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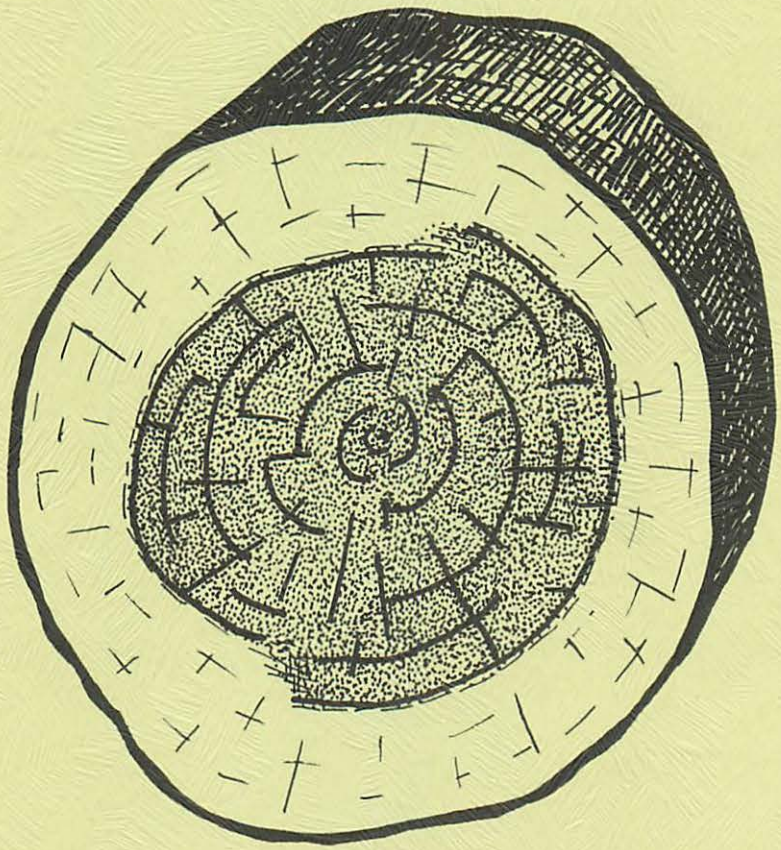
WOOD DEFECT AND DENSITY STUDIES OF LIVING TREES: 1-FIELD GUIDE

by G. Laflamme
J. Meades
G. Eagen



NEWFOUNDLAND FOREST RESEARCH CENTRE
ST. JOHN'S, NEWFOUNDLAND
INFORMATION REPORT N-X-148

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WOOD DEFECT AND DENSITY STUDIES OF LIVING TREES: I - FIELD GUIDE

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FOREWORD

This Field Guide provides specific instructions for measuring wood defect and density in living trees for the intensive forest cull survey now in progress in Newfoundland-Labrador. It replaces the Field Manual entitled Measuring Decay and Cull in Forests, Information Report N-X-119, published by D.G. Bryant and K.S. Richardson, June 1974. Unfortunately, the manual was prepared before completion of the computer program for this study. The present guide is based on experience acquired during three seasons of field work in close collaboration with the Province* and Bowater*. It incorporates changes in coding and tally form, and the metric system was introduced. The examples used have been taken from the manual prepared by Bryant and Richardson.

ACKNOWLEDGEMENTS

We are grateful to Mr. John Marshall for his assistance in drafting the illustrations.

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*The Newfoundland forests are controlled by the Forestry Branch, Department of Forestry and Agriculture of Newfoundland-Labrador, Bowater Newfoundland Limited and Price (Nfld.) Pulp and Paper Limited. Throughout the report, these agencies will be identified as Province, Bowater and Price respectively.

TABLE OF CONTENTS

Wood Defect and Density Studies of Living Trees:

I - Field Guide

by

G. Laflamme
J. Meades
G. Eagen[1]

Introduction

The Forest Management legislation enacted in 1973 requires that forest management plans be prepared for each Management Unit in Newfoundland and Labrador. The Forest Inventory completed in 1969 provided global estimates of volume and cull losses but was lacking in detailed data necessary for the preparation of sound management plans. In 1974 Bowater embarked on an inventory of their holdings using the Continuous Forest Inventory method and in 1975 the Province and Price initiated an inventory of all Crown lands and Price holdings using the method of air photo interpretation supplemented by stratified ground sampling. The Newfoundland Forest Research Centre is conducting a cull and density survey in conjunction with these inventories to provide estimates of losses from decay and form defect as well as to determine the basic density of the major commercial species. The survey is being carried out in cooperation with the various agencies involved in forest inventory.

The Computing and Applied Statistics Directorate, Fisheries and Environment Canada, developed a computer program to facilitate the data processing involved in the survey. This field guide explains the field procedures of the survey, presents the proper methods of coding data on the tally sheet and gives examples of how to measure specific defects.

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[1]Computing and Applied Statistics Directorate, Fisheries and Environment, Ottawa.

I Plot Location and Establishment

The survey is being conducted in cooperation with the Province, Price and Bowater. The two former agencies are using a stratified sampling design with temporary field plots while the latter is using the Continuous Forest Inventory System with permanent field plots. The difference in design introduces some difference in the plot location and establishment procedures for cull survey plots. The method of choosing, locating and establishing cull survey plots is listed below.

1. A list of random plot numbers will be generated for each agency for each management unit.

2. The crew chief will select a number from the list and refer to the Plot Tally Sheet to determine if the plot is productive. If it is not productive or is inaccessible, he will choose the next number from the list and check again.

3. After a productive, accessible plot has been found, the required plot data and location information will be transferred to the Stem Analysis Form (see Section II for the data which is to be transferred to the Stem Analysis Form).

4. When the plot has been located in the field the establishment procedure is as follows for each inventory design.

    a) Province and Price: .01 ha plots, the boundary will be re-established and all trees over 9.0 cm DBH will be marked and numbered.

    b) Bowater: Since the C.F.I. permanent plots cannot be cut, a cull plot will be established as close as possible to the permanent plot with special care being taken not to damage the C.F.I. plot and to ensure that the cull plot is in exactly the same type of stand condition. A plot center will be established and all trees over 9.0 cm DBH in a .01 ha (5.65 m radius) circle will be marked and numbered.

II Site and Stand Measurements

The methods of recording observations and measurements of site and stand characteristics are given in the coding schedule below. The schedule is arranged in the logical order of data collection. The specimen coding sheet (Figure 1) has the field numbers inserted for clarification. The abbreviations used on the coding sheet are given in the third column of the coding schedule. Copies of Plot Tally Sheets used by the various agencies are shown on Figures 2 and 3 with the cull survey data field numbers indicated for the data which is to be transferred to the Stem Analysis Form.

Data to be transferred from the inventory plot tally sheets

Field	Parameter	Abbr.	Coding instructions
5	Management Unit	MU	Enter Management Unit number recorded on plot tally sheet.
6*	Watershed		For Bowater plots, copy the four digit watershed number. For the Province and Price plots, leave this field blank.
7	Map number	Map	Copy the three digit map number.
8	Ownership	OW	Enter the two-character ownership code as described in the "Management Inventory User Documentation" manual.[2]

First character owner	Second character ownership type
B - Bowater	P - Private
P - Price	L - Leased
N - Government	H - Charter
M - Municipal	C - Crown
G - Private	R - Reserve

9	Plot number	Plot	Record the plot number from the plot tally sheet.

[2] Dunphy, A. 1977. Forest Management Inventory User Documentation, Nfld. & Labrador Computer Services.

STEM ANALYSIS FORM

TREE NO. _____ Height Increments: Last 5 Yrs _____ 10 Yrs _____ Recorded by: _____ Date: _____

Tree I.D. No.	FC	Rt	Spec.	MU	Watershed	Map	OW	Plot	Stand Type	Stratum	Ft	Slope	AS	SM	To
1 2	7	8	9	11	12	17	20	22	27 29 35 39	40	44	46	49	51	52
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)

TC	SS	I.D	CC	DBH	Ht.Cr.	Ht. 7.6 cm	Tot. Hgt.	Blts	St. age	Bh. age
53	54	55	57	60	61	64	68	73	74	77
(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)

Rt	Bolt No	BC	Dob.	Dib.	FD	Section 1 2 3 4	FD	Section 1 2 3 4	Ind. sec	Ind. sec	Decay Description & Measurement P	A	I	D/R-A	D/R-	L-A	L-I	DT	Decay org.	Density	RW
8	9	11	12	15	18	19	23	24	28	30	32	33	34	35	38	41	44	47	48	51	54
B	(29)	(30)	(31)	(32)	(33)	(34)	(35)	(36)	(37)	(38)	(39)		(40)	(41)	(42)	(43)	(44)	(45)	(46)	(47)	
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Figure 1. Stem analysis form used in cull plots.

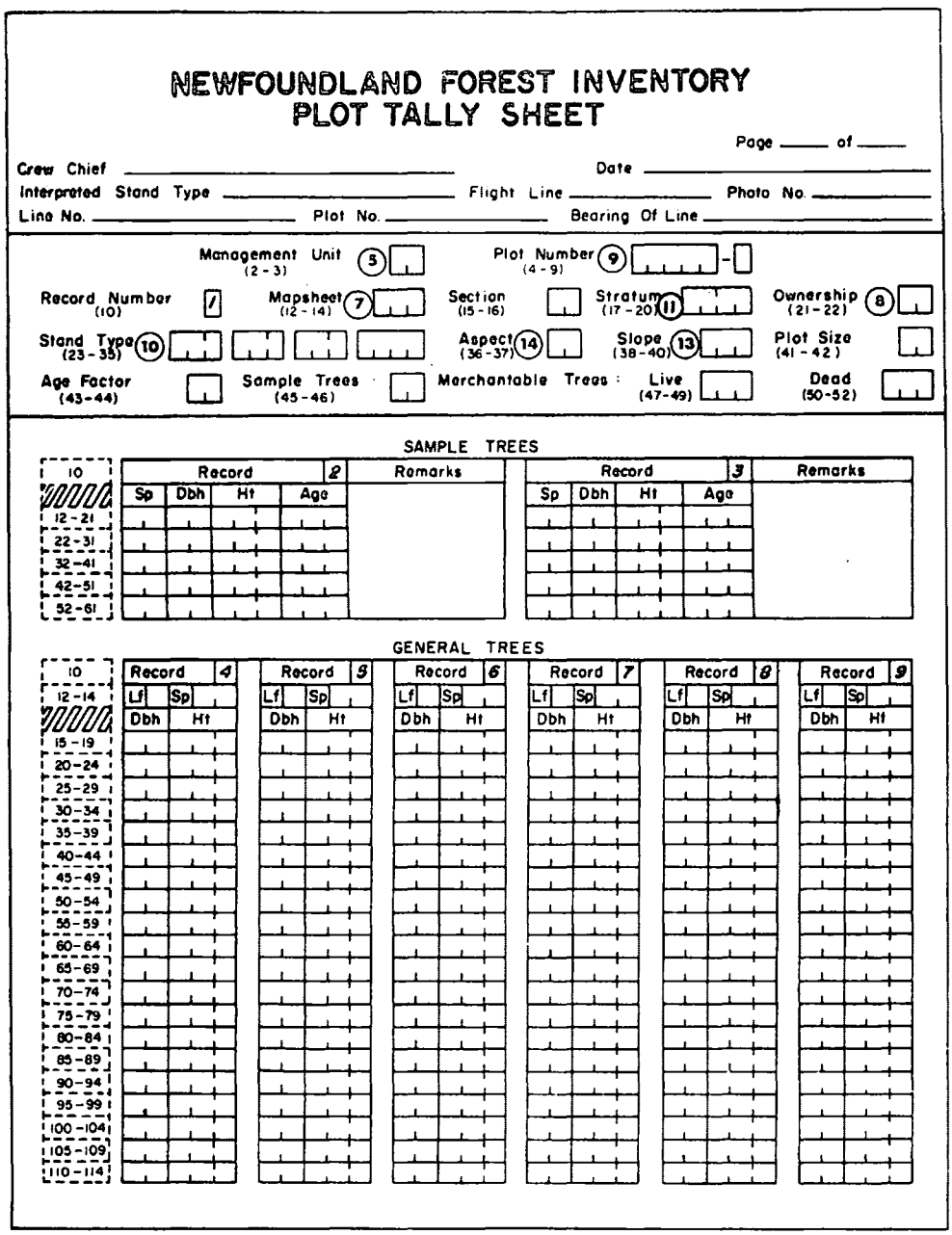


Figure 2. Tally sheet used by Province and Price.

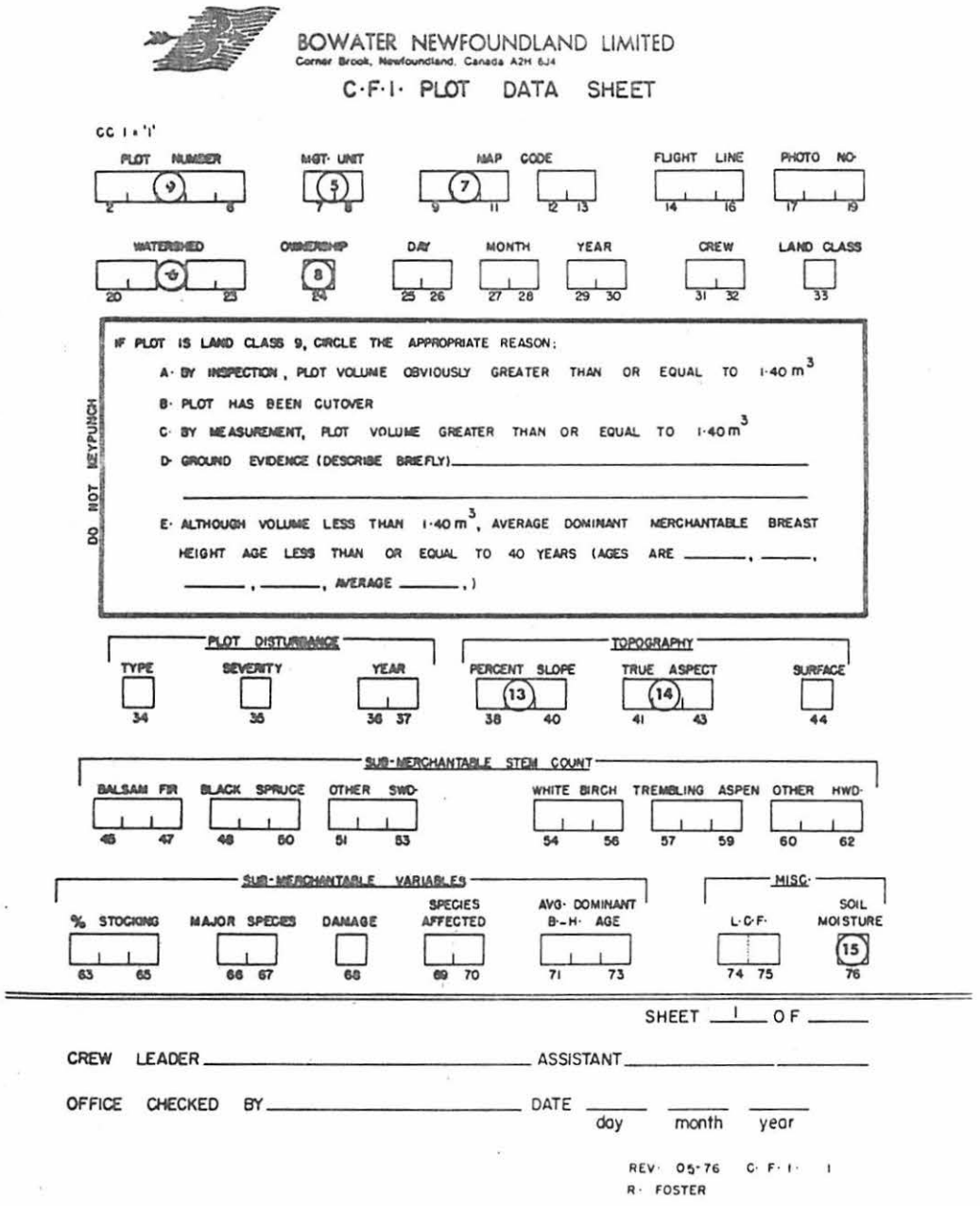


Figure 3. Tally sheet used by Bowater.

Field	Parameter	Abbr.	Coding instructions
10*	Stand type		Enter the 13 character stand type obtained from the Provincial Inventory Section. For the Province or Price plots the stand type can be copied from the plot tally sheet. For Bowater plots, the stand type will be acquired from the Provincial Inventory section at a later date.
11	Stratum		Enter the four character stratum code as determined by the Provincial Inventory Section.
12*	Forest type	Ft	Reserved for the ecological forest type. Leave blank until the types are available.
13	Slope		Enter the slope as a percentage (0-150).
14	Aspect	AS	Enter the two character aspect code (N, NE, E, etc.). In the case of Bowater plot tally sheets where the aspect is recorded in degrees, convert the azimuth reading to one of the 8 aspect codes and enter the two character code on the cull tally sheet.
15*	Soil moisture	SM	For Bowater plots, copy from their tally sheet. For the Province and Price plots, record in the field according to the classification described in Appendix 2.
16*	Topographic position	To	Enter the one digit code 1 - ridge top; 2 - upper slope; 3 - middle slope; 4 - lower slope; 5 - valley bottom.

*In these fields, the data can be transferred from Province sheet only, or Bowater sheet only, or must be left blank, or must be recorded in the plot (field 16).

III Tree Measurements to be Recorded on Standing Trees

All merchantable trees (DBH $\geq$ 9 cm) are numbered sequentially during plot establishment and the tree number recorded in the space provided at the top of the coding sheets. The following observations and measurements will be recorded for each tree before it is cut.

Measurements recorded on individual standing trees

Field	Parameter	Abbr.	Coding instructions
1	Tree Identification No.	Tree I.D. No.	Each tree will have a unique number coded as follows: first 2 digits - year cut third digit - crew number last 3 digits - tree number for that year (Example: 76 2 106)
2	Fork code	FC	Enter 0 for a tree with no forks. If the tree is forked enter 1 for the main stem and number the forks sequentially from 2, 3, ... to a maximum of 9. Note: A tree is not considered forked if the fork occurs below breast height (1.3 m).
4	Species	Spec.	Record the tree species according to the following codes: 02 - white pine 09 - red pine 11 - black spruce 13 - white spruce 21 - balsam fir 31 - larch 61 - trembling aspen 69 - balsam poplar 71 - white birch 72 - yellow birch 82 - red maple 99 - other hardwood
17	Tree condition	TC	Record 0 - living, 1 - dead.
18	Soundness class	SS	Determine soundness percentages as described in Appendix 3 Code: 1 — Soundness Range: 97 - 100% 2 — 84 - 96% 3 — 51 - 83% 4 — $\leq$ 50% (cull)

Field	Parameter	Abbr.	Coding instructions
19	Insect damage	I.D.	First digit refers to Aphid Damage Classification as described in Appendix 4

Code	Range
0	undamaged
1	light
2	moderate
3	severe
4	dead

Second digit refers to damage caused by defoliators.

Code	% defoliation range and insect	
0	NONE	
1	1 - 25%	budworm
2	26 - 50%	"
3	51 - 75%	"
4	76 - 100%	"
5	1 - 25%	hemlock looper
6	26 - 50%	"
7	51 - 75%	"
8	76 - 100%	"
9	Other defoliators present	

20	Crown class	CC	Crown class will be recorded using the following codes.

0 - For a secondary stem of forked tree
1 - Dominant
2 - Co-dominant
3 - Intermediate
4 - Suppressed
7 - Broken top

21	Diameter breast height	DBH	Record the outside bark diameter measured to the nearest 0.1 cm at 1.3 metres above ground line.

IV Methods of Dissecting Trees and Recording Data

Within each plot all trees ≥ 9.0 cm diameter at breast height (DBH) will be felled at stump height (0.18 m) and each tree will be marked at 1.22 m intervals commencing at the butt and extending to the top of the tree. The location of the 7.6 cm diameter outside bark will also be marked. The following data will be recorded before the trees are sectioned with the saw.

A. Data to be recorded before tree is bucked

Field	Parameter	Abbr.	Coding instructions
22	Height to living crown	Ht. Cr.	Record the length to the nearest 0.1 m from the stump to the living crown.
23	Height to 7.6 cm d.o.b.	Ht. 7.6 cm	Enter the length from the stump to 7.6 cm outside bark measured to the nearest centimetre. Record 77.77 if the tree is broken off below 7.6 cm d.o.b.
24	Total height	Tot. Hgt.	Enter the total length of the tree. If the top is broken off, record the height to the break.
25	No. of merchantable bolts	Blts.	Record the number of full 1.22 m bolts below 7.6 cm d.o.b. in the tree. For forks record the number of full 1.22 m bolts from the fork to 7.6 cm d.o.b.
26	Stump age	St. age	Record the stump age of the tree.
27	Breast height age	Bh. age	Record the breast height age of the tree.

B. Sectioning the tree

a. Cut the tree at each 1.22 m mark and at the 7.6 cm diameter mark.

b. Cut a 5 cm thick disc from the lower end of each bolt.

c. If decay is present cut another 10 cm thick disc for fungi isolation in laboratory.

d. If a fork occurs below 1.3 m and both stems are 9.0 cm DBHo.b. or more, the stems are treated as two trees.

e. If a fork occurs above 1.3 m the secondary stem is bucked at 1.22 m intervals from the beginning of the fork to 7.6 cm d.o.b.

C. Measuring the bolts[3] and recording the data

In the absence of defects the bolt numbers and diameter outside and inside bark will be recorded under the columns headed Bolt. no., Dob and Dib. The diameter will be measured to the nearest 0.1 cm by taking the average of two measurements made at right angles to each other. If defects are present, all observations and measurements for these defects are completed and recorded for each bolt before recording successive bolt numbers and their respective diameters. A list of coding specifications for bolt measurements follows and a detailed description of typical defects and the methods of recording their dimensions is given in Appendix 7.

The mean radius will be marked on each disc cut from the lower end of each bolt. After the measurements are completed, a wedge shaped sample including the pith and the mean radius will be cut from the disc. The tree I.D. number and disc number will be marked on each sample. A 10 cm disc of each decay type present in the tree will also be collected and labelled. These discs will be used for the laboratory analysis of density and identification of the causal organism of decay.

Measurements to be recorded from sectioned bolts

Field	Parameter	Abbr.	Coding instructions
29	Bolt number		Record the number of the bolt being measured beginning with one.
30	Bolt card number	BC	If the bolt measurements occupy only one line leave this field blank. When there is more than one line of data per bolt enter 1 for the first line; 2 for the second, etc.
31	Diameter outside bark	Dob	Record the average of two outside bark measurements to the nearest 0.1 cm.
32	Diameter inside bark	Dib	Record the average of two inside bark measurements to the nearest 0.1 cm.
33	Form defects	FD	Record the code for the form defect as described in Appendix 5 Blank - none 2 - crook 1 - fork 3 - sweep
34	Section[3] affected		Enter the number(s) of the 30.5 cm section affected by the form defect in the appropriate column (1, 2, 3, 4).

[3]The term bolt refers to the standard 1.22 m (4 foot) length of wood used in the pulp and paper industry. The term section refers to a 30.5 cm (1 foot) length.

Field	Parameter	Abbr.	Coding instructions
35 & 36	Same procedure as fields 33 & 34 if there is a second form defect in a bolt, otherwise leave blank.		
37	Indicators of decay	Ind. sec.	Record the code for the type of indicator in the first column and the number of the 30.5 cm section affected in the second column.
38	Indicators of decay	Ind. sec.	Same procedure as for field 37 if there is a second indicator in a bolt.
39	Decay description	P-A-I	Record the descriptive codes for the position of the decay and the characteristics of the advanced and incipient decays.

Code	Indicator
Blank	none
1	fork
2	crook
3	rotten branch
4	broken top
5	open scar
6	closed scar
8	canker
9	frost crack

Position

Blank - none	2 - trunk rot
1 - butt rot	3 - sap rot

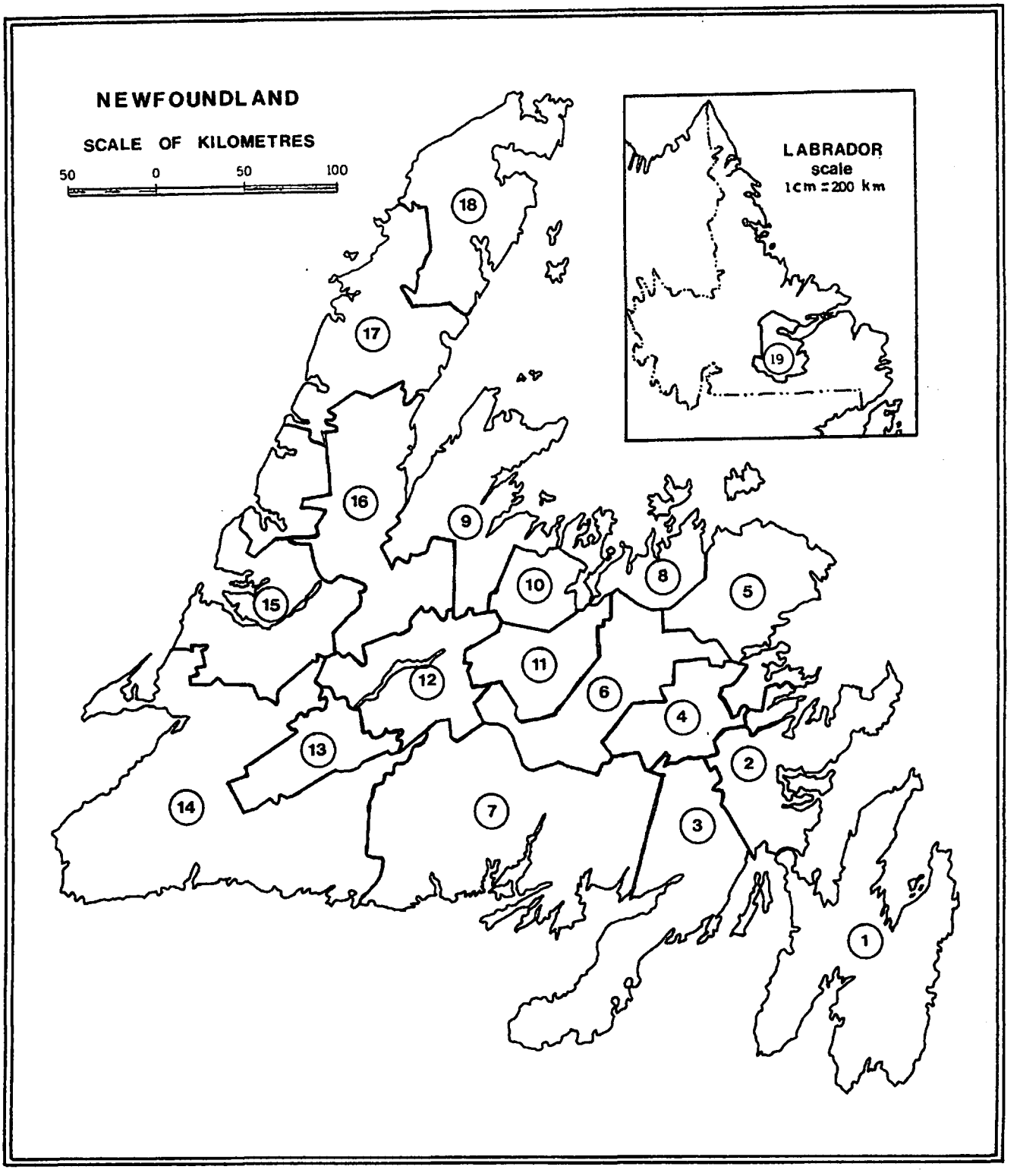
Advanced	Incipient
Blank - none	Blank - none
1 - yellow stringy	1 - yellow
2 - yellow spongy	2 - brown
3 - brown stringy	3 - red
4 - brown spongy	4 - pink
5 - brown cubical	5 - green
6 - white stringy	6 - purple
7 - white spongy	7 - black
8 - red stringy	8 - yellow-green
9 - red pocket	9 - red-brown

Field	Parameter	Abbr.	Coding instructions
40	Diameter or radius of advanced decay	D/R-A	Record the average diameter of advanced butt rot or trunk rot, or the average radial penetration of advanced saprot, measured to the nearest 0.1 cm.
41	Diameter or radius of incipient decay	D/R-I	Record the average diameter of total butt rot or trunk rot, or the average total radial penetration of saprot, measured to the nearest 0.1 cm.
42	Length of advanced decay	L-A	Record the length of the advanced decay to the nearest cm.
43	Length of incipient decay	L-I	Record the total length of the decay to the nearest cm.
44	Decay type	DT	The decay type will be coded in the laboratory after the causal organism has been identified.
45	Decay organism	Decay org.	The causal organism will be entered in the laboratory when the identification is completed.
46	Density	Density	The wood density will be added to the data files after the laboratory analysis is complete.
47	Redwood	RW	Enter -1- if aphid redwood is observed in the bolt.

Measurement of height-growth: The two measurements of height-growth will not be key-punched onto the computer file so they are to be recorded at the top of the sheet. To measure the height growth the tip should be sectioned until the 5 and 10 year growth rings are found. The increments should be recorded to the nearest cm.

APPENDIX 1

Forest management units



APPENDIX 2

Soil drainage classes[4]

The classes are defined in terms of (a) actual moisture content in excess of field capacity, and (b) the extent of the period during which such excess water is present in the plant root zone. They are represented by numerals as follows:

1 - Rapidly drained - The soil moisture content seldom exceeds field capacity in any horizon except immediately after water additions.

2 - Well drained - The soil moisture content does not normally exceed field capacity in any horizon (except possibly the C) for a significant period of the year.

3 - Moderately well drained - Soil moisture in excess of field capacity remains for a small but significant period of the year.

4 - Imperfectly drained - Soil moisture in excess of field capacity remains in subsurface horizons for moderately long periods during the year.

5 - Poorly drained - Soil moisture in excess of field capacity remains in all horizons for a large part of the year. This class includes peaty and mucky phases of soil series recognized in the surveyed area.

6 - Very poorly drained - Free water remains at or within 30 cm of the surface most of the year. The organic soils of the surveyed area generally fall within this category.

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[4]Canada Soil Survey Committee, 1974. The system of soil classification for Canada. Canada Dept. of Agriculture Publ. 1455, p. 220-221.

APPENDIX 3

Soundness classification[5]

"SOUNDNESS" - Each tree will be classed as 1 of 4 soundness classes based on VISIBLE DEFECT -

This is a judgement classification using obvious defects such as breakage, lightning scars, visible rot, extreme distortions of bole form and fire scars which have materially affected the amount of sound wood in the merchantable portion of the tree. No attempt should be made at estimating invisible defect such as probable decay in overmature trees.

The soundness classes refer to the percentage of merchantable volume in a tree. As a guide in sizing up the amount of deduction to apply, visually divide the total tree height into 3 equal lengths. Assume that the lower 1/3 of the tree contains 50% of the total merchantable volume, the middle 1/3 contains 35% and the upper 1/3 contains 15%.

Example: A very abrupt crook distortion in the middle 1/3 of a tree eliminates 1/2 of the middle 1/3. The middle 1/3 contains approximately 35% and 1/2 of that is defective due to crook, so reduce total tree soundness by 17% - or the total tree soundness is 83%.

Code	Soundness
1	97 - 100%
2	84 - 96%
3	51 - 83%
4	$\leq$ 50%

[5]Classification system used by Bowater.

APPENDIX 4

Aphid damage classification[6]

Upper and lower crown branches

Undamaged (1) - no visible symptoms of aphid attack

Light a (2) - nodal swelling indistinct, apparent only at close examination of branches

Light b (3) - nodal swelling distinct, stunting or distortion of branches present

Medium (4) - nodal swelling prominent, branches thinly foliated, branch tips inhibited, but no symptoms of branch mortality

Severe a (5) - as in Medium, but branches bare of needles from tips to 30 cm.

Severe b (6) - as in Severe a, but branches bare of needles from tips to more than 30 cm.

Dead ("Aphid killed") (7) - cambium dead at breast height, symptoms of aphid damage present in crown

Scan visually the upper and lower halves of crown. Based on the most prevalent symptom assign one of the above numerical damage ratings separately to each half of the crown. Average these numerical ratings and assign an average damage rating for the whole tree according to the following class limits:

Code	Range of average numerical gout class ($\bar{x}$)	Average damage to a tree
Blank	$\bar{x} = 1$	Undamaged
1	$\bar{x} = 1.5 - 3.0$	Light
2	$\bar{x} = 3.5 - 4.5$	Medium
3	$\bar{x} = 5 - 6.5$	Severe
4	$\bar{x} = 7$	Dead ("Aphid killed")

[6]This is the standard aphid damage classification system used for tree deterioration studies in Newfoundland, as described by Warren, Parrott, and Cochran, 1967.

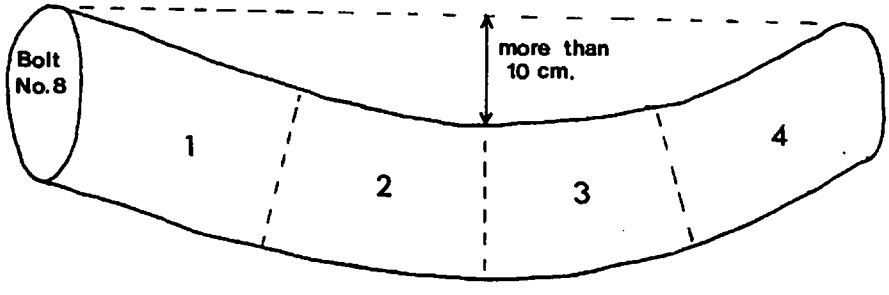
APPENDIX 5

Form defects

Form defects are crook, fork and sweep. The first two result from a damaged or killed leader or stem. Sweep is curvature in the stem and is recognized as a defect only if the curvature is more than 10 cm in a 1.22 m bolt.

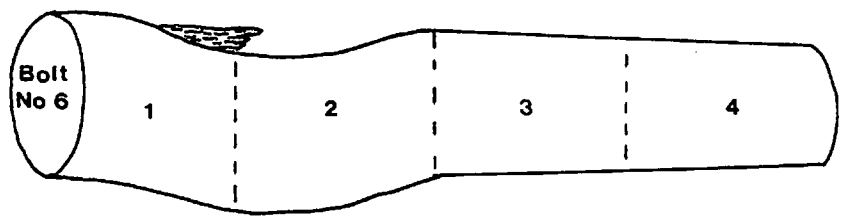
A bolt with form defects is marked into four 30.5 cm sections. The basal section is given the code "1" and the succeeding ones, "2", "3" and "4". Following are examples of different possibilities and the method of recording:

- one form defect (sweep) and four sections affected:



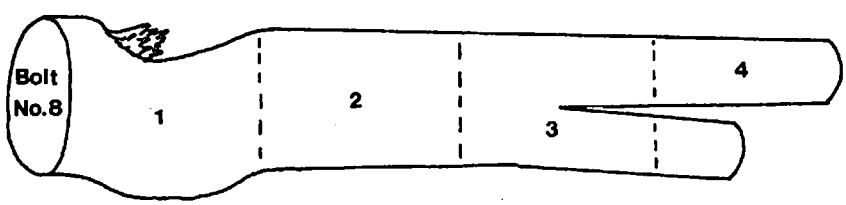
Bolt No	BC	Dob.	Dib.	FD	Section 1	2	3	4	FD	Section 1	2	3	4
9	11	12	15	18	19				23	24			
08		14.6	13.6	3	1	2	3	4					

- one form defect (crook) and two sections affected (1 and 2):



Bolt No	B C	Dob.	Dib.	F D	Section 1	2	3	4	F D	Section 1	2	3	4
9	11	12	15	18	19				23	24			
06		15.3	14.8	2	1	2							

- two form defects (crook and fork) and two sections affected (1 and 3):



Bolt No	B C	Dob.	Dib.	F D	Section 1	2	3	4	F D	Section 1	2	3	4
9	11	12	15	18	19				23	24			
08		14.9	14.1	2	1				1			3	

APPENDIX 6

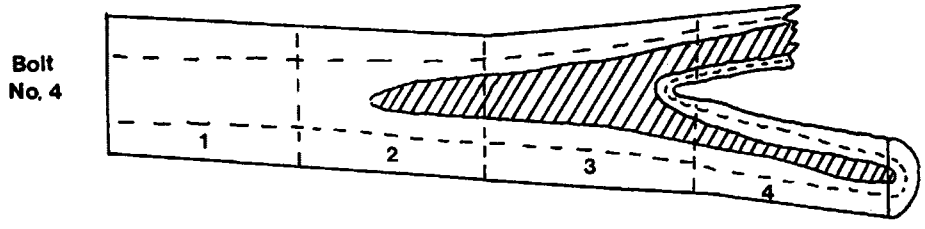
External indicators of decay

Nine external indicators of decay are recognized: conk, canker, fork, crook, rotten branch, broken tip, open scars, closed scars and frost crack.

A bolt with an external indicator must be dissected if decay is present at one end in order to determine if the decay is associated with the indicator. The bolt is marked into four equal sections from the base to the top and coded "1", "2", "3" and "4" respectively.

When an indicator occurs, the code for the indicator will be marked in the first column (Ind. sec.); if there is decay, the section on which the centre of the indicator occurs will be recorded. If more than two indicators of decay occur on a bolt, they are recorded on the succeeding line and the bolt number is repeated. Two examples are given below:

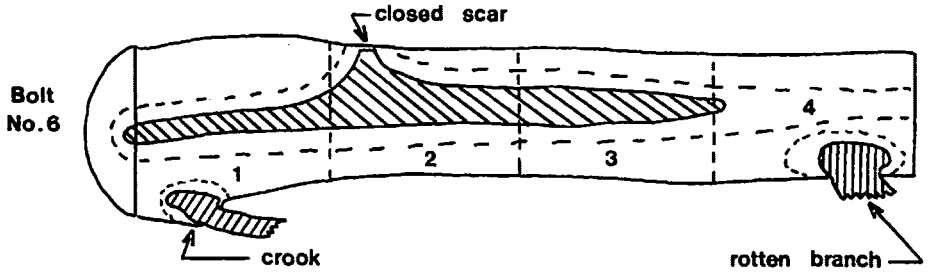
- One external indicator and associated decay.



Bolt No	B C	Dob.	Dib.
9	11	12	15
04		13.5	12.8

Ind. sec	Ind. sec
28	30
13	

- Three external indicators; one is associated with decay.



Bolt No	B C	Dob.	Dib.
9	11	12	15
06		14.0	13.5
06		.	.

Ind. sec	Ind. sec
28	30
62	20
30	

APPENDIX 7

Decay

Decay is recognized by the presence of discolored wood. The decay is classified according to its position in the tree, its stage of development, and its colour and texture.

Position: There are three positions defined as follows:

1. butt rot: caused by fungi that enter the main stem through the root;

2. trunk rot: caused by fungi that enter the tree through external injuries, dead branches, ... etc.

3. sap rot: caused by fungi that infected the sapwood under the dead bark.

Stage: Two different stages are identified:

1. incipient decay: discoloured wood that is not noticeably softer than sound wood;

2. advanced decay: discoloured wood that is softer than sound wood.

Colour and Texture: There are nine colours listed for incipient decay and nine colour-textures for the advanced decay.

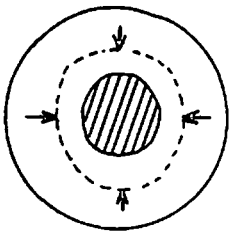
a) Method of measuring the width of decay:

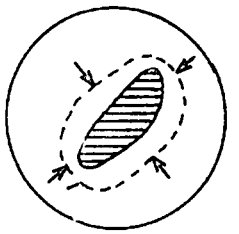
For butt and trunk rots, measure two diameters of decay at a right angle and record the average.

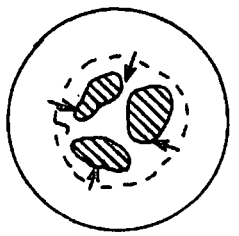
For sap rot, measure two widths of the decay penetration at a right angle and record the average. If only a part of the circumference is affected, say 2/3, reduce the width of the sap rot by 1/3.

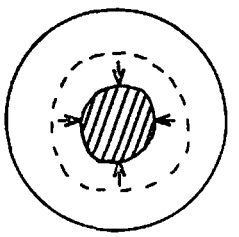
A few examples are given below:

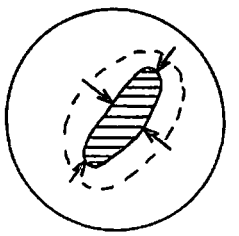
- Heart rot: one decay type.

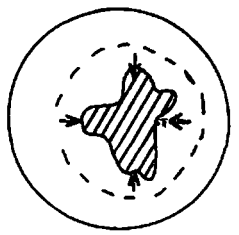

A-Incipient


C-Incipient


E-Advance

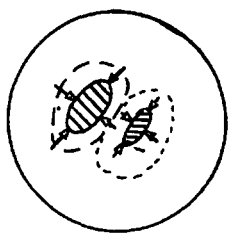

B-Advance

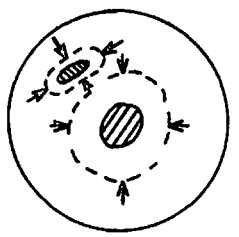

D-Advance


F-Advance

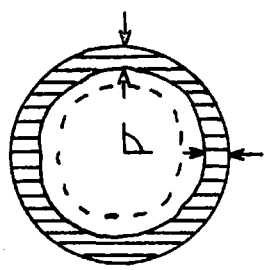
- Heart rot: two decay types.

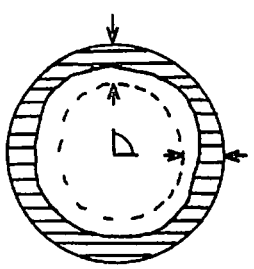

A-Incipient

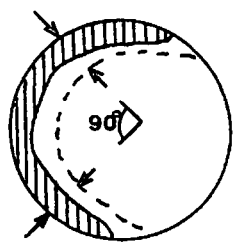

B-Advance


C-Incipient

- Sap rot.


A-Advance


B-Incipient



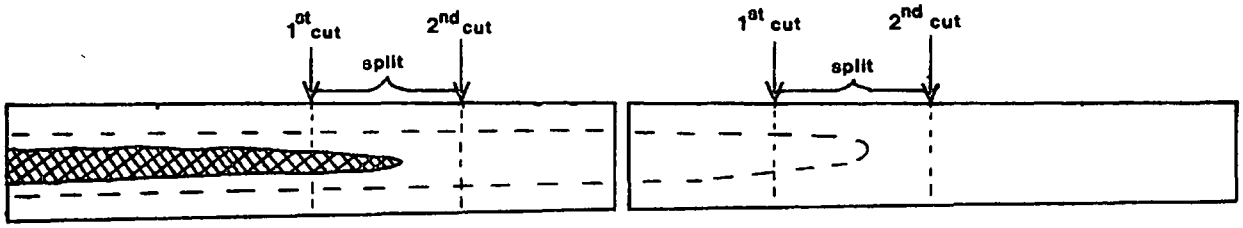
C- 2/3 of the width is recorded

b) Method of measuring the length of decay:

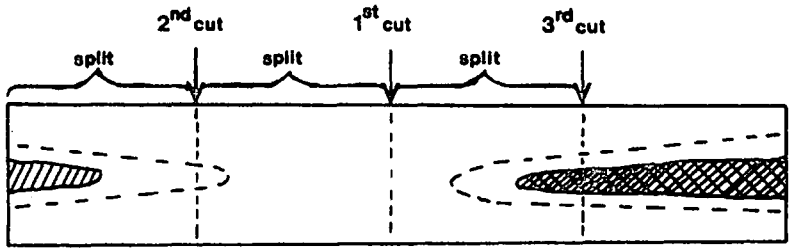
We assume that the decay column is 1.22 m long if the same decay is present in the same stage at both ends of the bolt.

If the stage or type of decay is not the same at both ends, the bolt must be dissected; surface notching is adequate for sap rot, but sectioning is necessary for heart rot. Here are a few examples:

One type of decay:



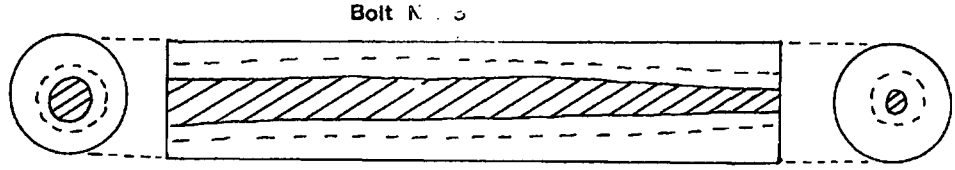
Two types of decay:



c) Method of recording the decay data:

The following examples show the method of recording the decay (position, stage, colour, width and length). If more than one type of decay occurs within a bolt, each type must be recorded on successive lines on the tally form and the bolt number repeated. If advanced decay is present at some levels, its code must be recorded with that of the incipient decay although only the incipient decay may be present at the point of measurement.

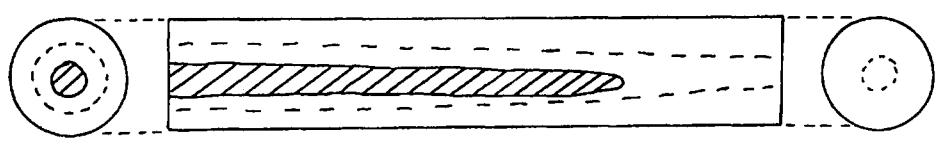
1) one decay type at both ends of a bolt:



Bolt No	B C	Dob.	Dib.
9	11	12	15
05		20.2	19.3

Decay Description & Measurement						
P	A	I	D/R-A	D/R-I	L-A	L-I
32	33	34	35	38	41	44
2	1	2	5.2	7.3	1.22	1.22

2) one decay type at both ends; advanced decay at the base:

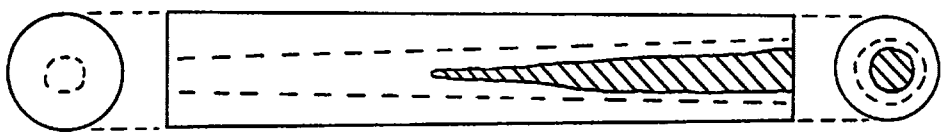


Bolt No	B C	Dob.	Dib.
9	11	12	15
01		22.0	20.8

Decay Description & Measurement						
P	A	I	D/R-A	D/R-I	L-A	L-I
32	33	34	35	38	41	44
1	5	4	09.8	13.3	0.95	1.22

3) one decay type at both ends; advanced decay at the top:

Bolt No. 7

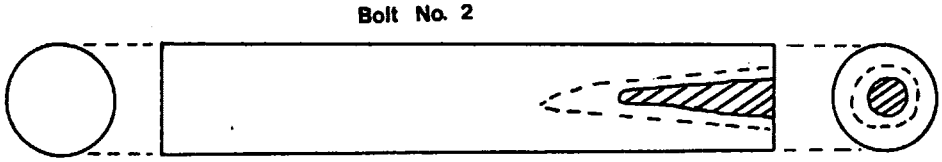


Bolt No	B C	Dob.	Dib.
9	11	12	15
07		16.3	15.5

Decay Description & Measurement						
P	A	I	D/R-A	D/R-I	L-A	L-I
32	33	34	35	38	41	44
2	3	2		6.2	0.68	1.22

4) one decay type at the top of a bolt:

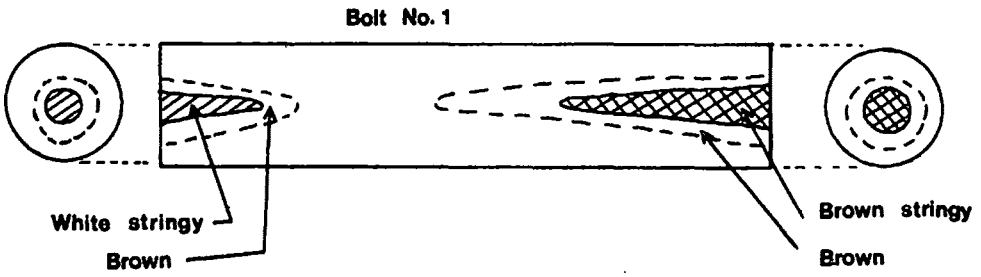
Bolt No. 2



Bolt No	B C	Dob.	Dib.
9	11	12	15
02		20.1	19.3

Decay Description & Measurement						
P	A	I	D/R-A	D/R-I	L-A	L-I
32	33	34	35	38	41	44
2	8	3			0.31	0.45

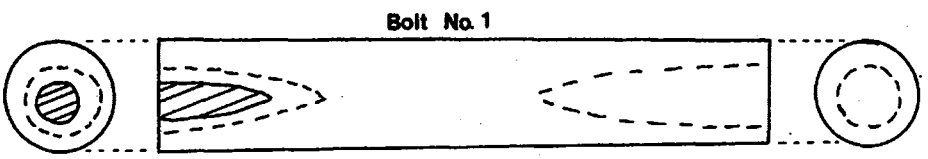
5) two decay types, one at each end of a bolt:

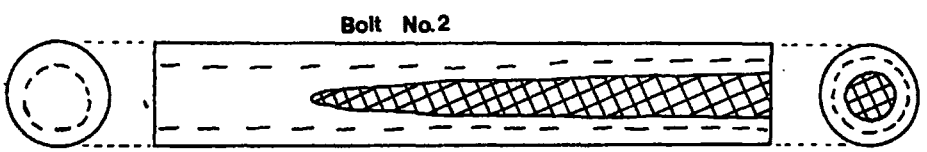


Bolt No	B C	Dob.	Dib.
9	11	12	15
01		25.2	24.1
01		.	.

Decay Description & Measurement						
P	A	I	D/R-A	D/R-I	L-A	L-I
32	33	34	35	38	41	44
1	6	2	10.2	15.4	0.22	0.38
2	3	2	.	.	0.48	0.75

6) two decay types; only incipient decay at the end of bolt 1:



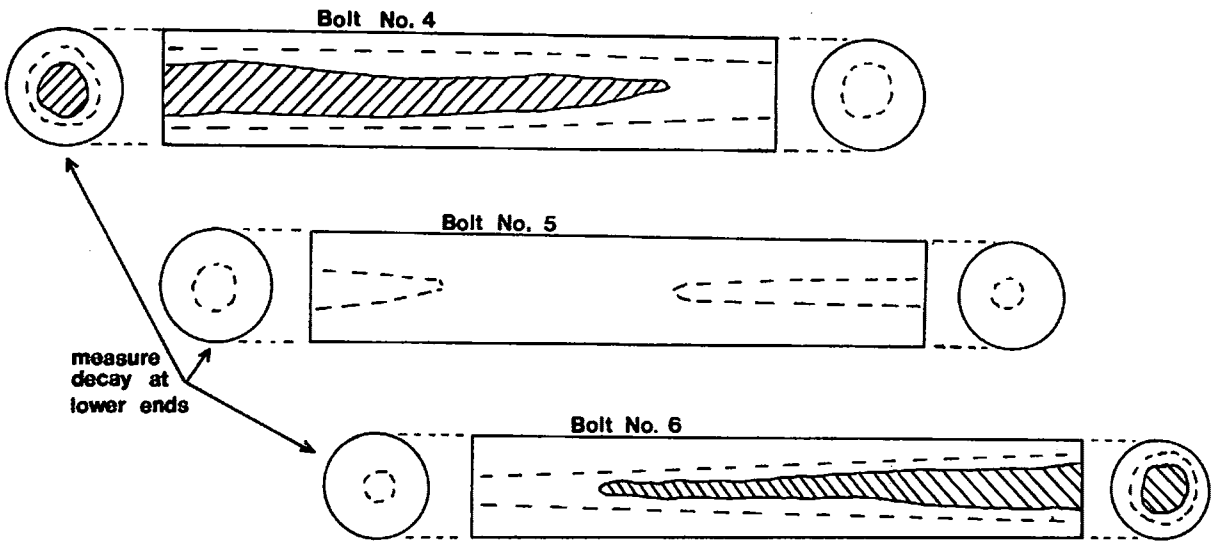


(described fully for computation)

Bolt No	B C	Dob.	Dib.
9	11	12	15
01		24.9	23.9
01		.	.
02		24.0	23.1

Decay Description & Measurement						
P	A	I	D/R-A	D/R-I	L-A	L-I
32	33	34	35	38	41	44
1	6	2	11.1	16.2	0.22	0.34
2	3	2	.	.	.	0.43
2	3	2	.	16.9	0.96	1.22

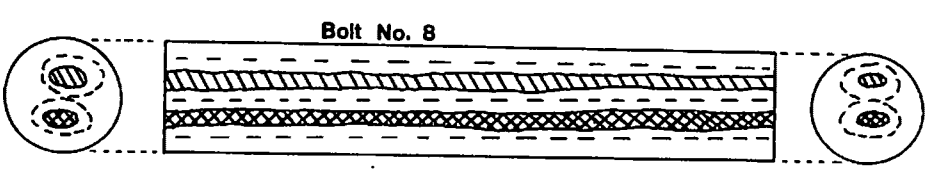
7) two decay types; two columns of incipient decay in a middle bolt:



Bolt No	B C	Dob.	Dib.	Decay Description & Measurement						
				P	A	I	D/R-A	D/R-I	L-A	L-I
9	11	12	15	32	33	34	35	38	41	44
04		16.4	15.7	2	3	2	7.6	12.2	0.94	1.22
05		16.0	15.2	2	3	2	"	4.1	"	0.28
05		"	"	2	5	2	"	"	"	0.60
06		15.1	14.4	2	5	2	"	3.5	0.90	1.22

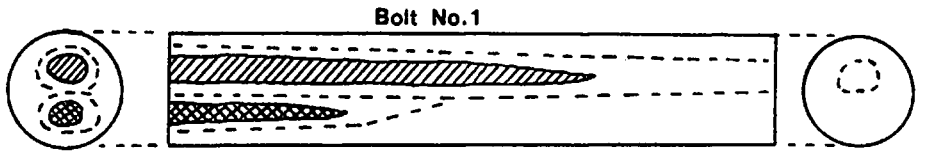
(described fully for computation)

8) two decay types side-by-side at both ends of a bolt:



Bolt No	B C	Dob.	Dib.	Decay Description & Measurement						
				P	A	I	D/R-A	D/R-I	L-A	L-I
9	11	12	15	32	33	34	35	38	41	44
08		16.0	15.3	2	1	1	5.1	5.8	1.22	1.22
08		"	"	2	2	2	4.5	5.1	1.22	1.22

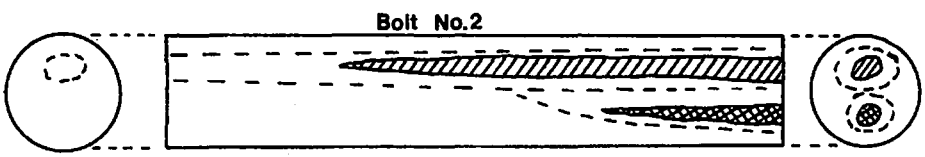
9) two decay types side-by-side, both progressing upwards:



Bolt No	B C	Dob.	Dib.
9	11	12	15
01		20.4	19.6
01			

Decay Description & Measurement						
P	A	I	D/R-A	D/R-I	L-A	L-I
32	33	34	35	38	41	44
1	1	2	7.1	9.5	0.78	1.22
1	5	4	6.6	8.2	0.37	0.54

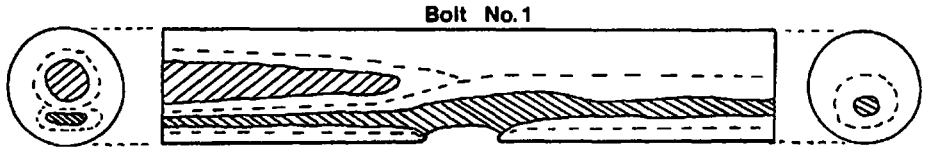
10) two decay types side-by-side, both progressing downwards:



Bolt No	B C	Dob.	Dib.
9	11	12	15
02		15.8	15.1
02			

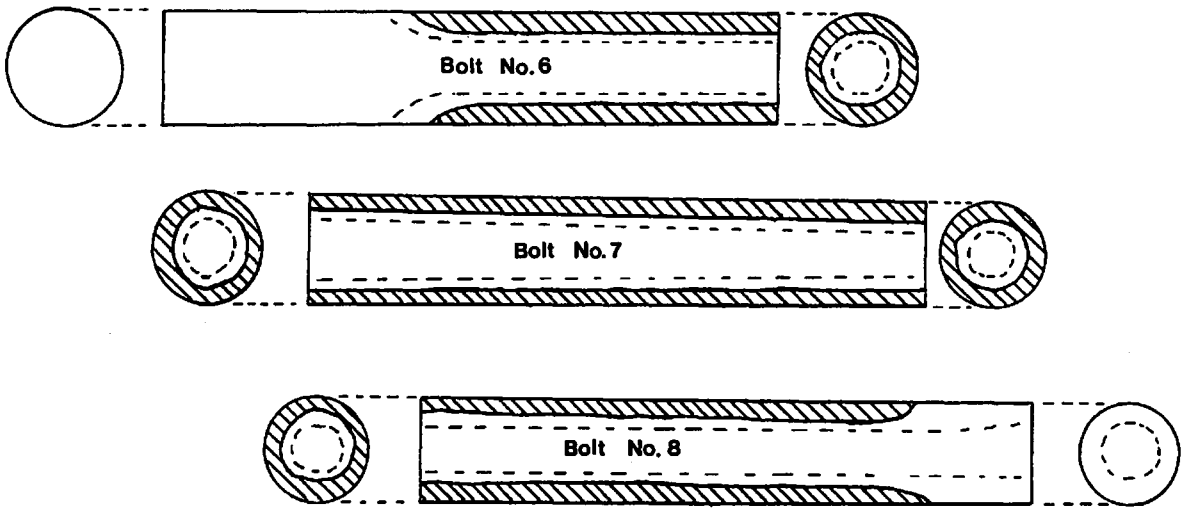
Decay Description & Measurement						
P	A	I	D/R-A	D/R-I	L-A	L-I
32	33	34	35	38	41	44
2	2	1		6.4	0.85	1.22
2	4	2			0.40	0.68

11) trunk rot adjacent to a butt rot:



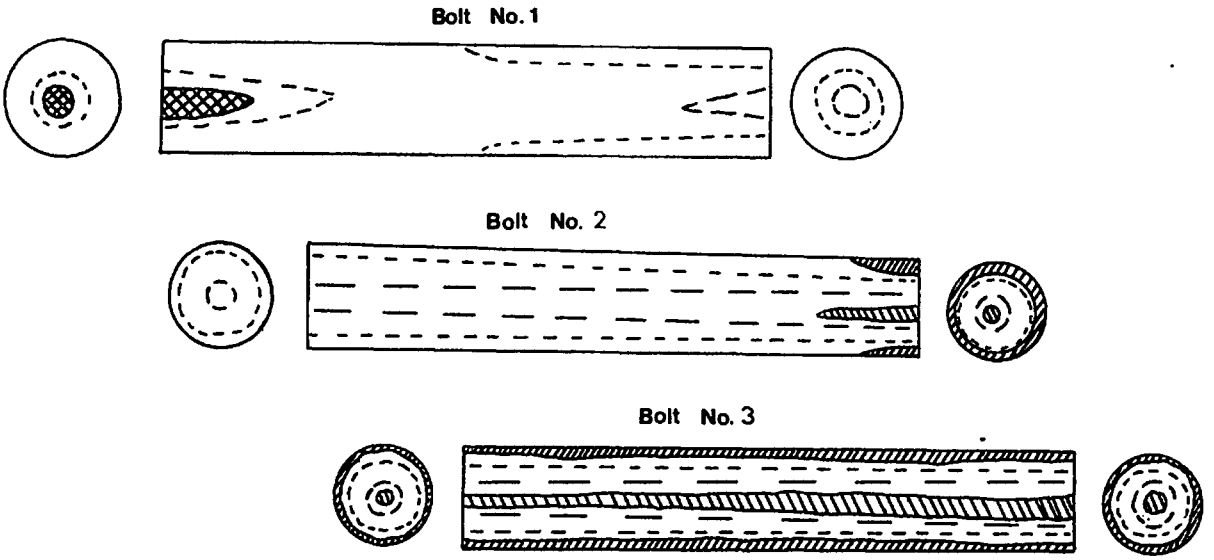
Bolt No	B C	Dob.	Dib.	Decay Description & Measurement						
				P	A	I	D/R-A	D/R-I	L-A	L-I
9	11	12	15	32	33	34	35	38	41	44
01		27.8	26.8	1	1	2	9.0	15.2	0.48	0.60
01		.	.	2	5	4	4.7	8.3	1.22	1.22

12) sap rot



Bolt No	B C	Dob.	Dib.	Decay Description & Measurement						
				P	A	I	D/R-A	D/R-I	L-A	L-I
9	11	12	15	32	33	34	35	38	41	44
06		21.8	21.0	3	8	3	.	.	0.64	0.76
07		21.1	20.3	3	8	3	2.1	4.2	1.22	1.22
08		20.2	19.5	3	8	3	1.9	3.8	1.00	1.22

13) three decay types in a tree

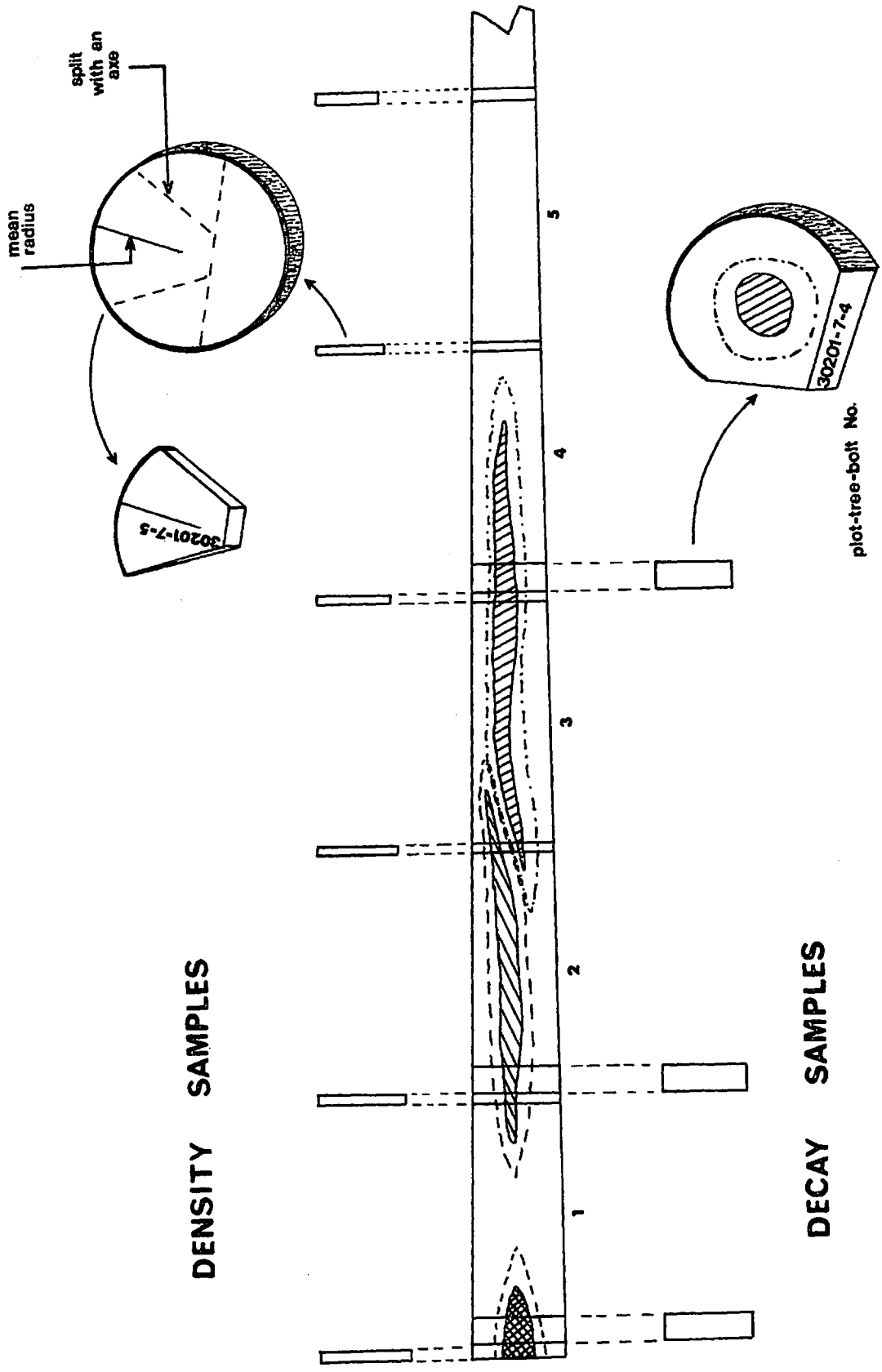


Bolt No	B C	Dob.	Dib.
9	11	12	15
01		26.6	25.7
01		.	.
01		.	.
02		25.8	25.0
02		.	.
03		24.9	24.1
03		.	.
		.	.

Decay Description & Measurement						
P	A	I	D/R-A	D/R-I	L-A	L-I
32	33	34	35	38	41	44
1	5	2	4.7	10.4	0.20	0.38
2	7	2	.	.	.	0.16
3	8	3	.	.	.	0.60
2	7	2	.	5.2	0.27	1.22
3	8	3	.	2.2	0.21	1.22
2	7	2	3.4	6.1	1.22	1.22
3	8	3	1.8	2.9	1.22	1.22
			.	.	.	.

APPENDIX 8

Wood Samples



APPENDIX 9

Cull Survey Coding List

Field	Parameter	Abbr.	Coding instructions
1	Tree Identification No.	Tree I.D. No.	Six-digit tree number coded as follows: first 2-digits: year cut; 3rd digit; crew numbers; last 3-digits: tree number (e.g. 76 2 001).
2	Fork code	FC	Enter 0 for tree with no forks; if the tree is forked enter 1 for main stem and number the forks starting with 2, 3 .... n to a maximum of 9.
3	Record type	Rt	Identifies the card type; H for header cards; B for bolt cards. This field will be filled when the tally sheet is printed.
4	Species	Spec.	Tree species as described in the Management Inventory User Requirements. 02 - white pine 09 - red pine 11 - black spruce 13 - white spruce 21 - balsam fir 31 - larch 61 - trembling aspen 69 - balsam poplar 71 - white birch 72 - yellow birch 82 - red maple 99 - other hardwoods
5	Management unit	MU	Enter Management Unit number from 1 - 19.
6	Watershed		Enter 4-digit number provided by Bowater for their plots.
7	Map No.	Map	Enter the 3-digit map code.
8	Ownership	OW	Enter the 2-letter ownership code as described in the "User Requirements". First character owner: B - Bowater; P - Price; N - Nfld. Govt.; M - Municipal; G - Private Second character ownership type: P - Private; L - Leased; H - Charter; C - Crown; R - Reserve

APPENDIX 9 - Continued

Field	Parameter	Abbr.	Coding instructions
9	Plot number	Plot	Enter the Inventory plot number used by the particular agency.
10	Stand type		Enter the 13 character stand type as provided by the Provincial Inventory Section.
11	Stratum		Enter the four character stratum obtained from the Provincial Inventory Section.
12	Forest type	Ft	Ecological forest type. This field is not being used at the present time.
13	Slope		Enter the slope as a percentage (0 - 150%).
14	Aspect	As	Enter the aspect as an alphanumeric code (N, NE, E, SE, S, SW, W, NW).
15	Soil moisture	SM	Enter the 1-digit code as described in Appendix 2.
16	Topographic position	To	1 - ridge top; 2 - upper slope; 3 - middle slope; 4 - lower slope; 5 - valley bottom.
17	Tree condition	TC	0 - alive; 1 - dead.
18	Soundness class	SS	Enter the 1-digit code for soundness percentage as described in Appendix 3.

Code	Range
1	97% - 100%
2	84% - 96%
3	51% - 83%
4	$\leq$ 50% (cull)

APPENDIX 9 - Continued

Field	Parameter	Abbr.	Coding instructions
19	Insect damage	I.D.	First digit refers to aphid damage class as described in Appendix 4.

Code	Range
0	undamaged
1	light
2	moderate
3	severe
4	dead

Second digit refers to damage by defoliators.

Code	Range of defoliation
0	NONE
1	1 - 25% budworm
2	26 - 50% "
3	51 - 75% "
4	76 - 100% "
5	1 - 25% hemlock looper
6	26 - 50% " "
7	51 - 75% " "
8	76 - 100% " "
9	other defoliators present

20	Crown class	CC	Enter 0 if a fork sheet 1 dominant 2 co-dominant 3 intermediate 4 suppressed 7 broken top
21	Diameter breast height	DBH	Enter the diameter in cm and tenths measured at 1.3 m above the ground line.
22	Height to living crown	Ht. Cr.	Enter the length from the stump to the living crown to the nearest 0.1 m.
23	Height to 7.6 cm d.o.b.	Ht. 7.6 cm	Enter the length from the stump to 7.6 cm diameter outside bark measurement to the nearest .01 m. 77.77 if the top is broken off below 7.6 cm d.o.b.

APPENDIX 9 - Continued

Field	Parameter	Abbr.	Coding instructions
24	Total height	Tot. Hgt.	Enter total tree length. If the top is broken off, record the height to the break.
25	No. of merchantable 1.22 m bolts	Blts.	Enter the total number of full 1.22 m bolts below 7.6 cm o.b.
26	Stump age	St. age	Record the stump age of the tree.
27	Breast height age	Bh. age	Record the breast height age of the tree.
28	Record type	Rt.	This field will be identified on the sheet for key-punching.
29	Bolt number		Record the bolt numbers beginning with one at the stump.
30	Bolt Card No.	BC	If the measurements require more than one line, enter 1 for the first; 2 for the second etc., otherwise leave blank.
31	Diameter outside bark	Dob.	Record the average of two outside bark diameter measurements to the nearest 0.1 cm.
32	Diameter inside bark	Dib.	Record the average of two inside bark diameter measurements to the nearest 0.1 cm.
33	Form defects	FD	Enter the form defect code. 0 - none; 2 - crook 1 - fork; 3 - sweep
34	Section affected		Enter the number of the 30 cm sections affected by the form defect in the appropriate column.

35 & 36 Same procedure as for fields 33 & 34 if there is a second form defect in a 1.2 m bolt otherwise leave blank.

APPENDIX 9 - Continued

Field	Parameter	Abbr.	Coding instructions
37	Indicators of decay	Ind. Sec.	Record the code for the type of indicator in the first column and the number of the 30.5 cm sections affected in the second column.

Code	Indicator
Blank	none
1	fork
2	crook
3	rotten branch
4	broken top
5	open scar
6	closed scar
8	canker
9	frost crack

38	Indicators of decay	Ind. Sec.	Same procedure as Field 37 if there is a second indicator in a bolt.
39	Decay description	P-A-I	Record the descriptive codes for the position of the decay and the characteristics of the advanced and incipient decays.

Position

Blank - none	2 - trunk rot
1 - butt rot	3 - sap rot

Advanced	Incipient
Blank - none	Blank - none
1 - yellow stringy	1 - yellow
2 - yellow spongy	2 - brown
3 - brown stringy	3 - red
4 - brown spongy	4 - pink
5 - brown cubical	5 - green
6 - white stringy	6 - purple
7 - white spongy	7 - black
8 - red stringy	8 - yellow-green
9 - red pocket	9 - red-brown

40	Diameter or radius of advanced decay	D/R-A	Record the average diameter of advanced butt or trunk rot or the average radial penetration of advanced sap rot, measured to the nearest 0.1 cm.

APPENDIX 9 - Concluded

Field	Parameter	Abbr.	Coding instructions
41	Diameter or radius of incipient decay	D/R-I	Record the average diameter of total butt or trunk rot or the total radial penetration of sap rot measured to the nearest 0.1 cm.
42	Length of advanced decay	L-A	Record the length of the advanced decay to the nearest cm.
43	Length of incipient decay	L-I	Record the total length of the decay to the nearest cm.
44	Decay type	DT	The decay type will be coded in the laboratory after the causal organism has been identified.
45	Decay organism	Decay org.	The causal organism will be entered in the laboratory when the identification is completed.
46	Density	Density	The wood density will be added to the data files after the laboratory analysis is complete.
47	Redwood	RW	Enter -1- if aphid redwood is observed in the bolt.

Measurement of height-growth: The two measurements of height-growth will not be key-punched onto the computer file so they are to be recorded at the top of the sheet. To measure the height growth the tip should be sectioned until the 5 and 10 year growth rings are found. The increments should be recorded to the nearest cm.