

Soil Methods

Overview:

In addition to the probes, we are requesting that all participants sample their study areas for nitrogen and carbon in the organic and mineral soils horizons, as well as depth to the mineral horizon, depth to permafrost, and bulk density. The rationale behind these additional measurements is to assess how the warming and snow addition/removal treatments affect total nitrogen in the soils as well as carbon storage. The probes measure only plant available nitrogen over the growing season. In order to convert the nitrogen and carbon data from the lab back to soil content per unit volume of soil or per square meter on the ground, we will need an estimate of the density and depth of the organic and mineral layers, as well as depth of the active layer. Rather than disrupt the individual plots with the larger cores required for bulk density, we are requesting that the bulk density measurements be made at each site (n=5/site) rather than each plot. An excel workbook is attached for recording sampling depths, soil weights, and active layer measurements. Please e-mail the completed spreadsheet to Sarah (scelmend@interchange.ubc.ca) when you submit your samples for analysis.

Coring in plots for total N and total C

In the field

Timing: Since soil nutrients fluctuate considerable over the growing season, we would like to standardize collections across sites by site-specific phenology. Please collect soil cores at peak biomass at your site. This is typically at the end of July in most sites. Be sure to note when the cores are taken.

Equipment:

Small diameter corer (e.g. 3 cm to reduce damage to plots). The corer may be affixed with a razor blade using duct tape, in some sites this seems to help with cutting the organic layer.

Plastic bags and labels for sample collection

Serrated knife

Scissors

Paper bags for drying

2 mm soil sieve and pan

Rolling pin or other tool for crushing dirt clods

Balance

Coring

1. Collect one soil core from each plot in which IEM probes are installed. If it is impossible to core through the organic layer due to roots, remove a sample of the organic layer using a serrated knife or other flat blade. Surface moss can be removed by hand or cut off with a knife or scissors. Core to 10 cm depth. If you do not reach mineral soils by 10cm, extend the depth of coring until you are at least 5cm into mineral soil. In a few wetland sites, it may not be possible to reach mineral soil before permafrost. To the extent possible, take care to avoid compacting the core.
2. Measure the total depth of hole (soil surface to bottom) as well as the length of mineral layer of core; measuring these two variables achieves the best estimate of the depth of the organic layer which is often disturbed during sampling.
3. Separate the core into organic and mineral horizons. If the top layer of organic material was removed with a knife, remember to include that with any remaining organic layer that is in the core itself.
4. Bag samples from the two depths for each plot separately, labeling each bag with soil horizon, site, treatment, plot number. Green plants and large roots are removed from the core before bagging the cores and can be returned to the plot. Soil samples should be stored in coolers with icepacks to keep cool until they can be dried.

Please note 2g dried, sieved, soil is the absolute minimum required to run the analyses; >20 g is preferable to allow grinding and homogenizing of a more representative sample. If you are sending soils to Canada for analysis, the shipped sample will be destroyed after analysis as part of the quarantine requirements. We encourage everyone to take a larger sample if possible and to store half the collected soil in their home labs for future study and comparison

In the lab

Chemical analyses are conducted on air-dried <2mm soil fractions, but we need to know the proportion (by weight) of <2 vs >2mm fractions in order to calculate C and N on a volumetric basis.

1. Air dry the cored samples¹, breaking up large clods and spreading soils as necessary to facilitate drying. If necessary, they can be dried at very low (~45C or less) ovens. **After drying, the samples can be stored and the remaining work done after the field season.**
2. Weigh the entire sample should be and its air dry weight.
3. Sieve soils using a 2 mm soil seive, crush soils (rolling pin on brown paper bags works well) and re-sieve. This process may need to be repeated a couple of times to ensure all the agglomerates are crushed to less than 2mm.

¹ Please note a “sample” refers to the core taken from a given *depth* within a plot.

4. Weigh the total air-dried <2mm soil fraction.
5. Place a >20g subsample of the air-dried <2mm fraction into a labeled ziplock bag for analysis.
6. Reweigh the remaining <2mm soil fraction. Place this fraction in a paper bag and oven dry at ~105°C until completely dry.
7. Bag the >2mm fraction (including >2mm rock, roots, etc) and oven dry at ~105°C until completely dry.
8. Record the dry weight of both oven-dried fractions. These oven-dried soils can be discarded. Note if you are using the same bags for each sample and bag weights are consistent, it is often most efficient to weigh 10 empty bags and subtract the average bag weight. If you do so please remember to also oven-dry empty bags, and subtract the appropriate weight (e.g. for oven-dried bags for oven-dried samples).
9. If you are having samples analyzed in Canada, ship air-dried <2mm samples in ziplock bags or other *sealed* containers to:

Clive Dawson

Forestry and Technical Services Section, Research Branch

Research Branch Laboratory

4300 North Road

P.O. Box 9536 Stn Prov Govt

Victoria, B.C. V8W 9C4

Phone: (250) 952-4133

Fax: (250) 952-4119

Please do NOT send ship soils to Clive unless you have told Sarah that you intend to do so, and we have gotten the appropriate import permits. Otherwise your samples may be sent back or destroyed

Coring in study sites for bulk density

Since bulk density measurements require larger core samples, we are requesting that 5 of these be taken in each SITE, rather than in individual plots.

Equipment

1. Corer, minimum 75mm inner diameter
2. Serrated knife (e.g. a steak knife)
3. Ruler
4. Paper bags
5. Drying oven
6. Balance

In the field

- 1.** Collect 5 soil cores from the immediate area (same plant community) around each *site* in which IEM probes are installed. If it is impossible to core through the organic layer due to roots, remove a rectangle of the organic layer using a serrated knife or other flat blade. Measure and record length, width and depth along with core number. Place in a labeled paper bag. Surface moss can be removed by hand or cut off with a knife or scissors. Core to 10 cm depth. If you do not reach mineral soils by 10cm, continue coring deeper until you are at least 5cm into mineral soil. To the extent possible, take care to avoid compacting the core.
- 2.** Measure the total depth of the hole (soil surface to bottom) as well as the length of mineral layer and organic layers of the actual core (the length of the organic layer in the actual core will likely be somewhat shorter than that on the ground). We can use these differences to account for compaction that occurred during coring.
- 3.** Section off a solid segment of part of the mineral core (and as separate, solid segment of part of the organic core, unless it was previously sampled with a knife). Record the lengths of the 2 sampled sections of core, as well as the inner diameter of the probe, for volume calculation. The idea here is to get a solid (i.e., no holes introduced from coring, and sliced flat on the ends) cylinder to calculate volume.
- 4.** Place the organic and mineral soil core segments into separate, labeled paper bags. Enter the sample dimensions into the attached spreadsheet to calculate the volume of the cores: Volume of a cylinder is: $V = \frac{1}{4}\pi d^2 \cdot ht$ (d=inner diameter of core, ht=length of core) or rectangles (L*w*ht) if you used the breadknife-technique on the organic layer. Formulas are also included in the spreadsheet.

In the lab

- 1.** Place samples in paper bags in an oven set to ~105°C. Drying time varies with core size and oven type. After drying record the weight of the dry soil. Note if you are using the same bags for each sample and their weight is consistent, is often most efficient to weigh 10 empty bags and subtract the average bag weight. If you do so please remember to also oven-dry empty bags, and subtract the average weight of oven-dried bags from each sample. After weighing, these soils can be discarded.

Active layer measurements (modified from Itex manual)

In the field:

Equipment:

<1cm diameter rigid metal rod

1. In each plot, measure active layer thickness at peak growing season (within 3 days of when soil cores are taken) Measurements are made with a thin, rigid metal rod (less than 1 cm in diameter) calibrated in centimeter increments, and pushed vertically into the soil to the depth at which ice-bonded soil provides firm resistance. When removing the rod, extreme care should be taken to prevent disturbance to the soil.