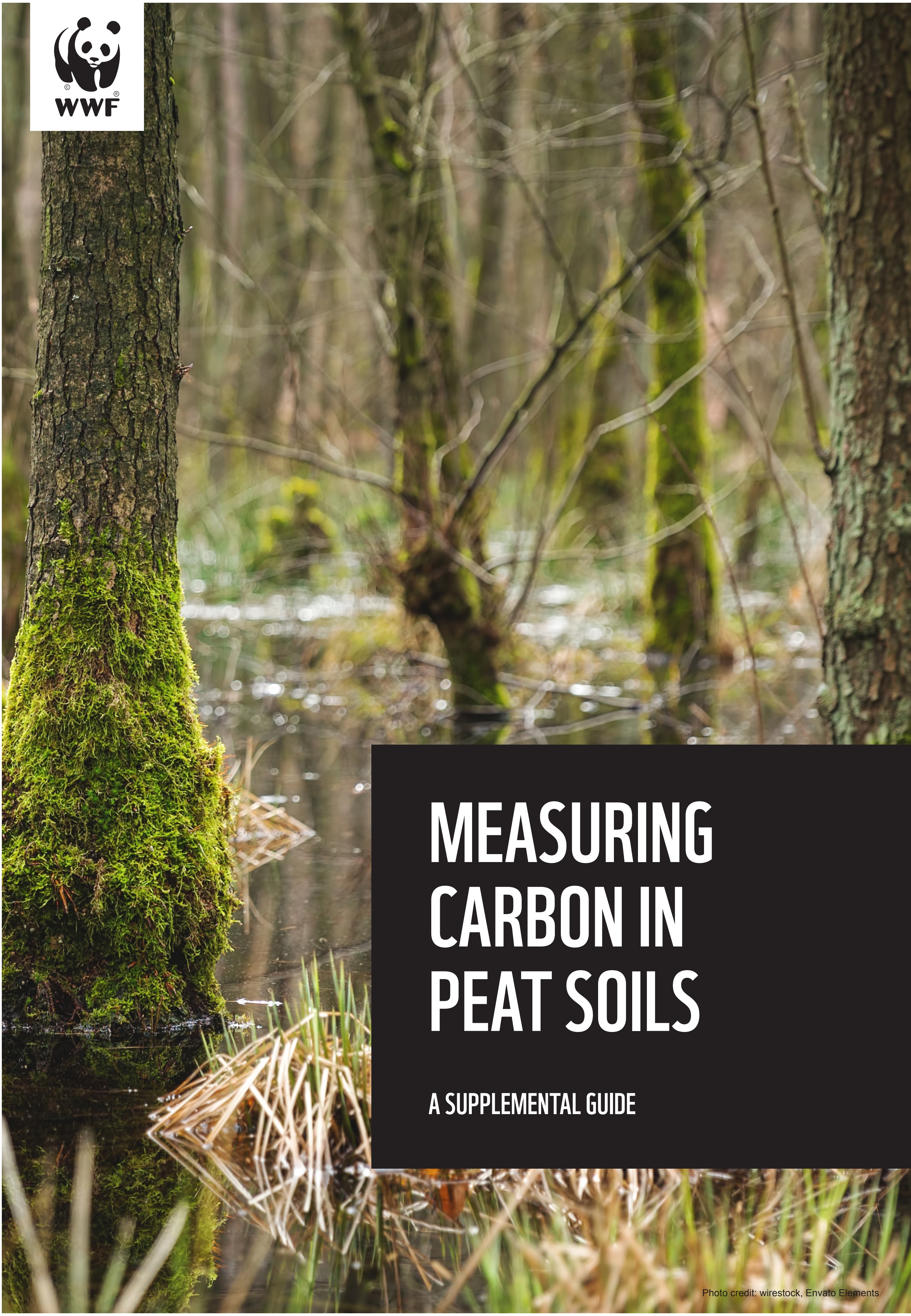


MEASURING CARBON IN PEAT SOILS

A SUPPLEMENTAL GUIDE

Photo credit: wirestock, Envato Elements

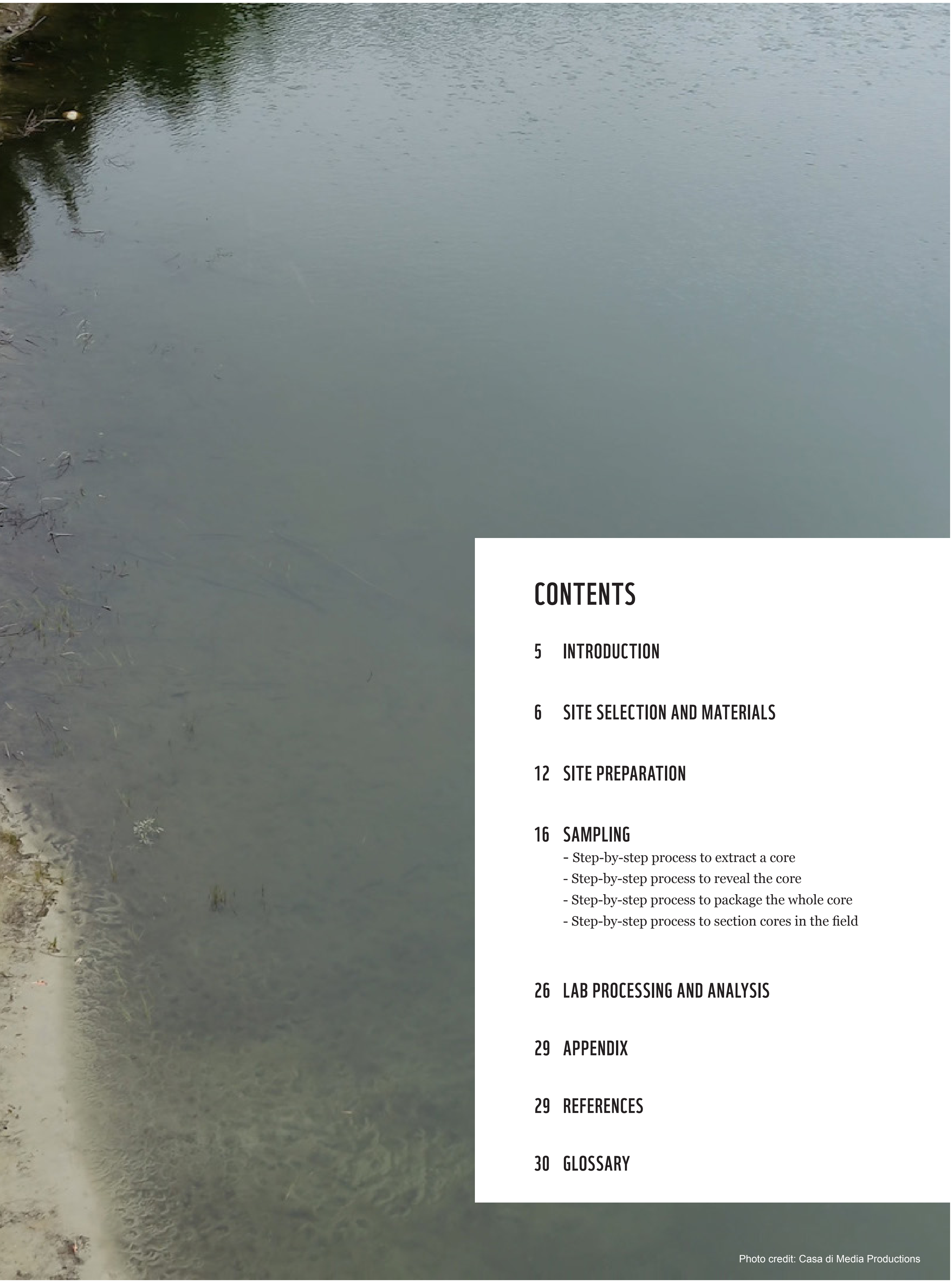


Photo credit: Casa di Media Productions

CONTENTS

MEASURING CARBON IN

PEAT SOILS

INTRODUCTION

Peatland ecosystems, such as bogs, fens and swamps, are known to be effective at sequestering and storing atmospheric carbon in large amounts. They also support biodiversity and provide many other important ecosystem services such as water purification, nutrient cycling and flood regulation. While carbon is stored temporarily in the above-ground plant material of these ecosystems, most is stored in the soil over a much longer time. There has been recent growing interest in the protection, sustainable management and restoration of peatlands as nature-based climate solutions, given their ability to capture and store atmospheric carbon.

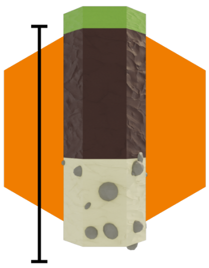
PEAT CORE

The most common method for measuring the carbon stored by peat is by taking peatland soil cores. Information from peatland soil cores, also called **peat cores**, can provide useful information on physical, chemical and biological processes. Some of the most common peat core data includes:

1) **Accumulation rates of soils**, which is the rate at which peat builds up. Changes to rates of peat accumulation can reflect local ecosystem disturbances as well as large-scale climatic shifts.

2) **Carbon stocks and sequestration rates** of peat, which can provide information on the climate change mitigation potential of peatland ecosystems and help inform the resilience of these ecosystems to environmental change. Both carbon stocks and carbon sequestration rates rely on information about the **carbon content** of the peat (i.e., the proportion of carbon in a sample) and its **bulk density** (i.e., the weight and volume of a sample in a peat core).

3) **Biodiversity and biological indicators of change**, which can be examined using a range of genetic, microscopic and biogeochemical tools. This data can be used to understand community and species changes in association with a changing environment.



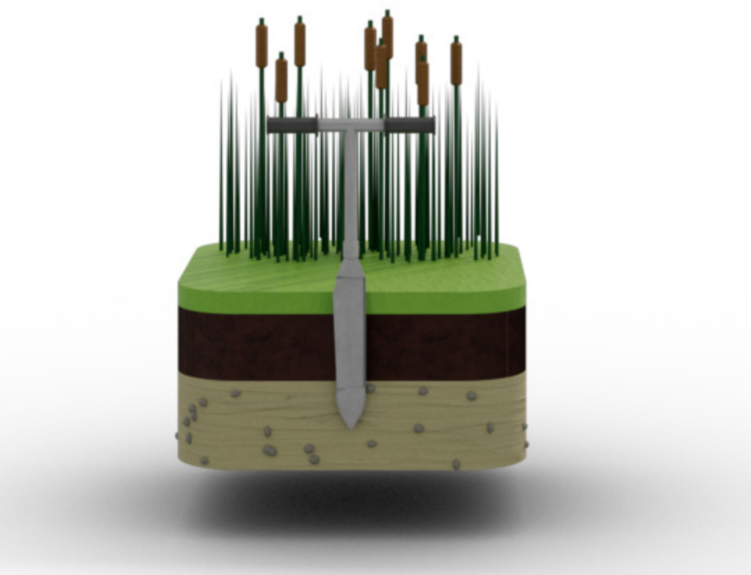
BULK DENSITY

THE TOTAL AMOUNT OF SOIL
(WEIGHT / VOLUME)

In this guide and its corresponding video, we demonstrate how to take peat cores in the field and describe how to obtain carbon values. Due to the large diversity of soil types found throughout Canada, the tools required for your specific site may vary. For a more comprehensive list of potential alternative techniques, refer to Bansal *et al.* (2023) and *The Blue Carbon Handbook (2023)*. Be sure to plan for lab analysis in advance to ensure the data collected meets the end goals of the project. Detailed information about processing samples for lab analysis for carbon measurement can be found in the document "Supplemental Guide: Laboratory Analysis." Reach out to the lab the team will be working with to see if they have any specific requirements. Please note that these guidelines are specific to collecting field data in plots, and the specific plot dimensions and number of samples may have to be adjusted based on the size of the study area.

1

SITE SELECTION AND MATERIALS



Before taking soil core samples, it is important to think about sampling locations and logistics for the coring sites. Consider the following:

- Where is the study region located?
- How large is the study area?
- How much variation is there across the study area?

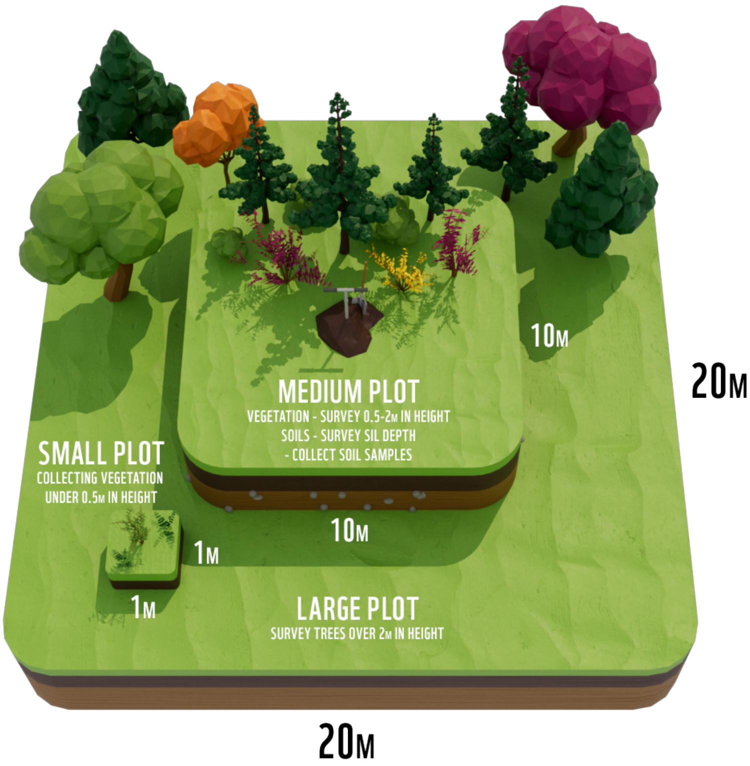
This will help inform key aspects of the project design, including:

- How many sites are needed within the study area
- Where the sites should be located
- How many peat core samples should be collected at each site
- How deep the peat core samples should be

SAMPLING FROM MULTIPLE CARBON POOLS

The team might be interested in sampling multiple carbon pools (e.g., sampling for trees, small vegetation and soils) from the same area. One method of accomplishing this is to use a nested/integrated plot design. This means setting up plots for each carbon pool that overlaps in a study area.

Nested/integrated plot design involves mapping out plots for large vegetation, medium vegetation, small vegetation and soil carbon before beginning sampling. In permanent plots, where carbon monitoring surveys are going to be repeated at the same location over multiple years, ensure that soil carbon samples and any other "destructive" sampling techniques are being completed outside of plot areas where non-destructive sampling takes place (e.g., vegetation plots; see the document "Supplemental Guide: Sampling Design," in the online Learning Library). Peat sampling is a destructive sampling technique; as a result, vegetation surveys must be completed **before** soil samples are collected in all plot types.



Schematic diagram of a nested/integrated plot design, where soils are sampled alongside the three vegetation types, within their respective large, medium and small plots.

For smaller study areas (e.g., 50 hectares [ha] or less) a systematic survey of soil depths using a soil probe can help with identifying study sites and plot locations. Larger study areas (e.g., 10,000 ha or more) require using mapping software to select plot locations. For more details, please see the section "Supplemental Guide: Sampling Design," in the online Learning Library.

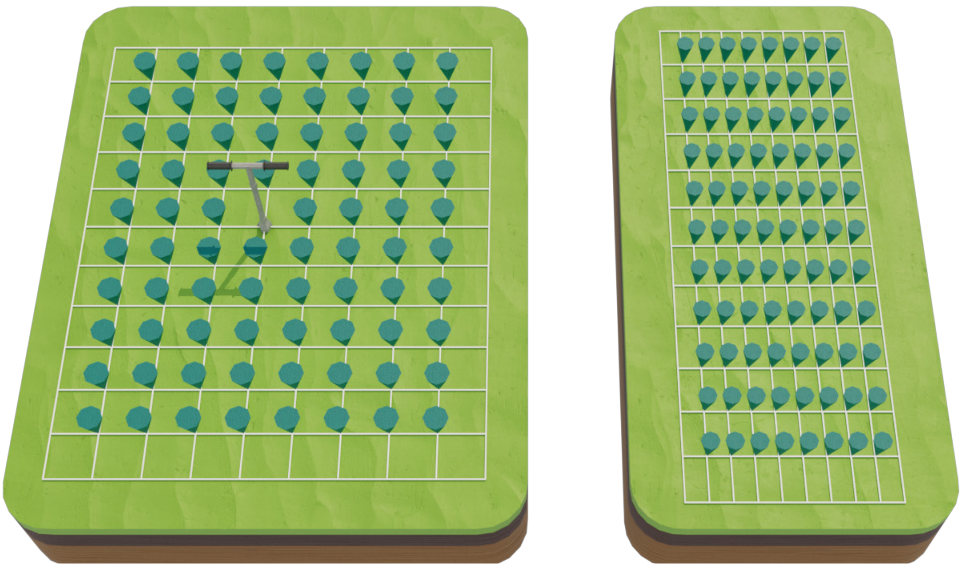
Note: *"Soil depths" refers to the depths from the ground surface to the "substratum," or the hard clay or bedrock materials underlying the soil.*

There are two ways to survey the site to determine the variation in soil depths. Both methods are described in the steps below.

STEP 1: SYSTEMATIC SURVEY OF SITE

1. The first method, which is done before going into the field, involves digitally overlaying a grid on the site. In the field, this grid acts as a map, where depths can be measured with a soil probe at every line intersection of the grid. Generally, lines are 10–25 metres (m) apart.

2. The second method also involves sampling at 10–25m increments but relies on the use of a compass and measuring tape.
    - Beginning at one end of the site, use the compass to run a measuring tape 10–25m across the site. Record the soil depth at the start and end of the measuring tape. Then, from the end of the tape, lay out the measuring tape another 10–25m in the same direction, taking soil depth measurements at each end of the tape measure. When a boundary of the site is reached, turn perpendicular to the current line and measure 10–25m. Run the measuring tape in the opposite direction parallel to the first line, continuing to measure soil depths at each end of the tape measure. Repeat this for the entire site to result in a soil depth measurement at every 10–25m intersection of the site.

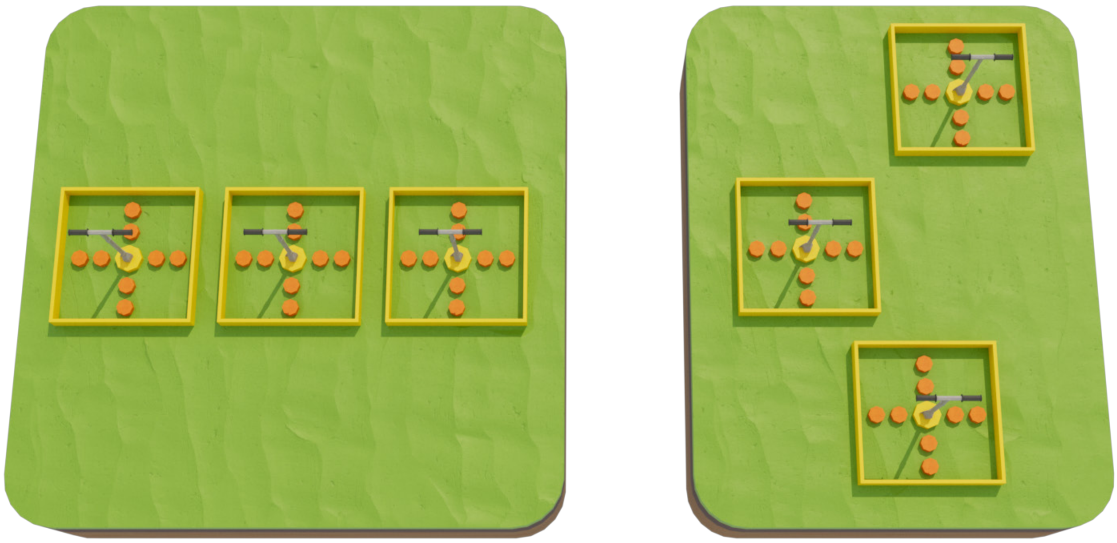


Example survey grid, where at each dot a measurement of peat depth is taken and recorded. This information is used to understand the variation in peat depths across the site, which will help to ensure sampling is effective.

STEP 2: PLOT IDENTIFICATION

Within each site, one to five plots can be established, depending on the nature of the site. Larger study areas (e.g., >10,000ha) may require 12 to 15 plots per site, with five to ten sites per study area — though the exact number depends on the size and variability of the site.

Plots can be established across the varying soil depths to capture the variation across the site. To sample within each site, plots are laid out to obtain a representative sample of the entire site. Within each plot, the coring site is established in the middle, and soil depths are taken every at every line intersection on the plot. The goal of surveying the soil depths within the plot is to take a measurement of soil depths at every 1m intersection within a 10m-by-10m plot. There are two methods for accomplishing this.

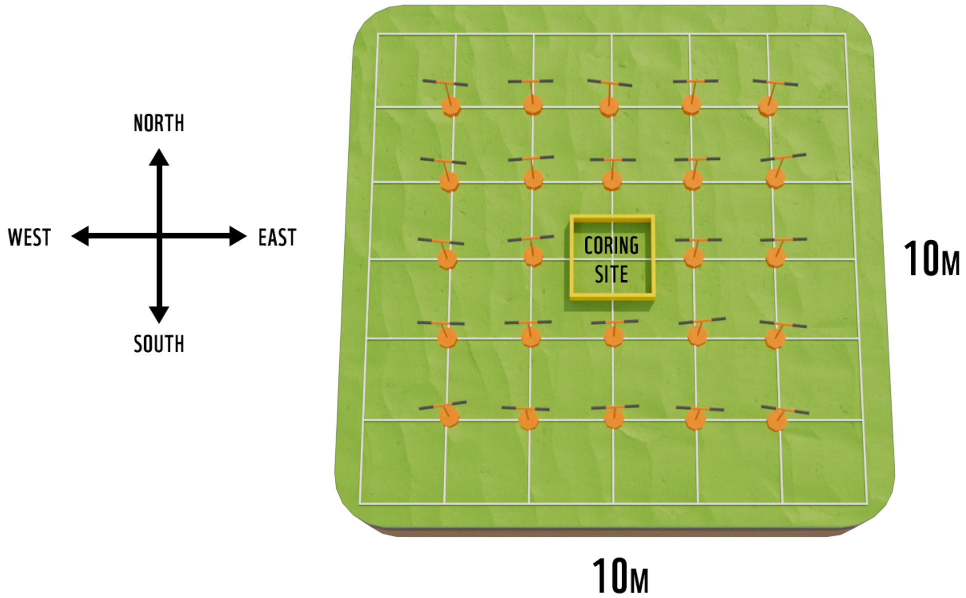


Example of how, using the recorded peat depths, plots can be laid out to capture the variation in peat depth across the study site. Note that this is most effective for small-scale study areas (e.g., 50ha or less). For larger study areas, a systematic random sampling technique is typically used (please refer to "Supplemental Guide: Sampling Design" for more details about larger projects).

PLOT IDENTIFICATION

1. The first method involves digitally overlaying a 1m-by-1m grid on the plot and recording the depth of the peat layer at every grid intersection.

2. Alternatively, beginning at the plot edge, run a measuring tape vertically from end to end (10m). Run a second measuring tape perpendicular to the first, starting at one end of the first measuring tape. Take a measurement of soil depth at every metre along the second tape. Move the tape one metre at a time across the plot and continue this process, eventually measuring for each 1m intersection in the plot.



An example of a 10-by-10m plot layout for taking peat cores, where each dot is a measure of the peat depth, and the coring spot is selected within the plot as a representation of the entire plot (typically average depth of the area, free from obstruction).

SECTION SUMMARY: SELECTING A CORING SPOT

- **Within each site, use a soil auger or soil probe to survey the depths of the peat at every 10–25m grid intersection across the study site following a strategic method.**
- **Establish plots within the site to capture the variation in peat depth across sites. Alternatively, select the plots at random in larger study areas.**
- **Survey every 1m-by-1m within a 10m-by-10m plot to ensure the coring location is representative of the plot area.**

REQUIRED FIELD EQUIPMENT

HERE'S WHAT YOU'LL NEED:

For setting up a plot:

- Permanent markers
- Packing material
- Cooler or storage box
- Tarps
- Small whiteboard and markers
- Utility knife
- Camera
- Notebook

For taking a peat core:

- Side-filling peat corer (number of extension rods depends on desired depth)
- Sledgehammer (optional)
- Vice grips
- Work gloves
- Measuring tape
- Duct tape

Additional material for whole core packaging:

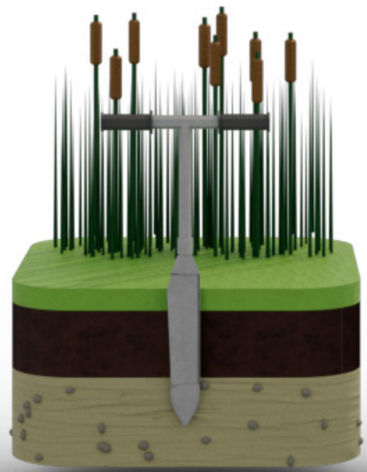
- PVC pipe cut lengthwise (at least as long as core size)
- Plastic wrap
- Aluminum foil
- Poster board/cardboard cut to length and width of PVC pipe
- Duct tape
- Permanent marker
- Cooler

Additional material for in-field sectioning:

- Measuring tape
- Knife
- Resealable bags
- Permanent markers/labels
- Trowel or flat blade

2

SITE PREPARATION

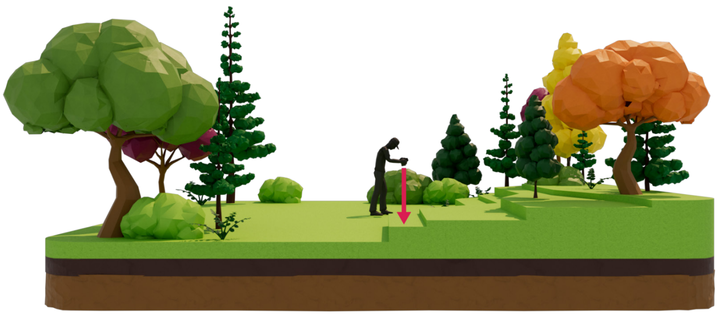


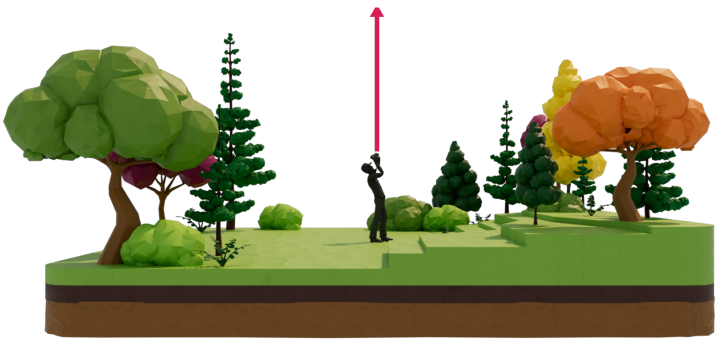
SITE PREPARATION

Once the team has arrived at the site, document the vegetation using a standardized photo series protocol.

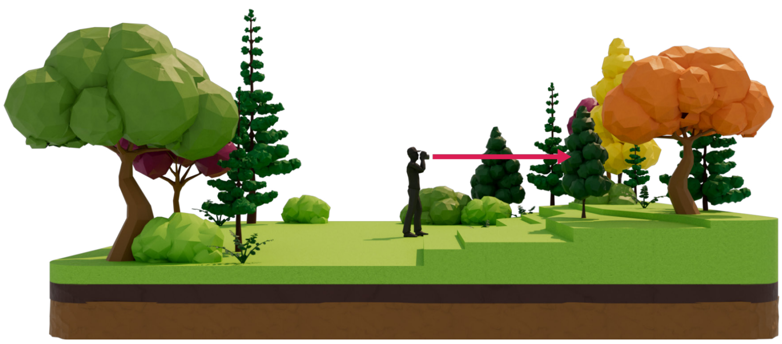
PHOTO SERIES PROTOCOL

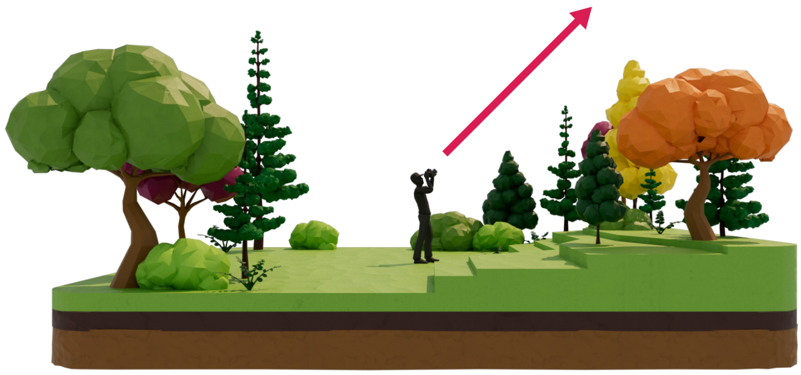
1. Start by documenting vegetation and canopy cover (if any) by taking two photos of the site:
   a. One pointing straight down (vegetation)
   b. One pointing straight up (canopy)



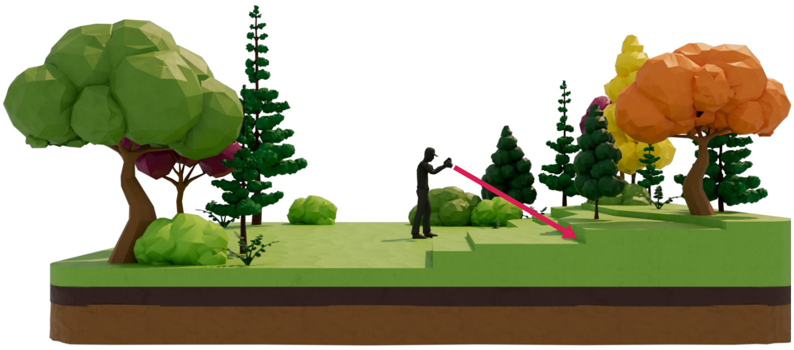


2. From the same spot, turn to each cardinal direction and take three photos:
   a. One parallel with the ground





b. One angled 45 degrees up



c. One angled 45 degrees down

3. Once finished, there will be 14 photos of the site (i.e., three photos for each cardinal direction, one documenting vegetation and one documenting canopy cover).

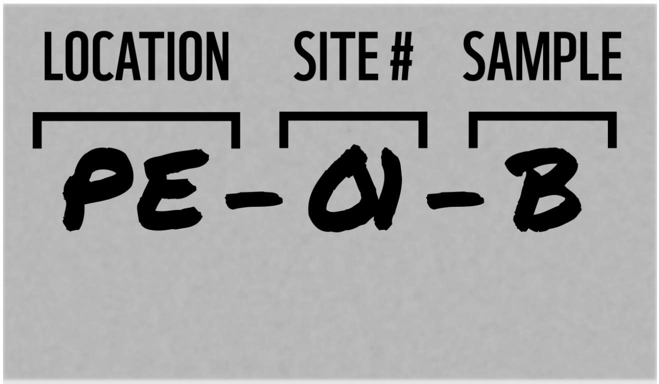
14 PHOTOS

3 PHOTOS FOR EACH CARDINAL DIRECTION

1 DOCUMENTING VEGETATION

1 DOCUMENTING CANOPY COVER

Be sure to record the site with a waypoint in a GPS and note the coordinates and site identifier in a notebook. Regardless of the number of samples being taken, we recommend using a systematic approach (i.e., using unique identifiers or CoreIDs) for labelling each core. The CoreID “PE-01-B,” for example, identifies the location (PE refers to “Peawanuck”), the core number or coring site e.g., “01” refers to the first site) and the sample (e.g., the second sample is “B”).

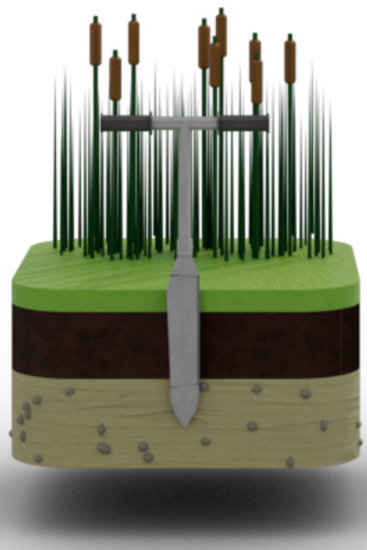


SECTION SUMMARY: SITE PREPARATION

- **Record the CoreID. For example, PE-01-B represents “location-site-sample.”**
- **Record the latitude, longitude and elevation of the coring site.**
- **Document the vegetation of the coring site using a 14-photo photo series protocol by taking photos from the coring site that capture views pointing:**
  - **straight up (canopy)**
  - **straight down (vegetation)**
  - **for all cardinal directions: one parallel with the ground, one 45 degrees up, and one 45 degrees down**

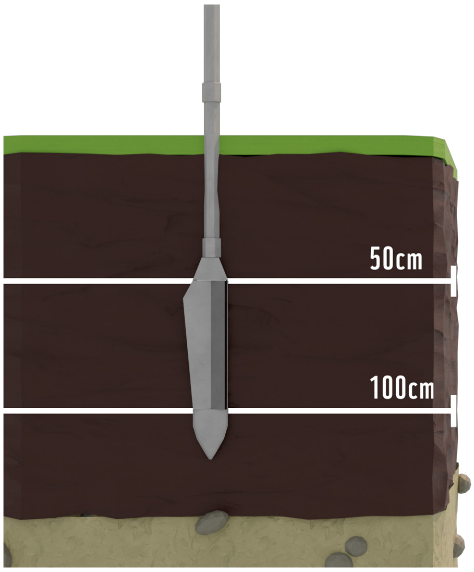
3

SAMPLING



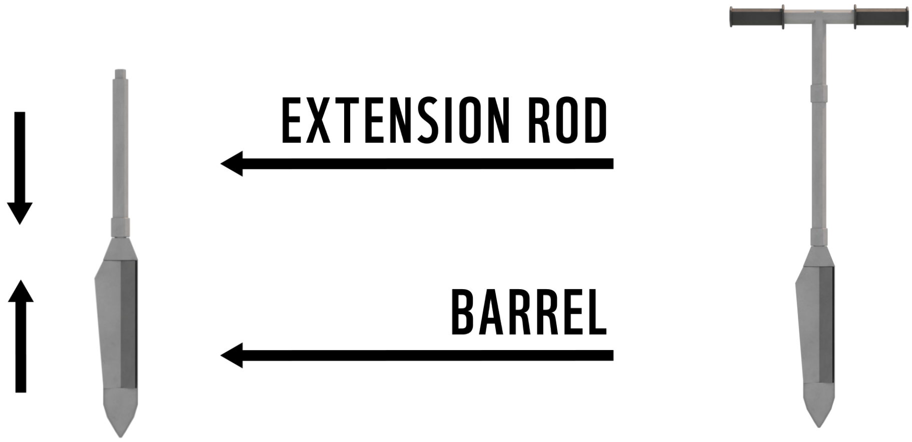
Before coring, find a flat area close to the coring spot, lay down a tarp and prepare all the required equipment.

There are various methods for taking peat cores, but this guide will focus on the most common and versatile method, which uses a Macaulay (or Russian) peat corer. This tool collects 50-centimetre (cm) samples. Therefore, to collect a full core (from the peat surface to the peat bottom, described in more detail in the Appendix), samples are taken sequentially in 50cm increments. The first sample is taken to a depth of 50cm, the second to 100cm and so on, until the corer can't be pushed any farther, indicating that it has reached the clay, rock, or any other object obstructing the core (see "refusal" in the Glossary).

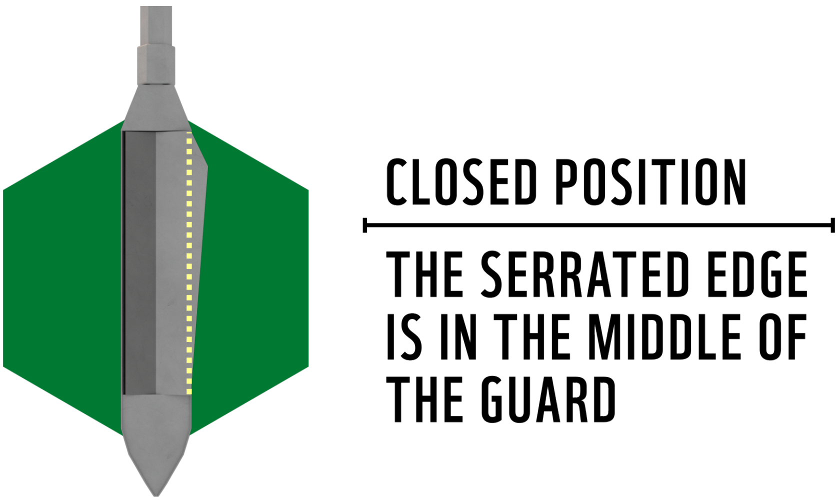


SAMPLES ARE TAKEN SEQUENTIALLY IN 50cm INCREMENTS

Macaulay/Russian corers are referred to as side-filling corers, characterized by their semi-cylindrical barrel with a pivoting guard and their attached extension rods and handle. To assemble the corer, attach a minimum of one extension rod to the barrel, either by screwing it in or securing it with a pin. The number of extensions required depends on the depth of peat being sampled. Generally, one additional extension rod is added for each 1m sampled to accommodate the increased sample depth. Attach the handle to the top of the corer.



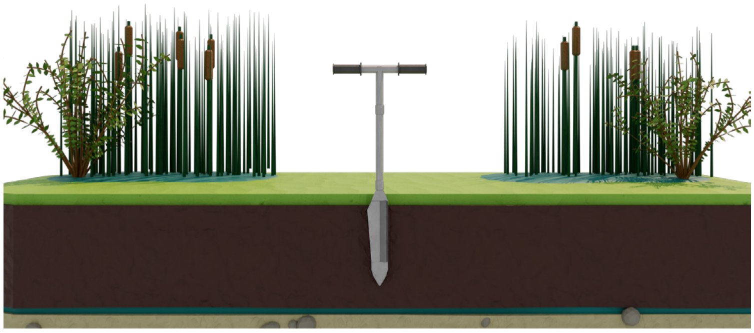
When coring, the guard remains locked in place as the handle is turned and the cylindrical barrel cuts through the peat, which closes and secures the peat inside the barrel. Note that peat core barrels have an "open" and a "closed" position. Check to see if the barrel has a serrated or sharpened edge; if the serrated edge is on the inside edge of the guard, the corer is in the "open" position. If the serrated edge is in the middle of the guard, the corer is in its "closed" position. Mark which position is "closed" to provide an easy visual cue.



STEP-BY-STEP PROCESS TO EXTRACT A CORE

1. Gather a team of three to four people who can assist with the steps that follow.

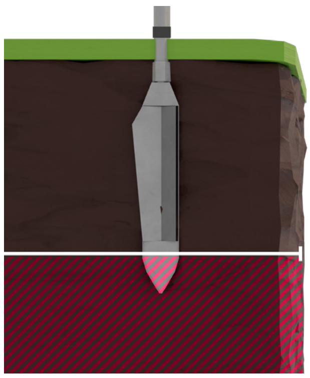
2. With the corer in the “open” position, align the corer with the selected coring spot.



3. Using the handle, push the corer into the peat until the top of the barrel is in line with the top of the sample being collected.

   a. How easily the corer pushes into the peat will differ depending on the density of the peat. Extremely dense peat might require two or three people on either side of the corer pushing down together, or a sledgehammer may be needed to persuade the corer into the ground.

   b. Make sure not to push the corer any deeper than the intended sample depth or the sample will be invalid. This risk can be mitigated by labelling the desired depth on the corer itself with tape before inserting it.



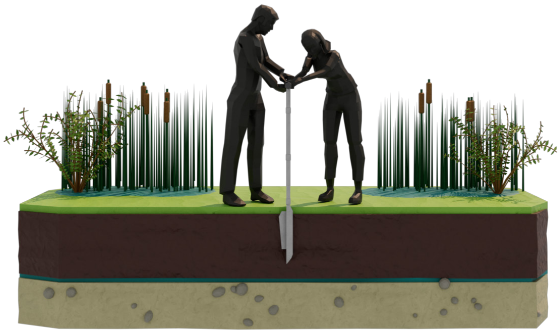
DO NOT PUSH THE CORER ANY DEEPER THAN THE DESIRED SAMPLE DEPTH

MARK THE DEPTH ON THE CORER WITH DUCT TAPE

EXTRACTING THE CORE

TURN THE CORER 180°

4. Once the corer is fully inserted, turn the handle 180 degrees so that the barrel carves through the peat, meeting the guard. It is now in the "closed" position.



TOGETHER, CAREFULLY LIFT THE CORER OUT OF THE GROUND

5. To extract the corer, one person lifts from the handle, ensuring that the barrel stays pressed against the guard by applying rotational pressure on the handle to keep the corer in the "closed" position.

6. A second person lifts lower on the extension rods, as close to the ground as possible, ready to catch and clasp the barrel and the guard together as it comes out of the ground.

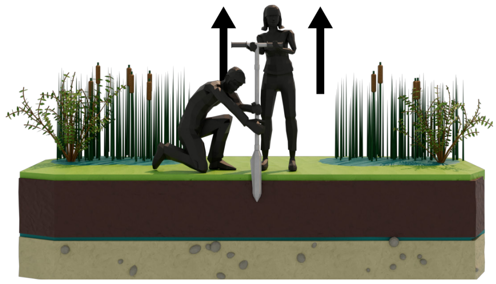
7. When lifting the corer out of the ground, try to keep it as straight as possible, until the corer is fully out of the ground.
   a. If the corer gets stuck, gently rock it back and forth to remove any suction and help free it.

8. Once the corer is fully removed from the ground, continue pressing the barrel against the guard to prevent any sample spilling out.

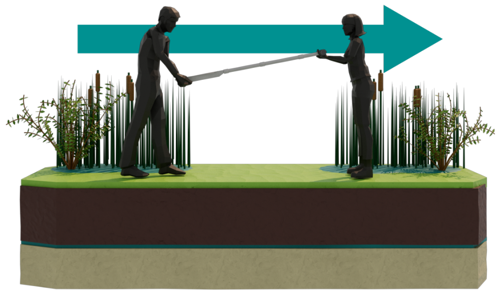
9. Turn the corer horizontally so the sample is resting on the guard and the barrel is facing upward.

10. Keep the core in this horizontal position when transporting it to the designated processing area.

LIFT STRAIGHT UP



TRANSPORT THE PEAT CORER TO YOUR PROCESSING AREA



SECTION SUMMARY: EXTRACTING THE CORE

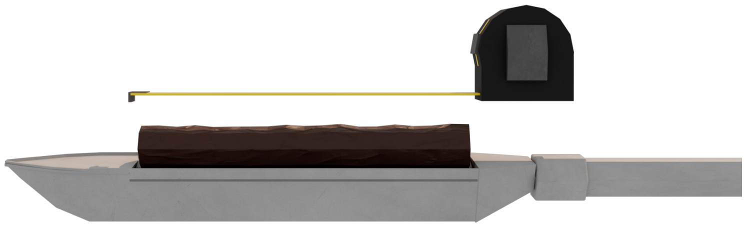
- **With the corer in the "open" position, align the corer as straight as possible in the coring spot and push it into the ground.**
- **Continue pushing the corer into the ground to its desired depth, which can be marked with tape on the corer itself.**
- **Turn the corer handle 180 degrees into its "closed" position.**
- **Lift the corer out of the ground, clasping the barrel and the guard together as it is pulled from the ground.**
- **Turn the corer horizontally with the core barrel facing upwards and transport to the processing area.**

STEP-BY-STEP PROCESS TO REVEAL THE CORE

MEASURE THE PEAT CORE

With the corer extracted, the core is ready to be revealed, measured and photographed.

1. On a flat area, lay the corer on a tarp with the barrel facing upward.
2. Keeping the corer in a horizontal position, have one person hold the barrel and guard, opening the barrel to reveal the sample as the corer turns.
3. Have a second person hold the corer handle and turn the corer while the first person helps reveal the sample. The corer may need to be lifted off the ground; ensure it is kept horizontal.
4. Once the core is fully open and the sample is fully revealed, lay it flat on the tarp again.
5. Measure the length of the core and make notes of any distinct changes in the soil profile in a notebook, such as:
   a. changes in colour;
   b. changes in texture;
   c. whether changes are gradual or distinct;
   d. visibly large objects, such as: wood, rocks, roots and other plant materials;
   e. any missing areas or gaps in the core;
   f. water saturation.



Mark the site and core number on the whiteboard and take photos of the core from above so that the entire core profile and whiteboard is in frame. Ensure that there are no shadows over the core when photographing.

SECTION SUMMARY: REVEALING THE CORE

- **Lay the corer flat on the tarp with the barrel facing upwards.**
- **Keeping the sample inside the corer facing upwards, reveal the core by opening the guard and turning the corer. Lay the corer back on the tarp with the sample exposed.**
- **Record the:**
  - **core length (cm)**
  - **any changes in soil colour or texture**
  - **any visibly large materials**
  - **gaps in the sample**
  - **water saturation (mucky, semi-saturated, dry, etc.)**

STEP-BY-STEP PROCESS TO PACKAGE THE WHOLE CORE

Once all measurements, notes and photos are taken, package the peat core for further analysis. Decide ahead of time whether the core will be sectioned in the field or transported whole to a lab. If short on time, transport the whole peat core to the lab for subsequent sectioning and processing.

Steps for packaging the whole core:

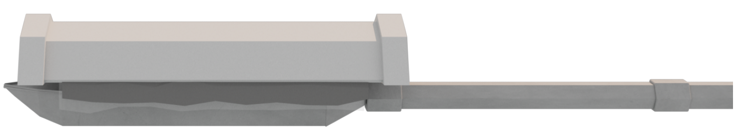
1. Double check to make sure the PVC pipe and the poster board cutouts are labelled on the top and bottom.

2. Line the PVC pipe with aluminum foil and plastic wrap.

3. Place the PVC pipe over the core, making sure the “top” label is at the top (closest to the surface) and the side labelled “bottom” is at the bottom.

4. Carefully flip the corer together with the PVC pipe upside down so that the core falls into the cradle of the PVC pipe (this process will need at least two people).

TRANSFER THE CORE TO THE PVC PIPE



5. Depending on the soil type, the sample may be stuck to the corer. If so, use a serrated knife or flat blade to separate the sample from the corer. Make sure to wash the knife between each section to reduce contamination.

6. Once the sample is fully removed from the corer, place the corer to the side.

7. Wrap the sample in plastic wrap and aluminum foil, continuing to keep note of top and bottom.

8. Place a piece of poster board over the sample.

9. Secure the poster board with duct tape.

10. Using a permanent marker, label the sample with its CoreID.

11. Keep the sample horizontal and poster board facing upright. Store the sample in an empty cooler.

12. Ensure the cooler is packed so as to limit the movement of samples in transit.

13. Transfer the sample to a freezer as soon as possible for subsequent lab analysis.

14. After the sample has been packaged, clean the corer and tools thoroughly.

WRAP THE PLASTIC AND FOIL AROUND THE CORE

SECURE THE SAMPLE USING POSTER BOARD AND TAPE

SECTION SUMMARY: PACKAGING THE CORE WHOLE IN THE FIELD

- **Label poster board and PVC-pipe cutouts "top" and "bottom."**
- **Line the PVC pipe with aluminum foil and plastic wrap.**
- **Place the PVC pipe over the core, with the top (closest to the surface) and bottom labels in the appropriate position.**
- **Flip the corer and PVC pipe over so that the core sample falls inside the PVC pipe. Use a knife to separate the sample from the corer if it gets stuck.**
- **Wrap the sample in plastic wrap and aluminum foil.**
- **Place a piece of poster board over the sample, ensuring the "top" and "bottom" labels are in the right position, and secure it with duct tape.**
- **Transport the sample to a cooler for short-term storage.**
- **Wash the corer and tools before taking another sample.**

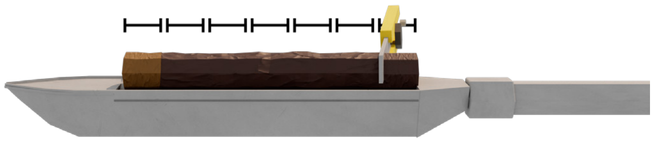
STEP-BY-STEP PROCESS TO SECTION CORES IN THE FIELD

When sectioning samples in the field, sections should be cut and packaged one at a time. Steps for sectioning a peat core in the field:

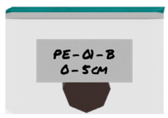
1. Section the core starting from the top (soil closer to the surface) and working down the core to the bottom, one section at a time.
2. Each section should be cut at a distinct layer of the peat profile, so that each section is a homogenous mass.
3. Sections should be at least 1cm and no more than 5cm in length.
4. Cut the section at the desired length using a serrated knife.
5. Keep the knife positioned where it made the cut and use a trowel to transfer the section to a pre-labelled resealable bag.
6 Immediately transfer the resealable bag to a cooler.
7. Wash and dry the knife and trowel.
8. Repeat this process for the rest of the peat core sample until the entire core is sectioned and packaged in the cooler.
9. Transfer the sections to a freezer as soon as possible for subsequent lab analysis.
10. After all the sections have been packaged, clean the corer and tools thoroughly.

Note: This method works most efficiently with one person sectioning and another person labelling the bags with CoreID, section number and section depth interval.

CUT SECTIONS 1-5cm IN LENGTH



TRANSFER THE SAMPLE TO A PRE-LABELLED RESEALABLE BAG

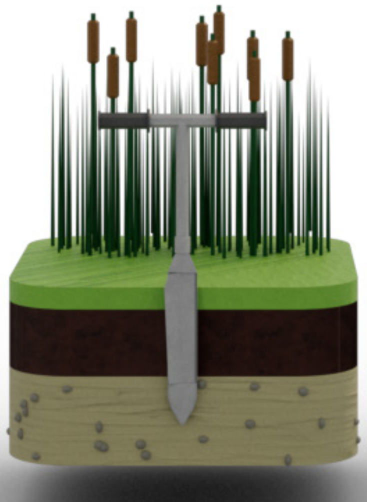


SECTION SUMMARY: SECTIONING THE CORE IN THE FIELD

- **Using a knife, cut the section at the desired depth.**
- **Start from the top of the core sample (part that is closest to the surface) and cut out sections of the core sample at distinct changes in soil colour or texture.**
- **The samples should be taken one at a time and be at least 1cm and no more than 5cm in length.**
- **Using a trowel, transfer the sample to its appropriately labelled resealable bag and place the sample in a cooler.**
- **Wash the knife and trowel and repeat the sectioning steps for the entire core sample.**

4

LAB PROCESSING AND ANALYSIS



If planning on doing the lab analysis independently, please see the document "Supplemental Guide: Laboratory Analysis." Alternatively, soil cores can be sent to a lab for analysis, in which case it's important to contact the lab ahead of time for specific requirements regarding the handling, packaging and delivery of the samples. There are multiple methods for determining the carbon content of the samples; the list below provides a brief overview of common methods and what they mean for calculating carbon stocks.

Dry bulk density

A key component of estimating the stock of an ecosystem is first determining how much material is in the ecosystem in the first place. Dry bulk density is a measurement of the weight and volume of a sample after it has been dried; this weight is then divided by the volume to obtain a value for the density of the sample (typically in grams per centimetre cubed; g/cm^3). Combining bulk density with other analyses, such as those for carbon, nitrogen, toxic metals or pollutants, can provide additional information that may be of value to the project.

Moisture content

Knowing the amount of water in a sample is important for determining the soil conditions. This is done by weighing the sample fresh from the ground, drying the sample in an oven to evaporate the water and then weighing the sample again. The difference between the fresh and dry sample is the moisture content of the sample.

Loss-on-ignition at 550 degrees Celsius (LOI550)

Once dried, the samples are combusted in a muffle furnace set to 550 degrees Celsius (^oC). Under these conditions, the organic matter (i.e., the dead plant material that has turned into peat or soil) is burnt off, converted to CO_2 and water vapour, and expelled from the sample. The remaining sample after four hours of burning is only the inorganic fraction of the peat or soil. The difference between the unburned weight of the sample and burned weight is called the LOI or organic matter fraction of the sample.

Carbon conversion factor

Organic matter is typically composed of 50 per cent carbon by weight. Using this value, we can convert the organic matter estimate from LOI to estimate the organic carbon fraction of the sample by multiplying the LOI550 value by 0.5.

Other methods might be more practical for estimating carbon content in ecosystems where the soil has a larger fraction of inorganic matter. In this case, methods such as infrared spectroscopy for organic carbon, acid dissolution of CO_2 for inorganic carbon and a CHN elemental analyzer for determining total carbon may be used. For further details on these methods, please see "Supplemental Guide: Laboratory Analysis."

SCALING FROM SAMPLES TO CORES TO SITES TO STUDY AREA

The total soil carbon stock within a study area is determined by the amount of carbon within a defined area and soil depth. It is important to define the depth to which you are measuring and calculating soil carbon stock, typically expressed at either 30cm, 50cm, 1m, or 2m depths. Calculating the total soil carbon for the study area requires the following information:

- dry bulk density (g/cm^3)
- total carbon content (%C) or organic carbon content (%C_{org})
- subsection depth interval (cm) = bottom depth (cm) - top depth (cm)

The average carbon stock of cores can be determined as follows:

1. For each core subsection, calculate the soil organic carbon density:
   - **Eq 1: Soil carbon density (g/cm^3) = dry bulk density (g/cm^3) * (% C_{org}/100)**
   - Note: Total carbon content (%) can be substituted with organic carbon content (%Corg) to determine the soil organic carbon density (g Corg/cm3).
2. To calculate the amount of carbon in a subsection, multiply each soil carbon density value obtained in Eq 1 by the subsection depth interval (cm):
   - **Eq 2: Average carbon stock of subsection (g/cm^2) = soil carbon density (g/cm^3) * subsection depth interval (cm)**
3. To obtain the average carbon stock (g/cm^2) of the core, add up the values for each subsection calculated above:
   - **Eq 3: average carbon stock of core (g/cm^2) = sum of average carbon stocks of subsections**
   - ***Note:*** *Subsections must add up to 100 per cent of the core to obtain the average carbon stock.*
4. Convert the average carbon stock of the core (g/cm^2) from Eq 3 into units of kg/m^2 by multiplying by 10, or more formally:
   - **Eq 4: Average carbon stock of core (kg/m^2) = average carbon stock of core (g/cm^2) * (1kg/1000g) * (10000cm^2/m^2)**
5. Repeat steps one to four for each core.

The carbon stock of a study area can be determined as follows:

6. To obtain the average carbon stock of each study site (kg/m^2), add up the average carbon values from Eq 4 (kg/m^2) for each core obtained and divide it by the number of cores taken in each site.
   - **Eq 5: Average carbon stock of site (kg/m^2) = sum of average carbon stocks of cores (g/cm^2)/ number of cores**
7. Multiply the average carbon stock of the site by the size of the site (in metres square) to obtain the total carbon stock of each site (kg C).
   - **Eq 6: Total carbon stock of study site (kg C) = Average carbon stock of study site (kg C/m^2) * Study site size (m^2)**
8. Add up the total carbon stocks for the sites and divide by the sum of the site sizes. This gives the average carbon stock of the study area (kg C/m^2).
   - **Eq 7: Average carbon stock of study area (kg C/m^2) = sum of total carbon stocks of sites (kg C) / sum of site sizes (m^2)**
9. Finally, to calculate the total carbon stock of the study area (kg C), multiply the average carbon stock of the study area by the size of the study area (in metres square).
   - **Eq 8: Total carbon stock of study area (kg C) = Average carbon stock of study area (kg C/m^2) * Study area size (m^2)**

*The carbon values calculated here are in units of "C." If interested in units of "CO_2 equivalents," multiply by 3.67.

APPENDIX

The Canadian Soil Classification System considers the peat profile as the organic (O) horizon, which is distinguished from the mineral sediments beneath it. When taking notes of each sample collected, it is important to make notes of any observable changes or distinguishing features. Three examples of this are shown below.

Frame A shows a surface core taken from a sphagnum-rich peat bog. An important note for this core would be the depth where the green, living sphagnum transitions to brown peat.

Frame B is a core sample taken between 0.5m and 1m deep. An important note for this core is the dark mucky peat starting at the top and slowly transitioning to a lighter peat, and the depth where significant wood piece is present.

Frame C shows a core where the peat transitions to the mineral layer. Important notes for this sample are the depth of the transitions, the texture and colour of the mineral layer, and the depth where there are many coarse fragments.

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GLOSSARY

Average carbon stock: A measure of the density of carbon in a carbon pool, expressed as carbon per square area, typically as kg/m2 (kilograms per metre square) or t/ha (tons per hectare).

Biodiversity: The variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

Biogeochemistry: Scientific discipline that explores the physical, chemical, biological and geological processes and reactions that govern the composition of and changes to the natural environment.

Biological indicators: Biological proxies found in soil that are sensitive to paleoclimatic changes.

Bog: A peatland system whose surface water and nutrient content is primarily derived from atmospheric sources, such as rain and snow.

Bulk density: The weight of a volume unit of powder, usually expressed in g/cm^3 or kg/m^3.

Carbon accumulation rate: A measure of carbon sequestration calculated by dividing the carbon stock by the age of the sample interval, typically expressed in kilograms of carbon per metre square per year (kg C/m^2/year).

Carbon content: The proportion of carbon in a sample, typically expressed as a percentage or decimal.

Carbon pool: A system that has the capacity to store or release carbon.

Carbon stock: A measure of the amount of carbon in a carbon pool, typically presented in kilograms or tonnes.

CHN elemental analyzer: A device used for rapid, quantitative determination of carbon, hydrogen, nitrogen and sulfur in organic samples. Through a combustion process, these elements are converted to CO_2, H_2O, N_2 and SO_2 gases and sent to the thermal conductivity detector to record the electrical signal proportional to the amount of each gas. This electrical signal then gives, for example, the percentage of elemental composition in proportion to the curve areas obtained in the spectrum.

Climate: The mean and variability of meteorological variables (i.e., weather) over a time spanning months to millions of years.

Climate change: The observed long-term shifts in meteorological variables, such as temperatures and weather patterns.

Coarse fragments: Soil particle or object on soil longer than 2 millimetres.

Crucible: A ceramic or metal container in which metals or other substances may be melted or subjected to very high temperatures.

Dry unit weight: Weight of soil solids (i.e., without any water content).

Dry bulk density: Dry unit weight of a sample divided by its volume, typically expressed as g/cm3 (grams per centimetre cubed) or kg/m^3 (kilograms per metre cubed).

Fen: A peatland supplied by water carrying minerals from surrounding or underlying mineral soil.

Isotope: Atoms with the same number of protons but different numbers of neutrons; can be used to infer the date of an object through the isotope's distinct half-life (i.e., rate of decay).

Lead-210 dating: A method for determining the rate of sediment accumulation within a 100- to 200-year time span using the decay of excess 210Pb activity.

Loss-on-ignition: Scientific method for determining the fraction of organic matter in a sample of soil by burning the sample between 450–950°C.

Mineral horizon: Soil horizons that have less than 17% organic carbon.

Muffle furnace: A laboratory instrument used to heat materials to extremely high temperatures while isolating them from fuel and the byproducts of combustion from the heat source.

Organic carbon: The amount of carbon found within the biomass of a thing (living or dead). Organic horizon: Soil horizons that contain 17% or more organic carbon.

Peat: The surface organic layer of a soil that consists of partially decomposed organic matter, derived mostly from plant material, which has accumulated under conditions of waterlogging, oxygen deficiency, high acidity and nutrient deficiency.

Peat core: A soil core specific to peat soils. A peat core consists of a vertical view (or soil profile) of everything below ground contained in a long clear tube. The core tube contains peat that is removed from a hole in the ground.

Peat core sample: A portion of a peat core that is collected using a peat corer.

Peat core section: A divided portion of a peat core sample, used for laboratory processing.

Peat core subsection: A portion of a peat core section that is further removed to be analyzed separately from the rest of the section.

Peatlands: Wetland type with soil layers consisting of organic horizon 30cm deep or greater.

Plot: Designated area for collecting data and samples.

Radio-carbon dating: A method for estimating the age of carbon-based materials that originated from living organisms through analyzing the ratio of carbon-13 to carbon-14 in a sample.

Refusal: The stage at which a corer can no longer be pushed into the medium it is trying to sample.

Russian-style peat corer: Also referred to as Macaulay or Belarus-style peat corers; side-filling corers designed specifically to take core of terrestrial peat.

Sediment: Particle of soil created from erosional processes.

Sediment accumulation: The vertical buildup of sediment particles.

Site: The specific location where data and samples are taken.

Soil core: Continuous length of soil.

Soil horizon: A layer parallel to the soil surface whose physical, chemical and biological characteristics differ from the layers above and beneath, defined in many cases by obvious physical features, mainly colour and texture.

Soil organic carbon: The carbon that remains in the soil after partial decomposition of any material produced by living organisms.

Soil organic matter: The fraction of the soil that consists of plant or animal tissue in various stages of breakdown (decomposition).

Soil texture: Refers to the proportion of sand, silt and clay-sized particles that make up the mineral fraction of the soil.

Sphagnum: A genus of over 380 species of mosses that colonize and help form bog ecosystems.

Swamp: A wetland with at least 25% tree cover; soil organic horizon depths can vary between shallow to very deep peat deposits.

Waypoint: Geographical position defined in terms of latitude/longitude coordinates.

Wetlands: Areas where water covers the soil, or is present either at or near the surface of the soil all year or for varying periods of time during the year, including during the growing season with the presence of aquatic adapted species.

Wet weight: Weight of soil sample before drying or losing any water content.

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