CHAPTER EIGHT
GROWTH AND YIELD
NATURAL STANDS

SECTION 8.13

REMEASUREMENT OF EXPERIMENTAL PLOTS IN NATURAL STANDS

1988

SECTION 8.13

REMEASUREMENT OF EXPERIMENTAL PLOTS IN NATURAL STANDS

TABLE OF CONTENTS

SECTION 8.13

REMEASUREMENT OF EXPERIMENTAL PLOTS IN NATURAL STANDS

LIST OF FIGURES

SECTION 8.13

REMEASUREMENT OF EXPERIMENTAL PLOTS IN NATURAL STANDS

Page

LIST OF TABLES

LIST OF APPENDICES

8.13 REMEASUREMENT OF EXPERIMENTAL PLOTS IN NATURAL STANDS

To evaluate the growth and yield of different forest types, the Research Branch established permanent growth plots from 1921 until 1949. To protect this large investment from any type of disturbance, a reserve was placed around each plot. In 1957, the Research Branch transferred responsibility for 65 experimental plots (all still in a natural state) to the Inventory Branch. Since then the Growth and Yield Section of the branch has continued to remeasure them periodically (10-year periods). Some of the original 65 have been abandoned owing to increased pressure on the area for other uses or to the fact that sufficient data have been collected. The standards of measurement for permanent samples are listed in Appendix 8-1. If not already done, all experimental samples due for remeasurement must be ecologically classified in accordance with Research Branch specifications.

Since permanent growth samples are cost intensive, their protection is of utmost importance. To ensure their protection, the buffers illustrated in Appendix 8-31 are recommended.

8.131 Office Preparation

Prepare field record sheets that allow room to record new measurements. If the previous measurements were recorded in imperial units, convert them to metric equivalents for diameter and height, and enter these equivalents in the margin for comparison with the new measurements. Obtain small-scale (1:20 000) forest cover maps showing plot locations and large-scale (1:250 000) maps for navigation as well as the most recent photos showing the original tie points. For a list of equipment used to remeasure growth and yield samples, see Appendix 8-17.

8.132 Field Training

All personnel involved in remeasurement must attend a short training course to familiarize them with field procedures. Crews should then work under the direct guidance of senior personnel for a period of time sufficient to gain a full understanding of the different phases of the work and to obtain reasonable efficiency in the collection of field measurements.

8.133 Relocation of the Plot

8.1331 Location and Access Description

Originally only a general description of access to each experimental plot was required, which has occasionally resulted in time wasted in relocation of the plot. For the benefit of future remeasurement crews, make a detailed description of the location of, and access to, the

8.1331 cont.

plot. When describing routes and distances to a tie point, always start from an easily identifiable point, the location of which will likely remain unchanged in the intervening 10-year period between measurements. On the way to the tie point, clock the kilometres from road junctions, from creek crossings, and from other prominent features to it. Describe the tie tree well, noting its species, diameter, and location.

8.1332 Tie Point

Whenever possible, the reference or tie point was located close to a prominent topographic feature. The tie point was marked with a cedar post driven firmly into the ground. However, many of these posts have rotted and are difficult to find. When the tie point cannot be found, try to find the tie line by crossing back and forth, looking for blazes or flagging tape on the trees. Having found the tie line, reverse the tie line bearing and look for the location of the tie point. To aid crews in the future relocation of the tie point, use a well marked tree, rather than a cedar post. At the time of remeasurement, choose a suitable tree near the post and attach to it two aluminum growth plot markers at a point approximately two metres up the tree. Each marker should be in line with the tie line bearing and nailed on opposite sides of the tie tree. Also flag the tie tree with two strands of red plastic flagging tape, one above and one below the markers.

Inscribe each of the aluminum growth plot markers with the following information: experimental plot number, region number, compartment number, bearing and distance to the plot, and date of plot establishment.

Note: "Date" refers to the original date of plot establishment.

8.1333 Tie Line

From the tie point, the tie line was run with a hand compass, an abney and a chain, and was marked with blazes on each side of trees at approximately 10-metre intervals, or at shorter intervals where undergrowth reduced visibility.

If the original tie line can be found, renew the old blazes and flag the tie line with strands of red flagging tape.

Sometimes the tie point and the tie line cannot be found. To locate the plot, first find the approximate location of the tie point and follow the tie line bearing. When you have travelled the approximate distance of the tie line, begin crossing the tie line back and forth looking for metal tags, flagging, and corner posts. Within the experimental plot, tags were nailed onto trees at breast height. When the light is adequate these tags can be seen from a great distance.

8.1333 cont.

If you cannot find the experimental plot, select a new tie point that is easy to recognize on the photos and on the ground. On the map, plot the tie point and measure the new bearing and distance to the experimental plot. Set the new bearing on the hand compass and run the tie line. Mark distance on the ground every 40 metres (or only 20 metres on broken terrain) and on sloping terrain use a clinometer to make an allowance for slope.

8.1334 Corner Posts

At the experimental plot, locate all four corner posts. Each of the corners was marked with a cedar post driven into the ground around which a cairn was sometimes built.

Check that each post is solid enough to last another 10 years and mark each one with red flagging tape. When necessary, replace a post with a new one or with a tubular aluminum stake.

8.134 Measurement of the Plot and Establishment of the Sub-plot

Accurate, conscientious work is required when comparing obtained measurements with previous measurements and when rechecking measurements that appear to be out of the expected range, that is, ones showing a large increase compared with those showing little or no increase. Place a check-mark against dougle-checked data on the growth sample record sheet. Correct errors in species identification and note them in the remarks column: for example, "Tree no. 60 is a Hw not a Fd".

Experimental samples are either square or rectangular in shape. Single plot experimental samples range in size from 0.04 ha to 0.40 ha.; the most common size is 0.16 ha. The multiple plot experimental samples range in size from 0.06 ha (2 plots) to 1.38 ha (34 plots). On file with each experimental sample is a map showing its layout.

At the time of sample establishment all living trees 2.5 cm and over in diameter at breast height (1.37 m) were tagged with numbered metal tags. During subsequent remeasurements, ingrowth trees (2.5 cm d.b.h. and greater at the time of remeasurement) were often disregarded. To simplify tagging, the plot was divided into sectors. Tagging was begun in one corner of the plot and was continued up and down each sector. Sector 1 is the one in which tagging was begun. Sector numbers increase towards the opposite end of the plot. The number of sectors in a plot varies among the experimental samples.

8.1341 D.B.H. Measurement and Tree Classification

After one base-year measurement of diameter at 1.3 m and 1.37 m above the germination point, all future remeasurements will only be at 1.3 m. All missing tags at the time of remeasurement must be replaced.

For this purpose, use one of two methods of tagging (the first being the preferred one). Only one method is to be used within a Forest Region, and use it for all applicable sections of this chapter.

8.1341 cont.

Method 1

Use the embosser to inscribe the tree number on the aluminum tape and nail this tape to the tree at 1.37 m height; if possible, use the original nail-hole. Drive a second nail into each previously tagged tree at a point 0.07 m below the original nail.

Method 2

Use the embosser to inscribe the tree number on the aluminum tape and nail this tape to the tree at 1.3 m height. Note on the sample record form that method 2 was used.

For both methods, record "new tag" in the remarks column for that tree if a tree tag and nail are missing.

For all originally tagged living trees 7.5 cm d.b.h. or greater at 1.3 m above the germination point (see Appendix 8-5) and without missing tags, either drive a second nail into each tree at a point 0.07 m below the original nail (if method 1 was selected) or first mark the point at 1.37 m and then move the nail and tag and place them at 1.3 m (if method 2 was selected).

Measure two diameters (d.b.h. at 1.3 m and d.b.h. at 1.37 m) just above the nails and record them to the nearest millimetre on the growth sample record sheet for natural stands (F.S. 820, see Appendix 8-7). Also record the sector number of each tree on the same sheet.

Note 1: When remeasuring diameter, readjust the nail holding the number. Pull it out enough to allow for tree growth until the next remeasurement.

Note 2: Measure the diameters at 1.3 m and 1.37 m above the nail for all previously numbered living trees that are now dead. Assign the same diameter as for the previous measurement if the dead tree cannot be found. In addition, for a tree class 6 tree, measure the stump height and diameter, determine whether the stump is old (10 years plus since cutting) or new (less than 10 years since cutting) and record this information in columns 46 to 52 of the field record sheet.

A. Tree Class and Decay Indicators

Classify each numbered tree 7.5 cm d.b.h. and greater (1.3 m above the germination point) into one of the tree class codes and record it under tree class (see Table 8-3).

Table 8-3

Tree class codes

Tree class	Code
Residual	1
Suspect	2
Dead potential (do not use on these plots)	3
Dead useless (standing or fallen down)	4
Veteran	5
Dead cut down	6

Tree Class 1 Residual

If none of the suspect characters (decay indicators) are visible, classify the tree as residual (code 1).

Tree Class 2 Suspect

If one or more of the decay indicators occurs on the tree, classify the tree as suspect (code 2, except veterans which are code 5). Enter the numerical decay indicator position code (see Appendix 8-8) to show the location on the tree being tallied of any of these decay indicators, which are defined and illustrated in Appendix 8-9:

Conk - In immature stands, it usually occurs on deciduous trees.

Blind Conk - It very seldom occurs on immature trees.

Scar - It must be weathered and may be grown over or open.

Fork or Crook - It includes multiple leaders.

Frost Crack - It may resemble a scar but it always follows the grain.

Mistletoe - It can occur on the trunk and on branches. Record a branch swelling that extends to the trunk of the tree as mistletoe. Because mistletoe may be an inhibitor of growth, also record it if present on swollen limbs, even if at some distance from the trunk but only in the remarks column.

Rotten Branch - It must have a minimum diameter of 10 cm and in immature stands should only be present on veterans.

8.1341 cont.

Dead or Broken Top - It includes a broken leader or a dead leader (see Appendix 8-6).

These abnormalities are not indicators of decay and are illustrated in Appendix 8-9: butt rot, flute, candelabra branch, branch fan, black knot, burl and gall, sweep, exposed root, spiral grain, dry side, sapsucker hole, and insect boring. Record their occurrence in the remarks section of the growth sample record sheet.

Select the decay indicator position code (see Appendix 8-8) that best describes the location by thirds of each decay indicator (including dead or broken top) on the tree and enter this code under the heading "Path. Remarks" on the field sheet.

These examples illustrate the relationship between the decay indicator and its position code:

A. Suppose that a suspect tree has scars in the lower and middle thirds, and a fork in the middle third. In the pathological remarks section under "SCAR', enter 4; and under "FK/CK", enter 2.

B. Suppose that a veteran tree has a dead top, conks in the lower third, and a crook in the middle third. In the pathological remarks section under "D/B T", enter 3; under "CONK", enter 1; and under "FK/CK", enter 2.

C. Suppose that a suspect tree has a fork in the middle third, a large scar extending the whole length of the tree, and the leader from the tallest fork is broken. In the pathological remarks section under "FK/CK", enter 2; under "SCAR", enter 7; and under "D/B T", enter 3.

Tree Class 4 Dead

All dead trees, standing or downed, are classified as dead useless (code 4). If a previously tagged tree cannot be found after a reasonable time, assume that it is dead (it is most likely buried under windfall) and note on the field sheet that it has not been found and is assumed to be dead. If the tree has been cut down, classify it as tree class 6 to distinguish it from one that has died through natural competition and record "cut down" in the remarks section. If it can be determined that the tree died as a result of an insect or disease, record tree class 4 and, in addition, record the primary insect or disease responsible for the death of the tree (see insect, disease and injury portion of this section).

Tree Class 5 Veteran Tree

If a tree in question proves to be at least 30 years older than the oldest bored tree of the main stand, record it as a veteran (tree class code 5). Also, record a V in the layer column of the growth sample record sheet (F.S. 820). For veteran trees (tree class code

5), record decay indicators in the same way as for other trees. Veteran trees belong to a distinctly older age class than that of the main stand being sampled. In growth sampling, it is important that veterans be properly classified, and the increment borer be used to determine the ages of trees that appear to be veterans. A veteran is not always an old tree: for example, a 20-year old stand could have 60-year old veterans which are remnants of a stand destroyed by fire. For a veteran component to be recognized, the veterans must have an estimated crown closure of less than 6 percent for the sample. Veterans are not recognized in stands 121 years or older except in lodgepole pine stands which may have a veteran component of Douglas-fir or larch.

Tree Class 6 Dead, Cut Down

Record tree class 6 if the tree is dead as a result of being cut down. In addition, record "cut down" in the remarks section.

A tree can be properly classified only when it has been viewed from all sides. Because most defects in the upper portion of a tree are not visible to an observer standing at the base, it is important that the recorder move around each tree until the crown being classified is clearly visible. The person measuring d.b.h. should move far enough away from the tree to be able to classify the lower third of the stem; whereas the recorder is responsible for classifying the upper two thirds.

B. Insect, Disease and Injury

To quantify the effects of insect, disease and injury on tree growth, the Growth and Yield Section has been requested to collect insect, disease and injury data during the remeasurement of permanent growth samples.

For each tree affected, record the primary insect, disease, or injury code listed below in the remarks columns of the field record sheet. Identify (if possible) the insect or disease species and subjectively assess the incidence of infection or infestation as 1 = low, 2 = medium, 3 = severe, 4 = past occurence for all agents except defoliators. Assess defoliation to the nearest 10 percent and record 10% as 1, 20% as 2 etc.

If the observer is not able to identify the insect or disease species, a shorter incomplete label is still useful. For example, an observer may identify a defoliating insect and assess the percent defoliation for the tree as 30 percent. This would be recorded as ID__3 in the remarks column.

In addition to recording the primary insect, disease or injury for each tree affected, make a general assessment of the primary insect, disease, or injury for the total sample and record it in the sample header section of the field sheet. If known, also record the year of attack.

8.1341 cont.

INSECT, DISEASE AND INJURY CODES

Acceptable Codes		Description
I	Insects	
IB	Bark Beetles	
IBM		mountain pine beetle
IBS		spruce beetle
IBD		Douglas-fir beetle
IBB		Dryocoetes (balsam bark beetle)
IBI		Ips sp.
ID	Defoliators	
IDW		western spruce budworm
IDE		spruce budworm (fumiferana)
IDB		2-yr cycle budworm (Biennis)
IDH		blackheaded budworm
IDL		western hemlock looper
IDG		green striped hemlock looper
IDT		Douglas-fir tussock moth
IDC		larch casebearer
IDA		black army cutworm
IDV		variegated cutworm
IA	Aphids	
IAS		spruce aphid (Elatobium)
IAG		gall aphid
IAB		balsam wooly aphid
IAC		Cinara sp.
IW	Weevils	
IWS		white pine weevil (on spruce)
IWP		lodgepole terminal weavil
IWM		Magdalis
IWW		warren's root collar weevil
IWC		Steremnius carinatus
IS	Shoot Insects	
ISE		european pine shoot moth
ISP		Petrova
ISB		western cedar borer

8.1341 cont.

A Animal damage

AH	hare or rabbit damage
AS	squirrel damage
AC	cattle damage
AV	vole damage
AP	porcupine damage
AB	bear damage
AD	deer
AE	elk
AM	moose

M Mite damage

B Abiotic injuries

BH	hail
BF	frost
BS	sunscald
BR	redbelt
BW	flooding

D Diseases

DM Dwarf Mistletoe

DMP	lodgepole pine dwarf mistletoe
DMF	Douglas-fir dwarf mistletoe
DMW	hemlock dwarf mistletoe
DML	larch dwarf mistletoe

DR Root Disease

DRL	laminated root rot
DRA	armillaria root disease
DRB	blackstain root disease
DRN	ennosus root disease
DRT	tomentosus root rot
DRR	rhizine root disease
DRC	laminated root rot cedar strain

DD Stem Rot (internal decay only)

DDL	laminated
DDA	armillaria
DDN	annosus
DDI	tomentosus
DDC	laminated cedar strain
DDS	schweinitzii butt rot

8.1341 cont.

Acceptable Codes		Description
DS	Stem Diseases (external cankers and rusts)	
DSA		atropellis (lodgepole pine)
DSB		white pine blister rust
DSS		lodgepole pine stalactiform blister rust
DSC		lodgepole pine comandra blister rust
DL	Leader and Branch Dieback	
DLS		sclerophoma
DP	Bark Disease (superficial)	
DF	Brooming (non-mistletoe)	

C. Crown Class

Crown class refers to the position of the crown of a tree relative to all other trees within the general plot area (not the whole stand). Each tagged tree classed as tree class 1, 2 or 5 is assigned a crown class code. The four recognized crown classes are dominant, codominant, intermediate, and overtopped and their respective crown class codes are 1, 2, 3, and 4 (see Appendix 8-10).

Record the crown class in column 36 of the growth sample record sheet (F.S. 820).

D. Live-crown Length

Live-crown length is the length from the top of the tree to where the major living branch nearest to the ground enters the bole of the tree. When finding the first major living branch, do not consider forks originating below breast height or epicormic branches. The live-crown length is recorded as a percentage of the total tree height.

Assign to each live tagged tree a live-crown length estimated to the nearest 10 percent. Record live-crown length in columns 62 to 64 of the growth sample record sheet (F.S. 820).

8.1342 Ingrowth

Once all previously tagged trees 7.5 cm d.b.h. and greater have been accounted for, follow the established sectors and tag by consecutive number all previously untagged trees that are now 7.5 cm d.b.h. and greater at 1.3 m above the germination point.

Special rules govern the tagging of forked trees:

A. If the fork occurs at or above 1.3 m, tag the stem as a single tree provided it has a d.b.h. of at least 7.5 cm.

8.1342 cont.

B. If the fork occurs below 1.3 m, and two or more stems of the fork are 7.5 cm or greater in d.b.h., tag each stem separately using consecutive numbers. When the diameters are recorded on the tally sheet, bracket the numbers of the stems making up the fork(s).

C. If the fork occurs below 1.3 m, and only one of the stems is 7.5 cm or greater, tag it as a single tree.

For tagging ingrowth trees, select method 1 if method 1 was used previously (see Section 8.1341) or method 2 if that one was used. For both methods either inscribe the ingrowth tree number on aluminum tags or use numbered, blue, plastic tags.

Method 1

Nail the tag to the tree 1.37 m above the germination point. Drive a second nail into each tree 0.07 m below the first nail, that is, 1.3 m above the germination point.

Method 2

Nail the tag to the tree 1.3 m above the germination point.

For each of these ingrowth trees, on the front of the growth sample record sheet record: measurement number, tree number, species, sector number, measured diameter at 1.3 m and 1.37 m to the nearest millimetre, tree class, decay indicators, crown class, live-crown length, insect, disease or injury code (if applicable) and the number of the closest previously numbered living tree.

8.1343 Sub-plot Establishment and Tree Count

To have some representation from trees below the 7.5-centimetre tagging limit a sub-plot is established at the centre of the square or rectangular experimental plot.

Mark the intersection of the corner post diagonals with an aluminum tubular stake and establish a circular sub-plot from the centre of the plot. Mark a large living tree close to the aluminum plot centre stake as the plot centre tree; nail two aluminum growth plot markers approximately two metres above the ground; and on these markers inscribe the experimental plot number, region number, compartment number, and the original date of plot establishment. Also mark the centre tree with two strands of red plastic flagging tape, one above and one below the aluminum markers. The sub-plot size is dependent upon the density of small trees on the plot as the aim is to obtain 30 living stems (minimum number accepted is 20) that are 0.3 m and greater in height but less than 7.5 cm d.b.h. at 1.3 m above the germination point. Select the sub-plot size from Appendix 8-19, but ensure that the sub-plot radius is

8.1343 cont.

less or equal to one half of the length of the shortest side of the rectangle; that is, the circular plot should stay within the rectangular plot, even if less than 20 stems are obtained. Mark the sub-plot circumference with string. Select three trees around the sub-plot centre and record the bearing and distance from the centre stake to each tree in the stem map columns. This information will aid future remeasurement crews in relocating the position of a centre stake that has been pulled out. For each ingrowth tree within the sub-plot, record 2 in the sub-plot tree column.

Follow the established sectors and tag, by consecutive number for the plot, all previously untagged living trees within the sub-plot that are 2.0 cm d.b.h. and greater but less than 7.5 cm d.b.h. (that is, d.b.h. measured at a point 1.3 m above the germination point). Special rules govern the tagging of forked trees that are at least 2.0 cm d.b.h. but less than 7.5 cm d.b.h. within the sub-plots:

A. If the fork occurs at or above 1.3 m, tag the stem as a single tree.

B. If the fork occurs below 1.3 m, tag each fork as a tree provided each is 2.0 cm d.b.h. and greater.

For tagging these previously untagged living trees, select method 1 (if method 1 was used previously) or method 2 (if that one was used). For both methods either inscribe the tree number on aluminum tags or use numbered, blue, plastic tags.

Method 1

Nail the tag to the tree 1.37 m above the germination point. Drive a second nail into each tree 0.07 m below the first nail, that is, 1.3 m above the germination point.

Method 2

Nail the tag to the tree 1.3 m above the germination point.

For previously tagged living trees within the sub-plot that are 2.0 cm d.b.h. and greater but less than 7.5 cm d.b.h. (at 1.3 m), select method 1 if used previously or method 2 if that one was used.

For each tagged tree in the sub-plot that is at least 2.0 cm d.b.h. but less than 7.5 cm d.b.h, record on the growth sample record sheet: measurement number, tree number, species, sector number, measured diameter at 1.3 m and 1.37 m to the nearest millimetre, tree class, decay indicators, crown class, live-crown length, insect, disease or injury code (if applicable), sub-plot tree code 1, and the number of the closest previously numbered intermediate, codominant, or dominant living tree.

If the major component of the stand is in trees greater than or equal to 2.0 cm d.b.h., tag only trees within the sub-plot that are 2.0 cm d.b.h. and greater. Count in a dot tally, the remaining trees within the sub-plot that are less than 2.0 cm d.b.h., derive their metric d.b.h. classes at 1.3 m (see Table 8-1), and record them on the tree count section of the field record sheet (see Appendix 8-7). In addition, record (on the imperial units section of the tree count form) as imperial d.b.h. class one (see Table 8-2) trees less than 2.0 cm d.b.h. but at least 1.5 cm d.b.h. at 1.37 metres.

If the major component of the stand is in trees less than 2.0 cm d.b.h., the tagging limit for trees within the sub-plot must be lowered to include trees greater than 1.3 metres. For trees greater than 1.3 metres but less than 2.0 cm d.b.h., wire their tags onto a branch (if large enough) or onto the main stem (ensuring that space sufficient for future growth is left), measure their height (instead of diameter) to the nearest decimetre, and record them in the small tree height section of the growth sample record sheet. In addition, record as imperial d.b.h. class one on the tree count section of the growth sample record sheet, trees less than 2.0 cm d.b.h. but at least 1.5 cm d.b.h. at 1.37 metres. Record the remaining trees within the sub-plot (0.3 m to 1.3 m in height) in a metric dot tally.

Give special attention to the method of tagging or counting forked trees less than 2.0 cm d.b.h. To avoid tagging or counting numerous leaders of trees that have been severely browsed, for example, tag as a tree only the tallest leader (see Appendix 8-6). If applicable (i.e. if the major component of the stand is in trees less than 2.0 cm dbh), for tagged trees less than 2.0 cm dbh record on the growth sample record sheet: measurement number, tree number, species, sector number, small tree height (instead of diameter) to the nearest decimetre, tree class code 1, crown class, live-crown length, sub-plot tree code 1, and the number of the closest previously numbered intermediate, codominant, or dominant living tree.

For tagged trees less than 2.0 cm d.b.h. small tree height replaces diameter and no decay indicators are recorded for the tree but note them in the remarks section. Measure the small tree height from the germination point to the tip of the terminal bud. For small trees with drooping leaders such as cedar and hemlock, measure the height to the highest point of the droop.

Now and then, unusual live trees are encountered within the sub-plot. Special rules apply to the measurement of the height of these abnormal trees that are less than 2.0 cm d.b.h. (see Appendix 8-6).

8.1343 cont.

The preceding detailed information is summarized in the office during the sample processing stage to make two different tree counts (metric and imperial) that use two different dbh class limits (see Tables 8-1 and 8-2). The tree count is a record of the number of living stems (within the sub-plot) 0.3 m in height and greater but less than 9.1 cm d.b.h. (assessed at 1.37 m). Always make a stem count by d.b.h. class, by species, and by sector and use the simple dot count method of tallying (see Appendix 8-7).

Table 8-1

Metric d.b.h. classes and limits

D.B.H. Class	Limits
0	All trees 0.3 m to 1.3 m in height
1	0.0 cm to 1.9 cm
2	2.0 cm to 3.9 cm
3	4.0 cm to 5.9 cm
4	6.0 cm to 7.9 cm
5	8.0 cm to 9.9 cm

For each tree within the sub-plot first derive the imperial d.b.h. class at 1.37 m (see Table 8-2) and secondly the metric d.b.h. class at 1.3 m (see Table 8-1). Include only trees that are at least 0.3 m in height but less than 9.1 cm d.b.h. (at 1.37 m) in the tree count. For example, a tree that is 9.1 cm d.b.h. at 1.37 m and 9.0 cm d.b.h. at 1.3 m would not be included in the tree count. However, a tree that is 9.0 cm d.b.h. at 1.37 m and 9.1 cm d.b.h. at 1.3 m would be included in the tree count and would be recorded as imperial d.b.h. class 3 and metric d.b.h. class 5.

Table 8-2

Imperial d.b.h. classes and limits
(d.b.h. class assessed at 1.37 m)

D.B.H. Class	Limits (inches)	Limits (cm)
1	0.6 to 1.5	1.5 to 3.9
2	1.6 to 2.5	4.0 to 6.4
3	2.6 to 3.5	6.5 to 9.0

8.1344 Stand Structure

Stand structure is the physical arrangement or pattern of organization of the stand. Stand structure is described and classified according to recognizable differences in age and in height.

The stand structures recognized are:

A. Single layer

1. Simple structure (even age, even height)

a) Without veterans
b) With veterans

2. Complex structure (uneven age, uneven height)

a) Without veterans
b) With veterans

B. Multi-layer

A multi-layered stand has two distinct layers:

1. Layer 1 (top layer)
2. Layer 2 (bottom layer)

For further details on stand structure, see Appendix 8-11.

For each tagged tree, identify the layer to which it belongs. For single-layered stands, only record the veteran layer code (v) in column 61 (F.S. 820), if veterans are present; for multi-layered stands, record the layer code for each tagged tree in column 61: codes 1, 2, and V for layer 1, layer 2, and a veteran layer, respectively.

8.1345 Sample Trees for Height

For single plot experimental samples 14 heights are required for each major species in the sample, of which 10 are to be taken from the ten dominant and/or codominant trees of largest diameter, while the other four are to cover the remaining range of stand diameters (down to 2.0 cm d.b.h.). A major species is one which comprises 20 percent or more of the gross sample volume. For a vertical profile of a single-layered simple stand illustrating the basis for sample tree selection, see Figure 8-1.

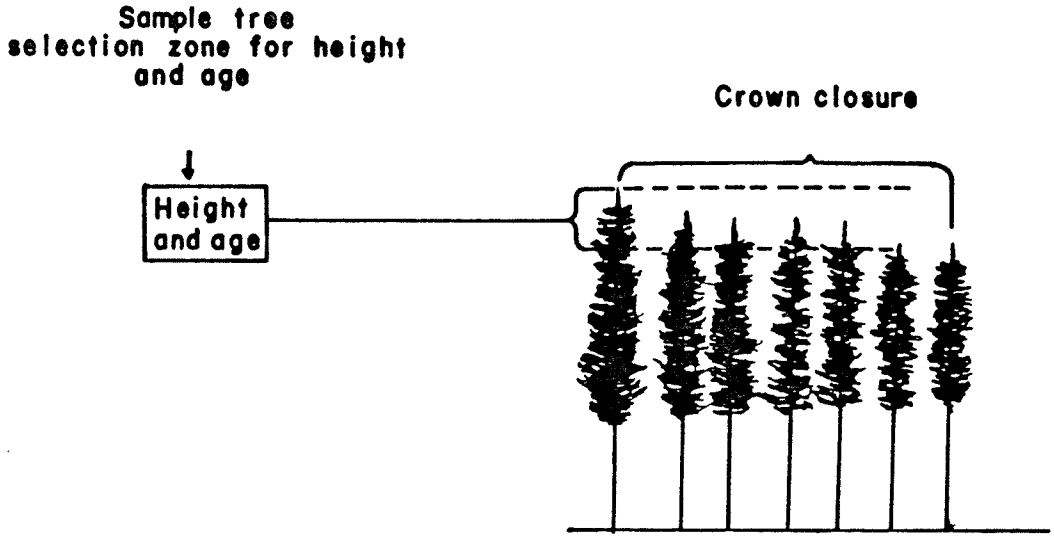

Figure 8-1 Sample tree selection in a single-layered, simple stand

For each minor species, take four heights from trees covering the full range of diameters for the particular species (down to 2.0 cm d.b.h.). A minor species is one which comprises from 10 to 19 percent of the gross sample volume. One height is required for each scattered species. A scattered species comprises less then 10 percent of the gross sample volume. If veteran trees are present in the sample, take at least one height for each species and estimate, to the nearest metre, the total height of all other veterans in the sample. Record each estimated height in columns 24 to 26 of the growth sample record sheet (F.S. 820).

Check the species composition of the previous measurement and use it as a guide for sample tree requirements. If the species composition has changed from the previous measurement, adjust the sample tree requirement accordingly.

For multiple-plot experimental samples, a minimum of 10 heights is required for each plot. Use the species composition to select sample trees by species. For example, if the species composition is Douglas-fir (70%) and lodgepole pine (30%), seven heights are required for Douglas-fir and three for lodgepole pine. For each species, select sample trees using a ratio of 10 trees of largest diameter to 4 representing the range of diameters down to 2.0 cm d.b.h. (a 5:2 ratio may be used). In the previous example, of the seven heights required for Douglas-fir, five are to be codominant and dominant trees of largest diameter while two are to be representative of the remaining range of diameters. Of the three heights required for lodgepole pine, two are to be codominant and

dominant trees of largest diameters while one is to be representative of the remaining range of diameters down to 2.0 cm d.b.h.

Remeasure the heights of all previously recorded sample trees if they meet the previously outlined requirements and they are still suitable for height measurement. Sample trees that are no longer suitable have broken tops (broken by wind and snow), have forks or crooks, or have died. Replace these trees with ones of the same species and of similar d.b.h.

Double-check measurements which indicate that trees have shrunk or have grown excessively between the two measurements. For each height measurement the top and bottom of the tree must be clearly visible and the reading on the Suunto percent scale should not exceed 90 percent. The bottom reading may be taken on a hard hat held at the tree-tag height for which the correction is 1.3 m.

Owing to the long time between establishment and present measurements, succession is now becoming visible in some experimental plots.

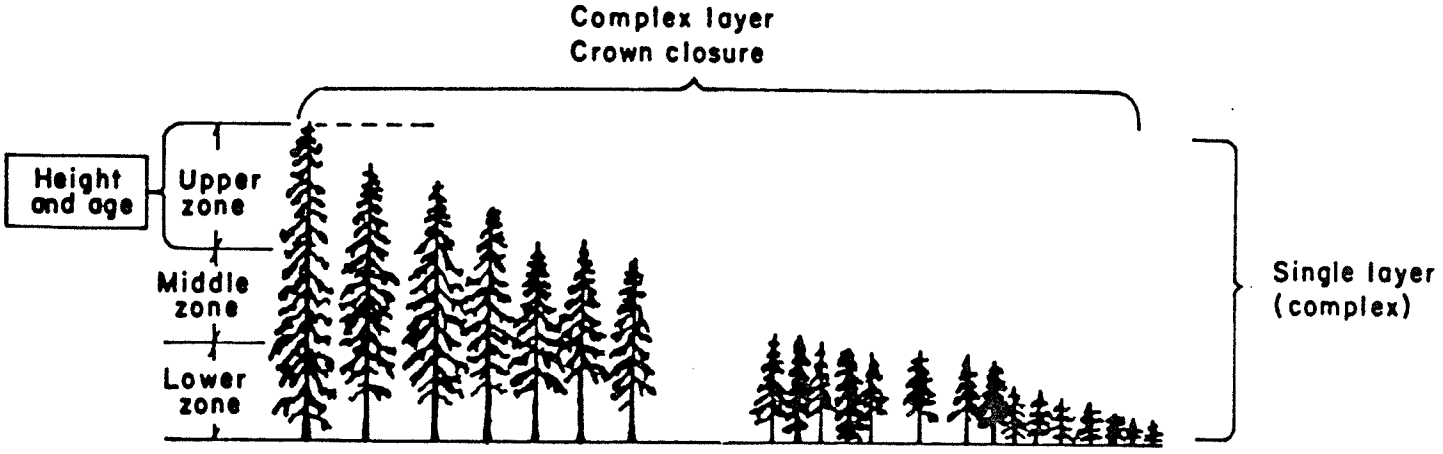

Figure 8-3 Sample tree selection in a multi-layered stand

If the stand structure has changed from a single-layered, simple structure to a multi-layered stand structure (see Section 8.1344), select height sample trees separately for each layer according to previously defined requirements in section 8.1345 of the manual. However, for layer 2 (bottom), replace height sample tree requirements for the dominant and codominant crown classes with the tallest trees of each species in layer 2. In addition, select for boring for age (from the bottom layer), the ten tallest trees of the leading major species. Figure 8-3 illustrates the basis for sample tree selection in a multi-layered stand. For every other major species in the bottom layer, take one additional age. Bore trees selected for age at 1.3 m (breast height) above the germination point. Half the cores taken must include the pith. If pith is included, record 1 in the pith column of the growth sample record sheet. If the pith is missed by more than an estimated three years on a tree under 100 years old, or

8.1345 cont.

by five years on a tree over 100 years old, then rebore the tree. Count ages in the field and record them in columns 46 to 48 in the sample tree section of the growth sample record sheet.

Because trees are bored for age above the germination point, a correction must be made to obtain total age. Calculate the average boring age and average height of the 10 sample trees selected from the leading species of the bottom layer provided that all 10 were successfully bored for age at 1.3 m above the germination point. From the species site curve in the Field Handbook, establish a temporary site class based on the average age and average height of the sample trees. Using the correction table for the species, select the age correction factor based on boring height and temporary site class. Then add this age correction factor to the average boring age to give total average age. Using this total average age, check the site curve again to make sure that the site class has not changed owing to the addition of the age correction factor. If the site class has changed, obtain the new age correction factor, and repeat the procedure.

If any sample tree has rot, count the rings on the portion of core that is sound, estimate the number of years in the rotten portion, add the number of years in the sound portion to the number of years in the rotten portion and record the total age in the total age section (columns 53 to 55 of card type 4) of the field record sheet. Record the number of years of rot in columns 46 to 52 of card type 4 (for example "75 years of rot").

8.1346 Crown Closure

Crown closure is the percentage of ground area covered by the vertically projected tree crowns. Estimate crown closure for the plot by layer to the nearest 10 percent, and record this estimate in the crown closure column of the growth sample record sheet (F.S. 820). Record crown closure for the veteran component to the nearest percent. Crown closure for the veteran component in the sample must be less than 6% or it must be classified as a separate layer.

8.1347 Growth Sample Record Sheet (F.S. 820)

Column	Item	Instruction
Front of the Growth Sample Record Sheet (see Appendix 8-7)		
Card Type 1 - Sample Data		
1 to 2	Region No.	- Entered previously.
3 to 5	Compt. No.	- Entered previously.
6	Compt. Letter	- Entered previously, when applicable. Enter a dash if it does not exist.

8.1347 cont.

7 to 9	Sample No.	- Entered previously.
10	Plot No.	- Entered previously.
11	Card Type	- Card type 1 is entered.
12	Measurement No.	- Enter 1 for the first remeasurement, 2 for the second, and so on.
13 to 15	Sample Size	- Entered previously.
16 to 19	Sample per Hectare Factor	- Entered previously.
20 to 23	Sub-sample Size	- Enter the sub-sample size in hectares.
24 to 29	Sub-sample per Hectare Factor	- Enter the factor, which varies with sub-sample size.
30 to 32	Mean Age (Layer 1)	- Enter the mean age for layer 1.
33 to 35	Mean Age (Layer 2)	- If it is a multi-layered stand enter the mean age for layer 2, otherwise record zeros.
36 to 38	Mean Age (Layer V)	- Enter the mean age for the veteran component. If layer V does not exist, leave the columns blank.
39 to 44	Age Range	- Do not use for E.P. remeasurement.
45 to 47	Damage to Sample (%)	- Enter damage to the sample, if any.
48	Stem Map	- If the sample is not stem mapped, enter 0; if it is stem mapped, enter 1.

8.1347 cont.

Column	Item	Instruction
49 to 51	T.S.A. No.	- Enter the T.S.A. number.
52	F.I.Z.	- Enter the forest inventory zone (letters A to L).
53 to 58	Stand Disturbance	- Enter the disturbance type, species, severity, and year of attack.
59 to 60	Tagging Limit	- Record the tagging limit in cm (silviculturally treated samples only)
11	Card Type 2 - Plot Data	
12	Measurement No.	- Enter a 1 for the first remeasurement, 2 for the second, and so on.
13 to 15	Plot Size	- Entered previously.
16 to 19	Plot Radius	- Do not use.
20-23	Sub-plot Size	- Enter the sub-plot size in hectares (see Appendix 8-19).
24 to 27	Sub-plot Radius	- Enter the sub-plot radius in metres (see Appendix 8-19).
28 to 29	Aspect	- Enter the plot aspect (e.g. N.SW.), left-justified.
30 to 31	Slope	- Enter the average slope of each plot in percent.
32 to 35	Elevation	- Enter the elevation above sea level obtained from a contour map.
36 to 38	Crown Closure (Layer 1)	- For layer 1, enter the crown closure of each plot to the nearest 10 percent.
39 to 41	Crown Closure (Layer 2)	- For layer 2, enter the crown closure of each plot to the nearest 10 percent.
42 to 44	Crown Closure (Layer V)	- Enter the crown closure of each plot for the veteran component.

Column	Item	Instruction
45 to 50	Date of Measurement	- Enter the date of plot measurement (year-month-day).
51 to 58	Map No.	- Enter the B.C.G.S. map sheet number.
59 to 66	Photo No.	- Enter the B.C. flight number and the photo number.
67 to 68	Plantation Year	- Enter the year in which the stand was planted (silviculturally treated samples only).
69	Age of Stock	- Enter the age of the stock planted (silviculturally treated samples only).
11	Card Type 3 - Tree Data	
12	Meas. No.	- Enter 1 for the first remeasurememt, 2 for the second, and so on.
13 to 15	Tree No.	- Enter the tag number of the tree being examined.
16 to 17	Species	- Enter the species code of the tree being examined. For species codes, see Appendix 8-14.
18 to 19	Sector No.	- Enter the sector in which each tagged tree is located.
20 to 23	D.B.H. (1.3 m)	- Enter the diameter at breast height (1.3 m above germination point) of each tagged tree 2.0 cm d.b.h. and greater to the nearest millimetre.
24 to 26	Small Tree or Curve Height	- Enter the small tree height to the nearest decimetre for tagged trees (trees 1.3 m in height but less than 2.0 cm d.b.h. at 1.3 m). Also record the estimated height for veterans.
27	Tree Class	- Enter the tree class code, of which four are recognized: residual (1), suspect (2), dead (4), veteran (5), or dead cut down (6).

8.1347 cont.

Column	Item	Instruction
28 to 35	Pathological Remarks	- Record the decay indicators present on each tree.
36	Crown Class	- Record the crown class of each tree.
37 to 45	Stem Mapping	- Record the stem-mapping information for each tree.
46 to 52	Stumps	- Do not use.
53 to 55	Near Tree No.	- Record the tree number of the closest numbered living tree to the ingrowth or sub-plot tree being measured.
56	Sub-plot Tree	- Record code 1 if the tree is located in the sub-plot and is less than 7.5 cm d.b.h. or code 2 if the tree is located in the sub-plot and is greater than or equal to 7.5 cm dbh.
57 to 60	D.B.H. (1.37 m)	- Record d.b.h. taken at 1.37 m above the germination point.
61	Layer	- If the stand has more than one layer, enter the layer to which that tree belongs (for single-layered stands, the layer column must be left blank).
62 to 64	Live-crown length	- Enter the length of the live crown expressed as a percentage of the total length of the tree (to the nearest 10%).
65 to 69	Remarks	- Enter pertinent tree information not recorded in the preceding columns. Record the insect, disease, or injury code in columns 65 to 68.

Back of the Growth Sample Record Sheet (see Appendix 8-7)

Card Type 4 - Sample Tree Data

1 to 10	Plot Identity	- Entered previously (region no., comp. no., letter, sample no., plot no.)

8.1347 cont.

Column	Item	Instruction
11	Card Type	- Card type 4 is entered.
12	Meas. No.	- Enter 1 for the first remeasurement, 2 for the second, and so on.
13 to 15	Tree No.	- Enter the tree number of the sample tree, right-justified.
16 to 17	Species	- Enter the species of the sample tree.
18 to 21	D.B.H.	- Enter the d.b.h. (measured at 1.3 m above the germination point) of the sample tree.
22 to 23	Top	- Enter the top Suunto reading. (% scale)
24 to 26	Bottom	- Enter the bottom Suunto reading (+ or - , % scale).
27 to 29	Total	- Enter the total of the top and bottom readings.
30 to 32	Slope Dist.	- Enter the slope distance from the tree to the measurer.
33 to 34	Slope %	- Enter the slope percent.
35 to 37	Horiz. Dist.	- Enter the horizontal distance between the tree and the measurer.
38 to 40	Height	- Enter the calculated height.
41 to 42	Height Correction	- Enter the height correction.
43 to 45	Total Height	- Enter the total height.
46 to 48	Boring Age	- Enter the boring age.
49 to 50	Boring Height	- Enter the boring height (1.3 m).
51 to 52	Age Correction	- Enter the age correction.
53 to 56	Total Age	- Enter the total age.
56	Pith (1)	- If the pith is included, enter 1.
57 to 62	Rad. Inc. (mm)	- Do not use for E.P. remeasurement.

Column	Item	Instruction
	Tree Count	- Record the tree count as a dot tally in this section.
Card Type 5 - Tree Count Summary Data		
11	Card Type	- Card type 5 is entered.
12	Measurement No.	- Enter 1 for the first remeasurement, 2 for the second, and so on.
13 to 14	Species	- Enter the species symbol.
15 to 30	Imperial D.B.H. Classes	- Enter the number of trees in each d.b.h. class by species as well as the total by species.
31 to 58	Metric D.B.H. Classes	- Enter the number of trees in each d.b.h. class by species as well as the total by species.
Card Type 6 - Stem Mapping Data		
(11 to 21)	Stem Mapping	- Record the necessary information for stem-mapped samples
11	Card Type	- Card type 6 is entered.
12	Measurement No.	- Enter 1 for the first remeasurement, 2 for the second, and so on.
13	Compass at PLT Centre Y = 1 N = 2	- If the staff compass was set up at plot centre, record 1; and if it was set up elsewhere, record 2.
14 to 16	Bearing From Compass to Plot Centre (0 to 360°)	- If the compass was not set up at plot centre, record the bearing (0 to 360°) from the compass to the plot centre.
17 to 18	Slope (%)	- Only if the compass was set up at plot centre, record the slope percent from the compass to plot centre. If the slope is zero, record 0.

8.1347 cont.

19 to 21	Slope Distance (0.01 m)	- If the compass was not set up at plot centre, record the slope distance from the compass to plot centre.
	Sector Diagram	- Do not use.
	Topography	- Do not use.
	Main Ground Cover	- Do not use.
	Location and Access	- If the access to the sample has changed, describe the change.
	Notes	- Record remarks and a summary of the condition of the experimental sample at remeasurement..
	Meas. No. __ by __	- Record the measurement number and have the measurer sign the sample.

8.135 Quality Control

Refer to Appendix 8-1 for the standards of measurement, which state the non-sampling error or variation allowed. Sampling crews should emphasize accuracy of measurement and then production.

To ensure that crews continue to work efficiently, and that they follow and understand the application of recommended procedures, regular inspections must be carried out on each crew. Inspect at least 10 percent of all experimental plots remeasured, and where the inspection shows that an experimental plot has been poorly done, the original crew may be required to redo it. So that their performance can be observed, occasionally visit each crew on the plot.

8.1351 Office Checking of Experimental Plots

All field sheets must be office checked before sending them to the Growth and Yield Section, at the Inventory Branch. To office check them properly:

A. Check that all information recorded is legible and dark enough for clear photocopying.

B. Check that the region number, the compartment number, the compartment letter, the sample number, and the plot number were recorded on every page and the tree information is complete, is recorded in the proper column, and is correctly justified (numbers are right-justified and letters are left-justified).

8.1351 cont.

C. Check that a general summary on the condition of the sample has been recorded in the "Notes" section of the growth sample record sheet. For example:

1980 - Corner posts were all in place
- Ten percent of the original tags were missing

D. Check that for each plot, the bearings and distances from plot centre to three tagged, living trees have been recorded in the stem-map columns.

E. For plots that have been stem mapped, check that the required information on the location of the staff compass has been recorded for card type 6.

F. Check that a zero has been recorded in the the slope percent column, that is, for stem-map and height measurements, if the distance measured is a horizontal distance.

G. Check that the assignment of tree class meets these criteria:

Tree class 1 - Tree has no decay indicators.
Tree class 2 - Tree has one or more decay indicators.
Tree class 3 - Not used.
Tree class 4 - Tree is dead.
Tree class 5 - Tree is a veteran and may or may not have decay indicators.
Tree class 6 - Tree is dead but cut down.

H. Compare diameter measurements with those of the previous measurement. If a diameter has not increased, has decreased, or has increased more than normal, make sure that the crew rechecked the diameter and placed a check mark in the remarks column.

I. Check that sample trees have been selected in accordance with the specifications in this manual (see Section 8.1345).

J. Check height calculations and compare the results with those of the previous measurement. If the height has decreased or has increased excessively, make sure that the crew rechecked the diameter and placed a check mark in the margin.

K. For each ingrowth or sub-plot tagged tree, check that the sector in which it is located and the tree number of the closest tagged living tree have been recorded in the appropriate column of the growth sample record sheet.

L. For stem-mapped plots, check that the tree number of the tree to which the flag is attached for 70 mm photography was recorded on the back of the growth sample record sheet.

M. Check that a one has been recorded in the sub-plot tree column for each tagged tree less than 7.5 cm d.b.h. within the sub-plot.

8.1351 cont.

N. Check that a tree count has been recorded for both imperial (if applicable) and metric d.b.h. classes, especially if the number of tagged sub-plot trees is less than 20. The total of the metric count must be equal to or greater than the total of the imperial count. Ensure that the tagged sub-plot trees plus those in the metric tree count total a minimum of 20 trees.

O. Check that mean sample age and mean sample height have been calculated correctly and have been recorded only on the first sheet for each plot.

P. Check that the measurement number, the sample and sub-sample sizes and per hectare factors, the T.S.A. number, the F.I.Z., the special cruise number, the plot and sub-plot sizes, the sub-plot radius, the crown closure, and the date of measurement have been recorded only on the first sheet of each plot.

Q. Check that the pages have been numbered properly and the tallyperson has signed the sample.

8.1352 Plot Inspection Procedures

Pre-field Inspection

A. Randomly select one plot that has been office checked according to the procedures in Section 8.1351

B. Randomly select six trees from the tree detail section (card type 3) of the growth sample record sheet and transcribe their respective measurements onto the top section of the plot inspection report (see Appendix 8-15). Of the six, one must be selected from the newly tagged ingrowth trees and another must be selected from the newly tagged sub-plot trees.

C. Randomly select three trees from the sample tree section (card type 4) of the growth sample record sheet and transcribe their height measurements onto the sample tree section of the natural stands plot inspection report.

D. Transcribe the crown closure of the plot into the appropriate section of the plot inspection report.

E. Transcribe the sample identity (region, compartment, sample, plot), plot and sub-plot sizes, plot and sub-plot radii, inspection date, original tally crew, and date of measurement at the top of the plot inspection report.

F. Randomly select one sub-plot sector to check (in the field) that all sub-plot trees less than 7.5 cm d.b.h. but at least 0.3 m in height were either tagged or counted in the dot tally.

Field Inspection

A. Use the access notes to get to the plot.

8.1352 cont.

B. If a new tie tree has been selected on remeasurement, check that it has been marked as specified in Section 8.1332

C. If a new tie line was run, verify that the tie line bearing and distance have been run within the allowable standards.

D. Check that the information on the aluminum plot centre markers is correct and the plot centre stake is protected with a cairn.

E. Check that the bearing and distance from plot centre to the three stem mapped trees are correct.

F. Check the plot and sub-plot perimeters each at a minimum of three different locations for trees that should have been included or excluded from the plot or sub-plot. Also, check that trees away from the perimeters, but within the plot and sub-plot, that are larger than the tagging limits, were not missed. Flag with a circled asterisk any tree missed or tallied when it should have been included or excluded respectively.

G. Check that all sub-plot trees less than 7.5 cm d.b.h. but at least 0.3 m in height were either tagged or counted in the dot tally.

H. Carefully measure all the selected trees recorded on the plot inspection report for:

1. Tree identification

   Check that the genus or species of each tree inspected is correct and place a circled asterisk beside a tree that was incorrectly identified.

2. Tree tag height

   Check the tag height of the selected ingrowth and sub-plot trees to verify that breast heights (if applicable) have been located at 1.3 m and 1.37 m above the germination point. At the same time, make sure that the nails have been securely driven into the trees and the nail with the tag has been driven in at a slight angle so that the tag hangs away from the tree.

3. Diameter and pathological remarks (decay indicators)

   Measure the six selected trees for d.b.h. and classify them.

4. Sample tree heights

   Measure the three selected trees for height.

8.1352 cont.

5. Stem mapping

If the sample was stem mapped, check the six selected trees for bearing, distance, and percent slope.

Also, assess crown closure for the plot. Compare all of these measurements with the previous measurements and give the crew the benefit of the doubt on any slight discrepancy.

I. Check that the results conform to the standards of measurement (see Appendix 8-1).

J. Use an asterisk in the margin to indicate that the difference between two measurements is greater than the allowable error.

K. Use a circled asterisk in the margin to indicate that the error is greater than one and a half times the allowable error.

L. Complete the inspection items section of the inspection report.

M. Rate the quality of the work done on the plot using the weighting system in Appendix 8-16.

N. Record the plot rating and any other comments in the remarks section of the plot inspection report.

Post Field Inspection

A. Discuss the results of the plot inspection with the original tally crew.

B. Make recommendations to the original field crew, when necessary, for improvement of their work.

C. Change, on the original field sheets, all data flagged with an asterisk or circled asterisk.

8.136 Damage to the Experimental Plot

Even though reserves were placed around the experimental plots, some have been disturbed through logging, road building, pipe-line and power-line right-of-way clearings, and escaped fires. Nature has also damaged some of the experimental plots through windthrow, slides, snow, fungi, insects, and fire.

Remeasure the plots if at least 50 percent of the initially measured trees are still alive. Attach a detailed description of the damage to the sample record sheet.

8.137 Return of the Growth Sample Record Sheets (F.S. 820)

Once the field sheets have been office checked and corrected, make good legible photo copies of all field sheets before sending the originals to the Growth and Yield Section at the Inventory Branch.

Store the photo copies in the Forest Region for security and reference. Send a covering letter with the originals that lists the experimental samples sent and keep a duplicate of it for field office records. If the data are being sent by mail, register them.