TEMPORARY POINT SAMPLING (TPS) FIELD MANUAL

2016 EDITION

Government of Newfoundland and Labrador
Forestry and Agrifoods Agency
Forestry Services

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METHODOLOGY

BACKGROUND

The Temporary Sample Plot (TSP) network, which was established by the Newfoundland and Labrador Forest Service throughout the 1970's, 80's, and 90's, has been an invaluable resource in the yield curve development component of wood supply analyses. During the 2001 wood supply analyses a number of possible deficiencies were noted in the TSP data set. Some of these were subsequently confirmed by T. Erdle during his external review of the 2001 wood supply analysis. Based on Erdle's recommendation, the old TSP network will be replaced with the new system outlined below. Because this system will employ a point sampling technique and thus represents a different dataset, it will be referred to as Temporary Point Sampling (TPS) to distinguish it from the TSP data, even though the data will be used in a similar manner.

STRATIFICATION

Stratification is based on working group (major species), 20-year age classes, and 3 crown density classes on up to 4 potential site classes. Initially, the goal is to sample 20 plots (cruise lines) in development stages from immature to over-mature, for a total of 60 plots for each major working group in a region. After these plots have been completed, the data will be used to calculate within stratum variances and to recalculate the sample size needed for a given statistical accuracy. Given the intended use of the TPS data, it is desirable that volume estimates are within +/- 5% at the 95% probability level. Based on the initial samples available for each stratum the number of plots will be determined to achieve this accuracy and additional samples completed if necessary. The purpose of this prism point / cruise line methodology is to obtain "within stand" variance estimates as well as to update the volume estimates to the current interpretation level.

While all strata should eventually be sampled, some strata by their relative abundance are more important to the island's wood supply than others. Given that resources are limited, and that the establishment of the new TPS network will take many field seasons, sampling will be prioritized with the major strata to be sampled first. A major stratum in this context is defined as one that comprises at least 6 to 10% of the total forest landscape within a region, and in most regions this usually means 5 to 6 strata will be targeted first. Listed below are the procedures to be used in the new TPS program.

PLOT ALLOCATION

Plots will be distributed proportionally across districts based on the relative strata occurrence in each district within a region. In addition, stands will be allocated randomly with the only valid reasons for exclusion being poor access and unsuitable stand size or shape. All stands must have a road access point or helicopter landing site within a reasonable walking distance and stands must be large enough to permit at least 6 points per stand.

STAND SELECTION

Stand selection is based on working group, age class, and crown density class. After the initial variance calculations, it will be determined which strata require additional sampling. The number of points per stand will depend upon the stand's area. Within stand sampling intensity will be approximately 1-2% or one prism point per hectare with a maximum of twelve points. For example, a ten hectare stand would require ten points and twelve hectares and greater size stands would require twelve points; within stand sampling intensity should only fall below one percent if the stand size is greater than 25 hectares (see Table 1).

A randomized stand list is produced for each district which includes an updated stand list with allowance for stand disturbance. This stand list is comprised of stands five hectares and greater in size each with a random number associated with it to allow for unbiased stand selection. Copies of forest type maps and aerial photography are required for final stand selection. Stand width and shape must accommodate a cruise line for point sampling. All sample points will be located within the typed - updated stand boundaries. (Note: Stands in the updated stand list may be artificially split due to alienation coding, insect mortality, etc. Therefore, the selected "stand" may only be a portion of the full typed stand. Additionally, two separate lines may be utilized rather than a single cruise line if a better representation of the entire stand would result.)

When determining the number of points required per stand, narrow portions of a stand may be ignored and the resulting area sampled at one point per hectare up to a maximum of twelve and a minimum of six. The orientation of the cruise line will be influenced by the shape of the stand and an attempt is made to cover as much of the stand as possible utilizing point intervals of between 50 and 150m using 25m increments. The distance between points should be the same for a particular stand and on the ground these points **must** be located wherever the interval distance falls. Points will not be moved to a better or more 'representative' location. Pin-prick the locations of each prism point onto the photograph; on the back of the photograph circle each point and write the point number next to the circle. Also record the cruise line number, the 1:50,000 map and 1:12,500 section numbers, ownership and updated stand type.

AREA (ha)	Sampling Intensity using 6 to 12 Prism Points						
	6	7	8	9	10	11	12
4	3.0	3.5	4.0	4.5	5.0	5.5	6.0
5	2.4	2.8	3.2	3.6	4.0	4.4	4.8
6	2.0	2.3	2.7	3.0	3.3	3.7	4.0
7	1.7	2.0	2.3	2.6	2.9	3.1	3.4
8	1.5	1.8	2.0	2.3	2.5	2.8	3.0
9	1.3	1.6	1.8	2.0	2.2	2.4	2.7
10	1.2	1.4	1.6	1.8	2.0	2.2	2.4
11	1.1	1.3	1.5	1.6	1.8	2.0	2.2
12	1.0	1.2	1.3	1.5	1.7	1.8	2.0
13	0.9	1.1	1.2	1.4	1.5	1.7	1.8
14	0.9	1.0	1.1	1.3	1.4	1.6	1.7
15	0.8	0.9	1.1	1.2	1.3	1.5	1.6
16	0.8	0.9	1.0	1.1	1.3	1.4	1.5
17	0.7	0.8	0.9	1.1	1.2	1.3	1.4
18	0.7	0.8	0.9	1.0	1.1	1.2	1.3
19	0.6	0.7	0.8	0.9	1.1	1.2	1.3
20	0.6	0.7	0.8	0.9	1.0	1.1	1.2
21	0.6	0.7	0.8	0.9	1.0	1.0	1.1
22	0.5	0.6	0.7	0.8	0.9	1.0	1.1
23	0.5	0.6	0.7	0.8	0.9	1.0	1.0
24	0.5	0.6	0.7	0.8	0.8	0.9	1.0
25	0.5	0.6	0.6	0.7	0.8	0.9	1.0
26	0.5	0.5	0.6	0.7	0.8	0.8	0.9
Assumes that each prism point is equivalent to a 200m2 plot size							

TABLE 1: APPROXIMATE WITHIN STAND SAMPLING INTENSITIES

FIELD PROCEDURES

LOCATE THE STAND TO BE SAMPLED

Stands selected for sampling will be delineated on 1:12 500 true color vertical aerial photographs and/or 1:12 500 Forest Cover Type Maps. The locations of all stands to be sampled may be plotted on smaller scale maps to allow planning of daily workloads. These maps and photos (or photocopies) will be used to properly locate the stands to be cruised.

LOCATE THE CRUISE LINE

The location of the cruise line is indicated by a line or lines drawn within the stand. The stand boundary is first transferred to the photo and then the cruise line is drawn within the stand. It is situated so as to adequately represent the full range of conditions within the stand. The cruiser is responsible for determining compass bearings and distances to get to the stand, locating the first prism point and traversing the cruise line. Using true bearings of linear ground features, a true north reference line may be drawn on the photo. All subsequent bearings shall be referenced from this true north line. If no linear feature is available the cruiser must assume that the **edge** of the photo is oriented north-south.

NOTE: All bearings should be true bearings (not magnetic) using the appropriate magnetic declination. Declination will depend on the year of the cruise and the latitude/longitude position of the stand. In situations where long traverses are required and there are no suitable landmarks within a short distance of the stand, the photo scale should be checked to ensure proper locating of the cruise line.

COMPLETE A CUT PLOT FORM

After the location of the cruise line has been determined, the next step is to determine the age structure of the stand by completing the latest **Cut Plot Form** using the following specifications:

HEADER SECTIONS

Parts 1 and 2 must be recorded on all sheets.

Crew Chief: name of crew leader

Page __ of __: if one tree is sampled then Page 1 of 1, etc.,

Interpreted Stand Type: from photo or stand list

Photo Roll# and Photo#: from the photo

Plot Type: enter the stage of development

I for immature (age 21 up to 40 at stump)

S for semi-mature (age 41 to 60 at stump)

M for mature (age 61 to 80 at stump)

O for over-mature (age 81 and above at stump)

Mgmt. *Dist.*: Management District Number

Year-Month-Day: date of data collection

Plot Number: first digit of plot number (1-PSP, **2**-**TPS**, 3-SMP, 4-RSP, 5-Private, 6-CFI, 7-industry TSP, 8-GTP, 9-IDA); the first two of the next five digits (the year); and the last digit for the page number/sequence number (0 if single page)

Re-measurement: for these plots enter 00

Stand and Site Description

Elevation: from NTS map or GPS unit

Latitude: from NTS map or GPS unit

Longitude: from NTS map or GPS unit

Map: NFS map number

Section: map section number

Aspect: general direction of slope (select one of the 8 cardinal compass positions) leave blank if no slope

Slope: percentage slope, enter 00 if level/no real slope present

Stratum: determined from actual stand type = "primary" species, height class and crown density class

Actual Stand Type: actual stand type = up to three species, age class, height class, density class and site class (see codes listed in Appendix I)

Status: **N**-natural, **T**-thinned {all types} or **P**-planted

Treatment Year: if status = T or P then enter year from map or stand list

Damman Type: enter code if possible to make a reasonable estimate of the type

Check Boxes: Vegetation and Soils if separate sheets completed for these

Stand Initialization Cause: **W**-wind, **X**-cut, **Y**-fire, **Z**-insect, **M**-mechanical /miscellaneous, **U**-unknown, **F**-advanced regeneration

Year of Disturbance: will be obtained from map

Age Determination Section

A visual inspection of representative trees within the stand, in terms of species, size and stem condition, is used to formulate a basis for selecting sample trees for aging. The greater the anticipated age variation, the more samples are needed. There is space provided for six sample trees on the Cut Plot Form; however, more samples may be required to fully describe the age structure of a particular stand. Additional sample trees should be recorded on the back of the tally sheet. **Caution**: sample trees should be collected so as not to remove any trees which may be within the prism sweeps.

For each sample tree:

1. Record the numeric species code and the dominance code (i.e., U-super dominant, D-dominant, C-co-dominant, I-intermediate or S-suppressed). Measure DBH and mark stump, 1m and DBH with a lumber crayon (distances from the root collar). If the location of the measured DBH must be moved up due to swelling or branches at breast height, note the distance moved in the **Comments** section.

2. Fell the tree and measure total tree height.

3. If the tree is selected for detailed stem analysis measurements, follow procedures listed in the STEM ANALYSIS and COLLECTING DISKS FOR SITE TREES sections of this document.

4. If the tree is not selected for detailed stem analysis, cut 1 inch cookies from the stump and DBH locations.

5. Label each disk with management district number, map number, plot number, sample tree number and section/cookie height.

6. Count the rings on the stump (Total Age) and breast height (BH Age) disks.

7. Measure decay if present by type of decay. Incipient Decay is identified by discolored wood that is not noticeably softer than the surrounding sound wood. Advanced Decay is discolored wood that is softer and weaker than the sound wood.

Diameter – If one or both stages of decay can be recognized at the stump, record the diameter to the nearest 0.1cm by taking the average of two measurements made at right angles to one another.

Length – The length of both incipient and advanced decay is measured to the nearest 0.1 meter. Begin by cross sectioning the tree at 1 meter intervals from the stump until no decay can be identified. The last bolt is then to be cross sectioned in 20cm sections to refine the length of decay. Finally, estimate the length of decay to the nearest 0.1 meter.

8. Return the disks to the office for age verification. The ages will be further verified in the office by scanning and detailed measurement of tree growth rings.

Site Tree Selection

At least one site tree in the dominant or co-dominant class must be selected for stem analysis measurements. If the stand type being sampled is comprised of more than one softwood species, then detailed measurements are required for one sample of each species represented. The sample tree chosen would normally be one of the trees measured for the age determination work, provided it meets the following criteria:

1. The tree should represent the dominant species in the over-story.

2. The tree should have a good crown formation, with branching nodes distinguishable. If balsam fir and black spruce occupy the stand equally, a balsam fir should be used for the stem analysis because the whorls can be more easily identified.

3. The tree should possess characteristics which suggest its growth has not been repeatedly stressed by severe suppression, insect attacks, snow and wind damage, etc. Avoid trees with patches of defoliation throughout the crown, deformed or twisted stems and irregular internodal distances.

Stem Analysis

After an appropriate site tree has been selected, complete a stem analysis as follows:

1. Before cutting the tree, mark stump height (0.15m), 1.0m and breast height (1.3m) with a lumber crayon; record *species*, *dominance* and *DBH* on the sheet.

2. Fell the tree, cutting below the stump height mark. If no significant rot, no major amount of early suppression or no indication of significantly deformed growth (off center pith, oval shape, etc.) is present, continue with measurements. Otherwise measure *height* and *decay*, and collect stump and BH disks.

3. Limb the tree leaving branch stubs so as to be able to determine the annual nodes/whorls.

4. Determine *total age* of tree (assume stump age equals total age). If total age is less than 30 years, then skip step 5 and proceed with step 6.

5. Place the end of the measuring tape **at the 1m mark** and measure the *Length* to the *top* of the tree (record the length to the nearest tenth meter). Next, measure to the first branching node from the top (record this measurement under *Node 1*). Repeat this procedure for the next branching node from the top (Node 2) and continue for each whorl of branches or branching scars until the stump is reached or the nodes can no longer be identified.

Caution: It's not uncommon to have nodes missing completely or impossible to identify. If this occurs, an attempt should be made to determine the number and location of missing nodes. This can be achieved by cross-sectioning the tree above and below the affected area and comparing ring counts.

6. For younger trees, measure the distance (to the nearest 0.1m) spanning the first five whorls or nodes above breast height (see Figure 2). Note: If it is not possible to accurately identify this position the information should be omitted.

7. Measure to the top of the tree and record 'Total Hgt.'. From the 1.0m mark, measure and mark 1.5m intervals up to a minimum top diameter of 6.0cm.

Collecting Disks for Site Trees

Record the Tree Number (from the list of age determination samples), place a check mark in the appropriate box to indicate the Method used (both Measurement and Disks are preferred), the Stump Height (normally 0.15m) and the Height to Live Crown from the 1.0m mark.

The disks are to be collected from the stump, from 1m, from BH, from 2.5m above the ground then from every 1.5m above that to the first disk measuring under 6.0cm diameter. Place a check mark in the appropriate boxes, indicating height positions for which disks were collected.

On each disk write the management district, map number, plot number, tree number and disk height position (see the left-hand side of Figure 1). This should be written on the under-side of the disk; the measurement side of the disk matches the height position and should remain clear (see the right-hand side of Figure 1). **Note: It is critical to record legible and accurate information on each disk** in order to permit subsequent analysis.

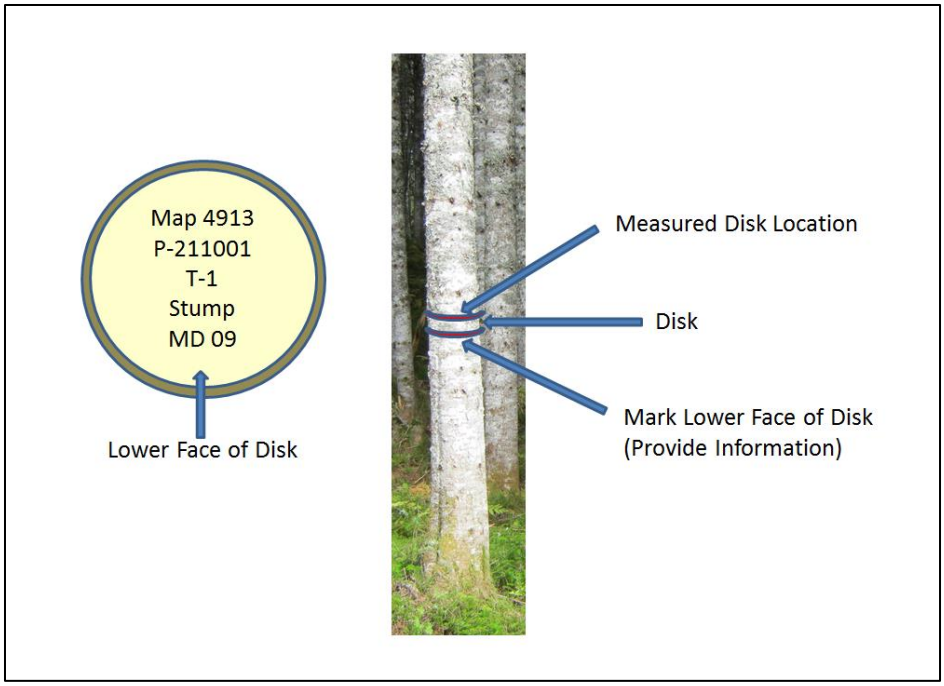

FIGURE 1: MEASURED VS. MARKED FACES ON COLLECTED TREE DISKS

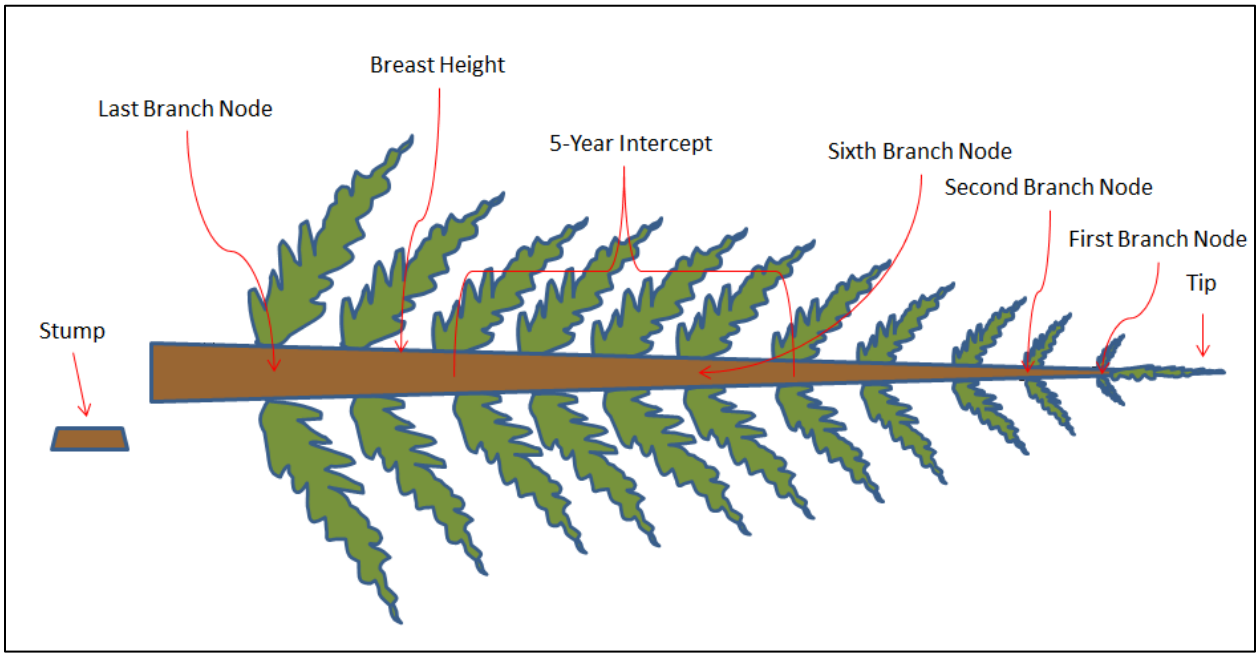

FIGURE 2: ILLUSTRATION OF BRANCHING NODES AND 5-YEAR INTERCEPT

PRISM POINT SAMPLING PROCEDURES

Place a post securely at the prism point and use this to ensure that all trees are viewed from the same position. Using a Basal Area Factor (BAF) 2 metric prism, view each tree in turn to determine if the tree is to be tallied. Wedge prisms bend reflecting light rays causing an image to be displaced along a desired angle. When viewing trees through a prism a section of the tree appears to be offset. If the offset section of the tree overlaps the tree stem then the tree qualifies to be tallied. With no overlap the tree is "out". Borderline trees are those in which the edge of the offset section exactly meets the edge of the tree stem (Figure 3).

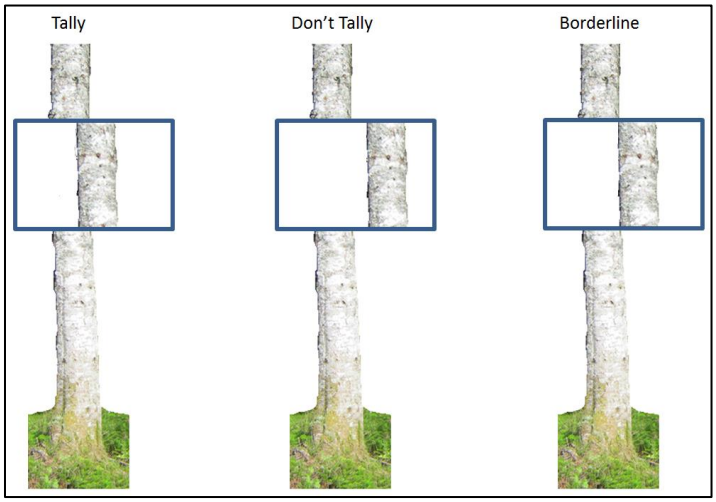

FIGURE 3: TREE IMAGE DISPLACEMENT VIEWED THROUGH A WEDGE PRISM

The prism should always be held directly over the sample point, which the cruiser will mark by a center stake. Trees should be viewed at breast height. It is important that the prism be held correctly and not tipped or swung (Figure 4).

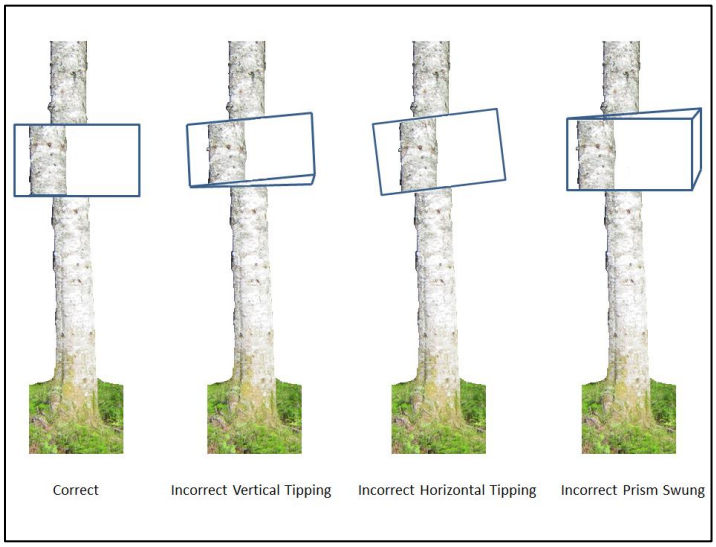

FIGURE 4: EXAMPLES OF CORRECT AND INCORRECT WAYS OF HOLDING A WEDGE PRISM ON SLOPES < 10%

When slopes greater than 10 percent are encountered the prism should be tipped in a vertical plane by an amount approximately equal to the slope between the sample point and the tree being viewed (Figure 5). For any sample point located on a slope, the degree of slope will vary with the positions of the trees on the slope. Trees directly downhill and uphill from the sample point will have the greatest amount of slope. Trees located at the same level as the sample point will have no slope. Trees in intermediary positions from the two mentioned will have less than the maximum slope. When in doubt follow the instructions on dealing with borderline trees in the following section.

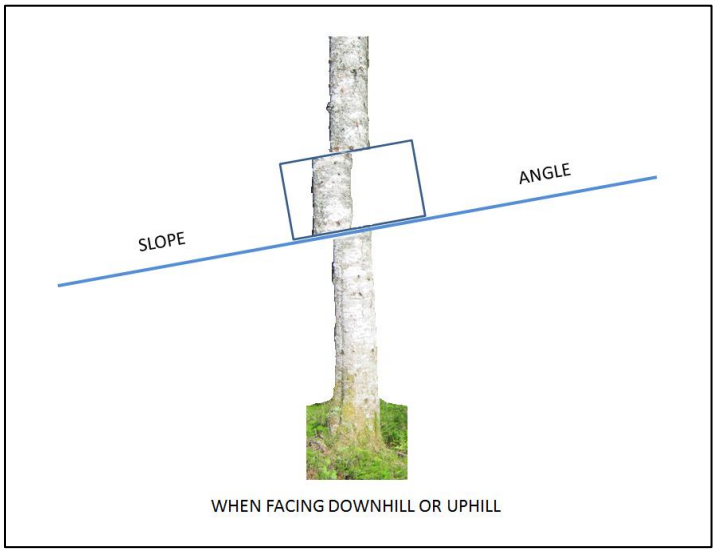

FIGURE 5: CORRECT POSITION OF PRISM ON SLOPES > 10%

Start the prism sweep at a distinguishing tree (e.g., large tree, closest tree, peculiar form) and view all trees clockwise about the sample point until the initial tree is again in sight. Trees must not be tallied more than once per point. If desired, each tree could be marked with a lumber crayon after it has been recorded.

Situations may warrant moving away from the sample point to view trees which are hidden at breast height; ensure the same distance is maintained between the tree and the sample point. The assistant cruiser is responsible for pointing out trees which may be completely hidden from the cruiser's view.

Borderline Trees

If a tree appears to be borderline the cruiser should make sure the prism is being held correctly over the center point and that the tree is being viewed at breast height. Also, placing a colourful background directly against the back of the tree is helpful in this situation. If the tree still appears borderline, measure the **horizontal distance** (nearest 0.01 m) from the prism point to the **center** of the tree at breast height. Measure the dbh (to the nearest 0.1 cm) and use the limiting distance table (Table 2) to determine whether the tree falls within the limiting distance for a tree of that diameter (trees within the limiting distance are to be measured and recorded). When using a BAF 2m prism, the limiting distance can be calculated in metres by multiplying the diameter in centimetres by 0.3535. There is a direct relationship between tree size and horizontal limiting distance meaning the limiting distance for a 20 cm tree is exactly twice as much as that for a 10 cm tree.

Diameter -> 0.1cm										Diameter <-0.1cm	
cm	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	cm
9	3.18	3.22	3.25	3.29	3.32	3.36	3.39	3.43	3.46	3.50	9
10	3.54	3.57	3.61	3.64	3.68	3.71	3.75	3.78	3.82	3.85	10
11	3.89	3.92	3.96	3.99	4.03	4.07	4.10	4.14	4.17	4.21	11
12	4.24	4.28	4.31	4.35	4.38	4.42	4.45	4.49	4.52	4.56	12
13	4.60	4.63	4.67	4.70	4.74	4.77	4.81	4.84	4.88	4.91	13
14	4.95	4.98	5.02	5.06	5.09	5.13	5.16	5.20	5.23	5.27	14
15	5.30	5.34	5.37	5.41	5.44	5.48	5.51	5.55	5.59	5.62	15
16	5.66	5.69	5.73	5.76	5.80	5.83	5.87	5.90	5.94	5.97	16
17	6.01	6.04	6.08	6.12	6.15	6.19	6.22	6.26	6.29	6.33	17
18	6.36	6.40	6.43	6.47	6.50	6.54	6.58	6.61	6.65	6.68	18
19	6.72	6.75	6.79	6.82	6.86	6.89	6.93	6.96	7.00	7.03	19
20	7.07	7.11	7.14	7.18	7.21	7.25	7.28	7.32	7.35	7.39	20
21	7.42	7.46	7.49	7.53	7.56	7.60	7.64	7.67	7.71	7.74	21
22	7.78	7.81	7.85	7.88	7.92	7.95	7.99	8.02	8.06	8.10	22
23	8.13	8.17	8.20	8.24	8.27	8.31	8.34	8.38	8.41	8.45	23
24	8.48	8.52	8.55	8.59	8.63	8.66	8.70	8.73	8.77	8.80	24
25	8.84	8.87	8.91	8.94	8.98	9.01	9.05	9.08	9.12	9.16	25
26	9.19	9.23	9.26	9.30	9.33	9.37	9.40	9.44	9.47	9.51	26

TABLE 2: HORIZONTAL LIMITING DISTANCES (BAF 2M PRISM (FACTOR = 0.3535))

TALLY SHEET INSTRUCTIONS

Crew: names of crew members

Interpreted Stand Type: most recent photo-interpreted stand typing

Photo Roll Number: on which the plot is allocated

Photo Number: on which the plot is allocated

Cruise Line: the number that has been assigned (usually the last two digits of plot number)

Point Spacing: the number of meters between sample points (assigned when allocating points)

District: Management District number

Year: year the plot was measured

Month: month the plot was measured

Day: day the plot was measured

Plot Number: plot number is the number assigned after the plot has been field sampled

Map: the department number assigned to a 1:50,000 scale topographic map

Section: the number assigned to one of the sixteen sections on a 1:50,000 topographic map

Actual Stand Type: completed **after** all the points have been sampled

Stratum: actual stand type (working group / height / density)

Ownership: two letter ownership code

Location of Point#1: *Latitude*, *Longitude* and *Elevation* measured at Point 1 (this can be calculated from a topographic map or determined using a G.P.S. unit)

Sub Merchantable Trees: To be measured on the first and every additional third point along the cruise line. Using a 2.82 m plot radius, measure all living trees by *species* and *DBH class*. A dot tally is to be used and the total for each species and diameter recorded. An *average height* is to be measured for each diameter code.

Point Number: is the point number along the cruise line (from 1 up to a maximum of 12)

Aspect: direction in which the slope is facing (N, NE, E, SE, S, SW, W, NW)

Slope: estimate the percent slope in the area surrounding the point

Plot compare for stand: This is an estimate of the expected volume/hectare for each point when compared to the overall stand volume per hectare. Complete this after all the points have been completed. There are six possible comparisons:

VH: very high
H: high
A: average
L: low
VL: very low
O: the point is completely different from the stand (this is possible in an area that is too small in size for a separate photo-interpretation classification)

Point Latitude: indicate latitude when using a G.P.S. unit

Point Longitude: indicate longitude when using a G.P.S. unit

Point Elevation: indicate elevation when using a G.P.S. unit

For each qualifying tree in the prism point, record:

Species: indicate the appropriate code as per the species table in Appendix I

LF: life code (indicate “0" for living and “1" for dead)

DBH: diameter at breast height to the nearest 0.1 cm

Height: measured height to the nearest 0.1 m or estimated to the nearest 0.5 m

Point comments: comments regarding the comparison of sample point characteristics to overall stand conditions

APPENDIX I: LOOKUP TABLES OF CODES USED FOR STAND TYPING

SPECIES CODES

Alphabetic Code	Numeric Code	Species Common Name	Species Latin Name
wP	02	White Pine	Pinus strobus
jP	03	Jack Pine	Pinus banksiana
Pl	09	Other Pine	Pinus (various)
bS	11	Black Spruce	Picea mariana
wS	13	White Spruce	Picea glauca
bF	21	Balsam Fir	Abies balsamea
tL	31	Tamarack	Larix laricina
tA	61	Trembling Aspen	Populus tremuloides
PO	69	Other Poplar	Populus (various)
wB	71	White Birch	Betula papyrifera
yB	72	Yellow Birch	Betula lutea
rM	82	Red Maple	Acer rubrum
OH	99	Other Hardwood	Various

AGE CLASS CODES FOR NEWFOUNDLAND AND LABRADOR

Insular Newfoundland			Mainland Labrador		
Development Stage	Age Range (yrs)	Age Class Code	Development Stage	Age Range (yrs)	Age Class Code
Regenerating	Up to 20	1	Regenerating	Up to 20	1
Immature	21 – 40	2	Immature	21 – 40	2
Semi-Mature	41 – 60	3		41 – 60	3
Mature	61 – 80	4	Semi-Mature	61 – 80	4
Over-Mature	81 – 100	5		81 – 100	5
	101 – 120	6	Mature	101 – 120	6
	Over 120	7		121 – 140	7
			Over-Mature	141 – 160	8
All-Aged	Various	9		Over 160	9

HEIGHT CLASS, CROWN DENSITY AND SITE PRODUCTIVITY CODES

Height Range	Height Code
Nearest tenth metre	
Below 3.5	**1**
3.6 to 6.5	**2**
6.6 to 9.5	**3**
9.6 to 12.5	**4**
12.6 to 15.5	**5**
15.6 to 18.5	**6**
18.6 to 21.5	**7**
Above 21.5	**8**

Percent Crown Density	Density Code
≥75%	**1**
51 – 75%	**2**
26 – 50%	**3**
≤25%	**NSR or DI**
Forest Site Class (Canada Land Inventory)	**Site Code**
High (2&3)	**H**
Good (4)	**G**
Medium (5)	**M**
Poor (6)	**P**