

Eastern Rivers and Mountains Network
Vegetation and Soil Monitoring Program
Standard Operating Procedures
Version 1.0 (2007)

**ERMN Vegetation Vital Sign Protocol
Using the Global Positioning System (GPS)
Version 1.1 (September 2007)**

Overview: This SOP delineates proper use of the ERMN Garmin GPSmap 60CSx unit.

Getting Started

Install two fully charged AA rechargeable batteries in the back of the unit. Make sure that you are carrying two additional fully charged AA batteries as back up.

Turn on the Garmin GPS by holding the small power button near the antennae for 2 seconds. Check SETUP options by pressing the menu button twice, scrolling down to the SETUP selection and pressing ENTER. Scroll through the sub-menus (using the Rocker keypad) to following menus:

System: GPS = Battery Saver

WAAS / EGNOS = Enabled

Units: Position Format = UTM UPS

Map Datum = WGS 84

Distance / Speed = Metric

Elevation = Metric

Heading: Display = Degrees

North Reference = True

Set other settings as desired by user. These settings will be saved on the GPS unit and should not have to be re-entered each time the unit is turned on.

Use the PAGE button to page through Satellite, Map, Compass, Altimeter, and Trip screens. Press the MENU button once to get a local menu, or twice to view the main menu of setup and other options. Use the center ROCKER keypad to scroll up, down, left or right through selections. Use the QUIT button to cancel a selection, or backup one step. When scrolling through fields in a menu, press the ENTER button to view all available options in a field. Also press ENTER to make a selection. To access the list of waypoints or navigate to a waypoint, press the FIND button.

To turn off the Garmin GPS unit, press and hold the small power button near the antennae for 2 seconds.

Uploading Plot Locations

GPS coordinates for pre-selected plot centers should be loaded into the unit before heading into the field. The datum for all coordinate values is NAD 83 and the coordinate system is Universal Transverse Mercator (UTM). The zone is 17 for BLUE, NERI, GARI, FONE, FRHI, ALPO, and JOFL. The zone is 18 for DEWA and UPDE.

Use the Minnesota DNR Garmin extension in Arcview 3.x or ArcGIS 9.x to upload the plot locations from the shapefile to the GPS unit.

Additional Antenna

In BLUE, GARI, and NERI, an external antenna should be used with the GPS unit to assist with capturing satellite signals. The external antenna requires its own battery, which will also power the GPS unit while the GPS unit is connected to the antenna. The battery should be charged overnight prior to beginning field work. A charged backup battery should also be carried in the field. The antenna can be disconnected from the battery during plot work to save battery life.

The antenna connects to the back of the GPS unit via two cables: a power cable and a “signal” cable. Place a rubber band around the GPS unit and cable connections in order to securely hold the cables in place. The signal cable should not be connected to the GPS unit when the power cable is not connected, as the antenna will then draw on the GPS’s AA batteries and quickly wear them down.

Navigating

Check the Satellite page. When sufficient satellites (4 for 3D navigation, 3 for 2D navigation) have been located, the satellite page will display the coordinates of your location and the estimated accuracy. If 3D navigation is active, “3D” will appear in the satellite on the top of the screen. The GPS is most accurate when it has four satellites and a 3D position. Satellite reception will vary with interference from trees, topography, structures, weather, and satellite positions. The antenna should be pointing skyward when navigating or collecting points.

You can navigate using the Map or Compass screens. Select a location (waypoint) to navigate toward by pressing the FIND button, and select WAYPOINTS. Select the Waypoint you would like to navigate to by Name or by Location. Now the Map or Compass screens will show which direction to travel.

When navigating using the GPS, remember that directional signals you receive from the GPS are only valid while you are moving. Unlike a compass, if you stop and turn to face a different direction, the GPS will not reposition until you move again. Also, the arrow that represents your position on the Map page is not necessarily pointing in the direction that you are moving. A compass may be used to determine the correct direction, and care must be taken to hold the compass sufficiently far from the GPS handheld unit to avoid influencing the compass needle.

Recording a new location

- 1) To record a new location (waypoint), press the MARK button from any of the main screens.
- 2) On this screen, scroll to the waypoint name adjacent to the blue flag. Hit Enter and type the name of the plot using the rocker bar and ENTER to select letters and numbers.
- 3) Plots should be named with the four letter park code, three digit unique number, plus the capital letter F to represent that this point was taken in the field. (e.g. NERI.031F) To find the “.” and the numbers, highlight the “↑” and hit ENTER. A number pad will appear on the right side of the screen. Once the name is entered, Highlight OK, and hit ENTER.
- 4) Scroll to AVE at the bottom right of the screen. Hit ENTER. Let the Measurement Count reach at least 100 – 150 points. Watch the Estimated Accuracy – good estimated accuracy is under 10 meters; excellent estimated accuracy is under 5 meters.

5) When the desired number of points or estimated accuracy has been reached, hit ENTER to save the location. Note the estimated accuracy displayed before you hit ENTER. Record this on the datasheet.

6) Make sure that the name of the plot now shows at the top of the screen. Record the coordinates shown on the screen onto the datasheet. Scroll to OK and hit ENTER.

Downloading Recorded Location to ArcGIS

Each week, use the Minnesota DNR Garmin extension in Arcview 3.x or ArcGIS 9.x to download the recorded field plot locations from the GPS unit to a shapefile. Save this shapefile with a descriptive name and date (e.g. DEWA_field_plot_locations_20070715.shp)

Suggested Reading

Garmin GPSMAP 60CSx Owner's Manual

Garmin GPSMAP 60CSx Quick Start Guide

ERMN Vegetation Vital Sign Protocol
Site Selection and Plot Establishment
Version 1.1 (September 2007)

Overview: This SOP provides instruction for establishing plots and collecting site information. Prior to the field season, plot locations will be selected using GIS and the GRTS sampling algorithm to provide a random, spatially balanced sample. Prior to the GRTS selection process, plots that fall on private land, non-vegetated land uses, and steep slopes >30 degrees will be removed from the sampling universe. Additional locations which present a safety hazard or are not feasibly accessible may be discarded in the field.

ERMN must ensure that plot marking procedures have been approved by the natural resource manager at each park prior to plot establishment, and these procedures may vary by park in response to individual park requirements.

Definitions

Horizontal distance is the straight line distance between two objects. This contrasts with slope distance which is measured parallel to the ground. Slope distance and horizontal distance are equivalent on flat land. On sloped land, the horizontal distance between two objects is less than the slope distance. Appendix A includes a table for converting horizontal to slope distance.

True north is the direction of the north pole relative to your position. This contrasts with magnetic north, which varies across the landscape and over time as the direction towards which your compass needle points when you are in the northern hemisphere. To find true north, use a magnetic declination chart or table to find the correct declination between true north and magnetic north for your position at the time you wish to navigate (such as at <http://www.ngdc.noaa.gov/seg/geomag/jsp/struts/calcDeclination>). Then, adjust your compass by dialing this declination into the faceplate. All azimuths referred to herein are based on true north. For 2007, the declination for ERMN parks is as follows:

BLUE: 7° 39' West

NERI: 7° 36' West

GARI: 7° 50' West

FRHI: 9° 5' West

FONE: 9° 5' West

ALPO: 10° 6' W

JOFL: 9° 48' W

DEWA Gap = 12° 32' W

DEWA Milford = 12° 49' W

Plot size will be a circular plot of 15-m radius, as measured in horizontal distance.

Establishing Plot Center

Examine park maps, topographic maps, and aerial photography to determine the best route to a preselected plot location. Using GPS and compass, travel to a proposed plot location. The GPS and compass should be held sufficiently far apart to avoid the GPS influencing the compass

needle. Do not take safety risks when traveling to plots - if off-trail topography becomes too steep or difficult, find an easier route to the plot location. If a safe route does not exist, discard the location and record the reason for doing so.

It is very important that plot center be established as closely to the pre-defined coordinates as possible to avoid any bias in plot location. Putting the plot center in the most convenient opening instead of where it actually falls has been known to cause serious data bias in some forestry sample designs. As you near the pre-selected location, use the following protocol to locate the plot center. The GPS unit will likely not have sufficient precision to allow you to navigate to exactly the predefined location. Thus, as soon as the GPS indicates you are within 15 m of the pre-selected location, continue exactly 10 steady paces (20 steps) in the direction of the pre-selected location and stop. Do not veer off course to avoid obstacles. This is the plot center.

Upon arrival at this plot location, visually examine the location to ensure that the area is not a managed grassland, cropland or developed land, and that plot center is ≥ 15 m away from the park boundary, agricultural fields, roads, developed land, or large perennial streams (without canopy closure over the stream). This will ensure that no part of the plot will fall outside the park boundary, and that roads, mowed grass, and large streams will not fall within the plot. If a stream is ephemeral or under closed canopy, it can be included in the plot. If the plot center is < 15 m from the posted park boundary, road, managed field, or large stream or river, move the plot center 20 meters from this feature. Measure 20 meters horizontal distance perpendicular to the feature. This is the new plot center.

If the plot presents a safety hazard such as extremely steep slopes or unstable snags, discard the plot and record the reason for doing so. Proceed to the next location on the list of plot locations included in the annual sample.

Once you have arrived at the plot center, set an 18 inch piece of rebar with appropriately labeled survey cap as close as possible to that location. If the rebar cannot be set in the ground exactly where you are standing, locate a place in the general vicinity (~2 m radius) where the rebar can be set into the ground. Survey cap should be flush with ground. Once the rebar has been set in the ground, it marks the plot center from which all plot measurements will be taken.

Establishing Transects

From the rebar, establish the 6 transects at 0, 60, 120, 180, 240, 300 degrees using a compass and measuring tape. The length of each transect should be 15 meters, **slope distance**. Be exact about sighting each transect since the plots are permanent. Distances should be measured to within 0.1 m error, and bearings should be sighted to within 4 degrees error.

When sighting compass bearings, crew members must take care that metal objects do not affect the compass needle, and that the compass is held level (flat) at all times. The compass needle will not be as responsive to small shifts in azimuth when the compass is tilted. When sighting up or down slope, remember to hold the compass level – do not tilt it in the direction of the slope.

To measure slope distance, lay the measuring tape flat along the ground, ensuring that it is not caught on vegetation. If the tape cannot be run along the ground due to thick vegetation, the tape

can be held in the air. However, both ends of the tape must be held at the same height above the ground to keep it parallel to the ground.

At the end of each transect, pound a galvanized 12” spike flush to the ground. If the spike cannot be placed exactly at the end of the transect due to rocks or trees, place the spike along the transect as close to the end as possible. It is important that the spike is on the same azimuth as the transect, even if the spike is not exactly 15 meters from the plot center. Note the location of the spike in Plot Notes on the datasheet (e.g. spike for 180 transect placed 10 cm closer to plot center from the end of the transect). At the ends of three transects, attach the claw of the measuring tape to the spike to keep the tape in place during plot work. At the ends of the other three transects, wrap the excess tape around the top of the spike to keep the tape in place during plot work.

Establishing Microplots

Establish 4 microplots at 30, 150, 210, and 330 degrees using a compass and measuring tape. The center of the microplot should be 7.5 meters **horizontal distance** from plot center. Be exact about sighting and length measurements since the plots are permanent. Distances should be measured to within 0.1 m error, and bearings should be sighted to within 4 degrees error.

When sighting compass bearings, crew members must take care that metal objects do not affect the compass needle, and that the compass is held level (flat) at all times. The compass needle will not be as responsive to small shifts in azimuth when the compass is tilted. When sighting up or down slope, remember to hold the compass level – do not tilt it in the direction of the slope.

To measure horizontal distance, hold the measuring tape horizontally level rather than parallel to the slope, using a plumb bob if necessary. On slopes, this will result in the upslope tape end held low to the ground while the downslope end is held high. On steep slopes, it will be necessary to measure the horizontal distance in sequential short increments that can be held level, or alternatively to use the slope conversion table included as Appendix A.

At the center of the microplot, pound a galvanized 12” spike flush to the ground. If the spike cannot be placed exactly at the center of the microplot due to rocks or trees, **place the spike along the transect as close to the end as possible. It is important that the spike is on the same azimuth as the transect, even if the spike is not exactly 15 meters from the plot center. Note the location of the spike in Plot Notes on the datasheet (e.g. spike for 180 transect placed 10 cm closer to plot center from the end of the transect).**

Data collection

PARK. Record 4-letter park code (BLUE, NERI, GARI, FRHI, FONE, ALPO, JOFL, DEWA, or UPDE).

PLOT. Record the plot identification number, unique within each park.

GRTS ORDER: Record the order that this plot fell in the GRTS-determined sampling order.

OBSERVER: Record first initial and last name of each crew member present.

DATE: Record the month / day / year that data was collected (e.g. 08/17/2007)

UTME. Record the East Universal Transverse Mercator value of the plot center from the GPS unit once the location of plot center has been recorded using the average position function.

UTMN. Record the North Universal Transverse Mercator value of the plot center from the GPS unit once the location of plot center has been recorded using the average position function.

DATUM. Record the datum in which the coordinates are taken. This should be UTM NAD 83. For ALPO, JOFL, FONE, FRHI, BLUE, NERI, and GARI, the zone will be 17. For UPDE and DEWA, the zone will be 18.

GPS ACCURACY. Record the positional accuracy of the UTMN and UTME coordinates, in meters, as determined by the GPS unit when the average position function is stopped.

DIRECTIONS. Record directions for driving and walking to the plot, including trails, landmarks, distances, and bearings. Include parking recommendations where applicable.

ELEVATION. Record the elevation above mean sea level of the plot center, in meters, as determined by the GPS unit.

SLOPE ANGLE. Record the down slope angle across plot to the nearest percent. Slope is determined with a clinometer by sighting parallel to the average incline or decline of the plot. To measure slope, Observer 1 stands at the upper plot boundary and sights Observer 2 who is standing at the lower plot boundary. Observer 1 must sight Observer 2 at a height equivalent to the eye-level of Observer 1. Read slope directly as percent (not degrees) from the clinometer.

SLOPE ASPECT. Record aspect across plot to the nearest 1°. Aspect is determined along the direction of slope for land surfaces with at least 5% slope in a generally uniform direction. If slope is less than 5%, record NA to signify no aspect. Aspect is measured downslope using a compass.

PLOT NOTES. Record any unusual plot features or problems encountered during plot setup, including the reason for discarding any pre-selected plot locations. Note any problem or irregularities inserting plot markers. Note any features which indicate plot history, including evidence of past agricultural, silvicultural or recreational use regardless of how long ago it may have been.

ERMN Vegetation Vital Sign Protocol
Photopoint
Version 1.1 (September 2007)

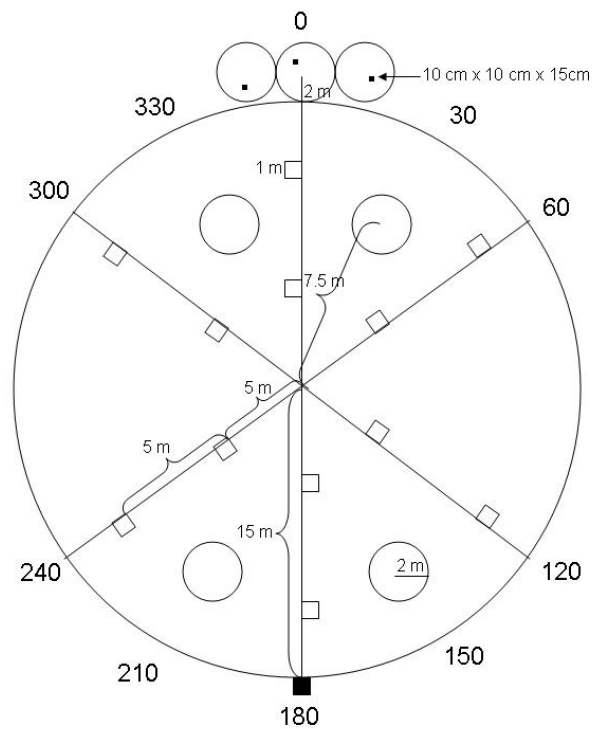
Overview: This SOP documents the procedure for photographing plots. Photographs will be archived and used as visual reference for change in appearance of plots over time. Photographs should be taken shortly after plot setup in order to visually record the plot before significant trampling occurs.

Data collection

A photograph of the plot is taken from the southern edge of the plot, at the end of the 180° transect (shown as black square in figure below). The photo should be taken facing north towards plot center.

If the scene at this location is blocked by a large tree or obstruction, move one pace to the east of the transect end point. The photo should be taken from this point facing towards plot center.

If a photo cannot be taken from one pace away from the end of the 180° transect, move the photo location to the end of another transect. The photo should be taken from this point facing towards plot center. Note the alternate location of the photo on the data sheet. If necessary (in very thick vegetation), the plot photo can also be taken from plot center facing the direction of one of the transects. In this case, clearly explain on the data sheet where the photo was taken and which direction the camera was facing.



An identification sign must be visible in each photograph. Insert a sheet of paper printed with the park, plot number and date in large black letters into the portable sign. Place the portable sign 2 - 5 meters in front of the camera location where it can easily be seen in the photograph.

Capture one digital photograph of the plot. The photos should be taken in landscape to get maximum coverage of all vegetation layers. Do not zoom-in on the scene. Allow the camera to automatically select the appropriate aperture for the given light conditions. Check the quality of the first photo on the camera's LCD screen. Take additional photographs if the quality is questionable. If lighting is questionable, take one photograph with the flash on and one photograph with the flash off. If the camera has a date stamp function, make sure the date and time are set correctly and turn this function on.

In remeasured plots, field crew should examine photographs from previous visits and attempt to recreate the position and angle used.

LOCATION FROM WHICH PHOTOGRAPH WAS TAKEN. Record the location in the plot from which the photograph was taken. This location will typically be from the end of the 180° transect.

PHOTO NUMBER. Record the photo number assigned to the photograph by the camera

PHOTO NOTES. Record any other important information about the photograph or its location.

**ERMN Forest Vital Sign Protocol
Stand and Site Measurements
Version 1.1 (September 2007)**

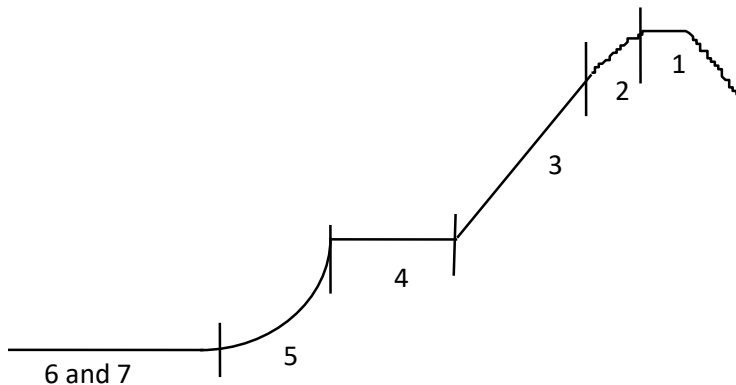
Overview: This SOP collects stand-level and site measurements. These data will allow proper interpretation of other measures, and will be used to assess stand structure and disturbance. This SOP is designed to be used only during the leaf-on period of the summer months (about May 15 to September 15).

When canopy closure and cover class are assessed, notice the exact breakpoints (e.g., 25%) are not included in any class. Classes are either above or below each breakpoint. This is not a mistake - it is to encourage the crew not to waste time trying to decide if the correct value is exactly 25%. The most suitable class should be assessed and recorded as rapidly as possible.

Data collection

TERRAIN POSITION. Record terrain position of the plot along slope profile, using codes below.

- 1 Top-of-slope - convex region
- 2 Upper-slope - convex region near top of slope
- 3 Mid-slope - uniform, fairly straight region
- 4 Bench - level land with slopes above and below
- 5 Lower-slope - concave region near bottom of slope
- 6 Bottomland - flat and low-lying; may be associated with drainage and flooding
- 7 Flatland - unrelated to slopes or drainage; may have minimal elevation change



STAND STRUCTURE. Record the basic stand structure in the plot using these codes:

- 1 Even-aged: A succeeding stand dominated by a single cohort of closely competing trees of relatively uniform size and height. Smaller trees are typically stressed or overtopped and have fallen behind their associates. Regeneration and/or tall relics from a previous stand may be present.
- 3 Multi-aged: A later-successional or mature stand characterized by a distinct canopy with typical regeneration below including trees of many sizes and heights. Canopy trees vary in age and diameter. Gap dynamics may be evident.

- 4 Mosaic: Contains at least two distinct size classes each covering at least 25% of the stand. These classes are not uniformly distributed, but are grouped in small repeating aggregations throughout the stand.
- 5 Early successional: A succeeding stand without a closed tree canopy. May be dominated by a mix of trees, shrubs and herbaceous vegetation.
- 6 Woodland: A stand with at least 25% tree cover but lacking a distinct closed canopy. Trees are open-grown, or growing in small groups interspersed with shrub or herbaceous cover or bare rock.

CROWN CLOSURE. Estimate % of plot area covered by live tree crowns directly overhead and record appropriate code. If foliage is not present due to seasonal variation or temporary defoliation, visualize the amount of live crown that would normally be present. Do not visualize foliage that formerly existed on dead branches.

- | | |
|---|------------|
| 1 | < 10 % |
| 2 | 10 to 25 % |
| 3 | 25 to 50 % |
| 4 | 50 to 75 % |
| 5 | > 75 % |

DEER BROWSE LINE. Visually inspect the plot and record the presence (1) or absence (0) of an evident deer browse line. A deer browse line is a notable lack of leaves and understory below about 2 meters – equivalent to the level a deer can easily reach.

MICROTOPOGRAPHY. Microtopography is small-scale variation in the soil surface caused by tree tip-ups which create a pit and mound undulation. Microtopography is eliminated when a site is plowed, and recovers over time once an area is reforested. Record presence (1) or absence (0) of pit and mound microtopography on the plot. If pit and mound topography is suggested but not clear, record 9.

% COVER BY LAYER. Estimate the total cover of vascular plant foliage by layer within the plot. A rapid cover estimate is made, ignoring overlap among species. It may help to visualize cover by collapsing each layer into a 2-dimensional space, ignoring normal spaces occurring between leaves. Estimate total cover for each layers listed below. Use the following cover classes: <1%, 1-2%, 2-5%, 5-10%, 10-25%, 25-50%, 50-75%, 75-95%, 95-100%

Groundstory: <0.5 m above ground

Mid-understory: 0.5 - 2 m above ground

High-understory: 2 - 5 m above ground.

Subcanopy: Height defined for each plot. Must be >5 m.

Canopy: Height defined for each plot.

SUBCANOPY HEIGHT. Within the plot, select an intermediate tree of typical height and with a crown visible from the ground. To measure, move to a position as far from the base of the tree as possible along minimal slope while still allowing sufficient view of the tree crown. Do not select a location downslope from the tree. Determine height to the top of the intermediate tree either using the laser hypsometer or an analog clinometer. Record the height in meters.

To use the laser hypsometer:

- Make sure that the laser is set to Height Routine and “HT” is visible in the bottom of the viewfinder.
- Hold the laser horizontal and sight the bole of the target tree through the viewfinder. Press the fire button.
- Then, sight the base of the target tree through the viewfinder. Press the fire button.
- Next, sight the top of the target tree through the viewfinder. Press the fire button.
- The height of the tree should appear in the viewfinder.

To use an analog clinometer and simple triangulation:

- Use the clinometer to read the angles from the top of the tree to its base. Grasp the clinometer with the right hand and sight through the optics with the right eye, keeping the left eye open and looking at the tree top. A movable scale with angle measurements in percent should be visible and should rotate as the clinometer is tilted up and down an optical illusion extends the hair-line crosshair outside of the clinometer frame. Aim the clinometer so that the extended hair-line coincides with the top of the tree. Hold the clinometer steady, close your left eye and read the percent on the right side of the rotating scale. Note this Percent 1, including whether the percent is positive or negative.
- Repeat the previous step, this time aiming the extended hair-line at the base of the trunk. Note this Percent 2, including whether the percent is positive or negative.
- Next, aim the extended hair- line of the clinometer above the base of the trunk to the point where the angle measurement is 0 degrees. This point on the trunk represents eye level of the observer. Run a measuring tape from the level of the observer’s eye to this point on the trunk. Check to make sure that your tape is measuring horizontal distance. Note this distance measurement in meters.
- Calculate tree height = (Percent 1 + Percent 2) * Distance

Based on this measured tree height, estimate the range of heights of the subcanopy trees (intermediate trees).

CANOPY HEIGHT. Repeat the instructions above to measure the height of a co-dominant tree. Based on this measurement, estimate the range of heights of the canopy trees (co-dominant trees).

DOMINANT VEG. For each of the strata listed above, record the type of vegetation that is dominant in that stratum. The type of vegetation with the most percent cover is the dominant vegetation. The types of vegetation are:

Fern, Graminoid, Herb, Deciduous Shrub, Evergreen Shrub, Deciduous Tree, Evergreen Tree, Vine

SECONDARY VEG. If there is a second type of vegetation which covers greater than 25% of the plot but does not cover the greatest percent area, record that type of vegetation in the secondary vegetation column. Do this for each stratum that has a second type of vegetation which covers greater than 25% of the plot but does not cover the greatest percent area. Not every stratum will have a secondary vegetation type. The types of vegetation are:

Fern, Graminoid, Herb, Deciduous Shrub, Evergreen Shrub, Deciduous Tree, Evergreen Tree, Vine

DISTURBANCE CODE. Record up to 3 disturbance codes from most to least important based on visual inspection of the plot. To be recorded, a disturbance must cause "significant threshold" damage, equivalent to either: 1) 25% of trees in a plot, 2) 50% of an individual tree species' count (but must include at least 2 trees in or near the plot), or 3) disturbance to at least 25% of the soil surface or understory vegetation. Only record disturbances which appear to have occurred since the previous inventory or within the last 4 years. If you record an unknown disturbance, attempt to capture a picture illustrating the disturbance.

- 00 None - no observable disturbance
- 10 Insect damage
 - 11 insect damage to understory vegetation
 - 12 insect damage to trees, including seedlings and saplings
- 20 Disease damage
 - 21 disease damage to understory vegetation
 - 22 disease damage to trees, including seedlings and saplings
- 30 Fire - prescribed or natural
- 40 Animal damage
 - 41 beaver damage to vegetation
 - 42 porcupine
 - 43 deer/ungulate
 - 44 bear
 - 45 rabbit
 - 46 domestic animal/livestock including grazing
 - 47 flooding caused by beaver
- 50 Weather damage
 - 51 ice/snow
 - 52 wind including hurricane, tornado
 - 53 flooding caused by weather
 - 54 drought
 - 55 earth movement/avalanches
- 60 Vegetation - suppression, competition, or vines
- 70 Unknown/not sure/other. Describe in Notes and take photo.
- 80 Human-caused damage – other than described in these codes. Describe in Notes.
- 90 Silvicultural treatment
 - 91 Overstory removal – removal of all or most of the canopy trees
 - 92 Selective cutting - removal of one or more trees from a stand (but see 91)
 - 93 Site preparation - clearing, slash burning, chopping, disking, bedding, or other practice to prepare site for regeneration.
 - 94 Artificial regeneration
 - 95 Other silvicultural treatment - use of fertilizers, herbicides, girdling, pruning, or other activities to improve the commercial value of the stand. Describe in Notes.

DISTURBANCE THRESHOLD. For each disturbance recorded above, record which threshold was triggered: 1) damage to 25% of trees in a plot, 2) damage to 50% of an individual tree species' count, or 3) disturbance to at least 25% of the soil surface or understory vegetation.

DISTURBANCE % COVER. For each disturbance recorded above, record an approximate disturbance percentage to the nearest 10%. If the recorded disturbance was triggered by threshold 1, record the approximate % of trees in the plot damaged by that disturbance. If triggered by threshold 2, record the approximate % of an individual tree species' count damaged by that disturbance. If triggered by threshold 3, record the % of the soil surface or understory affected by that disturbance.

FOREST FLOOR: Examine the ground within the plot and estimate the percent cover of each of the categories listed below. Use the following cover classes: <1, 1-5, 5-25, 25-50, 50-75, 75-95 or 95-100 %.

BARE SOIL. Record the percentage of the plot covered by bare soil (mineral or organic). Do not include soil covered by leaf litter.

ROCK. Record the percentage of the plot covered by exposed bedrock or large rocks (>10 cm).

WATER. Record the percentage of the plot covered by water.

OTHER. Record the percentage of other things that have significant cover in the plot (e.g. trash, etc).

TRAMPLED. Record the percentage of the plot showing evidence of trampling by humans, wildlife or livestock. Trampling is assessed relative to the conditions of adjacent undisturbed soil. Include area occupied by established or unofficial trails traversing the plot, and record type of trail in plot notes.

ERMN Vegetation Vital Sign Protocol
Coarse Woody Debris
Version 1.1 (September 2007)

Overview: This SOP quantifies coarse woody debris using line intercept transect sampling along six 15-m transects at each plot. These data yield information on forest structural diversity, and the availability of habitat for wildlife and fungi.

Definitions

Coarse woody debris (CWD) includes down, dead tree and shrub boles, large limbs, and other woody pieces ≥ 7.5 cm diameter and ≥ 1 m long. CWD includes dead trees leaning > 45 degrees from vertical, measured along the bole. Very decomposed logs reduced to slightly elevated 'humps' on the ground without structural integrity are not tallied as CWD.

Horizontal distance is the straight line distance between two objects. This contrasts with slope distance which is measured parallel to the ground. Slope distance and horizontal distance are equivalent on flat land. On sloped land, the horizontal distance between two objects is less than the slope distance.

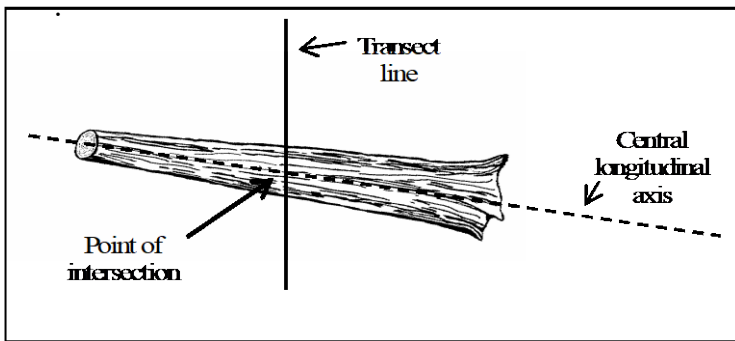
Transect Set Up

The six CWD transects extend 15 m slope distance from plot center in the following directions: 0° , 60° , 120° , 180° , 240° , and 300° . Transects must be laid out along a straight line to avoid biasing the selection of pieces. Detailed directions for establishing the transects are provided in the Site Selection and Plot Establishment SOP.

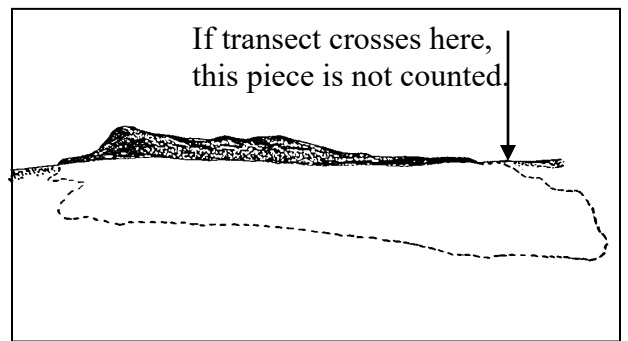
Tally Rules for CWD

Most CWD will be lying on the ground. To be tallied by this protocol, the transect must intersect the central longitudinal axis of the piece of CWD. The point of intersection between the transect and the central longitudinal axis of the piece must occur above the ground. The piece must meet the minimum diameter criteria (≥ 7.5 cm) at the point of intersection, as well as the minimum length criteria (≥ 1 m).

VIEW FROM ABOVE



VIEW FROM SIDE



There is no upper height limit for leaning snags in this protocol. All snags leaning $>45^\circ$ from vertical should be tallied regardless of height off the ground. If a snag is too high to reach, record this fact and estimate its diameter.

If a piece intersects a transect line more than once or intersects more than one transect, measure and record the diameter of the piece each time it intersects. However, when recording the diameter of a CWD piece's second intersection on a single transect, put an "Y" in "2nd Intersect" box on the data sheet. When recording the diameter of a CWD piece's intersection on a second or third transect, put an "Y" in "2nd Transect" box or "3rd Transect" box on the data sheet. If the plot center falls directly on a CWD piece, tally that piece only once upon the 0° transect. This case will be uncommon.

Data collection

TRANSECT SLOPE. Measure and record the average slope of the transect to the nearest 1% using a clinometer. The observer with a clinometer should stand over the plot center at transect origin and sight a known height on a second person located at the transect end. The known height is the approximate height of the observer's eye on the second person.

TRANSECT. Record the number indicating the azimuth of the transect: 0° , 60° , 120° , 180° , 240° , or 300° . Sample the 0° transect first and work clockwise around the plot until all transects have been sampled. If no pieces of CWD cross the transect, record the transect azimuth and put a horizontal line through the Diameter and Decay Class boxes. All transects must be recorded for each plot.

For each piece of CWD to be tallied, record the following:

DIAMETER AT INTERSECTION. Record the piece's diameter, to the nearest 0.5 cm, at the point where the transect intersects the central longitudinal axis of the piece of CWD. Take care to measure diameter perpendicular to the piece's central axis (not perpendicular to the transect) as shown below. Diameter of CWD is typically measured by holding a metal tape or ruler above the log. To avoid parallax error, position your eyes directly over each end of the ruler in sequence. First position your eyes above one side of the CWD piece. Align the 0 end of the ruler with that side of the CWD piece. Then, without moving the ruler, position your eyes above the other side of the CWD piece. Read the diameter at the distance that appears aligned with that side of the CWD piece.



(from Coulston 2003)

DECAY CLASS. Record the code indicating the predominant decay class (>50% of the piece) along the length of the entire CWD piece. If no single class dominates, average the decay classes present. See Figure 1 and Table 1 on the following pages for illustrations and descriptions of decay classes.

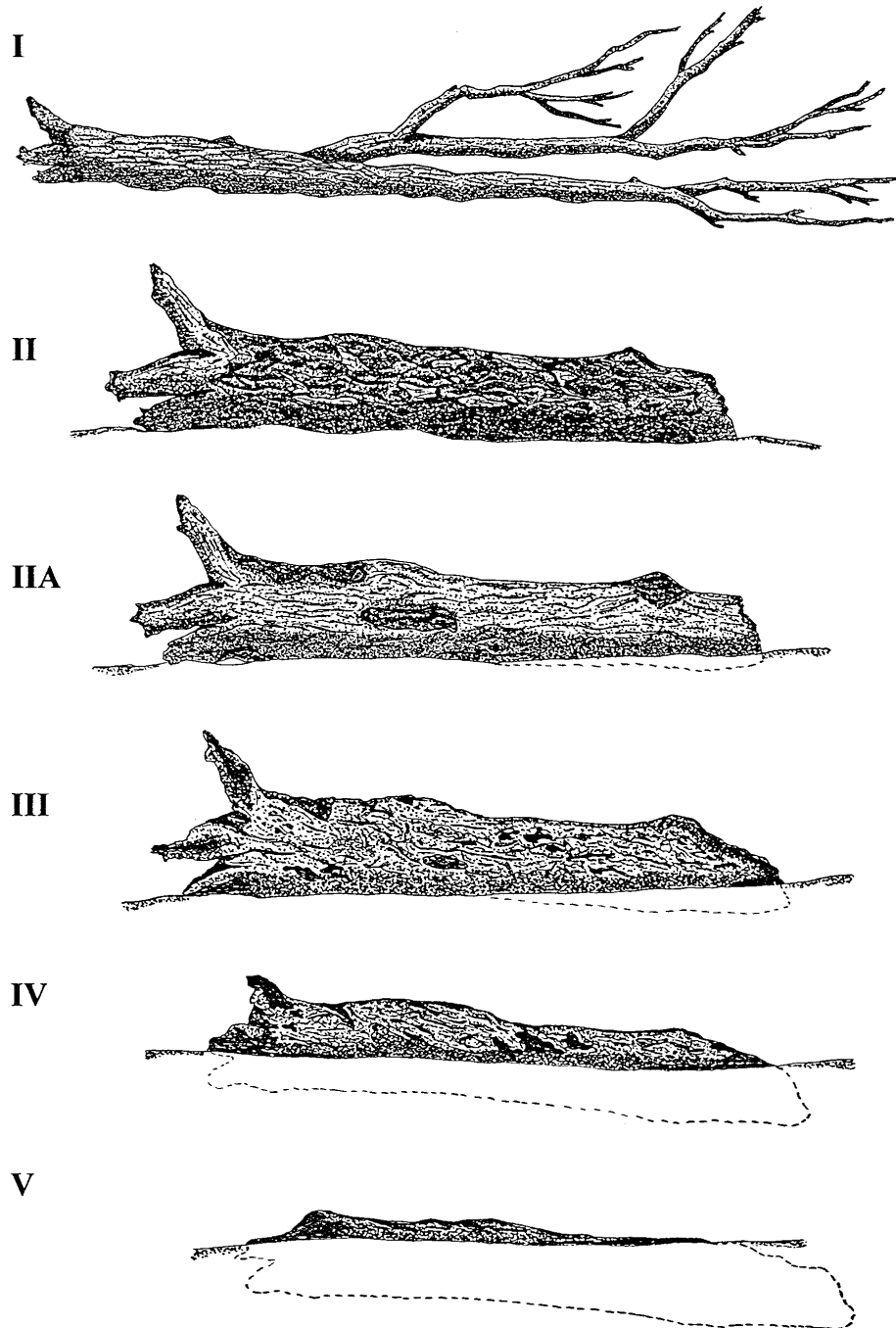


Figure 1. Decay stages of down deadwood in eastern deciduous forests. Classes are based upon Pyle and Brown (1998). Figure is adapted from Jenkins et al. (2004). We will not be using Decay Class IIA.

Class	Bark	Log shape and Integrity	Color of Exposed Wood	Primary surface substrate	Branches and twigs
I	Firmly attached	Round and solid	Fresh color, not stained by weathering	Sound bark	Branches retain many small twigs
II	If present, decayed, faded and not firmly attached	Round and solid	May be bleached and relatively smooth (like driftwood)	Decayed bark and hard wood - impenetrable with fingernail or pen point, may be case hardened with powder wood beneath	Branches retain some small twigs
III	Generally absent, except in <i>Betula</i> and <i>Prunus</i>	Round and firm		Soft wood - will spring back if compressed and easily penetrated with fingernail or pen point	No small twigs
IV	Absent	Oval or flattened, no longer a solid piece though some hard chunks remain		Very spongy wood - responds to finger pressure and may exude moisture - and powder wood - flows through fingers like coarse sawdust	No small twigs
V	Absent	Quite flat or flat with some rounding		Loosely aggregated powder wood	No small twigs

Adapted from Pyle and Brown 1998.

Table 1. Decay class for coarse woody debris (Adapted from Pyle and Brown 1998)

HOLLOW. Record whether piece is hollow (Y) or not (N). A piece is considered hollow if a cavity extends at least 0.5 m along the central longitudinal axis of the piece, and the cavity entrance is at least 1/4 the diameter of the piece.

2ND INTERSECT. If a piece of CWD intersects the same transect more than once, record an “Y” in the “2nd Intersect” box on the lines that record the second, third, etc diameters recorded from the same piece of CWD. Indicate in the Notes which pieces are connected, as shown in the example below.

2ND TRANSECT. If a piece of CWD intersects with a second transect, record an “Y” in the “2nd Transect” box on the line that records the second diameter measured from the same piece of CWD. Indicate in the Notes which diameters were measured from the same piece of CWD, as shown in the example below.

3RD TRANSECT. If a piece of CWD intersects with a third transect, record an “Y” in the “3rd Transect” box on the line that records the third diameter measured from the same piece of CWD, as shown in the example below.

NOTES. Record anything unusual about the transect placement or the pieces of CWD. If the species of the CWD can be easily identified, record that information in this space. Use this space to identify which pieces of CWD are connected to each other, or which diameters were measured from the same piece of CWD, as shown in the example below.

Example of Completed CWD Transect Data Sheet

Transect	Diameter	Decay Class	Hollow	2 nd Intersect	2 nd Transect	3 rd Transect	Notes
0	-----	-----					
60	8.5	2	N	N	N	N	#1
60	10.0	2	N	Y	N	N	Forked piece, connected to #1
120	-----	-----					
180	26.5	3	N	N	N	N	#2
180	13.5	4	Y	N	N	N	
240	19.0	3	N	N	Y	N	Same piece as #2
300	8.0	1	N	N	N	N	Pinus strobus

References:

Coulston, John W. et. al. 2003. Forest Health Monitoring 2003 National Technical Report. U.S. Department of Agriculture, Forest Service, Southern Research Station.

Jenkins, M. A., Webster, C.R., Parker, G.R., and M.A. Spetich. 2004. Coarse woody debris in managed Central Hardwood forests of Indiana, USA. Forest Science 50:781-792.

Pyle, C., and M. M. Brown. 1998. A rapid system of decay classification for hardwood logs of the eastern deciduous forest floor. Journal of the Torrey Botanical Society 125: 237-245.

ERMN Vegetation Vital Sign Protocol
Herbaceous Species and Seedlings
Version 1.1 (September 2007)

Overview: This SOP measures the composition and abundance of groundstory vascular plants and tree seedlings. Species percent cover data and tree seedling counts are collected in twelve 1-m² quadrats nested within each plot. This SOP is designed to be conducted by a botanist or crew member familiar with herbaceous and graminoid vegetation at the sampled park. This protocol should be used only during the summer months (about May 15 to September 15).

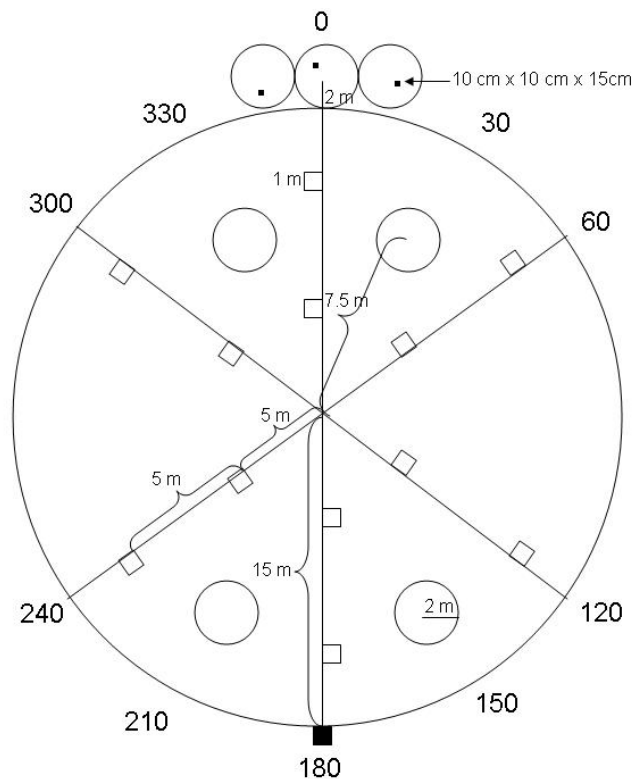
Quadrat Set Up

The quadrat frame can be made from ½ inch PVC pipe, with four pieces cut to be 1 m long when inserted into right angle corner pipe joints. One side of each corner joints should be detachable to improve maneuverability. The quadrat poles should be painted with 10-cm lengths of black paint, alternating with 10-cm lengths of unpainted area. Thus, when the quadrat is assembled, each 10-cm x 10-cm black or white square section illustrates 1% of the quadrat, facilitating the accurate estimation of percent cover.

The location of the twelve quadrats is determined by the six transects laid out to measure coarse woody debris. These six transects extend 15 m slope distance from plot center in the following directions: 0°, 60°, 120°, 180°, 240°, and 300°. Transects are laid out along a straight line to avoid biasing the data collection. Two quadrats are placed along each transect.

Quadrats are always placed to the LEFT of the transect meter tape, as one looks down the transect from plot center. In other words, the quadrats are always placed on the counter clockwise side of the transect tape (see adjacent figure). The lower corners of the quadrats should be placed at 5 and 10 meters from plot center, respectively, such that the quadrats cover 5-6 m from plot center and 10-11 m from plot center. The quadrats should be placed such that the outer edge of the quadrat frame touches the outside edge of the meter tape. The quadrat should be laid on the ground so that it is measuring 1 m slope distance along the transect. Do not prop up the edges of the quadrat to make it level.

When a quadrat is located on a steep slope the botanist should be positioned next to or downhill from the quadrat to prevent sliding or falling into the quadrat. In areas of thick vegetation, the quadrat poles should be slid through the vegetation.



In order to avoid trampling the vegetation in the quadrats, all crew members must be aware of the quadrat locations and avoid these areas. Always walk on the RIGHT side of the transect when heading away from plot center, and walk on the LEFT side of the transect when heading towards plot center. In other words, stay on the clockwise side of the transects and avoid the area on the counterclockwise side of the transects.

Data collection

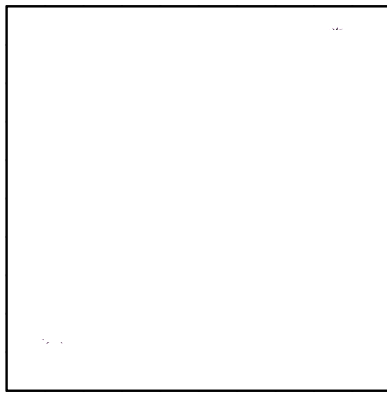
Percent cover class: For each species, percent cover will be recorded using the following cover classes. See Figure 1 below for illustrations of these percent cover classes.

Table 1. Percent cover categories (from Peet et al. 1998)

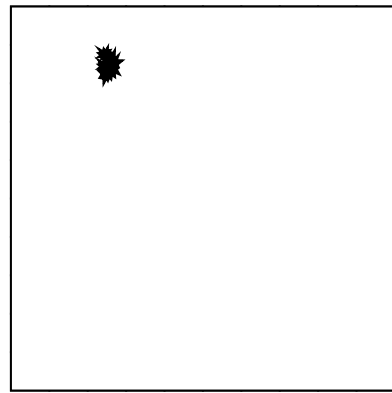
Percent Cover Range	Cover Class	Class Midpoint
Absent	0	0
0-1%	1	0.5
1-2%	2	1.5
2-5%	3	3.5
5-10%	4	7.5
10-25%	5	17.5
25-50%	6	37.5
50-75%	7	62.5
75-95%	8	85.0
95-100%	9	97.5

Notice the exact breakpoints (e.g., 25%) are not included in any class. Classes are either above or below each breakpoint. This is not a mistake - it is to encourage the crew not to waste time trying to decide if the correct value is exactly 25%. The most suitable class should be assessed and recorded as rapidly as possible.

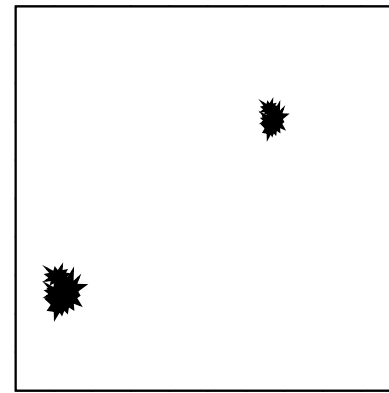
Use the 10-cm x 10-cm black or white square sections painted on the quadrat poles to help determine percent cover. Each black or white square illustrates 1% of the quadrat,



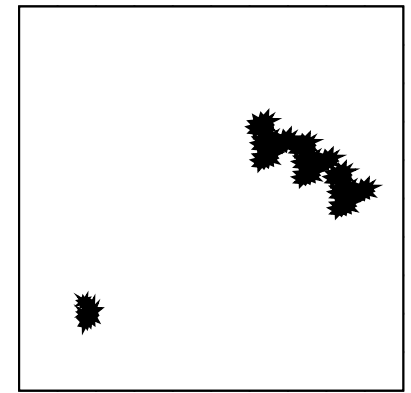
Class 0: Absent



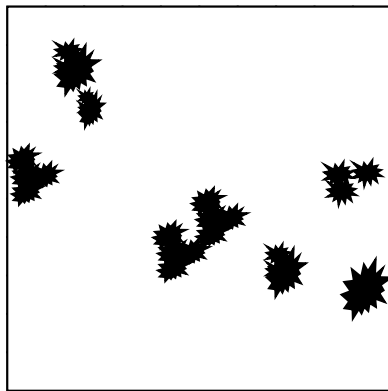
Class 1: 0 – 1 %



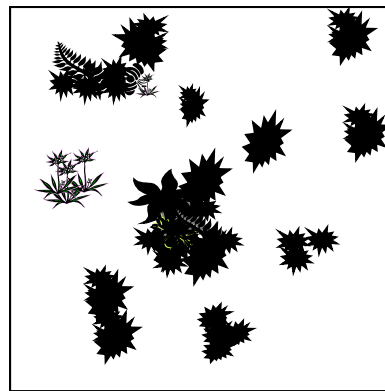
Class 2: 1 – 2 %



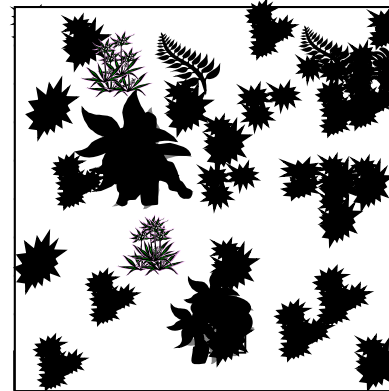
Class 3: 2 – 5 %



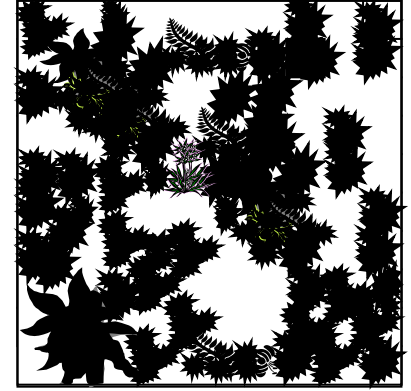
Class 4: 5 – 10 %



Class 5: 10 – 25 %



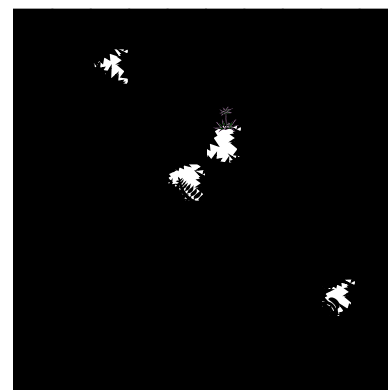
Class 6: 25 – 50 %



Class 7: 50 – 75 %



Class 8: 75 – 95 %



Class 9: 95 – 100 %

Figure 1. Graphic representation of cover class midpoints (modified from Peet et al. 1998).

Quadrat Substrate Characterization: Examine the quadrat. If the herbaceous species and nonvascular plants were removed (or it was winter), what does the surface of the quadrat look like? Record the appropriate percent cover class for each of the following within the quadrat. The first three categories (Rock, Wood and Trunk) provide information on how much space in the quadrat is unavailable for plant growth. The second three categories (Litter, Water, Dirt) provide information on the conditions available for plant growth. The total cover of these 6 categories should add up or exceed 100%.

% ROCK. Record the cover class of exposed rock. Moss- or lichen-covered rocks are counted as rock cover. Include all rocks greater than 1 cm in length by 1 cm in width.

% WOOD. Record the cover class of downed coarse and fine woody debris that is greater than >1 cm in diameter. Moss- or lichen-covered wood is counted as wood cover. Woody debris that is not touching the ground should not be included in the cover.

% TRUNK. Record the cover class that best represents the basal area of live woody trunks and stems that are > 1 cm in diameter at the root collar.

% LITTER. Record the cover class of leaf and other vegetative litter.

% WATER. Record the cover class of standing, ponded, or flowing water on the surface of the quadrat.

% DIRT. Record the cover class of exposed bare dirt or sand. Large areas of moss that are not on rock or wood are counted as dirt percent cover.

Quadrat Vegetation Characterization: Examine the vegetation < 2m in height in the quadrat. Record the appropriate percent cover class for each of the following within the quadrat. The total of these five categories can be less than 100% if portions of the quadrat are unvegetated. The total can add up to >100% if vegetation is dense and overlapping.

% NONVAS. Record the total cover class of all nonvascular plants, including moss and lichens.

% WOODY. Record the total cover class of all woody species (trees seedlings, saplings, and shrubs). Refer to the Master Plant List to determine which species are trees and shrubs.

% VINE. Record the total cover class of all woody and herbaceous vine species. Refer to the Master Plant List to determine which species are vines.

% GRAM. Record the total cover class for all graminoid species, including grasses, rushes, and sedges.

% FERN. Record the total cover class for all fern species and fern allies such as *Lycopodium* spp..

% HERB. Record the total cover class for all herbaceous species (vascular plants that are not woody, vines, graminoid, or fern). Refer to the Master Plant List to determine which species are herbaceous.

Species Data

SPECIES.

With Botanist -- Each quadrat is examined by a contract botanist or a crew member familiar with flora of that park. A list of species is recorded including all herbaceous, graminoid, fern, and vine species that are rooted in or overhanging the quadrat within 2 m of the ground. Species names follow the Integrated Taxonomic Information System (ITIS). Refer to the Master Plant List to determine which species are herbaceous, graminoid, fern, or vine. Species considered trees or shrubs are not included in the species list. Then, percent cover class of each species is estimated and recorded, using the cover classes discussed above.

For each species, cover is based on a vertically-projected polygon described by the outline of the foliage, ignoring any normal spaces occurring between leaves. Only estimate foliar cover on plants or portions of plants that fall inside the quadrat frame and less than 2 m above the ground. Base percent cover estimates on the current years' growth, by including living, damaged, and dead material from the current year. Record the percent cover present at the time of the plot visit. Do not adjust the percent for the time of year during which the visit was made (i.e., for immature or wilted plants). Overlap of plants of the same species is ignored. There will often be overlap of plants of different species. Therefore, the total cover for a quadrat may exceed 100%.

If a plant cannot be identified to species quickly and confidently, assign the species a specimen number, record genus or family, if possible, and give a short descriptive name. If the unknown plant is not locally sparse, collect a specimen away from the quadrat as described below. Do not collect any plants that are represented by 5 or fewer individuals (i.e., locally sparse) in the general vicinity of the plot. Do not collect a specimen if the plant occupies less than 1% cover in the quadrat or no mature foliage or reproductive parts are present. Anytime it is not possible to collect a specimen, collect a photograph. Place a ruler in the photograph for scale, and allow the camera to automatically select the appropriate aperture for the given light conditions. Use the Macro setting or Super Macro setting to take detailed close up photographs of smaller plants.

Without Botanist – Each quadrat will be examined for the following three fern species: eastern hayscented fern (*Dennstaedtia punctilobula*), New York fern (*Thelypteris noveboracensis*) and brackenfern (*Pteridium aquilinum*). The percent cover class of each species is jointly estimated and recorded by the team of two people. Use the cover classes listed above.

For each species, cover is based on a vertically-projected polygon described by the outline of the foliage, ignoring any normal spaces occurring between leaves. Only estimate foliar cover on plants or portions of plants that fall inside the quadrat frame and less than 2 m above the ground. Base percent cover estimates on the current years' growth, by including living, damaged, and dead material from the current year. Record the percent cover present at the time of the plot visit. Do not adjust the percent for the time of year during which the visit was made (i.e., for immature

or wilted plants). Overlap of plants of the same species is ignored. There will often be overlap of plants of different species. Therefore, your total cover for a quadrat may exceed 100%.

Deer Browse Indicators

QUADRAT. Record the code corresponding to each quadrat. Use the transect azimuth and the distance from plot center. Appropriate codes are: 0-5, 0-10, 60-5, 60-10, 120-5, 120-10, 180-5, 180-10, 240-5, 240-10, 300-5 and 300-10.

If any of the target species listed in Table 2 below occur in the quadrat, the following data will be taken:

SPECIES. Record the species name only if it is rooted in the quadrat. Plants that are overhanging into the quadrat but are not rooted inside are not counted in this section of the protocol.

NUMBER OF REPRODUCING PLANTS. Tally number of plants with evidence of flowering or fruiting for each target species using the dot box system.

NUMBER OF NON-REPRODUCTIVE PLANTS. Tally number of nonflowering plants of each target species using the dot box system.

HEIGHT. For each of the target species, measure the height of the tallest 3 plants in each quadrat. Height should be measured in centimeters, to the nearest 1 cm. Start with the plant that appears the tallest and work towards smaller statured plants until 3 plants have been measured (if 3 are present). To measure height, gently align the plant along a ruler. Realign the ruler along any curves present to account for additional height masked by a curved stem. See the drawings on the following pages that illustrate the point on each species at which height should be measured.

Table 2. Target herbaceous species that will be monitored as indicators of deer browse.

Scientific Name	Common Name
Actaea spp. (<i>A. pachypoda</i> , <i>A. podocarpa</i> , <i>A. racemosa</i> , <i>A. rubra</i>)	baneberries
<i>Arisaema triphyllum</i>	Jack in the pulpit
<i>Maianthemum canadense</i>	Canada mayflower
<i>Maianthemum</i> spp. (<i>M. racemosum</i> , <i>M. stellatum</i>)	false lily of the valleys
<i>Medeola virginiana</i>	Indian cucumber root
<i>Osmorhiza</i> spp. (<i>O. claytonia</i> , <i>O. longistylis</i>)	sweetroot
<i>Podophyllum peltatum</i>	mayapple
<i>Polygonatum</i> spp. (<i>P. biflorum</i> , <i>P. pubescens</i>)	solomon's seals
<i>Prosartes</i> spp. (<i>P. lanuginosa</i> , <i>P. maculata</i>)	yellow fairy bells, mandarin
<i>Trillium</i> spp. (numerous)	trilliums
<i>Uvularia</i> spp. (<i>U. grandiflora</i> , <i>U. perfoliata</i> , <i>U. puberula</i> , <i>U. sessilifolia</i>)	bellworts

Tree Seedlings

Seedlings are defined as live juvenile trees with at least two true leaves, and that have less than 1.0 cm DBH. Any juvenile tree that is shorter than breast height (<1.37 m tall) is considered a seedling. A seedling is counted only if it is rooted in the quadrat. Refer to the Master Plant List to determine which species are considered trees.

QUADRAT. Record the code corresponding to each quadrat. Use the transect azimuth and the distance from plot center. Appropriate codes are: 0-5, 0-10, 60-5, 60-10, 120-5, 120-10, 180-5, 180-10, 240-5, 240-10, 300-5 and 300-10.

SEEDLING SPECIES. Record the USDA PLANTS code for the genus and species. Species names follow USDA PLANTS and the Integrated Taxonomic Information System (ITIS). If species cannot be determined in the field, collect a twig sample with foliage, buds, cones, or flowers, and/or a photograph to make a positive identification later. Samples should not be taken if the entire plant will be killed or entirely removed from the quadrat. If possible, collect samples outside the entire plot from similar specimens and make a note to correct the species code later. Record genus or family if known, and “sp01”, “sp02” etc for each unknown species. For seedlings that cannot be identified to family, use “UNKCON” for Unknown Conifer and “UNKHDW” for Unknown Hardwood.

SEEDLING COUNT. Within each quadrat, record the number of live tree seedlings by species within each of the following height classes: <5 cm, 5.1 - 15 cm, 15.1 - 30 cm, 30.1 - 100 cm, 1.0 - 1.5 m, >1.5 m. Record the tally of seedlings on the datasheet using the dot box system. Juvenile trees that are > 1.5 m in height and have a DBH $\geq$ 1 cm are not included in the seedling count because they are considered saplings.

Tree seedlings that originate at a common root collar are considered independent seedlings. Tally the height of each seedling independently.

If a tree seedling forks or branches above ground, measure the height of the tallest terminal bud and count the seedling as one.

Do not count stump sprouts from a live tree as seedlings. A tree is considered live if it has any living parts (leaves, buds, cambium) present at or above DBH.

Tally stump sprouts from standing dead trees, counting each sprout as a separate seedling. A tree is considered a standing dead tree if it has no living parts (leaves, buds, cambium) present at or above DBH.

References

Peet, R. K., Wentworth, T. R., and P. S. White. 1998. A flexible multipurpose method for recording vegetation composition and structure. *Castanea* 63: 262-274.

Daubenmire, R.F. 1968. *Plant communities: A textbook of plant synecology*. Harper & Row. New York. 300p.

Braun-Blanquet, J. 1965. *Plant sociology: the study of plant communities* (Transl. by G.D. Fuller and H.S. Conard) Transl. of 1st edition of *Pflanzensoziologie* (1928). McGraw-Hill, New York and London. 438p.

Mueller-Dombois, D. and H. Ellenberg. 1974. *Aims and Methods of Vegetation Ecology*. John Wiley & Sons. New York. 547 p.

ERMN Vegetation Vital Sign Protocol
Tree Regeneration and Shrubs
Version 1.1 (September 2007)

Overview: This SOP quantifies live saplings, established seedlings, and shrubs by species on four 2-m radius circular microplots. Seedlings are also quantified by size class. These data yield information on advance regeneration, future cover, and the effects of deer browsing.

Definitions

Height of seedlings is defined as the distance from the root crown to the top of the terminal bud, or to the top of the tallest fork. Do not include leaves or needles in this measurement. Seedling height is determined from stems as they are naturally growing. Height is measured vertically from the ground to the tip of the terminal bud, not along the axis of the stem. Stems should **not** be straitened by hand prior to measurement. The tip of the highest terminal bud determines the height of the woody plant. Do not use leaves to determine the height.

Horizontal distance is the straight line distance between two objects. This contrasts with slope distance which is measured parallel to the ground. Slope distance and horizontal distance are equivalent on flat land. On sloped land, the horizontal distance between two objects is less than the slope distance.

Seedlings are defined as live juvenile trees with at least two true leaves, and that have less than 1.0 cm DBH. Any juvenile tree that is shorter than breast height (<1.37 m tall) is considered a seedling. A seedling is counted only if it is rooted in the microplot. Refer to the Master Plant List to determine which species are considered trees.

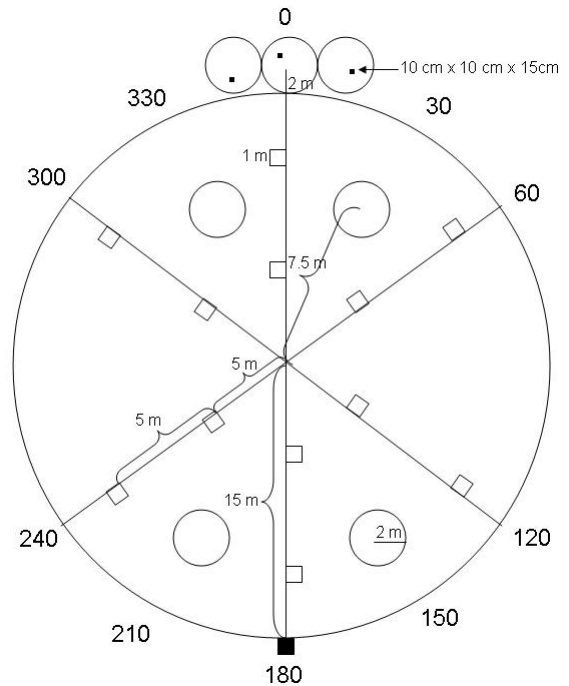
Saplings are defined as live juvenile trees with diameter-at-breast-height (DBH) ≥ 1.0 cm but less than 10 cm. Saplings are considered alive if there are any living parts (leaves, buds, cambium) at or above DBH. Saplings that have been temporarily defoliated are considered alive. A sapling is counted only if it is rooted in the microplot. Refer to the Master Plant List to determine which species are considered trees.

Shrubs are woody species that will not reach the canopy. Refer to the Master Plant List to determine which species are considered shrubs. To be counted in this protocol, a shrub must have at least two true leaves. Shrubs are considered alive if there are any living parts (leaves, buds, cambium) in the above ground portion of the plant. Shrubs that have been temporarily defoliated are considered alive. Many shrubs have multiple stems originating from a common base - these are counted as a single shrub. Shrub stems are counted only if they are rooted in the microplot. However, the percent cover of shrubs that are overhanging the microplot but are not rooted in it, will be recorded.

Microplot Set Up

From plot center, measure 7.5 meters slope distance in each of the following directions: 30°, 150°, 210°, and 330°, to find the centerpoint of each microplot (see figure below). Mark the microplot center with a spike set flush to the ground. Detailed directions for establishing the microplots are provided in the Site Selection and Plot Establishment SOP.

The microplot is a circular plot of 2-m radius slope distance. The boundary of the microplot is determined by using two 2-meter long ropes with loops at one end. To collect the microplot data, loop the end each 2-m rope around the center spike. Stretch one rope out to the north from the center spike, marking the location of the end of the rope with the metal mallet used to pound in the center spike. Stretch the other rope out from the center spike towards 30° or 60°, creating a triangle or pie piece between the two ropes. Make sure the ropes are lying flat and straight and are not caught on the vegetation. One crew member will search for saplings, seedlings, and shrubs in the roped-off pie piece, and will call out the species, tallies, and heights. The other crew member will record the data and assist with moving the ropes. Once all the data has been recorded from the first pie piece, the rope pointing north will be moved clockwise passed the second rope to create a new pie piece. Follow this procedure until the metal mallet marking the first rope's location has been reached and the entire microplot has been searched.



Data collection

Microplot Characterization: Examine the vegetation < 2m in height in the microplot. Record the appropriate percent cover class for each of the following within the microplot. The total of these four categories can be less than 100% if portions of the microplot are unvegetated or woody cover is dense. The total can add up to >100% if vegetation is dense and overlapping. Use the following percent cover categories: 0 = 0%, 1 = <1%, 2 = 1 - 2%, 3 = 2-5%, 4 = 5-10%, 5 = 10-25 6 = 25-50%, 7 = 50-75%, 8 = 75-95%, 9 = 95-100%

% NONVAS. Record the total cover class of all nonvascular plants, including moss and lichens.

% VINE. Record the total cover class of all woody and herbaceous vine species.

% GRAM. Record the total cover class for all graminoid species, including grasses, rushes, and sedges.

% FERN. Record the total cover class for all fern species.

% HERB. Record the total cover class for all herbaceous species (vascular plants that are not woody, graminoid, or fern).

SAPLING SPECIES. Record the USDA PLANTS code for the genus and species of each sapling. Species names follow the Integrated Taxonomic Information System (ITIS). If species cannot be determined in the field, collect a twig sample with foliage, buds, cones, or flowers, and/or a photograph to make a positive identification later. If possible, collect samples outside the microplot from similar specimens and make a note to correct the species code later. Record genus or family it is known, and “sp01”, “sp02” etc for each unknown species. For saplings that cannot be identified to family, use “UNKCON” for Unknown Conifer and “UNKHDW” for Unknown Hardwood.

SAPLING DIAMETER. Measure DBH at 1.37 m above ground line on the uphill side of sapling. To accurately re-measure diameter (dbh) at the same point on the sapling at successive visits, use a PVC pole marked at 1.37 cm. See instructions for measuring DBH in unusual situation in the "Tree" SOP. For saplings 1-8 cm DBH, use Finley saping gauge to measure DBH to the nearest 0.5 cm. For saplings 8.1-9.9cm, use the 2-m DBH tape to measure DBH to the nearest 0.5 cm.

SEEDLING SPECIES. Record the USDA PLANTS code for the genus and species. Species names follow USDA PLANTS and the Integrated Taxonomic Information System (ITIS). If species cannot be determined in the field, collect a twig sample with foliage, buds, cones, or flowers, and/or a photograph to make a positive identification later. Samples should not be taken if the entire plant will be killed or entirely removed from the microplot. If possible, collect samples outside the entire microplot from similar specimens and make a note to correct the species code later. Record genus or family it is known, and “sp01”, “sp02” etc for each unknown species. For seedlings that cannot be identified to family, use “UNKCON” for Unknown Conifer and “UNKHDW” for Unknown Hardwood.

SEEDLING COUNT. Within each microplot, record the number of live tree seedlings by species within each of the following height classes: <5 cm, 5.1 - 15 cm, 15.1 - 30 cm, 30.1 - 100 cm, 1.0 - 1.5 m, >1.5 m. Record the tally of seedlings on the datasheet using the dot box system. Juvenile trees that are > 1.5 m in height and have a DBH $\geq$ 1 cm are not included in the seedling count because they are considered saplings.

Tree seedlings that originate at a common root collar are considered independent seedlings. Tally the height of each seedling independently.

If a tree seedling forks or branches above ground, measure the height of the tallest terminal bud and count the seedling as one.

Do not count stump sprouts from a live tree as seedlings. A tree is considered live if it has any living parts (leaves, buds, cambium) present at or above DBH.

Tally stump sprouts from standing dead trees, counting each sprout as a separate seedling. A tree is considered a standing dead tree if it has no living parts (leaves, buds, cambium) present at or above DBH.

SHRUB SPECIES. Record the USDA PLANTS code for the genus and species. Species names follow the Integrated Taxonomic Information System (ITIS). If species cannot be determined in the field, collect a twig sample with foliage, buds, fruit, or flowers, and/or a photograph to make a positive identification later. If possible, collect samples outside the microplot from similar specimens and make a note to correct the species code later. Record genus or family if it is known, and “sp01”, “sp02” etc for each unknown species. For shrubs that cannot be identified to family, use “UNK” for Unknown.

SHRUB COUNT. Record the number of live shrubs on each microplot by species. Multiple stems originating from a common base are counted as a single shrub. Shrub stems are counted only if they are rooted in the microplot.

SHRUB COVER. Record the percent cover class for each shrub species using the cover classes listed below. Notice the exact breakpoints (e.g., 25%) are not included in any class. Classes are either above or below each breakpoint. This is not a mistake - it is to encourage the crew not to waste time trying to decide if the correct value is exactly 25%. The cover contributed by shrubs that are overhanging the microplot but are not rooted in it will be included in the total percent cover for that species. Likewise, for species which are overhanging, but do not have individuals rooted in the microplot, only percent cover will be recorded for those species. Use the following percent cover categories: 0 = 0%, 1 = <1%, 2 = 1 - 2%, 3 = 2-5%, 4 = 5-10%, 5 = 10-25 6 = 25-50%, 7 = 50-75%, 8 = 75-95%, 9 = 95-100%

ERMN Forest Vital Sign Protocol
Tree Measurements
Version 1.0 (May 2007)

Overview: This SOP measures species, diameter and condition of all live and standing dead trees ≥ 10 cm diameter-at-breast-height within each forest plot. These data will yield information on tree growth, mortality and condition, and stand structure and composition.

Caution

Dead trees can be a safety hazard. Crews must exercise caution - trees that are deemed unsafe to measure should be estimated but not touched.

Definitions

Diameter-at-breast-height (DBH) is measured at 1.37 m above the ground line on the uphill side of the tree.

Horizontal distance is the straight line distance between two objects. This contrasts with slope distance which is measured parallel to the ground. Slope distance and horizontal distance are equivalent on flat land. On sloped land, the horizontal distance between two objects is less than the slope distance.

Dead standing trees are trees without any living parts (leaves, buds, cambium) present at or above DBH that lean < 45 degrees from vertical, as measured along the bole. They need not be self-supported. Once included, standing dead trees are tracked until they no longer qualify as standing dead. Dead trees that are > 45 degrees from vertical are considered coarse woody debris and should be measured according to the coarse woody debris SOP.

Live trees are trees with any living parts (leaves, buds, cambium) present at or above DBH, including trees that have been temporarily defoliated. Trees that are still alive but are leaning or fallen are still considered live trees. Live trees do not have to be self-supported. They may be supported by other trees, branches, or their crown.

Trees are woody species (live or dead) with a diameter greater than or equal to 10 cm at DBH. Refer to the Master Plant List to determine which species are considered trees.

Procedure

According to the Plot Establishment SOP, six transects were established using measure tapes. Begin tallying trees from 0 degree (north) transect and continue clockwise around the plot.

A tree which occurs on the plot boundary will be included only if the center of the stem lies directly on or within the plot boundary. The lean of the tree bole into or out of the plot does not affect whether the tree is tallied.

For each tree, measure and record the horizontal distance to the front edge of the trunk from the plot center using the laser. The front end of the laser (not your eye) should be placed over plot center while taking the distance measurement. Make sure that “HD” is visible in the laser viewfinder while all distance measurements are being taken. In plots with tall dense shrubs or saplings, the laser may not work. In these circumstances, the Sonin distance measure can be used. However, the Sonin device measures slope distance, not horizontal distance. Therefore, on slopes, if the two Sonin parts cannot be held at the same horizontal level, the distance measurement must be converted from slope distance to horizontal distance using the slope conversions provided in Appendix A.

Measure and record the tree’s azimuth from plot center using a compass. Identify and record the tree species. Record data on tree status and condition (see specific fields below). Measure the diameter at breast height, using the white DBH mark on the tree pole to identify the height of DBH. Using the tree scribe, create a horizontal mark on the bark of the tree 5 cm below DBH, using the blue mark on the tree pole to identify the height of the scribe mark. The scribe mark should face plot center. At FONE, FRHI, ALPO, and JOFL, if there is a trail close to the plot, scribe marks should be placed on the far side of the tree, away from the trail, so that the marks cannot be seen from the trail. Do not scribe snags that sway when touched in order to ensure no snags are knocked down. Note in Tree notes that snag was not scribed, and proceed to record data as usual.

Data collection

TREE NUMBER. Assign each live or dead tree >10cm DBH a sequential number, starting with 1, 2, 3, etc, for each plot. The tree closest to the 0 degree transect will be labeled 1 and tree numbers will be assigned in order proceeding clockwise around the plot.

SPECIES. Record the USDA PLANTS code for the genus and species of each sapling. Species names follow the Integrated Taxonomic Information System (ITIS). If species cannot be determined in the field, collect a twig sample with foliage, buds, cones, or flowers, and/or a photograph to make a positive identification later. Record genus or family it is known, and “sp01”, “sp02” etc for each unknown species. For standing dead trees that cannot be identified to family, use “UNKCON” for Unknown Conifer and “UNKHDW” for Unknown Hardwood.

DISTANCE. Measure the horizontal distance to the front edge of the trunk from the plot center using the laser. Record the distance to the nearest 0.1 meter. Remember that horizontal distance is the distance that determines if a tree is in the plot, not the distance along the slope.

AZIMUTH. Measure the azimuth from the plot center to each tree, sighting the center of the base of each tree with a compass. Record the azimuth to the nearest degree. The compass should be declinated appropriately for each park each year (see Plot Establishment SOP).

DBH. Measure tree diameter at breast-height (1.37 m) above the ground on uphill side of tree (Figure 1). Do not measure from a pit or atop a mound or emergent rock. Use the white DBH mark on the tree pole to consistently find breast-height. Round diameter measurement to the nearest 0.1 cm.

Make certain that you are reading the correct side of the DBH tape; often one side has standard centimeters and the other side has units calibrated to give the diameter in centimeters when wrapped around the circumference of the tree. Read off of the calibrated side of the tape. First press the hook at the end of the tape into the bark and then run the tape around the trunk, ensuring that the tape is straight and pulled perpendicular to the axis of the trunk. Tapes not run straight will give an overestimate for the trunk diameter. Wrap the tape tightly around the tree and read the number where the tape crosses the zero mark at the hook end of the tape.

For unusual DBH situations, determine where DBH should be located on the tree using the guidelines below. Always scribe the tree 5 cm below where DBH is taken, even if DBH is taken in an unconventional place on the trunk. Note the location of the DBH measurement in Tree Notes, using distances and landmarks found on the tree. When re-measuring the diameter of a tree tallied at a previous survey, always take the measurement 5 cm above the scribe mark unless it is not physically possible (e.g., tree buried by mudslide) or there is an abnormality at the previous diameter measurement point. Always note deviations from previous year's measurements in the Notes section for that tree.

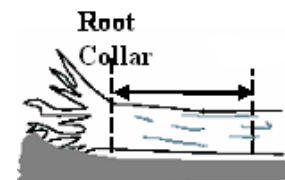
Irregularities at DBH: If there is an abnormality (swellings, bumps, depressions, or branches) at DBH, take the measurement just below the abnormality if possible. If the abnormality extends far below DBH, then take the measurement just above DBH. Describe the location of the measurement in Tree Notes.

Missing wood or bark: Do not reconstruct the DBH of a tree that is missing wood or bark. Record diameter of the wood and bark as the tree is, and note that wood or bark was missing in Tree Notes.

Leaning tree: Diameter is always measured perpendicular to the bole axis. Find the point equivalent to breast-height (1.37 m) by measuring along the uphill side of the tree. Measure diameter perpendicular to the bole as shown in Picture 3 – Leaning Tree.

Curved bole: Treat a curved bole as if it were a leaning tree. Measure a straight line from the uphill side of the tree base to 1.37 m. Do not measure along the curve of the bole.

Live windthrown tree: Find the point equivalent to breast-height (1.37 m) by measuring from the top of the root collar along the bole, as shown in picture at right.



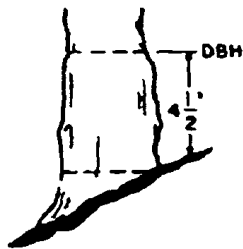
Swollen bases: Trees with swollen bases rising higher than 0.91 m are measured 0.46 m above the top of the swelling. Trees with swelling below 0.91 m are measured at standard DBH.

Independent trees that grow together: If two or more independent stems have grown together at or above the point of DBH, continue to treat them as separate trees. Estimate the diameter of each, and explain the situation in Tree Notes.

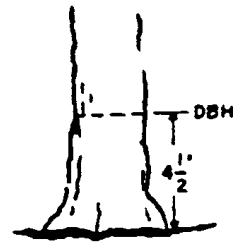
Forked tree: Trees which fork at or above breast-height (1.37 m) are tallied and measured as one tree. Diameter should be measured below the point at which forking affects DBH (see Picture 4). This point should be marked and recorded in Tree Notes.

For trees that fork below breast-height (1.37 m), each trunk ≥ 10 cm is tallied as a separate tree. Measure the diameter of each trunk at 1 m above the fork (see Picture 5). Scribe each trunk with a horizontal mark 5 cm below where DBH was measured. Multiple stems should be recorded from left to right when facing the trees from plot center. Note which trees fork from a common base in Tree Notes.

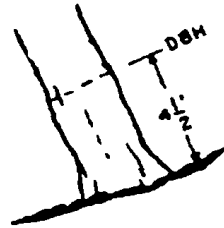
DIAMETER BREAST HIGH MEASUREMENT IN A VARIETY OF SITUATIONS



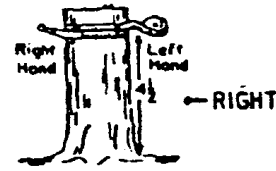
1. Tree on slope



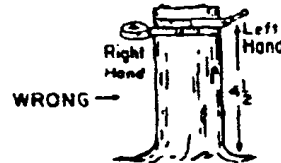
2. Tree on level ground



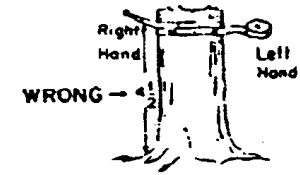
3. Leaning tree



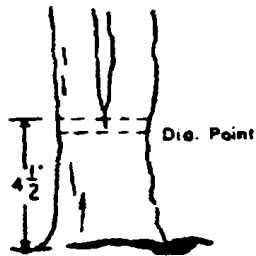
LEFT HANDED - Right hand crossed under.



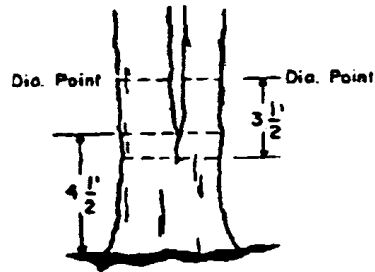
RIGHT HANDED - Left hand crossed over.



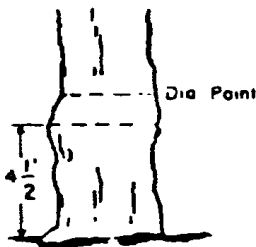
LEFT HANDED - Right hand crossed over.



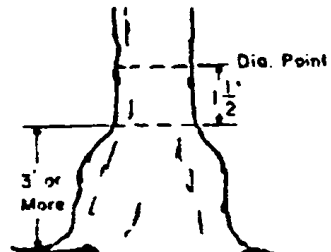
4. Tree forking at or above 4 1/2 feet



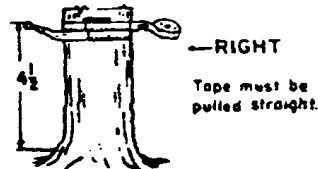
5. Tree forking below 4 1/2 feet



6. Tree deformed at 4 1/2

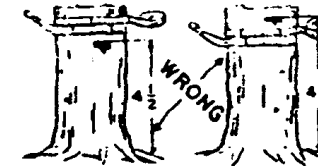


7. Bottleneck tree



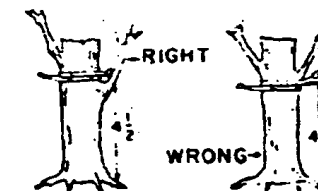
Tape must be pulled straight.

The tape must be at right angles to the lean of the tree.



Always assume that the 4 1/2 ft D.B.H. point is at the top of lower tape at this point

Don't place tape at abnormal place on the bole

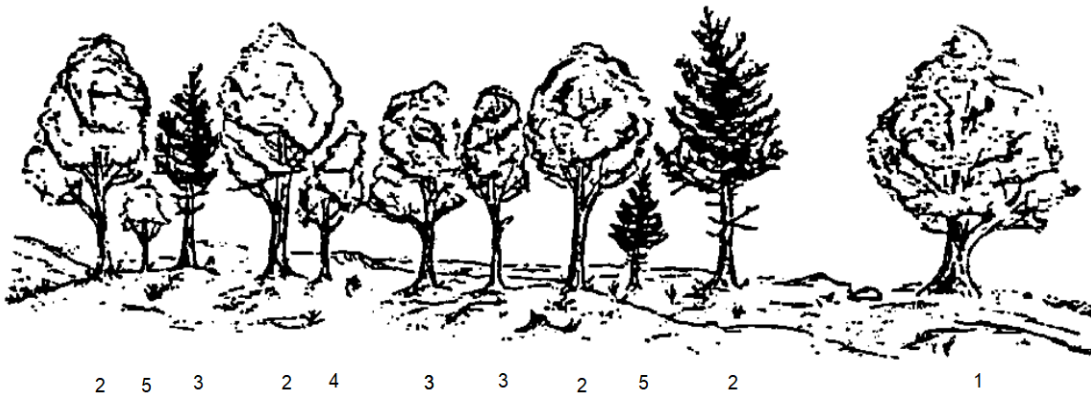


TREE STATUS. Record a status code for each tree to track status over time.

- 0 No status. Previously tallied tree is no longer in sample because tree was incorrectly tallied last time, or a change in procedure now excludes this tree. Record reason in Tree Notes.
- 1 Live tree. New live trees in remeasured plots are assumed to be ingrowth. If a new tree is tallied that was missed during a previous inventory, note this in Tree Notes.
- 2 Standing dead tree.
- 3 Removed. Previously tallied tree has been cut and removed by humans during harvest, silviculture or land clearing.
- 4 Fallen dead tree. Previously tallied tree has fallen and will no longer be tracked as a live tree.

CROWN CLASS. Assign crown class code describing tree crown position in canopy and amount of sunlight received.

- 1 Open-grown – crown has received full sunlight from above and all sides through much of its life, particularly during early development, as seen by well developed lower branches.
- 2 Dominant – crown extends above canopy, receiving full light from above and some light from sides. Taller than the average tree in stand and has well-developed crown.
- 3 Co-dominant – crown at the general level of the canopy, receiving full light from above but little direct light from sides. Typically, co-dominant trees have medium-sized crowns and are crowded on the sides; in dense stands, co-dominant trees have small crowns.
- 4 Intermediate – tree is shorter than co-dominant trees but with a crown that extends into the general canopy. Tree has small crown and is very crowded from the sides.
- 5 Overtopped – crown is entirely below the general level of the canopy.



TREE CONDITION. Record the presence of any of the following pests, pathogens, or damages. If none of these conditions exist, record a horizontal line in the Tree Condition box.

Pests and Pathogens

ALB - Asian Longhorned Beetle

BBD - Beech Bark Disease

BTC - Butternut Canker

DWA - Dogwood Anthracnose

ETC – Eastern Tent Caterpillar

EAB - Emerald Ash Borer

GPM - Gypsy Moth

HWA - Hemlock Woolly Adelgid

SOD - Sudden Oak Death

Damage Code	Description of Damage
ABGR	Abnormal growth pattern for the species of concern. This category would include a range of physical deformities not included in the remainder of the damage codes.
BIRD	Bird damage such as Woodpecker or sapsucker holes.
BLIG	Blight is generally defined as any plant disease or injury that results in general withering and death of the plant without rotting. Blight can result from a wide variety of needle, cone, and stem rusts, as well as canker diseases, and is often species- or genus-specific. Consultation with local plant pathologists may assist in identifying specific blight conditions.
BROK	Broken top of the tree.
BROM	Witches' broom diseases are characterized by an abnormal cluster of small branches or twigs on a tree as a result of attack by fungi, viruses, or insects.
BURL	A hard, woody, often rounded outgrowth on a tree. This occurs naturally in some tree and shrub species, and is a sign of an infection or disease in other species.
CONK	The knobby fruiting body of a tree fungal infection visible on a tree bole, such as a shelf fungus.
CROK	Crooked or twisted bole for species in which this is uncharacteristic.
DECY	Advanced decay of bole and limbs.
DTOP	Dead top.
EPIC	Epicormic sprouting, adventitious shoots arising from suppressed buds on the stem; often found on trees following thinning or partial girdling.
FIRE	Fire scar or cambial damage due to fire.
FORK	Forked top of a tree or multiple primary leaders in a tree crown for species in which this is uncharacteristic. Forks assume vertical growth and should be distinguished from branches, which assume horizontal growth.
FRST	Frost crack or other frost damage.
GALL	Galls found on stems, leaves or roots. Galls are formed by infection of the plant by bacteria or fungi, or by an attack by certain mites, nematodes, or insects, most notably wasps.

HOLW	Hollowed-out trees. Repeated hot fires can burn through the bark and the tree's core may then rot out, especially in trees with tough bark, but soft heartwood. These hollowed-out trees are sometimes called "goose pens" because early settlers kept poultry in them.
INSE	Visible insects in the tree bole or the canopy, or their sign, such as frass, pitch tubes or bark beetle galleries.
LEAN	Tree is leaning significantly. If on a slope, tree deviates considerably from plumb.
LIGT	Lightning scar or other damage to the tree caused by lightning.
MAMM	Damage caused by mammals, such as bear claw marks, porcupine or beaver chewings, and deer or elk rubbings.
OZON	Ozone damage. Ozone injury is often seen in the form of stippling or speckling on the leaves or needles of trees. This discoloration varies among species and ranges in color from red or purple to yellow or brown. Susceptible species often drop their leaves prematurely.
ROOT	Large exposed roots.
ROTT	A rot of fungus other than a conk, often associated with a wound or crack in a tree.
SPAR	Unusually sparse foliage for that species and size of tree.
SPRT	Basal sprouting; new shoots arising from the root collar or burl.
UMAN	Human-caused damage such as axe marks, embedded nails or fence wire, or vandalism.
VINE	Vines present in canopy or climbing bole of tree. List vine species or genus in Notes section.
WOND	A wound to a tree that cannot be identified by one of the other damage codes, including wounds or cracks of unknown cause.

FOLIAGE CONDITION. Visually assess canopy foliage and record up to 3 problems as chlorosis (C), necrosis (N), holes (H), small leaves (S), wilting (W), leaf loss (L), or other (O – describe in Tree Notes). Only record L for needle loss if fine twigs in the canopy are affected – disregard lower branches and large dead branches.

FOLIAGE PERCENTAGE. Estimate amount of crown affected for each foliage condition using the following classes: 1-10, 10-25, 25-50, 50-75, 75-100%.

DECAY CLASS. For each standing dead tree, record code indicating the tree's stage of decay.

Class	Bark	Log shape and Integrity	Color of Exposed Wood	Primary surface substrate	Branches and twigs
I	Firmly attached	Round and solid	Fresh color, not stained by weathering	Sound bark	Branches retain many small twigs
II	If present, decayed, faded and not firmly attached	Round and solid	May be bleached and relatively smooth (like driftwood)	Decayed bark and hard wood - impenetrable with fingernail or pen point, may be case hardened with powder wood beneath	Branches retain some small twigs
III	Generally absent, except in Betula and Prunus	Round and firm		Soft wood - will spring back if compressed and easily penetrated with fingernail or pen point	No small twigs
IV	Absent	Oval or flattened, no longer a solid piece though some hard chunks remain		Very spongy wood - responds to finger pressure and may exude moisture - and powder wood - flows through fingers like coarse sawdust	No small twigs
V	Absent	Quite flat or flat with some rounding		Loosely aggregated powder wood	No small twigs

Adapted from Pyle and Brown 1998.

TREE NOTES: Record any unusual tree features or notes required above, including location of diameter measurement if not measured at breast-height.

ERMN Vital Sign Protocol
Soil Measurements and Sampling
Version 1.2 (August 2007)

Overview: This SOP serves to characterize forest soil chemistry and provide information on the effects of atmospheric deposition upon the ability of soils to support forested ecosystems. Soil samples will be shipped to designated facilities for soil chemistry analysis. This SOP also includes a rapid assessment of earthworm presence, used to characterize the spatial extent of earthworms across the network.

Three samples of soil approximately 10 cm x 10 cm x 10 cm in size will be collected. One sample will be collected from within each of three 2-m radius circles along the vegetation monitoring plot's northern edge.

Regulations Governing Sample Collection: The National Historic Preservation Act of 1966 (as amended) provides for the protection of historical and cultural artifacts. Due to the random placement of the vegetation monitoring plots, a soil sampling site may occur on a site of prehistoric or historical significance. To obtain permission to sample, contact park archeologists or cultural resource specialists prior to field visits. If cultural artifacts are encountered at a plot where permission to sample has been granted, do not take a soil sample. Code the site as not sampled and record a note explaining why a soil sample was not taken.

Definitions

Earthworm burrows are temporary or permanent soil channels made by earthworms. Burrows appear as circular openings in the soil surface. Sometimes burrows are covered by, or surrounded by, casts, litter or organic matter.

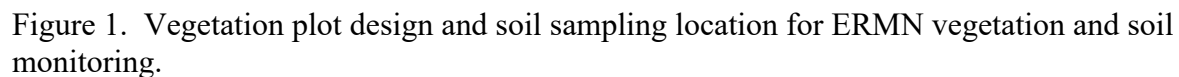
Earthworm casts are earthworm excrement composed of soil mixed with digested plant residues. Casts appear as distinctive, moist aggregates of rich soil. In areas with established earthworm populations, casts may be visible throughout the summer. Cast production is highest during moist spring and fall seasons.

Horizons are layers which develop in soil under the influence of climate, living organisms and other soil forming factors. Major horizons from top to bottom include the O (organic) horizon, A, E (eluviated), B and C horizons.

Litter is intact or partially decomposed organic material that is easily identified (e.g., plant leaves, twigs, etc.).

Mineral soil is a soil consisting predominantly of products derived from the weathering of rocks (e.g., sands, silts, and clays). As soil develops under the influence of climate, living organisms and other soil forming factors, it typically develops layers or horizons. Typical mineral soil horizons include the A, E and B horizons.

Locate the soil sampling frames along the plot's northern edge (Figure 1). To locate the middle soil sampling frame, measure 2 meters slope distance along the 0° azimuth from metal spike that marks the end of the 0° transect. This point is also 17 meters slope distance from the plot center along the 0° azimuth. Place a chaining pin at this point. This is the center of Soil Sampling Frame 2 (see Figure 2).



From the chaining pin in the center of Soil Sampling Frame 1, measure 8 meters slope distance along the 90° azimuth. Place a chaining pin at this point. This is the center of Soil Sampling Frame 3 (see Figure 2). The three chaining pins should be in a straight line.

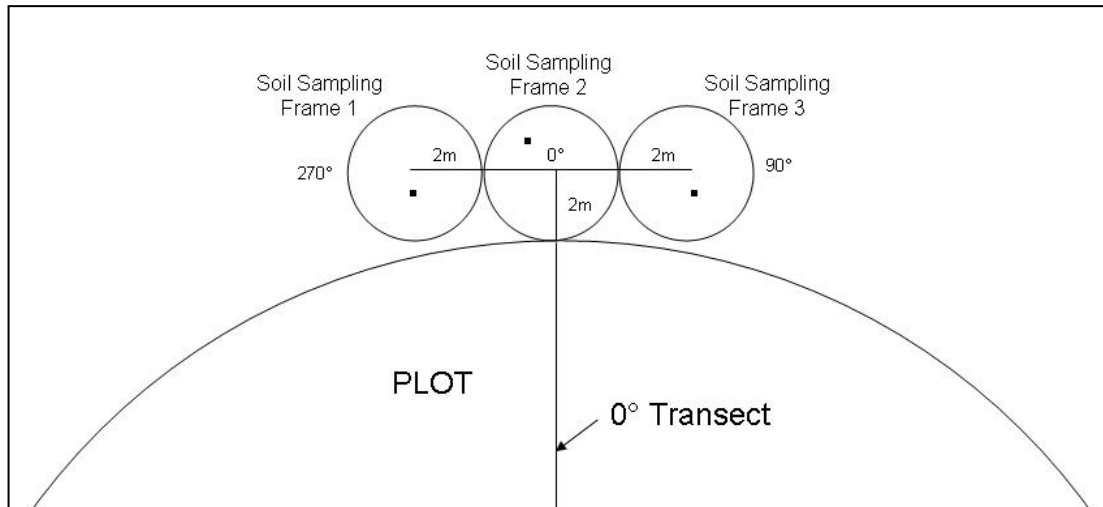


Figure 2. Location of the soil sampling frames in relation to the vegetation monitoring plot and each other.

If soil cannot be measured or sampled on the vegetation monitoring plot's northern border due to obstructions (e.g., boulders, standing water), establish the sampling frames on the end of the 60° transect. If soil cannot be sampled at the end of the 60° transect, move clockwise around the plot to subsequent transect, until a location from which soil can be sampled is found. In these cases, note the location of the sampling frames in Frame Location on the datasheet.

Soil Sampling Procedure

For each vegetation monitoring plot, take one soil sample in each of three soil sampling frames (three 2-m radius circles).

First, select a 10 cm x 10 cm area within Sampling Frame 1 that is relatively free of rocks, roots or other obstructions that prevent soil sampling. Visually divide the sample plot into the 16 sections shown on the datasheet and in Figure 3.

Determine which sector of the sampling frame contains the selected soil sampling area. Use the 2 meter rope to help determine the sample area sector. Place an "X" on the datasheet in the appropriate sector to indicate the location of the soil sample. Write the last two digits of the current year (e.g. "'07") adjacent to the "X".

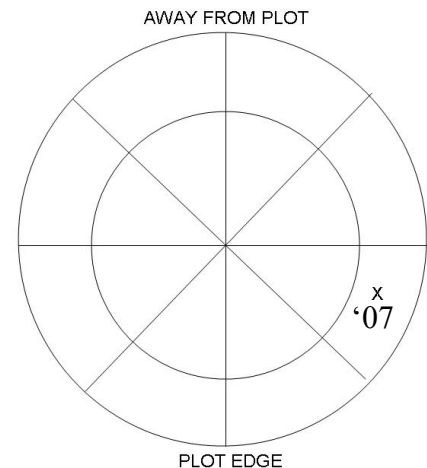


Figure 3. Example of the record of the soil sampling area located in one section of the soil sampling frame.

In the selected area, place the 10 x 10 cm sampling quadrat carefully on the ground to avoid compacting the forest floor. Use small survey flags to mark the approximate midpoints of the upper and lower edges of the quadrat, and then remove the quadrat. Use a ruler to measure the depth of the litter layer to the nearest cm at each flag. The bottom of the litter layer can be distinguished as the boundary where plant parts (such as leaves or needles) are no longer

recognizable as such because of decomposition. Record the litter layer depth on the data sheet to the nearest 0.5 cm.

Replace the sampling quadrat. Using a pair of clippers, carefully remove all live vegetation from the sample area. Living mosses should be clipped at the base of the green, photosynthetic material. Then brush aside all unconsolidated litter (leaves, bark, wood fragments, etc.). Unconsolidated litter is easily brushed aside by hand. Do not remove consolidated litter (leaves, etc.) which has begun to compress and decompose.

Once the unconsolidated litter has been removed, visually examine quadrat to assess and record the presence (1) or absence (0) of earthworm casts and burrows. If examination is inconclusive, record 9, and record a brief note explaining why in Soil Notes.

Next, use a sharp knife or keyhole saw and a pair of clippers to carefully cut through the forest floor along the inner surface of the quadrat to separate it from the surrounding soil. Using inward scooping motions, carefully collect and bag the consolidated organic horizon to expose the top of the mineral soil. Place the organic material in a plastic bag labeled with Collection Date (MM/DD/YY), Park (Four letters), Vegetation Monitoring Plot Number, Soil Sampling Frame Number (1, 2, or 3), and Horizon (O). Discard all recognizable woody debris including pine cones, large pieces of bark, and partially decomposed wood, and any rocks or pebbles.

Measure to the nearest 0.5 cm the thickness of the O Horizon. The O Horizon thickness is the distance from the top of the consolidated litter to the top of the mineral soil. The boundary between the O horizon and the underlying mineral soil is detected by soil texture and weight. The O horizon is light in weight and has a greasy feel. The underlying mineral soil may vary in color or have a dark color similar to the O horizon and contain a mix of organic and mineral particles which is heavier in weight and may feel gritty. Record the color of the O Horizon (e.g. “dark brown”, “grayish brown”). If there is no consolidated leaf litter, do not collect an O Horizon sample, and make a note of such in Soil Notes.

After collecting the O Horizon, use a trowel to carefully remove the mineral soil and place it in a plastic bag labeled with Collection Date (MM/DD/YY), Park (Four letters), Vegetation Monitoring Plot Number, Soil Sampling Frame Number (1, 2, or 3), and Horizon (A). Continue carefully removing soil until a color change is observed in the soil. If a color change is observed, expose the soil profile along the edge of the sample area. Examine the exposed profile for distinct color changes that identify the boundary between the A horizon and underlying soil. The E horizon, if present, will be a relatively narrow band of markedly lighter colored soil between the overlying A and underlying B horizons. If no E horizon is present, it may still be possible to note a distinct color change between the dark brown A horizon and the lighter brown or pale B horizon underneath.

If the lower boundary of the A horizon is distinct and apparent, carefully measure and record the depth of the A horizon to the nearest 0.5 cm as the distance from the bottom of the O Horizon to the top of the B Horizon. Record the color of the A Horizon (e.g. “light brown”, “dark gray”). Circle “Y” next to “Observed Bottom of A Horizon”. Record the color of the underlying B Horizon (e.g. “light brown”, “grayish brown”).

If the lower boundary of the A horizon is not observed, do not collect more than 15 cm in depth of A horizon soil. Measure the depth of the exposed A horizon to the nearest 0.5 cm as the distance from the bottom of the O Horizon to the bottom of the soil pit. Under “A Horizon Thickness” on the datasheet, write a “>” symbol before the observed thickness. For example, record “>11.5 cm” if the observed depth of exposed A horizon soil was 11.5 cm. Record the color of the A Horizon (e.g. “light brown”, “dark gray”). Circle “N” next to “Observed Bottom of A Horizon”.

If the A horizon is < 5cm in depth, carefully measure and record the depth of the A horizon to the nearest 0.5 cm. Record the color of the A Horizon (e.g. “light brown”, “dark gray”). Circle “Y” next to “Observed Bottom of A Horizon”. Then, carefully remove the B Horizon soil and place it in a plastic bag labeled with Collection Date (MM/DD/YY), Park (Four letters), Vegetation Monitoring Plot Number, Soil Sampling Frame Number (1, 2, or 3), and Horizon (B). Continue carefully removing soil until a maximum depth of 15 cm from the bottom of the O Horizon. Record the color of the underlying B Horizon (e.g. “light brown”, “grayish brown”). Carefully measure and record the depth of the B Horizon to the nearest 0.5 cm. Circle “Y” next to “Collected B Horizon”.

Next, repeat this entire procedure in the remaining two soil sample plots.

Soil Sampling Procedure on Remeasurement Plots

On subsequent remeasurments, use the same soil sampling frames. Read the Frame Location notes from the previous visit’s datasheet. Reestablish the center points of the three sampling frames on the end of the transect specified in Frame Location.

Using the previous visit’s datasheet to determine which sectors of the sampling frame were previously sampled. Select a sector not previously sampled and follow the soil sampling procedure outlined above. Place an “X” on the datasheet in the appropriate section of the soil plot and sector to show the location of the soil sample. Write the last two digits of the current year (e.g. “07”) adjacent to the “X”.

Data collection

FRAME LOCATION. Record the location (distance and azimuth) of the center point of soil sampling Frame 2 in relation to the end of a transect. (e.g. “ 2 meters north of the end of the 0° trasect”)

SAMPLE LOCATION. Draw an X in the appropriate sector of the circle representing the soil sampling frame to show the location of the soil sample in the sampling frame. Write the last two digits of the current year (e.g. “07”) adjacent to the “X”.

LITTER THICKNESS UPPER SIDE and LOWER SIDE. At the approximate midpoints of the upper and lower edges of the soil sampling frame, measure the depth of the litter to the nearest 0.5 cm as described above.

EARTHWORMS. Record the presence (1) or absence (0) of earthworm casts and burrows at the soil sampling location for the current year. If examination is inconclusive, record 9, and record a brief note explaining why in Soil Notes.

O HORIZON THICKNESS. After excavating the O horizon, record the thickness of the O horizon as the distance from the top consolidated litter to the top of the mineral soil. Measure the thickness to the nearest 0.5 cm.

O HORIZON COLOR. Record the color of the O horizon, such as “dark brown”, “grayish brown”.

A HORIZON THICKNESS. Measure and record to the nearest 0.5 cm the thickness of A horizon as observed in the soil profile. If the lower boundary of the A horizon is not observed, write a “>” symbol before the observed thickness. For example, record “>11.5 cm” if the observed depth of exposed A horizon soil was 11.5 cm.

A HORIZON COLOR. Record the color of the A horizon, such as “medium brown”, “grayish brown”.

OBSERVED THE BOTTOM OF A HORIZON. Circle Y if the lower boundary of the A Horizon was observed. Circle N if the lower boundary of the A Horizon was not observed.

A HORIZON THICKNESS. Measure and record to the nearest 0.5 cm the thickness of A horizon as observed in the soil profile. If the lower boundary of the A horizon is not observed, write a “>” symbol before the observed thickness. For example, record “>11.5 cm” if the observed depth of exposed A horizon soil was 11.5 cm.

A HORIZON COLOR. Record the color of the A horizon, such as “medium brown”, “dark gray”.

B HORIZON THICKNESS. Measure and record to the nearest 0.5 cm the exposed depth of B horizon as observed in the soil profile. In most cases, the lower boundary of the B horizon will not be observed. If these cases, write a “>” symbol before the observed thickness. For example, record “5.0 cm” if the observed depth of exposed B horizon soil was 5.0 cm.

B HORIZON COLOR. Record the color of the B horizon, such as “light brown”.

COLLECTED B HORIZON. Circle Y if any B horizon soil was collected. Circle N if B horizon soil was not collected.

SOIL NOTES. Note which, if any, horizons were absent. If soil could not be collected from certain horizons, note why. If it was difficult to find a suitable soil location, record the reason. Record any unusual soil features.

Sample drying

Upon return from the field, leave soil sample bags open to air-dry in a safe location until soil no longer appears moist. To test dryness, gently squeeze the soil through the bag to break up clumps, and arrange the sample so it has maximum exposure to the air (fold back the lip of the bag, move soil out of the corners of the bag, and let the sample lay as flat as possible). In order for this to work properly, use flexible plastic soil sampling bags that are wider at the opening than they are long. As the soil dries, check and mix the sample by gently squeezing from outside the bag.

Prior to sending samples to the lab, prepare a master list of sample information. Assign each sample a unique number from 1 to n, mark this number prominently on the bag (using a different color ink than other info on the bag and circle this number), and create a list identifying which sample number corresponds to which park, plot number, soil horizon or depth increment, date collected and date finished drying. Print a copy of this list for ERMN, and include a copy with the samples when shipped or delivered to the lab.

Sample analysis

Send dried samples to a designated soil chemistry lab that has experience analyzing forest soils. Several soil laboratories have sufficient capabilities, including the Analytical Lab at the University of Maine (<http://anlab.umesci.maine.edu>, contact Sue Ehrich erich@maine.edu).

The lab should prepare samples by passing each through a 2 mm sieve to remove larger particles. Analysis must include:

- Total carbon and total nitrogen by dry combustion
- NH_4Cl extractable ions including Ca and Al