# Old-growth Forest
# Field Sampling Protocols for Citizen Science

## Level 3 – Advanced Survey Protocol v2.1

### Peterborough Old-growth Forest Project
**Ancient Forest Exploration & Research**
Funding provided by the Ontario Trillium Foundation

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## Introduction

It is generally accepted that all types of old-growth temperate forests in Ontario are endangered ecosystems, and the vast majority of them remain unprotected and available to logging.  These unique landscapes provide numerous benefits to people locally, regionally and globally including carbon storage and sequestration, biodiversity protection, education, scientific study, recreation, and spirituality.  In this document, we present a sampling protocol that has been developed to support field surveys of potential undocumented old-growth forests in Peterborough County, Ontario to be carried out by citizen scientists during the 2019 field season.  However, it is also applicable to other temperate forest landscapes in Ontario.

Relative to the Level 1 and 2 sampling protocols, this old-growth forest sampling protocol requires more time-intensive plot-based sampling and expertise that can support quantitative forest descriptions and comparisons with other studied old-growth forests.  For all protocol levels, we recommend using *Trees of Ontario* (Kershaw 2001) or *Forest Plants of Central Ontario* (Chambers et al. 1996) to identify tree species, however, there are many other good tree identification field guides that apply to Ontario.

Whenever possible, Ancient Forest Exploration & Research (AFER) will create maps of potential undocumented old-growth forests to support citizen-science surveys and will recommend high priority areas for sampling.  However, since these protocols include a minimum tree diameter at breast (4.5 ft) height (DBH) and circumference at breast height (CBH) (Table 1), AFER maps are not required for the use of the Basic Survey Protocol (Level 1).  AFER mapping should be used, however, for Protocol Levels 2 through 4.  Metric units are used for these protocols.  For those using tapes with English units, 1 inch is equal to 2.54 cm – be sure to convert when applying the values presented here.

The conservation status of Ontario's temperate forests at risk (all forest ages) is provided in Tables 2 and 3, which can be used to help determine which forest types and/or forest community types for citizen scientists to focus their surveys on.  Some may prefer to survey in old-growth forests that are most at risk thus increasing the likelihood that they may be protected.

AFER will collect, analyze and present field data and related results obtained by citizen scientists on one or more of AFER's websites.  These protocols will inevitably be revised as the number of old-growth forest surveys carried out by citizen scientists grows and feedback is received.  In particular, we are interested in the relationships among tree age, tree size and habitat conditions in order to refine our predictions of tree age from tree diameter under a variety of growth influences.

## Level 3 – Advanced Survey Protocol

***Overview:*** The *Advanced Survey Protocol* is not a rapid assessment approach but rather a means to obtain plot- and transect-based field data that can be used to provide scientific descriptions of old-growth forests at the level of professional technical reports and refereed journals. This protocol requires an approved AFER field leader with the following attributes: able to identify vascular plant species in the sampling area, an advanced understanding of forest ecology, experience with plot- and transect-based forest sampling, and experience bushwacking and leading groups in remote locations. AFER will assist those interested in becoming an approved Level 3 field leader. Although many references were reviewed in the process of designing this protocol, the primary ones include Dunwiddie and Leverett (1996), Woldendorp (2002) and Lombardi et al. (2015).

***Variables (features) to Assess:*** This protocol will combine line intersect sampling for logs; a large circular plot for sampling trees, snags, and stumps; and nested small quadrats to sample tree regeneration (seedlings and saplings) (Figure 1). Each combined transect plot (CTP) will be placed to represent a combination of habitat conditions within the forest stand as reflected in slope position, slope aspect, and slope steepness (see Appendix A). A site observations survey form should be completed for each CTP.

- *Sampling for logs:* 50 m transect; measure diameter (≥10 cm) where line crosses log; assess decay class (1 – 5; 1=least decayed, 5=most decayed); species identification where possible. See Appendix B for more information on assessing decay classes.

- *Sampling for trees, snags, and cut stumps ≥10 cm DBH:* sample within circular plot with a 12.6 m radius (totalling 500 m$^2$) centred at the 25 m mark on the line transect used for log sampling. The following should be assessed:

    - all trees (≥ 10 cm DBH) – species identification, DBH;
    - big trees (DBH meets minimum requirement for old tree, see Table 1) – for at least two trees, take photos, geolocations and cores for aging;
    - snags (minimum height 2 m) – species identification, DBH, and assess decay class (1 – 5) (see Appendix B);
    - stumps (≥ 10 cm DBH)– species identification (if possible), diameter, geolocation, and decay class (1- 5) (see Appendix B); and
    - geolocations of any healthy American beech and ash trees.

- *Sampling for saplings and seedlings:* the following should be assessed: five sapling (trees < 10 cm DBH and > 0.5 m tall) quadrats (2 x 2 m) one each at 12 m from the circular plot centre in each of the four cardinal directions and one at the plot centre, saplings identified to species, % foliage cover of each species assessed in each quadrat; 12 seedling (trees < 0.5 m tall, including fallen saplings) quadrats (1 x 1 m) located at 4, 8, and 12 m from the plot centre in each of the four cardinal directions, seedlings identified to species, and % foliage cover of each species.

- *Site observations:* The Site Observations Form (Appendix A) should be completed, excluding for the snags and logs assessment.

***Spatial Distribution of Samples (measured trees):*** surveyors should distribute CTPs within the forest stand to represent as much of the habitat gradients as possible. This can be done by sampling the variety of slope position, slope aspect, and slope steepness types (see Appendix A) present in the forest stand with a minimum of one CTP at each different habitat location. More so than the first two protocols, this protocol often requires negotiating difficult terrain in order to obtain samples to represent specific habitat conditions. CTPs should be at least 20 m away from major roads or paths and separated by at least 50 m.

***Recommended Equipment and Materials:*** (1) tree identification field guide, (2) local topographic maps, (3) compass, (4) GPS unit or phone with a GPS app, (5) camera, (6) pens, pencils, field notebook, and clipboard, (7) DBH tape or standard measuring tape for CBH, (8) a 50 or 100 m tape and two to four 20 meter tapes, (9) tree increment borer, (10)

binoculars to view branches, leaves/needles, (11) flagging tape, and (12) standard bushwack-hiking items such as a first-aid kit, bug jacket, mosquito repellent, rainwear, waterproof boots, etc.

**Figure 1.  Combined Transect Plot Layout**
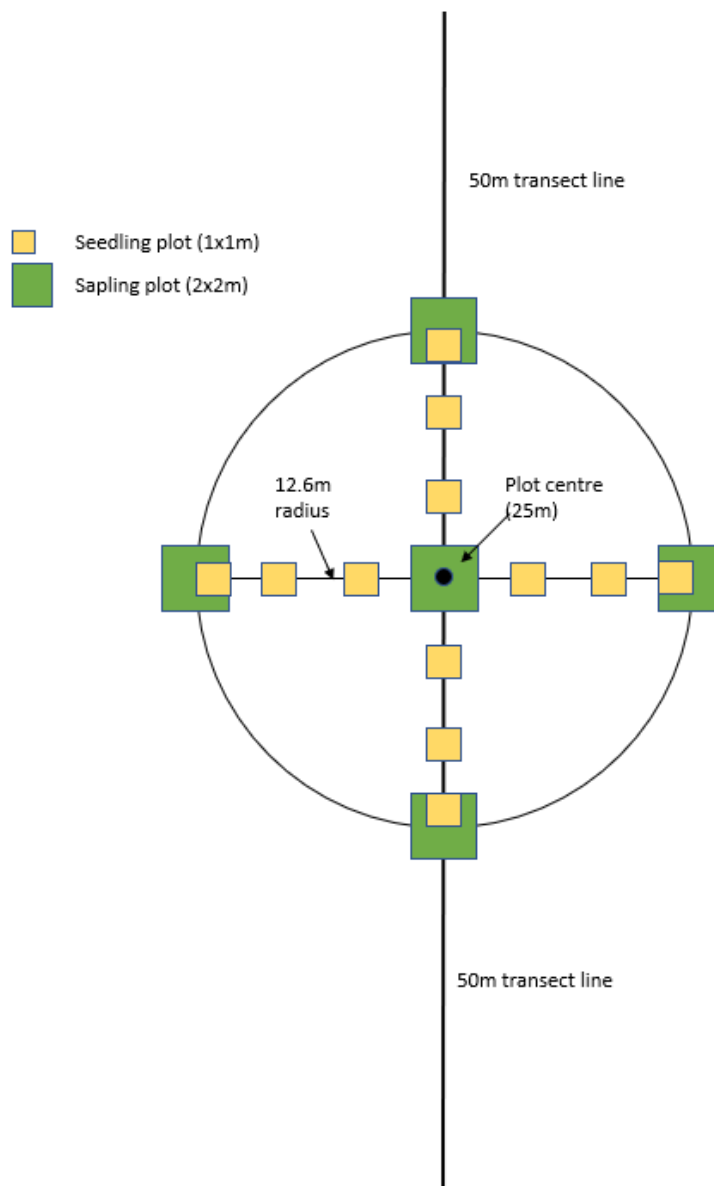
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Woldendorp, G. et al.  2002*. An Analysis of Sampling Methods for Coarse Woody Debris in Australian Forest Ecosystems*, A Report For the National Greenhouse Strategy, Module 6.6 - Criteria and Indicators of Sustainable Forest Management, Bureau of Rural Sciences, The Landscape Management Sciences Program, Canberra, Australia.  (http://data.daff.gov.au/brs/brsShop/data/12882_analysis_cwd.pdf)

**TABLE 1. Estimated Minimum Diameters for Old-growth Forest Trees in Temperate Forests of Ontario**

| Species | Minimum Old-Growth Age (yrs) | Minimum Diameter (cm/in) | Minimum Circumference (cm/in) |
|---|---|---|---|
| American Basswood | 110 | 60 | 188 |
| American Beech | 140 | 30 | 94 |
| Balsam Fir | 70 | 30 | 94 |
| Black Ash (from Green Ash) | 120 | 50 | 157 |
| Black Cherry | 120 | 50 | 157 |
| Black Spruce Swamps | 100 | 15 | 47 |
| Black Spruce Uplands | 100 | 30 | 94 |
| Bur Oak (from White Oak) | 120 | 40 | 126 |
| Eastern Hemlock | 140 | 40 | 126 |
| Eastern White Pine | 120 | 50 | 157 |
| Jack Pine | 120 | 25 | 79 |
| Poplar | 90 | 40 | 126 |
| Red Maple | 90 | 35 | 110 |
| Red Oak | 120 | 50 | 157 |
| Red Pine | 120 | 40 | 126 |
| Silver Maple | 120 | 60 | 188 |
| Sugar Maple | 140 | 35 | 110 |
| Tamarack | 90 | 25 | 79 |
| White Ash (from Green Ash) | 120 | 50 | 157 |
| White Birch | 100 | 35 | 110 |
| White Cedar | 110 | 30 | 94 |
| White Oak | 120 | 40 | 126 |
| White Spruce | 100 | 30 | 94 |
| Yellow Birch | 140 | 45 | 141 |

**TABLE 2. Conservation Status of Temperate Forest Types in Central Ontario (on the Canadian Shield) (>60% dominance in the overstory; all ages; based on FRI data) (Watkins, 2011)**

| Forest Type | 2001 | | 2006 | | 2011 | | 10-yr Change | Conservation Status |
|---|---|---|---|---|---|---|---|---|
| | Ha | % | Ha | % | Ha | % | | |
| American Basswood | 263 | 0.02 | 177 | 0.02 | 177 | 0.01 | declined (33%) | Critically Endangered |
| American Beech | 2,261 | 0.2 | 388 | 0.2 | 404 | 0.03 | declined (82%) | |
| Yellow Birch | 4,913 | 0.3 | 5,670 | 0.4 | 5,366 | 0.4 | increased (9%) | |
| Eastern Hemlock | 20,236 | 1.4 | 18,140 | 1.5 | 18,618 | 1.5 | declined (8%) | Endangered |
| Red Maple | 165,213 | 11.6 | 21,043 | 12.5 | 20,930 | 1.6 | declined (87%) | |
| Ash (Black & White) | 24,575 | 1.7 | 29,792 | 1.9 | 27,580 | 2.2 | increased (12%) | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Oak (all; primarily Red) | 52,671 | 3.7 | 37,271 | 4.0 | 38,902 | 3.0 | declined (26%) | **Threatened** |
| Red Pine | 59,193 | 4.2 | 67,195 | 4.5 | 73,025 | 5.7 | increased (36%) | **Special Concern** |
| Balsam Fir | 102,838 | 7.2 | 127,316 | 7.8 | 100,940 | 7.9 | | |
| White Spruce | 99,007 | 7.0 | 115,953 | 7.5 | 108,785 | 8.5 | | |
| Eastern White Pine | 110,607 | 7.8 | 121,607 | 8.4 | 130,916 | 10.2 | | **Common** |
| Northern White Cedar | 237,805 | 16.8 | 253,444 | 18.0 | 237,691 | 18.6 | | |
| Sugar Maple | 539,900 | 38.0 | 521,883 | 40.9 | 515,099 | 40.3 | | |
| Total | 1,419,482 | | 1,319,879 | | 1,278,433 | | | |

**TABLE 3. Ontario's Endangered Forested Ecosystems**
**(Ontario NHIC 2019; https://www.ontario.ca/page/natural-heritage-information-centre)**

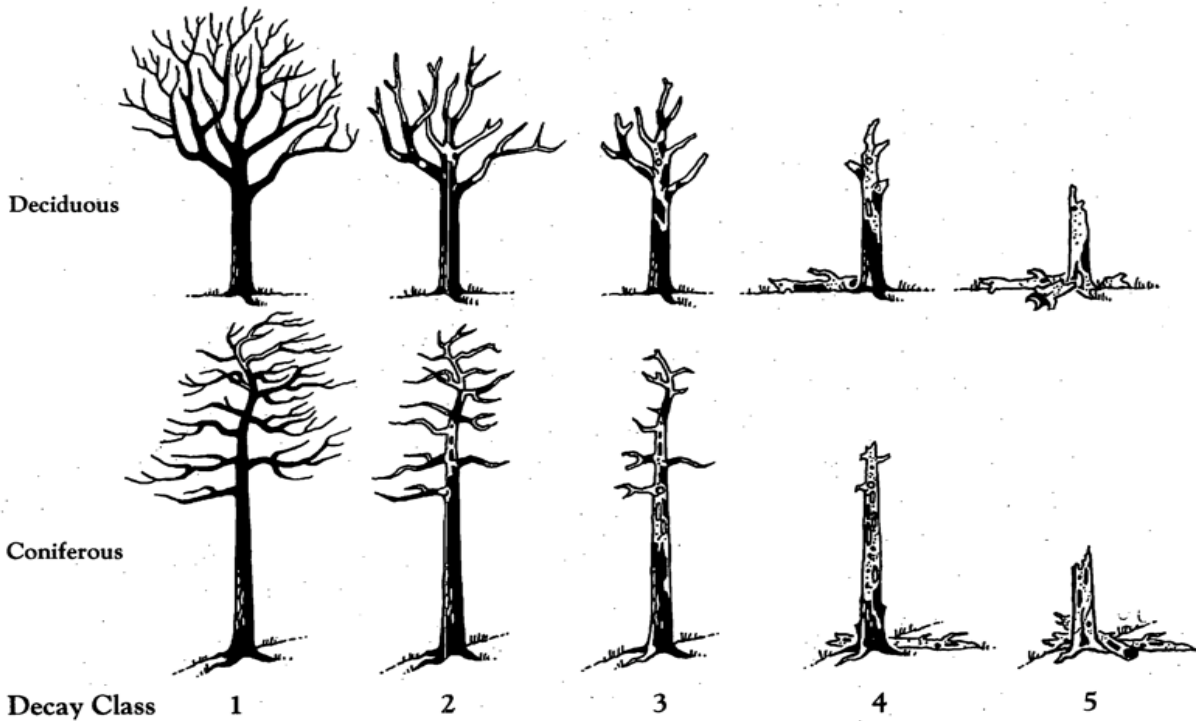| Critically Imperiled Forested Ecosystems (S1) |
|---|
| |
| **Upland Types** |
| *Cedar Forests* |
| Red Cedar Basic Treed Rock Barren |
| Red Cedar Treed Granite Barren |
| Red Cedar Treed Limestone Barren |
| *Hickory Forests* |
| Shagbark Hickory-Prickly Ash - Philadelphia Panic Grass Treed Alvar Grassland |
| *Oak Forests* |
| Black Oak Tallgrass Dry Savannah |
| Black Oak-Pine Tallgrass Dry Savannah |
| Black Oak-White Oak Tallgrass Dry Woodland |
| Black Oak-White Oak Tallgrass Moist-Fresh Woodland |
| Bur Oak Northern Tallgrass Moist-Fresh Savannah |
| Black Oak Tallgrass Moist-Fresh Savannah |
| Bur Oak Treed Alvar |
| Bur Oak-Shagbark Hickory Tallgrass Dry Woodland |
| Chinquapin Oak - Nodding Onion Treed Alvar Grassland |
| Chinquapin Oak Carbonate Treed Dry-Fresh Talus |
| Oak Treed Limestone Barren |
| Oak-Pitch Pine Mixed Dry Forest |
| |
| Pin Oak-Bur Oak Tallgrass Moist-Fresh Savannah |
| Pin Oak Tallgrass Fresh-Moist Woodland |
| *Pine Forests* |
| Pitch Pine Treed Granite Barren |
| |
| **Imperiled (S2)** |
| |
| **Upland Types** |
| *Basswood Forest* |
| Basswood-White Ash-Butternut Moist Treed Limestone Talus |
| *Black Walnut Forest* |

| |
|---|
| Black Walnut Moist-Fresh Deciduous Forest |
| *Hemlock Forest* |
| Hemlock-Sugar Maple Moist Limestone Talus |
| *Oak Forest* |
| Bur Oak Basic Treed Rock Barren |
| Bur Oak-Green Ash-Trembling Aspen Moist-Fresh Deciduous Forest |
| Bur Oak Saskatoon Berry Dry Deciduous Woodland |
| Chinquapin Oak-Pine Dry Mixed Forest |
| **Wetland Types** |
| *Maple Forest* |
| Red Maple-White Pine Mineral Mixed Swamp |
| *Oak Forest* |
| Pin Oak Mineral Deciduous Swamp |
| Shumard's Oak Mineral Deciduous Swamp |
| Swamp White Oak Mineral Deciduous Swamp |
| *Pine Forest* |
| White Pine-Coniferous Mineral Swamp |
| |
| **Vulnerable (S3)** |
| |
| **Upland Types** |
| *Birch Forests* |
| White Birch-Aspen Treed Limestone Cliff |
| White Birch Dry Treed Limestone Talus |
| *Cedar Forest* |
| White Cedar-White Spruce Philadelphia Panic Grass Treed Alvar Grassland |
| White Cedar Dry Treed Limestone Talus |
| White Cedar Treed Limestone Cliff |
| *Hickory Forest* |
| Bitternut Hickory Fresh-Moist Deciduous Forest |
| Hickory Dry-Fresh Deciduous Forest |
| Shagbark Hickory Fresh-Moist Deciduous Forest |
| *Maple Forest* |
| Sugar Maple-Black Maple Moist-Fresh Deciduous Forest |
| Black Maple Lowland Fresh-Moist Deciduous Forest |
| Sugar Maple-Ironwood-White Ash Treed Limestone Cliff |
| |
| Sugar Maple Moist Treed Limestone Talus |
| *Oak Forest* |
| Mixed Oak Dry-Fresh Deciduous Forest |
| Black Oak Dry Deciduous Forest |
| Oak-Hickory Dry Deciduous Forest |
| Bur Oak Fresh-Moist Deciduous Forest |
| Hill's Oak-White Pine-Poplar Acidic Treed Rock Barren |
| *Sassafras Forest* |
| Sassafras Fresh-Moist Deciduous Forest |
| **Wetland Types** |
| *Cedar Forest* |

| |
|---|
| White Cedar-Hemlock Coniferous Mineral Swamp |
| White Cedar-Hemlock Coniferous Organic Swamp |
| *Maple Forest* |
| Red Maple-Hemlock Mixed Mineral Swamp |
| Red Maple-Hemlock Mixed Organic Swamp |
| *Oak Forest* |
| Bur Oak Mineral Deciduous Swamp |
| *Pine Forest* |
| White Pine-White Birch Mineral Mixed Swamp |
| *Tamarack Forest* |
| Tamarack-Leatherleaf Treed Kettle Peatland |
| |
| **Apparently Secure (S4)** |
| |
| *Cedar Forest* |
| Red Cedar Dry Coniferous Forest |
| *Maple Forest* |
| Maple-Yellow Birch-Hardwood and Mixedwood |
| Sugar Maple-Basswood-Leatherwood Forest |
| Sugar Maple-Hickory Dry-Fresh Deciduous Forest |
| *Oak Forest* |
| Oak-Maple Fresh-Moist Deciduous Forest |
| Oak-Red Maple-Pine Basic Treed Rock Barren |
| Oak-Sugar Maple Fresh-Moist Deciduous Forest |
| White Oak Dry-Fresh Deciduous Forest |
| *Pine Forest* |
| Jack Pine Basic Treed Rock Barren |
| Red Pine-White Pine Dry Coniferous Forest |

# APPENDIX A – SITE OBSERVATIONS FORM (June 2019)

| SITE CHARACTERISTIC | DESCRIPTION |
|---|---|
| **TOPOGRAPHIC HABITAT DETERMINANTS** (circle appropriate choice) | **1) slope position:**  hilltop;    upper slope;    mid-slope;    lower slope;    valley;    riparian<br><br>**2) slope aspect:**  N;    NE;    E;    SE;    S;    SW;    W;    NW<br><br>**3) slope steepness:**  none/flat;    low;    medium;    high |
| **BEDROCK/SURFICIAL GEOLOGY** (large slabs, boulders, jagged rocks, etc. - covered by moss/lichen?) – add notes | |
| **EVIDENCE OF FIRE** (e.g., fire scars on trees, burned foliage, burned logs, burned snags, charcoal in soils, other) – add notes | |
| **ANIMALS** (scat, bird/frog calls, tracks, sightings, insects, antlers, bones, etc.) – add notes | |
| **GAPS IN OR NEAR PLOT** (describe location (N, E, S, W), size, composition) – add notes | |
| **WETLANDS** (in or near plot - how close to plot?  Type of wetland?  Open water? Extent of wetland?) | |
| **SNAGS AND LOGS ASSESSMENT FOR SURVEY LEVEL 1** (describe size, amount, decay level, and distribution relative to big tree) | |
| **OTHER** (impressions, rare or uncommon plant species, etc.) | |

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# APPENDIX B – Decay Class Cheat Sheet



Decay Class    1        2        3        4        5

| Field Sign | Live tree with dead and dying branches or broken top | Decay Class 1 | Decay Class 2 | Decay Class 3 | Decay Class 4 | Decay Class 5 |
|---|---|---|---|---|---|---|
| **Tree Top** | Broken top or dead stub on tree top | Tree top intact and just recently dead | Tree top intact | Tree top intact | Top broken off | Top broken to a stub, less than 6 m high |
| **Branches** | Many or most branches still alive. About 25% of canopy dead | Recently dead Fine branches still present | Fine branches gone Less than half of large branches gone | More than half of large branches gone | All large branches gone | All large branches gone |
| **Bark** | Bark on trunk intact Bark on branches may be dead | Bark mostly intact | Bark loosening | Bark usually falling off | Bark nearly gone | Bark and wood deteriorating |
| **Cavity Nesters** | Dead sections may be used by cavity nesters Yellow-bellied Sapsucker may already be nesting in tree Dead parts of tree used as drumming and display sites for woodpeckers Pileated Wood-pecker can excavate these living trees | Same as live tree with dead top. Pileated Wood-pecker can use this tree | Used for nesting and foraging sites for strong excavators like Pileated Wood-pecker | Nesting site for weaker excava-tors like Downy and Hairy Wood-pecker | Used by weaker excavators like the Downy Woodpecker for nesting sites and then by cavity nesters like flying squirrels | Used by weak excavators like chickadees as well as mice and chipmunks for nesting sites |
| **Wildlife Use** | Waterfront nesting sites for osprey, eagles and herons. Tree top perching and hunting sites for sites for hawks, owls and perching birds. Dead branches are common perching sites for birds such as Eastern Phoebe, flycatchers and hummingbirds. Used by herons, raptors and perching birds. Brown Creepers nest and bats roost under loose bark. | | | | | |

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.
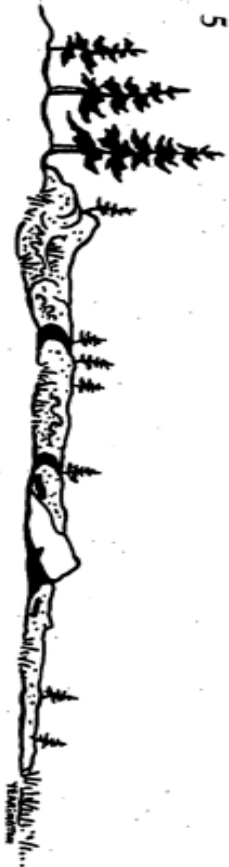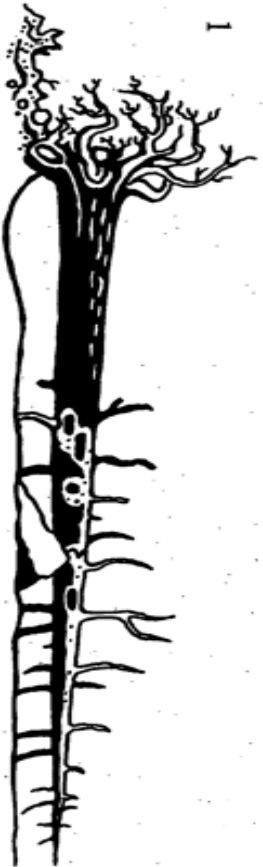


| Decay Class | Form and Shape of Log | Branches | Bark | Wood Moisture/Texture | Plant and Animal Habitat |
|---|---|---|---|---|---|
| Decay Class 1 | • Tree recently fallen, form still distinct<br>• Log round and rigid | • May be elevated by branch stubs or ground | • Bark intact | • Solid, rigid tree with dry, hard wood | • Little or no new plant growth on log |
| Decay Class 2 | • Form still distinct<br>• Log round<br>• Log supports weight of person | • Branches and branch stubs mostly gone | • Bark loose but patches may still remain | • Moist wood, beginning to soften<br>• Log somewhat rigid but sags | • Some new moss, lichen, fungal and algal growth on parts of the log<br>• Grouse drumming and woodpecker foraging site |
| Decay Class 3 | • Log round but sags to conform with ground contours | • No branches | • Trace of bark | • Wood breaks into large hard pieces<br>• Log does not fully support weight of person | • Tree seedlings and flowering plants begin to grow on log<br>• Bear foraging site (ants) |
| Decay Class 4 | • Log oval or flattened<br>• All of log on ground or beneath surface of ground or leaf litter | • No branches | • No bark | • Soft and powdery wood<br>• May not appear as log at first glance | • Nurse log for tree seedlings<br>• Perched trees or seedlings may be only evidence of log |
| Decay Class 5 | • Log rotten and covered with leaves | • No branches | • No bark | • Soft and powdery wood<br>• May not appear as log at first glance | • Nurse log for tree seedlings<br>• Perched trees<br>• Breeding site for snakes and salamanders |