Vermont Long-Term Soil Monitoring Study Methods Manual

Version 1.0

Last updated: May 24, 2021

Preferred citation: Villars, T.R., Wilmot, S.W., Bailey, S.W., Ross, D.S., Quintana, A., Shanley, J.B. and J.A. Duncan (Eds.) 2021. Vermont Long-Term Soil Monitoring Study Methods Manual, Version 1.0. Forest Ecosystem Monitoring Cooperative: South Burlington, VT. https://www.doi.org/10.18125/j2oftg

Contents

Introduction

The impacts of air pollution and climate change on forest soil quality are a concern to land managers and the general public. Potential concerns include the fate of heavy metals (e.g. mercury) deposited from the atmosphere, loss of available nutrients (especially calcium and magnesium) from acid anion-induced leaching, and changes in carbon and nitrogen due to nitrogen saturation and the effects of climate change. Potential implications of such changes include loss of biodiversity and forest productivity (regeneration, and growth and mortality rates) and degradation of water quality (increases in heavy metal, aluminum and nitrate concentrations; decreases in pH, base cations and alkalinity). Despite these concerns, documentation of temporal patterns in forest soil quality is rare and difficult to obtain due to confounding effects of spatial variability and the slow rate of change compared to the time span of typical scientific studies. To address this need, a committee of scientists associated with the Vermont Monitoring Cooperative (VMC) established a long-term forest soil monitoring study, with representatives from the University of Vermont (UVM), Vermont Agency of Natural Resources (VT-ANR), Natural Resources Conservation Service (NRCS), the USDA Forest Service Green Mountain National Forest (USGS-GMNF, later Green Mountain and Finger Lakes National Forest) and Northern Research Station (USFS-NRS). The VMC, now the Forest Ecosystem Monitoring Cooperative (FEMC), produced this manual with these partners to document the evolution of the study methodology in preparation for the 2017 sampling year.

The most recent information on the Long-Term Soils Monitoring Study can be found online at https://www.uvm.edu/femc/data/archive/project/long-term-soil-monitoring.

Study Design

The initial dialogue began at a workshop held at the Proctor Maple Research Center on April 29, 1998. A working group was formed including Sandy Wilmot (VT-ANR), Deane Wang (UVM), Thom Villars (NRCS), Tim Scherbatskoy (UVM), Don Ross (UVM), Nancy Burt (USFS-GMNF), and Scott Bailey (USFS-NRS). The area of study would include both the VMC study sites at Mount Mansfield and in the Lye Brook Wilderness Area. Sampling would be done periodically over a 200-year period with sample archiving at each interval.

Following site reconnaissance during the 1999 field season by Thom Villars, and further reconnaissance by Villars and Scott Bailey, the choice of sites was narrowed to five: 3 on Mount Mansfield and 2 in the Lye Brook Wilderness Area. The locations collocated at VMC sites were chosen to facilitate interactions with other types of forest monitoring and to provide for long-term protection from other land uses. The 5 sites represent a range of forest cover types and elevations: subalpine; conifer/hardwood transition; and northern hardwoods at Mount Mansfield, and coniferous and northern hardwood at Lye Brook. Sites are as internally uniform as possible to minimize possible spatial variability that could compromise detection of temporal trends and are relatively stone-free to minimize logistical difficulties. As part of the Green Mountain Biophysical Region, the soils at these sites are representative of large forested areas. Tree species at these sites were characteristic of climax forests, but did have a history including logging activity.

A 50X50 m site size was established using permanent markers at each corner. This size allowed for 100, 5x5 m sampling points (plots) with similar canopy characteristics to minimize confounding factors. Using a random number generator, 10 sample plots were selected at each site for each sampling year. In 2000, soil characterization and sampling was conducted by the NRCS using a pit outside the 50x50 m plot at each site and soil descriptions were conducted at the NRCS Nebraska Laboratory. Sites were established and sampled for the first time in 2002, and again in 2007, 2012, and 2017.

In 2017, following soil results from previous sampling years showing a statistical need to revise sampling intervals to every 5 years to show trends over time the team decided to further subdivide each remaining plot into four 2.5x2.5 m quadrants and sample within one randomly chosen quadrant. If the chosen quadrant was not sampleable because of large boulders or other obstruction, sampling in a second randomly chosen quadrant was attempted, etc. The original randomization of the plots was kept the same. Over time, after working through all the plots once using the first sampleable quadrant in each, the team will restart with the remaining plots with unsampled quadrants, which could be as many as 70 (the 30 plots from the first three sampling years are no longer available). It may be necessary to re-randomize the plot selection if one or more of the 70 plots was unavailable because all possible quadrants were used.

Field Methods

Relocation of soil plots

2002	One field crew was responsible for relocation of soil site corners, previously established during the study design phase. The original corners had been flagged during reconnaissance and were more accurately measured with compass and tape during the 2002 establishment. Site orientations were north-south using magnetic north and 15 degrees as a compass bearing. A tape and compass were used to measure the length of each 50-meter side. A wooden dowel was placed at each corner as a temporary marker, then baling twine was stretched along each side for field sampling orientation. The site diagonals were measured to ensure that side lengths and corner angles were as close as possible to an exact square. At a later date, 2003, permanent metal monuments were installed at each of the four corners for relocation at future sampling dates. Corner markers consist of 1 m metal stakes with a round brass survey marker on top with the words, “VMC 200 Soil Plot” and the specific corner. At the Lye Brook Wilderness Area, a Class I Wilderness Area where minimal human presence is required, corner markers were placed so that the top of the survey stakes are below the duff layer. At the Mount Mansfield plots, corner marker stakes protrude just above the soil surface. At each corner, two witness trees are marked using two diagonal bark scribes at DBH and one scribe below ½ m, and distance and azimuth (magnetic) to the corner has been recorded. In addition, GPS coordinates have been recorded using a Trimble GPS unit. Under canopy cover, the accuracy of the GPS corner locations at that time was estimated at 1-3 m. It is anticipated that the location of soil sites and corner markers will be accomplished using the GPS coordinates to find the general location, and a metal detector to locate the corner stakes, particularly at Lye Brook. Witness tree markings will aid in corner marker location and they should be maintained to ensure their visibility over the sampling intervals.
2007	Soil sites and corner markers were found and flagged to facilitate visual contact on the ground during sampling work. Small rock cairns were set up directly around the corner markers for future use in locating the site. All sites are accessed on foot.

2012	Soil sites and corner markers were found and flagged to facilitate visual contact on the ground during sampling work. Small rock cairns were set up directly around the corner markers for future use in locating the site. All sites are accessed on foot.
2017	Soil sites and corner markers are found and flagged by surveyors to facilitate visual contact on the ground during sampling work. Small rock cairns were set up directly around the corner markers for future use in locating the site. All sites are accessed on foot.

Setting up sampling grid

2002	The 50x50 m sites were large enough to support a grid of 100, 5x5 m potential soil sampling locations (plots) over a 200-year period. A random numbers system was used to determine which of the 100 potential sampling plots would be used during each sampling period, and each soil site had its own array of random sample plot numbers. To accurately establish plots on the ground, the south and north sides were flagged every 5 meters using flags on wires, and twine stretched perpendicular to the sides used as a guide to locate each sampling plot, then marked using labeled flags. The soil pits were dug as near to the center of each plot as possible depending on the location of trees or boulders.
2007	At each of the 50x50 m soil sites a 10 X 10 grid of 5x5 m sampling plots was temporarily established for sampling 10 of the potential 100 plots. To accurately establish the grids, the south and north sides of each site were flagged every 5 meters, and baling twine was stretched perpendicular to the sides as a guide for locating each sampling plot. A random number generating program selected which of the 100 potential plots were to be sampled, and this was done individually for each site. At each of the 10 sampling plots, flags were labeled (NE, NW, SE, SW) and placed at each of the 4 plot corners.
2012	At each of the 50x50 m soil sites a 10 X 10 grid of 5x5 m sampling plots was temporarily established for sampling 10 of the potential 100 plots. To accurately establish the grids, the south and north sides of each site were flagged every 5 meters, and baling twine was stretched perpendicular to the sides as a guide for locating each sampling plot. A random number generating program selected which of the 100 potential plots were to be sampled, and this was done individually for each site. At each of the 10 sampling plots, flags were labeled (NE, NW, SE, SW) and placed at each of the 4 plot corners along with a flag in the center saying, “dig here”.
2017	At each of the 50x50 m sites a 10 X 10 grid of 5x5 m sampling plots is surveyed to locate the 10 randomly selected plots for this year. This is done by surveyors. Within each plot, the designated sampling quadrant (2.5x2.5 m) is marked by surveyors. Quadrants were introduced this sampling year to extend the potential life of the project, and for each plot the order of use of the quadrants is randomized. At each of the 10 sampling quadrants, flags (with a plastic stake) were labeled (NE, NW, SE, SW) and placed at each of the four quadrant corners along with a flag (plastic stake) in the center saying “dig here”. If a large boulder or other obstruction prevents a pit from being dug in that quadrant, the next quadrant in the list was used.

Inventorying trees

2002	Trees at each site were tallied across the 50m x 50m site by species and DBH class. All standing dead trees were included as one group (not by species). No trees were tallied at Mansfield Forehead; Only portions were sampled of the other sites: Mansfield Underhill 40% of the site, Mansfield Ranch, Lye Road and Lye Trail 25% of the site.
2007	All trees >= 2 inches DBH were measured on the entire 50x50 m at each site. Measurements included: DBH, species, live/dead. An exception was the Forehead site where only 1/4 of the site was inventoried as a representative sample.
2012	All trees >= 2 inches DBH were measured on the entire 50x50 m for each site. Measurements included: DBH, species, live/dead. An exception was the Forehead site where only 1/4 of the site was inventoried as a representative sample.
2017	All trees >= 1 inch DBH were measured on the entire 50x50 m site, and the inventory was conducted and tracked in quarters of the site. Measurements included: DBH, species, live/dead.

Inventorying regeneration within plots

2002	Not collected this year
2007	Tree seedlings were counted by species on each of the 10 sampling plots at each site. All seedlings with true leaves (more than just cotyledons) and all saplings less than 2" DBH were tallied. For root sprouted seedlings (e.g. beech) each individual stem branching below ground was counted separately.
2012	Tree seedlings were counted by species on each of the 10 sampling plots at each site. A 5x5 m PVC square was placed on the perimeter of each plot and all seedlings whose stems originated in the square were counted. All seedlings with true leaves (more than just cotyledons) and all saplings less than 2" DBH were tallied. For root sprouted seedlings (e.g. beech) each individual stem branching below ground was counted separately.
2017	Tree seedlings were counted by species on each of the 10 plots with sampling quadrants at each site. A 5x5 m PVC square is placed on the perimeter of each plot and all seedlings whose stems originated in the square were counted. In 2017, a 2.5x2.5 m square is nested inside the 5x5 m plot square to overlap the sampling quadrant. The crew tallied seedlings in the quadrant as well as for the containing plot as a whole. All seedlings with true leaves (more than just cotyledons) and all saplings less than 2" DBH were tallied. For root sprouted seedlings (e.g. beech) each individual stem branching below ground was counted separately.

Inventorying understory plant cover

2002	All herbaceous plants across the entire 50x50 m site were identified to species (where possible) and listed. No abundance data was recorded.
2007	Using the list of herbaceous plants identified in 2002, a casual inventory of plants present across each 50x50 m site was completed in the process of other inventory work.
2012	The protocol was changed from a presence/absence by species at each site, to an abundance measure (percent cover) at each of the 10 plots per site. A 5x5 m PVC square was placed on the perimeter of each plot, then all plants whose stem originated in the square were recorded by species and percent cover.
2017	A 5x5 m PVC square was placed on the perimeter of each plot, then all plants whose stem originated in the square were recorded by species and percent cover. In 2017, a 2.5x2.5 m square is nested inside the 5x5m plot square to overlap the sampling quadrant. The crew quantified abundance for the quadrant as well as for the containing plot.

Digging soil pits

2002	Within each plot, a 0.7 to 1 m wide soil pit was dug at roughly the center point (depending on obstacles) of the plot. Tarps were used to hold pit contents to avoid contamination of surrounding soil. The organic layer was separated from the other soil to facilitate replacing this layer following sampling. Pits were of variable depth (a few cm into the C horizon). Where bedrock prevented adequate sampling of multiple horizons, attempts were made to relocate the pit within the 5x5 m plot.
2007	Within each 5x5 m plot to be sampled, a 0.7-0.9 m (27-36 in) wide soil pit was dug at roughly the center point of the plot, with some adjustment for stones and boulders. All excavated material from the soil pit were placed on plastic tarps to avoid contamination of surrounding surface soil. The organic layer was stockpiled separately from the excavated soil to facilitate replacing this layer following sampling. Pits will generally be dug to 75 cm where possible, but the depth of the pits is expected to vary. Large stones and boulders may limit excavation depth at a few sample plots.
2012	Within each 5x5 m plot to be sampled, a 0.7-0.9 m (27-36 in) wide soil pit was dug at roughly the center point of the plot, with some adjustment for stones and boulders. All excavated material from the soil pit were placed on plastic tarps to avoid contamination of surrounding surface soil. The organic layer was stockpiled separately from the excavated soil to facilitate replacing this layer following sampling. Pits will generally be dug to 75 cm where possible, but the depth of the pits is expected to vary. Large stones and boulders may limit excavation depth at a few sample plots.
2017	Within each 2.5x2.5 m quadrant of plots to be sampled, a soil pit was dug at roughly the center point of the quadrant, with some adjustment for stones and boulders. All excavated material from the soil pit was placed on plastic tarps to avoid contamination of surrounding surface soil. The organic layer was stockpiled separately from the excavated soil to facilitate replacing this layer following sampling. The pits were 0.7-0.9 m (27-36 in) wide and were generally dug to 75 cm from the soil-air interface where possible, but the depth of the pits is expected to vary. Large stones and boulders may limit excavation depth at a few sample sites.

Identifying soil horizons

2002	Once all 10 soil pits were dug at a site, pit examinations were made to determine which horizons would be sampled. At a minimum, an organic layer sample and several other soil horizons were sampled. Not all horizons could be sampled in each pit, based on presence and volume of soil at each horizon.
2007	All 10 soil pits at each site were dug and observed concurrently by the soil sampling crew before the profiles at individual pits were described. The reason for this was to assure consistency in horizon delineation and designations among the teams of soil describers working on the site. There were no criteria for minimum horizon thickness (and extent, for discontinuous horizons like E horizons). However, enough soil material was needed for splitting into sub-samples for submission to several labs and for the archives if the soil horizon was only a centimeter or two thick, therefore, not all horizons that were described were sampled.
2012	At Lye Road, all 10 soil pits were dug and observed concurrently by the soil sampling crew before the profiles at individual pits were described. The reason for this was to assure consistency in horizon delineation and designations among the teams of soil describers working on the site. At other sites, several teams worked on digging pits and as they finished, others began describing and sampling the soil profiles. This method was found to be more time-effective than digging all ten of the pits before beginning to describe any of the soil profiles. There were no criteria for minimum horizon thickness (and extent, for discontinuous horizons like E horizons). However, enough soil material was needed for splitting into sub-samples for submission to several labs and for the archives if the soil horizon was only a centimeter or two thick, therefore, not all horizons that were described were sampled.
2017	All 10 soil pits are dug by a separate crew and subsequently (same day or one day after) observed by the soil sampling crew before the profiles at individual pits were described. The reason for this was to assure consistency in horizon delineation and designations among the teams of soil describers working on the site. There were no criteria for minimum horizon thickness (and extent, for discontinuous horizons like E horizons). However, enough soil material was needed for splitting into sub-samples for submission to several labs and for the archives if the soil horizon was only a centimeter or two thick, therefore, not all horizons that were described were sampled.

Describing soils

2002	Soils were described using general guidelines from the first edition of the Field Book for Sampling and Describing Soils. Properties and features described include those listed below for 2007.
2007	Soils were described using NRCS procedures referenced in the **Field Book for Describing and Sampling Soils**, version 2.0, September, 2002. The Soil Profile Description Form was provided by Thom Villars, based on a form in the Field Book, page 2-75. The following soil physical properties were described, and the numbers in parentheses refer to page numbers in the Field Book referencing that property: Horizon Designation and lower Boundary (pgs 2-2 to 2-6).; Depth of horizon (upper and lower) in centimeters; Matrix color, moist, Munsell notation; Texture (pgs 2-29 to 2-31); Percent rock fragments by volume (shape- pg 2-40, note basic Percent Chart on page 2-9 – some Munsell color books also have a Percent Chart); structure; grade, size, and type (pgs 2-41 to 2-48); consistence, moist (also referred to as Rupture Resistance, pgs 2-49 to 2-50); Redoximorphic features; quantity, size, contrast – and Munsell color (pgs 2-14 to 2-17; see also quantity, size and contrast charts under Mottles on pgs 2-9 to 2-12); Roots (pgs 2-56 to 2-58); other features such as: organic streaks and stains, type of organic material, moisture status, slope percent, aspect and horizons sampled. Soil chemical properties (such as pH) was not recorded in the field, since these were analyzed more accurately in the lab at a later date.
2012	Soils were described using NRCS procedures referenced in the **Field Book for Describing and Sampling Soils**, version 2.0, September, 2002. The Soil Profile Description Form was provided by Thom Villars, based on a form in the Field Book, page 2-75. The following soil physical properties were described, and the numbers in parentheses refer to page numbers in the Field Book referencing that property: Horizon Designation and lower Boundary (pgs 2-2 to 2-6).; Depth of horizon (upper and lower) in centimeters; Matrix color, moist, Munsell notation; Texture (pgs 2-29 to 2-31); Percent rock fragments by volume (shape- pg 2-40, note basic Percent Chart on page 2-9 – some Munsell color books also have a Percent Chart); structure; grade, size, and type (pgs 2-41 to 2-48); consistence, moist (also referred to as Rupture Resistance, pgs 2-49 to 2-50); Redoximorphic features; quantity, size, contrast – and Munsell color (pgs 2-14 to 2-17; see also quantity, size and contrast charts under Mottles on pgs 2-9 to 2-12); Roots (pgs 2-56 to 2-58); other features such as: organic streaks and stains, type of organic material, moisture status, slope percent, aspect and horizons sampled. Soil chemical properties (such as pH) was not recorded in the field since these were analyzed more accurately in the lab at a later date.
2017	Soils were described using NRCS procedures referenced in the Field Book for Describing and Sampling Soils, version 3.0, September, 2012. The Soil Profile Description Form was provided by Thom Villars, based on a form in the Field Book, page 2-93. The following soil physical properties were described, and the numbers in parentheses refer to page numbers in the Field Book referencing that property: Horizon Designation and lower Boundary (pgs 2-2 to 2-7).; Depth of horizon (upper and lower) in centimeters; Matrix color, moist, Munsell notation; Texture (pgs 2-36 to 2-38); Percent rock fragments by volume (shape- pg 2-47, note basic Percent Chart on pgs 7-1 to 7-9 – some Munsell color books also have a Percent Chart); structure; grade, size, and type (pgs 2-52 to 2-61); consistence, moist (also referred to as Rupture Resistance, pgs 2-62 to 2-63); Redoximorphic features and mottles, quantity, size, contrast – and Munsell color (pgs 2-12 to 2-19; Roots (pgs 2-70 to 2-72); other features such as: organic streaks and stains, type of organic material, moisture status, slope percent, aspect and horizons sampled. Soil chemical properties (such as pH) was not recorded in the field since these were analyzed more accurately in the lab at a later date.

Labeling soil bags

2002	No standard
2007	No standard
2012	No standard
2017	In 2017, the group agreed to a standard for labeling the sample bags. Genetic samples are labeled with site, plot, quadrant, year and horizon: • i.e. LT-028NE-2017-Oa-3-10cm Bulk samples are collected from one of 4 depths, and are labeled with site, plot, quadrant, year and depth increment: • LT-028NE-2017-Oi/Oe • LT-028NE-2017-Oa/A • LT-028NE-2017-top10cmB • LT-028NE-2017-60-70cm

Soil sampling

2002	After soil descriptions were completed, samples were taken from the side of the pit that was described, using a knife and trowel. If Oe was sampled, a larger area of soil surface was peeled backwards and "mined". All samples were collected into 60-ounce clear polyethylene sterile bags (Fisher Scientific), and labeled with soil site, soil pit number, and date (?) Sample size was dependent on the thickness and continuity of the described horizons.
2007	At the same time the 10 soil pits were initially reviewed, evaluations were made to determine which horizons to sample at each soil pit. At a minimum, an organic horizon and several mineral soil horizons were sampled. If Oe was sampled, a larger area of soil surface was peeled backwards and "mined". Not all horizons were sampled in each pit, due primarily to the minimal thickness of some horizons. Samples were taken from the side of the pit that was described, using a knife, trowel, or other hand tools. All samples were collected into 60-ounce clear polyethylene sterile bags (Fisher Scientific), and labeled with site name, plot number, and date. Sample size was dependent on the thickness and continuity of the described horizon. In addition to the genetic horizon sampling similar to the 2002 sampling, a depth increment sampling was completed at each pit. The genetic horizon samples will be kept as reference samples and the depth increment samples were used for all analytical work. Depth increment sampling consisted of collecting one gallon of material from: the Oi and Oe horizons together; the Oa and A horizons together; the upper 10 cm (4 inches) of uppermost B horizon; between the depths of 60 to 70 cms below ground surface.

Soil sampling (continued)

2012	The 2012 sampling included genetic horizon sampling and bulk depth increment sampling, as performed in the 2007 sampling. The genetic horizon samples were kept as reference samples and the bulk depth increment samples were used for all analytical work. Genetic horizon samples were taken from the side of the pit that was described, using a knife, trowel, or other hand tools and collected into small clear polyethylene sterile bags (e.g. sandwich bags), and labeled with a two-letter site initial, plot number, horizon label, and depth. Sample size was generally sufficient to fill the small bags, but was somewhat dependent on the thickness and continuity of the described horizon. Bulk depth increment samples, for all but the MM Forehead site, were one gallon of material from: the Oi and/or Oe horizons, mixed together if both were present; the Oa and/or A horizons, mixed together if both were present; the upper 10 cm (4 inches) of the uppermost B horizon(s); and between the depths of 60 to 70 cms below the mineral soil surface. For the MM Forehead site, bulk depth increment samples consisted of one gallon of material from: the Oi and/or Oe horizons, mixed together if both were present; the Oa and/or A horizons, mixed together if both were present; the upper 10 cm (4 inches) of the uppermost B horizon(s), if a B horizon was present between the depths of 60 to 70 cms below the mineral soil surface, if the soil pit was deep enough to bedrock to reach this depth. If a B horizon was not present, the E horizon, if present, was sampled in its entirety.
2017	The 2017 sampling included genetic horizon sampling and bulk depth increment sampling, as performed in the 2012 and 2007 sampling. The genetic horizon samples were kept as reference samples and the bulk depth increment samples were used for all analytical work. Genetic horizon samples were taken from the side of the pit that was described, using a knife, trowel, or other hand tools and collected into small clear polyethylene sterile bags (e.g. sandwich bags), and labeled according to the sample bag labeling step, above. Sample size was generally sufficient to fill the small bags, but was somewhat dependent on the thickness and continuity of the described horizon. Bulk depth increment samples, for all but the MM Forehead site, were one gallon of material from: the Oi and/or Oe horizons, mixed together if both were present; the Oa and/or A horizons, mixed together if both were present; the upper 10 cm (4 inches) of the uppermost B horizon(s); and between the depths of 60 to 70 cm below the mineral soil surface. For the MM Forehead site, bulk depth increment samples consisted of one gallon of material from: the Oi and/or Oe horizons, mixed together if both were present; the Oa and/or A horizons, mixed together if both were present; the upper 10 cm (4 inches) of the uppermost B horizon(s), if a B horizon was present between the depths of 60 to 70 cm below the mineral soil surface, if the soil pit was deep enough to bedrock to reach this depth. If a B horizon was not present, the E horizon, if present, was sampled in its entirety.

Mercury soil sampling

2002	After the general soil sampling was completed, additional samples were collected for mercury analysis using clean-sampling techniques to prevent contamination of the samples. These included polyethylene sampling tools and storage vials (20-mL ‘scintillation’ vials with plastic caps), and nitrile gloves worn by the sampler. Separate samples for THg were taken from a fresh pit face. The uppermost sampleable humified soil horizon was taken, either an Oa (H) or A horizon. The vials were frozen as soon as feasible after sampling and stored at -18 C until processing for analysis.
2007	After the general soil sampling was completed, additional samples were collected for mercury analysis using clean-sampling techniques to prevent contamination of the samples. These included polyethylene sampling tools and storage vials (20-mL ‘scintillation’ vials with plastic caps), and nitrile gloves worn by the sampler. Separate samples for THg were taken from a fresh pit face. The uppermost sampleable humified soil horizon was taken, either an Oa (H) or A horizon. The vials were frozen as soon as feasible after sampling and stored at -18 C until processing for analysis.
2012	After the general soil sampling was completed, additional samples were collected for mercury analysis using clean-sampling techniques to prevent contamination of the samples. These included polyethylene sampling tools and storage vials (20-mL ‘scintillation’ vials with plastic caps), and nitrile gloves worn by the sampler. Separate samples for THg were taken from a fresh pit face. The uppermost sampleable humified soil horizon was taken, either an Oa (H) or A horizon. The vials were frozen as soon as feasible after sampling and stored at -18 C until processing for analysis.
2017	After the general soil sampling was completed, additional samples were collected for mercury analysis using clean-sampling techniques to prevent contamination of the samples. These included polyethylene sampling tools and storage vials (20-mL ‘scintillation’ vials with plastic caps), and nitrile gloves worn by the sampler. Separate samples for THg were taken from a fresh pit face. The uppermost sampleable humified soil horizon was taken, either an Oa (H) or A horizon. The vials were frozen as soon as feasible after sampling and stored at -18 C until processing for analysis.

Refilling pits

2002	Once all the soil samples were collected, soil from the tarps was replaced into the pits, and topped off with the original organic layer.
2007	Once all the soil samples were collected, soil from the tarps was replaced into the pits, and topped off with the original organic layer. The goal was to not leave any soil material extracted from the pit remaining on the soil surface around the pit.
2012	Once all the soil samples were collected, soil from the tarps was replaced into the pits, and topped off with the original organic layer. The goal was to not leave any soil material extracted from the pit remaining on the soil surface around the pit. At Mount Mansfield sites, plastic coated magnets were left in soil pits to indicate their location for future site visits (using a magnet detector). Because of Wilderness restrictions, these were not used at Lye Brook sites.
2017	Once all the soil samples were collected, soil from the tarps was replaced into the pits, and topped off with the original organic layer. The goal was to not leave any soil material extracted from the pit remaining on the soil surface around the pit. At Mount Mansfield sites, plastic coated magnets were left in soil pits to indicate their location for future site visits (using a magnet detector). Magnets are placed against the lateral center of the sampling face, in the upper mineral soil. Because of Wilderness restrictions, these were not used at Lye Brook sites.

Initial soil sample handling

2002	
2007	Samples were air-dried on black plastic on lab benches out of direct sunlight at the University of Vermont Plant and Soil Science Department building (Hills Building). After drying, samples were stored in their original field bag (if viable). Subsequent processing included sieving through a 2-mm polyethylene sieve and separating into four 8-ounce containers using a riffler.
2012	Samples were air-dried on black plastic on lab benches out of direct sunlight at the University of Vermont Plant and Soil Science Department building (Hills Building). After drying, samples were stored in their original field bag (if viable). Subsequent processing included sieving through a 2-mm polyethylene sieve and separating into four 8-ounce containers using a riffler.
2017	Samples were air-dried on black plastic on lab benches out of direct sunlight at the University of Vermont Plant and Soil Science Department building (Jeffords Building). After drying, samples were stored in their original field bag (if viable). Subsequent processing included sieving through a 2-mm polyethylene sieve and separating into four 8-ounce containers using a riffler.

Providing the information needed to understand, manage, and protect the region's forested ecosystems in a changing global environment