ARNEWS

Canada's National Forest Health Monitoring Plot Network Manual on Plot Establishment and Monitoring (Revised)

S.P. D'Eon, L.P. Magasi, D. Lachance, and P. DesRochers

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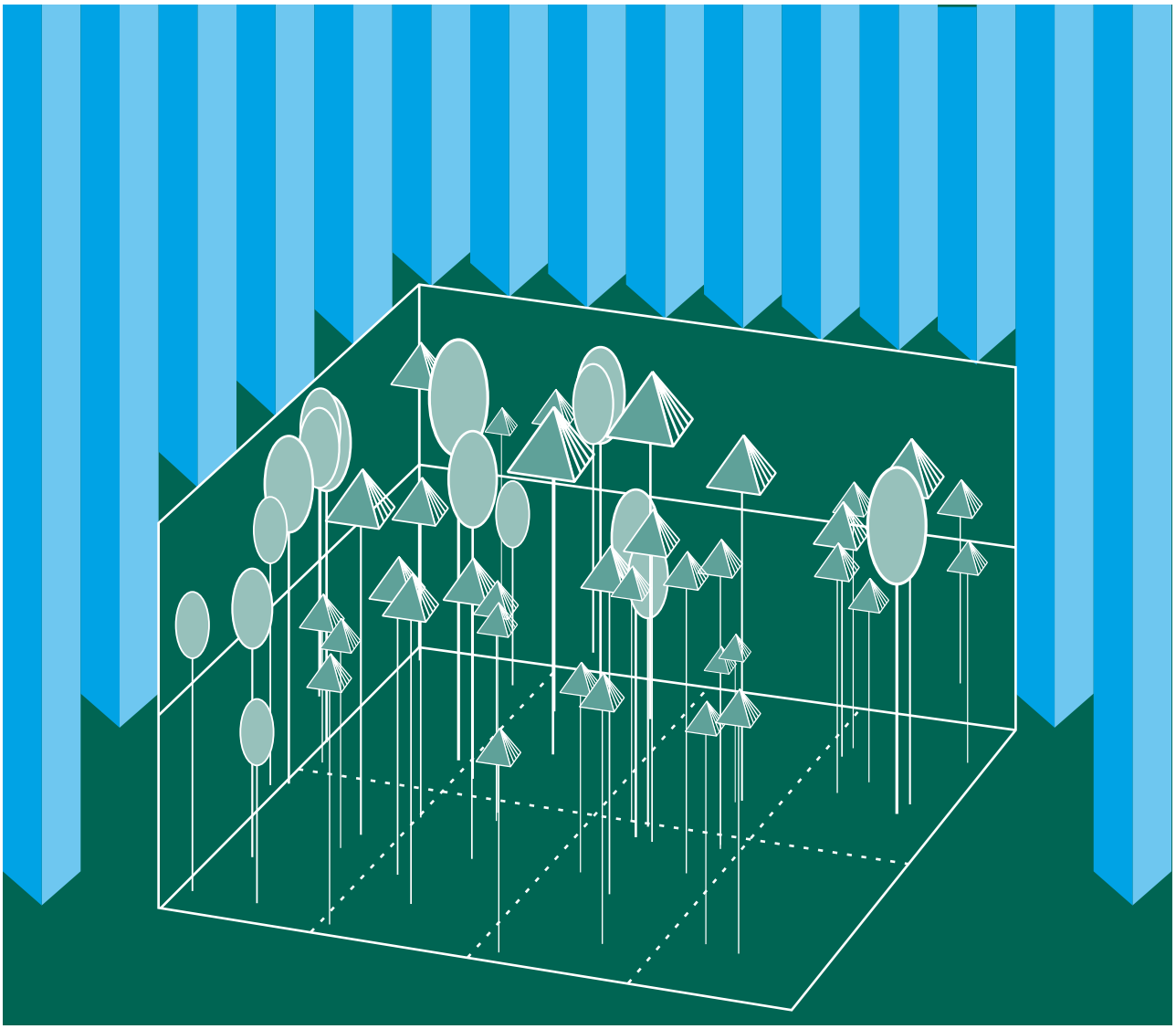

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Canada's National Forest Health Monitoring Plot Network
Manual on Plot Establishment and Monitoring (Revised)

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Executive Summary

The Acid Rain National Early Warning System (ARNEWS) plot network was initiated in 1984 when the then Canadian Forestry Service decided to establish a national program to detect early signs of air pollution damage to Canada's forests. Since that time, more than 150 ARNEWS plots have been established across Canada to monitor changes in forest vegetation and soils caused by air pollution and environmental change. More than 10 000 trees are currently monitored in the ARNEWS plot network.

The original ARNEWS methods were implemented in 1984, modified somewhat in 1985, and finalized in 1986. A review of the original methods started in late 1991. Three objectives guided the review: practicality, meaningfulness, and repeatability. Field methods must be *practical* so that they can be conducted consistently and efficiently to avoid wasting field time. Methods must provide data that, once analyzed, will be *meaningful* in terms of meeting the ARNEWS study objectives. Methods must also be *repeatable* so that a high degree of confidence can be placed in the data. All components of ARNEWS methods were examined with regard to these objectives.

Plot establishment guidelines were revised to include a required administrative reserve and buffer area. Guidelines for stand selection and locating the plot within the stand were clarified, as were procedures for laying out an ARNEWS plot. Detailed methods were added for tree numbering, ingrowth, and selecting off-plot trees for destructive sampling. No destructive sampling is permitted within the 10 m by 40 m ARNEWS plot boundaries. Basic plot information and tree mapping requirements were slightly modified.

The protocol for collecting general mensuration data every 5 years was revised. These measurements include vertical and horizontal crown position, diameter at breast height (DBH), and tree height. Stem form was added to indicate major structural stem defects when present. Live crown width was replaced by a visual assessment of the closure of neighbouring tree crowns. Measurement of live crown length was divided into two fields: height to top of live crown and height to base of live crown. Softwood shoot assessments were streamlined to include only defoliation and shoot length and hardwood shoot assessments were dropped completely. Instructions for repeat measurements of the same tree for increment coring were added.

Soil analysis was revised, making microelement analysis optional. Foliage analysis was revised to remove the requirement for mean fascicle weights and to clarify sample collection.

Methods for annual tree condition assessments of crown condition, needle retention, and woody tissue damage were revised. The crown condition of hardwoods is based upon the appearance and quantity of foliage, quantity of dead twigs, and quantity of dead branches present in the outer crown. Softwood crown condition will be assessed by vertically dividing the crown into equal thirds and assessing the damage within each third. Needle retention is an ocular estimate of the age of the oldest shoot internode retaining at least 25% foliage. Branch condition assessments were dropped and assessing the level of woody tissue damage was replaced with recording the location of damage on the tree. More detailed classes were added for recording the level of damage by agents. Procedures to determine the identity, abundance, and level of damage by known biotic and abiotic agents were clarified. Formerly separate reporting of assessments of hardwood and softwood pest conditions was streamlined onto one field tally sheet.

The annual assessment of ground vegetation and regeneration was revised to become a biennial procedure. The size and number of subplots was increased from three 1 m^2 subplots to four 4 m^2 subplots, saplings were added to the regeneration assessments, and an estimation of the quantity of ground vegetation by species or vegetation group was added.

Numerous new figures were appended to describe parameters and to provide examples of procedures to follow for abnormal situations. Appendices have been attached listing tree species codes and summarizing other code values used. Codes were synchronized with other studies conducted by the Forest Insect and Disease Survey.

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Résumé à l'intention de la direction

Le réseau de parcelles du Dispositif national d'alerte rapide pour les pluies acides (DNARPA) a été déployé en 1984, lorsque ce qui était alors le Service canadien des forêts a décidé de déceler à la grandeur du pays les signes avant-coureurs des dégâts infligés aux forêts du Canada et imputables à la pollution atmosphérique. Depuis, plus de 150 de ces parcelles ont été établies d'un bout à l'autre du pays pour contrôler les changements provoqués à la végétation et aux sols forestiers par la pollution atmosphérique et l'évolution du milieu. Grâce à ce réseau, on surveille plus de 10 000 arbres.

En 1985, on a quelque peu modifié les méthodes utilisées à l'origine, puis on les a mises sous leur forme finale en 1986. Vers la fin de 1991, on a entrepris de les réviser dans le triple but suivant : les rendre pratiques, significatives et répétables. Les méthodes de terrain doivent être *pratiques*, afin de s'appliquer de façon constante et efficace ainsi que d'éviter les pertes de temps. Elles doivent procurer des données qui, après analyse, seront *significatives*, c'est-à-dire qui permettront d'atteindre les objectifs d'étude du DNARPA. Enfin, elles doivent être *répétables*, de sorte que l'on puisse se fier beaucoup aux données. On a examiné tous les éléments des méthodes utilisées par le DNARPA en fonction de ce triple objectif.

On a révisé les lignes directrices concernant l'établissement des parcelles, de façon à intégrer à ces dernières la réserve administrative et la zone tampon exigées. On a clarifié la marche à suivre pour sélectionner le peuplement, y compris choisir l'emplacement de la parcelle et jalonner cette dernière. On a ajouté des méthodes détaillées pour la numérotation des arbres, le recrû, la sélection des arbres à l'extérieur des parcelles en vue des prélèvements destructifs d'échantillons. Aucun prélèvement destructif n'est permis à l'intérieur des parcelles DNARPA de 10 m sur 40 m. En outre, on a modifié légèrement ce qu'on exige comme renseignements de base sur la parcelle et ce qu'on exige pour localiser les arbres sur le plan de la parcelle.

On a révisé le procédé de collecte quinquennale des données dendrométriques générales : position verticale et horizontale de la cime, diamètre à hauteur de poitrine et hauteur de l'arbre. S'y ajoute désormais la forme de la tige pour tenir compte, s'il y a lieu, de ses importants défauts structuraux. On a remplacé la largeur de la cime vivante par une évaluation visuelle de la fermeture du couvert formé par les arbres voisins. La longueur de la cime vivante a été divisée en deux champs : la hauteur jusqu'au sommet de la cime vivante, et la hauteur jusqu'à la base de la cime vivante. On a simplifié l'évaluation des pousses de résineux, en ne tenant compte, désormais, que de la défoliation et de la longueur de la pousse, tandis qu'on a complètement abandonné celle des pousses de feuillus. On a ajouté des instructions pour le prélèvement répété de carottes à la sonde de Pressler dans le même arbre.

On a révisé l'analyse des sols, pour rendre facultative celle des oligo-éléments, et l'analyse du feuillage, pour supprimer la nécessité d'établir le poids moyen des fascicules et clarifier les modalités de prélèvement des échantillons.

On a révisé l'évaluation annuelle des paramètres de l'état des arbres (examen de la cime, taux de conservation des aiguilles et dégâts infligés aux tissus ligneux). Chez les feuillus, la cime est évaluée d'après l'aspect du feuillage et la quantité de ce dernier ainsi que par la quantité de rameaux morts et de branches mortes dans la partie extérieure de la cime; chez les résineux, on évaluera les dommages visibles dans chaque tiers de la cime (dans le sens de la hauteur). La conservation des aiguilles est une façon d'estimer visuellement l'âge de l'entre-nœud des pousses les plus vieilles qui conservent au moins 25 % de leur feuillage. L'évaluation des branches n'est plus exigée, tandis que l'on a remplacé l'évaluation des dégâts causés aux tissus ligneux par l'enregistrement de l'emplacement des dégâts sur l'arbre. On a ajouté des classes pour l'enregistrement de l'intensité des dégâts causés par le divers agents. On a clarifié la marche à suivre pour identifier les agents biotiques et abiotiques connus et en déterminer l'abondance ainsi que les déprédations. On a simplifié l'évaluation de l'infestation des feuillus et des résineux, autrefois séparée, en y consacrant une feuille identique de pointage.

L'évaluation annuelle de la couverture vivante du sol et de la régénération est maintenant biennale. Les sous-échantillons ont été agrandis de 1 m^2 à 4 m^2, et leur nombre a passé de 1 à 3 à l'intérieur d'un échantillon. On a aussi ajouté les gaules à l'évaluation des régénérations et on estime désormais la quantité de végétation couvre-sol selon l'espèce ou le groupe d'espèces.

De nombreuses figures décrivent les paramètres et montrent la marche à suivre en cas d'anomalies. De nouvelles annexes comprennent la liste des codes des essences et expliquent sommairement d'autres codes utilisés. Les codes ont été coordonnés avec ceux d'autres études effectuées par le Relevé des insectes et des maladies des arbres.

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Acknowledgments

Preparation of this manual was guided by the original *Acid Rain National Early Warning System Manual on Plot Establishment and Monitoring* (Magasi, L.P. 1988. Inf. Rep. DPC-X-25, Can. For. Serv., Ottawa). To all who worked on the original manual goes credit for their contributions.

The major credit for this revised manual goes to all Forest Insect and Disease Survey (FIDS) field staff who followed ARNEWS methodologies over the years, and who provided extremely valuable input to these revised methods. J. Thibault and J.P. Bérubé field tested new methods in Quebec, and W. MacKay, T. Walsh, A. Doane, R. Cormier, S. Meikle, and G. Lemieux did the same in the Maritimes. D. Stone reviewed procedures in Newfoundland while R. Turnquist provided input for Canada's west coast forests. H. Cerezke and J. Brandt compiled input from the prairie provinces, and T. Hopkin did so for Ontario. I.K. Morrison revised the soil and foliage chemistry monitoring sections.

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Introduction

Airborne pollutants and climatic change are global concerns. Concern over the effects of air pollution on North America's forests has prompted much scientific and public debate. The cumulative effects of all types of airborne pollutants — wet precipitation, dry deposition, ambient gaseous concentrations of pollutants, and airborne particulates — combined with climatic change may directly or indirectly affect the health of North America's forests.

Anxiety over the future health of North American forests intensified with reports of damage from other parts of the world. The Acid Rain National Early Warning System (ARNEWS) plot network was initiated in 1984 when the then Canadian Forestry Service decided to establish a national program to detect early signs of air pollution damage to Canada's forests. The United States and Mexico have since established forest plot networks similar to ARNEWS.

The objectives of the ARNEWS program are:

1) to detect, clearly and accurately, damage to forest trees and soils caused by air pollutants or to identify damage sustained by Canada's forests (trees and soils) that is not attributable to natural causes or management practices; and
2) to monitor vegetation and soils to detect long-term changes attributable to air pollutants in representative forest ecosystems.

The Forest Insect and Disease Survey (FIDS) was given responsibility for plot establishment and biological monitoring, and to assist in obtaining foliage and soil samples for chemical analysis. Permanent forest sample plots have been established, and are being maintained in all regions of Canada, to monitor:

1) the condition and changes in the condition of forest stands;
2) the presence and fluctuation of biotic and abiotic factors that affect the condition of the forest (insects, diseases, stand changes, climate, etc.);
3) the changes and symptoms that indicate factors not attributable to (2); and
4) the effects of air pollutants on the condition of various tree species.

The original ARNEWS methods were implemented in 1984, modified somewhat in 1985, and finalized in 1986. A review of the original methods started in late 1991. The objective of the review was to improve the efficiency and scientific merit of ARNEWS. Three objectives guided the review: practicality, meaningfulness, and repeatability. Field methods must be *practical* so that they can be conducted consistently and efficiently to avoid wasting field time. Methods must provide data that, once analyzed, will be *meaningful* in terms of meeting the ARNEWS study objectives. Methods must also be *repeatable* so that a high degree of confidence can be placed in the data.

The merits of all components of existing ARNEWS methods were examined with regard to the above objectives. Field staff comments highlighted many areas where methods were not practical. Data analysis revealed several areas where the meaningfulness of the data was questionable. Field trials of new methods, conducted in the summer of 1992, were used to determine the repeatability of proposed methods.

Largely, the methods remain the same. The instructions were revised to be more complete. Several parameters have been removed from the survey, and a few new ones added. The data collected on numbered off-plot trees have been extensively revised. Numerous figures and guidelines to deal with difficult trees have been added.

This document describes the methods to be used when surveying existing plots of the ARNEWS network and the procedures to be followed when establishing new plots. This is an instruction manual for field use. Discussion of the reasons for doing the various assessments is minimal. The manual is divided into three parts: Part I describes ARNEWS and how to establish a plot, Part II describes the specific assessments to be done on each plot, and Part III contains appendices.

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Part I. Description of ARNEWS

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Aboveground Parameters for ARNEWS Plots

The Forest Insect and Disease Survey is the Canadian Forest Service (CFS) unit responsible for carrying out aboveground assessments, managing the data, and reporting results for ARNEWS plots. Foliage samples are collected by FIDS and submitted for analysis to CFS Long Range Transport of Airborne Pollutants (LRTAP) personnel. FIDS also assists in soil sampling as agreed upon with regional LRTAP personnel.

Not all aboveground parameters are monitored with the same frequency, and not all parameters can be evaluated during a single plot visit (Table 1). The timing of such visits must be based upon the seasonal development of the parameter to be assessed. For each ARNEWS plot, there is a base year during which all parameters are assessed; this information serves as baseline data.

The assessment of some parameters requires destructive sampling, such as removing tree branches or taking increment cores. However, no plot tree shall be the subject of any treatment that in any way affects its natural condition or influences changes induced by external factors. Therefore, all sampling of a destructive nature must be done on off-plot trees of the appropriate species and with a crown position representative of that existing on the plot. This will result in a certain amount of interpolation and inference, but it eliminates the introduction of artifacts that would preclude proper conclusions.

ARNEWS Plot Work Schedule

The timing of ARNEWS assessments must be synchronized with the biological conditions present on the plot. Some assessments must be made after growth has ceased for the year. Others, notably forest pest conditions, should be assessed more than once during the growing season. The various assessments should be performed at the optimal seasonal developmental stage of the parameter being assessed on the correct plot components (Table 2).

Insect and Disease Conditions

Without a thorough assessment of forest pests, their population, fluctuation, the amount of damage they cause, and their other effects on trees, analysis of most of the other ARNEWS parameters would be difficult. The seasonal nature of forest pests necessitates detailed assessment. Plot trees are assessed in general terms; off-plot trees are studied in detail.

All forest pest assessment methods selected were chosen from techniques used routinely by at least some FIDS units in Canada; thus, they pose no problems to FIDS personnel with expertise in forest insect and disease surveys. Regular assessment of pest conditions is a routine FIDS activity that often coincides with related work. It is unnecessary to assess all conditions every time a plot is visited. If a pest condition, such as needle rust, is assessed at its peak, it is unnecessary to assess the needles remaining at the next visit as this second count could create misleading data.

Plot Selection Guidelines

The plots are dedicated to the ARNEWS program and monitored uniformly regardless of their location in Canada. Uniformity of data collection is very important. However, it may be impossible to obtain some of the measurements in the specified manner under certain situations. Although difficulties are encountered in some cases, they do not reduce the importance of the parameter being measured. Try to maintain uniformity, but use common sense to avoid collecting unreliable data.

Location of ARNEWS Plots

Plots should be established in each Canadian Forest Service region to allow for maximum representation of air pollution regimes (where applicable) and economically and commercially important tree species.

The recommendation of equal distribution of plots in different air pollution deposition zones may, at times, contradict the recommendation regarding the equal distribution of plots in stands of economically important tree species (for example, the small area of highly acidic precipitation in southeastern Quebec will likely not contain tree species in the same proportions as the vast area of less acidic precipitation farther north). Obviously, there should be ARNEWS plots in the different deposition zones, just as different tree species should be represented and differences in

Table 1. Parameter assessment schedule

Base year
- Plot characteristics
- Tree mapping

Base year plus 5 year assessments
- Radial tree growth
- Vertical tree growth
- Crown structure and density
- Foliage sampling for analysis
- Soil sampling for analysis
- Softwood shoot growth

Every second year
- Regeneration and saplings
- Ground vegetation

Base year plus annual assessments
- Tree mortality *in* the stand
- Tree condition

Several assessments per growing season
- Abiotic foliar symptoms
- Insect and disease conditions
- Seed production

Table 2. ARNEWS plot work schedule

Growing season	Procedure	Component	Form	Periodicity
Mid June/July)	Pest conditions	Plot/stand	8, 8a	Seasonal
	Abiotic foliage symptoms	On-plot trees	4	Seasonal
	Hardwood seed crop	On-plot trees	4	Seasonal
Late (August)	Pest conditions	Plot/stand	8, 8a	Annual
	Plot tree assessment	On-plot trees	4	Annual
	Off-plot tree assessment	Off-plot trees	X4	Annual
	Abiotic foliage symptoms	On-plot trees	4	Annual
	Hardwood seed crop	On-plot trees	4	Annual
	Regeneration and saplings	Subplots	5	Biennial
	Ground vegetation	Subplots	6	Biennial
	Softwood shoots	Off-plot trees	7	Five year
	Foliage samples	Off-plot trees		Five year
After growth has ceased (September)	Plot tree data	On-plot trees	3	Five year
	Off-plot tree data	Off-plot trees	X3	Five year
	Soil sampling	Plot/stand		Five year
	Increment cores	Off-plot trees	12	Five year
Anytime	Plot establishment	Plot/stand	1	Base year
	Plot mapping	On-plot trees	2	Base year
	Plot mapping	Ingrowth trees	2	Five year

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soil sensitivity to air pollution-induced changes should be considered. The distribution of plots is left to the discretion of regional FIDS establishments.

To allow for climatic and other abiotic fluctuations during data analysis, it is important to have as much relevant information as possible. Therefore, ARNEWS plots should be established near weather or environmental monitoring stations whenever possible. Furthermore, ARNEWS plots should be located near other research plots, if possible, as the latter may provide valuable background information. However, ARNEWS plots should not overlap nor be influenced by activities in adjacent research plots.

ARNEWS plots should not be established in a location where they would be influenced by known point sources of concentrations of pollutants, such as smelters and power plants. Point sources usually have a downwind deposition zone that is not representative of the regional air pollution situation.

Because ARNEWS plots are being established for a 20 to 25 year period, plot security is important. Crown land is preferable, but if private land is chosen as the location for a plot, a written agreement must be obtained to ensure that the future of the plot is secure.

ARNEWS plots should have a buffer zone, with the borders prominently marked and the plots and buffer zone registered in the provincial system of reserve areas. The buffer zone should be large enough to eliminate the influence of local disturbances, such as dust from roads. ARNEWS plots should not be located on stand boundaries. Plots must be located in areas large enough to contain the plot, allow the plot to be located away from stand edges, provide a sufficient buffer from local disturbances, and contain enough off-plot trees for destructive sampling.

Stand Age and Species Composition of ARNEWS Plots

Semi-mature natural stands should be selected because of the long-term nature of the project. Trees in such stands have already been exposed to whatever conditions exist and should remain in existence for the planned 20 to 25 year period of the project, during which time they can react to possible environmental changes. Species composition of the plots is important. Pure stands of economically important species in each region were originally recommended; however, this suggestion poses several problems:

1) pure stands of the most important tree species do not exist in some regions;
2) the relatively small number of plots per region allows for few replications;
3) semi-mature trees in some regions are of a size that does not allow for practical (and efficient) assessment;
4) the economically important tree species may be the least likely to exhibit “early warning” signs of damage; and
5) tree species vary in economic importance among regions.

Regional FIDS establishments are in the best position to determine the most suitable species composition of their ARNEWS plots within the general guidelines. It may be more useful to have a few trees of a given economically important species present in several widely spread, mixed plots than to have a single, pure plot of that species in the region with no opportunity to compare changes in condition of the species. If regional circumstances allow, a few widely and wisely placed pure plots would serve the same purpose.

Regional flexibility allows selecting areas for plot establishment where more sensitive, and therefore better, indicator species can be included. The only constraint imposed is that at least one ARNEWS plot in each region should have a white spruce (*Picea glauca*) component. White spruce was selected because it has a Canada-wide distribution, is economically important in all regions, and is considered to be among the more sensitive tree species; thus, it can provide the necessary linkage for the ARNEWS program.

Part II. ARNEWS Procedures

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Introduction

These instructions constitute that part of the ARNEWS program that deals with field and laboratory procedures. They also render obsolete procedures and forms contained in earlier versions of the ARNEWS program.

Procedures are presented in order of ARNEWS assessment number (except for plot establishment) regardless of the frequency with which they are to be carried out in future years (annual, biennial, or 5 year), the location where they are to be performed (on-plot or off-plot), or their perceived importance (mandatory or optional).

Shaded columns on the field data sheets are for recording parameter values measured to the indicated number of decimal places. The decimal point is implied by the column being shaded.

Zero (0) has a specific meaning in many of the categories presented in this section (for example, negative, not present, 0%, normal, etc.). It must not be used on the form to signify “no data available” or “not applicable.” To indicate that the parameter has been considered but neither of the latter two categories applies, the observer should insert a dash (-) in the appropriate box. For example, a tree with no bare top would have the “bare top length” recorded as “0.0.” A tree of which one cannot see the top does not necessarily have a bare top length of “0.0.” Instead, the bare top length should be recorded as a dash. Binoculars should be used if necessary to observe the tree’s upper crown.

The format of the instructions presented in this section is as follows:

- Each ARNEWS form constitutes a self-contained unit (with the exception of appendices).
- Within each unit, the pages are numbered in the lower corner, indicating the section designation/page number within the unit. For example, the section dealing with ground vegetation surveys, known as ARNEWS Form 6, is paginated 6/1, 6/2, etc.
- The first page of each section deals with general rules, comments, and instructions.
- The second page contains the appropriate ARNEWS form. Within each form, columns are numbered according to the column numbers contained in the original manual if the parameter has been retained from that manual. New columns have been assigned new numbers.
- The third and subsequent pages for each form contain details regarding the appropriate assessment.

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Plot Establishment

Plot establishment involves physically setting up the plot plus gathering baseline data. Generally accepted procedures should be followed, with only slight modifications to meet special requirements.

Plot Marking

1) Only wooden stakes should be used to mark specific reference points on plots. The use of metal stakes (especially aluminum) is strongly discouraged because some metals have been implicated in connection with air pollution-induced changes in forest soils.
2) Corner posts should be positioned first. The plot should then be subdivided as illustrated in Figure 1. Care must be taken to avoid trampling the four 2 m × 2 m subplots that will serve as regeneration and ground vegetation assessment areas. It is advisable to stake out the subplots early.
3) The borders of the buffer zone should be marked in a prominent manner as agreed to by the landowner (be it Crown land or private ownership), preferably as a cooperative undertaking. The plot area and buffer zone should be registered with the appropriate authorities to ensure plot security.
4) Marker posts are susceptible to damage (animals, humans, natural decomposition) and must be replaced as necessary.

When locating subplots within existing plots, the guidelines for establishing new plots should be followed unless these areas have been heavily trampled, in which case the subplots should be moved along the plot perimeter to a more representative and untrampled area. Subplots should remain within the plot boundaries.

Plot Numbering System

Plots are numbered consecutively in each Canadian Forest Service region by two-digit numbers preceded by the single-digit region designation. For example, plot number 5 in Quebec is designated as 305. If a plot is discontinued, the plot number should not be reused when the plot is replaced; instead, the new plot should be designated by the next available consecutive number. This system allows for 99 plots in each region. Regional designations are as follows:

1 Newfoundland and Labrador Region
2 Maritimes Region (New Brunswick, Nova Scotia, and Prince Edward Island)
3 Quebec Region
5 Ontario Region
8 Northwest Region (Alberta, Saskatchewan, Manitoba, and the Northwest Territories)
9 British Columbia and the Yukon Region

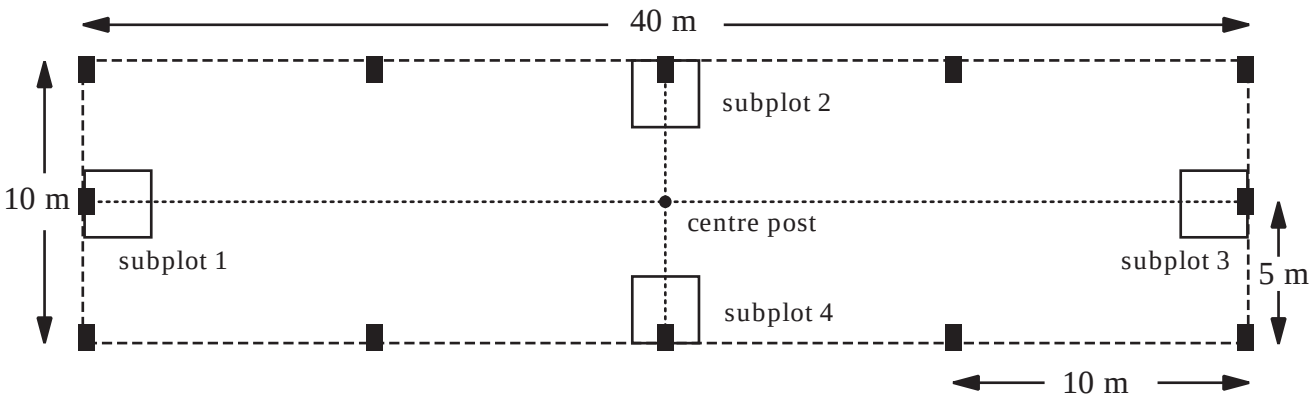

Figure 1. Plot marking

Size of ARNEWS Plots

Each plot should measure 10 m by 40 m (0.04 ha) and be positioned with the longer side as parallel as possible to a contour line in the stand. The plot should not be orientated with the longer side running downslope as micro site differences may exist. As well, running the longer axis down a significant slope would result in the introduction of errors into horizontal distance measurements.

Selecting a Stand

Plots must be located in stands large enough to contain the plot, allow the plot to be located away from stand edges, provide a sufficient buffer from local disturbances, and contain enough off-plot trees for destructive sampling. A minimum stand area of 2 ha is recommended.

Locating a Plot Within the Desired Stand

Care must be taken to find the "best" location within the desired forest stand. The plot must be located away from local disturbances, such as roads. The plot should also be located away from stand edges. A general guideline is to locate the plot a distance of at least three times the height of the tallest trees from the stand edge. For example, if a stand consists of 15 m high trees, the plot should be located at least 45 m from the edge of the stand. The plot should also be located in an area that is representative of the stand. If the stand contains numerous small openings, for instance, then it would be representative for the plot to include part of an opening. If the stand is very dense, on the other hand, with a high number of stems per hectare and a single small opening, it would be inappropriate to include the small opening in the plot. The plot should represent the tree species and tree sizes present in the stand. In even-aged pure stands, this does not pose a problem, but in mixed stands, some planning may be necessary. Prior to staking the plot, one should estimate which trees will be in the plot to determine if they will be representative of the stand in terms of the tree species and tree sizes present.

On-plot Tree Numbering

1) Tree numbers consist of four digits.
2) Trees retain their number permanently. Metal nails should not be used to attach tags as metals may be translocated in the tree. If numbers are painted on the trees, the type of paint used should be considered carefully as many paints contain the same elements (e.g., Pb) for which soil samples will be analyzed. The use of 18 or 24 gauge plastic coated wire to attach tags loosely to the trees is recommended. Periodic adjustments will be necessary at about the same frequency as renewing painted numbers. An alternative numbering method involves the use of a silicon compound, such as the white bathtub silicone sealer available in tubes, to write the numbers. The numbers should be about 10 cm high and face the normal direction of travel within the plot. The bark of some tree species may have to be smoothed to ensure that the sealer adheres to it. Care must be taken not to injure the tree. It will be necessary to renew the numbers occasionally.
3) All standing trees, living or dead, 10 cm or larger in diameter at breast height (DBH) should be numbered. Only dead understory trees whose top does not reach into the canopy are left unnumbered.
4) The tree trunk should be marked on two sides, using a permanent nontoxic substance, 1 cm below the level at which periodic DBH measurements will be taken. The marks should be 5 cm long and orientated horizontally. DBH will be measured 1 cm above the marks. Breast height is defined as 1.3 m above the ground, measured from the midpoint of the ground (slope). See Figure 5 for where to measure DBH on abnormal stems. An alternative procedure involves placing a 1.3 m long stick at the midpoint of the ground; the top of the stick would then determine breast height. It is not necessary to mark breast height for normally formed trees if this procedure is followed at each 5 year assessment. For abnormally formed trees, breast height can be determined as illustrated in Figure 5.
5) Trees with forked trunks are considered to be separate trees (and are assigned individual numbers) if the fork is 1.3 m or less above the ground. Trees that fork above this height are treated as a single tree.
6) Trees that occur on the plot boundary shall be considered in the plot if the tree's point of germination is within the plot boundary. The point of germination is where the seedling took root and became established. Thus, a tree may be leaning outside the plot, but its point of germination could render it an "on-plot" tree. Conversely, a tree may be leaning into the plot, but its point of germination could

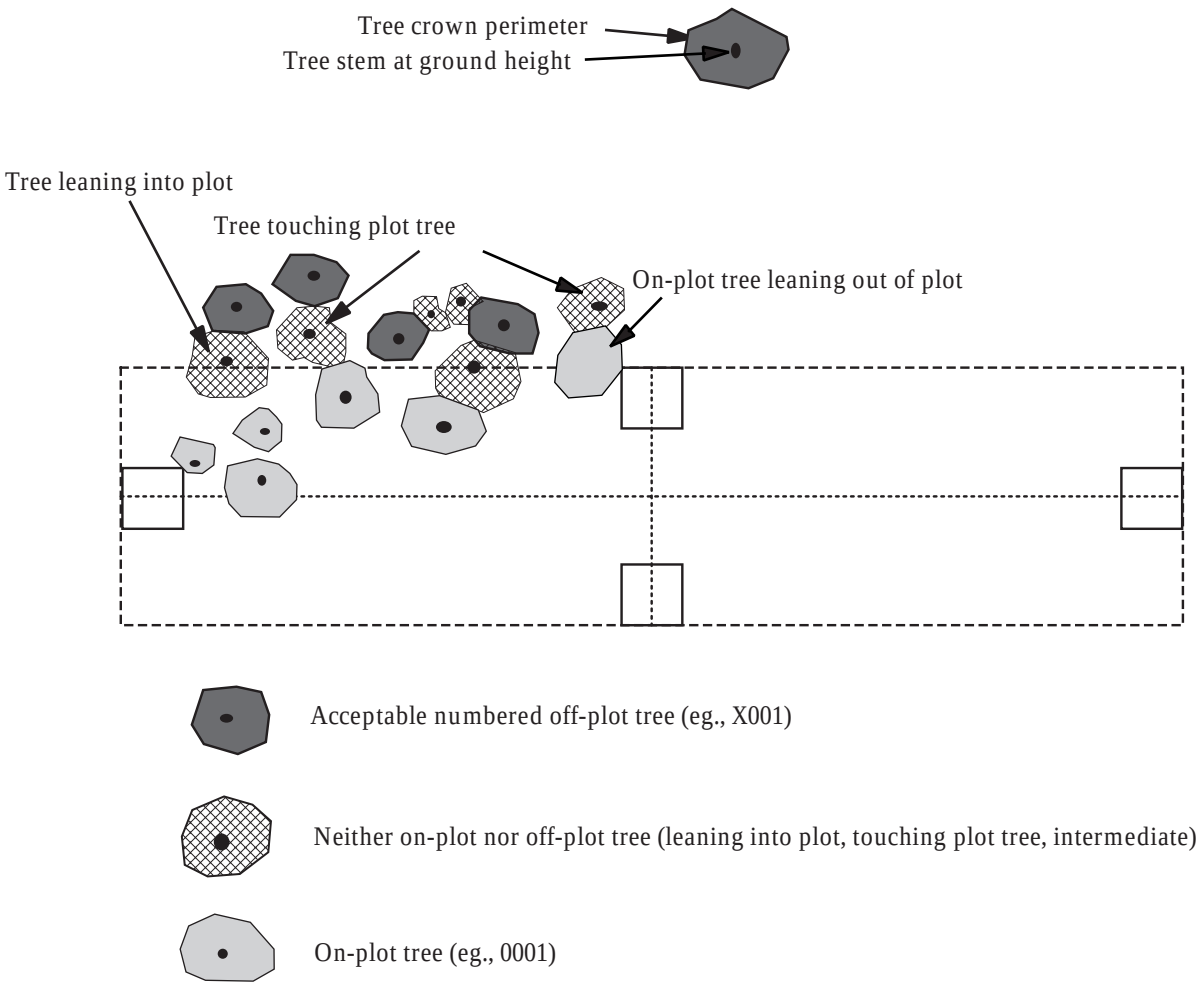

Figure 2. On-plot / off-plot numbered trees

render it an “off-plot” tree. Trees that grow in clumps and sprout from the same origin are deemed to have the same point of germination; hence, all stems in the clump are within the plot or all stems in the clump are outside the plot. Clumped trees should be numbered in the same manner as forked trees as described in (5) above.

Ingrowth

Following plot establishment, saplings should be included as trees once they reach 10 cm DBH. They should be included in the first 5 year assessment once they have reached 10 cm DBH. These saplings must be numbered, mapped on ARNEWS Form 2, and subsequently treated as all other on-plot trees.

Off-plot Tree Numbering

1) Select 10 dominant or codominant living off-plot trees of each species that constitutes at least 10% of the canopy.
2) The general size, crown closure, and health of the off-plot trees should be representative of the on-plot trees of the same species. Do not select the 10 “best” trees.
3) Do not select off-plot trees that are touching or leaning into on-plot trees. Do not select trees that are leaning into the plot (Figure 2).
4) Off-plot trees should be marked in the same manner as described in (2) and (4) for on-plot tree numbering.
5) Off-plot tree numbers consist of a letter followed by three digits. Off-plot tree numbers cannot be the same as those used for on-plot trees; they must be unique.

Random Off-plot Trees

Each plot should have sufficient numbers of off-plot trees for destructive sampling. These trees need not be mapped or numbered, but should not be leaning into the plot nor touching a plot tree.

Replacement of Numbered Off-plot Trees

In the years following plot establishment, some numbered off-plot trees will need to be replaced. When to replace numbered off-plot trees is left up to regional staff. Use common sense and the following as guidelines:

- Replace a numbered off-plot tree when destructive sampling has resulted in significant injury to the tree. Destructive sampling includes increment coring, cutting branches, and damaging roots when digging a soil pit.
- Replace numbered off-plot trees when they are not representative of on-plot trees due to some localized agent. For example, a localized root rot infection could affect the majority of off-plot trees, but not the on-plot trees.
- Replace a numbered off-plot tree when it ceases to be dominant or codominant.

A general decline in the health of off-plot trees that is mirrored by the on-plot trees is not a valid reason to replace the numbered off-plot trees.

When replacing a numbered off-plot tree, select a new tree following the guidelines for plot establishment. Give the tree a new number, do not reuse the old number.

ARNEWS Form 1: Basic Plot Information

This form is completed only once for each plot. The information, recorded after plot establishment, covers the most basic characteristics of the plot. Once recorded, it eliminates the need to repeat the information (such as the nine-digit UTM grid designation) on subsequent ARNEWS forms.

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BASIC PLOT INFORMATION | **INFORMATION DE BASE SUR LA PARCELLE**

ARNEWS DNARPA 1

Assessment type / Type d'évaluation: 0 1 (1 2)

Plot Number / Numéro de la parcelle: (3 4 5)

UTM Grid / Coordonnées selon le quadrillage MTU: Zone (6 7) | Easting/Vers l'est (8 9 10) | Northing/Vers l'ouest (11 12 13 14)

Location / Localisation

Plot Orientation / Orientation de la parcelle: (15 16 17)

Slope% / Pente %: (30 31)

Year of Establishment / Année d'établissement: (18 19)

Aspect / Exposition: (32 33)

Date of Mapping / Date de mise en plan: Y-A M-M D-J (20 21 22 23 24 25)

Elevation (m) / Élévation (m): (26 27 28 29) M

Terrain position / Position du terrain: (34)

Comments - Remarques

Forest Insect and Disease Survey (FIDS) | Relevé des insectes et des maladies des arbres (RIMA) RES 1255 (94/03)

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ARNEWS Form 1: Basic Plot Information

Assessment type (columns 1-2):	ARNEWS form number expressed as a two-digit number, e.g., 01 signifies Form 1 (Basic Plot Information).
Plot number (columns 3-5):	Single-digit region designation followed by a two-digit plot number, e.g., 305 (Quebec Region plot number 5).
UTM grid (columns 6-14):	The location of ARNEWS plots is determined to the nearest square kilometre and the nine-digit universal transverse Mercator (UTM) grid designation entered. The first two digits are the UTM zone (columns 6-7), the next three digits are the easting (columns 8-10), and the last four digits are the northing (columns 11-14), e.g., 20 504 4997 (Upper Musquodoboit, Nova Scotia). Optional: The UTM grid designation can be recorded to the nearest 100 m by using the shaded boxes to the right of columns 10 and 14 for the extra easting and northing digits respectively.
Location:	Describe in as much detail as necessary. Information provided should include the names of the plot, nearest town, county, township, municipality, and province and the names of nearby roads and distances along roads.
Plot orientation (columns 15-17):	Three-digit number indicating the compass bearing of the orientation of the longer centre line of the plot from magnetic north in a clockwise direction, e.g., 67• would be recorded as 067.
Year of establishment (columns 18-19):	Two-digit number denoting the year during which the plot was established, e.g., 1985 would be recorded as 85.
Date of mapping (columns 20-25):	Six-digit number denoting the year/month/day, e.g., 15 September 1985 would be recorded as 850915.
Elevation (columns 26-29):	Four-digit number indicating the elevation above mean sea level (in metres), e.g., 800 m would be recorded as 0800.
Slope (columns 30-31):	Two-digit number indicating the general slope of the plot (percent), e.g., 5% would be recorded as 05. If the plot is flat, the slope would be recorded as 00.
Aspect (columns 32-33):	The compass direction of the downward slope of the plot. Select from N, NE, E, SE, S, SW, W, or NW. A plot with no measurable slope is designated as F (flat).

Terrain position (column 34):

The position of the plot in relation to the surrounding topography. The plot should be viewed as a whole using the illustration presented in Figure 3 as a guide. The following codes should be used to designate terrain position:

1 Top and upper slope — convex region on the upper part of the profile
2 Midslope — uniform, fairly straight region of the middle part of the profile
3 Bench — area of level terrain with midslope above and below
4 Lower slope — concave region on the lower part of the profile
5 Flatland — level or near-level terrain, not part of or related to a major change in elevation
6 Bottomland — region subject to a high water table

Comments:

This box should be used to record any other relevant information, such as the origin and history of the forest or stand if known, or evidence of past events such as fires or cutting.

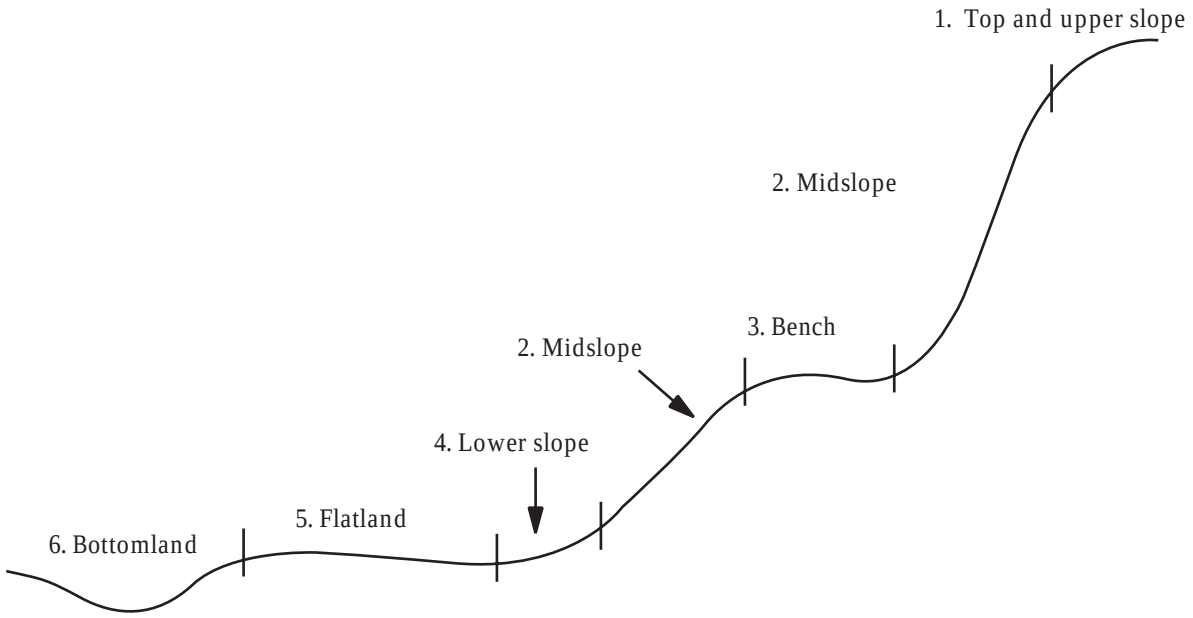

Figure 3. Terrain position

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ARNEWS Form 2: Particulars for Plot Map

All numbered on-plot trees 10 cm or larger in diameter at breast height should be mapped as to their position within the plot boundaries. Additional information recorded for each tree should include the tree species (using standard FIDS codes), the status of the tree (alive or dead), and remarks on other permanent features that may affect the future health of the tree. Standing dead trees 10 cm or larger in diameter at breast height should also be mapped unless they were suppressed understory trees that died.

ARNEWS Form 2 should be filled out during the base year. At 5 year intervals when new trees are added because they have grown to a diameter at breast height of 10 cm or larger, the new trees must also be mapped. A new ARNEWS Form 2 must be completed for these new trees.

The coordinates method should be used for mapping plot trees. Initial subplot mapping should be carried out simultaneously.

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PARTICULARS FOR PLOT MAP | **MISE EN PLAN DE LA PARCELLE**

ARNEWS DNARPA 2

Assessment Type / Type d'évaluation: 0 2 (1 2)

Plot Number / Numéro de la parcelle: (3 4 5)

Assessment Date / Date de l'évaluation: Y-A M-M D-J (20 21 22 23 24 25)

Location/Localisation

Assessed by/Évaluation faite par

Page of / de

Tree Number / Numéro de l'arbre				Tree Spec. / Essence			Type	Status/État	Distance along center line (Y) 0.0 to 20.0 m / Distance le long de l'axe (Y) (0 à 20 m)				Distance from center line (X) (0.0 to 5.0 m) / Distance à partir de l'axe (X) (0 à 5 m)			Remarks/Remarques
33	34	35	36	37	38	39	40	41	+/-	42	43	44	+/-	45	46	

Forest Insect and Disease Survey (FIDS) | Relevé des insectes et des maladies des arbres (RIMA) RES 1256 (94/03)

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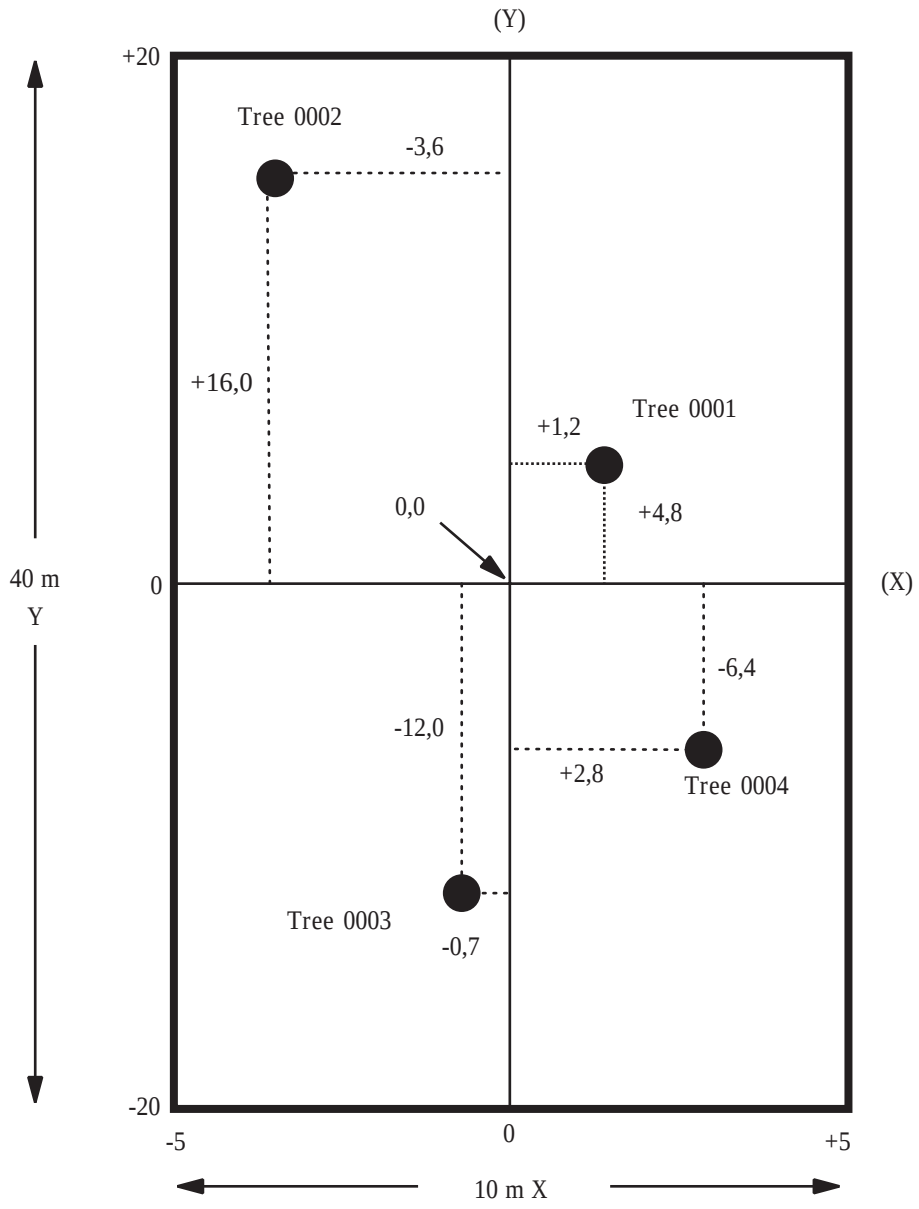
ARNEWS Form 2: Particulars for Plot Map

Assessment type (columns 1-2):	ARNEWS form number expressed as a two-digit number, e.g., 02 signifies Form 2 (Particulars for Plot Map).
Plot number (columns 3-5):	Single-digit region designation followed by a two-digit plot number, e.g., 305 (Quebec Region plot number 5).
Assessment date (columns 20-25):	Six-digit number denoting year/month/day, e.g., 7 September 1985 would be recorded as 850907.
Location:	Provide a brief description of the plot location.
Assessed by:	Provide name(s) of individual(s) conducting the work.
Page _ of _ :	Complete after the last tree has been assessed to assist in form handling.
Tree number (columns 33-36):	Four-digit number, e.g., tree 57 would be recorded as 0057.
Tree species (columns 37-39):	Use standard three-digit FIDS species designation, e.g., balsam fir would be recorded as 003. Refer to Appendix 1 for the codes used by FIDS to designate tree species.
Tree type (column 40):	Enter 1 for conifer or 2 for hardwood.
Tree status (column 41):	Enter 0 for dead or 1 for alive.
Tree location (distance along/from centre line) (columns 42-46):	Determine the location of the centre of the bole of each tree by measuring the distance along the appropriate axis. The longer centre line of the plot is considered the Y axis, the shorter centre line the X axis. Consequently, the plot centre has coordinates Y = 0, X = 0. At ground level, measure the distance to the centre of the bole of each tree along the two axes. Record Y (three digits) and X (two digits) to the nearest 0.1 m with the decimal implied by the shaded columns. Use + and - designations as appropriate (see example illustrated in Figure 4).
Remarks:	Note permanent features of each tree that may affect the future health of the tree, such as a forked stem below breast height, the situation where a tree is one stem of a clump of stems, trees sharing root systems, or a tree growing out of a crack in a rock.



Examples:

Tree Number				Species			T	S	Distance Y				Distance X			Remarks
33	34	35	36	37	38	39	40	41	+/-	42	43	44	+/-	45	46	
0	0	0	1	0	0	3	1	1	+	0	4	8	+	1	2	
0	0	0	2	0	4	3	1	1	+	1	6	0	-	3	6	
0	0	0	3	0	4	3	1	0	-	1	2	0	-	0	7	Tree dead.
0	0	0	4	1	1	0	2	1	-	0	6	4	+	2	8	

Figure 4. Particulars for plot map (not drawn to scale)

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ARNEWS Form 3, X3: Tree Data

All numbered on-plot trees should be assessed when the plot is first established and every 5 years thereafter for general characteristics and tree form. All numbered off-plot trees should be assessed at the same time. This procedure provides a description of the physical condition of individual trees and the stand as a whole. All saplings that have attained tree size (10 cm or greater DBH, taller than 2 m) since ARNEWS Form 3 was last completed must be numbered, mapped on ARNEWS Form 2, and assessed on the current ARNEWS Form 3.

Living On-plot Trees

Parameters assessed every 5 years include vertical and horizontal characteristics of the crown, the position of each tree in the canopy (dominance), diameter at breast height, and tree form. The length of any dead tops and the length of the tree's live crown are calculated from the vertical crown measurements recorded on this form.

Dead On-plot Trees

The tree number and species of old dead trees or trees that have died recently should be recorded. Trees that have died recently should have their DBH recorded as well.

Tree Heights

Three tree height measurements (total height, height to top of live crown, and height to base of live crown) can be measured for each tree or 30 representative trees of each species. The second procedure should be followed when there are more than 30 trees of a given species, thereby eliminating the need to take a lot of height measurements in dense single-species plots. The minimum of 30 trees can be exceeded when necessary to develop a good height/diameter relationship. Trees selected for the height measurements must be representative of the range of diameters, heights, dominance, and crown closures for the species. It is not acceptable to select only those trees whose tops are easy to see for height measurements. Such trees may be representative of the range of diameters and dominance, but they would bias against crowded trees that may not have the same height growth as trees growing under uncrowded conditions. Numbered off-plot trees can be used as part of the required 30 trees, but it should be borne in mind that they will always be dominants or codominants. All three height parameters should be measured on the selected trees. Table 3 can be used to check the distribution of trees measured to ensure a good height/diameter relationship.

The height of all on-plot trees with broken tops should be measured. However, trees with broken tops will not be used in the height/diameter relationship.

Numbered Off-plot Trees

These trees must be assessed every 5 years using the same procedures as for numbered on-plot trees. ARNEWS Form 3 should be completed up to and including column 45 (crown closure). Completion of columns 46 to 62 is optional. Fill out a separate form and indicate that the assessment type is X3. Data pertaining to off-plot trees should not be recorded on the same form as data pertaining to on-plot trees. Instead, a separate ARNEWS Form 3 should be completed for numbered off-plot trees with an assessment type designation of X3.

Natural Resources Canada | Ressources naturelles Canada
FIDS | RIMA

TREE DATA
(Five-year Assessment)

DONNÉES SUR LES ARBRES
(Évaluation quinquennale)

ARNEWS 3
DNARPA

Assessment type / Type d'évaluation [1] [2]
Plot No. / N° de la parcelle [3] [4] [5]
Assessment Date / Date de l'évaluation [20] [21] [22] [23] [24] [25]

Location/Localisation

Assessed by/Évaluation faite par

Page of / de

Tree No. N° de l'arbre				Dominance / Tree Spec. Essence			↓	Crown Closure Contiguïté des cimes / DBH/DHP (cm)				↓	Stem form Forme du tronc / Total height Hauteur totale de l'arbre ↓			Ht. to top live crown Hauteur au haut de la cime vivante			Height to base of live crown Hauteur à la base de la cime vivante			Remarks/Remarques
33	34	35	36	37	38	39	40	41	42	43	44	45	46	51	52	53	57	58	59	60	61	62	

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ARNEWS Form 3, X3: Tree Data

Assessment type (columns 1-2):	ARNEWS form number expressed as two characters, e.g., 03 signifies Form 3 for numbered on-plot trees and X3 signifies Form 3 for numbered off-plot trees.
Plot number (columns 3-5):	Single-digit region designation followed by a two-digit plot number, e.g., 305 (Quebec Region plot number 5).
Assessment date (columns 20-25):	Six-digit number denoting year/month/day, e.g., 7 September 1985 would be recorded as 850907.
Location:	Provide a brief description of the plot location.
Assessed by:	Provide name(s) of individual(s) conducting the work.
Page _ of _:	Complete after the last tree has been assessed to assist in form handling.
Tree number (columns 33-36):	Four-digit number, e.g., tree 57 would be recorded as 0057.
Tree species (columns 37-39):	Use standard three-digit FIDS tree species designation, e.g., balsam fir would be recorded as 003. Refer to Appendix 1 for the codes used by FIDS to designate tree species.
Dominance (column 40):	The crown of each tree should be assessed with respect to the amount of sunlight received and the proximity to neighbouring trees. For trees that are dead at the time of plot establishment, estimate their dominance class at the time when they were last alive (do not use class 9 for the plot establishment assessment, suppressed dead trees should not have been numbered during plot establishment). Use the following codes to record dominance:

1 Dominant: tree's crown extends above the general level of the crown canopy and receives full sunlight from above and partial sunlight from the sides
2 Codominant: tree's crown is at the general level of the crown canopy and receives full sunlight from above but little sunlight from the sides; may be somewhat crowded at the sides
3 Intermediate: tree's crown extends into the general level of the crown canopy but is shorter than codominants; receives little direct sunlight from above
4 Suppressed: tree's crown is entirely below the general level of the crown canopy
9 Tree has died since last assessment
- Not applicable; tree was dead at last 5 year assessment

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DBH (columns 41-44):

Using a diameter tape, measure the diameter of each tree (living or dead since the last 5 year assessment) at a height of 1.3 m above the ground as measured from the midpoint of the ground (slope) (Figure 5D). If breast height has already been marked, the new measurement should be taken 1.0 cm above the existing marks. A “stick” 1.3 m in length can also be used to determine breast height. DBH should be recorded as a four-digit number to the nearest 0.1 cm, e.g., a DBH of 35.7 cm would be recorded as 0357. Figure 5 illustrates where to measure DBH on trees with abnormal stems. Comments on the type of problem tree encountered and where DBH was measured should be recorded under “remarks.” If a tree is being measured for the first time, it should be marked 1.0 cm below where DBH was measured so that in 5 years time, DBH can be remeasured along the same circumference of the trunk.

Crown closure (column 45):

For each living or recently dead (died during the last 5 years) on-plot dominant or codominant tree, estimate the number of sides of the tree’s crown that are touching or overlapping neighbouring dominant/codominant trees. Include the influence of off-plot trees. Do not consider neighbouring trees that are intermediate, suppressed, or dead. Examine the middle to upper crown but do not consider neighbouring trees that are only touching or overlapping in the lower crown. Record the number of sides touching or overlapping according to the following guidelines: divide the crown into four equal quadrants, arrange the axis of the quadrants to minimize the number of quadrants where neighbouring trees are touching or overlapping in the middle to upper crown (Figure 6). Count the number of quadrants touching or overlapping. Where the middle to upper crown is not visible, estimate as accurately as possible. Use the following codes to record crown closure:

0	None
1	Neighbouring trees touch or overlap on one quadrant
2	Neighbouring trees touch or overlap on two quadrants
3	Neighbouring trees touch or overlap on three quadrants
4	Neighbouring trees touch or overlap on all four quadrants
8	Not applicable; tree is intermediate or suppressed
-	Not applicable; tree was dead at last 5 year assessment

Stem form (column 46):

Record the general characteristic of each tree’s stem form, taking into consideration what is normal for the species, using the following codes:

0	Normal stem form for the species, no deformities
1	Main stem broken off
2	Top of tree broken off
3	Main stem abnormally forked below the living crown
4	Stem significantly twisted (spiral)
5	Tree leaning more than 15• from vertical
9	Other (specify under “remarks”)
-	Tree is dead

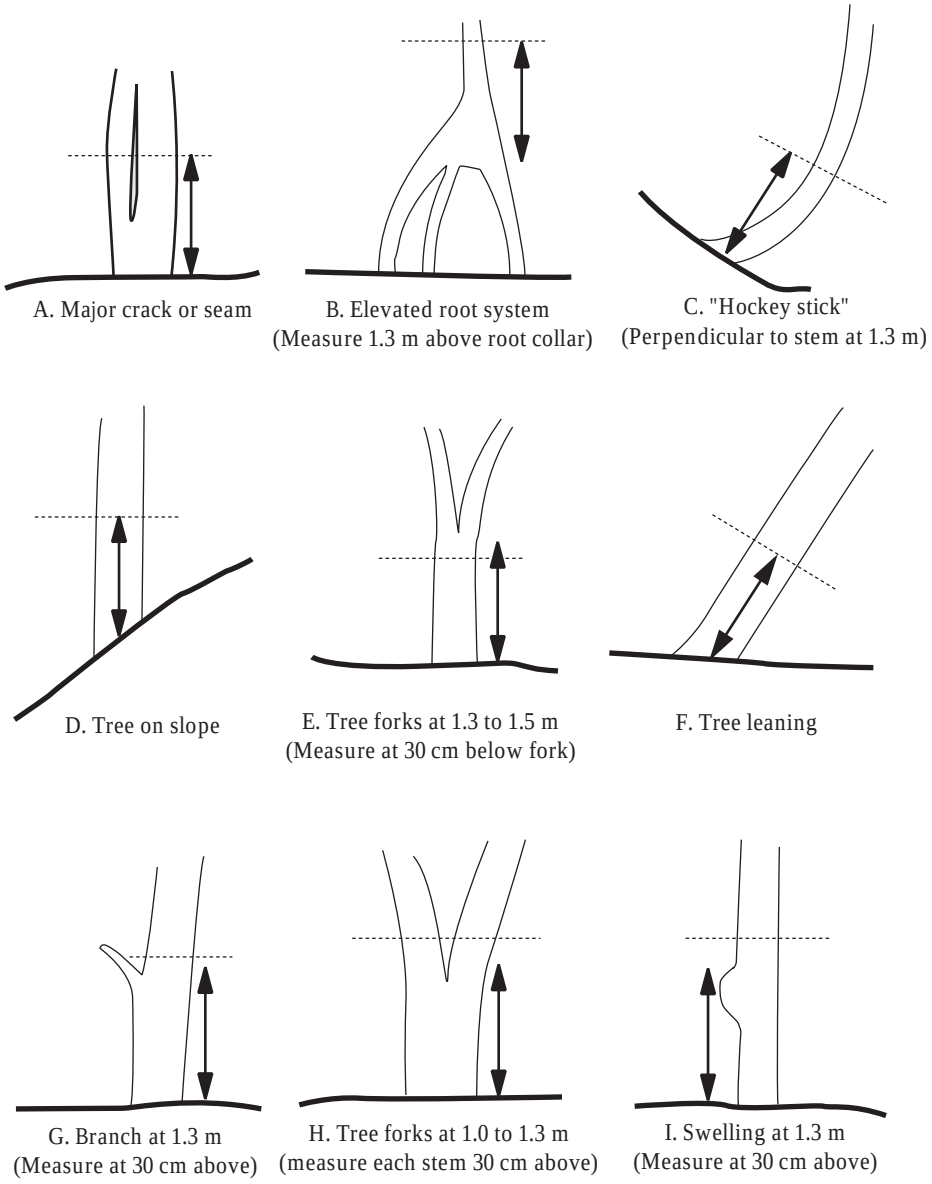

Figure 5. Where to measure DBH on abnormal stems.

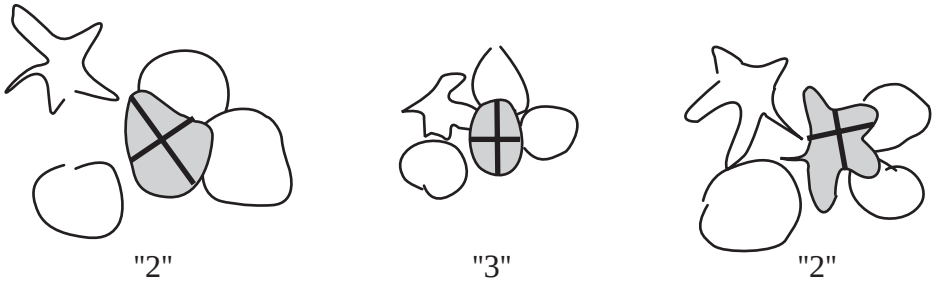

Figure 6. Examples of crown closure.

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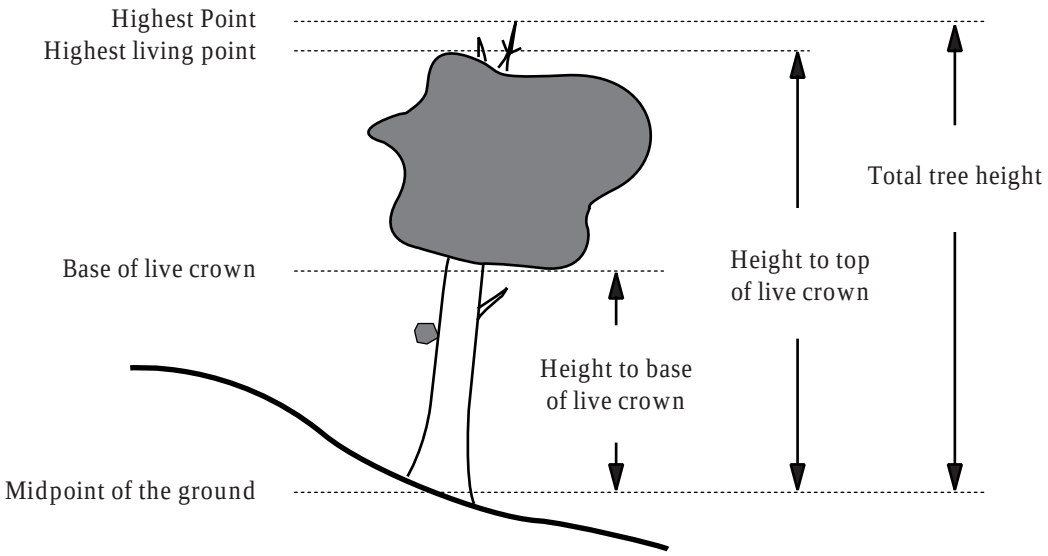
Total height (columns 51-53):	Remarks: From the midpoint of the ground (slope) at the base of the tree, measure the highest point (alive or dead) of each selected on-plot tree to the nearest 0.1 or 0.5 m as appropriate (Figure 7). The total height should be recorded as a three-digit number, e.g., 9.2 m would be recorded as 092.
Height to top of live crown (columns 57-59):	From the midpoint of the ground (slope) at the base of the tree, measure the highest living point of each selected on-plot tree to the nearest 0.1 or 0.5 m as appropriate (Figure 7). If there is no dead top present, this measurement will be the same as the total height measurement. The height to top of live crown should be recorded as a three-digit number, e.g., 8.5 m would be recorded as 085. The length of any dead tops can be calculated by subtracting the height to top of live crown measurement from the total height measurement.
Height to base of live crown (columns 60-62):	Determine the base of the live crown as the horizontal line at the bottom of the living productive foliage of the lowest qualifying branch. The lowest qualifying branch need not be a complete whorl of branches. Epicormic shoots and straggler branches, which usually do not contribute much to tree health, should be excluded. Only branches that support living productive foliage should be considered. Recently defoliated branches that currently have no foliage but are expected to recover should be included. Defoliated branches that are not expected to recover should not be included. When there are significant gaps in the crown (greater than 2 m vertical height), decide if the lower disjoined branches contribute to the health of the tree. For example, a 5 m crown followed by a 2 m gap followed by 3 m of healthy lower branches should be measured from the lowest foliage of the lower 3 m of healthy branches (Figure 8I). If the same tree supported only one whorl of unhealthy branches below the 2 m gap, however, the lower whorl would not be included (Figure 8E). A tree with a 5 m crown followed by a 1 m gap followed by one whorl of unhealthy branches, on the other hand, should be measured at the lower whorl of branches below the gap because the gap is less than 2 m (Figure 8A, 8D). Where branches extend down only one side of a tree, the living foliage of the lowest qualifying branch on that side will form the base of the live crown (Figure 8B, 8G). Do not average the two sides of a tree with uneven crown bases. From the midpoint of the ground (slope) at the base of the tree, measure the height of the base of the live crown of each selected on-plot tree to the nearest 0.1 or 0.5 m as appropriate (Figure 7). The height to base of live crown should be recorded as a three-digit number, e.g., 2.4 m would be recorded as 024. The live crown length can be calculated by subtracting the height to base of live crown from the height to top of live crown. The live crown length need not be recorded. Note any additional tree characteristics or difficulties encountered in obtaining Form 3 data (e.g., “DBH measured 30 cm above swelling”). Note all decisions made with respect to collecting the data so that during future reassessments, the same approach can be followed to collect comparable data and to determine real changes in tree and stand characteristics, not just changes resulting from different interpretations of these instructions. (Optional: Note the bearing and distance from the tree where Sunto measurements were taken so that future measurements can be taken from the same place on the ground.)

(a)



(b)

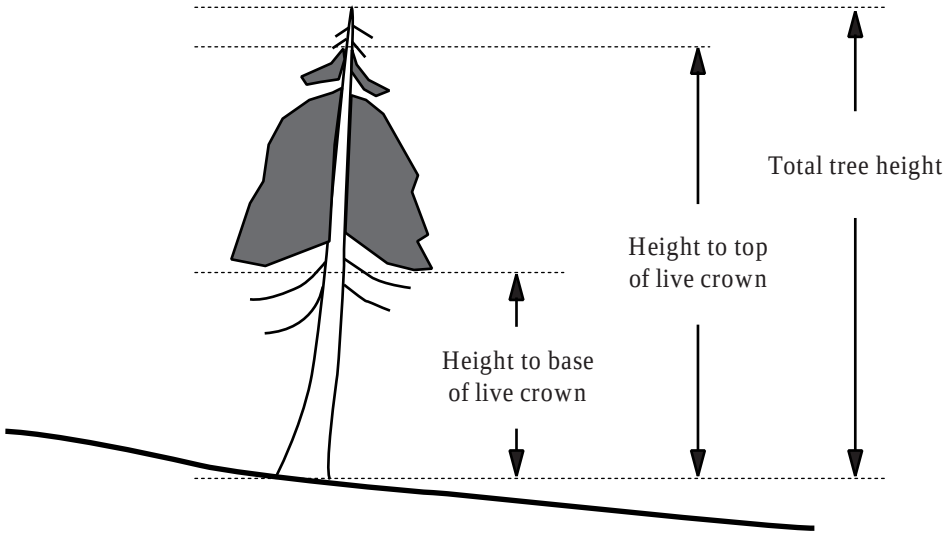


Figure 7. Form 3 height measurements. (a) Hardwood. (b) Softwood.

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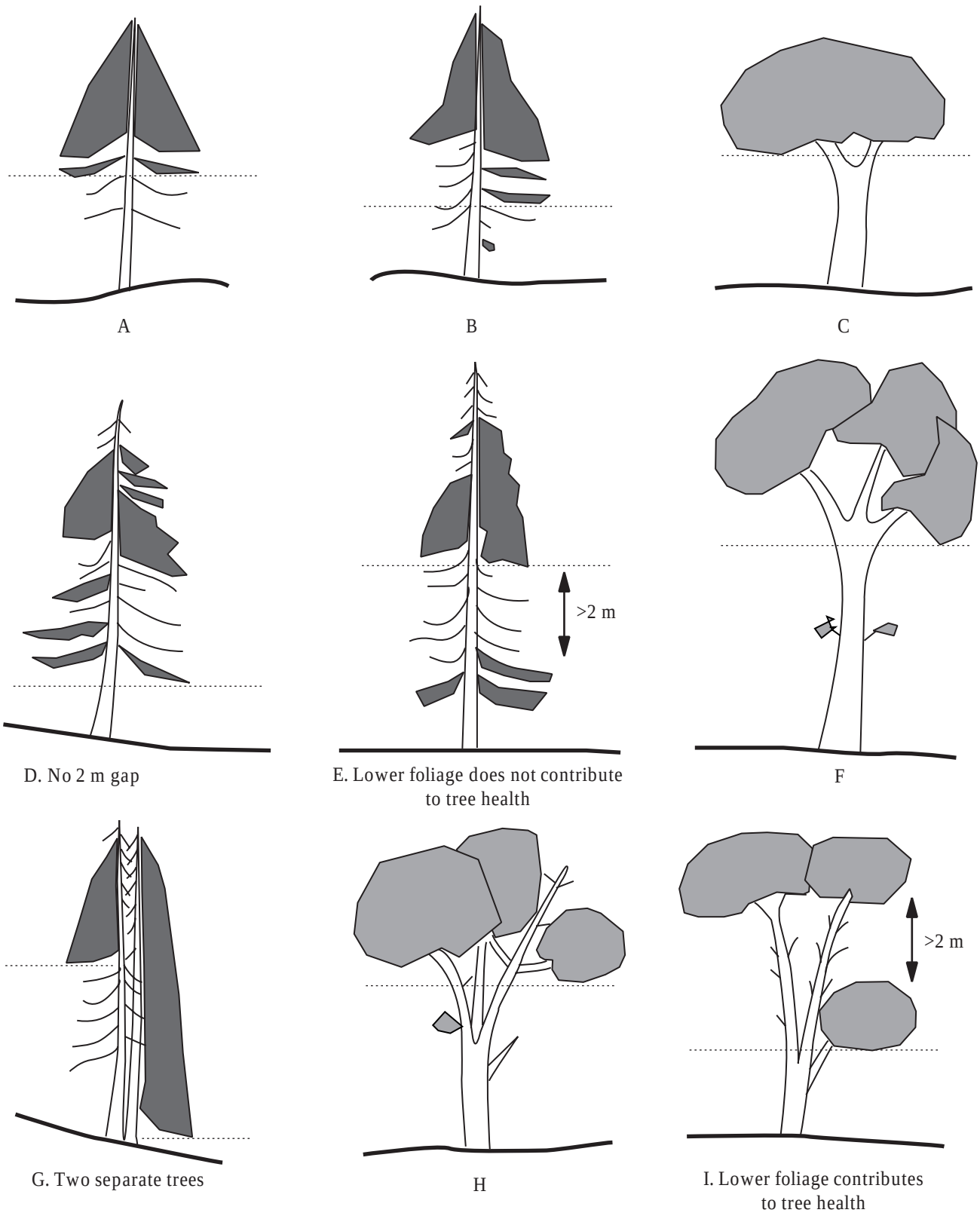

Figure 8. Determining the base of the live crown.

Table 3. Table to check the distribution of trees measured for height

Dominance	Crown Closure	DBH class (cm) 10.0 to 11.9	12.0 to 13.9	14.0 to 15.9	16.0 to 17.9	18.0 to 19.9	20.0 to 21.9	22.0 to 23.9	24.0 to 25.9	26.0 to 27.9	28.0 to 29.9	30.0+
Dominant and codominant	0 & 1											
	2											
	3 & 4											
Intermediate	8											
Suppressed	8											

This table can be used to determine if the correct distribution of trees has been sampled for each species that has had 30 trees measured for the three height variables (columns 51-62). This table should not be used if all trees of a species have been measured for heights. Furthermore, trees with broken tops must be measured for height but should not be included in the height/diameter relationship.

Method 1: Check the distribution after measuring 30 trees for height and all trees for DBH

After 30 trees have been selected and measured, place a check mark in the appropriate box in the table for each measured tree's dominance (column 40), DBH class (columns 41-44), and crown closure (column 45). Scan the data sheets for trees of the same species that have not had their heights measured, noting which box applies to their DBH, dominance, and crown closure. If there is no check mark in the box for the unmeasured tree, return to that tree and measure the three height variables. Scan all unmeasured trees to ensure that their boxes have been marked.

Method 2: Check the distribution as you go

Check the appropriate box for each tree of a species after the three height variables have been measured for that tree. For the next tree of the same species, note the appropriate box; if it does not have a check mark, measure the tree's height. Repeat this procedure until all of the trees of the species have been measured. Count the check marks. If the total is less than 30, return to enough randomly selected on-plot trees to bring the total to 30 trees and measure the three height variables at each of these additional trees.

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ARNEWS Form 4, X4: Plot Tree Assessment

Form 4 is completed annually and involves all numbered on-plot trees (assessment type 04).

The assessment is normally carried out towards the end of the field season after growth is completed — by this time, too, most insects and annual diseases have already caused whatever damage they are likely to inflict on the trees — and before fall colouration interferes with visual observations. It is useful to conduct a Pest Condition Assessment (ARNEWS Form 8) before assessing the on-plot trees because this information will facilitate dealing with most of the symptoms observed. No destructive sampling should be conducted on the plot.

This assessment includes parameters to determine:

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Natural Resources Canada | Ressources naturelles Canada

FIDS | RIMA

PLOT TREE ASSESSMENT (Annual)

ÉVALUATION DES ARBRES DE LA PARCELLE (Annuelle)

ARNEWS DNARPA **4**

Assessment type / Type d'évaluation (1 2) | Plot No. / N° de la parcelle (3 4 5) | Assessment Date / Date de l'évaluation (20 21 22 23 24 25)

Location/Localisation | Assessed by/Évaluation faite par | Page of / de

Tree Number / Numéro de l'arbre				Tree Spec. / Essence			Type	Bare top length (m) / Longueur de la cime morte		Crown Condition / État de la cime				NRet	SDam	CDef	Abiotic foliage symptoms / Symptômes foliaires abiotiques				Level/Niveau	Seed/Graine	Foliage damage / Dommage au feuillage				Woody tissue damage / Dégâts aux tissus							Remarks/Remarques
										Code		Conifer / Résineux					1		2				Insect / Insecte		Disease / Maladie		Insect / Insecte		Disease / Maladie		Other / Autres			
																							T	L	T	L	T	D	T	D	T	D	L	
33	34	35	36	37	38	39	40	41	42	U	M	L	43	44	45	46	47	48	49	50	51	65	56	57	58	59	60	61	66	63	68	70	71	72	

Forest Insect and Disease Survey (FIDS) | Relevé des insectes et des maladies des arbres (RIMA) RES 1236 (94-01)

4/2

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ARNEWS Form 4, X4: Plot Tree Assessment

Assessment type (columns 1-2):	ARNEWS form number expressed as two characters; e.g., 04 signifies Form 4 for numbered on-plot trees and X4 signifies Form 4 for numbered off-plot trees.
Plot number (columns 3-5):	Single-digit region designation followed by a two-digit plot number, e.g., 305 (Quebec Region plot number 5).
Assessment date (columns 20-25):	Six-digit number denoting year/month/day, e.g., 7 September 1985 would be recorded as 850907.
Location:	Provide a brief description of the plot location.
Assessed by:	Provide name(s) of individual(s) conducting the work.
Page _ of _:	Complete after the last tree has been assessed to assist in form handling.
Tree number (columns 33-36):	Four-digit number, e.g., tree 57 would be recorded as 0057.
Tree species (columns 37-39):	Use standard three-digit FIDS tree species designation, e.g., balsam fir would be recorded as 003. Refer to Appendix 1 for the codes used by FIDS to designate tree species.
Tree type (column 40):	Enter 1 for conifer or 2 for hardwood.
Crown condition (columns 41-42):	Crown condition is determined for all numbered on-plot trees using either the hardwood or the conifer classification system. (Conifers undergo a secondary assessment that is recorded in columns 42U to 42L). Treat larches as hardwoods.

Dead Trees

At the time of plot establishment, all dead trees fall into class 09 regardless of whether they died recently or have been dead for some time. For all other annual assessments, trees that have died recently come under class 08 in the year they are first observed as dead. A note describing the probable cause of death **must** be made in the remarks (e.g., suppressed, blown down, removed, presence of *Choristoneura fumiferana*, root rot, etc.). The note should be as specific and descriptive in nature as possible. The remaining columns on Form 4 should not be completed (i.e., columns 42U to 72). Instead, a straight line should be drawn through the rest of the page, except for the remarks column. In subsequent years, trees that were dead at the time of the last assessment come under class 09. Again, columns 42U to 72 should not be completed; rather a straight line should be drawn through the rest of the page, except for the remarks. Note in the remarks column any change in the physical status of old dead trees (condition 09), e.g., fell down, leaning into a neighbouring tree, removed, etc. (Table 4).

Table 4. How to record dead trees

Assessment	Tree status	Class (columns 41-42)	Columns 42U to 72	Remarks
Plot establishment	Treat all dead trees as old dead trees	09	Draw straight line through columns	Note any evidence of the cause of death
Annual assessment	Dead at time of last annual assessment	09	Draw straight line through columns	Note any changes in physical status of tree, e.g., fell down, leaning, etc.
Annual assessment	Died since last annual assessment	08	Draw straight line through columns	Describe probable cause of death, including primary and secondary factors.

Hardwood Crown Classification System

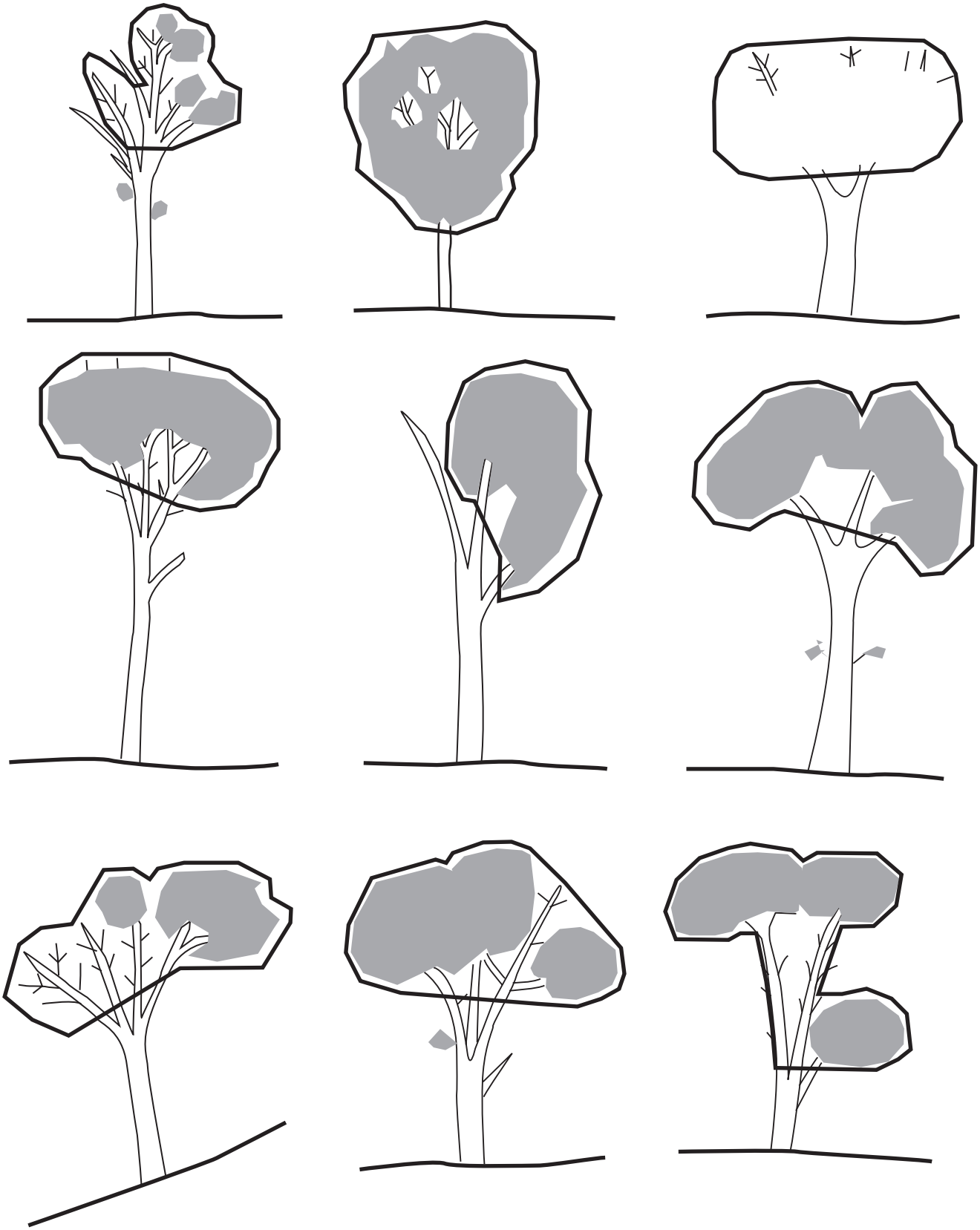
The hardwood crown classification system is based upon the visible parts of the outer crown, e.g.,

- the quantity and quality of foliage in the outer crown;
- the percentage of the outer crown that contains bare twigs; and
- the percentage of the outer crown that contains dead branches.

Bare twigs or dead branches in the inner crown are not considered when rating hardwoods; bare twigs support no living foliage, although the twig may be living or dead. The perimeter of the outer crown includes dead branches and bare twigs (Figure 9), but excludes epicormic or adventitious shoots as well as old dead branches from which all of the twigs and secondary branches have fallen. Refer to Appendix 2 for additional definitions and diagrams.

Record the hardwood crown condition using the following codes:

	10	Full complement of foliage. Tree exhibits no visible crown damage.
	20	Foliage thin, off-colour. No dead branches present or bare twigs visible.
	30	No dead branches present.* Bare twigs present in up to 5% of the crown.
	35	No dead branches present.* Bare twigs present in more than 6% of the crown.
** Ignore occasional small dead branches not representative of the rest of the crown in 30, 35, and 40.*	40	Dead branches* and bare twigs present in up to 15% of the crown.
	45	Dead branches and bare twigs present in 16 to 25% of the crown.
	50	Dead branches and bare twigs present in 26 to 37% of the crown.
	55	Dead branches and bare twigs present in 38 to 50% of the crown.
	60	Dead branches and bare twigs present in 51 to 75% of the crown.
	65	Dead branches and bare twigs present in 76% or more of the crown.
	70	More than 50% of the crown dead. Only small adventitious branches present, usually at the base of the crown or stem.
	08	Tree died since last assessment. Specify the probable cause of death in the remarks column.
	09	Dead tree. All dead trees recorded as class 08 or 09 at the last annual assessment should be recorded as class 09. Record any change in the physical status of the tree (e.g., fell down, removed, etc.) in the remarks column.



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Conifer Crown Classification System

Conifers (except larches) are classified according to the amount of defoliation in the crown. Defoliation is defined as foliage missing, for whatever reason, from the "normal" foliage complement of the tree species. Consider bare and dead tops as defoliated. Refer to Appendix 2 for diagrams illustrating the crown perimeter.

Record the conifer crown condition using the following codes:

01 No defoliation.
02 Only current foliage defoliated. Defoliation less than 25%.
03 Current and/or some older foliage defoliated. Defoliation less than 25%.
04 25-50% defoliation.
05 51-75% defoliation.
06 76-90% defoliation.
07 More than 90% defoliation.
08 Tree died since last assessment. Specify the probable cause of death in the remarks column.
09 Dead tree. All dead trees recorded as class 08 or 09 at the last annual assessment should be recorded as class 09. Record any change in the physical status of the tree (e.g., fell down, removed, etc.) in the remarks column.

Conifer 1/3: (conifer crown damage assessment by thirds) (columns 42U - 42L)	All living numbered conifers must be assessed for crown damage. This assessment differs from the information recorded in columns 41-42 in that crown damage is considered rather than just defoliation. For hardwoods and larches, draw a line through columns 42U to 42L.

Determine Base of Live Crown (refer to Form 3 columns 60-62)

Determine the base of the live crown as the horizontal line at the bottom of the living productive foliage of the lowest qualifying branch. The lowest qualifying branch need not be a complete whorl of branches. Epicormic shoots and straggler branches, which usually do not contribute much to tree health, should be excluded. Only branches that support living productive foliage should be considered. Recently defoliated branches that currently have no foliage but are expected to recover should be included. Defoliated branches that are not expected to recover should not be included.

When there are significant gaps in the crown (greater than 2 m vertical height), decide if the lower disjoined branches contribute to the health of the tree. For example, a 5 m crown followed by a 2 m gap followed by 3 m of healthy lower branches should be measured from the lowest foliage of the lower 3 m of healthy branches. If the same tree supported only one whorl of unhealthy branches below the 2 m gap, however, the lower whorl would not be included (Figure 10D). A tree with a 5 m crown followed by a 1 m gap followed by one whorl of unhealthy branches, be measured at the lower whorl of branches below the gap because the gap is less than 2 m (Figure 10C). Where branches extend down only one side of a tree, the living foliage of the lowest qualifying branch on that side will form the base of the live crown (Figure 10B). Do not average the two sides of a tree with uneven crown bases.

Divide Crown into Thirds

Locate the highest point of the tree regardless of whether it is alive or dead. Divide the crown into three vertical sections of equal length from the base of the live crown to the top of the tree (Figure 10).

Do not divide the crown into thirds for trees with total crown lengths of less than 3 m. Instead, assess the entire crown for damage, record the damage in column 42U and draw a line through columns 42M and 42L.

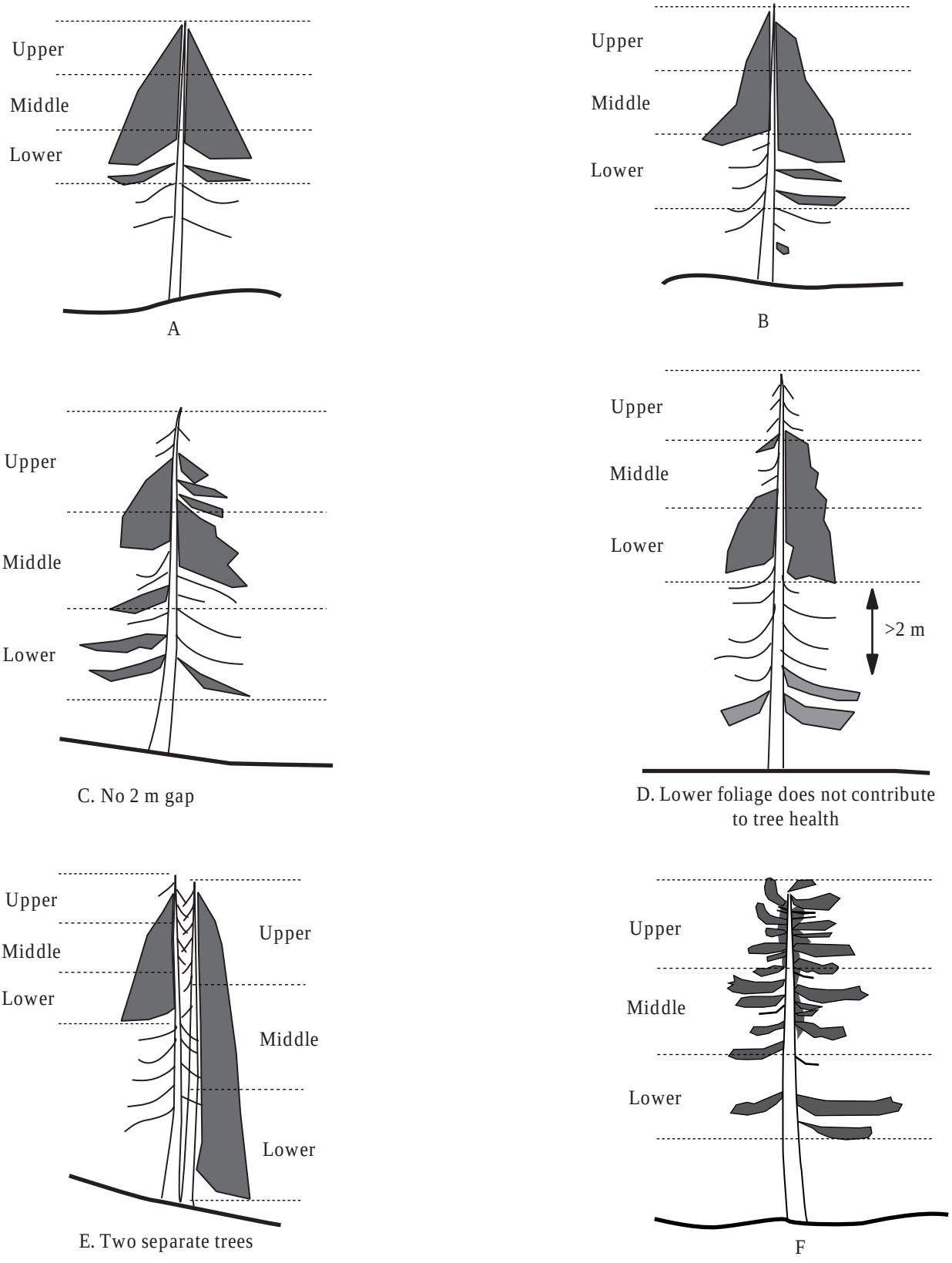

Figure 10. Conifer crown thirds.

Assess Crown Damage

Visually assess damage in each third of the crown, starting with the upper third. Consider the inner and outer crown using the information presented in Appendix 2 as a guideline for determining the crown perimeter. Repeat the procedure for the middle and lower thirds. Record the percentage crown damage for the upper, middle, and lower thirds in columns 42U, 42M, and 42L, respectively, using the following codes:

0	No visible damage
T	1-5% (trace)
1	6-15%
2	16-25%
3	26-35%
4	36-45%
5	46-55%
6	56-65%
7	66-75%
8	76-85%
9	86-100%
-	Cannot see section to rate damage

Definition of Damage Guidelines

Damaged areas should include those parts of the crown that have been impacted by agents to the extent that the vigour of the tree has been reduced. Use your professional judgement and note any unusual conditions in the remarks column. Include other agents as appropriate, but always include:

- dead twigs, dead branches, and dead tops;
- missing foliage — consider the oldest 2 years of foliage to be half as important as missing newer foliage (i.e., a spruce tree missing 6 and 7 year old foliage is 6% defoliated rather than 12.5% defoliated);
- foliage damaged/diseased to the extent that it is not productive (e.g., red flagging); and
- witches'-broom, mistletoe.

Bare top length (columns 43-44):

For hardwoods, visually estimate the length of top dieback (branches/twigs not supporting living foliage). Do not estimate the length of the entire bare branch (Figure 11).

For conifers, visually estimate the continuous length (from the top down) of the main stem not supporting living foliage (Figure 7b). When a conifer has more than one main stem, assess the stem with the least bare top and note in the remarks column the condition of the other stem(s) if radically different from the assessed stem. (Treat larch as a conifer.)

Estimate the bare top length to the nearest 0.5 m and record as a two-digit number with the decimal implied by shaded column 44, e.g., 1.5 m would be recorded as 15. Bare tops greater than 9.5 m should be recorded as 99. If you cannot see the top of the tree, do not enter 00; instead, draw a line through columns 43-44.

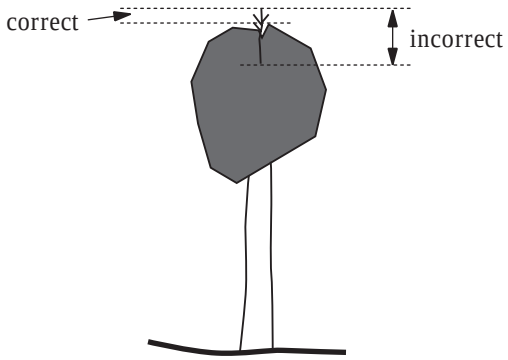

Figure 11. Bare top length measurements.

Needle retention (column 45):

Assess needle retention for all conifers except larches, cedars, and junipers. If possible, at least 30 trees should be assessed for each species in each plot. Assessing additional trees is optional. Needle retention is defined as the age of the oldest internode with at least 25% of the needles present.

The internodes can be discontinuously foliated. For example, a shoot with 50% of its current year's needles, 0% of its 1 year old needles, 40% of its 2 year old needles, and no older needles would be recorded as code 2, not code 0.

Use binoculars to examine the exposed portion of middle to upper crown branches. At several locations in the crown, determine the age of the oldest internode supporting at least 25% of its needles. The current year's shoots are considered to be age 0, the previous year's elongation age 1, and so on. Consider foliage loss for whatever reason (insect defoliation, excessive flowering, etc.). When estimating 25% needle retention, take care to consider species morphology in that some species do not support needles over the entire length of each year's shoot (e.g., eastern white pine). Record the age of the oldest shoots supporting at least 25% foliage using the following codes:

0	current year's foliage only
1	1 year old
2	2 years old
3	3 years old
4	4 years old
5	5 years old or older
-	Not applicable (hardwoods, larches, junipers, and cedars) or unable to assess (canopy too dense to see into the middle or upper crown)

Storm damage (column 46):

Consider only new physical damage that has occurred since the last assessment. Visually assess the damage over the tree's entire living crown and consider new damage to the living main stem or damage to branches or twigs **that constitutes at least 5% of the tree's live crown**. (In cases where the damage occurs in different locations within the crown, sum the areas damaged and determine if the total is greater than 5%). Record the most serious damage if more than one part of the tree has been damaged (i.e., main stem > branches > twigs > foliage). Do not consider damage to dead areas of the crown, such as a dead top or a dead branch that has broken off. Record the damage using the following codes:

0 No new damage since the last assessment
1 Foliage component damaged
2 Live twigs broken
3 Live branch(es) other than main branches broken
4 Live main branch(es) broken or severely cracked
5 Live portion of main stem broken or severely cracked
8 Other (specify in remarks column)
9 Not applicable

Current foliage missing (column 47):

Based on an examination of the foliage of hardwoods or current shoots of conifers, visually estimate the amount of foliage missing at several locations in the live crown. Consider current defoliation regardless of the causal agent. Treat larch as a hardwood. Use "-" (not applicable) for cedars and junipers. Record current foliage missing using the following codes:

0 None missing
T 1-5% (trace)
1 6-15%
2 16-25%
3 26-35%
4 36-45%
5 46-55%
6 56-65%
7 66-75%
8 76-85%
9 86-100%
- Not applicable

Abiotic foliage symptoms (columns 48-51):

This section is reserved for recording discolouration and other symptoms of unknown (abiotic) origin. Symptoms caused by or attributable to insects and/or diseases (fungi) should be recorded in columns 57-60. Record abiotic damage of known origin as a disease (columns 59-60).

Using binoculars, inspect the tree and record one or two conditions if present. If possible, record the suspected causal agent in the remarks column. Record abiotic foliage symptoms using the codes listed below; symptoms not listed should be recorded as "99" and described in the remarks column.

00 Green (normal) — no undetermined abiotic symptoms
85 Chlorotic (yellow green)
86 Yellow (current foliage)
87 Chlorotic yellow (old foliage) (for tree assessment only)
88 Mottled (yellow, brown, or red spots)
89 Marginal tip or edge discolouration (brown, red, or yellow)
90 Needle banding of all needles per fascicle
91 Needle banding of some needles per fascicle
92 Spotted — dead areas on leaves or needles
93 Interveinal discolouration
94 Entire needle or leaf red or brown
95 Needle tips dead and broken off at same length per fascicle
96 Needles or leaves on entire shoot or branch red or brown
99 Other (describe in remarks column)

Level (column 65):

Record the amount of foliage affected by all disorders listed under abiotic foliage symptoms (columns 48-51) using the following codes:

0	None affected
T	1-5% (trace)
1	6-15%
2	16-25%
3	26-35%
4	36-45%
5	46-55%
6	56-65%
7	66-75%
8	76-85%
9	86-100%

Seed (cone) production (column 56):

The season to observe this parameter will depend on the tree species involved. Observations should be made during the plot visit most suitable for each species. Estimate and record seed (cone) production for dominant and codominant trees only using the following codes:

0	No cones or seeds
1	Very light
2	Light
3	Medium
4	Heavy
-	Not applicable

Forest pest conditions (columns 57-63, 66-72):

Insects and diseases on plot trees are assessed only in a general manner because there should be no destructive sampling within plot boundaries.

Identify only the most common insect and the most common disease by the type (group) of effect caused and the overall damage category. If the organism can be identified in the field, record the name (preferably the scientific name) in the remarks column. When two or more organisms are equally common, record the name of the organism responsible for the most damage.

The foliar and woody parts of the tree are assessed independently. “Damage” is rated in general terms. This assessment may be carried out by staggering the observations over the field season according to the life cycle of the different major groups of organisms.

Foliar damage is classified according to the type of insect or disease that caused the damage and by the amount of damage sustained. Abiotic foliar damage is classified as a disease if the cause is known (e.g., climatic factors, physical damage, animal damage, etc.) and as a symptom (in columns 48 to 51) if the cause is unknown.

Woody tissue damage is classified according to the agent (insect or disease) responsible and the location of the damage. Abiotic woody tissue damage resulting from wind, hail, animals, etc. is classified separately based on the level and location of the damage.

Type of foliar insects (column 57):

Identify the most common insect present (or that which has caused identifiable "damage") on foliage, buds, or current shoots. When two or more organisms are equally common, identify the organism responsible for the most damage. Record this type of foliar insect in column 57 using the codes listed below. Record the name of the other organism in the remarks column.

0 None recorded
1 Free-feeding defoliator (e.g., spruce budworm, western hemlock looper, forest tent caterpillar, etc.)
2 Leaf roller, leaf miner, leaf skeletonizer, needleminer (e.g., maple leaf roller, birch leaf miner, birch skeletonizer, lodgepole needleminer, etc.)
3 Tent or nestmaker (e.g., eastern tent caterpillar, spruce web-spinning sawfly, etc.)
4 Budminer, shootminer (e.g., hard maple budminer, balsam shoot-boring sawfly, etc.)
5 Gallmaker (e.g., balsam gall midge, maple bladder gall, etc.)
6 Sucking insects (woolly alder aphid, balsam twig aphid, etc.)
8 Other — specify in remarks column

Level of foliar damage caused by insects (column 58):

Assess the overall foliar damage caused by insects. When more than one insect species is present, assess the damage caused by all species combined even though only the most damaging species has been recorded in column 57. Record the level of damage using the following codes:

0 No visible damage
T 1-5% (trace)
1 6-15%
2 16-25%
3 26-35%
4 36-45%
5 46-55%
6 56-65%
7 66-75%
8 76-85%
9 86-100%

Type of foliar diseases (column 59):

Identify the most common disease present (or that which has caused identifiable "damage"). When two or more diseases are equally common, identify the disease responsible for the most damage. Record this type of foliar disease in column 59 using the codes listed below. Record the name of the other disease in the remarks column.

0 None recorded
1 Needle rust, leaf rust
2 Needle cast
3 Needle blight, leaf blight
4 Leaf spot
5 Anthracnose
6 Leaf blisters
7 Physical damage (e.g., wind, hail, frost, etc.)
8 Other — specify in remarks column

Level of foliar damage caused by diseases (column 60):

Assess the overall foliar damage caused by diseases. When more than one disease is present, assess the damage caused by all diseases combined even though only the most damaging disease has been recorded in column 59. Record the level of damage using the following codes:

0	No visible damage
T	1-5% (trace)
1	6-15%
2	16-25%
3	26-35%
4	36-45%
5	46-55%
6	56-65%
7	66-75%
8	76-85%
9	86-100%

Type of woody tissue insect (column 61):

Identify the insect likely to damage the health of the tree to the greatest extent (e.g., the eastern larch beetle would probably kill a tree long before appreciable damage would be caused by the larch shoot moth, even if the latter is more common). Record the type of woody tissue insect present using the following codes:

0	None recorded
1	Sucking insect (e.g., balsam woolly adelgid, beech scale, etc.)
2	Gallmaker (e.g., pine gall weevil, gouty oak gall wasp, etc.)
3	Tip borer, shoot borer (white pine weevil, larch shoot moth, etc.)
4	Bark beetles (mountain pine beetle, spruce beetle, etc.)
5	Wood-boring insects (white-spotted sawyer, blue horntail, etc.)
6	Root and root collar insects (root collar weevil, clay-coloured root weevil, etc.)
8	Other — specify in remarks column

Location of damage caused by woody tissue insects (column 66):

This is the location on the tree where woody tissue damage was caused by the type of insect listed in column 61. If more than one area of the tree is damaged and a code is not defined for the combination of areas, indicate where the most significant damage has occurred in terms of its effect on the future health of the tree. Record the location of the damage using the following codes:

0	No visible damage
1	Crown stem — the main trunk or bole within the crown
2	Upper bole — the upper half of the trunk between the roots and the crown
3	Lower bole — the lower half of the trunk between the roots and the crown
4	Roots (exposed) and stump (up to 25 cm in height)
5	Whole trunk — includes codes 1 to 3
6	Branches and twigs — woody stems other than main stem(s)
7	Shoots and buds — current year’s growth only
8	Whole crown — includes codes 6 and 7
9	Other — specify in remarks column

Type of woody tissue disease (column 63):

Identify the disease likely to damage the health of the tree to the greatest extent (e.g., root rot would probably kill a tree before witches'- broom, which reduces growth). Record the type of woody tissue disease present using the following codes:

0 None recorded
1 Stem and branch rust (e.g., Cronartium, etc.)
2 Stem canker (e.g., Atropellis, Hypoxylon, Nectria, etc.)
4 Twig canker, branch canker (e.g., Cytospora, Scleroderris, etc.)
5 Witches'-broom, mistletoe
6 Stem decay fungi
7 Root rot (e.g., Armillaria, Poria, Polyporus tomentosus, etc.)
8 Other — specify in remarks column (e.g., Sirococcus shoot blight)

Location of damage caused by woody tissue diseases (column 68):

This is the location on the tree where woody tissue damage was caused by the type of disease listed in column 63. If more than one area of the tree is damaged and a code is not defined for the combination of areas, indicate where the most significant damage has occurred in terms of its effect on the future health of the tree. Record the location of the damage using the following codes:

0 No visible damage
1 Crown stem — the main trunk or bole within the crown
2 Upper bole — the upper half of the trunk between the roots and the crown
3 Lower bole — the lower half of the trunk between the roots and the crown
4 Roots (exposed) and stump (up to 25 cm in height)
5 Whole trunk — includes codes 1 to 3
6 Branches and twigs — woody stems other than main stem(s)
7 Shoots and buds — current year's growth only
8 Whole crown — includes codes 6 and 7
9 Other — specify in remarks column

Types of other damaging agents (column 70):

Identify other (noninsect, nonfungi disease) agents likely to have damaged the health of the tree. When more than one agent is involved, select the one responsible for causing the most damage. Record the type of damaging agent using the following codes:

0 None recorded
1 Animal
2 Snow
3 Ice
4 Hail
5 Wind
6 Frost
7 Mechanical damage (e.g., whipping, etc.)
8 Other — specify in remarks column

Location of damage caused by other agents (column 71):

This is the location on the tree where damage was caused by the type of agent listed in column 70. If more than one area of the tree is damaged and a code is not defined for the combination of areas, indicate where the most significant damage has occurred in terms of its effect on the future health of the tree. Record the location of the damage using the following codes:

0	No visible damage
1	Crown stem — the main trunk or bole within the crown
2	Upper bole — the upper half of the trunk between the roots and the crown
3	Lower bole — the lower half of the trunk between the roots and the crown
4	Roots (exposed) and stump (up to 25 cm in height)
5	Whole trunk — includes codes 1 to 3
6	Branches and twigs — woody stems other than main stem(s)
7	Shoots and buds — current year's growth only
8	Whole crown — includes codes 6 and 7
9	Other — specify in remarks column

Level of woody tissue damage caused by other agents (column 72):

Assess the overall woody tissue damage caused by other agents. When more than one agent is present, assess the damage caused by all agents combined even though only the most damaging agent has been recorded in column 70. Record the level of damage using the following codes:

0	No visible damage
T	1-5% (trace)
1	6-15%
2	16-25%
3	26-35%
4	36-45%
5	46-55%
6	56-65%
7	66-75%
8	76-85%
9	86-100%
-	Not applicable

Remarks:

Use this column as needed to record observations such as hardwood leaves smaller than normal, the identity of insects or diseases (use scientific names if known), or additional information not covered under the various codes.

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ARNEWS Form 5: Regeneration and Sapling Survey

The regeneration and sapling survey is a biennial on-plot procedure conducted during even-numbered years (1994, 1996, etc.).

Regeneration surveys are conducted on the subplots. Only plants whose point of origin lies within the subplot boundaries should be included in the survey. These same subplots are used for the ground vegetation survey, as well as repeat measurements in future years, so it is important to avoid trampling on the plants. Treat each subplot separately, completing one Form 5 for each. Do not combine the totals from the four subplots on one Form 5. If, for some reason, it becomes necessary to discontinue surveying a subplot and that subplot is replaced with a new one, use the next available two-digit number to identify the new subplot. Never reuse a subplot number.

Regeneration is defined as seedlings that are 16 to 200 cm tall with a DBH of less than 10 cm. Record only species that have the potential to grow to tree size in the region. Do not consider seedlings of shrub species as regeneration (record as ground vegetation on Form 6). Seedlings less than 16 cm tall are not considered because their numbers are too variable from year to year to be useful in monitoring surveys.

Seedlings are tallied by species within 20 cm height classes (with the exception of the 156-200 cm height class). It is permissible to use dot tally or similar tally systems on the form when carrying out the assessment, but the numerical count must be written on the form for each tree species in the spaces provided. If a tally system is used, the recommended method is to utilize two lines per species. While counting, record the tally symbols on the first line. When finished, record the actual figures on the second line. Only the actual figures will be entered into the ARNEWS data base for analysis.

Saplings are defined as younger trees greater than 2 m tall with a DBH of less than 10 cm. There is no need to record the DBH or height of saplings. Count the number of living saplings by species on the subplot and enter the total in the appropriate column.

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FIDS | RIMA

REGENERATION AND SAMPLING SURVEY (Biennial)

RELEVÉ DE LA RÉGÉNÉRATION ET DES GAULES (Bi-annuel)

ARNEWS DNARPA 5

Assessment type / Type d'évaluation: 0 5 (1 2)

Plot No. / N° de la parcelle: (3 4 5)

Assessment Date / Date de l'évaluation: (20 21 22 23 24 25)

Subplot No. / N° de la sous-parcelle: (26 27)

Location/Localisation

Assessed by/Évaluation faite par

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Tree Spec. Essence			Height Classes (cm)/Classe de hauteur														Total Regen. Régénér. totale			Total Sapling Total des gaules			Remarks/Remarques
			16-35		36-55		56-75		76-95		96-115		116-135		136-155		156-200							
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	

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Forest Insect and Disease Survey (FIDS) | Relevé des insectes et des maladies des arbres (RIMA) RES 1237 (94-01)

ARNEWS Form 5: Regeneration and Sapling Survey

Assessment type (columns 1-2):	ARNEWS form number expressed as two characters, e.g., 05 signifies Form 5 (Regeneration and Sapling Survey).
Plot number (columns 3-5):	Single-digit region designation followed by a two-digit plot number, e.g., 305 (Quebec Region plot number 5).
Assessment date (columns 20-25):	Six-digit number denoting year/month/day, e.g., 7 September 1985 would be recorded as 850907.
Subplot number (columns 26-27):	Enter as a two-digit number, e.g., subplot 3 would be recorded as 03.
Location:	Provide a brief description of the plot location.
Assessed by:	Provide name(s) of individual(s) conducting the work.
Page _ of _:	Complete after the last subplot has been assessed to assist in form handling.
Tree species (columns 37-39):	Use standard three-digit FIDS tree species designation, e.g., balsam fir would be recorded as 003. Refer to Appendix 1 for the codes used by FIDS to designate tree species.
Height classes (columns 40-55):	Regardless of the tally system used, the number of seedlings in each height class for each tree species present in the subplot should be recorded as a two-digit number in the appropriate column. When there is no regeneration for a height class, record 00 in the columns.
Total regeneration (columns 56-58):	Three-digit number denoting the total number of seedlings per species present in the subplot. If there are saplings but no seedlings present for a species, record total regeneration as 000.
Total saplings (columns 59-61):	Three-digit number denoting the total number of saplings per species present in the subplot. If there are seedlings but no saplings present for a species, record total saplings as 000.
Remarks:	Complete as appropriate.

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ARNEWS Form 6: Ground Vegetation Survey

The ground vegetation survey is biennial on-plot procedure conducted during even-numbered years (1994, 1996, etc.). Both species diversity and changes in composition over time are analyzed.

Ground vegetation surveys are conducted on the subplots. Ground vegetation leaning into the subplot is included in the survey even though its point of origin may lie outside the subplot. These same subplots are used for the regeneration and sapling survey, as well as repeat measurements in future years, so it is important to avoid trampling on the plants. Treat each subplot separately, completing one Form 6 for each. Do not combine the totals from the four subplots on one Form 6. If, for some reason, it becomes necessary to discontinue surveying a subplot and that subplot is replaced with a new one, use the next available two-digit number to identify the new subplot. Never reuse a subplot number.

Completion of Form 6 involves classifying ground vegetation into broad types (mandatory) and estimating the percentage of the subplot covered by each type (mandatory). The ground vegetation can be further classified into families, genera, or species (optional). Identification of ground vegetation to the species level is desirable. Complete Form 6 in the following manner:

1) Classify the ground vegetation into broad types (i.e., mosses, ferns, herbs, etc.) The common names of some types of ground have been preprinted on Form 6; other types can be written on the form as indicated. All ground vegetation must be classified.
2) Optionally, identify the ground vegetation to the family, genus, or species level where appropriate. Use the space below the type names, or additional forms if required, to record all species and types present. The use of scientific names is desirable, but unambiguous common names are acceptable.
3) Estimate the percentage of the subplot covered by each ground vegetation type. Ground vegetation may occupy space at different strata in the subplot and overlap. Total coverage can easily exceed 100% because of overlap and different heights. If the ground vegetation has been further identified by family, genus, or species, estimate the percentage of the subplot covered by each level identified if practical. Complete the percent cover column next to the appropriate name (i.e., type, family, genus, or species). As a guideline to estimating percent cover, the surface area of this page is about 1.5% of a subplot's 4 m^2. Divide the subplot into 1 m^2 quadrants if it will help in estimating percent cover.

Use the remarks column as needed to further clarify any identification features or characteristics. The plots will be remeasured in subsequent years and the data analyzed for changes in the vegetative species mix and abundance.

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GROUND VEGETATION SURVEY (Biennial)

RELEVÉ DE LA COUVERTURE VIVANTE (Bi-annuel)

ARNEWS DNARPA 6

FIDS RIMA

Assessment type / Type d'évaluation: 0 6 (1 2)

Plot No. / N° de la parcelle: (3 4 5)

Assessment Date / Date de l'évaluation: (20 21 22 23 24 25)

Subplot No. / N° de la sous-parcelle: (26 27)

Location/Localisation

Assessed by/Évaluation faite par

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Type - Species/Type - Espèces	% Cover Couverture %	Remarks/Remarques
Mosses - Mousses		
Ferns - Fougères		
Herbs - Plantes herbacées		
Shrubs - Arbustes		
Seedlings - Semis (</=0.5 m)		
Bare soil - Sol nu		
Other (tree stems, rocks, lichens, etc.) Autre (troncs d'arbres, roches, lichens, etc.)		

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ARNEWS Form 6: Ground Vegetation Survey

Assessment type (columns 1-2):	ARNEWS form number expressed as two characters, e.g., 06 signifies Form 6 (Ground Vegetation Survey).
Plot number (columns 3-5):	Single-digit region designation followed by a two-digit plot number, e.g., 305 (Quebec Region plot number 5).
Assessment date (columns 20-25):	Six-digit number denoting year/month/day, e.g., 7 September 1985 would be recorded as 850907.
Subplot number (columns 26-27):	Enter as a two-digit number, e.g., subplot 3 would be recorded as 03.
Location:	Provide a brief description of the plot location.
Assessed by:	Provide name(s) of individual(s) conducting the work.
Page _ of _:	Complete after the last subplot has been assessed to assist in form handling.
Type:	Record the presence of the various types of ground vegetation. The types preprinted on the form are only guidelines; other types can be added as indicated. Optionally, identify families, genera, or species in association with the ground vegetation types if possible. Use of scientific names is desirable (refer to Appendix 1 for the correct spelling of common shrubs). Group on a line below the type name as appropriate; use additional forms if required.
Percent cover:	Estimate the percentage of the subplot covered by each ground vegetation type. Types may overlap or occupy space at different heights, so total coverage may exceed 100%. Estimate percent cover and round off as appropriate. If families, genera, or species have been identified, estimate the percentage of the subplot covered by each level identified if possible.
Remarks:	Complete as appropriate.

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ARNEWS Form 7: Softwood Shoot Data

True Firs, Pines, Spruces, Larches, Douglas-fir, Hemlocks

Form 7 is completed every 5 years. This assessment of off-plot trees is conducted at the same time as Foliage Sampling and Analysis (ARNEWS assessment 11) and Increment Cores and Growth Ring Analysis (ARNEWS Form 12). Do not assess the shoots of cedars or junipers.

Because of the long-term nature of the ARNEWS study, no destructive sampling is carried out on trees within the 10 m by 40 m plot boundaries. Parameters that require destructive sampling are measured on off-plot trees. ARNEWS Form 7 requires destructive sampling in that branches must be cut from the crown. Ten numbered off-plot trees plus seven unnumbered random trees per major species are assessed for shoot length and foliage retention. (Refer to page P/3 for off-plot tree selection guidelines.)

Numbered Off-plot Trees:

From each of the 10 numbered off-plot trees selected, cut one mid-crown branch long enough to include 8 years of growth. Conifers should be sampled during the dormant season except for larch, which should be sampled late in the growing season.

Random Off-plot Trees

From each of the seven unnumbered off-plot dominant/codominant conifers selected, cut two branches. Keep track of which of the seven trees these branches were obtained from and record them as tree numbers T001 to T007 on ARNEWS Form 7 utilizing one line per branch, repeating the tree number (T001 to T007) and species for the second branch from each tree. There is no need to permanently identify the trees. Do not average values from the two branches.

In all, the sample should consist of 24 branches for each conifer species, 10 from numbered off-plot trees and 14 from seven randomly selected off-plot trees.

Relationship with ARNEWS Assessment 11 (Foliage Sampling and Analysis)

Preferably, the single branch cut from each of the 10 numbered off-plot trees should be used to provide foliage for ARNEWS assessment 11. Keep each tree's foliage separate. If there is not enough foliage from the single branch for the assessment, do not supplement with foliage from other trees and *do not* cut any more branches. In these cases, random unnumbered off-plot trees should be used to provide foliage for ARNEWS Assessment 11 because any number of branches may be cut from random trees. *Never* mix foliage from more than one tree.

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SOFTWOOD SHOOT DATA
(Five year assessment)

DONNÉES SUR LES POUSSES DE RÉSINEUX
(Évaluation quinquennale)

ARNEWS DNARPA **7**

Assessment type / Type d'évaluation: 0 | 7 (1 2)

Plot No. / N° de la parcelle: (3 4 5)

Assessment Date / Date de l'évaluation: (20 21 22 23 24 25)

Location/Localisation

Assessed by/Évaluation faite par

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Tree Number / Numéro de l'arbre				Tree Spec. / Essence			Branch/Branche	Current / Actuelle				1 Year old / 1 an passé				2 Year old / 2 ans passés				3 Year old / 3 ans passés				4 Year old / 4 ans passés				5 Year old / 5 ans passés				6 Year old / 6 ans passés				7 Year old / 7 ans passés				Remarks/Remarques
								Defoliation / Défoliation			Shoot Length / Longueur de la pousse	Defoliation / Défoliation			Shoot Length / Longueur de la pousse	Defoliation / Défoliation			Shoot Length / Longueur de la pousse	Defoliation / Défoliation			Shoot Length / Longueur de la pousse	Defoliation / Défoliation			Shoot Length / Longueur de la pousse	Defoliation / Défoliation			Shoot Length / Longueur de la pousse	Defoliation / Défoliation			Shoot Length / Longueur de la pousse	Defoliation / Défoliation			Shoot Length / Longueur de la pousse	
33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	

Forest Insect and Disease Survey (FIDS) | Relevé des insectes et des maladies des arbres (RIMA) RES 1258 (94-03)

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ARNEWS Form 7: Softwood Shoot Data

Assessment type (columns 1-2):	ARNEWS form number expressed as two characters, e.g., 07 signifies Form 7 (Softwood Shoot Data.)
Plot number (columns 3-5):	Single-digit region designation followed by a two-digit plot number, e.g., 305 (Quebec Region plot number 5).
Assessment date (columns 20-25):	Six-digit number denoting year/month/day, e.g., 7 September 1985 would be recorded as 850907.
Location:	Provide a brief description of the plot location.
Assessed by:	Provide name(s) of individual(s) conducting the work.
Page _ of _:	Complete after the last tree has been assessed to assist in form handling.
Tree number (columns 33-36):	Record as four characters, e.g., tree 8 would be recorded as X008. For the seven random off-plot trees (unnumbered), use tree numbers T001 to T007 to indicate temporary trees that will not necessarily be resampled in future years.
Tree species (columns 37-39):	Use standard three-digit FIDS species designation, e.g., balsam fir would be recorded as 003. Refer to Appendix 1 for the codes used by FIDS to designate tree species.
Branch number (column 40):	Enter 1 for the first branch assessed for the tree 2 for the second branch assessed for the tree
Shoot age:	Each shoot age class on the main branch is assessed separately and observations are recorded in the appropriate column. A total of eight shoot age classes can be rated. Assessments are to be carried back from the current shoot only as far as the accuracy of observations justifies. For older shoots that cannot be accurately assessed, draw a line through the appropriate columns to indicate that these shoot age classes were not rated. “Current” refers to growth that occurred during the year of assessment, development completed, and terminal buds formed.
Shoot length (columns 42-44, etc.):	Measure from the middle of the scales at the start of the internode to the middle of the scales at the start of the next internode and record to the nearest 0.1 cm as a three-digit number, e.g., 7.9 cm would be recorded as 079. If the shoot originated from a side terminal, internodal, or epicormic bud, this should be noted in the remarks column. Measure shoot length for as many years as possible even if defoliation assessments cannot be made.

Defoliation (columns 41, etc.):

Estimate the percentage of foliage missing for each shoot age class for as many years as possible. Record defoliation using the following codes:

0	No visible defoliation
T	1-5% (trace)
1	6-15%
2	16-25%
3	26-35%
4	36-45%
5	46-55%
6	56-65%
7	66-75%
8	76-85%
9	86-100%
-	Not applicable

Do not assess larches for defoliation.

Remarks:

Complete as appropriate to record comments about the branch or shoot.

ARNEWS Form 8: Pest Condition Assessment

This procedure should be repeated several times during each growing season if possible.

Biomonitoring is included in the mandate of the ARNEWS network. This includes monitoring forest pest populations, fluctuations in the populations, and the appearance of “new” or the disappearance of “old” species. In addition, the system retains its ability to provide explanations for changes in tree conditions that may be the result of pest activity.

Form 8 is used to record specific information on pests and abiotic conditions present on the plot at the time of the assessment. Standard assessment techniques are used to establish the level of pest populations and the damage sustained. Other forms (e.g., Form 4) assess pests in general terms and do not replace the quantitative nature of Form 8, nor do on-plot assessments allow for destructive sampling so that specimens can be forwarded to the laboratory.

Ideally, pest condition assessments should be conducted several times a year to allow for seasonal variations. Pest conditions *must* be assessed at least once a year at the time of detailed plot assessments. If several assessments are made during the year, a combined list may be produced or a selection of “appropriate” entries indicated before submission for data input (refer to “documentation” below).

Method: All insects, diseases, and abiotic conditions detected on the plot during a predetermined time period (60 - 90 min) are assessed, using a prescribed set of quantitative assessment techniques, and recorded on Form 8. Although preference is given to the most obvious and most damaging organisms present, *observations should not be limited to these*. The time period should not be extended and no extraordinary effort expended to find obscure organisms. To maintain the integrity of plot trees, sampling should be restricted to unnumbered off-plot trees that are representative of the plot trees.

NOTE: ALL DESTRUCTIVE SAMPLING MUST BE PERFORMED ON *RANDOM UNNUMBERED* OFF-PLOT TREES!

Documentation: Information on all insects and diseases found on all tree species (or on “ground vegetation”) should be recorded on the same form during any one visit. When the same pest is recorded more than once in a given year (i.e., during two or more visits), only the most serious, highest level is entered into the data base (e.g., the level of needle rust infection will change depending on the time of the assessment). All ARNEWS Form 8s completed in a given year should be submitted for data entry only once each year AFTER the above selection in the Region.

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PEST CONDITION ASSESSMENT (Seasonal)

SITUATION DES RAVAGEURS (Saisonnier)

ARNEWS DNARPA 8

Assessment type / Type d'évaluation: 0 8 (1 2)

Plot No. / N° de la parcelle: (3 4 5)

Assessment Date / Date de l'évaluation: (20 21 22 23 24 25)

Location/Localisation

Assessed by/Évaluation faite par

Survey Time/Durée de l'évaluation

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Insect or Disease / Insecte pathogène	Host tree species / Essence hôte			Type	Part/Partie	Collection No. / N° de collecte; Lab. No. / N° de laboratoire	Count Type / Type de dénombrement		Counts, Remarks / Dénombrement, remarques	Calculated from counts / Calculé selon le dénombrement			Ocular est. / Est. oculaire; Damages / Dommages; Incidence (%)			
	37	38	39	40	41		42	43		44	45	46	47	48	49	50

Forest Insect and Disease Survey (FIDS) | Relevé des insectes et des maladies des arbres (RIMA) | RES 1259 (94-03)

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SAMPLE FOR LABS ANALYSIS | **ÉCHANTILLONS POUR L'ANALYSE DE LABORATOIRE**

ARNEWS DNARPA **8a**

Assessment type / Type d'évaluation: 8 a (1 2)

Plot Number / Numéro de la parcelle: (3 4 5)

Assessment Date / Date de l'évaluation: Y-A (20 21) M-M (22 23) D-J (24 25)

Location/Localisation

Assessed by/Évaluation faite par

Tree Species / Essence: (37 38 39)

Collection No. from Form 8 / N° de collecte selon le formulaire 8

Problem Description/Description des problèmes

Laboratory Analysis and Identification/Analyse de laboratoire et identification

Forest Insect and Disease Survey (FIDS) | Relevé des insectes et des maladies des arbres (RIMA) RES 1260 (94-03)

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ARNEWS Form 8: Pest Condition Assessment

Assessment type (columns 1-2):	ARNEWS form number expressed as two characters, e.g., 08 signifies Form 8 (Pest Condition Assessment).
Plot number (columns 3-5):	Single-digit region designation followed by a two-digit plot number, e.g., 305 (Quebec Region plot number 5).
Assessment date (columns 20-25):	Six-digit number denoting year/month/day, e.g., 7 September 1985 would be recorded as 850907.
Location:	Provide a brief description of the plot location.
Assessed by:	Provide name(s) of individual(s) conducting the work.
Survey time:	Record the approximate accumulated time taken to conduct the assessment in 5 min intervals. Consider only the time spent by the technical expert (ranger) and not time spent by others (students, assistants, etc.).
Page _ of _:	Complete after the last pest has been assessed to assist in form handling.
Insect or Disease:	Insects, diseases, or abiotic conditions (traditionally handled as diseases within FIDS) are identified and assessed quantitatively during this assessment. Print the scientific name of organisms identified in the field. Legible printing is important to facilitate data input, and proper spelling is essential to avoid “creating” nonexistent organisms. Print a description of the damage sustained or abiotic condition. More than one line may be used to describe a situation, but subsequent information regarding the situation must all be on one line. Once the organism has been identified in the laboratory, record the FIDS catalogue number for that organism in the seven-digit box provided omitting the first digit of the taxonomic code (1 for insects and 2 for diseases). Insert the correct name of the organism if this was not done properly in the field.
Host tree species (columns 37-39):	Use standard three-digit FIDS species designation, e.g., balsam fir would be recorded as 003. Refer to Appendix 1 for the codes used by FIDS to designate tree species. For ground vegetation species not listed in Appendix 1, use code 801 (miscellaneous ground vegetation) and for shrubs use code 802 (miscellaneous shrubs); print the scientific name of the plant in the remarks column.
Pest type (column 40):	Enter 1 for insect 2 for disease or abiotic

Tree part (column 41):

If more than one tree part is affected, record the more important and list the other(s) in the remarks column. Record tree parts using the following codes:

1	Flower and/or fruit
3	Buds
4	Old foliage
5	New foliage
6	New shoot
7	Twig and/or branch
8	Stem
9	Butt
0	Root
2	Other — specify in remarks column

Collection number:

Laboratory procedures for tracking samples should be established by each region. It is vitally important that the results of the laboratory identification be included on ARNEWS Form 8. In most regions, each sample collected for submission is accompanied by a separate ARNEWS Form 8a or a General Survey Form (GSF).

The collection number on Form 8 and the collection number on Form 8a (or the GSF) must be the same. Completing Form 8a is self-explanatory. Under “problem description,” insert any comments that would normally go under “remarks” on the GSF. The “survey type field” on the GSF must be 002 to indicate ARNEWS, and the “collection point field” on the GSF must include ARNEWS plot xxx, where xxx is the ARNEWS plot number.

Lab number:

Laboratory numbers are recorded (in the laboratory) when appropriate to help track specimens, e.g., rearing records, culture numbers, etc.

Count type (columns 42-43):

Choose the appropriate pest assessment technique from those listed on the following pages for coniferous (softwood) species or deciduous (hardwood) species and record the two-digit number. Valid count type codes are as follows:

Softwoods	Hardwoods
01, 02	
03, 04	03, 04
05, 06	05, 06
08	07, 08
09	09
11, 12	11
13, 14	13, 14
15	

Pest Assessment Techniques for Coniferous Trees

01 Needle count — current growth. Count affected over total needles on one side of the current growth of three shoots selected at random from each of three trees. Record individual counts separately.

Calculation: ((a/b + c/d + e/f) + (g/h + i/j + k/l) + (m/n + o/p + q/r)) × 100 = % needles affected
where a/b, c/d, etc. refers to needles affected/total needles of each shoot.

02 Needle counts — noncurrent growth. Count affected over total needles on one side of the noncurrent growth of three shoots selected at random from each of three trees. Record individual counts separately. State growth year counted (e.g., 1992, 1991, 1990, etc. growth).

Calculation: Same as 01.

03 Shoot counts (current growth or 1 year old twigs). Examine 25 shoots of each of three trees and record the number affected over the total for each tree.

Calculation: $\frac{a + b + c}{75} \times 100 = \%$ (where a, b, and c are the counts for each tree).

04 Branch counts — branch tips. Examine three whole branches from each of three trees and record the number affected over the total for each tree.

Calculation: $\frac{a + b + c}{9} \times 100 = \%$ (where a, b, and c are the counts for each tree).

05 Branch counts — whole branch. For conditions not localized on branch tips. Count the number of organisms on three whole branches from each of three trees and estimate the incidence of the organisms.

Calculation: DO NOT CALCULATE. Enter the total number of organisms counted.

06 Tree counts. Examine 25 trees, if possible, of a given species. Tally positive trees over total counted. Note whether trees are being killed and the type (e.g., dominant, suppressed).

Calculation: a/25 × 100 = %.

08 "Stand" defoliation estimates. For some pests, when damage is extensive or the organism is not one of the more important forest pests, a single estimate of the leaf surface affected will suffice.

Calculation: DO NOT CALCULATE. Use ocular estimates column only.

09 Nest counts. Count the number of nests along a 100 m traverse. Note: this method is used for insects such as the uglynest caterpillar. For other nestmakers, such as the fall webworm and orchard tent caterpillar, use assessment technique 04.

Calculation: Enter the number of nests counted.

11 Beating — 2 m × 3 m. Use a 3 m pole to sample ONE side of each of three off-plot trees.

Calculation: $\frac{\text{total number of insects sampled}}{\text{number of trees (3)}}$ = larvae/sheet.

12 Beating — 1 m × 1 m. Use a 1 m pole to sample TWO sides of each of three off-plot trees.

Calculation: $\frac{\text{total number of insects sampled}}{\text{number of trees (6)}}$ = larvae/sheet.

13 Other. Specify and state method used.

14 Broom counts or nest counts. Count and record the number of brooms (nests) found on 25 randomly selected trees.

Calculation: (number of brooms (nests))/25 = brooms (nests)/tree.

15 Cone counts. Examine 25 cones from each of three trees. Record the number affected over the total.

Calculation: $\frac{a + b + c}{75} \times 100$ = % of cones affected.

Pest Assessment Techniques for Deciduous Trees

03 Shoot counts (current growth or 1 year old twigs). Examine 25 shoots of each of three trees and record the number affected over the total for each tree.

Calculation: $\frac{a + b + c}{75} \times 100 = \%$ (where a, b, and c are the counts for each tree).

04 Branch counts — branch tips. Examine three whole branches from each of three trees and record the number affected over the total for each tree.

Calculation: $\frac{a + b + c}{9} \times 100 = \%$ (where a, b, and c are the counts for each tree).

05 Branch counts — whole branch. For conditions not localized on branch tips. Count the number of organisms on three whole branches from each of three trees and estimate the incidence of the organisms.

Calculation: DO NOT CALCULATE. Enter the total number of organisms counted.

06 Tree counts. Examine 25 trees, if possible, of a given species. Tally positive trees over total counted. Note whether trees are being killed and the type (e.g., dominant, suppressed).

Calculation: $a/25 \times 100 = \%$.

07 Foliage counts. Examine 25 leaves selected from mid-crown branch tips of each of three trees. Record the number affected over the total.

Calculation: $\frac{a + b + c}{75} \times 100 = \%$ (where a, b, and c are the counts for each tree).

08 "Stand" defoliation estimates. For some pests, when damage is extensive or the organism is not one of the more important forest pests, a single estimate of the leaf surface affected will suffice.

Calculation: DO NOT CALCULATE. Use ocular estimates column only.

09 Nest counts. Count the number of nests along a 100 m traverse. Note: this method is used for insects such as the uglynest caterpillar. For other nestmakers, such as the fall webworm and orchard tent caterpillar, use assessment technique 04.

Calculation: Enter the number of nests counted.

11 Beating — 2 m × 3 m. Use a 3 m pole to sample ONE side of each of three off-plot trees.

Calculation: $\frac{\text{total number of insects sampled}}{\text{number of trees (3)}} = \text{larvae/sheet}.$

13 Other. Specify and state method used.

14 Broom counts or nest counts. Count and record the number of brooms (nests) found on 25 randomly selected trees.

Calculation: (number of brooms (nests))/25 = brooms (nests)/tree.

Counts, remarks:

Complete as appropriate. Record individual counts determined when applying an assessment technique along with remarks.

Calculated from counts (columns 44-46):

Record calculations from individual counts as appropriate. Although three columns are provided, their use will depend on the assessment technique used. Zero fill to the left (i.e., 12 would be recorded as 012).

Ocular estimate, damage intensity (column 47):

Damage intensity is defined as the level of damage caused by a particular pest on the specific tree part of the host species in question on the plot. Visually estimate the level of damage and record using the following codes:

0	No visible damage
T	1-5% (trace)
1	6-15%
2	16-25%
3	26-35%
4	36-45%
5	46-55%
6	56-65%
7	66-75%
8	76-85%
9	86-100%

Although the trees selected for assessment are “average” for the condition, some of the assessment techniques do not adequately express the situation. For example, a defoliator could feed on all of the leaves in a sample (25/25 count), but the amount of chewing on the leaves could be light. The calculated count would indicate a high level of “damage” even though the plot trees would be mostly green. The ocular estimate in this case, which would be 2 (16-25%), would express the situation better.

Ocular estimate, incidence (columns 48-50):

Visually estimate the percentage of the host species affected on the plot by the particular pest and record as a three-digit number in increments of 10%. Zero fill to the left (i.e., 10% would be recorded as 010).

ARNEWS Assessment 11a (no form required): Soil Description, Sampling, and Analysis

At the time of plot establishment, a detailed description of the soil associated with each ARNEWS plot is prepared and the soils are sampled and analyzed. At 5 year intervals, soils are resampled and analyzed. Ideally, all ARNEWS plots in a given region should be sampled in the same year for both soil and foliage.

The following protocol calls for two levels of investigation: (1) at the time of plot establishment, soils are formally classified according to the Canadian System of Soil Classification to the subgroup level, and sampled following the "Baseline Soil Description and Sampling protocol" and (2) at the time of plot establishment, and at 5 year intervals thereafter, a soil monitoring program is instituted following the "Soil Monitoring protocol."

The principal comparison will be between the same soil over time. It is recommended that all samples be analyzed at the outset, that the samples be stored, and that all samples or a subset be analyzed when future resampling occurs. This procedure should minimize drift from methods, and modulate the impact of new technologies, instrumentation, etc.

Baseline Soil Description and Sampling Protocol

1) Immediately outside each ARNEWS plot, at a site representative of the plot (generally avoiding obvious hummocks and depressions), excavate a pit 1 m by 1 m into the C horizon.
2) When excavating the pit, the contents should be piled carefully (preferably on a sheet) on one side of the pit to avoid contaminating the surrounding area.
3) At the time of initial sampling, a pedon associated with the pit should be described as follows:

   Horizon designation (Canadian terminology)
   Depth (centimetres from H/A interface)
   Colour (Munsell notation, colour name [moist/dry])
   Texture (field approximation followed by laboratory analysis)
   Mottles (matrix/mottle colour, mottle abundance, colour, contrast with matrix)
   Structure (grade/distinctness, class/size, type)
   Consistency (resistance to deformation, degree of cohesion/adhesion)
   Roots (abundance, size, orientation, distribution, depth of penetration)
   Pores (abundance, size, orientation, distribution, depth of penetration)
   Clay films (frequency, thickness, location, colour)
   Horizon boundaries (lower boundary distinctness, form)
   Other features

4) Assign the soil to the appropriate subgroup of the Canadian System of Soil Classification (Canada Soil Survey Committee, Subcommittee on Soil Classification 1987) and, in surveyed areas, to the appropriate map unit.
5) Estimate (from the pit content) the percent (vol./vol.) coarse fragment content (shape and kind, size and name).
6) Before collecting soil samples, photograph the most illustrative face of the pit in colour (include a scale).
7) For both forest floor and mineral horizons, avoid contamination with materials from above and beneath, and compose a single sample of materials from all faces of the pit for each horizon (L, F, H, A, B, C, etc.). To avoid contamination, it may be preferable to collect forest floor (L, F, H) samples before pit excavation from approximately within the (proposed) pit perimeter, and to collect mineral soil samples upward from the bottom of the pit.
8) Collect a sufficient volume of field sample in each instance to yield, when sieved of coarse fragments (>2 mm), about 500 cm^3 of fine earth (<2 mm).
9) Field collections may be placed in plastic bags or other suitable containers. Ensure that each sample is permanently and legibly identified with the following information:

   i) ARNEWS plot number;
   ii) baseline sample;

iii) soil horizon; and
iv) collection date.

10) Following sampling, refill the pits and mark the location permanently using stakes. Sketch the location of the pit and include the sketch on a separate sheet of paper with ARNEWS Form 1.

Soil Monitoring Protocol

Because sampling depends upon the identification of soil horizons, initial soil monitoring sampling should not take place until the horizons have been described. To this extent, at least, the soil monitoring program should be coordinated with the baseline survey.

1) Immediately outside each ARNEWS plot, site five sampling stations, each representative of the plot (generally avoiding obvious hummocks and depressions). Mark permanently with stakes.

2) Randomly, within about a 5 m radius of each stake, use a trowel, soil auger, or other suitable sampling device to obtain samples composed of at least 10 subsamples of the most appropriate or abundant organic horizon and at least five subsamples of the most abundant A and B horizons (NOTE: Avoid contaminating the samples, particularly with materials from above. Also, avoid disturbing the area in general, so as not to invalidate future analyses). It may be necessary to relocate sampling stations in future years.

3) Collect a sufficient volume of field sample in each instance to yield, when sieved of coarse fragments (>2 mm), about 500 cm^3 of fine earth (<2 mm).
4) Field collections may be placed in plastic bags or other suitable containers. Ensure that each sample is permanently and legibly identified with the following information:

i) ARNEWS plot number;
ii) soil monitoring sample;
iii) station number;
iv) soil horizon; and
v) collection date.

Sample Preparation Procedure

NOTE: The following procedure pertains to samples collected under the Baseline Soil Description and Sampling Protocol or the Soil Monitoring Protocol.

1) Following removal to the laboratory, sufficient (about 50 cm^3) subsamples of field-fresh material are set aside for pH and other determinations.
2) The remaining sample is allowed to air-dry. It is then sieved through a 2 mm sieve, the <2 mm (fine earth) fraction is retained, and the remainder is discarded. For L, F, and H horizons, grind the samples in a laboratory cutting mill if the mineral content is sufficiently low (if the mineral content is appreciable, the knife blades could be damaged). If necessary, aggregates of mineral soil should be broken down using a rolling pin.
3) Store samples in 500 cm^3 plastic, glass, or other suitable containers labelled as previously indicated.

Soil Analysis Procedure

NOTE: The following procedure pertains to samples collected under the Baseline Soil Description and Sampling Protocol or the Soil Monitoring protocol.

1) Standards, duplicates, and reagent blanks, including extractants, should be run with every batch or with every 40 samples, whichever is less.
2) Quality assurance of analytical results will be provided by full and continued participation in the Canadian Forest Service Quality Assurance Inter-Laboratory Comparability Program.

3) For forest floor (L, F, H horizons) samples, determine the following:

pH in 0.01 M $CaCl_2$ (field-fresh sample)
Organic matter (loss-on-ignition)
Total N (semi-micro Kjeldahl procedure or equivalent)
Total P, K, Ca, Mg, S, Fe, Mn ($HClO_4$ digest)
Cation exchange capacity (1.0 M NH_4Cl extractant, unbuffered)
Exchangeable K, Ca, Mg, SO_4-S, Fe, Mn, Na, Al (1.0 M NH_4Cl extractant, unbuffered)
Percent base saturation (by summation)

4) For mineral (A, B, C horizons) samples, determine the following:

pH in 0.01 M $CaCl_2$ (field-fresh sample)
Organic matter (loss-on-ignition)
Total N (semi-micro Kjeldahl procedure or equivalent)
Available P (Bray and Kurtz No. 1 extractant)
Cation exchange capacity (1.0 M NH_4Cl extractant, unbuffered)
Exchangeable K, Ca, Mg, SO_4-S, Fe, Mn, Na, Al (1.0 M NH_4Cl extractant, unbuffered)
Percent base saturation (by summation)

5) Any of the following optional analyses can also be carried out:

pH in H_2O (in forest floor or mineral soil)
Organic matter by wet oxidation (in forest floor or mineral soil)
Total B, Zn, Cu, etc. concentrations (in forest floor)
Exchangeable Zn, Cu, etc. concentrations (in forest floor or mineral soil)

6) Analytical results should be reported in the following units:

pH	pH units
Organic matter	Percent
Total N	Percent
Total S	Percent
Total, available P	mg/g
Cation exchange capacity	cmol(+)/kg
Exchangeable cations	cmol(+)/kg
Exchangeable anions	cmol(-)/kg

7) Results of analyses should be reported to the designated staff member at each regional establishment who, in turn, should forward a copy to the ARNEWS Plant/Soil Coordinator.

8) Remaining sample material should be stored in a suitable place at regional establishments for future analysis unless other arrangements have been made.

ARNEWS Assessment 11b (no form required): Foliage Sampling and Analysis

Foliage analysis is an ARNEWS procedure that is repeated at 5 year intervals (unless circumstances dictate otherwise). Ideally, all ARNEWS plots in a given region should be sampled in the same year for both foliage and soil.

The intent of the ARNEWS plant/soil analysis program is to: (1) establish a baseline; (2) measure departures, if any, over time from this baseline; and (3) ascertain, if possible, the causes of these departures. Obscuring any trends, however, may be the natural variability related to species and sites, tree-to-tree and within-tree variability, and season-to-season and within-season variability. In addition, errors may be introduced during sample preparation and analysis. The following procedures are designed to minimize variability and errors.

In brief, the procedure calls for sampling 10 trees of the principal species or, in the case of multispecies stands, 10 trees of each of the two most abundant species on each ARNEWS plot by collecting current leaves from the middle to upper parts of the live crowns of dominant or codominant trees and returning the samples to a laboratory for oven-drying and chemical analysis.

An initial analysis is conducted at the outset. All or a subset of these original samples should be analyzed along with samples collected at 5 year intervals. The chief arguments in favour of reanalysis are: (1) the reduction in methodological error involving machine drift, etc., and (2) the likelihood that new methods and instrumentation will render later analyses more useful. Analyses are carried out at regional establishments or at a central location and the results are collated as described below.

Field Procedure

1) Collect foliage from each of 10 numbered off-plot trees provided that sampling will not induce serious injury to the trees. If sampling to collect the required amount of foliage will seriously injure the trees, use random off-plot trees representative of conditions on the plot. Do not mix foliage from more than one tree.
2) For both coniferous and hardwood species, samples should be whole, well-formed, current-year leaves, preferably from several branchlets representing various sides of the middle to upper part of the live crown of each tree (if it is not possible to reach the middle to upper part of the live crown, the sample location should be recorded).
3) For coniferous species (other than larches), samples should be collected during the dormant season, preferably from late September through early March (depending upon the locality), when element concentrations are most stable.
4) For hardwood species and larches, samples should be collected late in the growing season, but at least 2 weeks before the onset of autumn colouration (this suggests late July to mid-August in most instances).
5) The actual method of procuring samples (e.g., tree climbing, helicopter, pole pruners, shooting, etc.) will vary with local conditions, especially factors such as tree height.
6) For coniferous species, use secateurs to separate current-year leaves and twigs from older leaves and twigs, collecting enough current material to fill (when tamped down) approximately half a 4.5 kg (9 cm × 16 cm × 35 cm) paper bag. Material may come from lateral branches. For hardwood species, collect enough fresh, whole (blade and petiole) leaves to give the same volume. Clip foliage so that it falls directly into the bag with a minimum of handling and staple the bag shut.
7) Ensure that the sample bags are labelled with the following information:

   i) ARNEWS plot number;
   ii) species;
   iii) sample tree number (if a random tree is sampled, identify using the numbers T001 to T010);
   iv) position (if other than middle to upper crown);
   v) collection date; and
   vi) additional notes (e.g., abnormal colouration).

8) If possible, return the samples to a laboratory within 24 h for oven-drying. Otherwise, allow samples to thoroughly air-dry. Normally, this can be achieved by opening the sample bags; placing them in a dry, well-ventilated location; and turning the sample over periodically.

Sample Preparation Procedure

1) Leaving the samples in their original paper bags, oven-dry at 70•C until constant in weight. This procedure normally takes about 24 h in most forced-draught laboratory ovens.
2) Wearing rubber gloves, separate foliage from twigs or other material (for hardwood leaves, ensure that petioles are attached).
3) Grind oven-dried sample to pass a 1 mm (alternatively, 20 mesh) screen using a laboratory cutting mill; retain 15-30 g of the final sample and store away from light in an airtight, 100 mL plastic, glass, or other suitable container. Ensure that the sample number and other identifying information is recorded legibly and permanently on the body of the container (not the lid).

Analytical Procedure

1) Analyses should be carried out in regional laboratories or a central location. For the initial analysis, there should be 10 or 20 samples per plot. For subsequent samplings, all or a subset of samples from the previous sampling should be analyzed as well.
2) Re-dry samples at 70•C immediately before they are analyzed.
3) Standards, duplicates, and reagent blanks should be run with every batch or with every 40 samples, whichever is less.
4) Quality assurance of analytical results will be provided by full and continued participation in the Canadian Forest Service Quality Assurance Inter-Laboratory Comparability Program.
5) Oven-dried samples should be analyzed for concentrations of total N (mg/g), total P (mg/g), total K (mg/g), total Ca (mg/g), total Mg (mg/g), total S (mg/g), total Fe (mg/g), and total Mn (mg/g).
6) If preferred (by regional establishments) additional analyses can also be carried out, e.g., for B, Zn, Cu, Mo, Na, Al, Pb, Ni, and Cd concentrations.
7) Results of analyses should be reported to the designated staff member at each regional establishment who, in turn, should forward a copy to the ARNEWS Plant/Soil Coordinator.
8) Remaining sample material should be stored in a suitable place at regional establishments for future analysis unless other arrangements have been made.

ARNEWS Form 12: Increment Cores and Growth Ring Analysis

This procedure, involving the collection of increment cores from numbered off-plot trees, is repeated at 5 year intervals. Increment cores should be taken from 10 numbered off-plot trees of each major species present on the plot. The same trees will be resampled in future years.

The **first time** a numbered off-plot tree is cored (at the time of plot establishment), a single increment core should be collected from the north-facing side of the tree at breast height. If there are stem abnormalities (e.g., compression wood, scars, etc.) that affect normal radial growth at this height, the sample position should be moved to another face at breast height or up or down the stem to eliminate the effect of the abnormality. Note in the remarks column any change in sampling due to stem abnormalities. The core should be as perpendicular to the tree bole as possible to give accurate ring widths. This first core should extend right to the pith if possible.

The **second time** a tree is cored (at the time of the first 5 year reassessment), the core should again extend to the pith if possible. The second core should be taken from a different face of the tree than the first core.

Subsequent increment cores (at 10 years, 15 years, etc.) should be taken on the opposite face or above or below previous cores as appropriate. These subsequent cores need not extend all the way to the pith, but must be deep enough to include the last 10 years' growth.

All cores should be cemented in corrugated cardboard holders using glue (such as Lepage's Household Cement), labelled, and stored in a freezer to avoid shrinkage. Plastic straws can also be used. Separate containers should be used for each species to avoid confusion.

Ring widths should be measured with an optical device attached to a computer if possible. These devices usually produce a fixed-length ASCII data file that can be added directly to the ARNEWS data base without re-keying the data. The ASCII file must contain the plot number, tree number, tree species, year of the outermost ring, and ring year (labelled for each ring or appropriately indicated for each ring) along with the ring widths. Measurements to the nearest 0.01 mm can be stored. Whether the core entered the pith or not should also be recorded.

Optional

Collect one increment core from on-plot trees that have died in the last 5 years following the procedure for coring a tree for the first time. Record the "year of the most recent ring" as the year the tree died.

Natural Resources Canada | Ressources naturelles Canada

GROWTH RING ANALYSIS (Five year assessment)

ANALYSE DES CERNES (Évaluation quinquennale)

ARNEWS 12
DNARPA

Assessment type / Type d'évaluation: 1 2 (1 2)

Plot Number / Numéro de la parcelle: (3 4 5)

Assessment Date / Date de l'évaluation: (20 21 22 23 24 25)

Tree Species / Essence: (33 34 35)

Tree Number / Numéro de l'arbre: (36 37 38 39)

Plot Location/Localisation de la parcelle

Measured by/Mesuré par

Did Core Enter Pith? / La carotte est-elle rentrée dans la moelle? Y N

Year of most Recent Ring / Année du dernier cerne: (40 41 42 43) = 00 below / = 00 plus bas

Date Measured/Date des mesures

Calendar Year / Année civile	Desig. / Désign.		Width of Ring (mm) / Épaisseur du cerne (mm)				
	44	45	46	47	48	49	

Calendar Year / Année civile	Desig. / Désign.		Width of Ring (mm) / Épaisseur du cerne (mm)				
	44	45	46	47	48	49	

Forest Insect and Disease Survey (FIDS)

Relevé des insectes et des maladies des arbres (RIMA) RES 1261 (94-03)

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ARNEWS Form 12: Increment Cores and Growth Ring Analysis

Assessment type (columns 1-2):	ARNEWS form number expressed as two characters, e.g., 12 signifies Form 12 (Increment Cores and Growth Ring Analysis).
Plot number (columns 3-5):	Single-digit region designation followed by a two-digit plot number, e.g., 305 (Quebec Region plot number 5).
Assessment date (columns 20-25):	Six-digit number denoting year/month/day, e.g., 7 September 1985 would be recorded as 850907.
Tree species (columns 33-35):	Use standard three-digit FIDS species designation, e.g., balsam fir would be recorded as 003. Refer to Appendix 1 for the codes used by FIDS to designate tree species.
Tree number (columns 36-39):	Record as four characters, e.g., tree 8 would be recorded as X008.
Location:	Provide a brief description of the plot location.
Measured by:	Provide name(s) of individual(s) taking measurements.
Date measured:	Six-digit number denoting year/month/day, e.g., 23 November 1985 would be recorded as 851123.
Entered pith:	Circle Y if the core extended to and entered the pith; circle N if it did not.
Year of most recent ring (columns 40-43):	Enter the calendar year of the outermost ring. For living trees, this is the same as the year of collection if the coring took place in the fall or early winter, i.e., after the growing season but before the end of the calendar year. The calendar year would be one year earlier if the increment core was collected in early spring. Record as a four-digit number. The main body of the form need not be completed if computerized equipment is used to measure ring widths and fixed-length ASCII data files are submitted.

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Part III. Appendices

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Appendix 1. Host species codes sorted by Latin (scientific) name

Code	Latin (scientific) name	Common name
001	Abies spp.	fir
002	Abies amabilis (Dougl.) Forbes	Amabilis fir
003	Abies balsamea (L.) Mill.	balsam fir
004	Abies balsamea var. phanerolepis Fern.	bracted balsam fir
005	Abies concolor (Gord. & Glend.) Lindl.	silver fir
006	Abies grandis (Dougl.) Lindl.	grand fir
007	Abies lasiocarpa (Hook.) Nutt.	alpine fir
100	Acer spp.	maple
101	Acer circinatum Pursh	vine maple
114	Acer ginnala Maxim.	ginnala maple
102	Acer glabrum var. douglasii (Hook.) Dipp.	Douglas maple
103	Acer macrophyllum Pursh	broadleaf maple
104	Acer negundo L.	Manitoba maple
105	Acer negundo var. interius (Britt.) Sarg.	inland Manitoba maple
106	Acer nigrum Michx. f.	black maple
107	Acer pensylvanicum L.	striped maple
108	Acer platanoides L.	Norway maple
109	Acer pseudoplantanus L.	sycamore maple
110	Acer rubrum L.	red maple
111	Acer saccharinum L.	silver maple
112	Acer saccharum Marsh.	sugar maple
113	Acer spicatum Lam.	mountain maple
120	Aesculus spp.	buckeye
121	Aesculus carnea Hayne	red horse-chestnut
122	Aesculus hippocastanum	horse-chestnut
126	Ailanthus spp.	tree-of-heaven, Chinese sumac
127	Ailanthus altissima (Mill.) Swingle	Chinese sumac, tree of heaven
130	Alnus spp.	alder
131	Alnus crispa (Ait.) Pursh	green alder
132	Alnus glutinosa (L.) Gaertn.	black alder
133	Alnus incana (L.) Moench	grey alder
134	Alnus rhombifolia Nutt.	white alder
135	Alnus rubra Bong.	red alder
136	Alnus rugosa var. americana (Regel) Fern.	speckled alder
137	Alnus serrulata (Ait.) Willd.	common alder
138	Alnus sinuata (Regel) Rydb.	Sitka alder
139	Alnus tenuifolia Nutt.	mountain alder
510	Amelanchier spp.	serviceberry
511	Amelanchier alnifolia (Nutt.) Nutt.	Saskatoon-berry
512	Amelanchier canadensis (L.) Medic.	serviceberry
150	Arbutus spp.	madrone
151	Arbutus menziesii Pursh	arbutus
535	Arctostaphylos spp.	bearberry
536	Arctostaphylos uva-ursi (L.) Spreng.	common bearberry
341	Aronia arbutifolia (L.) Ell.	red chokecherry
155	Asimina spp.	pawpaws

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Appendix 1 (cont'd)

Code	Latin (scientific) name	Common name
156	*Asimina triloba* (L.) Dunal	pawpaw
010	*Auracaria* spp.	monkey tree
490	*Berberis* spp.	barberry
491	*Berberis thunbergii* DC.	Japanese barberry
492	*Berberis vulgaris* L.	common barberry
160	*Betula* spp.	birch
166	*Betula alleghaniensis* Britton	yellow birch
161	*Betula borealis* Spach	northern birch
162	*Betula caerulea-grandis* Blanch.	blueleaf birch
163	*Betula eastwoodae* Sarg.	Yukon birch
164	*Betula glandulosa* Michx.	dwarf birch
165	*Betula lenta* L.	sweet birch
167	*Betula occidentalis* Hook.	water birch
168	*Betula papyrifera* Marsh.	white birch
169	*Betula papyrifera* var. *commutata* (Reg.) Fern.	western white birch
170	*Betula papyrifera* var. *cordifolia* (Reg.) Fern.	mountain white birch
171	*Betula papyrifera* var. *elobata* (Fern.) Sarg.	Gaspé white birch
172	*Betula papyrifera* var. *humilis* (Reg.) Fern. & Raup	Alaska white birch
173	*Betula papyrifera* var. *macrostachya* Fern.	large-fruited white birch
174	*Betula papyrifera* var. *pensilis* Fern.	weeping white birch
175	*Betula papyrifera* var. *subcordata* (Rydb.) Sarg.	northwestern white birch
176	*Betula pendula* Roth	weeping birch
177	*Betula populifolia* Marsh.	grey birch
178	*Betula pumila* L.	swamp birch
180	*Caragana* spp.	caragana
181	*Caragana arborescens* Lam.	Siberian caragana
182	*Caragana frutex* K. Koch	Russian caragana
183	*Caragana pygmaea* DC.	pygmy caragana
184	*Caragana spinosa* (L.) DC.	spiny caragana
187	*Carpinus* spp.	blue-beech
188	*Carpinus caroliniana* Walt.	blue-beech
190	*Carya* spp.	hickory
191	*Carya cordiformis* (Wang.) K. Koch	bitternut hickory
192	*Carya glabra* (Mill.) Sweet	pignut hickory
193	*Carya laciniosa* (Michx. f.) Loud.	big shellbark hickory
194	*Carya ovalis* var. *borealis* (Ashe) Sarg.	Michigan red hickory
195	*Carya ovalis* var. *odorata* (Marsh.) Sarg.	roundnut red hickory
196	*Carya ovata* (Mill.) K. Koch	shagbark hickory
197	*Carya ovata* var. *fraxinifolia* Sarg.	ashleaf hickory
198	*Carya tomentosa* Nutt.	mockernut hickory
200	*Castanea* spp.	chestnut
201	*Castanea dentata* (Marsh.) Borkh.	chestnut
202	*Catalpa* spp.	catalpa
203	*Catalpa hybrida* Spaeth	hybrid catalpa
204	*Catalpa ovata* G. Don	Chinese catalpa
205	*Catalpa speciosa* Warder	western catalpa
011	*Cedrus* spp.	cedar
012	*Cedrus libani* Loud.	Lebanon cedar
206	*Celtis* spp.	hackberry
207	*Celtis occidentalis* L.	hackberry

Code	Latin (scientific) name	Common name
208	Cercis spp.	redbud
209	Cercis canadensis L.	redbud
013	Chamaecyparis spp.	cedar
014	Chamaecyparis nootkatensis (D. Don) Spach	yellow cedar
499	Chamaedaphne calyculata (L.) Moench	leatherleaf
210	Cornus spp.	dogwood
211	Cornus acadiensis Fern.	hybrid dogwood
212	Cornus alternifolia L. f.	alternate-leaved dogwood
213	Cornus drummondii C.A. Meyer	roughleaf dogwood
214	Cornus florida L.	eastern flowering dogwood
215	Cornus nuttallii Audubon	western flowering dogwood
216	Cornus rugosa Lam.	round-leafed dogwood
217	Cornus stolonifera Michx.	red osier dogwood
220	Corylus spp.	hazelnut
221	Corylus americana Walt.	American hazelnut
224	Corylus avellana L.	European filbert
222	Corylus californica K. Koch	California hazelnut
223	Corylus cornuta Marsh.	beaked hazelnut
580	Cotoneaster spp.	cotoneaster
230	Crataegus spp.	hawthorn
231	Crataegus chrysocarpa Ashe	golden fruited hawthorn
232	Crataegus columbiana Howell	Columbia hawthorn
233	Crataegus douglasii Lindl.	black hawthorn
018	Cupressus spp.	cypress
019	Cupressus macrocarpa Gord.	Monterey cypress
480	Diervilla lonicera Mill.	bush honeysuckle
575	Elaeagnus spp.	Russian-olive
576	Elaeagnus angustifolia L.	Russian-olive
240	Fagus spp.	beech
241	Fagus grandifolia Ehrh.	American beech
242	Fagus sylvatica L.	European beech
250	Fraxinus spp.	ash
251	Fraxinus americana L.	white ash
252	Fraxinus excelsior L.	European ash
253	Fraxinus nigra Marsh.	black ash
254	Fraxinus pennsylvanica Marsh.	red ash
255	Fraxinus pennsylvanica var. austini Fern.	northern red ash
256	Fraxinus pennsylvanica var. subintegerrima (Vahl) Fern.	green ash
257	Fraxinus quadrangulata Michx.	blue ash
260	Ginkgo biloba L.	ginkgo
262	Gleditsia spp.	honey-locust
263	Gleditsia triacanthos L.	honey-locust
264	Gymnocladus spp.	coffee-tree
265	Gymnocladus dioicus (L.) K. Koch	Kentucky coffee-tree
266	Hamamelis spp.	witch-hazel
267	Hamamelis virginiana L.	witch-hazel
270	Ilex spp.	holly
271	Ilex aquifolium L.	English holly
272	Ilex glabra (L.) Gray	inkberry
273	Ilex verticillata (L.) Gray	Canada holly

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Code	Latin (scientific) name	Common name
275	Juglans spp.	walnut
276	Juglans cinerea L.	butternut
277	Juglans nigra L.	black walnut
020	Juniperus spp.	juniper
021	Juniperus communis L.	common juniper
022	Juniperus communis var. depressa Pursh	ground juniper
023	Juniperus communis var. hibernica Gord.	Irish juniper
024	Juniperus horizontalis Moench	creeping juniper
025	Juniperus scopulorum Sarg.	Rocky Mountain juniper
026	Juniperus virginiana L.	eastern red cedar
027	Juniperus virginiana var. crebra Fern. et Grisc.	northern red cedar
030	Larix spp.	larch
031	Larix decidua Mill.	European larch
032	Larix laricina (Du Roi) K. Koch	tamarack
033	Larix leptolepis (Sieb. and Zucc.) Gord.	Japanese larch
034	Larix lyallii Parl.	alpine larch
035	Larix occidentalis Nutt.	western larch
036	Larix siberica Ledeb.	Siberian larch
570	Ledum spp.	Labrador-tea
278	Liquidambar spp.	sweet gum
279	Liquidambar styraciflua L.	sweet gum
280	Liriodendron spp.	tulip-tree
281	Liriodendron tulipifera L.	tulip-tree
475	Lonicera spp.	honeysuckle
476	Lonicera canadensis Bartr.	fly honeysuckle
283	Maclura pomifera (Raf.) Schneid.	Osage-orange
284	Magnolia spp.	magnolia
285	Magnolia acuminata L.	cucumber-tree
340	Malus spp.	apple
342	Malus coronaria (L.) Mill.	sweet wild crab-apple
343	Malus fusca (Raf.) Schneid.	Pacific crab-apple
344	Malus glaucescens Rehd.	wild crab-apple
287	Morus spp.	mulberry
288	Morus alba L.	white mulberry
289	Morus rubra L.	red mulberry
290	Nemopanthus spp.	mountain-holly
291	Nemopanthus mucronata (L.) Trel.	mountain-holly
292	Nyssa spp.	tupelo
293	Nyssa sylvatica Marsh.	black gum
294	Ostrya spp.	ironwood
295	Ostrya virginiana (Mill.) K. Koch	ironwood
040	Picea spp.	spruce
041	Picea abies (L.) Karst	Norway spruce
042	Picea engelmannii Parry	Engelmann spruce
043	Picea glauca (Moench) Voss	white spruce
044	Picea glauca var. albertiana (S. Brown) Sarg.	western white spruce
045	Picea mariana (Mill.) B.S.P.	black spruce
046	Picea pungens Engelm.	blue spruce
047	Picea rubens Sarg.	red spruce
048	Picea sitchensis (Bong.) Carr.	Sitka spruce

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Appendix 1 (cont'd)

Code	Latin (scientific) name	Common name
050	*Pinus* spp.	pine
051	*Pinus albicaulis* Engelm.	whitebark pine
052	*Pinus banksiana* Lamb.	jack pine
053	*Pinus contorta* var. *contorta* Dougl.	shore pine
054	*Pinus contorta* var. *latifolia* Engelm.	lodgepole pine
055	*Pinus flexilis* James	limber pine
056	*Pinus monticola* Dougl.	western white pine
057	*Pinus mugo* var. *mughus* Zenari	mugho pine
058	*Pinus nigra* Arnold	Austrian pine
065	*Pinus peuce* Griseb.	Balkan pine
066	*Pinus pinaster* Ait.	cluster pine
059	*Pinus ponderosa* Laws.	ponderosa pine
060	*Pinus resinosa* Ait.	red pine
061	*Pinus rigida* Mill.	pitch pine
062	*Pinus strobus* L.	eastern white pine
063	*Pinus sylvestris* L.	Scots pine
064	*Pinus thunbergii* Parl.	Japanese black pine
296	*Platanus* spp.	sycamore
297	*Platanus acerifolia* (Ait.) Willd.	London plane
298	*Platanus occidentalis* L.	sycamore
300	*Populus* spp.	poplar
301	*Populus* × *acuminata* Rydb.	lanceleaf cottonwood
302	*Populus alba* L.	European white poplar
303	*Populus angustifolia* James	narrowleaf cottonwood
304	*Populus balsamifera* L.	balsam poplar
305	*Populus* × *canadensis* Moench	Carolina poplar
306	*Populus candicans* Ait.	balm of Gilead
307	*Populus deltoides* Bartr.	eastern cottonwood
310	*Populus deltoides* var. *occidentalis* Rydb.	plains cottonwood
308	*Populus grandidentata* Michx.	largetooth aspen
309	*Populus nigra* var. *italica* Muenchh.	Lombardy poplar
311	*Populus tremuloides* Michx.	trembling aspen
312	*Populus trichocarpa* Torr. & Gray	black cottonwood
320	*Prunus* spp.	cherries and plums
321	*Prunus americana* Marsh.	wild plum
520	*Prunus amygdalus* Batsch	almond
322	*Prunus cerasifera* Ehrh.	plum cherry
323	*Prunus emarginata* Dougl.	bitter cherry
324	*Prunus nigra* Ait.	Canada plum
521	*Prunus padus* var. *commutata* Dipp.	May-day tree
325	*Prunus pennsylvanica* L. f.	pin cherry
326	*Prunus serotina* Ehrh.	black cherry
327	*Prunus virginiana* L.	choke cherry
328	*Prunus virginiana* var. *demissa* (Nutt.) Torr.	western choke cherry
329	*Prunus virginiana* var. *melanocarpa* (A. Nels.) Sarg.	black choke cherry
070	*Pseudotsuga* spp.	Douglas-fir
071	*Pseudotsuga menziesii* (Mirb.) Franco	Douglas-fir
072	*Pseudotsuga menziesii* var. *glauca* (Beissn.) Franco	interior Douglas-fir
330	*Ptelea* spp.	hop-tree
331	*Ptelea trifoliata* L.	hop-tree

Code	Latin (scientific) name	Common name
350	Quercus spp.	oak
351	Quercus alba L.	white oak
352	Quercus bicolor Willd.	swamp white oak
354	Quercus coccinea Muenchh.	scarlet oak
355	Quercus ellipsoidalis E.J. Hill	northern pin oak
356	Quercus garryana Dougl.	Garry oak
357	Quercus macrocarpa Michx.	bur oak
359	Quercus muehlenbergii Engelm.	chinquapin oak
360	Quercus palustris Muenchh.	pin oak
358	Quercus prinus L.	chestnut oak
353	Quercus rubra L.	red oak
361	Quercus velutina Lam.	black oak
370	Rhamnus spp.	buckthorn
371	Rhamnus alnifolia L'Her.	alder-leaved buckthorn
372	Rhamnus cathartica L.	common buckthorn
374	Rhamnus frangula L.	alder buckthorn
373	Rhamnus purshiana DC.	cascara
376	Rhododendron spp.	rhododendron
377	Rhododendron maximum L.	great Laurel
380	Rhus spp.	sumac
381	Rhus glabra L.	smooth sumac
382	Rhus typhina L.	staghorn sumac
383	Rhus vernix L.	poison sumac
540	Ribes spp.	currants and gooseberries
390	Robinia spp.	locust
391	Robinia pseudoacacia L.	black locust
392	Robinia viscosa Vent.	clammy locust
560	Rosa spp.	rose
400	Salix spp.	willow
401	Salix alaxensis (Anderss.) Cov.	feltleaf willow
402	Salix alba L.	white willow
403	Salix alba var. vitellina (L.) Stokes	golden willow
404	Salix amygdaloides Anderss.	peachleaf willow
405	Salix babylonica L.	weeping willow
406	Salix bebbiana Sarg.	Bebb willow
407	Salix candida Flugge	hoary willow
408	Salix caudata (Nutt.) Heller	whiplash willow
409	Salix cordata Michx.	heart-leaved willow
410	Salix coulteri Anderss.	Coulter willow
411	Salix discolor Muhl.	pussy willow
412	Salix exigua Nutt.	coyote willow
413	Salix fragilis L.	crack willow
414	Salix hookeriana Barratt	Hooker willow
415	Salix interior Rowlee	sandbar willow
416	Salix lasiandra Benth.	Pacific willow
417	Salix lucida Muhl.	shining willow
418	Salix lutea Nutt.	yellow willow
419	Salix mackenzieana (Hook.) Barratt	Mackenzie willow
420	Salix melanopsis Nutt.	dusky willow
421	Salix nigra Marsh.	black willow

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Code	Latin (scientific) name	Common name
422	Salix pentandra L.	bayleaf willow
423	Salix pseudomonticola Ball	serviceberry willow
424	Salix purpurea L.	basket willow
425	Salix pyrifolia Anderss.	balsam willow
426	Salix scouleriana Barratt	Scouler willow
427	Salix sericea Marsh.	silky willow
428	Salix sessilifolia Nutt.	northwest willow
429	Salix sitchensis Sanson	Sitka willow
430	Salix vestita Pursh	hairy willow
440	Sambucus spp.	elder
441	Sambucus canadensis L.	elderberry
442	Sambucus glauca Nutt.	blue elder
443	Sambucus pubens Michx.	red-berried elder
446	Sassafras spp.	sassafras
447	Sassafras albidum (Nutt.) Nees	white sassafras
448	Sassafras albidum var. molle (Raf.) Fern.	red sassafras
080	Sequoia spp.	sequoia
495	Shepherdia spp.	shepherdia
496	Shepherdia argentea Nutt.	buffalo-berry
497	Shepherdia canadensis (L.) Nutt.	soapberry
345	Sorbus americana Marsh.	American mountain-ash
346	Sorbus aucuparia L.	European mountain-ash
347	Sorbus decora (Sarg.) Schneid.	showy mountain-ash
348	Sorbus occidentalis (S. Wats.) Greene	western mountain-ash
349	Sorbus sitchensis Roem.	Sitka mountain-ash
500	Spiraea spp.	spiraea
530	Syringa spp.	lilac
531	Syringa vulgaris L.	lilac
082	Taxus spp.	yew
083	Taxus brevifolia Nutt.	western yew
084	Taxus canadensis Marsh.	ground hemlock
085	Thuja spp.	cedar
086	Thuja occidentalis L.	eastern white cedar
087	Thuja plicata Donn	western red cedar
450	Tilia spp.	basswood
451	Tilia americana L.	basswood
452	Tilia cordata Mill.	lime-leaved linden
453	Tilia platyphyllos Scop.	large-leaved linden
090	Tsuga spp.	hemlock
091	Tsuga canadensis (L.) Carr	eastern hemlock
092	Tsuga heterophylla (Raf.) Sarg.	western hemlock
093	Tsuga mertensiana (Bong.) Carr.	mountain hemlock
460	Ulmus spp.	elm
461	Ulmus americana L.	white elm
462	Ulmus glabra Huds.	Wych elm
463	Ulmus montana Stokes	Scotch elm
468	Ulmus parvifolia Jacq.	Chinese elm
464	Ulmus procera Salisb.	English elm
465	Ulmus pumila L.	Siberian elm
466	Ulmus rubra Muhl.	slippery elm

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Code	Latin (scientific) name	Common name
467	Ulmus thomasii Sarg.	rock elm
481	Virburnum spp.	viburnum
483	Viburnum cassinoides L.	wild-raisin
482	Viburnum lentago L.	nannyberry
484	Viburnum trilobum Marsh.	highbush cranberry
801	Miscellaneous ground vegetation	
802	Miscellaneous shrubs	

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APPENDIX 2. Crown perimeter diagrams

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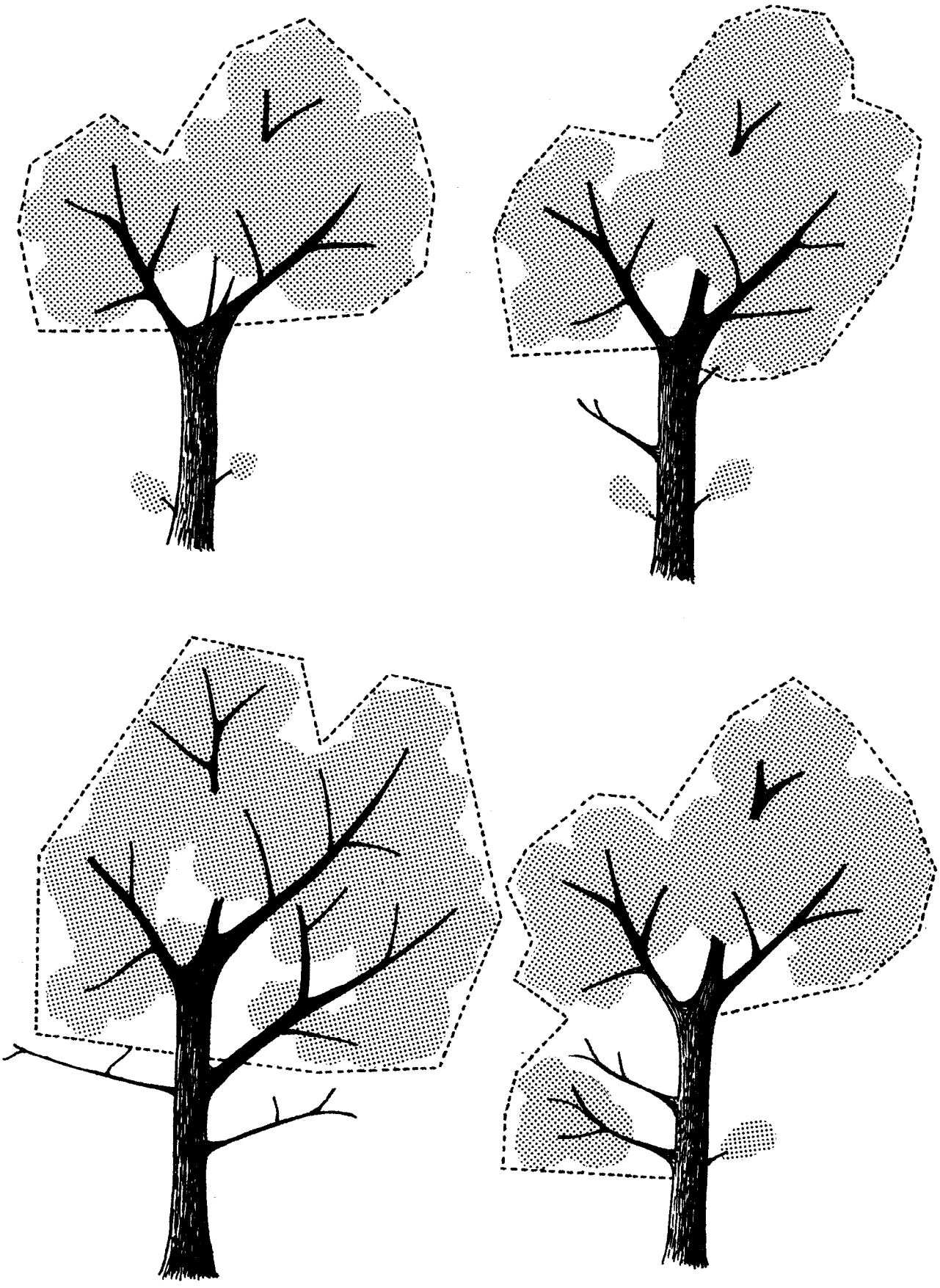

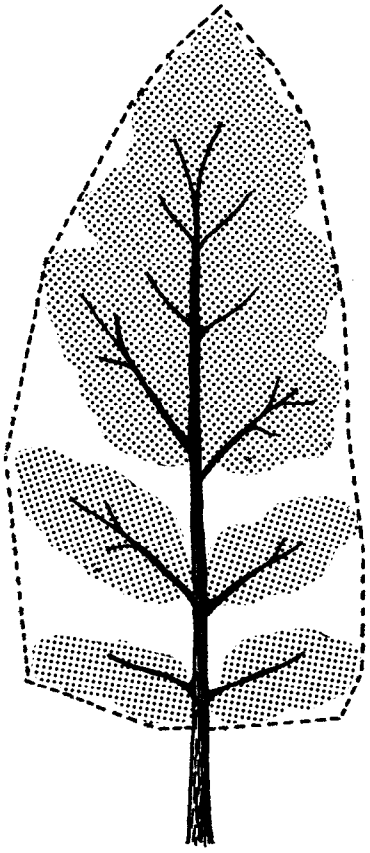

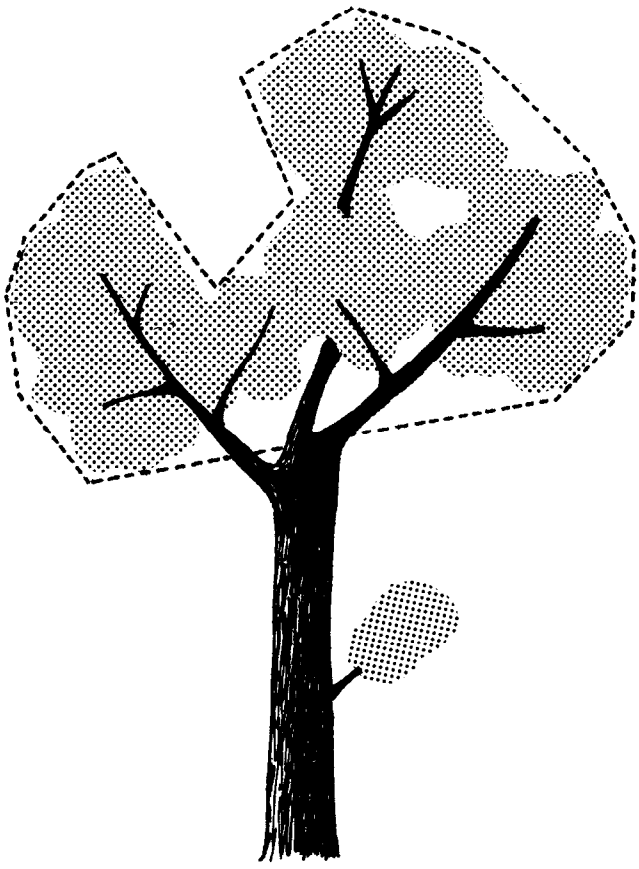

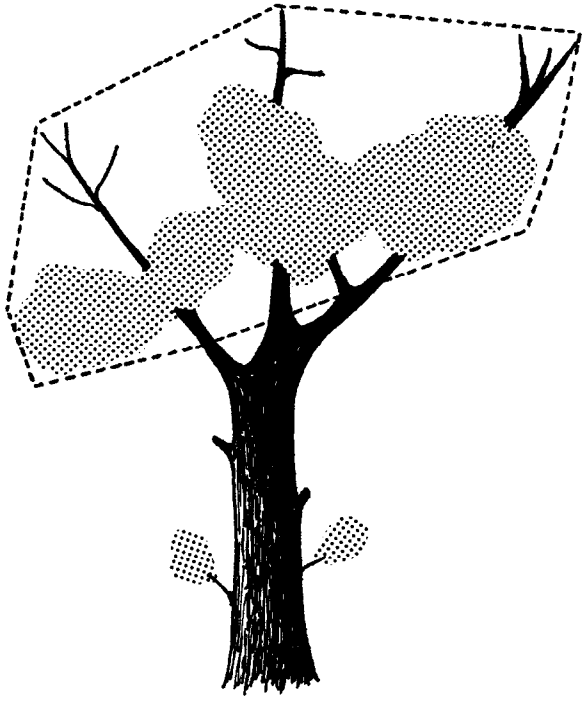

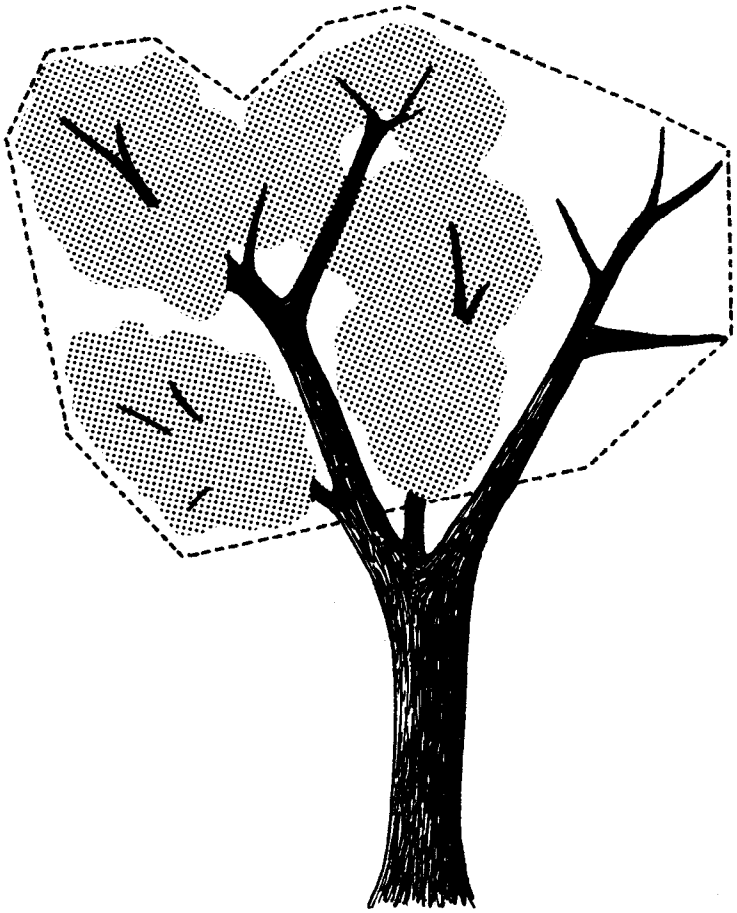

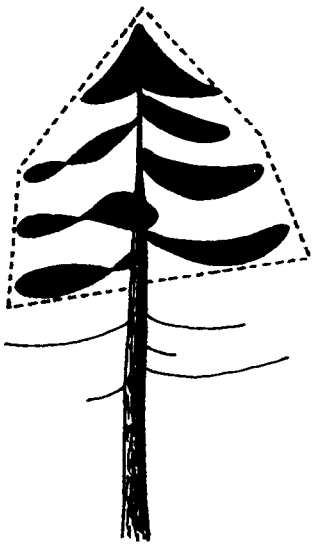

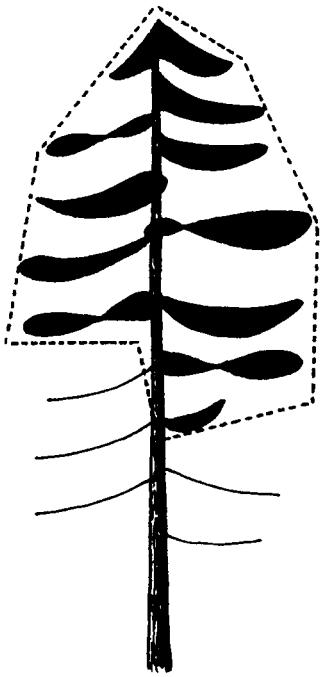

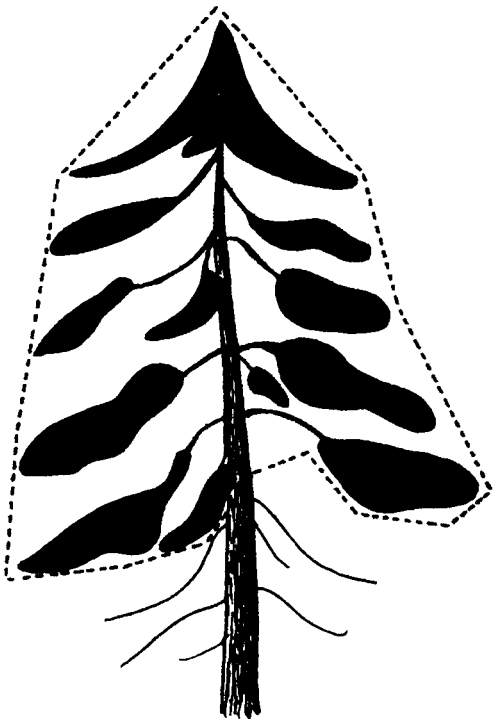

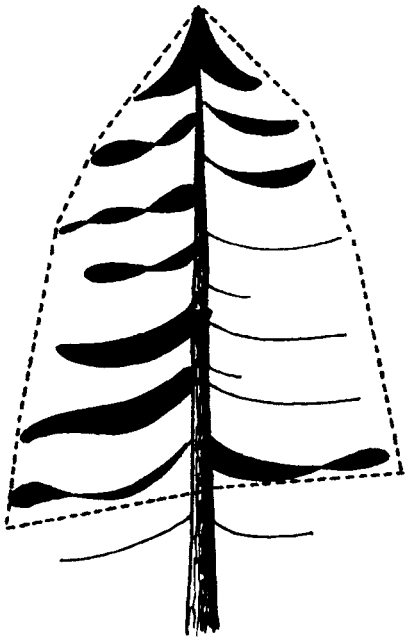

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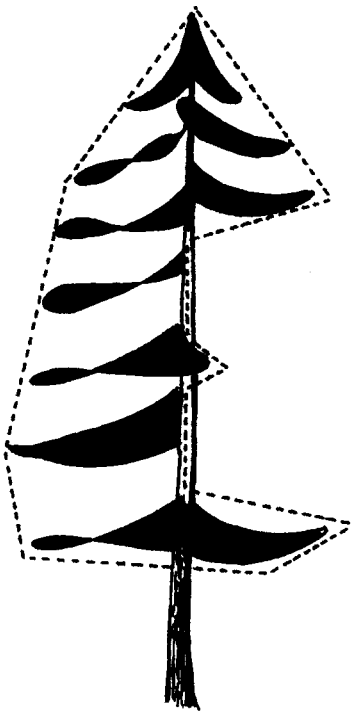

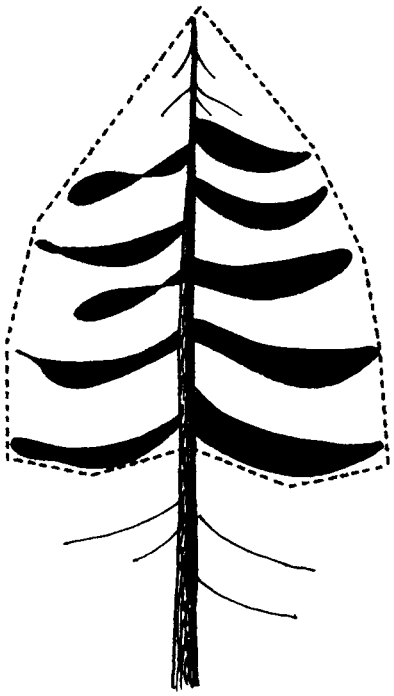

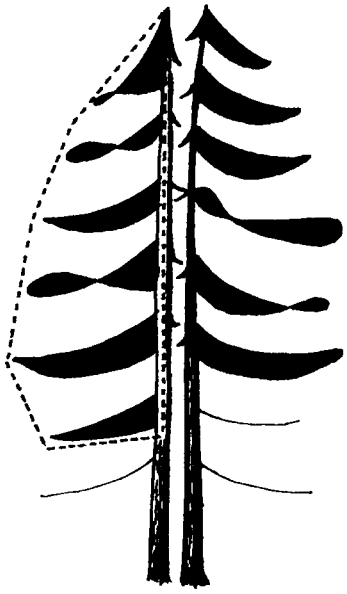

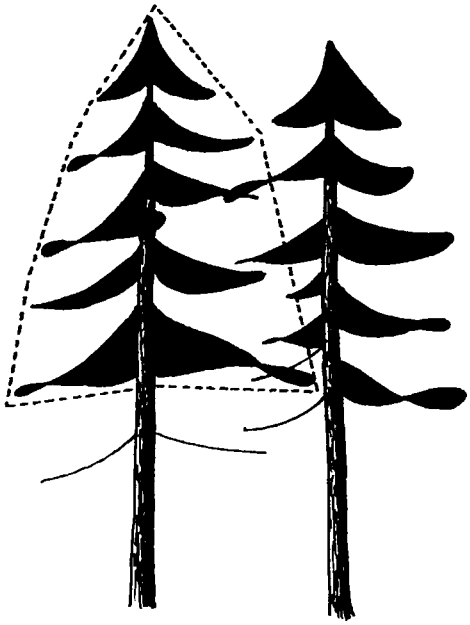

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APPENDIX 3. Code Lookup Sheet

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ARNEWS CODES FORM 4 (ANNUAL)

Tree Condition (41-42)

Hardwood

10	=	Full complement of foliage, no visible outer crown damage
20	=	Foliage thin, off-colour, no dead branches or twigs
30	=	No dead branches, bare twigs present up to 5% of crown
35	=	No dead branches, bare twigs present on more than 6% of crown
40	=	Dead branches and twigs present up to 15% of crown
45	=	Dead branches and twigs present in 16 to 25% of crown
50	=	Dead branches and twigs present in 26 to 37% of crown
55	=	Dead branches and twigs present in 38 to 50% of crown
60	=	Dead branches and twigs present in 51 to 75% of crown
65	=	Dead branches and twigs present in 76% or more of crown
70	=	More than 50% of crown dead, only adventitious branches usually at base of crown
08	=	Tree died since last assessment, specify cause of death in remarks
09	=	Dead tree, indicate any physical change, ie. fell down, removed

Conifer

01	=	No defoliation
02	=	Only current foliage defoliated. Defoliation less than 25%
03	=	Current with some older foliage defoliated. Total less than 25%
04	=	25-50% defoliation
05	=	51-75% defoliation
06	=	76-90% defoliation
07	=	More than 90% defoliation
08	=	Tree died since last assessment, specify cause of death in remarks
09	=	Dead tree, indicate any physical change, ie. fell down, removed

Columns 42 U,M,L conifer crown damage

Assess the total crown damage, not just defoliation, in each 1/3 section of the crown - U = upper, M = middle, L = lower.

For trees with less than 3 meters of crown, assess entire crown and record in 42U. For hardwoods, draw line through columns 42U to 42L.

0	=	no visible damage
T	=	1-5% (trace)
1	=	6-15%
2	=	16-25%
3	=	26-35%
4	=	36-45%
5	=	46-55%
6	=	56-65%
7	=	66-75%
8	=	76-85%
9	=	86-100%
-	=	cannot see section to rate damage

Bare Top Length (43-44)

Estimate bare top length for conifers and the extent of top dieback for hardwoods. Estimate to nearest 0.5 metre, record as two digit number, eg. 1.5 m = 15. Bare tops greater than 9.5, record as 99.

Needle Retention (45)

Defined as the year of the oldest internode with at least 25% of needles present. Record the age of oldest shoot retaining at least 25% of needles. Current year's shoot is age 0, last year age is 1, ... 5 years old or older = 5.
Draw a line through hardwoods, larch, and cedars.

Storm Damage (46)

Consider only new damage since last assessment. Record most serious damage if more than one type of damage.

0	=	No new damage
1	=	Foliage component damaged
2	=	Live twigs broken
3	=	Live branch(s) other than main branch
4	=	Live main branch(s) broken or severely cracked
5	=	Live portion of main stem broken or severely cracked
8	=	Other, specify in remarks
9	=	Not applicable

Current Defoliation (47)

Current year's foliage only

0	=	None missing
T	=	1-5% (Trace)
1	=	6-15%
2	=	16-25%
3	=	26-35%
4	=	36-45%
5	=	46-55%
6	=	56-65%
7	=	66-75%
8	=	76-85%
9	=	86-100%

Abiotic Foliage Symptoms (48-51)

00	=	Green (normal): no undetermined abiotic symptoms
85	=	Chlorotic (yellow green)
86	=	Yellow (current foliage)
87	=	Chlorotic yellow (old foliage) (for tree assessment only)
88	=	Mottled (yellow, brown, or red spots)
89	=	Marginal tip or edge discoloration (yellow, brown, or red)
90	=	Needle banding of all needles per fascicle
91	=	Needle banding of some needles per fascicle
92	=	Spotted - dead areas on leaves or needles
93	=	Interveinal discoloration
94	=	Entire needle or leaf red or brown
95	=	Needle tips dead and broken off at same length per fascicle
96	=	Needles or leaves on entire shoot or branch red or brown
99	=	Other (describe in remarks column)

Level (65)

Amount of foliage affected in colums 48-51.

0	=	None affected
T	=	1-5% (trace)
1	=	6-15%
2	=	16-25%
3	=	26-35%
4	=	36-45%
5	=	46-55%
6	=	56-65%
7	=	66-75%
8	=	76-85%
9	=	86-100%

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Seed (Cone) Production (56)

Estimate for each dominant and codominant tree.

0 = None - no cones or seed
1 = Very light
2 = Light
3 = Medium
4 = Heavy
- = Not applicable

Forest Pest Conditions

Type of Foliage Insects (57)

Identify and record most damaging insect if two or more are present.

0 = None recorded
1 = Free-feeding defoliator (spruce budworm, forest tent caterpillar)
2 = Leafroller, leafminer, leaf skeletonizer, needleminer
3 = Tent or nestmaker (webspinning sawfly)
4 = Budminer, shootminer
5 = Gall maker (maple bladder gall)
6 = Sucking insect (aphids)
8 = Other - specify in remarks

Level of Foliar Damage by Insects (58) and Diseases (60) (Total Foliage Affected)

0 = No visible damage
T = 1-5% (trace)
1 = 6-15%
2 = 16-25%
3 = 26-35%
4 = 36-45%
5 = 46-55%
6 = 56-65%
7 = 66-75%
8 = 76-85%
9 = 86-100%

Type of Foliage Diseases (59)

Identify and record most damaging disease if two or more are present

0 = None recorded
1 = Needle rust, leaf rust
2 = Needle cast
3 = Needle blight, leaf blight
4 = Leaf spot
5 = Anthracnose
6 = Leaf blisters
7 = Physical damage (wind, hail, frost)
8 = Other - specify in remarks

Type of Woody Tissue Insects (61)

Identify and record most important insect.

0 = None recorded
1 = Sucking insect (adelgids, scale)
2 = Gallmaker (pine gall weevil)
3 = Tip borer, shoot borer (white pine weevil)
4 = Bark beetles
5 = Woodboring insects (sawyer beetle)
6 = Root and root collar insects
8 = Other - specify in remarks

Location of Damage by Woody Tissue Insects (66) and Diseases (68) and Other Agents (71)

If more than one pest present, record the most significant damage.

0 = No visible damage
1 = Crown stem - the main trunk or bole within the crown
2 = Upper bole
3 = Lower bole
4 = Roots (exposed) and stump (up to 25 cm in height)
5 = Whole trunk - includes 1 to 3
6 = Branches and twigs - other than main stem
7 = Shoots and buds - current year's growth only
8 = Whole crown - includes 6 and 7
9 = Other - specify in remarks

Type of Woody Tissue Diseases (63)

If more than one pest present, record the most significant damage.

0 = None recorded
1 = Stem and branch rust
2 = Stem canker (Hypoxylon)
4 = Twig and branch cankers
5 = Witches' broom, mistletoe
6 = Stem decay fungi
7 = Root rot
8 = Other - specify in remarks

Type of Other Damaging Agents (70)

Non-insect and non-fungi

0 = None recorded
1 = Animal
2 = Snow
3 = Ice
4 = Hail
5 = Wind
6 = Frost
7 = Mechanical (whipping)
8 = Other - specify in remarks

Level of Damage by Other Agents (72)

0 = No visible damage
T = 1-5% (trace)
1 = 6-15%
2 = 16-25%
3 = 26-35%
4 = 36-45%
5 = 46-55%
6 = 56-65%
7 = 66-75%
8 = 76-85%
9 = 86-100%

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