Tree Health

AIM

To measure crown condition and stem defects as an indicator of tree health based on protocols developed by the Canadian Forest Service, Sault Ste. Marie.

RATIONALE

Monitoring crown conditions and stem defects is essential in providing an early warning system to recognise changes in the tree health of Canadian forests and urban areas. The detection of the types and extent of tree damage and defects will help to identify the symptoms of tree and forest decline.

BACKGROUND

Forests are not only critical to environmental health and stability; they are an important part of Canadian economic and social systems. Forest protection and sustainability is also becoming a priority internationally, which is evident in the recent increase in global environmental policy and protocol establishment related to forests.

Both abiotic and biotic factors affect forest health. Tree age, size and disturbance history are all essential pieces of information in understanding changes to forest structure. Short-term stress factors such as insect defoliation or weather extremes may cause dieback, but when the stress is removed, the trees should recover. Prolonged stress factors may result in dieback and decline, and possibly in whole tree mortality. However, forests can recover following disturbances and can prove to be quite resilient. By recording crown conditions and stem defects, the levels of damage on a variety of age or size classes and their death or recovery can be tracked.

The monitoring of national tree health in Canada began in the mid 1980's through two programmes; the Acid Rain National Early Warning System (ARNEWS) and the North American Maple Project (NAMP). These programmes were designed in order to monitor long-term changes in forests that are attributed to pollution and acid deposition. This EMAN protocol is an adaptation and simplification of the ARNEWS Tree Health Protocols (D'Eon, S.P., et al. 1984), designed principally by Bob Sajan, Canadian Forest Service. Modifications have been made in order to allow for a system that will accurately detect changes in tree health, but also be understandable and usable by a variety of interest groups. For more detailed information please refer to the full ARNEWS Manual at:
http://www.eman-rese.ca/eman/reports/publications/arnews/arnews.html

By compressing the various categories of the ARNEWS and NAMP system into broad groups this method comprises just four categories. The tree crown condition is rated as:

1. Healthy (0-10% crown dieback)
2. Light to Moderate decline (11-50% crown dieback)
3. Severe decline (greater than 50% crown dieback)
4. Dead.

The categories are easily defined and produce data that is capable of showing an accurate view of the state of health of the rated trees.

CHECKLIST OF MONITORING ACTIVITIES

- ✍ Select location of study site
- ✍ Establish 20m x 20m or 1 hectare vegetation monitoring plots or
- ✍ Choose a minimum of 15 trees to monitor in an urban area or
- ✍ Locate, mark and measure trees for long-term sampling
- ✍ Ascertain crown condition and record stem defects
- ✍ Record data and manage data sets

EQUIPMENT

Tree Health data sheet
Pens
Tree identification key
Dbh measuring tape
Tree corer
Site map (optional)
Camera (optional)

LOCATION AND SET UP

Forest Biodiversity Plot

Information on tree crown status and defects can be easily added to a forest biodiversity programme within an established forest biodiversity plot. The steps to establish a plot, survey and map area, number and map trees, measure dbh (diameter at breast height), record tree status and stand age will have already been completed. (See Terrestrial Vegetation Monitoring Protocol:
http://www.eman-rese.ca/eman/ecotools/protocols/terrestrial/vegetation

Urban and Natural Areas

A suitable location for monitoring may be along a street, a city park, or along a waterway. Sites need to be easily accessible and free of hazards. In all cases once a site it chosen, a site description data sheet should be completed. Site characteristics need to be recorded and the location of each tree within each site should be plotted on a site map. Photographs of the site may also be useful in describing the sample area. If available use a GPS system to determine latitude and longitude. Alternatively, one or more topographic maps such as the 1:50,000 NTS (National Topographic System)

covering the site(s) can be used to determine precise coordinates (latitude and longitude or UTM military grid easting and northing values). Another option is to use the following search tool provided by Natural Resources Canada (http://geonames.nrcan.gc.ca/). When you receive the search results, click on the place name to view additional data including, latitude and longitude.

TREE HEALTH RECORDING

Timing

Tree Crown condition should be monitored on an annual basis and around the same time each year. Data can be collected anytime between early July and late August, so that all of the leaves will be mature and the onset of fall colours has generally not begun.

Data Collection

1. Collect Stand Data. This information is collected as part of the Terrestrial Vegetation Biodiversity Monitoring Protocols, however if you are not undertaking tree health monitoring as part of a forest diversity plot, stand data should be collected and recorded prior to rating the tree crowns. The tree age, size and disturbance history are essential pieces of information. Short-term stress factors such as insect defoliation or weather extremes may cause dieback, but when the stress is removed the trees should recover. Prolonged stress factors may result in dieback and decline and possibly whole tree mortality. Young, vigorously growing trees can withstand these various stress factors far greater than slow growing overmature trees. By recording stress factors the level of the damage on a variety of age or size classes may be understood.

> ***A.*** *Stand Age*: Determine stand age from increment cores taken at either breast height (1.3m) or stump height (30cm). A minimum of five codominant (see Appendix 2) trees within the stand should be sampled. If there is more than one obvious age class, then both ages could be sampled.
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> ***B.*** *Tree Diameter*: The tree diameter is measured at 1.3m (diameter at breast height [dbh]) above ground for all on plot trees. Measurements should be recorded to the nearest 0.1 cm. For further instructions see Section 1 of the Terrestrial Vegetation Biodiversity Monitoring Protocols on "How to measure diameter at breast height" http://www.emanrese.ca/eman/ecotools/protocols/terrestrial/vegetation/page14.html
>
> ***C.*** *Disturbance*: There are five major stand or tree disturbances that should be recorded: logging, defoliation, storm damage, grazing and tapping history. Each of these can have a significant impact on the overall vigour and health of an individual tree or complete stand.

2. Select Trees for Assessment. All the trees in at least two 20m x 20m quadrats in a one hectare terrestrial vegetation monitoring plot should be assessed. If 20m quadrats are scattered in a homogenous forest then assessing the trees in at least two quadrats should be sufficient. A minimum of 15 trees should be selected at an urban site.

3. Record Tree Status The tree status is the first element that is established and recorded:

1. Living, has green foliage attached
2. Recently dead, no green foliage, fine branches and bark still attached (died from natural causes)
3. Old dead, no fine branches attached, bark sloughing off (died from natural causes)
4. Cut down, or girdled (human caused)

4. Evaluate Crown Class This is a reflection of the amount of sunlight received by each tree and can be used as an indicator of stand density. Plot data can be sorted by crown class to determine if there is a specific tree size related to dieback or decline). See Appendix 2 for crown class ratings and diagram.

5. Record Stem Damage. The entire stem of each tree, greater than 10 cm in diameter, are examined for the presence of biotic or abiotic damage. For deciduous trees the stem is defined as the portion of the trunk that extends from just above the ground line to the base of the major branches. For open grown conifers the stem extends from the ground line to the top of the tree. For trees growing in a closed canopy conifer stand, the stem extends from the ground line to the base of the major branches. Record the location and type of defects on the tree health data sheet (See Appendix 3 for codes and examples).

6. Determine Crown Rating. The tree crown is observed in silhouette, or single plane, outlined by the periphery of the branch tips. The base of the crown is the lowest foliated area, not including the large branch stems that support the crown. Large open areas within the crown are excluded. Old broken off branches (stubs) are not included in the overall rating of the crown. Two observers rate each tree simultaneously, from opposite sides of the tree. Good communication between the observers will result in more accurate collection of data. The observers walk around back from the outer fringe of the crown of the tree until they find the location from which they have the best, unobstructed view. When evaluating mature hardwoods in a closed canopy situation, trees will often be encountered where only a portion of the crown is visible. In these instances rate only the portion that is visible and note in the "Comments" section that the crown was only partially visible. One observer verbally delineates the area of the crown, deciding where the base of the crown is located and if old dead branch stubs are to be included as part of the crown damage. Each observer in turn calls out the level of damage that is visible within the

crown and where it is located. This gives the other observer an opportunity to re-examine the crown for areas of damage that may have been missed. Occasionally all of the damage will be visible from only one side of the tree.

Once all of the damage has been located, the observers together determine the overall damage level to be recorded for the particular tree. To rate the trees simply look at the crown and ask the question " is more or less than half of the crown dead". If more than 50% of the crown is dead, the crown code is rated as "severe decline". If less than 50% of the crown is dead, then determine if more or less than 10% of the crown is dead. If less than 10% of the crown is dead, the tree is classified as healthy. If between 10-50% of the crown is dead, the crown code is classified as "light-to-moderate" decline. Rating and examples can be found in Appendix 4.

Record all of the data collected on the Crown Condition data sheet.

File paper and/or electronic copies of the Crown Condition data sheet where they can be located the next season.

DATA MANAGEMENT AND SHARING

Hard copies of the data sheets or electronic copies should be submitted to the Environmental Monitoring and Assessment Network (EMAN) in order to allow for regional, provincial and national comparison of tree crown mortality and forest status and health in general. Submit to: eman@ec.gc.ca

EMAN Coordinating Office
Canada Centre for Inland Waters • 867 Lakeshore Road • Burlington • Ontario • L7R 4A9
Phone: 905 336 4414 • Fax: 905 336 4499 • Email: eman@ec.gc.ca

REFERENCES

D'Eon, S.P., L.P. Magasi, D. Lachance, and P. DesRochers. 1994. ARNEWS Canada's National Forest Health Monitoring Plot Network Manual on Plot Establishment and Monitoring (Revised). Petawawa National Forestry Institute. Information Report PI-X-117.

Millers, I., D. Lachance, W.G. Burkman, D.C. Allen. 1992. North American Sugar Maple Decline Project: Organization and Field Methods. Gen. Tech. Rep. NE-154. Radnor, P.A.: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experimental Station. 26p.

Roberts-Pichette, P. and L. Gillespie. 1999. Terrestrial Vegetation Biodiversity Monitoring Protocols. EMAN Occasional Paper Series. Report No. 9.

Sajan, R. 2000. Community Based Tree Health Monitoring. Draft unpublished manuscript. Canadian Forest Service, Sault Ste Marie, Ontario.

Environment Canada Environnement Canada

Canadian Forest Service Service canadien des forêts

Tree Condition Data Sheet

SITE NAME:	**DATE:**	**OBSERVATION AREA NAME AND DESCRIPTION:**
LATITUDE/LONGITUDE:	**NEAREST NAMED PLACE:**	
COUNTY/TOWNSHIP:	**PROVINCE:**	
OBSERVER NAME(S):	**OBSERVER ADDRESS:** **TELEPHONE:**	

Tree #	Species	DBH (cm)	Age (yrs)	Tree Status	Stem Defect 1		Stem Defect 2		Crown Class	Crown Rating	Comments
					Type	Location	Type	Location			

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DISTURBANCE (mark all applicable)

DISTURBANCE / EXTENT				
LOGGING DAMAGE	Comments:			
1. Current	2. Recent, less than 5 years, but not current	3. Recent, greater than 5 years (firm stumps)	4. Old (no firm stumps)	5. None

DEFOLIATION/INSECT DAMAGE	Comments:	
1. Current	2. Recent, in the last 5 years	3. Greater than 5 years

WIND/STORM DAMAGE	Comments:	
1. Current (obvious damage, trees blown over or large branches)	2. Recent, in the last 5 years	3. Greater than 5 years

BROWSE/GRAZING	Comments:		
1. No sign	2. current, light damage, (no obvious tree damage)	Current, heavy damage (obvious tree damage and soil compaction)	Old damage EXTENSIVE

TAPPING	Comments:		
1. Current/active (tap holes are open)	2. In last five years, but not current (tap holes have closed)	3. Greater than 5 years	4. No history of tapping EXTENSIVE

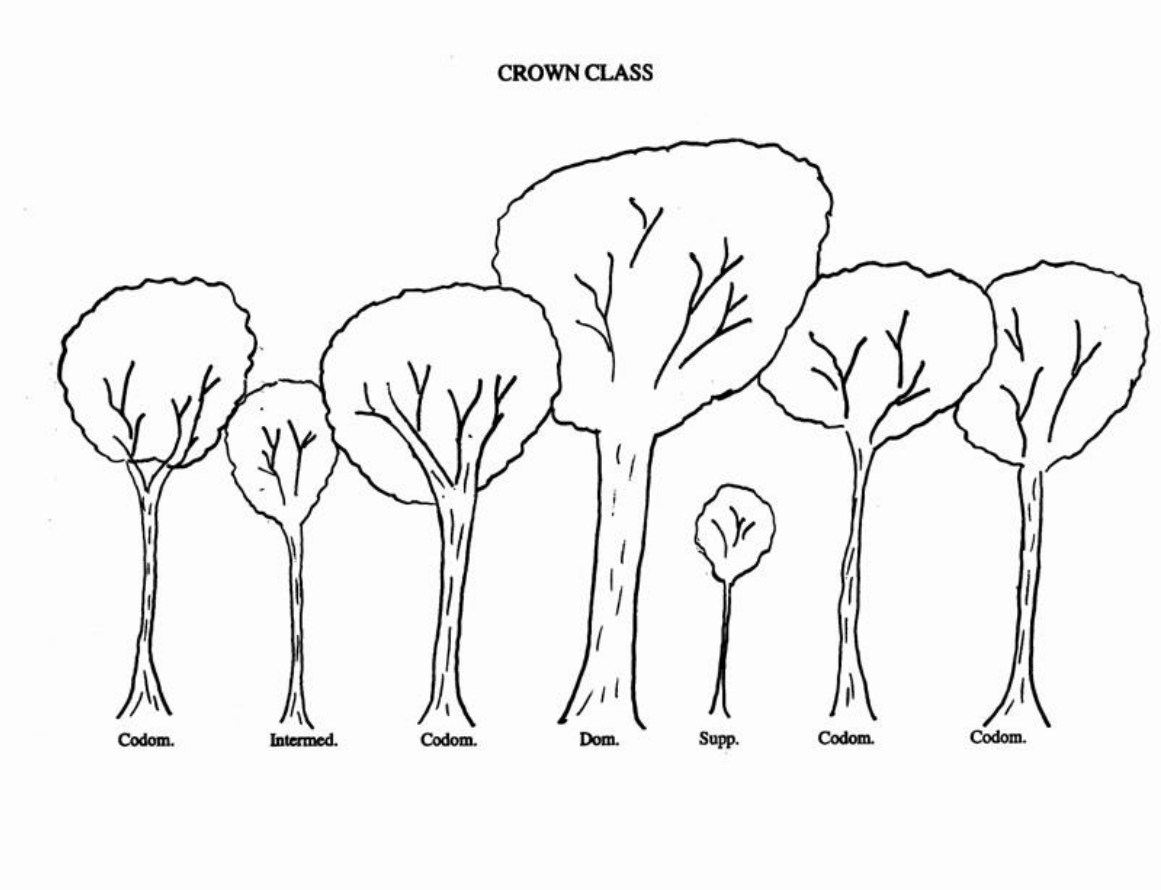
ATTACH PHOTOGRAPH OF SITE HERE

APPENDIX 1 TREE STATUS

CODES
AS – alive standing **AB** – alive broken **AL** – alive leaning **AF** – alive fallen/prone **AD** – alive standing dead top **DS** – dead standing **DB** – dead broken **DL** – dead leaning **DF** – dead fallen/prone

APPENDIX 2 CROWN CLASS

CROWN CLASS CODES	
Crown Class	
1 Dominant	Crown extends above the general canopy level and receives full sunlight from above and partly from the sides; larger than the average trees in the stand.
2 Codominant	Crown forms the general canopy level and receives full sunlight from directly above and comparatively little from the sides.
3 Intermediate	Shorter than the two preceding classes, and receiving little direct sunlight from above and one from the sides; their crowns extend into the base of the canopy of the dominant and codominant trees.
4 Suppressed	Receives no direct sunlight from above or the sides, their crowns are entirely below the general level of the crown cover.
5 Open grown	Exposed to full sunlight from directly above and on all sides; typically growing in a field or along a boulevard.



APPENDIX 3 STEM DEFECT CODES AND EXAMPLES

CODES	
Stem Defect Location *Visually divide the stem in half horizontally and record the location using the following codes:* **1.** lower stem **2.** upper stem **3.** stump or root collar **4.** entire trunk (all of the above)	**Stem Defect Type** *It is not necessary to identify the type of fungi on the stem, but when linked with location, it can indicate the type of decay. Enter the appropriate code:* **1** decay fungus, fruiting body **2** seam or frost crack (dry) **3** seam or frost crack (bleeding/wet) **4** open wound **5** closed wound **6** canker **7** insect damage (ants, wood borer) **8** pruned (human activity) **9** animal damage (wood pecker, beaver)

EXAMPLES OF STEM DEFECTS:

1. Decay fungus, fruiting body






2. Seam or frost crack, dry



3. Seam or frost crack, bleeding/wet

**No photos available (similar to dry seam/crack but with sap or liquid)

4. Open wound




5. Closed wound

6. Canker

7. Insect damage

8. Pruned/Human Activity

9. Animal damage (woodpecker, beaver etc)

APPENDIX 3 CROWN RATING CODES AND EXAMPLES

CODES		
1	healthy	Appears in good health, no major branch mortality,<10% branch/twig mortality
2	light-moderate decline	Branch and twig mortality<50% of the crown,<50% branch/twig mortality
3	severe decline	Branch and twig mortality>50% of the crown,>50% branch/twig mortality
4	dead, natural	Tree is dead; either standing or down
5	dead, human	Tree cut down; removed; girdled

5% Canopy Loss

10% Canopy Loss

15% Canopy Loss

15% Canopy Loss

20% Canopy Loss

20% Canopy Loss

35% Canopy Loss

40% Canopy Loss

60% Canopy Loss

70% Canopy Loss

90% Canopy Loss

0% Canopy Loss