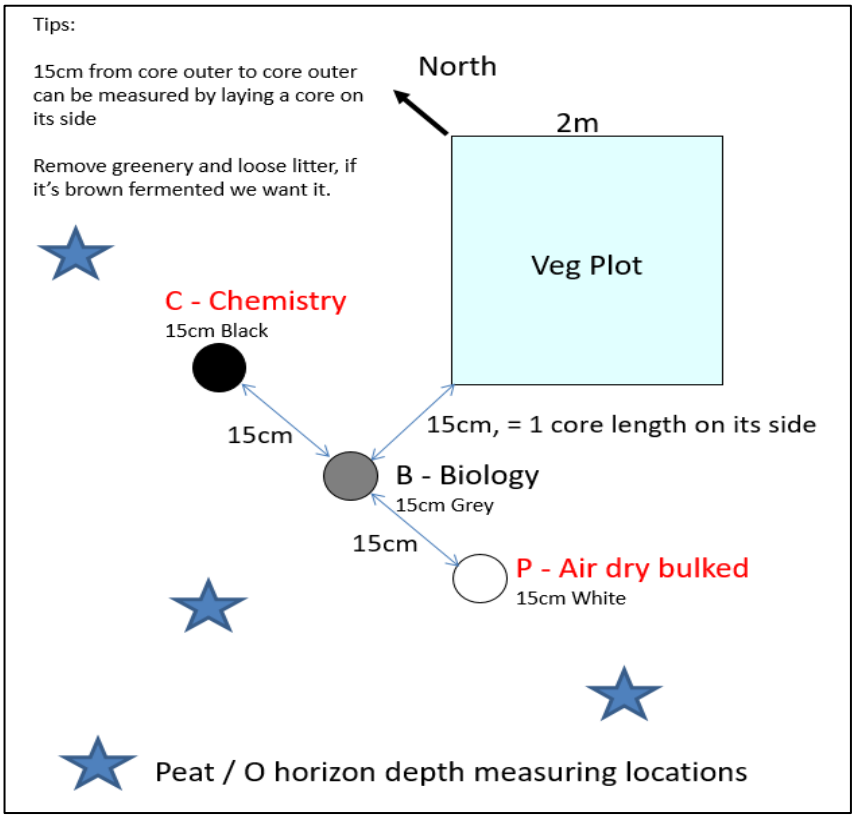


Figure 1.2.1.1 *The veg plot soil sampling layout is shown above with soil samples taken from* ***WEST*** *corner in the first round of re-surveying GMEP locations between 2021 and 2024*

Step1: Once the X plot has been located (see method section in Vegetation Plots handbook ERAMMP Document-49), locate the coring positions as shown in the Figure 1.2.1. This should be on the due west line of the X plots 15 cm outside the 2 m x 2 m vegetation quadrate.

There are 3 plastic cores for each plot (1-Black (Chemistry Analysis), 1-White (P-Storage), 1-Grey (B-Biology)): Each core type needs to be taken from a specific location as shown in Figure 1.2.1 (layout for soil sampling in relation to veg plots). These sampling backs for each core type are pre-labelled (see below).

Step 2: In peaty soil (if the soil has an organic layer, ~30% of soils) we would like to know the peat or organic layer depth (cm). After the soil cores were taken, use the avalanche rod to test the peat/O horizon depth at 3 locations marked with a star and record in the software if depth is over 2 cm (Figure 1.2.2). In each case press as far as it goes without major resistance which should be equivalent to the depth of the organic layer. Measure the depth with the tape measure or using the scale on the pole. The poles extend to 3 m, don't push into clay, they are hard to extract.

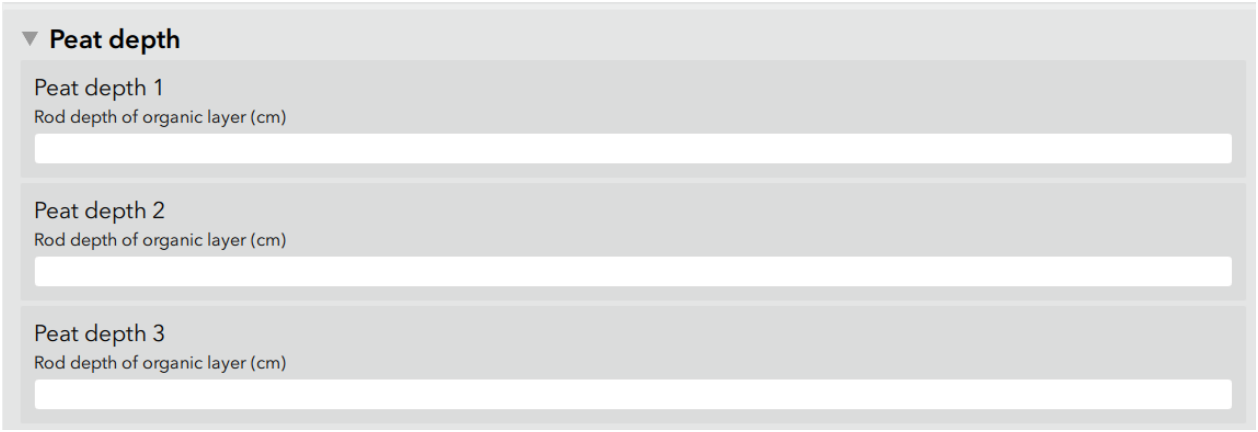


Figure 1.2.1.2. Screen shot for peat depth recording

Step3: Locate the bags with the labels for this X-plot and the correct coloured core to go in the bag, they should be brought together in a single bag. The three core type are listed below and labels will be as shown in Figure 1.2.1.3.

Cores & Labels

Core C (Chemistry): LONG BLACK 15 cm long x 5 cm dia.

Core P (Physical): LONG WHITE 15 cm long x 5 cm dia.

Core B (Biology): LONG GREY 15 cm long x 5 cm dia.

Lay the cores on the ground 15 cm out from the **West** corner of the plot. Long Black core on left, long white core on the right. The Grey biology in the middle:

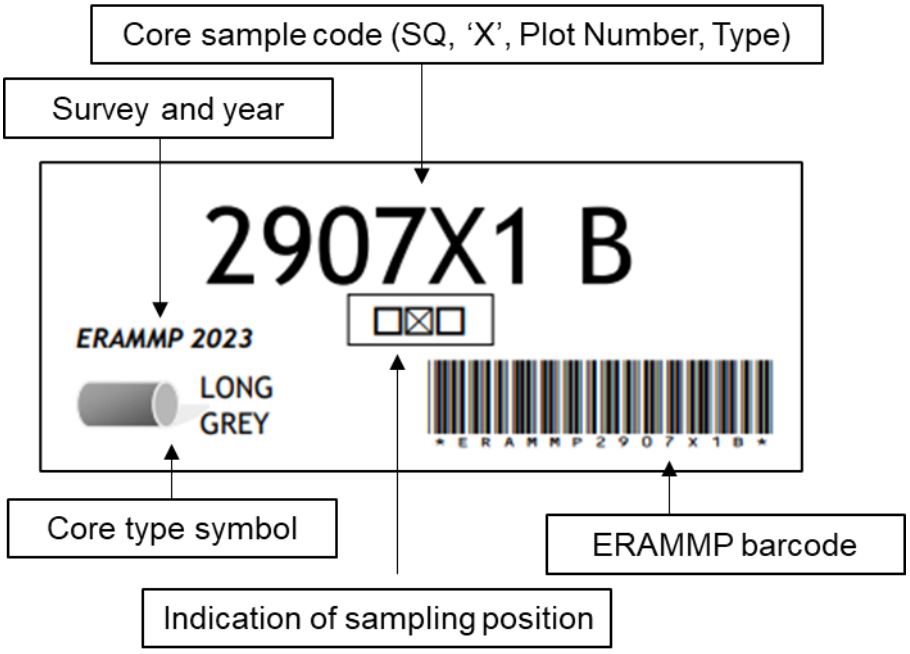


Figure 1.2.1.3 *Sample labels on soil bags*

1.2.2 Sampling procedure for all cores (White, Black and Grey Core Sampling)

At the onset of soil sampling, put on gloves and safety googles. Gloves will minimize the risk of soil-borne diseases being transmitted, and keep your hands clean.

1.2.2.1 Prepare sampling location

- **Clear the surface of green vegetation and fresh green plant material.**

  In the forest this means loose leaves and needles, it does not include the fermented needles/leaves (these are included in the sample): See guide at the end on forest floor sampling (Figure 1.3.3.5). In a peat soil, the top is regarded as the point the sphagnum changes to brown, no green.

- Mineral soils: cut off the surface vegetation – do not pull out plants.

1.2.2.2 Mineral soil sampling method (Visualised steps in Figure 1.3.3.1)

1. Ensure the coring device is clean.
2. Insert first core in corer device, hold the corer upright with the bevelled end on the soil surface while you cut round the bottom edge with the knife; cut vertically down into the soil through any roots and push in a little to prevent bouncing when hammered. Use the hammer (3lb, 4lb) to drive the corer into the soil until the horizontal cross bar is flush on the soil surface, the soil should rise in the core accordingly.
3. Check the success of coring by removing the metal cap, before extracting the soil core. This can be done as many times as needed.
4. If there is not enough depth of soil, move the sampling points slightly and start again. For more information on SHORT OR COMPRESSED CORES, see section 1.2.4.
5. If on the second attempt a full core is still not possible (due to rocks or large roots) then measure the depth from the base of the cross bar into the soil core to the ground to determine the core depth missing, and make a note on the tablet. These cores are **SHORT** cores.

   Simply measuring the depth of the hole after the core was extracted from the soil is not sufficient as the corer is several cm longer than the plastic core, so depth will not be equivalent.
6. Write the note “SHORT” on the corresponding plastic bag and put a note in the comments section on the tablet.

   A core might have gone in the full distance, but the plastic core doesn’t appear full because the sample squashed. This is a COMPRESSED core. Write COMP on the bag label. This allows us to differentiate between compressed (“comp”) soil and “short” soil/short cores in the lab.
7. Use the handle to twist and pull the core to one side to break the soil at the bottom, pull the coring device out (Figure 1.3.3.2). If extraction is difficult twisting the core or using the handle of the hammer, the crowbar or wood muddler can be used as shown. (We do encourage you to use the two latter one to save the handle of the hammer from any damage.

8. If the soil is too loose and the bottom part of the soil core won`t come out with the corer device, use your hand or the long handle spoon to dig out the bottom of the sample from the hole and put it into the bottom of the soil core.
9. If the soil is very sandy and likely to fall out, use the trowel to dig underneath to hold the sample in. Work over a tray when pulling the plastic core out of the corer to keep the sample safe (Figure 1.3.3.3).
10. Push the core out of the coring device, cap the top with a RED cap as it comes out. (Roger red hat, top) Slide the remaining core out with the soil end in the air, trim the soil and fit the BLACK cap on the bottom.

1.2.2.3 Organic soil

1. For organic soils, clear the surface of vegetation and fresh plant material.
2. The coring device may not work in organic or fibrous soil. In these circumstances (with an organic layer extending more than 15 cm) place the plastic core directly on the soil surface while you cut round the bottom edge with the knife; cut vertically down into the soil through any roots.
3. Push the plastic core firmly into the ground, continue to use the knife to cut ahead of the core, and push the core into the cut until the soil has come to the top of the core; you can use hammer to knock the core in if pushing alone is not sufficient.
4. Cut under the core with the trowel, use pliers to twist the plastic core free from the soil if necessary, being careful not to lose soil from either end of the plastic core (especially in dry/sandy soils or potentially peat). The trowel can be used to dig the plastic core out or to stop soil falling from the bottom. If soil falls out, put it back into the core bottom. (The trays can be useful while working with this type of soil by keeping the fallen out soil on a safe place, without contamination (Figure 1.3.3.3).
5. Carefully scrape/remove any lumps of soil from the exterior of the plastic core.
6. If needed, cut the bottom end of the core sample until it is level with the end of the plastic core (Figure 1.3.3.3).

In **very peaty, boggy** soil cut the block out with the knife rather than using the core and try to hammer it in, since this causes a very big compression in the sample and/or ends up having only water in the plastic core. Make sure the cut core is as close to the required size as possible both in length and diameter.

1.2.2.4 Scree or rocky soils

Some plots may land on scree slopes or fine gravel. It is not possible to use the coring device on this ground. We are still interested and if possible use the trowel to dig out the fine material and place in the core collecting the gravel and any material in between. If the stones are too big then don’t collect the material. Label clearly as scree on the label, and make a note on the tablet.

1.2.2.5 Finishing soil sampling

After finishing soil sampling **fill and cover up the sampling holes** since it can cause injuries to livestock e.g. sheep. Do not fill it with soil from different area or stones or dung since that can affect future surveys` results. Instead hammer in the top of the hole (Figure 1.2.2.1).

- **When each sample is obtained, ensure the caps cover the sample, RED on top, BLACK on the bottom.**
- **If you haven't already done this, carefully place each soil core in the corresponding appropriately labelled plastic bag and seal it using its zip lock or similar.**

In the vegetation software, the X Plot setting will prompt you to record if the soil sample was taken (yes / no); only click yes if the samples were taken. When the X plot was surveyed for plants, but soil sampling failed, don't tick the box (*see vegetation handbook section 4)*.

Figure 1.2.2.1 *Cover up the sampling hole so no animals are harmed*

1.2.3 Sampling of "Elevated-risk soils"

"Elevated-risk soils" are defined as soils potentially contaminated with bovine tuberculosis (TB) or other threats identified in the field. There is a negligible risk associated with soil sampling from farmland which was or is used for cattle (Allen et al. 2018). The soil sampling procedure described, especially the use of gloves, will reduce the risk of transmitting TB even further. The conclusion therefore is that soil, even if sampled from a farm currently under TB restrictions, bears no greater risk than normal soil as soil is not sampled from manure, dead carcases, water troughs etc.

As part of the ERAMMP permission process, landowners are asked if "there are any specific disease or bio-security measure to be aware of when visiting your land." This information will be relayed to the surveyors. Further, landowners may also flag TB issues with surveyors when calling before the survey visits.

If a farm is known to be, or assumed to be, down with TB, surveyors are asked to be specifically vigilant in cleaning the soil sampling equipment between sampling locations, and to put "ELEVATED RISK" labels on soil sampling bags from these fields. Post all elevated risk soils from one square in one envelope, and none elevated risk soils in another. The envelope containing the elevated risk samples should also be labelled with the same label to alert our laboratory teams.

1.2.4 Short and compressed cores

All soil cores which are not 15 cm long when taken will cause inaccuracy when calculating the soil bulk density and associated soil carbon and nutrient stocks. If cores are not 15 cm long (e.g. as described in section 1.2.2.2), then they can either be short cores, or compressed cores.

Short cores are cores where the sampling depths was smaller than 15 cm. Thus, the soil corer did not go fully into the soil and the cross-bar did not touch the soil surface. These cores should be marked as “SHORT” on the label, and on the tablet. The reason for a short core, e.g. stones, bedrock, roots etc. should be noted in the associated comment field on the tablet.

Compressed cores, in contrast, are cores where the soil corer went all the way into the soil, the cross bar touched the surface, but when extracted, the plastic core was much smaller than would be anticipated. Cores are NOT compressed if soil material fell back into the hole during the extraction process (In these cases, soil should be spooned back into the bottom of the core). These cores should be marked as “COMP” on the label, and on the tablet.

1.3 Soil sample scanning, storage and dispatch

When the soil sampling is finished at each X-plot, and the cores are sealed in the correct bags, scan the labels with the scanner provided (See Vegetation Handbook - 'plot specific headers' for X-plots). Make sure you scan the correct ones into each option (see below). If there are any issues with this procedure (e.g. too heavy rain, camera issues etc.), you can manually type in the appropriate barcode from the label. Alternatively, scan the labels later at the accommodation.

Take all cores back to the accommodation or laboratory in cool box vehicle storage, if in accommodation, store in the plug-in cool box provided.

1.3.1 Instructions for posting

- Pack the same SQ cores in the same bag and envelope; note that black and white cores can be posted together, grey cores go separately (see sections 1.3.2 and 1.3.3)
- Post the soil samples once per week, or as soon as reasonably possible.
- Do not post on Thursday or Friday or over the weekend, instead refrigerate the cores until Monday. Take to the nearest post office.

Instructions from the post office which explains why we wrap the samples:

- A leak-proof primary receptacle (Plastic core)
- A leak proof secondary receptacle (Sealed plastic bag), and
- An outer packaging of adequate strength for its capacity, mass and intended use, and with at least one surface measuring 100 mm x 100 mm (Tyvek envelope)
- If there is any liquid (or the possibility of) then an absorbent material must be placed between the primary receptacle and the secondary receptacle so that any release or leak will not reach the outer packaging (use absorbent cloth).

The packaging described is that used for exempt patient specimens.

1.3.2 Black and white cores

These cores are to be sent to **UKCEH Bangor**. They will be stored in a cold room (4 °C) on arrival.

UK Centre for Ecology & Hydrology
Environment Centre Wales
Deiniol Road
BANGOR
LL57 2UW

1.3.3 Grey cores

Grey cores must be placed in envelopes and posted directly to UKCEH Lancaster. In Lancaster, they will be frozen at -20°C as soon as possible.

UK Centre for Ecology & Hydrology
Lancaster Environment Centre
Library Avenue, Bailrigg
LANCASTER
LA1 4AP

Figure 1.3.3.1 – Sampling for cores:

If the core doesn't go in fully due to a hard layer or rock/root record the height from the crossbar to the ground surface in the software and take a "short" note on the plastic bag. This is so we can work out the correct bulk density and do not mistake it with a compressed ("comp") core.

Figure 1.3.3.2 – Tips & tricks for pulling out the corer from hard/dry soil

Figure 1.3.3.3 *– Trim the core and measure the depth of hole if needed.*

If the core didn't fully penetrate to 15cm, record the depth from the bottom of the cross bar to the ground surface in the software and take a "short" note on the plastic bag. This is so we can work out the correct bulk density and do not mistake it with a compressed ("comp") core.

Brush the loose leaves and needles to the side, we don't collect this.

Litter – Relatively fresh organic residues, identifiable plant material, such as leaves, wood or twigs resting on the surface of the forest floor. Some discolouration or other signs of early decomposition may be visible, but the origins of plant residues are still easy to discern.

This is the material to be collected in the core:

F (Fermented, fibric, fragmented) – Decomposition of plant material is apparent, but the origins of plant residues are still distinguishable. Often, roots are present.

H (Humic) – Well-humified plant material so that plant residues are not recognizable, with the exception of some roots or wood. This material is in advanced stage of humification in which fine substances predominate over plant residues.

Source: ***http://forestfloor.soilweb.ca/definitions/soil-horizons/***

Figure 1.3.3.4 *– Guide to the organic layer sampling in forests*

1.4 Soil-sampling specific Risk Assessment

RA Name / Description:	Soil sampling		**Assessor:**	David Robinson / Sabine Reinsch			
Names of those involved:	ERAMMP field surveyors taking soil samples		**Assessment Date:**	2023		**Review Date:**	
What are the Hazards	**What harm is most likely to occur?**	**What are the present control measures in place?**	**Residual risk ratings for each hazard** (After present control measures applied)			**Any further actions necessary?**	**Action by whom and when?**
			Likelihood of harm A-E	**Severity of harm 1-5**	**Risk Rating A1 – E5**		
Animals (farm or wild)	Getting trodden on or pushed over, even bitten by farm animals Insect bites, or bites from adders causing swelling or other reactions	Avoid working in fields with animals through land owner contact and scheduling Dress in protective clothing; wear boots	D	3	D3	Check the general field work risk assessment and Safe Systems of work	
Infections from soil borne pathogens and animal related diseases (e.g. Bovine tuberculosis)	Tetanus or infections in cuts	All scientists should have a tetanus up to date Gloves be worn when handling soils Follow the instructions in this hanbook	A	3	A3	Replenish gloves if running low	
Hammering cores into the ground	Hitting fingers Something flying up into face	Use slow dead blows Hold handle of sampler Optional: Wear goggles or glasses	C	2	C2		
Cutting roots with knives and vegetation with scissors	Cuts on fingers, arms or elsewhere	Use knife guards	C	2	C2	When using knives, always point knife away from body and hand when	

						putting back in the sheath Carry first aid kit to prevent contamination if you cut yourself	
Core extraction from the soil	Back injury	Do not crouch and use the small of your back to level a core out Follow the soil manual procedure and use the hammer as a lever, not your back to extract a core	C	3	C3	Consult tips and tricks in this handbook if unsure	
Heavy backpack with equipment and soil cores	Back injury and tiredness	Plan the day, take some cores back to the car at lunch time or when possible	C	3	C3	Manual handling training session during the training	

			Likelihood				
Hazard Severity	**H&S Hazards**	**Environmental Hazards**	**A** **Very unlikely** A freak combination of factors required for event to result	**B** **Unlikely** A rare combination of factors would be required for an event to result	**C** **Possible** Could happen when additional factors are present, but otherwise unlikely to occur	**D** **Likely** Not certain to happen, but an extra factor may result in it occurring	**E** **Very Likely** Almost inevitable that the event will occur
1 Slight	Little or no health effect/injury	Little or no actual damage.	**A1**	**B1**	**C1**	**D1**	**E1**
2 Minor	Minor health effect/ injury	Within site boundary, short term impact recoverable by the work site	**A2**	**B2**	**C2**	**D2**	**E2**
3 Major	Significant health effect/injury	Beyond the site boundary unlikely to last beyond 1 month. Recovery may require external aid.	**A3**	**B3**	**C3**	**D3**	**E3**
4 Severe	Major health effect/serious injury	Beyond the site boundary unlikely to last beyond 12 months. Recovery requires external aid.	**A4**	**B4**	**C4**	**D4**	**E4**
5 Critical	Multiple serious injuries/long term disability/ fatality	Massive Uncontrolled release with significant impact extending well beyond the site boundary.	**A5**	**B5**	**C5**	**D5**	**E5**

2 REFERENCES

Allen, A.R., Skuce, R.A. and Byrne, A.W., 2018. Bovine tuberculosis in Britain and Ireland–A perfect storm? The confluence of potential ecological and epidemiological impediments to controlling a chronic infectious disease. *Frontiers in Veterinary Science*, *5*, p.109.

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