

Establishing a Long-term, Permanent Plot Research Program in the Catchacoma Forest, Trent Lakes, Ontario

Appendix 1 – Materials and Methods

Research Report No. 42

Catchacoma Forest Stewardship Committee & Ancient Forest Exploration & Research

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Trent Lakes & Powassan, Ontario

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This document provides step-by-step permanent plot protocols and materials required to complete in-field forest surveys in support of old-growth forest landscape research and ecological monitoring at the Catchacoma Forest.

1.0. Materials

A detailed description of all materials required to complete the protocols and for citizen scientists to be safe and comfortable in the field should be included in the next version of this report. This should include items like decent shoes/boots, bug spray, rain jacket, first aid kit, compass, gps, etc.

2.0. Methods

2.1 Plot Selection

The two inaugural plots were randomly selected based on slope aspect, slope steepness and disturbance history using digital mapping in the office. Additional plot locations will be selected based on research goals and accessibility. Maps will be created, and suitable plot conditions will be verified prior to sampling.

2.2. Plot Access

After the coordinates of the plot centre have been assigned, these coordinates are to be located in the field using a GPS unit, compass and maps provided by AFER. Once within the general vicinity of the plot, best efforts should be made to identify the plot centre within the capabilities of the GPS unit. Spatial bias, such as preference for easier working conditions or presence of larger trees should be avoided.

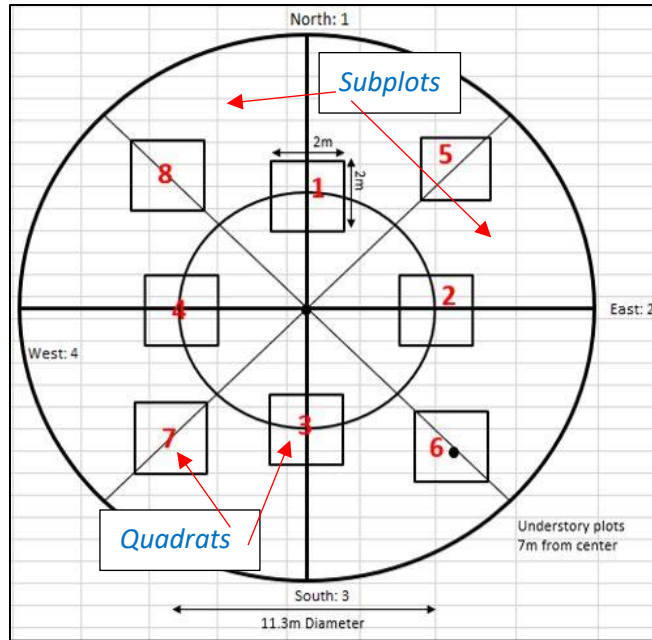
2.3. Plot Establishment

The location of the plot centre is then to be marked by a painted metal rebar stake, which is to be hammered into the ground to a depth of at least 10 cm. If the rebar cannot be secured into the ground, the closest suitable spot is to be used. The GPS is then used to record the coordinates of the rebar as the established plot centre location.

2.3.1. Plot and subplot boundaries

A circular plot with a radius of 11.3 m is to be established around the plot centre (Figure 1). A measuring tape

Figure 1. Plot (11.3 m radius), Subplot (one eighth of plot) and Quadrat (2x2 m) Layout



and a compass should be used to measure 11.3 m north of the plot centre. A flag should be placed at the 11.3 m mark, as well as two evenly spaced flags between this point and the plot centre. This process is to be repeated for lines in each of the cardinal directions (north, east, south and west). These lines of two flags are used to divide the plot into 4 quadrants (Figure 1). Next, lines should be demarcated from the plot centre to the plot outer boundary in the following four directions: NE, SE, SW, and NW in order to create 8 subplots, 4 of which should be sampled by skipping every other subplot. Additional flags (suggested minimum of 12) can be used to mark points at 11.3 m from the plot centre to clearly delineate the plot limits, which should be verified using a measuring tape if higher accuracy at certain locations is required for data collection.

2.3.2. Quadrats

This step of plot establishment is for sampling the understory and should be left until after the overstory and mid-story data collection are complete. Eight 2 x 2 m quadrats should be established within the 400 m² circular plot. Start in the north direction (0 degrees), 5 meters away from the stake, extend the 2-meter rulers fully and use them to create a 2 x 2 m "t shape" on the ground (Figure 1). Place a ruler along the cardinal line 5 meters away from the center stake, having one meter on either side of the measuring tape that is placed in the cardinal direction. Place the other ruler perpendicular to the first ruler at the 1-meter mark. Ensure that the quadrat goes directly through the 5 m mark. Do not step within the subplot. Repeat for east (90 deg.), south (180 deg.) and west (270 deg.) directions, in specified order.

After cardinal directions are completed, survey intercardinal directions. Measure from the center out 11.3m in the intercardinal directions (north-east, south-east, south-west, and north-west), place tape measures down. Start in the northeast direction (45 degrees), 7 m away from the stake, extend the 2-meter rulers fully and use them to create a 2 x 2 m "t shape" on the ground. Place a ruler along the intercardinal line 7 m away from the

center stake, having one meter on either side of the measuring tape that is placed in the cardinal direction. Place the other ruler perpendicular to the first ruler, at the 1-meter mark. Ensure that the quadrat goes directly through the 5 m mark. Repeat for south-east (135 deg.), south-west (225 deg.), and north-west (315 deg.), in specified order.

2.4. Data Collection

2.4.1. Site photos and %slope

Four photos are to be taken from the plot centre, one directed at each cardinal direction. The direction should be recorded either by taking note of the photo ID or by having a team member hold a sheet marked with the plot number and N, S, E or W at the corresponding location along the plot edge. Additional photos should be taken of notable observations especially those that may not be present upon revisits, such as wildlife and tree health condition.

Measure %slope using a clinometer using the percent (%) scale on the clinometer. Sight the clinometer parallel with the ground (upslope or downslope) to a target, aiming at a point on the target that is equal to the height of your eye above the ground. Draw the slope type and shape on a data sheet and record the %slope.

2.4.2. Meteorology

At the center of the plot, hold out handheld weather stations for 30 seconds in the air to allow for calibration, then collect wind speed, direction and air temperature on the stand description data sheet. Also estimate cloud cover over the plot center in increments of tenths as well as the presence or absence of precipitation in the previous 24 hours, to the extent possible.

2.4.3. Wildlife observations

Use all your senses to assess the 400 m² plot (and adjacent areas) for the presence of wildlife from the time arriving at the plot to the departure time. All wildlife includes mammals, birds, reptiles, amphibians, and fish. Record any presence/sign of an animal, which includes sounds, visual sighting, markings and scat. Record observations on data sheets. Merlin and/or iNaturalist app (if possible) can also be used to share field data. Identify potential wildlife habitat within the plot including vernal pools, hibernacula/shelter, snag cavities, etc.

2.4.4. Vegetation

2.4.4.1. Trees

For every tree that is within the plot and larger or equal to 10 cm DBH, record the following tree inventory information: tree number (if tags are nailed to trees), species of tree (use 7-letter code) and DBH. Record the approximate location of each tree on the Plot Map Data Sheet. A tree is counted as “in”, if any part of the trunk is within the 11.3 meter radius. Then, assess the health of the tree using the Tree Health Index. If one or more afflictions listed on the Tree Health Index is present, write the specified code provided in the designated area under the affected part of the tree including trunk, lateral branch and foliage.

Standing at the center stake, face the north direction, move in a clockwise direction (from north to the east), collect azimuth of the first tree encountered within the plot that has a DBH larger than 10 cm (see Overstory Data Sheet). After collecting the tree inventory information, tag 3 trees of the dominant species in the plot including the tree with the largest DBH recorded, the tree with a DBH closest to, but not below 15 cm DBH and

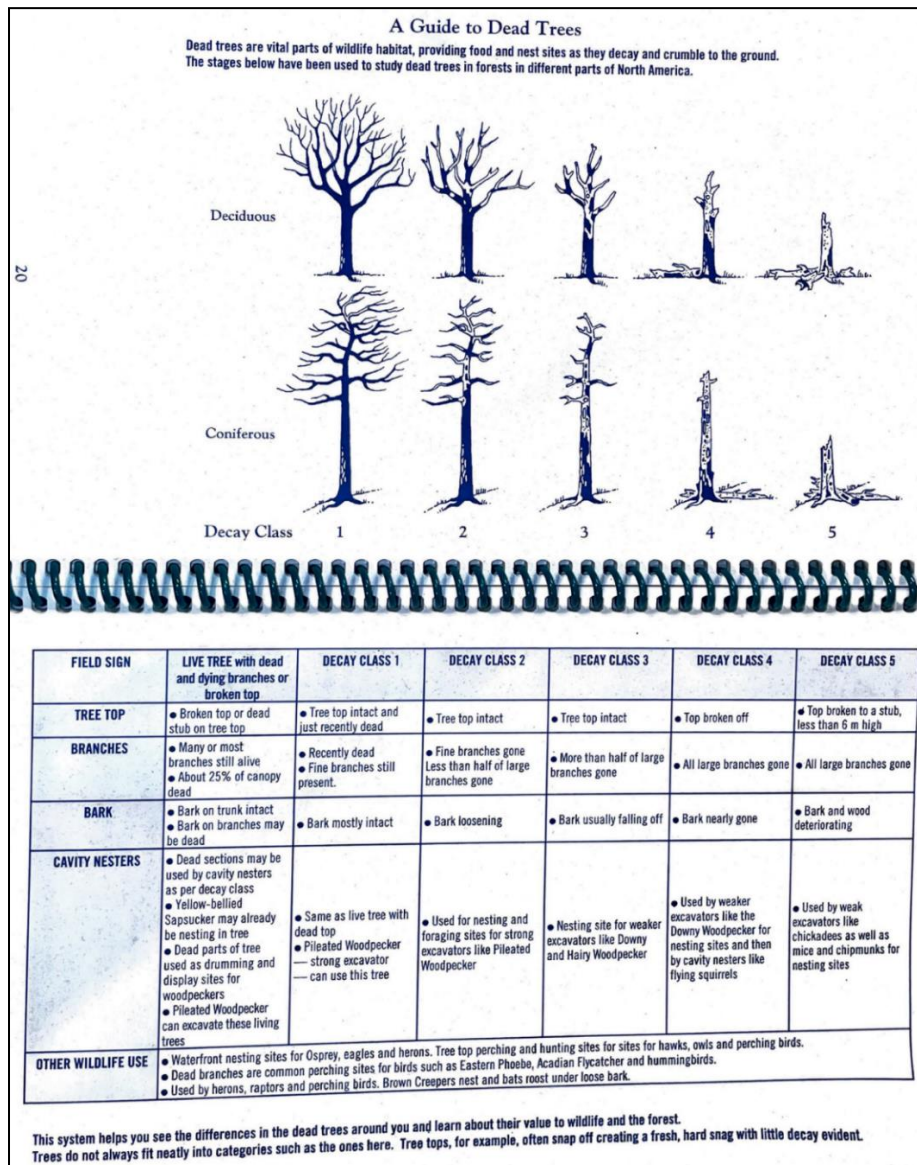
the tree that is closest to the DBH average of all the trees recorded in the plot. Tag the 3 trees at 1.3 m from the ground on the side facing towards the center stake. Ensure the tag can swing around the nail freely, allowing for further growth of the tree. Record the tag numbers on the data sheet under "Tree I.D. #".

Use the increment borer to obtain core samples from the 3 tagged trees. For each tree cored, label and store the core in a straw, which is best kept in a freezer since cores will go moldy. Record internal health (options underneath chart on plot map data sheet), number of rings counted in core sample (take photo of core sample) and height of tree using the clinometer. Ensure to mark the trees as cored on the plot map.

2.4.4.2. Snags

Within the entire plot, identify, assess and label all snags (dead standing trees). Identify and label them alphabetically starting from the northernmost point and following a clockwise direction (east). Snags are assessed if they have a DBH greater than 10 cm and a height greater than 2 m. Determine the species (if possible) or state "unknown", measure and record the DBH and the decay class (Figure 2). Identify and describe snag cavities that are present, and fill in the Snags Data Sheet.

Figure 2. Assessment of Snag Decay Class (from Ontario's Old Growth - A Learner's Handbook)



2.4.4.3. Logs

Identify all logs (note if the log was a cut tree) from the northernmost point, following a clockwise direction (east). The minimum diameter for a log is 15 cm diameter – portions of the log that are less than 15 cm diameter are not to be measured. Identify the species (if possible) or state “unknown”, and the diameter of the largest and the smallest point (minimum is 15 cm diameter) that is within the plot. Measure log length in m and record the decay class (Figure 3).

Figure 3. Assessment of Log Decay Class (from Ontario’s Old Growth - A Learner’s Handbook)

A Guide to Logs

Look at the different logs around the forest. Look at the different sizes and states of decay. As with snags, logs do not always conform to neat categories. Birch logs, for example, may be rotten mush on the inside, while the bark remains intact. The important point is that the log provides food and shelter for wildlife and substrate for plants as it decays.

LOG ETIQUETTE

Looking beneath logs is a good way to start studying the ecology of downed woody debris. But be careful. If you roll a log over to look beneath it, remember to roll it back. If the log is left rolled over, the moist micro-habitat will dry out and will take quite a while to recover.

Decay Class	Form and Shape of Log	Branches	Bark	Wood Moisture and Texture	Plant and Animal Habitat
Decay Class 1	<ul style="list-style-type: none"> Tree recently fallen, form still distinct Log round and rigid 	<ul style="list-style-type: none"> May be elevated by branch stubs or ground 	<ul style="list-style-type: none"> Bark intact 	<ul style="list-style-type: none"> Solid, rigid tree with dry, hard wood 	<ul style="list-style-type: none"> Little or no new plant growth on log Site for grouse drumming and woodpecker foraging
Decay Class 2	<ul style="list-style-type: none"> Form still distinct Log round Log supports weight of a person 	<ul style="list-style-type: none"> Branches and branch stubs mostly gone 	<ul style="list-style-type: none"> Bark loose but patches may still remain 	<ul style="list-style-type: none"> Moist wood, beginning to soften Log somewhat rigid but sags 	<ul style="list-style-type: none"> Some new moss, lichen, fungal and algal growth on parts of the log Grouse drumming and woodpecker foraging site
Decay Class 3	<ul style="list-style-type: none"> Log round but sags to conform with ground contours 	<ul style="list-style-type: none"> No branches 	<ul style="list-style-type: none"> Trace of bark 	<ul style="list-style-type: none"> Wood breaks into large hard pieces Log does not fully support weight of person 	<ul style="list-style-type: none"> Tree seedlings and flowering plants begin to grow on log Bear foraging site (ants)
Decay Class 4	<ul style="list-style-type: none"> Log round to oval All of log on ground Becoming meshed with soil 	<ul style="list-style-type: none"> No branches 	<ul style="list-style-type: none"> No bark 	<ul style="list-style-type: none"> Wood breaks into small, soft and/or moist pieces 	<ul style="list-style-type: none"> Log soft Nurse log for tree seedlings Breeding site for snakes and salamanders
Decay Class 5	<ul style="list-style-type: none"> Log rotten and covered with litter Log oval or flattened All of log on ground or beneath surface of ground or leaf litter 	<ul style="list-style-type: none"> No branches 	<ul style="list-style-type: none"> No bark 	<ul style="list-style-type: none"> Soft and powdery wood May not appear as log at first glance 	<ul style="list-style-type: none"> Nurse log for tree seedlings Perched trees or seedlings may be only evidence of log Breeding site for snakes and salamanders

2.4.4.4. Stumps

Identify all stumps from the northernmost point following a clockwise direction and measure the diameter at the cut/break by laying a tape measure/ruler along the top surface. Record any regrowth occurring on the stump, and the decay class based on Ontario’s Old Growth - A learner’s handbook (Figure 2). Record whether the stump was a result of logging (flat cut, knicks in stump) or not. Complete the Stumps Data Sheet.

2.4.4.5. Mid-story (shrubs and saplings)

In every other subplot (pie-shaped; 1/8 of plot; Figure 1), identify each woody plant to species that is >0.5 m high and <10 cm DBH. Subplots are labeled 1 to 8 in clockwise fashion starting at north. For each plant that fits these criteria, record the number of individuals of that species occurring in that sub-plot and estimate percent cover (in increments no less than 5%) for each species. Then assess the general health of that species in the subplot, using the Tree Health Index. Record the code for the affliction that is observed in the space labeled tree health. Repeat for each of the four sub-plots within each 400 m² plot.

2.4.4.6. Understory (seedlings and herbaceous plants)

Understory vegetation is assessed using 2 x 2 m quadrats (Figure 1). Within each quadrat, each individual of a woody species <0.5 m high should be identified to species. A stem count and %cover (in increments no less than 5%) assessment should be done for each woody species. The health of each species group is to be assessed using the acronyms at the bottom of the Understory Data Sheet. Use the 7-letter name codes for the woody plants. For ferns, herbs/forbs, grasses, mosses, and fungus, estimate percent cover (in increments no less than 5%) and assess the health of each cover type within the quadrat.

2.4.5. Soils

Find an area within the plot that has the most amount of soil. Record the location of the soil pit and draw it on the plot map. The soil pit should be at least 1 m from all trees if possible. Dig a pit as far down as possible, or stop at 1.2 m depth. Using the shovel, ensure the pit is at least 50 cm long and at least 10 cm wide to allow for visualization and measurement of layers. Once the pit is dug to all possible proper dimensions, use a shovel to take a fresh layer off the wall for all layers present to allow for a flat visualization of each layer underground. Assess for any presence of gleyes or mottles and describe them.

Place a measuring tape or meter stick into the pit to determine how deep each layer is from 0 cm above ground. Depth (cm) is measured at the start of each layer. If the entire plot is bedrock, record findings and skip other details in the soil analysis. Take the top layer of vegetation out in large chunks in order to cover the hole adequately after the survey.

Assess the O, A, B and C layers based on specifications from the *Ontario Ecological Land Classification* soil section or *Field Guide to Forest Ecosystems of Central Ontario* soil section. Use the soil key to describe soil texture using the ribbon method. The drainage should be assessed and described, and pH should be tested. Draw the soil profile with measurements to exact depths, relative to each layer. Ensure a picture is taken and uploaded to assess colour. Place the soil back into the hole, covering it with the set aside top soil layer.

3.0. Field Recommendations

The following were not done or completed: soil temperature, complete soil pit sampling, tree height, canopy density (use densitometer), and only 15 snags within each plot were assessed, which should be changed to assess all snags and logs within each plot. Protocol modifications should address these issues, and other potential protocol changes will be considered prior to establishing the next set of permanent plots.

4.0. Analyses

This section describes how to convert raw field data into select variables of relevance to project questions and objectives using the methods described in this report. Once more plots have been sampled, these variables, and others, will be used for further analyses. Examples of such analyses include the use of t-tests to compare

means of metrics that define a forest and its health (e.g., tree species regeneration) between logged and old-growth plots, and regression analyses to analyze relationships between variables within different structural layers within plots. Calculations and plotting can be completed using Excel.

3.1. Calculations

A few calculations are key to derive the primary variables to be used to assess forest structure and composition, including measures of basal area, density, volume and cover percentage, as well as further categorization by plot, species, diameter class, decay class and evidence of harvesting, for example. Calculations must also consider the area sampled, which differs depending on the scale of the survey, within the entire plot, the subplots or within quadrats.

3.1.1. Basal area

For basal area, the goal is to estimate circular tree trunk (bole) area at 4.5 ft. in units of square meters/ha. To calculate the total basal area for trees, snags or stumps, the basal area of each individual should be calculated using the equation for the area of a circle (πr^2). The r represents the radius, and in this case is equal to half the DBH. Before calculation, this value must first be divided by 100 to convert to meters, as the desired unit for basal area square meters (m^2). After basal area is calculated using πr^2 for each individual, all values are to be added together to get the total basal area within the plot. The final step is to extrapolate this value to basal area per hectare. This can be done by dividing the total basal area by the plot area ($400 m^2$), then multiplying by the area of a hectare ($10,000 m^2$).

3.1.2. Density

Density of individual trees, snags or stumps per hectare is calculated by dividing the total number of individuals by the sampled area, then converting to individuals per hectare by multiplying the calculated value of the area of a hectare ($10,000 m^2$). For overstory calculations, the sampled area is the plot area ($400 m^2$). For the mid-story, the sampled area is 50% of the plot area or $200 m^2$. For the understory, the sampled area is the total area of the eight $2 \times 2 m^2$ quadrats, which is $32 m^2$. Stems or individuals from the four sub-plots and eight quadrats must be summed before dividing by the sampled area.

3.1.3. Volume

The measure of volume is exclusive to logs. While log density allows for estimates of the frequency of log occurrences, volume gives insight into overall quantity of woody material on the forest floor. Field measurement of logs included the widest point, narrowest point, and length of each log. The first step is to add both width measurements together and divide by two to get the average log width for each log. The log width is then used to calculate the average area of a cross section of the log. This is calculated in the same way as basal area (πr^2), where r is the average log width divided by two, then divided by 100 to convert to metres. This area value is then multiplied by the log length to get the individual log volume. All individual volumes are added together, then converted to volume per hectare by dividing by the plot area ($400 m^2$), then multiplying by the area of a hectare ($10,000 m^2$).

3.1.4. Cover percentage

Cover percentage or %cover, is only used to estimate biomass for the mid-story and the understory. Since this variable is already recorded as a percentage in the raw data, the only calculation necessary is to convert %cover in samples to %cover over the whole $400 m^2$ plot, which can be directly extrapolated to larger areas without

conversion. For mid-story subplots, this can be achieved by summing all %cover values for each species or species group and dividing the sum by four (number of subplots). For quadrats, the summed values should be divided by eight (number of quadrats). If within plot analyses are of interest, the values for subplots and quadrats can be left separate for comparison. For preliminary analysis, %cover values under 1% were excluded from calculations.

3.1.5. Classification

Classification of groups within the data is an important step in analysis and consists of categorizing variables such as basal area, density, volume and cover percentage into groups. The simplest and perhaps the most important form of categorization is by plot. This allows the comparison between plots as well as the analysis of variables across multiple plots. Classification by species is essential for determining species composition at different levels of the forest. Classification and comparison by decay class and size, such as DBH class, are also valuable forms of analysis.

3.1.6. Mean and median

Calculations of the mean and median of variables such as DBH and log width can be valuable for simple assessment of structural conditions. The comparison of means and medians can be used to infer details about the distribution of values without deeper investigation and/or classification. In the case of forest structure variables, a median that is much lower or much higher than the mean typically indicates that the diameter distribution is skewed towards lower values or higher values, respectively. If the median and mean are similar, that the diameter distribution can be assumed to be more evenly spread.