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PERMANENT PLOT PROTOCOL

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I. Permanent Plot Establishment

A. Surveying the plot

Upon arrival outside the perimeter of the plot, all equipment is accounted for and left at one central point (usually on and/or underneath a tarp). The general data (elevation, weather, plot number, slope, aspect, micro-relief, land form, and slope position) are recorded. The corners of the plot are then established.

1. Laying Out The Corners

A crew of two to three proceeds (along a corridor) to the plot center and sets up the jacob staff and staff compass. The declination on the compass is checked before any readings are taken. A plumb bob is used to ensure that the compass is directly over plot center. To establish the first corner, the azimuth through the "free" subplot is taken and one technician is sent along that azimuth with a metal tape (~ 30 m long). Great care is taken to keep the tape on line. When a distance of 14.14 meters from plot center is reached (along the slope) the tape is pulled taught and a marker is placed at the point 14.14 meters from plot center. To correct for slope, the two technicians use a clinometer to determine the slope along the azimuth and then calculate what the corrected slope distance should be. Readings for slope are taken by both technicians, sighting at their eye level on their partner.

When this distance is calculated, the tape is pulled taught and a plumb bob is used to help determine exactly where the plot center are checked fro accuracy. Throughout these procedures, accuracy of readings between crew members is ensured through repetition of calls.

This procedure is then repeated for each of the three remaining corners of the plot. The PVC pipe is placed in the ground so that the top is directly over the corner. Each corner has its own color: green for north, yellow for east, red for south and orange for west. Flagging is placed over (as close as possible) each corner to allow its location to be easily seen by the crew while working on the plot.

2. Marking Witness Trees

As soon as the first corner is established, a crew of two can establish witness trees in relation to the corners. Two trees (not spruce) outside of the plot are flagged and painted with blue paint at approximately six feet above the ground, in a four to six inch strip around the bole of the tree. These trees are tagged (one meter below DBH) and the DBH is recorded. An azimuth from the corner to the tree is also recorded along with the distance (along slope) between the corner and the center of the tree. The azimuth is recorded to the nearest degree, the distance to the nearest centimeter. This procedure is repeated for each of the corners (see "plot location" data sheet).

3. Marking The Perimeter

Once at least two corners are established, a 50 m fiberglass tape is stretched from one PVC pipe, along the perimeter, to the next corner. The reading on the tape at the center of each pipe is recorded.

The tape is stretched tightly but not so tight as to affect the pipe's location. both the readings on the tape as it leaves one pipe and as it comes into the next pipe are recorded. With these data, the slope distance between the two points can be calculated. Ten equal increments are then established along each side. Each increment is marked using a wire flag (top of wire flag over the point to be marked). A permanent PVC pipe (not painted) replaces the four flags at the midpoints of the sides (along the perimeter).

4. The Corridors

Once the mid points of the sides along the perimeters are established, two 30 meter tapes are stretched from mid point to mid point, parallel with the sides. These tapes go through the middle of the plot corridors (four meters wide). These are set aside as areas where the crew may walk. Five equal intervals along each half of the two corridors are established through the same procedure used along the perimeters.

5. Herb & Shrub Strip Layout

The location of the strip plots (two meter by eight meter areas where herbs, shrubs, seedlings; saplings, and other qualities are analyzed; see diagram below) is randomly selected before arriving at the plot. Three of the four sub-plots are randomly selected for location of strip plots. In the fourth subplot, only trees are measured. Within each of the three sub-plots, the location of the strip plots must be randomly selected from four possibilities (see "tree location/mapping" data sheet). These strip plots are always oriented as depicted in the data sheet (Northeast / Southwest).

The establishment of the strip plots in the field involves stretching tapes along the 8 meter long sides and then putting flags at two meter intervals from the side to the edge of the corridor. The corners of these plots are established using PVC pipe painted yellow, red, and blue. The 2m by 2m plots are corrected for slope. The 1m by 1m plots are not. The 2m by 2m increment is taken from the perimeter or the corridor, depending on which the strip falls closer to. A one meter by one meter square is established in the corner closest to the center of the plot within each of the four quadrats in the strip plot (see diagram below). Wire flags to establish the corners of the one meter by one meter plots were used during the 1986 field season. These flags are removed when the data collection is completed.

B. Location of soil sampling sites

1. spodosols

One point was located for excavation of one quantitative pit associated with each permanent plot. Sampling points for quantitative pits were located systematically at 12 meters from the twenty by twenty meter plot corners, beginning at North and proceeding to East, South, and West of plot corners, N, E, S, and W respectively. The 0.71 square meter frame is fastened to the ground with rerod at the same north/south orientation as the permanent plot.

Rejection criteria:

1.soil type spodosol/folist evaluated in the same way as extensive contour surveys.

2. Reject if tree (live or dead) > 5 m DBH falls within the frame.

3. Reject if frame cannot be fastened securely because of bolders.

4. Reject if < 30 m from trail.

5. Reject if < 5 m from stream or disturbed area.

If the point is rejected because of a tree or inability to fasten the frame, a point two meters further on the same azimuth is chosen. If these eight points were rejected our protocol would then evaluate eight more points located ten meters from the original four points (twelve meters from each plot corner). These eight points would be located on azimuths perpendicular to those taken from the plot corners to establish the first set of eight points. We would begin with North and proceed to East, South, and West. At the North point, the two points perpendicular at East and West would be evaluated, selecting the clockwise azimuth first. The points at East, South, and West would follow the same protocol.

Sampling points for fifteen by fifteen cm forest floor blocks were selected relative to the point chosen for the quantitative pit.

A point (A) was selected by going perpendicular to the azimuth that defined the quantitative pit a distance of six meters from the point establishing the quantitative pit. The direction of the perpendicular was always the cardinal compass direction clockwise from the azimuth defining the quantitative pit (i.e. East if North had been selected).

The point (A) established a center about which four fifteen by fifteen cm forest floor blocks were excavated with their North, East, South, or West corners being oriented one meter North, East, South, or West respectively from this center point (A).

2. Folists

Four points were located for the excavation of four quantitative pits associated with each permanent plot. Sampling points were located systematically at points twelve meters North, East, South, and West of the North, East, South, and West corners of the permanent plots.

Rejection criteria:

1. Reject if a live or dead tree > five cm DBH falls within the frame.

2. Reject if < thirty meters from a trail or < five meters from a stream or disturbed area.

If the point is rejected because of a tree, a point two meters farther along the same axis is chosen. If this point were rejected then a point five meters distant from the original point (twelve meters from the plot corner) on an azimuth 90 clockwise from the azimuth taken from that plot corner was evaluated. If this was rejected then a point ten meters from the last point on an azimuth 180 from the azimuth taken to evaluate the last point is evaluated. If this point is rejected then this azimuth (from plot corner) is abandoned and another point must be evaluated five meters distant from a point selected on the remaining azimuths beginning with the North azimuth and proceeding clockwise. The azimuth taken to select a second point associated with an azimuth from a plot corner is always 90 in a clockwise azimuth from the original azimuth taken from the plot corner.

II. Sampling Methods

A. Herbs and shrubs

Data collection for herbs and shrubs is done with two or three crew members. Many of the measurements are visual estimates. Two or three separate visual estimates are made and then an estimate is discussed and agreed upon by the two to three crew members, and recorded. Shrub data are measured in the 2x2 quadrats, herbs are measured within each quadrat in the 1x1 meter closest to the center of the plot. (see diagram page 4).

In the 2x2 quadrat (shrub plot) the percent cover of each shrub species is estimated. Percent cover refers to the percentage of the area being analyzed that would be covered if the plants were laid flat on that surface. The number of saplings and number of seedlings for each tree species within the 2x2 quadrat is also recorded. If there are more than fifteen seedlings within the 1x1 meter herbaceous plot, only that 1x1 meter plot is looked at for number of seedlings. If there are less than fifteen seedlings in the 1x1 then all the seedlings in the 2x2 quadrat are measured. The areas that are measured are noted on the data sheet.

The 1x1 meter plots (herb plots) are measured similarly to the shrub plots. The % cover of each plant species present (herbs and woody plants) is analyzed and recorded using the same method as with the shrub plots. The % cover of all other properties listed on the dat sheet is also recorded. Percent cover, for these objects, refers to the area of the ground covered by their vertical projection. If percent cover estimates are greater than ten percent different among observers, a discussion follows until all observers agree within ten percent.

These measurements are made for each of the three strip plots. Great care is taken to mark these areas before tree measurements are made, so as to avoid damage to the shrubs and herbs within.

8. Trees

Tree measurement is a two stage process in this project. The first set of measurements consists of mapping the trees using a coordinate system, measuring the DBH, and estimating the width of the crown. The second set of measurements are used to establish the height of the tree and its crown and to determine the decline class of the tree. Each individual measurement within each stage must be done as accurately as possible, following protocol.

Location of any tree within the plot is done using the flages and pipes and tapes set up when the plot is originally surveyed. Each 2m by 2m area is assigned a two digit value (1, 1 or 9, 5 for example). To locate any point within that area, an x, y grid system with 40, 5 cm graduations along each axis, recorded in meters, is used. With this system it is possible to digitize, in the field, the exact location of any tree. The location of the crown is also entered in digit form. It is important to take the time to be as accurate as possible. Great care is taken to avoid damaging the herb/shrub plots whenever possible.

Trees are tagged with a numbered aluminum tag during the DBH measurement. To measure DBH, the field technician must have determined where 1.37 meters from the bottom of his/her shoes is on his/her body. Once that is known, the measurement is made on the tree ont he uphill side (see p. 22 of the Quality Assurance Methods Manual for Site Classification and Field Measurements). To complete the measurement, the technician simply stands next to or leans against the tree to be measured and transfers the known point on his/her body to a point on the tree. This point on the tree is then assumed to be the correct distance from the ground at which DBH is to be measured. The manual describes how to handle certain irregular trees.

Once breast height is determined, a meter stick is extended from that point down towards the base of the tree. One meter below DBH, a hole is drilled and a .25 inch PVC rod with an aluminum numbered tag attached is hammered in. The rods have heads on them to prevent the tag from falling off. As a precaution, the hole should be drilled at a slight downward angle to decrease the chances of the tag falling off of the rod (see diagram below). For dead trees, no drilling is required. An aluminum nail is used in place of a PVC rod.

With the rod in place, the meter stick is placed on top of the rod and the DBH measured one meter above the rod. Special care is taken to make sure that the diameter tape is set on a perpendicular plane to the long axis of the bole of the tree (see notes on potential problems in the QA manual, p.2 22-23). The DBH is recorded along with the tree number (see "DBH and Crown Width" data sheet).

Crown width is approximated from the ground. A visual estimate of which is the longest axis is made. This distance (from tip of foliage to top of foliage) is estimated using a tape measure between two technicians on the ground. The azimuth of this axis is also recorded (accurate to within ten degrees). The longest axis perpendicular to the first axis is also measured and recorded. The location of the crown center in relation to the tree is also recorded using the coordinate system described above.

Tree and crown heights are determined for each live tree on the plot. For dead trees, only the total height is calculated (with broken-off tops so indicated). A clinometer and a tape measure are used to gather the data. The two technicians needed to gather the data must determine where their eye level is on their partner (their nose, forehead, etc.). One person stays at the base of the tree and records the data collected while the other goes away from the tree a distance greather than the height of that tree. It is best to go along the contour, second best to go upslope. Avoid going down slope as this creates the chance of greater errors in clinometer readings. Readings over 90% may be significantly less accurate. The slope distance between the tree and the clinometer is recorded, along with the % slope betweent he two. The % slope to the base of the tree, to the top of the tree, to the top of the live crown, and to the base of the live crown are recorded. With these measurements, the height of the tree, the length of the live crown, and the length of the dead top can be calculated. Height poles will be used when possible. The height pole is placed on the uphill side of the tree and raised to the top of the tree and the height is read directly.

Note:

When it is not possible to see the base of the tree (or the partners feet at the base of the tree), the distance from the ground to the eyes of the person standing next to the tree is noted. This value is added to the other distances calculated to obtain the total height of the tree.

The decline class of each conifer is also estimated:

CLASS DESCRIPTION

1 0 - 10% needle loss

2 11 - 50% needle loss

3 50 - 99% needle loss

4 100% needle loss (dead)

Decline is estimated from the ground, looking from at least two points with at least two persons making the estimate.

C. Soils

1. Spodosols

a. Quantitative pits

A square reference frame (0.71 by 0.71 m inside dimension) was secured to the soil surface with pins and the area within excavated. The forest floor was excavated by horizon. The Oi and Oe (L+F) horizons were excavated collectively and pooled as one sample and the Oa (H) was removed separately. The distinction between the Oa and underlying mineral soil was based on organic matter content, with all material > 40% organic matter being included in the Oa sample. All material from the O horizons was bagged directly or, in cases with large forest floor volumes, seived through a 12.5 mm mesh screen, weighed and subsampled in the field.

Sampling by horizon in the mineral soil was considered impractical due to the subjectiveness of distinguishing horizon boundaries, the discontinuity within a horizon and the evidence of buried horizons and disturbed profiles. Therefore, mineral soil was excavated in three depth strata designated nominally as 0-10 cm, 10-20 cm, and 20 + cm (20 cm depth to bottom of B horizon) beneath the Oa horizon. The actual depth of excavation for the O horizons and each mineral soil stratum was measured relative to the plane of the reference frame on a five by five cm grid. The pit walls were were maintained perpendicular to the plane of the reference frame during excavation. All material from each mineral soil depth stratum was sieved through 12.5 mm screening and weighed using a spring scale. Rocks not passing the sieve were weighed. All roots not passing the sieve were saved for analysis. The sieved material was mixed, weighed and subsampled in the field. The weight of soil removed from each horizon or depth stratum after sieving and correction to an oven dry weight basis was used in the calculation of elemental pool sizes.

The bulk density and rock volume of each depth stratum were calculated from the data collected. Rock volumes were estimated by weighing rocks and assuming a mean rock density of 2.65 g cm-3. The volume of unmovable large rocks was estimated by contouring their surfaces using the five by five cm grid described above and assuming the rock ended at the average depth of the bottom of the B horizon found in the rest of the pit. Soil bulk density was then calculated from soil weight, rock volume, and actual volume of each depth increment.

The faces of each pit were mapped by horizon and composite samples were collected from representative horizons on the pit faces. Grab samples were also collected from the bottom of the pit representing the C horizon.

Mineral soil samples were air dried and sieved through a two mm mesh screen and weighed. Rock and other coarse fragments not passing the screen were weighed. Roots passing the two mm mesh were analyzed as part of the soil. Roots larger than 2 mm are analyzed separately. Subsamples will be ground in an agate mortar and pestle to finer than 32 mesh and oven dried to constant weight at 105 c.

Forest floor samples were air dried and sieved through 6.25 mm mesh and both fractions weighed. Subsamples were ground in two successive steps in a Wiley Mill to 20 and finally 60 mesh. The forest floor samples were dried to constant weight at 55 c prior to analysis with the C-N analyzer. Further subsamples of forest floor were dried to constant weight at 105 c. All results for both mineral and organic strata are reported on an oven dry weight basis (constant weight at 105 c).

b. Forest floor blocks (15 by 15 cm)

Templates, fifteen cm square, were fastened to the soil surface. Roots and decaying organic matter were cut around the outside of the templates verticlaly downward perpendicular to the plane of the template. Soil was excavated around the template well into the mineral soil leaving an intact pedestal under the template. The pedestal was removed, inverted and the minral soil carefully removed and discarded. The remaining forest floor block was bagged directly and then weighed and processed as described for the forest floor samples collected from the quantitative pits.

2. Folists

The square .71 by .71 meter reference frame was fastened securely where possible. Where this was not possible, as on the sides of boulders, the frame was held in a fixed position with the slope equal to the average slope over 20 m at that point. The square was visually projected down on to the surface with the help of a meter stick and the lines were scribed with a key hole saw. The frame was then removed for excavation if necessary. The frame was repositioned as required to maintain the pit faces perpendicular to the plane of the frame.

The O horizons were collected with the same procedure as described for the spodosols. Where present, the mineral soil was removed quantitatively to the depth of the C or rocks too large to move. The mineral soil was taken out as one stratum only. Rocks were not quantified in the forest floor or mineral soil.

The depth of the forest floor was recorded at twenty locations evenly spaced on the pit faces.

D. Miscellaneous

Estimation of the amount of dead wood and the relative quality of that wood is done throughout each plot. Four diameter categories (5-10 cm, 10-15 cm, 15-20 cm, and 20+ cm) were established. The length of a piece of wood is recorded (to the nearest meter) under its diameter class. The specific diameter is recorded for anything over 20 cm in diameter. The quality of the dead wood is also categorized into five types (see "dead wood" data sheet). Recording the wood under these categories requires qualitative judgements ont he part of the field technician.

The species check list is to be filled out for each plot. It is a check to make sure that no species in the plot were missed. All plant species within the 20 by 20 meter plot are to be checked off on this list.

The additional spruce plots were set up to supplement the low amount of data being collected on spruce in the 20 m by 20 m plots. These areas (ten meter radius circle with the center at each of the four corners) are surveyed for living spruce. Each live spruce tree within this area is tagged and its DBH determined and recorded. The area itself is not delineated in the field. Each tree is recorded on a map (see additional spruce data sheet).