Woodlands and Waterways EcoWatch

Terrestrial Monitoring Protocol Manual

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Executive Summary

The purpose of this protocol is to monitor long-term forest health following modified Ecological Monitoring and Assessment Network (EMAN) protocols originally detailed by Trent University student researcher Jenna Ketel. In 2018, Jenna Ketel completed a community-based research project coordinated by U-Links Centre for Community Based Research in collaboration with the Haliburton Highlands Land Trust (HHLT). This document outlines procedures for establishing and monitoring a permanent sample plot based on the protocols produced by Jenna Ketel. These procedures and protocols are used by the Woodlands and Waterways EcoWatch (WWEW) for the terrestrial monitoring program.

To monitor the long-term health of a forest PSPs are established and monitored every 5 years to track changes in tree health, growth/survival of seedlings and saplings, and decomposition of downed woody debris. This protocol details the steps for establishing the 20m x 20m tree health monitoring plot, four 2m x 2m regeneration sub-plots, and 45.14m downed woody debris transect that comprises a PSP. The methods for collecting and recording data on tree health, seedlings/saplings, and downed woody debris are defined.

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1 Introduction

1.1 Woodlands and Waterways EcoWatch (WWEW)

Woodlands & Waterways EcoWatch is a community based environmental monitoring program coordinated by the U-Links Centre for Community Based research in conjunction with a number of volunteer and not-for-profit organizations in the Haliburton Region. The program utilizes the resources and knowledge of Trent University and Sir Sandford Fleming College in order to assist community organizations monitor the long-term health of the forests and lakes of Haliburton County and the surrounding region.

The landscape of Haliburton County is equally as important as the aquatic ecosystems that are connected to it. In conjunction with the Haliburton Highlands Land Trust (HHLT) and the Haliburton Forest & Wild Life Reserve (Haliburton Forest), U-Links is coordinating a number of terrestrial monitoring projects starting with forest health monitoring. WWEW is assisting in establishing a number of permanent sampling plots on the properties of the HHLT and forested areas of Haliburton County. These plots are sampled every five years in order to assess how stressors like climate change are impacting these incredibly important ecosystems.

1.2 Ecological Management Assessment Network (EMAN)

The terrestrial biomonitoring efforts of WWEW follow Ecological Management Assessment Network protocols. EMAN was established in 1994 to coordinate integrated ecosystem monitoring and research to understand the effects of anthropogenic activities on ecosystems. EMAN is a long-term monitoring protocol that can easily be replicated and shared to compare monitoring efforts across Canada.

2 Plot Location Guidelines

The location of Permanent Sample Plots (PSPs) is determined based on ecosites or habitat types present at the property being monitored. For example, at the HHLTs Dahl Forest Nature Reserve, there are two ecosites/habitat types present: a Sugar Maple ecosite, and a Mature Red Pine ecosite. PSPs are distributed throughout each of the ecosites based on the following criteria. The ecosite is also recorded on a field sheet (Appendix A.).

PSPs should be established:

1. In the most representative area of the ecosite
2. Away from areas of single occurrence atypical vegetation (monoculture)
3. Away from the forest's edge where plots may be visible and tampered with by the public
4. Away from human disturbances such as trails
5. In areas that are accessible without any safety hazards

3 Terrestrial Monitoring Protocol - Permanent Sample Plots (PSPs)

3.1 Establishing a Permanent Sample Plot

Permanent Sample Plots are 20m by 20m tree health monitoring plots (area: 400m^2), with four 2m by 2m regeneration sub-plots at each corner, and a 45.14 meter downed woody debris (DWD) transect along the perimeter. An aerial view of a PSP is found in Figure 1.

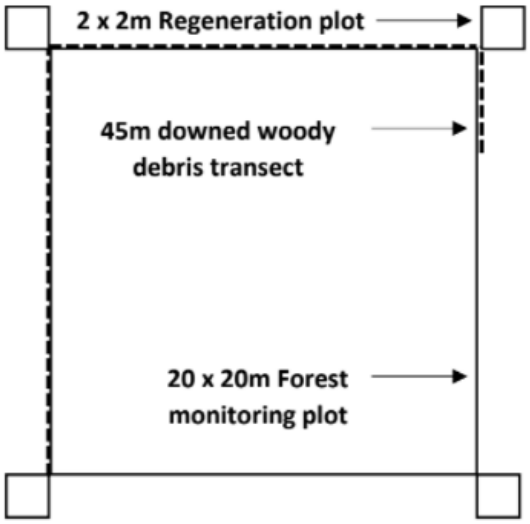

Figure 1: Example of plot layout including the regeneration plots, downed woody debris transect and forest monitoring plot

Each PSP is given its own unique code, following this naming convention: **4 letter code for forest - ##,** for example: **DAHL-01** or **DAHL-02**. Below is a list of the equipment required to establish a PSP.

- Compass
- 30m measure tape
- 16 wooden stakes
- 5 site tags: 1 for center tree, 4 for each stake
- Tree tags
- Galvanized nails
- Permanent marker
- Flagging tape
- GPS unit

To establish the main **20m x 20m tree health plot** follow these steps:

****Note:** In instances where there is a significant slope present, adjustments should be made to the distances between corners to ensure an area of 400m2 within the plot. Adjustments are made using the formula **d1 = h1 / cosine (θ),** where **d1** is the corrected distance and **h1** is the height of the slope, measured with a clinometer.

Step 1: Start by selecting a centre tree for your plot based on the plot location guidelines in section 2. Mark that tree with 1 of the tree tags, label it with a large “C” and nail it to the tree at diameter and breast height (DBH: 1.3m). You may also mark the tree with flagging tape. **Collect and record the GPS coordinates of the centre tree.**

****Note:** Be careful to not hammer the nail all the way into the tree as space must be available for the tree to grow.

Step 2: Standing at the centre tree, use a compass to determine the South West (SW) direction. Using a 30m measure tape walk along the SW transect 14.14 meters. The 14.14m mark will be the SW corner of the PSP. Label 1 of the tags with a large “SW” and nail it to 1 of the wooden stakes. Hammer the stake into the ground at the SW corner location.

Step 3: Standing at your SW stake, continue in a clockwise direction and use the compass to determine the North (N) direction. Using the 30m measure tape walk along the N transect 20 meters. That is the NW corner of the plot, label 1 of the tree tags with “NW” and nail it to 1 of the wooden stakes. Hammer the stake into the ground at the SW corner location.

Step 4: Repeat Step 3. in the East and West directions to establish the North East and North South East corners of your plot.

Step 5: Remeasure the distances between each corner stake of the plot to check that the plot is a perfect 20m x 20x square. If any side of the plot is off by a measurement of 1m or more, redo the transect until it is between 19m-20m long.

To establish the **2m x 2m regeneration sub-plots** follow the steps below:

Step 1: From the SW, NW, NE, and SE corner stakes measure 2.83m out along the corresponding bearing (i.e. for the SW corner, measure out 2.83m along the SW bearing). Hammer a stake in the ground.

Step 2: At a right angle, measure 2m from your first stake on either side to establish the other corners of the regeneration plot. Hammer those stakes in the ground

Step 3: Remeasure the distances between each stake to check that each plot is a perfect 2m x 2m square.

To establish the **45.14m downed woody debris transect** follow the step below.

Step 1: Starting at the SW corner of your 20m x 20m plot and continuing in a clockwise direction to the NW corner, measure 45.14m along the perimeter of the plot.

3.2 Permanent Sample Plot Data Collection Procedure

3.2.1 Tree Selection and Tagging

Data is collected from each tree that falls within or on the perimeter of the 20m x 20m tree health plot, with a diameter at breast height (DBH: 1.3m from the ground) of 10cm or more. Trees are tagged starting from the South West corner and continuing clockwise towards the North West corner and spiraling in towards the centre tree until data is collected from all. Tags are numbered starting with 001, 002, 003 etc, and nailed to the tree at DBH height (remember: do not nail all the way into the tree to allow space for growth). If a tree has multiple stems that divide before 1.3m they are tagged and considered as individual trees. The tree health data collected includes each tree's assigned number, species, DBH, clinometer readings (height), status, crown class, stem defects, and any comments. This data is recorded on a field sheet (Appendix A.) How to measure and collect each of these parameters is explained in the sections below.

List of equipment required for data collection:

- Field sheet (digital or physical)
- 30m measure tape
- DBH tape
- Clinometer
- Tree tags
- Galvanized nails
- Permanent marker

3.2.2 Tree Species

Each tree is identified to the species level and recorded on the field sheet using the correct species code. Common species for the Haliburton area and their corresponding codes can be found in Appendix B. If the tree cannot be identified, record 'species unknown'.

3.2.3 Diameter at Breast Height (DBH)

The diameter of each tree is measured using a diameter tape at 1.3m from the bottom of the tree, this is referred to as Diameter at Breast Height (DBH). DBH measurements are collected and recorded on the field sheet. Trees may grow at irregular angles and have stems that split before or after 1.3m. Figure 2 below demonstrates how to collect DBH measurements in different situations.

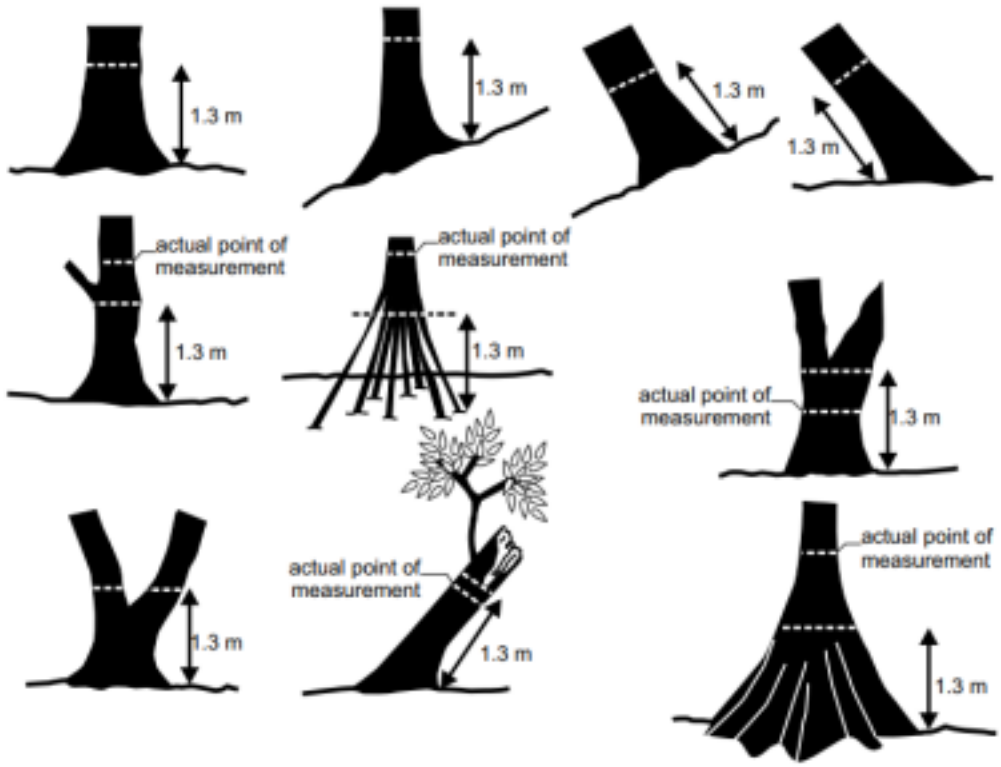

Figure 2: Examples of where to measure DBH on a tree that is leaning, on a slope, has multiple stems etc.

3.2.4 Tree Height

Tree height is measured using a 30m measure tape and a clinometer - a small piece of equipment that has a scale inside of an eye piece. The measuring tape is used to measure your distance from the base of the tree, and the clinometer is used to gather a degree reading from the top and the bottom of the tree. The distance (m), top degree, and bottom degree are recorded on the field sheet and put into the formula:

$$Tree\ Height\ =\ ((TAN(Top\ Degree))\ +\ (TAN(Bottom\ Degree)))\ X\ Distance(m)$$

****Note**, clinometers may use different scales and have different instructions. Read the instructions of the clinometer you are using carefully before use, and calculate height using the appropriate formula.

3.2.5 Tree Status

Tree status considers whether or not a tree is living, the position of the tree, and the physical condition of the tree. Tree status is recorded on the field sheet using one of the codes defined below and pictured in Figure 3.

AS: Alive standing
AB: Alive broken
AL: Alive leaning
AF: Alive fallen
AD: Alive standing, dead top

DS: Dead standing
DB: Dead broken
DL: Dead leaning
DF: Dead fallen

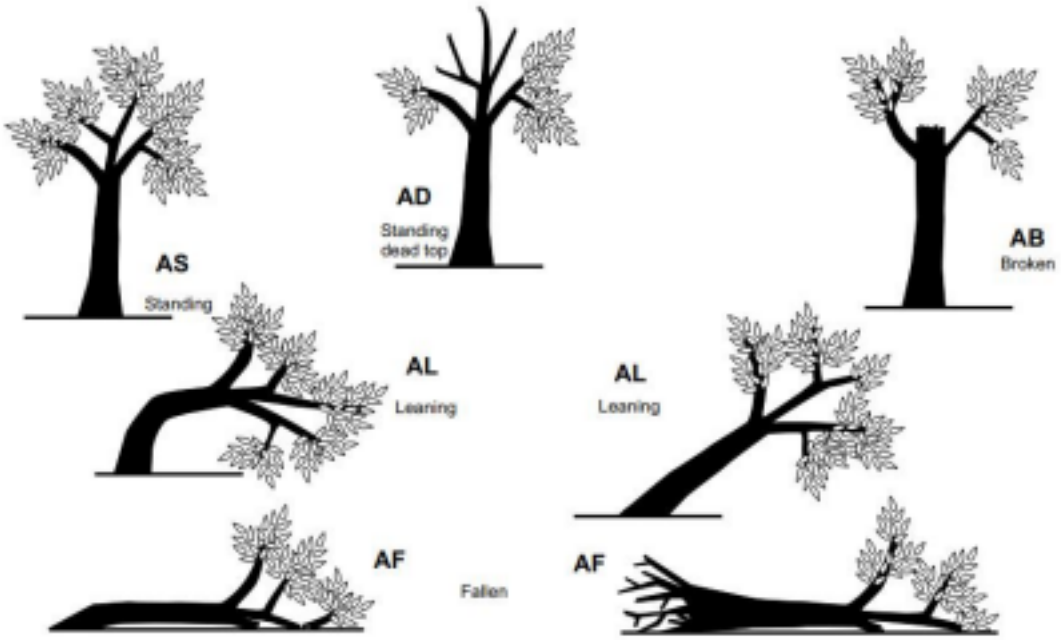

Figure 3: Examples of tree status and their associated codes.

3.2.6 Crown Class

Crown class is an assessment of how much sunlight is received from the crown of a tree in comparison to the trees surrounding it. There are 5 different types of crown class that are recorded using an associated number code of 1, 2, 3, 4, or 5. The code and description of each crown class is listed in Table 1 and examples of each crown class are pictured in Figure 4.

Table 1: Crown Class Descriptions

Crown Class	Description
1 - Dominant	Larger than the average tree in the plot, and extending above the general canopy. Receives full sunlight from above and partial sunlight on the sides.
2 - Codominant	The crown is a part of the average canopy level. Receives full sunlight from above and little sunlight from the side.
3 - Intermediate	The crown is slightly below average canopy level. Receives little sunlight from above and no sunlight on the sides.

4 - Suppressed	The crown is below all previous crown classes. Receives no sunlight from above or the sides.
5 - Open growth	Generally found in an open field. Receives sunlight from all angles.

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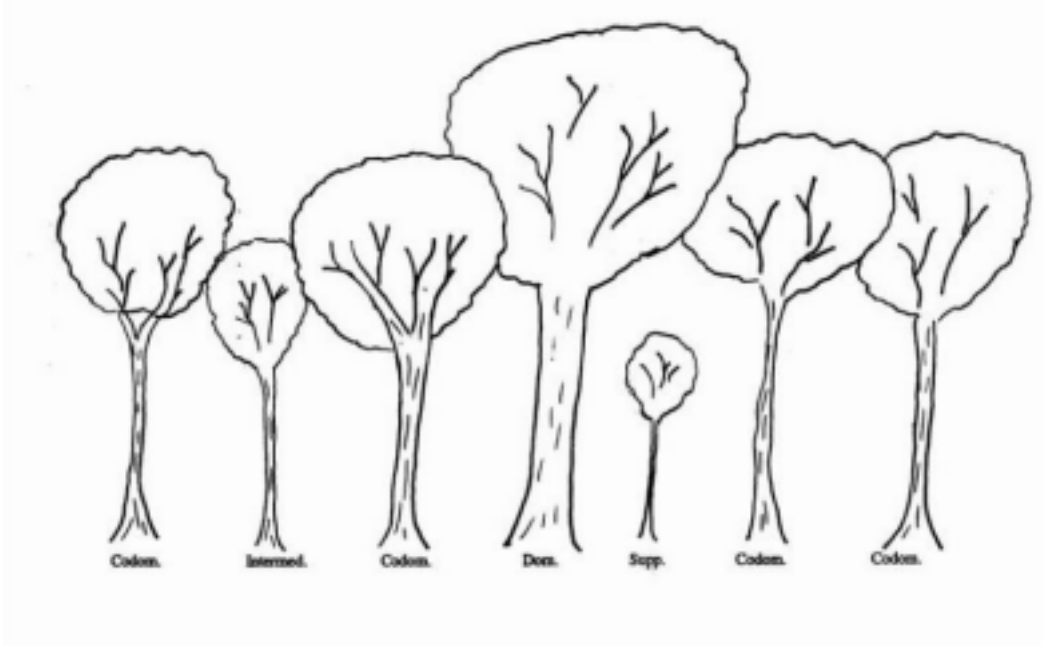

Figure 4: Examples of crown class.

3.2.7 Stem Defects

Stem defects are any signs of damage present on the stem of a tree. For deciduous trees the stem is considered the portion of the tree from above the ground line to the top of major branches. For a coniferous tree the stem is considered the portion of the tree from the ground line to the top of the tree. Up to two stem defects and their locations on the tree are identified and recorded on the field sheet using their associated number code. The location of the defect can range from the lower stem to the upper stem and the type of defect can be the presence of abiotic or biotic damage. The possible locations and types and their associated codes are listed in Table 2. Reference images for examples of defect types can be found in (Appendix C).

Table 2: Defect Types

Location of Defect	Type of Defect
1 - Lower Stem	1 - decay fungus, fruiting body
2 - Upper Stem	2 - seam or frost crack (dry)
3 - Stump or root collar	3 - seam or frost crack (bleeding/wet)

4 - Entire trunk	4 - open wound
	5 - closed wound
	6 - canker
	7 - insect damage (ants, wood borer)
	8 - pruned (human activity)
	9 - animal damage (woodpecker, beaver)

3.2.8 Downed Woody Debris

Downed woody debris (DWD) is any above ground tree debris. DWD data is monitored and recorded along the 45.14m DWD transect starting at the SW corner and continuing towards the NW corner. The line number, distance (m) to the point of intersection on the transect, species, diameter (cm) at point of intersection, type of debris, and the decomposition class are recorded for all DWD with a diameter of at least 7.5cm. Table 3 below describes what to record for line #, distance (m), species, diameter (cm), type of debris, and decomposition class.

Table 3: Downed Woody Debris Data and Description

DWD Data	Description
Line number	Recorded as 1, 2, or 3. 1 - 20m from the SW corner to the NW corner 2 - 20m from the NW corner to the NE corner 3 - 5.14m from the NE corner towards the SE corner
Distance to point of intersection (m)	Recorded in meters at the centre of the DWD
Species	Recorded if species is identifiable
Diameter (cm)	Measured using a diameter tape at the point of intersection on the transect
Type of Debris	Recorded as a log or a stump
Decomposition Class	Recorded as Class 1, Class 2, Class 3, Class 4, or Class 5. Table 4. Below describes how to determine decomposition class based on DWD characteristics.

Table 4: How to determine decomposition class based on Downed Woody Debris characteristics

Downed Woody Debris Characteristics	Class 1	Class 2	Class 3	Class 4	Class 5
Bark	Intact	Intact	Trace	Absent	Absent
Twigs	Present	Absent	Absent	Absent	Absent
Texture	Intact	Intact to soft	Hard, large pieces	Small, soft blocky pieces	Soft and powdery
Shape	Round	Round	Round	Round to Oval	Oval
Colour of wood	Original colour	Original colour	Original colour to faded	Light brown to faded brown or yellowish	Faded to light yellow or grey
Portion of log on ground	Log elevated on support points	Log elevated on support points but sagging slightly	Log is sagging near ground	All of log on ground	All of log on ground

3.2.9 Regeneration Plots

Data is collected on seedlings and saplings present in each of the four 2m x 2m regeneration plots. Tree seedlings are considered any tree between 16cm and 200cm in height, and tree saplings are considered any tree greater than 200cm in height with a DBH of less than 10cm. Tree seedlings are recorded by tallying the number of seedlings in each height class per species (Table 5). Tree saplings are recorded by tallying the number of saplings per species.

Table 5: Height classes for tree saplings.

Class	Height
1	16-35cm
2	36-55cm
3	56-75cm
4	76-95cm
5	96-200cm

Appendices

Appendix A. Field Sheets

Appendix B. Common Tree Species and Codes

Appendix C. Stem Defect Type Reference Photos