CLASSIFICATION AND SAMPLING MANUAL

LIBRARY COPY (IONLY) 1979
FOREST CLASSIFICATION AND SAMPLING

SUPPLEMENTARY DRAFT GUIDELINES FOR

THE 1979 FIELD SEASON

NOT FOR DISTRIBUTION

FOREST INVENTORY BRANCH

LIBRARY - MINISTRY OF FORESTS
PO BOX 9523 STN PROV GOVT
VICTORIA BC V8W 9C2
FOREWORD

I. SUPPLEMENTARY FOREST CLASSIFICATION AND SAMPLING PROCEDURES FOR THE 1979 FIELD SEASON

The 1979 field season should be considered an experimental year. The enclosed guidelines are interim and intended for Inventory Branch field crews only. Experience gained in 1979 will provide the basis for revising the Forest Classification and Sampling Manual in the future. All comments and suggestions, either positive or negative, will be gratefully received.

The enclosed guidelines include:

(1) procedures developed and/or modified from the 1978, Level 4 inventories;
(2) traditional procedures (clarified); and
(3) some new procedures intended to improve methodology and to meet the needs for a vastly improved computer technology.

The following list summarizes the major procedural changes proposed for 1979 that were not used in the last full field season of 1977.

A. Forest Classification

1. Basic map label description for forest type labels

<table>
<thead>
<tr>
<th>Variable</th>
<th>Basic Description</th>
<th>1977</th>
<th>1979</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species composition</td>
<td>species order</td>
<td>10% by species</td>
<td>10% by species</td>
</tr>
<tr>
<td>Age</td>
<td>age class</td>
<td>nearest year</td>
<td>nearest year</td>
</tr>
<tr>
<td>Height</td>
<td>height class</td>
<td>nearest 0.1 m</td>
<td>nearest 0.1 m</td>
</tr>
<tr>
<td>Stocking</td>
<td>5 classes</td>
<td>no change</td>
<td>no change</td>
</tr>
<tr>
<td>Site</td>
<td>4 classes</td>
<td>no change</td>
<td>no change</td>
</tr>
<tr>
<td>Crown closure</td>
<td>nil</td>
<td>10%</td>
<td>number of stems/ha</td>
</tr>
<tr>
<td>Density</td>
<td>nil</td>
<td></td>
<td>(for stands measured)</td>
</tr>
<tr>
<td>Secondary elements</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Older</td>
<td>plus - seed trees</td>
<td>plus - species order,</td>
<td>plus - species order,</td>
</tr>
<tr>
<td></td>
<td>- vets</td>
<td>age</td>
<td>age</td>
</tr>
<tr>
<td></td>
<td>- volume</td>
<td>height class, volume</td>
<td>height class, volume</td>
</tr>
<tr>
<td></td>
<td>e.g. + FPY Vol</td>
<td>class</td>
<td>class</td>
</tr>
<tr>
<td>Younger</td>
<td>plus species imm.</td>
<td>e.g. + FPY 83-3(17.5+)</td>
<td>e.g. + FPY 83-3(17.5+)</td>
</tr>
<tr>
<td></td>
<td>e.g. +S imm.</td>
<td>e.g. +S 65-16.0</td>
<td>e.g. +S 65-16.0</td>
</tr>
</tbody>
</table>
2. Specific changes

a) Non-productive forest types:

- e.g. (1977) A For HB 832
- (1979) A For H₂B₃ 200-24.4-2-8
  (composition to nearest 10%, age to nearest year or to the mid-point of
  the age class, height to the nearest metre or mid-point of the height
  class, stocking class, crown closure to nearest 10%)

b) Cover class:

Replace "Residual" cover class with a full description of stand characteristics, plus history.
Degree of disturbance from 0 to 70% is no longer used as a criterion for type stratification.

- (1977) SB 83 Resid-P 67
- (1979) S₇B₃ 210-24.4-2-P-7 67

c) Age:

Designate all-age or multi-age stands with a "V" beside the stand age.

- (1977) PlS 420-P
- (1979) Pl₇S₃ (62V)-16.0-0-P-7

d) Site:

Assign the actual or most representative site class to stands comprised of suppressed
understories released by disturbance. The site is circled when it does not reflect the age and
height for the stand.

- e.g. B understory released following logging

- (1977) B 410-L 671
- (1979) B₁₀ 62-2.0-0-4 671

e) NSR types:

For all NSR types with regeneration surveys show
species composition, age, height, site, crown
closure, stocking.

- (1977) NSR-M 672
- (1979) NSR S₇B₃ 4-1.5-0-M-1-67

f) Crown closure:

Describe the percentage of area covered by the
crown canopy of the main stand to the nearest 10%
for all productive and non-productive types.
Crown closure will replace stocking class in the
near future.
g) Stand density:
   Record the number of stems per acre in the main stand when supported by adequate ground measurements. Fixed base photography will also be developed for this purpose in the future.

h) History:
   The degree of insect or mistletoe infestation is recorded by one of four classes.

3. Ground classification

   Ground calls: The main emphasis for ground calls will be double sampling with 70 mm, fixed base photography.
   Classification sheet: There is a new multi-purpose classification sheet.

4. Updating

   A procedure using a "Reference Year" is described that allows type labels to be automatically updated by computer. The "Reference Year" is the calendar year for which the age and height for the type was determined most accurately.

5. Sampling

   The conventional 2/5 acre ground sample is replaced with a new sampling system combining multi-stage and multi-phase sampling. The primary sampling units are photo-plots obtained with 70 mm stereo photography, and a sub-sample of these photo plots is then measured on the ground within the context of double sampling. Each ground sample consists of six point samples taken at varying intervals in a previously defined direction, with the main objective of obtaining a representative sample of that stratum.
   Measurements on the photo plots include crown diameters, heights and number of stems per species, while detailed measurements of trees are obtained on all ground samples. A sub-sample of ground samples is further examined for growth, yield, decay, and waste.

   More detailed instructions, with examples and illustrations, are presented in the following sections.
FOREST CLASSIFICATION AND SAMPLING
SUPPLEMENTARY DRAFT GUIDELINES FOR THE 1979
FIELD SEASON

NUMERICAL INDEX

1.0 CLASSIFICATION STANDARDS
1.1 Introduction
1.11 Definitions
1.2 Forest Type Standards
1.21 Non-Forest Land
1.211 Map Notes
1.212 Full Type Description of Alpine Forest, Non-Productive
      Forest, and Black Spruce Forest Types
1.22 Forest Land
1.221 Cover Class
1.2211 Mature
1.2212 Immature
1.2213 Not Satisfactorily Restocked
1.2214 Disturbed Stocking Doubtful
1.2215 Non-Commercial
1.222 Forest Type Characteristics
1.2221 Species
1.2222 Age
1.22211 Maturity Ages of Commercial Species
1.22222 Multi-age Stands
1.2223 Height
1.2224 Stocking
1.2225 Site
1.2226 Crown Closure
1.2227 Stand Density
1.2228 Secondary Elements
1.22281 Secondary Older Elements
1.22282 Secondary Younger Elements
1.2229 Disturbances
1.22291 Disturbance Responsible
1.22292 Recent Disturbance
1.22293 Types of Disturbance
1.223 Basic Guide for Forest Type Classification

2.0 AIR PHOTO PREPARATION FOR T.S.A. RE-INVENTORY
2.1 Alternative Methods for Revising Forest Inventories
2.2 Use and Preparation of New Photographs
2.21 Photo Organization
2.22 Pre-Typing
2.221 General Rules for Pre-Typing
2.23 Collecting and Recording Available Information
2.3 The Use and Preparation of Original Photographs
2.4 Using a Combination of Old Classification Photos and
   New Photos
3.0 FIELD PROCEDURES
3.1 Ground Calls
3.11 Inventory Classification Sheet
3.2 Ground Observations
3.3 Fixed Base, Low-Level, Aerial Photography (70 mm)
3.4 Sample Strips
3.5 Establishing Priorities
3.6 Summary and Recording
3.61 General Guidelines
3.62 Specific Guidelines

4.0 FINAL LABELLING OF FOREST TYPES

5.0 UP-DATING FOREST TYPE LABELS
5.1 Manual Revision
5.2 Automatic Computer Up-dating

6.0 PREPARING MAPS FOR DIGITIZING

7.0 SAMPLING
7.1 Objectives
7.2 Determining Sample Requirements
7.3 Forest Type Selection
7.4 Sample Layout
7.5 Plotting Samples
7.6 Field Procedures
7.61 Sample Trees
7.62 Sample Sheet
7.63 Sample Inspection
7.631 Sample Inspection Sheet Description
7.7 Double Sampling
7.71 Basic Concept
7.72 Office Preparation
7.73 Field Preparation
7.74 Low Level Flight

APPENDICES

APPENDIX A A Selected List of Instruction Material for the Relascope (Relaskop)
B Fixed Base, Large Scale, Aerial Photography
C Summary of Operational Guidelines for 70 mm Fixed Base Photography
D Recognition of Texture
1.0 CLASSIFICATION STANDARDS

1.1 INTRODUCTION

The purpose of any forest area classification system is to divide the forest area into forest types on the basis of significant observable differences, and the non-forest area into non-forest types (e.g. swamps, meadow, cultivated, alpine, etc.)

The standard basis for the separation of forest types will depend on those stand characteristics which can be observed from the air and on the ground. Generally speaking, specific stand characteristics are ascertained most accurately through groundwork, whereas the extent of type and species distribution are best determined from the air. Classification by intensive groundwork is often more costly than that by airwork because of the greater time required to cover the same area. Consequently a judicious combination of ground and air work is recommended to produce the best results.

The criteria used to form the basis for classification standards are as follows:

- forest land versus non-forest land;
- cover class;
- species composition;
- age by species;
- height by species;
- stocking;
- crown closure; and occasionally
- site; and
- history

This classification system is based on the observer's ability to see significant differences within each of these criteria, and to record these differences in a standard manner in order that they may be used in the definition and mapping of forest and non-forest types.

1.11 DEFINITIONS

Air Call - detailed examination of a forest stand made from the air.

Air Observation - brief examination of a forest stand made from the air.

Ground Call - ground examination of a forest stand supported by sample tree measurements.

Ground Observation - observations made from the ground where stand details are usually estimated instead of measured.
1.2 FOREST TYPE STANDARDS

1.2.1 NON-FOREST LAND

1.2.1.1 Map Notes

Non-forest types are described by the use of map notes except for Alpine and NP Forest areas described in Section 1.2.1.2. On photos and forest cover maps, mapping symbols or descriptions are used to denote non-forest types.

<table>
<thead>
<tr>
<th>Description</th>
<th>Map Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barren - Alpine</td>
<td>A</td>
</tr>
<tr>
<td>- Rock</td>
<td>R</td>
</tr>
<tr>
<td>- Non-productive Burn</td>
<td>NP Ø</td>
</tr>
<tr>
<td>- Claybank</td>
<td>Claybank</td>
</tr>
<tr>
<td>- Other</td>
<td>NP</td>
</tr>
<tr>
<td>Non-productive Decid. Brush</td>
<td>NP Br</td>
</tr>
<tr>
<td>Water</td>
<td>Lake, River</td>
</tr>
<tr>
<td>Swamp, Muskeg</td>
<td></td>
</tr>
<tr>
<td>Cleared, Cultivated, Urban</td>
<td>C or Urban</td>
</tr>
<tr>
<td>Improved Grassland</td>
<td>C</td>
</tr>
<tr>
<td>Isolated Industrial Plant</td>
<td>C or Plant Name</td>
</tr>
<tr>
<td>Wild Hay Meadow</td>
<td>M</td>
</tr>
<tr>
<td>Range Land</td>
<td>OR</td>
</tr>
<tr>
<td>Rock, NP Ø, Claybank, NP Br, swamp</td>
<td></td>
</tr>
<tr>
<td>Environmental Protection Forest</td>
<td>E</td>
</tr>
<tr>
<td>Plantation</td>
<td>P</td>
</tr>
</tbody>
</table>

1.2.1.2 Full Type Description of Alpine Forest, Non-Productive Forest and Black Spruce Forest Types

Alpine Forest

High elevation forest lying adjacent to alpine areas, of very low productivity, broken up by rock outcrops and slides and of no commercial interest in the foreseeable future. Classify by species composition, age, height, stocking and crown closure:

Example:  A For H₈B₂ 270-9.0-1-2
          A For B₁₀ 100-12.0-0-4
          A For B₇S₃ 280-15.0-2-5

Non-Productive Forest

Forest of very low productivity and of no commercial interest in the foreseeable future.
Examples:  (a) NP Swamp Forest: common to central and northern interior areas; typically comprises black spruce and associate trees bordering swamps.

Classify and label as follows:

NP \( Sb_{10} \) 290-9.0-2-4
NP \( Sb_{10} \) 140-12.0-2.6
NP \( Sb_{10} \) 90-6.0-0-2

(b) NP Lowland Forest: common to central and northern coastal lowlands; comprises short stunted, limby, poorly formed trees.

Classify and label as follows:

NP \( C_sC_yP_l_2 \) 310-18.0-1-6
NP \( C_yP_l_3H_3 \) 290-9.0-2-4

(c) Miscellaneous Forest Areas: characterized by rocky, broken terrain, often excessively steep and generally inaccessible.

Classify and label as follows:

NP \( F_{10} \) 280-20.0-2-3
NP \( P_yP_5 \) 300-15.0-2-3
NP \( B_7P_l_3 \) 100-9.0-0-2

Note: As a guide, regard all mature stands over 10.5 metres in height as potentially productive; they might be pulp stands. However, remember that some non-productive areas support stands taller than 10.5 metres in height.

Black Spruce Productivity

For black spruce forest of marginal productivity, use the following guidelines to establish whether it is productive or non-productive:

To be classed as productive a stand 90 years old must be 12 metres or greater in height, have an average diameter of 10 centimetres or greater, and contain at least 15 stems per hectare 17.5 cm plus.

To be classed as non-productive, a black spruce stand would not meet the preceding specifications.

Examples:  (a) A black spruce stand of 90 years, 10-12 metres high, average diameter 10 cm, with only 10 stems per hectare 17.5 cm plus, would be classified as non-productive and labelled as follows:

NP \( Sb_{10} \) 90-11.0-0-4

(b) A black spruce stand meeting all specifications (90 years, 12-14 metres high, average diameter 12.5 cm and with 20 stems per acre 17.5 cm plus) would be classified as productive and labelled as follows:

NP \( Sb_{10} \) 90-13.0-0-P-6
Note: The numeral 6 represents the crown closure class (51-60%). Refer to the definition of crown closure in the text.

1.22 FOREST LAND

See chart near beginning of section.

1.221 Cover Class

The classes of cover are: Mature, Immature, Not Satisfactorily Restocked (N.S.R.), Disturbed Stocking Doubtful (D.S.D.) and Non-Commercial (N.C.).

1.2211 Mature

121 years of age and over for coniferous species with the exception of Lodgepole Pine (Pl) and Whitebark Pine (Pa).

81 years of age and over for deciduous species and for Lodgepole Pine and Whitebark Pine.

1.2212 Immature

Less than 121 years of age for coniferous species with the exception of Pl and Pa.

Less than 81 years of age for deciduous species and for Pl and Pa.

1.2213 Not Satisfactorily Restocked (N.S.R.)

Denuded areas that do not meet minimum stocking requirements of approximately 750 healthy, well distributed seedlings (or juvenile stems) per hectare. Verify N.S.R. areas by ground examination using Regional guidelines. Record species composition to the nearest 10 percent; age to the nearest year and height to the nearest 0.1 m, site, crown closure, and number of stems per hectare.

1.2214 Disturbed Stocking Doubtful (D.S.D.)

Use as an interim label only if an area has not been verified either as stocked or as N.S.R.

1.2215 Non-Commercial

Use this cover class sparingly, and confine it as much as possible to deciduous brush growing on productive sites. On occasion use it to describe stands, usually disturbed, of very low quality that cannot be classified as commercial, N.S.R. or D.S.D.

Example: NC Br-P NCB₁₀ 65-3.2-0-L-4

θ67
### Forest Type Characteristics

#### Species

Below, find a list of genera and/or species by common and scientific names and symbol used in classification of forest stands. This list includes all genera/species found in forest cover map labels.

<table>
<thead>
<tr>
<th>Common Name of Genus/Species</th>
<th>Scientific Name of Genus/Species</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alder</td>
<td>Alnus</td>
<td></td>
</tr>
<tr>
<td>Red Alder</td>
<td>A. rubra</td>
<td>D</td>
</tr>
<tr>
<td>Balsam</td>
<td>Abies</td>
<td></td>
</tr>
<tr>
<td>Alpine Fir</td>
<td>A. lasiocarpa</td>
<td>B</td>
</tr>
<tr>
<td>Amabilis Fir</td>
<td>A. amabilis</td>
<td>B</td>
</tr>
<tr>
<td>Balsam Fir</td>
<td>A. balsamea</td>
<td>B</td>
</tr>
<tr>
<td>Grand Fir</td>
<td>A. grandis</td>
<td>B</td>
</tr>
<tr>
<td>Birch</td>
<td>Betula</td>
<td></td>
</tr>
<tr>
<td>White Birch</td>
<td>B. papyrifera</td>
<td>Bi</td>
</tr>
<tr>
<td>Cedar</td>
<td>Thuja</td>
<td></td>
</tr>
<tr>
<td>Western Red Cedar</td>
<td>T. plicata</td>
<td>C</td>
</tr>
<tr>
<td>Cypress</td>
<td>Chamaecyparis</td>
<td></td>
</tr>
<tr>
<td>Yellow Cedar</td>
<td>C. nootkatensis</td>
<td>Cy</td>
</tr>
<tr>
<td>Douglas Fir</td>
<td>Pseudotsuga</td>
<td></td>
</tr>
<tr>
<td>Douglas Fir</td>
<td>P. menziesii</td>
<td>F</td>
</tr>
<tr>
<td>Hemlock</td>
<td>Tsuga</td>
<td></td>
</tr>
<tr>
<td>Mountain Hemlock</td>
<td>T. mertensiana</td>
<td>H</td>
</tr>
<tr>
<td>Western Hemlock</td>
<td>T. heterophylla</td>
<td>H</td>
</tr>
<tr>
<td>Larch</td>
<td>Larix</td>
<td></td>
</tr>
<tr>
<td>Alpine Larch</td>
<td>L. lyallii</td>
<td>L</td>
</tr>
<tr>
<td>Tamarack</td>
<td>L. larnicina</td>
<td>L</td>
</tr>
<tr>
<td>Western Larch</td>
<td>L. occidentalis</td>
<td>L</td>
</tr>
<tr>
<td>Maple</td>
<td>Acer</td>
<td></td>
</tr>
<tr>
<td>Broadleaved Maple</td>
<td>A. macrophyllum</td>
<td>Mb</td>
</tr>
<tr>
<td>Pine</td>
<td>Pinus</td>
<td></td>
</tr>
<tr>
<td>Lodgepole Pine</td>
<td>P. contorta</td>
<td>Pl</td>
</tr>
<tr>
<td>Western White Pine</td>
<td>P. monticola</td>
<td>Pw</td>
</tr>
<tr>
<td>Whitebark Pine</td>
<td>P. albicaulis</td>
<td>Pa</td>
</tr>
<tr>
<td>Yellow Pine</td>
<td>P. ponderosa</td>
<td>Py</td>
</tr>
<tr>
<td>Poplar</td>
<td>Populus</td>
<td></td>
</tr>
<tr>
<td>Aspen</td>
<td>P. tremuloides</td>
<td>A</td>
</tr>
<tr>
<td>Balsam Poplar</td>
<td>P. balsamifera</td>
<td>Ct</td>
</tr>
<tr>
<td>Black Cottonwood</td>
<td>P. trichocarpa</td>
<td>Ct</td>
</tr>
<tr>
<td>Spruce</td>
<td>Picea</td>
<td></td>
</tr>
<tr>
<td>Black Spruce</td>
<td>P. mariana</td>
<td>Sb</td>
</tr>
<tr>
<td>Engelmann Spruce</td>
<td>P. engelmannii</td>
<td>S</td>
</tr>
<tr>
<td>Sitka Spruce</td>
<td>P. sitchensis</td>
<td>S</td>
</tr>
<tr>
<td>White Spruce</td>
<td>P. glauca</td>
<td>S</td>
</tr>
</tbody>
</table>
In addition, several species listed above may be indicated by a specific, instead of a generic, symbol on classification sheets (not in map labels) when the classifier is certain of species identification:

<table>
<thead>
<tr>
<th>Common Name of Genus/Species</th>
<th>Scientific Name or Genus/Species</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balsam</td>
<td>Abies</td>
<td></td>
</tr>
<tr>
<td>Alpine Fir</td>
<td>A. lasiocarpa</td>
<td>Bl</td>
</tr>
<tr>
<td>Amabilis Fir</td>
<td>A. amabilis</td>
<td>Ba</td>
</tr>
<tr>
<td>Balsam Fir</td>
<td>A. balsamea</td>
<td>Bb</td>
</tr>
<tr>
<td>Grand Fir</td>
<td>A. grandis</td>
<td>Bg</td>
</tr>
<tr>
<td>Larch</td>
<td>Larix</td>
<td></td>
</tr>
<tr>
<td>Alpine Larch</td>
<td>L. Lyallii</td>
<td>Ll</td>
</tr>
<tr>
<td>Tamarack</td>
<td>L. laricina</td>
<td>Lt</td>
</tr>
<tr>
<td>Western Larch</td>
<td>L. occidentalis</td>
<td>Lo</td>
</tr>
<tr>
<td>Hemlock</td>
<td>Tsuga</td>
<td></td>
</tr>
<tr>
<td>Mountain Hemlock</td>
<td>T. mertensiana</td>
<td>Hm</td>
</tr>
<tr>
<td>Western Hemlock</td>
<td>T. heterophylla</td>
<td>Hv</td>
</tr>
<tr>
<td>Pine</td>
<td>Pinus</td>
<td></td>
</tr>
<tr>
<td>Limber Pine</td>
<td>P. flexilis</td>
<td>Pf</td>
</tr>
</tbody>
</table>

Occasionally, use may be made in field notes (not in map labels) of symbols for some non-commercial trees and shrubs:

<table>
<thead>
<tr>
<th>Species</th>
<th>Scientific Name</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alder, Sitka</td>
<td>Alnus sinuata</td>
<td>DS</td>
</tr>
<tr>
<td>Arbutus</td>
<td>Arbutus menziesii</td>
<td>AR</td>
</tr>
<tr>
<td>Cascara</td>
<td>Rhamnus purshiana</td>
<td>CA</td>
</tr>
<tr>
<td>Cherry, Wild</td>
<td>Prunus emarginata</td>
<td>CH</td>
</tr>
<tr>
<td>Dogwood, Flowering</td>
<td>Cornus nuttallii</td>
<td>DG</td>
</tr>
<tr>
<td>Juniper, Rocky Mountain</td>
<td>Juniperus scopulorum</td>
<td>JU</td>
</tr>
<tr>
<td>Maple, Smooth</td>
<td>Acer glabrum</td>
<td>MS</td>
</tr>
<tr>
<td>Maple, Vine</td>
<td>Acer circinatum</td>
<td>MV</td>
</tr>
<tr>
<td>Oak, Garry</td>
<td>Quercus garryana</td>
<td>Q</td>
</tr>
<tr>
<td>Willow</td>
<td>Salix</td>
<td>W</td>
</tr>
<tr>
<td>Yew, Pacific</td>
<td>Taxus brevifolia</td>
<td>Y</td>
</tr>
</tbody>
</table>

Species Composition

Note: It is very important to correctly determine species composition in a stand.

Most stand measurements are based on the leading major species, and combined with the second major species, determines type group. The type groups (see Appendix 12) have an important use in data processing. In the field, determine and record species composition by percent of total volume (to the nearest 10% by volume) or, in the case of stands of below minimum d.b.h. (7.5 cm) or less, by stem count. List the species present in a forest type by declining percent volumes. Class each species comprising 20% or more of the gross volume as "major" and each comprising 10-19% of the gross
volume as "minor". Any percentage ranging from 10-19% becomes 10% and any one less than 10% is not recorded. As a guide, restrict the number of species per type to three or less, but four and five are permissible.

In ground classification, determine species composition by a thorough examination of the type. If a large stand of timber is reasonably homogeneous, class it as one type. It is realized that the species composition often changes throughout a large type. If this is true, determine the average composition and use it as the type description.

The Wedge Prism - An Aid in Ground Classification and Volume Estimation

Use the wedge prism as an aid in the determination of the species composition of mixed stands as follows:

- Take all measurements at d.b.h. (1.3 m);
- Select a Basal Area Factor that will give 8 to 12 trees per sweep;
- Make a circular sweep with the prism;
- Record the number of "in" (sample) trees by species;
- Measure the average height of each species;
- Calculate species composition by multiplying the number of trees for each species by the average height for that species to give the percentage total volume for each species

<table>
<thead>
<tr>
<th>Example:</th>
<th>Sweep No.</th>
<th>F</th>
<th>C</th>
<th>H</th>
<th>Mb</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>13</td>
<td>11</td>
<td>6</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Example:</th>
<th>(1) Av. Ht. (m)</th>
<th>45</th>
<th>30</th>
<th>36</th>
<th>24</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) x (2)</td>
<td>585</td>
<td>330</td>
<td>216</td>
<td>48</td>
<td>1179</td>
</tr>
<tr>
<td>Percent</td>
<td>50</td>
<td>28</td>
<td>18</td>
<td>4</td>
<td>100</td>
</tr>
</tbody>
</table>

- Record species composition to the nearest ten percent. In the preceding example, record the species composition as follows:
  
  F 50, C 30, H 20, Mb 0. Type label: F_{5}C_{3}H_{2} 140-45.0-1-G-6

In a prism sweep, separate trees belonging to secondary older elements,* including vets,* from the main stand. See Section 1.2312 for classifying the secondary older elements. Also do not include dead trees.

*Secondary older elements - the residual element of a former stand, mature or immature, but at least 40 years older than the trees of the main stand.

*Veteran - a live tree at least 40 yrs. older than the trees of the main stand; e.g., a former stand remnant. It need not be a mature tree.
In aerial classification, species composition is based on the percentage of crown area occupied by each species modified by height.

Type Group Designation

Pure Forest Types

For pure forest types, major species must be 81% or greater by volume of live trees in the main stand. Do not include secondary older elements, including vechs, in this calculation. During area classification, note percent volume by species to the nearest 10% on the forest classification sheet, but to ensure that a type is recognized as "pure" record percent volume as at least 90%. Species totals do not have to equal 100%.

Examples:  
   a) F 81%, S 19% would be recorded as F 9 and S 1 as a minor species.
      Forest Type = F(S) (pure type)  
      Type Group = 1 (F)
   
   b) Note that in this example the type is not pure.
      F 80%, S 20% would be recorded as F₃S₂.
      Forest Type = FS (mixed type)  
      Type Group = 4 (FS)

Mixed Forest Types

(i) The second species by volume must be equal or greater than 20%.

Example: S 50%, Pl 40%, B 10% would be recorded as S₅Pl₄B₁.
      Forest Type = SP₁(B)  
      Type Group = 25 (SP₁)

(ii) When the major species does not form a pure type.

Examples:  
   a) H 80%, S 10%, C 10% would be recorded as H₅S₁C₁.
      Forest Type = H(SC)  
      Type Group = 12 (H)
   
   b) F 70%, S 15%, B 12% would be recorded as F₇S₁B₁.
      Forest Type = F(SB)  
      Type Group = 1 (F)
   
   c) Pl 65%, S 15%, F 10%, B 10% would be recorded as Pl₇S₁F₁B₁.
      Forest Type = Pl(SFB)  
      Type Group = 28 (Pl)

Type Group

Once the Forest Type has been established by the above rules, the Type Group can be designated from the chart in Appendix 12. Note that pure Forest Types (other than pure Pl) are combined with mixed Forest Types to form some Type Groups.
1.2222  Age

Stand age is the age of the leading major species. In ground
classification base the age on sample tree borings from at least
three dominant and codominant trees from the leading species, using
a ratio of one dominant to two codominants. In air classification,
estimate age on the basis of local knowledge and experience of
species characteristics. Forest types are stratified by age class
but described to the nearest year. The age class limits and age
class codes are:

<table>
<thead>
<tr>
<th>Age Class Limits</th>
<th>Age Class Code</th>
<th>Age Class Limits for Age in Tens</th>
<th>Age in Tens</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- 20</td>
<td>1</td>
<td>1- 10, 11- 20</td>
<td>01, 02</td>
</tr>
<tr>
<td>21- 40</td>
<td>2</td>
<td>21- 30, 31- 40</td>
<td>03, 04</td>
</tr>
<tr>
<td>41- 60</td>
<td>3</td>
<td>41- 50, 51- 60</td>
<td>05, 06</td>
</tr>
<tr>
<td>61- 80</td>
<td>4</td>
<td>61- 70, 71- 80</td>
<td>07, 08</td>
</tr>
<tr>
<td>81-100</td>
<td>5</td>
<td>81- 90, 91-100</td>
<td>09, 10</td>
</tr>
<tr>
<td>101-120</td>
<td>6</td>
<td>101-110, 111-120</td>
<td>11, 12</td>
</tr>
<tr>
<td>121-140</td>
<td>7</td>
<td>121-130, 131-140</td>
<td>13, 14</td>
</tr>
<tr>
<td>141-250</td>
<td>8</td>
<td>141-250</td>
<td>15, 25 (20)</td>
</tr>
<tr>
<td>251+</td>
<td>9</td>
<td>251+</td>
<td>26, 27, etc. (26)</td>
</tr>
</tbody>
</table>

1.22221  Maturity Ages of Commercial Species

All coniferous species (other than Pl and Pa) are considered mature
at 121 years.

All deciduous species (Ct, D, Mb, A, Bi), plus Pl and Pa are
considered mature at 81 years.

1.22222  Multi-Age Stands

Multi-age stands are characterized by a relatively uneven distribution
of stems across a wide range of age classes. This makes age
difficult to determine. Typical examples include stands of
interior dry belt FPY and stands consisting of residual balsam left
after logging.

To determine age:

1. separate the stand into mature and immature
   components;

2. describe each component separately;

3. if the main stand is immature and all aged,
   visually stratify the stand into age classes,
   then select sample trees for the leading
   species from the two adjacent age classes to
   which most trees belong; and

4. for mature stands, select sample trees for the
   leading species from the diameter range
   representing the greatest percentage of stand
   volume.
Show age for a multi-aged stand in the descriptive label to the nearest year with a "v" for variable (e.g. F7Py3 (62V) 18.3-0-P-7).

1.2223  Height

Stand height is determined from the height of the leading species. From ground examinations determine the average height of the leading major species by measuring at least one dominant and two codominants selected while traversing the type. Measure, average, and record height to the nearest one-tenth metre. From the air, estimate height to the nearest three metres.

Forest types are stratified by nine metre classes but described as precisely as the source data permits. Height class limits are as follows:

<table>
<thead>
<tr>
<th>Height Code</th>
<th>Height (metres)</th>
<th>Class Limits</th>
<th>Height Class Limits for Height in 3's</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3, 6, 9</td>
<td>0-10.4</td>
<td>0- 4.4, 4.5- 7.4, 7.5-10.4</td>
</tr>
<tr>
<td>2</td>
<td>12, 15, 18</td>
<td>10.5-19.4</td>
<td>10.5-13.4, 13.5-16.4, 16.5-19.4</td>
</tr>
<tr>
<td>3</td>
<td>21, 24, 27</td>
<td>19.5-28.4</td>
<td>19.5-22.4, 22.5-25.4, 25.5-28.4</td>
</tr>
<tr>
<td>4</td>
<td>30, 33, 36</td>
<td>28.5-37.4</td>
<td>28.5-31.4, 31.5-34.4, 34.5-37.4</td>
</tr>
<tr>
<td>5</td>
<td>39, 42, 45</td>
<td>37.5-46.4</td>
<td>37.5-40.4, 40.5-43.4, 43.5-46.4</td>
</tr>
<tr>
<td>6</td>
<td>48, 51, 54</td>
<td>46.5-55.4</td>
<td>46.5-49.4, 49.5-52.4, 52.5-55.4</td>
</tr>
<tr>
<td>7</td>
<td>57, 60, 63</td>
<td>55.5-64.4</td>
<td>55.5-58.4, 58.5-61.4, 61.5-64.4</td>
</tr>
<tr>
<td>8</td>
<td>66+</td>
<td>64.5+</td>
<td>64.5+</td>
</tr>
</tbody>
</table>

1.2224  Stocking

Assign a stocking class to all mature and immature stands on the following basis:

I. Immature Stands

Stocking Class 0

II. Mature Stands

(1) 76 or more trees per hectare
    27.5 cm + d.b.h.

(2) Fewer than 76 trees per hectare
    27.5 cm + d.b.H.
   (a) Leading species not Lodgepole Pine
   (b) Leading species Lodgepole Pine
    1) 311 or more stems per hectare 17.5 cm + d.b.h.
        i. 50% or more of the stems
           7.5 cm d.b.h. + are
           12.5 cm + d.b.h.
        ii. Fewer than 50% of the stems 7.5 cm d.b.h. + are 12.5 cm + d.b.h.
    2) 0-310 stems per hectare
       17.5 cm + d.b.h.

Stocking Class 1

Stocking Class 2

Stocking Class 3

Stocking Class 4

Stocking Class 4
Note: For marginal stands, determine the stocking class by using either the relascope and the density table on the back of the classification sheet or a fixed radius plot and a diameter tape (see Section 10.1 of manual).

1.2225 Site

Determine site for all productive forest types from the age-height-site curves in the Field Pocket Manual. Ascertain whether the site is Good (G), Medium (M), Poor (P), or Low (L) and note that it must always be based on the first species in order of predominance regardless of the percentage composition of the stand or of the number of species in the label. Similar types may be separated on the basis of site alone; (e.g. medium from poor). Show site on the labels of photos and maps as follows:

a) $S_7B_3$ 138-30.4-1-G-8  b) $P_{10}$ 30-8.1-0-P-7  c) $P_{38}F_2$ 18-8.1-0-G-7
d) NSR-M  e) NSR-G
   $\Theta 63$  +F 83-1(17.5+)
f) NC Br-P

Note 1: The site as determined from age/height measurements for advanced immature trees released after long suppression, may be too low for the site. Determine site from the current rate of growth and from the site of the original stand. If the assigned site class differs from the one expressed by the actual age and height, circle the site to indicate the difference.

Example: variable age height circle site

$B_{10} (61V)-8.0-0-M-6$

Note 2: In immature age class 1 stands, if suitable sample trees are not available, determine the site class from remnants, from surrounding stands or, failing these, from local knowledge.

Note 3: Do not designate a site class for non-productive forest types.

1.2226 Crown Closure

Crown closure is the percentage of area taken up by the crown canopy of the main stand. Assign crown closure to both immature and mature stands. The preferred method of determining crown closure is through photo interpretation with the aid of the U.B.C. crown closure scales. Estimate crown closure to the nearest 10 percent, but stratify into one of three classes. Crown closure is intended to replace stocking class in the near future. The crown class limits and crown class codes are:
<table>
<thead>
<tr>
<th>Crown Class Limits %</th>
<th>Crown Class Codes</th>
<th>Crown Class Limits U.B.C. Scale</th>
<th>Crown Class 10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-20</td>
<td>1</td>
<td>0-10</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11-20</td>
<td>2</td>
</tr>
<tr>
<td>21-60</td>
<td>2</td>
<td>21-30</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>31-40</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>41-50</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>51-60</td>
<td>6</td>
</tr>
<tr>
<td>61-100</td>
<td>3</td>
<td>61-70</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>71-80</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>81-90</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>91-100</td>
<td>10</td>
</tr>
</tbody>
</table>

1.2227 Stand Density

Stand density is the number of stems per hectare in the main stand. Record stand density when supported by adequate ground measurements.

1.2228 Secondary Elements

1.22281 Secondary Older Elements

In many stands classed either as N.S.R. or immature, there are residual elements of older trees left from a previous stand following a major disturbance such as fire or logging.

Secondary older elements include trees two age classes (40 years+) older than the age of the immature stand. Identify these older or residual elements and describe them separately from the main stand because: (1) volumes and growth rates for the immature stand would be overestimated if older elements were included, (2) the older elements often represent immediate commercial potential, (3) residual elements may have to be removed to promote the release and development of younger stands.

Secondary older elements may be recognized in:

1) immature stands;
2) N.S.R.;
3) N.C. immature;
4) mature Pl age classes 5 to 7 with a component of much older and larger F or L vets.

Classify and describe all secondary older elements by species order, age class, height class and by volume increments of 50 m³ per ha (close gross), for all stems either 17.5 cm + or 27.5 cm +.¹

Use the following classes and class limits to describe the volume of the secondary older elements:

¹Minimum diameter determined by Region
<table>
<thead>
<tr>
<th>Class</th>
<th>Volume (m³/ha) close gross min. d.b.h. 17.5 cm+ or 27.5 cm+</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0-50</td>
</tr>
<tr>
<td>2</td>
<td>51-100</td>
</tr>
<tr>
<td>3</td>
<td>101-150</td>
</tr>
<tr>
<td>4</td>
<td>151-200</td>
</tr>
<tr>
<td>5</td>
<td>201-250</td>
</tr>
</tbody>
</table>

Determine the appropriate class by combining information derived from relascope sweeps, ground estimation and photo interpretation. For relascope sweeps, determine volume from the summary table on the back of the classification data sheet.

**e.g.** the main stand is immature S_{7}B_{3} 62-22.2-0-G-7 plus an older component of SB, age class 8, height class 3, and a measured volume of 140 m³/ha 27.5 cm+

record as:  S_{7}B_{3} 62-22.2-0-G-7

+ SB 83-3(27.5+)  
  age.class  min. d.b.h. 
  species order  volume code  
  height class

**e.g.** the main stand is mature P_{10} 110-22.0-1-M-8 plus an older element of F, age class 8, height class 4, and with an estimated volume of 120 m³/ha 27.5 cm+

record as:  P_{10} 110-22.0-1-M-8

+ F 94-3(27.5+)

1.22282  Secondary Younger Elements

Secondary younger elements are only recognized for thrifty, well stocked, coniferous understories of significant potential commercial value. These are generally restricted to:

1) thrifty  S under older immature or mature deciduous or P

2) thrifty  F, FPY, PYF under older immature or mature combinations of F and PY
Describe species present, age to the nearest year, and when possible, height to the nearest metre.

\[ \text{e.g. } A_7 \text{Cot}_3 \ 110-31.2-1-M-9 \ \text{or} \ \ F_7 \text{PY}_3 \ 160-35.0-1-G-6 \\
\quad + \ S \ 65-22.0 \ \text{height to nearest metre} \\
\quad \text{age to nearest year} \]

1.2229 Disturbances

Disturbances are an important part of a stand's history. Disturbances may be old or recent, minor or major, man-caused or natural (e.g. fire, logging, silvicultural thinning, insects, windthrow, slides, clearing for cultivation, etc.). Two general classes of disturbances are recognized:

1) Disturbances responsible
2) Recent disturbances

1.22291 Disturbance Responsible

This class includes severe disturbances that result in the establishment of a new stand. At least 70 to 80 percent of the previous stand, by area, is destroyed. In this class, fire and logging are the most common disturbances.

On photos and maps disturbances are shown by a history symbol and the year the disturbance occurred. Fire dates are of particular value to classifiers for the establishment of age patterns in areas with large burns, and history symbols are useful in the prediction of species composition for types that must be photo interpreted. Obtain history from old and new history maps and files.

1.22292 Recent Disturbances

Recent disturbances are disturbances that have affected an established stand within the last 20 years. They fall into one of two classes: minor (0 to 20% by area) or major (21 to 70% by area). The description of a minor disturbance is optional and depends on its significance. Denote all major disturbances with a history symbol and the year of disturbance. This history, together with crown closure and stocking assist the forest manager to estimate current stand conditions.
1.22293 Types of Disturbance
1.22931 Logging

1) Clear Logging

Standard symbols:

(a) single date 0 56
(b) multiple date - show first year and last year 0 54-56
(c) two separate dates - show first date to the left and
second date to the right of the symbol (e.g. 51 0 56)

With clear logging, most of the trees are cut and removed. To
rate as clear-logging, the area has to be 70 to 100% disturbed
by logging.

Note: Clear logging can take a number of forms: strips, patches,
blocks, continuous clearcut, clearcut with seed blocks.
Cut-and-leave strips may be treated as selectively logged
areas.

2) Selective Logging

Standard symbol: 0 76

Selective logging means that from 1 to 70%, by area, of a forest type
has been logged. Selective logging is most common in interior
B.C., but is also used on the coast.

The usual reasons for selective logging are:

- on the Coast: - to prelog mature stands for specialty
  products, usually Cedar poles;
- in the Interior: - to pre-log mature stands for specialty
  products;
  - to remove mature trees from immature
  stands;
  - to remove trees within or above specified
d.b.h. limits.

1.222932 Fires

Standard symbols:

1) Crown fires

- single date 55
- multiple date (show latest) 59
- two separate dates (show latest) 56

2) Ground fires

- single date 55G
- multiple date (show latest) 59G
- two separate dates (show latest) 56G
Disturbance is much more likely to be slight with ground first than with crown fires. Evidence of fires which have caused slight disturbance are difficult to identify on photographs and to detect by air observation. If the boundaries of the fire are not visible either from the ground or from the air, do not record a fire history.

1.222933 Logging and Burning

Standard symbols:
- single dates ⊕ 54
- multiple dates (show latest burn only) ⊕ 54-56
- log, burn and re-burn (show latest burn only) ⊕ 58 55-58

1.222934 Windfall

Standard symbol: ↯ 65

This will normally be used as a "disturbance responsible" symbol as most stands with recognizable wind damage will be severely disturbed.

1.222935 Insects and Disease

For insects: record the insect species and year(s) of infestation. The degree of infestation may be coded as:
(1) light, (2) moderate, (3) heavy or (4) past occurrence.

  e.g. Mountain pine beetle (2) 78-79
  or MP Beetle (2) 78-79

For disease: areas killed by disease are usually too small to map out.

1.222936 Slides

Standard symbol: ⬇

Note: the arrow must point in the direction of the slide.

Classify slides that left nothing but rock and those that recur yearly as non-productive. Wherever possible, type slide areas as a part of other non-productive areas (e.g. alpine), but use the slide symbol. Slides which have occurred once, and that have removed the vegetation but have left the site productive, may be mapped and described in the same manner as other productive disturbed areas.

1.222937 Ice and Snow Break

Treat areas of forest damaged by ice and snow in the same way as windfall.
1.222938  Plantations and Disturbed Areas

Describe the type and show the disturbance symbol, the date of disturbance, the species planted, the plantation symbol, and the age of planting (use multiple dates if desired):

Examples:

$$S_7P_{13} \quad 11-3.0-0-G-4 \quad S_7P_{13} \quad 11-3.0-0-G-4 \quad S_7P_{13} \quad 11-3.0-0-G-4$$

61

61

61

$$S \circ 68 \quad S \circ 66-68 \quad S \circ 66,67,68$$

1.223  Basic Guidelines for Forest Type Classification

Forest classification is a description of existing physical stand characteristics based on measurements and estimates.

Classification Steps:

1. Determine the main and secondary cover classes for the type. Regardless of the presence, absence or history of disturbance, choose the best cover class or combination of cover classes for describing the present type. This choice is a silvicultural decision based on the relative values of each component and on regional management objectives. The most common combinations of cover classes are:

a) main stand mature
    or main stand mature, plus secondary immature
    or main stand mature, plus secondary older element
    (only for mature P1 plus F or L vets)

b) main stand immature
    or main stand immature, plus secondary immature
    plus secondary older element

c) N.S.R. (D.S.D.)
    or N.S.R. (D.S.D.) plus secondary older element

d) N.C.
    or N.C. plus secondary older element

e) NP
(2) Assess and describe the characteristics required for each component.

(3) Attach a record of stand history when necessary.

See also "Chart summarizing forest classification procedures".

Examples of cover class combinations:

Ex. a: An area clearcut in 1976 (80% by area) is found to be under stocked but has an older residual component of Balsam (B).

Possible type labels:

<table>
<thead>
<tr>
<th>NSR</th>
<th>NSR</th>
<th>NC Br-P</th>
</tr>
</thead>
<tbody>
<tr>
<td>B7S3 3-1.0-0-M-1-62</td>
<td>B10 3-1.0-0-M-1-260</td>
<td>+B 83-1(27.5+)</td>
</tr>
<tr>
<td>□ 76</td>
<td>□ 76</td>
<td>□ 76</td>
</tr>
<tr>
<td>+B 83-1(27.5+)</td>
<td>+B 83-2(17.5+)</td>
<td>+B 83-2(17.5+)</td>
</tr>
</tbody>
</table>

Ex. b: Main stand mature. Selectively logged in 1972 with a 30% area disturbance, and a healthy, well stocked understory of FPY.

\[ F_7 \text{PY}_3 200-33.0-1-G-6 \rightarrow \text{describe present physical component regardless of degree of disturbance and year} \]

\[ + \text{FPY 60-20.0} \rightarrow \text{secondary younger element} \]

Ex. c: The main stand is now immature with a secondary old element left after major logging in 1966.

\[ B_8 S_2 (66V) - 7.0-0-□-7 \rightarrow \text{describe the immature component first,} \]
\[ + B_8 S_2 (66) \rightarrow \text{using a relascope, photo measurement or estimation, classify and describe the secondary older element,} \]
\[ + B_8 S_2 (27.5+) \rightarrow \text{attach the history symbol to the main stand.} \]

Note: For stands with residual components following a major disturbance always use the latest aerial photography for assessing current stand structure.
FOREST CLASSIFICATION SUMMARY
(with or without a history of disturbances)

FOREST TYPE

UNDERSTOCKED

MAIN STAND INMATURE WITH/WITHOUT SECONDARY OLDER ELEMENT

SINGLE AGED STAND

R-SITE DIO-SITE NOD-SITE NP

SPECIES HEIGHT CROWN CLOSURE
Age Stocking
INMATURE

NC

SPECIES HEIGHT SITE
Age Stocking
CROWN CLOSURE

SPECIES HEIGHT SITE
Age Stocking
CROWN CLOSURE

SPECIES HEIGHT SITE
Age Stocking
CROWN CLOSURE

+ SECONDARY OLDER ELEMENT

VOL. CODE   VOL. (m3/ha)
1             8-50
2             51-100
3             101-150
4             151-200
5             201-250

<76 TREES/ha 27.5cm+DBH
STOCKING 1

PI OTHER
STOCKING 2

≥76 TREES/ha 27.5cm+DBH

+ SECONDARY YOUNGER ELEMENT
SPECIES, AGE, HEIGHT

TVG OR MORE AGED STAND
0.45 YRS. APART

MAIN STAND MATURE

+ SECONDARY OLDER ELEMENT
(17.5cm + or 27.5cm + )
for trees ≥ 48 yrs. older than
main stand
(species, age, height/volume codes)
+ disturbance symbol w/data
es. & a.2.
2.0 AIR PHOTO PREPARATION FOR A TIMBER SUPPLY AREA RE-INVENTORY

2.1 ALTERNATIVE METHODS FOR REVISING FOREST INVENTORIES

All of British Columbia's forests have been inventoried at least once. But the forest landscape is constantly changing and must be periodically rechecked and revised. Forest inventories are revised in at least three ways:

1. completely retype the area on the most recent air photography;
2. revise and improve the classification on the typed air photos used in the previous inventory; and
3. use a combination of 1 and 2.

The advantages and disadvantages of each alternative are listed:

1. Retype on new photographs

Advantages:
- photos are clean and uncluttered;
- current history, roads and stand conditions are displayed;
- only one set of photos has to be used in the field and in the office;
- every type is reassessed using current methodology.

Disadvantages:
- all the old base data has to be transferred from the old photos to the new;
- the whole area has to be retyped and relabelled;
- the photo interpretation skills of current classifiers may not be equal to those of previous classifiers.

2. Revise and improve previously typed photos

Advantages:
- old base data does not have to be transferred from old to new photos;
- pre-typing is unnecessary;
- proposed final type labels and type lines can be checked in the field;
- most type lines do not have to be transferred to base maps;
- the planning of field work is facilitated (e.g. the selection of ground calls and ground samples).

Disadvantages:
- areas with major changes in labels, type lines, history and access are difficult to update and to revise on old photos;
- the accurate placement of new boundaries and roads on old photos is difficult;
- navigation on the ground and from the air is difficult using old photos in areas with recent disturbances.
3. Use a combination of old photos supplemented, where necessary, with new ones.

Advantages:
- the main advantages of using old photos are combined with some of the advantages of using new ones.

Disadvantages:
- two sets of photographs are often difficult to combine, to tie together, and to cross reference, especially when photo scales are different and/or photo flight lines run in different directions.

Recommendations:
- for a first round inventory use the latest photos available for forest classification;
- for a subsequent inventory, update or revise as much as possible on first round photos but don't hesitate to retype all or a portion of an area on new photos when (1) classification standards of the first inventory are poor (2) there are numerous changes in history, stand structure, and classification procedures, and (3) when old 1:31 680 photography or poor quality 1:15 840 photography was used in the previous inventory.

2.2 USE AND PREPARATION OF NEW PHOTOGRAPHS

2.21 PHOTO ORGANIZATION

Outline the project area boundaries on a photo key map and note the flight lines required to ensure complete photo coverage. List and order the photographs. Upon receipt of the photos:

- check for missing photos;
- mark the north side of each photo with a red "N", for future navigational purposes;
- mark the unit boundaries in yellow on the odd-numbered photographs;
- file the photos either by flight line number or in consecutive strips from north to south.

2.22 PRE-TYPING

Before the field season, pre-stratify the whole project area into forest types based on recognizable differences in species composition, age, height, stocking, site, crown closure, and history. Accurate pre-typing is the cornerstone for a good forest inventory. Draw forest type boundaries on the even numbered photos in black ink if definite, or in pencil if indefinite. Pre-typed boundaries are theoretically final, subject to field confirmation.
Benefits from good pre-typing include:
- proposed final type boundaries can be field checked;
- field assessment of stand variations can be made more accurately;
- sample selection is facilitated;
- final typing is speeded up; and
- the classifier becomes familiar with the area.

2.221 General Rules For Pre-typing

1. Before pre-typing, become completely familiar with classification standards for stratifying forest and non-forest land.

2. TYPE SEPARATION IS BASED ON SIGNIFICANT OBSERVABLE DIFFERENCES BETWEEN TYPES. This means that there must be at least a one class difference in height, age, stocking, site or in crown closure to justify a type separation. For example, in immature stands a 15-yr. age difference between adjacent similar types would not justify a type boundary between them whereas a 25-yr. difference would.

3. Type only on the even numbered photos (the odd numbered photos are used as work photos and for storing field information).

4. Confine typing to within the photo wing points where there is less distortion and kail plotting is facilitated.

5. Separate obvious types first:
   - productive from non-productive;
   - sharp differences in height (two height classes); and
   - obvious differences in species composition (e.g. pure deciduous from coniferous).

6. Separate homogeneous from heterogeneous forest stands. When a forest type is determined, it should have roughly the same characteristics throughout. Check each type for consistency before leaving it.

7. Avoid complicated, irregular type lines. Keep type lines smooth to facilitate plotting, mapping, and digital storing.

[Handwritten notes: No and Yes]
8. Avoid small types when possible, because they are difficult to label, and expensive to store, to summarize, and to retrieve.

Example:

Note: the exception to this rule is non-productive patches down to 2 ha which may be isolated within high volume types.

Example:

9. If in doubt, be conservative.

Example:

10. Concentrate on areas with the highest volumes and values, once the obvious types are separated. An accurate separation of height classes is particularly important. Height and site values are often predictable from the topographic location of the type (i.e. slope position, aspect and elevation).

Example:
11. Separate species composition on the basis of photo characteristics (e.g. tone, texture, shape), and the ecological requirements and limitations of each species. Refer to the manual of photo interpretation for species guidelines.

Example:

```
changing species composition with elevation
B(H)                        2000 m - elevation
BH                           |
HB                           |
HC                           |
CFH                          |
C(H)                         |
500 m
```

2.23 COLLECTING AND RECORDING AVAILABLE INFORMATION

Considerable ground and air classification information from previous forest surveys is available for most areas of the Province. This information represents a large investment of time and money, and should be conscientiously used to reduce current field costs and to improve classification standards. To ensure the best use of existing data use the following procedure:

1. Check each data source for usefulness:
   - adjust and correct for errors that are obvious (e.g. improper age class);
   - reject data of doubtful value (e.g. a misplaced air call).

2. Check history:
   Well documented history recorded on photos and on maps has considerable value for determining stand age and for predicting the order of species establishment, and species composition.
   Sources of information:
   - classification photos used for previous inventories;
   - history maps of fires, logging, insect infestations, plantation, thinning, etc.
   Recording of history:
   - record all confirmed history on the even photos (kind, date, boundaries) using standard symbols.

3. Convert and transfer old data from old to new photos as follows:
   
   Note: to avoid congestion and to improve legibility, keep writing neat, compact, and, when possible, confined within the forest type boundary.
(a) Old ground samples

Transfer all ground samples 1953+ (standard fixed radius, growth and yield, and volume and depletion) accurately to the new photos. Include all samples that now occur in disturbed types (NSR, Residual, etc.) as well as samples that are located in undisturbed types. As samples are transferred, check them off in the Provincial X0 listing, which lists samples consecutively by region and compartment.

Recording samples on photos:

- even photos (typed)
  - sample location, number and year
  - back - sample location, region, compartment, number, year
  - sample
  - Location → X 10-32-6(64) ← year
  - compartment
  - region

- odd photos, front (purple ink)
  - sample location
  - species composition (10%)
  - age - 1-140 years (record to nearest year)
  - 141 years + (record to nearest 10 years)
  - height to nearest 0.1 m
  - stocking class
  - site

Note: Take the age and height for the sample from the age and height for the leading species as determined from three or four representative "sample" trees (i.e. dominants and codominants).

(b) Ground calls

Record the location, extent, number, year and forest type summary for all ground calls, 1953+. For the original sample tree data, check the pertinent ground call sheets and on the back of the original classification photos.

Record as follows:

- even photo, front (black ink)
  - XG-2(64) — [ground call location]
  - [reference number and year]
To determine age and height for the ground call, use the most representative sample trees of the leading species. Occasionally, sample tree measurements will not agree with the age and height assigned to the ground call. If the ground call cannot be rechecked in the field, assume that the discrepancy was deliberate, and disregard the sample tree measurements. When this discrepancy occurs, assign age to the nearest five years, and height to the nearest three metres, e.g. for a ground call show as 60 years and 50 feet use 55 years (mid-point of 60 year age class) and 15.2 metres (50 feet converted to metres).

(c) Air calls

By means of either inspection or stereo, transfer and record the boundaries, reference number, year and forest type summary as follows:

- even photo, front (black ink)
  - center of air call
    X1-16(64)
  - reference number
    X1-16
  - year

- odd photo, front (purple ink)
  - original air call boundary in green
  - location and reference number
  - species composition (10%)
  - age - nearest 5 years (mid-point of ten year class)
  - height - convert height from Imperial to metric to nearest 0.1 m
  - stocking class
  - site

was 60 yrs., 60 ft.  
record information along the bar  
was 70 years and 70 feet
Note: show age to a specific year if it can be supported by local sample tree measurements or by a history date.

2.3 THE USE AND PREPARATION OF ORIGINAL PHOTOGRAPHS

Preparation is simplified when the classification photos from the previous inventory are used because there is no need to either pre-type or to transfer basic information.

Prepare as follows:

1. clean-up work photos by removing only extraneous lines connecting air calls but not the air call boundaries;

2. convert all Imperial units of height to metres and age to the nearest year for old ground samples 1953+, ground calls and air calls;

Example: 1964 ground sample

work photo (odd), front (purple ink)

\[ P_{19} S_{1} \text{ G-7'-0-M} \rightarrow \text{original information} \]

53-15.2\rightarrow \text{converted}

Determine the age and height for the sample from three to four representative sample trees for the leading species.

Example: old ground calls

work photo (odd), front (purple ink)

1964 ground call

G-2

\[ P_{19} S_{1} \text{ G-7'-0-M} \rightarrow \text{original} \]

56-21.3\rightarrow \text{converted and record to nearest year and tenth of a metre using representative sample trees from the leading species}

Example: old air calls

work photo (odd), front (purple ink)

1964 air call

\[ P_{19} S_{2} \text{ G-7'-0-M} \rightarrow \text{original} \]

75-21.3\rightarrow \text{revised age and height (age was determined by taking the mid-point of the last 10 year age class)}

X

2-22

Note: age can be shown to the nearest year if more precise evidence is available such as a local sample or a fire date.
3. transfer new access routes from the most recent photos to the original photos.

2.4 USING A COMBINATION OF OLD CLASSIFICATION PHOTOS AND NEW AIR PHOTOS

The classifier should use new photos for typing and for classifying disturbed areas. Whenever new photos are used in combination with the old photos, the photos should be cross referenced.

Example

<table>
<thead>
<tr>
<th>Old Photo</th>
<th>New Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>BC 5012:68(16)</td>
<td>BC 7452:21(2)</td>
</tr>
<tr>
<td>See 7452:21(2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NSR-M 077</td>
</tr>
<tr>
<td></td>
<td>See 5012:68(16)</td>
</tr>
</tbody>
</table>
3.0 FIELD PROCEDURES

Field classification combines ground measurements, photo measurements, and visual estimates to describe and classify forest type characteristics. Four procedures are used:

1) ground calls;
2) ground observations;
3) large scale, low-level photography (70 mm); and
4) sample strips.

3.1 GROUND CALLS

A ground call is a forest stand description supported by ground measurements. Ground calls are used:

1. for multi-phase sampling, i.e. for correlating specific photo estimates with ground estimates using 70 mm fixed base photography (species composition, stand height, crown closure, stand density);
2. to establish patterns of age, height, site, species occurrence and stand density throughout a project area;
3. to train the classifier to recognize and estimate specific stand variables; and
4. to improve photo interpretation.

The type of ground call used will depend on the purpose for the ground call, and stand complexity. All ground calls will require a minimum of three sample trees from the leading species to establish stand age and height (one dominant and two codominants).

For simple, homogeneous stands the classifier's inspection may include sample trees only or sample trees supplemented by relascope sweeps for species composition.

For complex types or types of particular interest, run a ground strip through a representative portion of the type and establish a number of point samples at pre-determined intervals. Establish the first sample point at least 50 metres inside the boundary of the type.
At sample point one the classifier selects a basal area factor (relascope band width) that will give an average of eight to twelve trees per sweep. Use the same BAF at all successive sample points. Measure or estimate all "in" trees to the nearest centimetre and record these measurements on the relascope data sheet for point one. Estimate heights to the nearest metre. Confirm line trees as being either "in" or "out" using the line tree table in the pocket manual. To complete sample point one, measure one or more representative sample trees from the leading species and record the measurements under the section headed "sample tree details". The crew then moves to the next sample point and repeats the procedure.

Note: for unbiased results, establish each successive sample point accurately.
For multi-aged stands with a recognizable "secondary older component", tally the older trees or "vets" separately on the plot record sheet. Take one or two representative sample trees to establish an age and height for the secondary older component.

3.11 INVENTORY CLASSIFICATION SHEET

Record all measured and descriptive information for the forest stand on the Inventory Classification sheet. The attached classification sheet specifies the variables that must be described for each forest type. Detailed explanations for many of the variables are given earlier.

<table>
<thead>
<tr>
<th>Card Type</th>
<th>Column</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2-37</td>
<td>Filled in by the classifier.</td>
</tr>
<tr>
<td></td>
<td>2-4</td>
<td>Timber Supply Area number.</td>
</tr>
<tr>
<td></td>
<td>5-7</td>
<td>Special Cruise number if used, e.g. 232.</td>
</tr>
<tr>
<td></td>
<td>8-9</td>
<td>Inventory reference region number, e.g. R. 4 as 04.</td>
</tr>
<tr>
<td></td>
<td>10-12</td>
<td>Compartment number, e.g. C. 1 as 001.</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>Compartment letter, if applicable, e.g. A.</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>Forest Inventory Zone, e.g. C.</td>
</tr>
<tr>
<td></td>
<td>15-20</td>
<td>Measurement date.</td>
</tr>
<tr>
<td></td>
<td>21-24</td>
<td>Ground call number, no duplications, start from 1 for each year surveyed.</td>
</tr>
<tr>
<td></td>
<td>25-29</td>
<td>Photo flight number for high level photography.</td>
</tr>
<tr>
<td></td>
<td>30-32</td>
<td>Photo number on which ground call located.</td>
</tr>
<tr>
<td></td>
<td>33-35</td>
<td>Photo flight number for low level photography (70 mm).</td>
</tr>
<tr>
<td></td>
<td>36-38</td>
<td>Air call number assigned to photographs taken for sample.</td>
</tr>
<tr>
<td>2</td>
<td>2-70</td>
<td>Filled in by classifier.</td>
</tr>
<tr>
<td></td>
<td>2-17</td>
<td>Species composition of stand (summarized from species composition table on back of data sheet).</td>
</tr>
<tr>
<td></td>
<td>18-20</td>
<td>Stand age determined to the nearest year from sample trees for the leading species.</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>Record even-aged stands as E; variable-aged stands as V.</td>
</tr>
<tr>
<td></td>
<td>22-24</td>
<td>Stand height is the average total height of dominants and codominants, based on the leading species, to one decimal.</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>Stocking, enter as 0, 1, 2, 3 or 4 depending on guidelines met, use density table on back of data sheet.</td>
</tr>
<tr>
<td>Card Type</td>
<td>Column</td>
<td>Description</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>2</td>
<td>26</td>
<td>Site code, i.e. G = good, M = medium, P = poor, L = low</td>
</tr>
<tr>
<td>27</td>
<td>Kind; enter N when site used is non-representative of stand age and height, and R if it is representative.</td>
<td></td>
</tr>
<tr>
<td>28-29</td>
<td>Crown closure to nearest 10% as estimated from the ground.</td>
<td></td>
</tr>
<tr>
<td>30-31</td>
<td>Crown closure to nearest 10% as estimated from the photo.</td>
<td></td>
</tr>
<tr>
<td>32-36</td>
<td>Density: stems/ha from stand density table on back of data sheet.</td>
<td></td>
</tr>
<tr>
<td>37-39</td>
<td>Stand diameter: average stand diameter for main stand.</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>History symbol for the disturbance responsible for establishing the stand: Θ, Θ, Θ, Θ.</td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>History code: Θ = 1, Θ = 2, Θ = 3, Θ = 4, insects 5, other 6.</td>
<td></td>
</tr>
<tr>
<td>42-43</td>
<td>History year (show last two digits only): G</td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>History symbol for a recent disturbance: G, G, G, etc.</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>History code: Θ = 1, Θ = 2, Θ = 4, insects 5, other 6.</td>
<td></td>
</tr>
<tr>
<td>46-47</td>
<td>Year of disturbance, last two digits.</td>
<td></td>
</tr>
<tr>
<td>48-49</td>
<td>Percentage of area disturbed (nearest 10%).</td>
<td></td>
</tr>
<tr>
<td>50-52</td>
<td>Defoliator/Bark Beetle/Mistletoe - code in each case as 0 = none, 1 = light, 2 = moderate, 3 = heavy, 4 = past occurrence.</td>
<td></td>
</tr>
<tr>
<td>53-58</td>
<td>Species composition (in order) for species 10% or greater by volume from volume table from back of data sheet.</td>
<td></td>
</tr>
<tr>
<td>59</td>
<td>Age class.</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>Height class.</td>
<td></td>
</tr>
<tr>
<td>61</td>
<td>Volume code (m³) 0-50 = 1, 51-100 = 2, 100-150 = 3, 151-200 = 4, 201-250 = 5 from volume table from back of data sheet.</td>
<td></td>
</tr>
<tr>
<td>62</td>
<td>D.B.H. limit for volume calculation in 61, i.e. 17.5 + = 1, 27.5 + = 2.</td>
<td></td>
</tr>
<tr>
<td>63-68</td>
<td>Species composition.</td>
<td></td>
</tr>
<tr>
<td>69-70</td>
<td>Age in years.</td>
<td></td>
</tr>
<tr>
<td>71-72</td>
<td>Height to the nearest metre.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Site details are only to be described for the actual area covered by the ground call (not the whole type).</td>
<td></td>
</tr>
</tbody>
</table>
3.12 INVENTORY CLASSIFICATION SHEET

Ministry of Forests
Inventory Branch

<table>
<thead>
<tr>
<th>CARD TYPE</th>
<th>T.S.A.</th>
<th>SPECIAL CRUISE</th>
<th>REGION NO.</th>
<th>COMPARTMENT NUMBER</th>
<th>F</th>
<th>MEASUREMENT DATE</th>
<th>GROUND CALL NO.</th>
<th>AERIAL PHOTOGRAPHY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>HIGH LEVEL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>70mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>FLIGHT NO.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PHOTO NO.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>FLIGHT NO.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CALL NO.</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>1</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
<td>17</td>
</tr>
<tr>
<td>1</td>
<td>18</td>
<td>19</td>
<td>20</td>
<td>21</td>
<td>22</td>
<td>23</td>
<td>24</td>
<td>25</td>
</tr>
<tr>
<td>1</td>
<td>26</td>
<td>27</td>
<td>28</td>
<td>29</td>
<td>30</td>
<td>31</td>
<td>32</td>
<td>33</td>
</tr>
<tr>
<td>1</td>
<td>34</td>
<td>35</td>
<td>36</td>
<td>37</td>
<td>38</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CARD TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPECIES COMPOSITION OF STAND (NEAREST 10%)</td>
</tr>
<tr>
<td>SP</td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CARD TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAND DETAILS</td>
</tr>
<tr>
<td>DISTURB. RESPONS. FOR ESTAB.</td>
</tr>
<tr>
<td>RECENT DISTURBANCE</td>
</tr>
<tr>
<td>DECOMIATOR MISTLETOE</td>
</tr>
<tr>
<td>BARK BEETLE</td>
</tr>
<tr>
<td>SPECIES ORDER</td>
</tr>
<tr>
<td>AGE CL.</td>
</tr>
<tr>
<td>VOL. CODE</td>
</tr>
<tr>
<td>HT. CL.</td>
</tr>
<tr>
<td>DBH</td>
</tr>
<tr>
<td>SPECIES ORDER</td>
</tr>
<tr>
<td>AGE</td>
</tr>
<tr>
<td>HEIGHT (M)</td>
</tr>
<tr>
<td>TYPE</td>
</tr>
<tr>
<td>40</td>
</tr>
</tbody>
</table>

| CARD TYPE |
| SITE DETAILS |
| E.R.A. ENVIRONMENTAL PROTECTION AREA CODES |
| ELEVATION |
| ASPECT |
| % (10's) |
| SLOPE |
| DEPTH |
| TEXTURE |
| TYPE |
| Es | Ep | El | Es | Er | Er | Es | En |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |

REMARKS: ____________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

Classifier: ____________________________

SUMMARY OF SAMPLE TREES (LEADING SPECIES ONLY)

<table>
<thead>
<tr>
<th>Sp.</th>
<th>D.B.H.</th>
<th>Age</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total

Average
FOOTNOTES:
1. KEEP A SEPARATE TALLY OF VETERANS OR SECONDARY OLDER VOLUME TREES.
2. LINE TREE CALCULATION: SEE POCKET MANUAL.

<table>
<thead>
<tr>
<th>SPECIES</th>
<th>COMP</th>
<th>ALL POINTS (NO VETS)</th>
<th>SPEC.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PT. 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A.M.H.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T x A.M.H.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STEM COUNT/ha (ALL POINTS)</th>
<th>D.B.H. CLASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>4  3  2  1  2  3  4  2  3  4  4  3  4  2  3  4</td>
<td></td>
</tr>
<tr>
<td>2 x 3</td>
<td></td>
</tr>
<tr>
<td>RATIO STEMS/TREE</td>
<td>TOTAL TREES</td>
</tr>
<tr>
<td></td>
<td>V/BAR 2 x 3</td>
</tr>
<tr>
<td></td>
<td>TOTAL TREES</td>
</tr>
<tr>
<td></td>
<td>V/BAR 2 x 3</td>
</tr>
<tr>
<td></td>
<td>TOTAL TREES</td>
</tr>
<tr>
<td></td>
<td>V/BAR 2 x 3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SAMPLE TREE MEASUREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CARD TYPE</td>
</tr>
<tr>
<td>4</td>
</tr>
</tbody>
</table>

STEMS/ha = [(4 COL. 4) x (BAND USED)^2 ÷ (4 No. of Pts.)]
= [(.............) x (.............) ÷ (.............)]
= ............ No. of STEMS/ha

VOLUME/ha m^3 = [(4 COL. 4 ALL SPECIES) x (BAND USED)^2 ÷ (4 No. of POINTS)]
= [(.........) x (.........) ÷ (.........)] = ............ m^3/ha
### Summary of Classes and Codes Used for Selected Variables

**Forest Classification Sheet**

<table>
<thead>
<tr>
<th>Card Type</th>
<th>Column</th>
<th>Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>21</td>
<td>(V) - variable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(E) - even</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>Stocking 0, 1, 2, 3, 4</td>
</tr>
<tr>
<td>26</td>
<td></td>
<td>Site L, P, M, G</td>
</tr>
<tr>
<td>27</td>
<td></td>
<td>(N) non-representative</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(R) representative</td>
</tr>
<tr>
<td>40</td>
<td></td>
<td>Disturbance Respond.</td>
</tr>
<tr>
<td>41</td>
<td></td>
<td>θ, φ, ω, insects, other</td>
</tr>
<tr>
<td>42</td>
<td></td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>44</td>
<td></td>
<td>Recent Disturbance</td>
</tr>
<tr>
<td>45</td>
<td></td>
<td>θ, φ, ω, insects, other</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 2 4 5 6</td>
</tr>
<tr>
<td>50-51</td>
<td></td>
<td>Def./B. Beetle/Mistle.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 = none, 1 = light, 2 = moderate, 3 = heavy, 4 = past occurrence</td>
</tr>
<tr>
<td>61</td>
<td></td>
<td>Secondary volume</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 = 0-50, 2 = 51-100, 3 = 101-150, 4 = 151-200, 5 = 201-250</td>
</tr>
<tr>
<td>62</td>
<td></td>
<td>1 = 17.5 cm +</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 = 27.5 cm +</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>E.P.A.'s</td>
</tr>
<tr>
<td>2-8</td>
<td></td>
<td>0 = N/A, 1 = high constraint, 2 = low constraint</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Elevation</td>
</tr>
<tr>
<td>9-10</td>
<td></td>
<td>100's of m</td>
</tr>
<tr>
<td>11-13</td>
<td></td>
<td>Aspect</td>
</tr>
<tr>
<td>14-15</td>
<td></td>
<td>Slope</td>
</tr>
<tr>
<td>16</td>
<td></td>
<td>Slope Position</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 = upper, 2 = middle, 3 = lower, 4 = flat</td>
</tr>
<tr>
<td>19</td>
<td></td>
<td>Soil Depth</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 = thin 0-50 cm, 2 = shallow 51-200 cm, 3 = deep &gt;200 cm</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>Surface, Soil, Texture</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 bouldery &gt;64 mm, 2 rubbly &gt;2 mm, 3 gravelly 2-64 mm</td>
</tr>
<tr>
<td>21</td>
<td></td>
<td>4 sandy 0.4-2 mm, 5 fine sandy 0.06-0.4 mm, 6 silty 0.004-0.06 mm, 7 clayey &lt;0.004</td>
</tr>
<tr>
<td>Card Type</td>
<td>Column</td>
<td>Description</td>
</tr>
<tr>
<td>-----------</td>
<td>--------</td>
<td>-------------</td>
</tr>
<tr>
<td>3</td>
<td>2-8</td>
<td>According to E.P.A. guidelines: 0 = N/A, 1 = high constraint, 2 = moderate constraint.</td>
</tr>
<tr>
<td></td>
<td>9-10</td>
<td>Elevation: record to the nearest 100 m, e.g. 2100 as 21. Use either an altimeter or good contour map.</td>
</tr>
<tr>
<td></td>
<td>11-13</td>
<td>Aspect: use an azimuth bearing, e.g. 275°.</td>
</tr>
<tr>
<td></td>
<td>14-15</td>
<td>Slope: nearest 10%.</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>Slope position (use column 15 only) 1 = Upper, 2 = Middle, 3 = Lower, 4 = Flat.</td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>Leave blank for now.</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>Leave blank for now.</td>
</tr>
<tr>
<td></td>
<td>19</td>
<td>Soil depth: 1 = thin 0-50 cm, 2 = shallow 51-200 cm 3 = deep &gt;200 cm.</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>Surface soil texture: 1 = bouldery &gt;64 mm, 2 = rubbly &gt;2 mm, 3 = gravelly 2-64 mm.</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>Surface soil texture: 4 = sandy 0.4-2 mm, 5 = fine sandy 0.06-0.4 mm, 6 = silty 0.004-0.06 mm, 7 = clayey &lt;0.004.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(See Appendix D for texture determination)</td>
</tr>
</tbody>
</table>

### 3.2 GROUND OBSERVATIONS

Ground observations are visual estimates of forest type characteristics that can be made quickly and accurately, and reduce the need for photo interpretation.

Ground observations can be made with or without supporting sample tree measurements. Observations are recorded on the face of the work photo and any sample trees are recorded on the back of the work photo. Denote the presence of sample trees on the face of the work photo with the symbol "XG" and the year of measurement.

### 3.3 FIXED BASE, LOW-LEVEL, AERIAL PHOTOGRAPHY (70 mm)

Fixed base, low-level, large scale, aerial photography is another means of obtaining forest type characteristics. Low-level photographs are used to make assessments of species composition and crown closure, and to measure tree height and crown widths.

---

1See also Forest Classification Manual, Section 9.0-9.8 and Section 7.7 and Appendix C of this guideline.
Species composition is determined by using either a line intersect method or an area method:
- the line intersect method involves drawing a line on one frame of a stereo pair and counting the trees by species that touch the line;
- the area method involves placing a 2 cm x 2 cm area based assessment square on one frame of a stereo pair and counting the trees by species that have tops within the perimeter of the square. Because the photo scale of the frame can be determined, the number of stems per unit area can also be calculated.

Crown closure is estimated by using a dot grid. The clear grid which has a series of dots or x's is placed on a single frame. Under stereo, crown closure is estimated by determining the ratio of dots touching the crowns of stems in the main stand to those that do not.

Tree height and crown widths are measured with a parallax bar (see Appendix B for details).

3.4 SAMPLE STRIPS

Sample strips are intended to give an accurate cross section of a forest type's characteristics. As each sample strip is established and summarized, sample strip data is recorded on the work photo [see Section 3.52(4)].

3.5 ESTABLISHING PRIORITIES

Field work is expensive, and must be planned to yield the greatest returns for the time and manpower expended. In the absence of specific regional priorities, the classifier should concentrate on the following:
- the largest types;
- types and sites with the highest values;
- complex types that will be difficult to photo interpret;
- strata with a shortage of ground measurements;
- types that should be double sampled for 70 mm low-level photography;
- identifying types likely to require management treatment within the next 10 years;
- identifying age, height and species patterns in each drainage.

3.6 SUMMARIZING AND RECORDING CURRENT FIELD INFORMATION ON THE CLASSIFICATION PHOTOGRAPHS

All information is summarized and recorded on the odd numbered work photos.
Purpose:
- to store information on one document;
- to assist future updates and reinventories;
- to determine type labels.

3.61 GENERAL GUIDELINES

- separate old information from new information by using different colours (e.g. suggest purple ink for old information and aquamarine for new information);
- keep writing neat and compact;
- record information in a standard order:
  1. species composition
  2. age
  3. height
  4. stocking
  5. site
  6. crown closure
  7. density in stems/ha
  8. history
  9. secondary values

3.62 SPECIFIC GUIDELINES

(1) Ground Call

odd photo (work)  

G-22

P19S1 42-14.2-0-M-7

record - the ground call number
- the extent and direction of the ground call with an elongated "→"
- the ground call summary along the bar

even photo (typed)  

record - the center of the ground call
- the letter "G" for ground call
- the ground call number and year

XG-22(79)

(2) Ground Observation

odd photo only (no sample trees)  

record - the extent of observation
- the estimated variables

P19S1 36-15.0-0-M
(with sample tree information)

G(79)
Pl₉S₁ 42-16.2-0-M-8

record - on the front of the photo
- an x with a "G"
- the year
- summary of type details

record - on the back of the photo
- the location and summary of sample tree details

XG(79)
Pl 6.4 cm, 42 yrs., 16.2 m

(3) 70 mm Air Call

odd photo
record - start and direction of call
- "L" for low-level photography and air call number, i.e. roll number, first frame number and number of frames used
- summary of type details

L 35-6(4)
Pl₉S₁ 45-16.2-0-M-8

even photo
record - an "X" at the start of the photo flight
- "L" for low-level photography
- call number, no. of frames & yr.

XL 35-6(4)79

(4) Sample Strip

odd photo
record - tie point and tie line
- the sample strip with a circle at plot one and an arrow at plot six
- the sample summary

(front)
Pl₉S₁ 32-11.4
0-M-7-622 stems/ha

(record - tie point and tie line with direction and distance
- the sample strip with direction and distance
- approximate location of point samples
- full sample number (region, compartment, sample, year)
- date done with initials of tallyperson

65° 250 m

(back)
32-11-1(79)
(12-7-79)
J.B.

20° 180 m
even photo (front)

record - the sample location with a rectangle positioned over plot one and orientated along the strip
- sample number and year

2(79)

point 1
4.0 FINAL LABELLING OF FOREST TYPES

The characteristics of every forest type or type island are summarized by a descriptive label. Each label is determined from an assessment of the best information available for the type - usually recorded on the work photo. Data usefulness and reliability is a function of data source, data extent, stand variability, and year of collection. The following table is a guide for determining the relative reliability of information to be used for labelling.

**TABLE TO SHOW RELATIVE RELIABILITY OF SOURCE DATA**

<table>
<thead>
<tr>
<th>DATA SOURCE</th>
<th>AGE</th>
<th>HEIGHT</th>
<th>SPECIES COMPOSITION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Even</td>
<td>Multi-Aged</td>
<td>Even</td>
</tr>
<tr>
<td>sample strip</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>standard sample</td>
<td>G</td>
<td>A</td>
<td>G</td>
</tr>
<tr>
<td>2/5 ac. (0.16 ha)</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>ground call</td>
<td>A</td>
<td>A-P</td>
<td>G</td>
</tr>
<tr>
<td>70 mm air call</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>standard air call</td>
<td>P-A</td>
<td>P-A</td>
<td>A</td>
</tr>
</tbody>
</table>

G - Good   A - Average  P - Poor

Type characteristics are described as precisely as possible to permit data aggregation into classes and to allow automatic updating of type labels by computer. Depending on data source, describe forest type characteristics to the following levels of precision:
### TABLE TO SHOW LEVEL OF PRECISION FOR DESCRIPTION OF FOREST TYPE CHARACTERISTICS

<table>
<thead>
<tr>
<th>Forest Type Characteristic</th>
<th>Sample Strip 1978+</th>
<th>Standard Sample Pre 1978</th>
<th>Ground Call Pre 1978</th>
<th>Ground Call 1978+</th>
<th>70 mm Air Call 1978+</th>
<th>Standard Air Call Pre 1978</th>
<th>Photo Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main Stand</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>species composition</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>age¹</td>
<td>1 yr.</td>
<td>1 yr.</td>
<td>1 yr.</td>
<td>1 yr.</td>
<td>+5 yr.²,⁴</td>
<td>+5 yr.²,⁴</td>
<td>+10 yr.³,⁴</td>
</tr>
<tr>
<td>height</td>
<td>0.1 m</td>
<td>0.1 m</td>
<td>0.1 m</td>
<td>0.1 m</td>
<td>0.1 m</td>
<td>+1.5 m⁵</td>
<td>+1.5 m⁵</td>
</tr>
<tr>
<td>Stocking (0,1,2,3,4)</td>
<td>class</td>
<td>class</td>
<td>class</td>
<td>class</td>
<td>class</td>
<td>class</td>
<td>class</td>
</tr>
<tr>
<td>crown closure</td>
<td>10%</td>
<td>-</td>
<td>-</td>
<td>10%</td>
<td>10%</td>
<td>-</td>
<td>10%</td>
</tr>
<tr>
<td>stems/ha</td>
<td>closest</td>
<td>-</td>
<td>-</td>
<td>closest</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><strong>Secondary Older Element</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>species composition</td>
<td>type group</td>
<td>-</td>
<td>type group</td>
<td>type group</td>
<td></td>
<td>type group</td>
<td></td>
</tr>
<tr>
<td>height</td>
<td>ht. class</td>
<td>-</td>
<td>ht. class</td>
<td>ht. class</td>
<td>-</td>
<td>height class</td>
<td></td>
</tr>
<tr>
<td>age</td>
<td>age class</td>
<td>-</td>
<td>age class</td>
<td>age class</td>
<td>-</td>
<td>age class</td>
<td></td>
</tr>
<tr>
<td>volume (m³) (17.5+, 27.5+)</td>
<td>vol. class</td>
<td>-</td>
<td>vol. class</td>
<td>vol. class</td>
<td>-</td>
<td>volume class</td>
<td></td>
</tr>
</tbody>
</table>

¹Stands older than 140 years may be described to the nearest 10 years.
²Use mid-point of 10 year class.
³Use mid-point of 20 year class.
⁴Age may be described to the nearest year when a precise age can be borrowed from an adjacent stand of the same age class or when the date for the history responsible for the stand's establishment is known.
⁵Use mid-point of three m class.
Example of forest type labels to be used on the typed photo or forest cover map:

<table>
<thead>
<tr>
<th>Old Label</th>
<th>New Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pl-320-P</td>
<td>Pl₁₀ 46 - 15.2 - 0 - M - 7</td>
</tr>
<tr>
<td></td>
<td>↓ species composition ↓</td>
</tr>
<tr>
<td></td>
<td>↓ age ↓</td>
</tr>
<tr>
<td></td>
<td>↓ site ↓</td>
</tr>
<tr>
<td></td>
<td>↓ stocking ↓</td>
</tr>
<tr>
<td></td>
<td>↓ height ↓</td>
</tr>
<tr>
<td>2. Å For BH 832</td>
<td>crown closure</td>
</tr>
<tr>
<td></td>
<td>Å For B₇H₃ 210-21.0-2-3</td>
</tr>
<tr>
<td>3. PwH(B) 410-L</td>
<td>crown closure</td>
</tr>
<tr>
<td></td>
<td>↓ stocking ↓</td>
</tr>
<tr>
<td></td>
<td>↓ height ↓</td>
</tr>
<tr>
<td></td>
<td>↓ Pw₆H₃B₁ (62V) - 5.0 - 0 - ₀ - 6 - 450 ↓</td>
</tr>
<tr>
<td></td>
<td>↓ species composition ↓</td>
</tr>
<tr>
<td></td>
<td>↓ site change (present site not represented by age-height for stand) ↓</td>
</tr>
<tr>
<td></td>
<td>↓ multi-aged stand ↓</td>
</tr>
<tr>
<td></td>
<td>↑ density (optional) ↓</td>
</tr>
<tr>
<td></td>
<td>↑ history ₀62 ↓</td>
</tr>
<tr>
<td></td>
<td>↑ minimum d.b.h. ↓</td>
</tr>
<tr>
<td></td>
<td>↓ BH Vol. + BH 83-2 (27.5 +) ↓</td>
</tr>
<tr>
<td></td>
<td>↓ secondary older component comprised of:</td>
</tr>
<tr>
<td></td>
<td>BH, age class 8, height class 3,</td>
</tr>
<tr>
<td></td>
<td>volume class 3 (101-150 m³) 27.5 cm +/-ha</td>
</tr>
</tbody>
</table>

Photo record:
To conserve space, split and record the characteristics:

1) Pl₁₀ 46-15.2
2) Å For B₇H₃ 210-21.0-2-3
3) Pw₆H₃B₁ (62V)-7.0
   ₀62
   + BH 83-2(27.5 +)
5.0 UP-DATING FOREST TYPE LABELS

Periodic up-dating of forest inventories is necessary to account for continuous physical changes taking place in the forest landscape and to satisfy demands for new information to meet changing social, technological and managerial needs. Up-dating of forest inventories is done either manually, or automatically by computer.

5.1 MANUAL REVISION

Manual revision includes annual up-dates of disturbances; (e.g. logging, fires, windthrow, insects, etc.) and periodic field checks of forest type boundaries and labels using the latest inventory methodology and aerial photographs. Manual up-dates include:

1) Checking and correcting type boundaries and labels based on new field information;

2) Checking the effects of new classification procedures on old labels established under different guidelines:
   e.g. - Prior to 1969 species preference rules were used to establish the age and height for the stand. Stand, age and height was determined from the most important of the first two major commercial species. In descending order of importance, coniferous species were first, lodgepole pine second and deciduous third. (e.g. in a PI5 stand age and height came from the S).
   - Age class limits changed in 1964. Break-points for a 30 year old stand in 1963 were 26-35; in 1964 they became 21-30.
   - Residual labels are no longer used, which means that all old types with "Resid" labels will have to be reassessed.
   - Site tables, curves and guidelines used for assessing site have changed progressively over time.

3) Collecting and recording new type characteristics not required on previous inventories:
   e.g. - crown closure;
      - species composition to the nearest 10% for all stands;
      - height to the nearest three metres for all stands.

4) Converting all original forest type labels to a form that can be automatically up-dated by computer.
5.2 AUTOMATIC COMPUTER UP-DATING

Starting in 1979, all forest cover map details will be stored digitally on computer files. The boundary for each forest type is stored by geographic coordinates. Each digitized type island is called a "polygon" and is given a unique number.

All the characteristics for the "polygon," including its identification number, form an "attribute list" unique to that type, and are stored on magnetic tape. This filing system is very flexible and can be expanded, contracted, up-dated, or corrected at any time. To optimize computer capabilities use the following:

1) Leave to the computer as much up-dating of age and height as possible. This will reduce human error, be more efficient, and establish a consistent up-dating procedure.

2) Attach a "Reference Year" to each forest type label. The "Reference Year" will be used as the base year for up-dating up-dateable stand characteristics. It represents the calendar year for which the age and height for the stand is considered most reliable. The "Reference Year" for most types will be the latest year when sample trees were measured within the type island.

  e.g. A forest type with a 1967 ground sample would be shown in 1979 as:

Using the forest type characteristics illustrated above, the computer can calculate and predict:

- for age - the date of establishment
- the up-dated age for the type at any time in the future to an exact age or age class

- for height - an up-dated stand height or height class at any time using the latest age-height-site equations

- for site - the precise site index or site class using the latest age-height-site equations

- other - volumes/ha, growth rates/ha, stocking or density levels
Example: Summary of steps required to prepare a 1964 forest type label for digitizing in 1979 using original photographs.

STEP 1 Convert 1964 ground information to nearest year and 0.1 m.

STEP 2 In 1979 check, correct, and/or prepare the 1964 forest type labels for digitizing.

STEP 3 Transfer latest photo details to forest cover map for digitizing.

STEP 4 Transfer forest cover map details into computer storage.

STEP 5 Print up-dated forest cover map on request.
Examples of 1964 forest type labels revised and prepared in 1979 for digitizing.

**Data Source**

**Work Photo (1964)**

- **Ground samples**
  - $P_{10} \ 4-4-0-P$
  - 38-12.2
  - 41-12.2
  - $P_{19}S_{1} \ 5-4-0-P$

**Typed Photo (1964)**

- **Ground calls**
  - $G-2(64)$
  - $P_{19}S_{1} \ 42-12.2$
  - $G-117(79)$
  - $P_{18}S_{4} \ 57-16.2-M-7$

- **Air calls**
  - $I-2(64)$
  - $S_{6}P_{6} \ 6-3-0-P$
  - 15.2

- **Photo interpretation**
  - $P_{17}S_{3} \ 50-15.2$
  - $0-M-9(64)$
  - $P_{18}S_{3} \ 320-M$

- **Photo interpretation**
  - $B_{7}S_{3} \ 180-24.0$
  - $1-P-6(64)$
  - $BS \ Resid-P$
  - $62$

- age and height from 1967 sample reference year = (67)
- crown closure interpreted from photo
- original label

- age and height from 1979 ground call
crown closure interpreted from photo
old air call looks correct
- age from midpoint of 60 yr. class
crown closure interpreted from photo
- reference year from air call
- species compos. interpreted
- age mid-point of class $(60-20 = 50)$
- height mid-point of class or interpreted to nearest 3 metres
- crown closure interpreted (all interpret. from 1964 photo)
- species compos. age, height and crown closure photo interpreted from 1964 photo
6.0 PREPARING MAPS FOR DIGITIZING

The following uniform procedure should be followed for preparing forest cover maps for digitizing.

1) Labels
   - show all new forest type labels in blue ballpoint ink
   - cross out original labels

2) Type lines
   - show all new type lines in red (suggest thinex 425T or equivalent)
   - cross out cancelled lines by means of a series of small "x's" along the length of the line cancelled in red
   - where the new type line reflects disturbance, the area of the disturbance may be cross hatched or where the new area is large, it may be indicated by cross hatching along the new boundary in red

3) E.P.A. lines and labels
   - show new lines in brown
   - cross out old lines in brown
   - show new labels in red, i.e. Er, Es, etc.

4) New roads
   - show new roads in solid orange and describe class of road, i.e. trail, logging road, etc.

5) New samples, ground call, 70 mm locations
   - show all new locations in red

6) Reference numbers for all samples, ground calls, air call 70 mm
   - record full reference number with year measured in purple
7.3  FOREST TYPE SELECTION

Use forest cover maps and the typed classification photos from the last inventory to locate suitable forest types for sampling. Select forest types that are large enough to accommodate the ground sample layout, (Section 7.4); that cannot be broken down or further stratified by photo interpretation; and that are undisturbed by recent history.

7.4  GROUND SAMPLE LAYOUT

A sample consists of a series of six sample relascope points spaced at equal intervals along a sample strip. No sample point can be located within 50 m of a type boundary. The distance between sample points must be > 50 m and < 250 m and the distance between sample points is the distance of the sample strip divided by five. Exceptions to the previous sampling design can be made in odd shaped types where a "dogleg" can be placed in the sample line, but the minimum length of 50 m between sample points and between the strip and type boundary still applies. For those samples that will be selected for integrated sampling purposes the field supervisors will determine what points will be chosen on the basis of local conditions and requirements. Some samples will have certain points remeasured for one requirement only, e.g. growth and yield. Other samples may have individual points remeasured for a number of requirements, e.g. two points for growth and yield and two other points for vegetation and soils. Other samples will have points remeasured for decay and waste and points for vegetation and soils, etc. The map symbols for both double and integrated samples has not yet been determined and will be announced in a later memorandum once finalized.

Previously established growth and yield samples that are being measured as part of the periodic remeasurement program can be integrated by placing either or both a relascope sample and a series of 70 mm primary units across the forest types so as to include the permanent growth and yield plots. New permanent growth and yield samples that are being established at relascope points will be fixed radius plots according to standards outlined in the Growth and Yield Natural manual.

Decay and waste samples that are being established at relascope points as part of the integrated inventory program will be on a selected tree basis to cover the existing range in diameters according to instructions outlined in the Volume and Decay manual.

7.5  PLOTTING GROUND SAMPLES

On the forest cover base map select the reference point (usually the first relascope point), and the last relascope point in a representative portion of the type. The total distance between the first point and the last point should be to the nearest
multiple of 50 m. Transfer these three points by radial intersection to an air photo and locate a tie-point. Measure bearings and distances for the tie line and sample strip and record both on the map and appropriate photographs (see Section 3.52 for recording sample strips on photographs).
7.0 SAMPLING

Sampling design and layout will be under development throughout 1979 and final procedures and technology may not be published till after the field season. However, beginning immediately, sampling will be implemented on an integrated basis using a multiphase sampling design with the primary, secondary, and tertiary sampling units being designated as follows.

1. Primary - the low level fixed base photo sample (70 mm).

2. Secondary - representative six point relascope ground samples laid out as double samples over selected 70 mm photo plots to obtain ground truth.

3. Tertiary - a number of the representative six point relascope samples will be sampled further for growth and yield, decay and waste, vegetation, soil and other environmental factors to establish ground truth for integrated inventory purposes.

Operational difficulties may prevent the establishment of 70 mm samples for some Regions before ground sampling will commence, and thus, in most instances it will be expedient to proceed with the secondary units before the primary units are in place. However, this will not prevent the photographing of the ground samples after they have been established to establish the primary units and crews should plan their operations accordingly. In this way the double samples will be obtained regardless of the operational sequence.

7.1 OBJECTIVE

The main sampling objective is to obtain an estimate of volume within the boundaries of the T.S.A. to within ± 10% at the 95% confidence level.

7.2 DETERMINING SAMPLE REQUIREMENTS

Obtain a forest type area summary listing for the unit to be sampled. Determine the area covered by each forest stratum, and the total number of samples currently established in each. Using guidelines from the sampling manual, (Section 5.2\(^1\)) calculate the minimum sampling requirements with the funds and manpower available. Plan to establish enough primary sample units (70 mm) to cover adequately the major strata to be sampled. Practical and technical limitations will have a strong bearing on how many photo plots are obtained. Attempt to get at least two ground strips or secondary units inside each stratum to be sampled.

\(^1\)See main manual
Examples of Sample Strips:

1 or 2 give the best cross section

250 m ÷ 5 = 50 m

50m

170 m

2

3 (3)

50m

4

50m

150m

750 m ÷ 5 = 150 m

Total strip is 300 m

Strip interval is 300 ÷ 5 = 60 m

400 m ÷ 5 = 80 m
Examples of Sample Strips with Tie-Lines:

General Guidelines:

- mark the length of the sample strip to the nearest 50 m;
- divide the strip length by five to determine the intervals between sample points;
- establish strips perpendicular to contours when possible;
- align the strip along the longest possible traverse of the type; and
- try not to make the strip parallel to type boundaries.
The starting point of each strip or primary unit must be tied to a feature that can be recognized on the photo, as well as on the ground. At the tie point, a tree tag is to be stapled to a sound tree, with a minimum d.b.h. of 17.5 cm, facing the tie line. Enter on the tag with felt pen: strip number, strip direction, distance to first point, BCFS and date. Also, attach two strands of red plastic tape to the tie tree, one above and one below the tree tag.

Diagram to show method for marking the tie tree at the start of the tie line.

The tie line will be run with hand compass, clinometer (Relascope or Suunto) and chain. At the end of each 40 m, a slope allowance will be made to establish the correct horizontal distance. Mark the tie line with red plastic marking tape at least every 20 m along the line. The end of the tie line should be at the first sample point. Plot one is marked with a tagged reference tree. The reference tree is the closest suitable living tree to the plot centre, i.e. 17.5 cm + when possible. Place a tag on the tree so that it faces in the opposite direction to that of the sample strip. On the tag write: region number, compartment number, the sample number, the strip direction, the distance between sample points, BCFS and the date.

Diagram showing method for marking reference tree.
Attach red plastic tape to three neighbouring trees.

A flagged stake marks the place for the first point sample. Each point sample must be marked by a stake and labelled with the following information: BCFS, Region No., Compartment No., Sample strip No., Point No., and Date. The tag should face opposite to the direction of travel, i.e., facing back along the sample strip.

A total of six point samples must be taken along each strip at equal intervals. The plotted sample strip must be accurately located in the field. Deviation from the plotted location is allowed only when a recent disturbance is found less than 50 m in distance from a sample point. (Disturbance refers to new roads, clear cuts, or natural phenomena such as windfall which are large enough to type out). When a recent disturbance is a problem, along the sample strip, move a section of the strip to the left or right in order that this section of the strip is at least 50 m in distance removed from the disturbance and parallel to the rest of the sample line. Note that the rest of the sample line is located as originally plotted. Sometimes it is impossible to offset a disturbance by as much as 50 m; then abandon the sample.

![Diagram of Sample Offset]

For each strip select a basal area factor (BAF) or band width for the Relaskop that will give an average of eight to twelve trees per point. THE B.A.F. USED MUST BE THE SAME FOR ALL SIX POINTS ON THE STRIP. It is advisable to establish the strip and roughly measure the six plot locations first before selecting the Relaskop band width to be used.

The minimum number of live trees per strip is 40. Less than 40 trees is acceptable when:

1. See Appendix B for Relaskop instructions
- a Relaskop band width of 1.5 is used on large coastal timber on steep terrain;
- a Relaskop band width at 1.0 is used in very dense stands of or near minimum d.b.h. of 7.5 cm +.

At each point the Relaskop is used to check each tree for being either "in" or "out". The Relaskop and not the observer's eye must be over the point. All "line" trees are also confirmed as being either "in" or "out" using the appropriate line tree table in the pocket manual (the horizontal distance measured for the object tree must be from the point of germination to the plot centre). Each sweep starts from the steel tape which marks the direction of travel from the preceding point on the line and continues clockwise through a full 360°.

All "in" trees must be tagged, measured for d.b.h., and assessed for species, tree class, crown class, path and quality remarks, (see attached tally sheet and sampling manual section for detailed instructions). In addition, approximately two sample trees must be selected at each point for height and age measurement and be well spaced to aid height estimation for all remaining trees not measured. In cases where heights cannot be either measured or estimated enter curve heights. The height source must be indicated on the tally sheet next to the height column.

MAKE A SECOND CHECK SWEEP TO ENSURE THAT ALL "IN" TREES ARE INCLUDED.

7.61 \( \text{SAMPLE TREES} \) (Low Cap)

Sample trees are individuals selected from within the sampled population to represent the stand age and height. Use the following guidelines for selecting sample trees:

1. For the leading major species:
   
   Take height and age measurements of two dominant and four codominant trees;
   
   Take the height only of two intermediate and one over topped trees.

2. For each secondary major species:
   
   Take height and age measurements of one dominant and two codominant trees.

3. For secondary older elements including veterans:
   
   Take a minimum of one representative age and height.
<table>
<thead>
<tr>
<th>Card Type</th>
<th>Columns</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>28-29</td>
<td>Plot size: enter the appropriate number of relaskop bands. This must be kept blank if the sample is not a point sample.</td>
</tr>
<tr>
<td>1</td>
<td>30-33</td>
<td>Plot size: if sample is not a point sample, then enter the area of the plot in hectares; if the sample is a point sample, enter the total length of the strip in kilometres (from point 1 to point 6).</td>
</tr>
<tr>
<td>1</td>
<td>34-36</td>
<td>Sample crew code, must be unique number for each tally person.</td>
</tr>
<tr>
<td>1</td>
<td>37-42</td>
<td>Measurement date for the sample.</td>
</tr>
<tr>
<td>1</td>
<td>43-68</td>
<td>Filled in by the classifier.</td>
</tr>
<tr>
<td>1</td>
<td>43-44</td>
<td>Crown closure percent measured on the photos used for updating.</td>
</tr>
<tr>
<td>1</td>
<td>45-46</td>
<td>Crown closure percent measured on the photos used for updating the type island or stand.</td>
</tr>
<tr>
<td>1</td>
<td>47-68</td>
<td>Species composition of stand.</td>
</tr>
<tr>
<td>1</td>
<td>69-70</td>
<td>Disturbances.</td>
</tr>
<tr>
<td>2</td>
<td>2-11</td>
<td>As per card type 1.</td>
</tr>
<tr>
<td>2</td>
<td>12-14</td>
<td>Slope percent and position.</td>
</tr>
<tr>
<td>2</td>
<td>15-19</td>
<td>Soil data, according to the specifications of the Resource Analysis Branch (determined in the field).</td>
</tr>
<tr>
<td>2</td>
<td>20-21</td>
<td>According to R.A.B.</td>
</tr>
<tr>
<td>2</td>
<td>22-28</td>
<td>According to E.P.A. Guidelines.</td>
</tr>
<tr>
<td>2</td>
<td>29-30</td>
<td>Aspects, e.g. 10 = N, 13 = NE, 00 = Flat.</td>
</tr>
<tr>
<td>2</td>
<td>31-36</td>
<td>As coded.</td>
</tr>
<tr>
<td>2</td>
<td>36-38</td>
<td>1.13 m radius plot.</td>
</tr>
<tr>
<td>2</td>
<td>39-46</td>
<td>Sample strip location.</td>
</tr>
<tr>
<td>3</td>
<td>2-11</td>
<td>As per card type 1.</td>
</tr>
<tr>
<td>3</td>
<td>12</td>
<td>Sample point number.</td>
</tr>
<tr>
<td>3</td>
<td>13-14</td>
<td>Sample tree number.</td>
</tr>
<tr>
<td>3</td>
<td>15-16</td>
<td>Species code, as per Classification and Sampling Manual.</td>
</tr>
<tr>
<td>3</td>
<td>17-20</td>
<td>Diameter at b.h. of each &quot;in&quot; tree.</td>
</tr>
<tr>
<td>3</td>
<td>21-23</td>
<td>Total height of each &quot;in&quot; tree, either measured, estimated or entered from curves.</td>
</tr>
<tr>
<td>3</td>
<td>24</td>
<td>Source of height estimation.</td>
</tr>
<tr>
<td>3</td>
<td>25-47</td>
<td>As per Sampling and Classification Manual, except dead or broken top, which is now tree class 3, and the knot code is reversed. Also, the total age and radial increment columns are filled in only when appropriate.</td>
</tr>
</tbody>
</table>

Compass sheet on the back of tally sheet is for the sample. Tie line into the sample will be put on separate compass sheet which can be available for classifiers use.
### Inventory Tally Sheet

**Ministry of Forests**  
**Inventory Branch**

#### Sample Strip Data

<table>
<thead>
<tr>
<th>Reg. No</th>
<th>Compartment</th>
<th>Sample Number</th>
<th>Kind</th>
<th>P.S.Y.</th>
<th>Fiz</th>
<th>Stand Age</th>
<th>Height (m)</th>
<th>Site</th>
<th>D.B.H. Limit (cm)</th>
<th>P.O.T. Size</th>
<th>Plot Size Hectares</th>
<th>Length of Strip</th>
<th>Sample Crew Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Stand Data

<table>
<thead>
<tr>
<th>Measurement Date</th>
<th>Crown Closure % (in 10%)</th>
<th>Species Composition of Stand (Nearest 10%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>Month</td>
<td>Day</td>
</tr>
<tr>
<td>37</td>
<td>38</td>
<td>39</td>
</tr>
</tbody>
</table>

#### Sample Strip Environmental Factors

<table>
<thead>
<tr>
<th>Card Type</th>
<th>Slope % Position</th>
<th>Soil % Position</th>
<th>Drainage</th>
<th>Texture</th>
<th>Erosion</th>
<th>Exposure Rock</th>
<th>Environmental Protection Area Codes</th>
<th>Aspect</th>
<th>Undergrowth</th>
<th>Windfall</th>
<th>Defoliator</th>
<th>Bark Beetle</th>
<th>Mistletoe</th>
<th>Understory</th>
<th>Sample Strip Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
<td>17</td>
<td>18</td>
<td>19</td>
<td>20</td>
<td>21</td>
<td>22</td>
<td>23</td>
<td>24</td>
<td>25</td>
<td>26</td>
</tr>
</tbody>
</table>

### Remarks:

Slope Position: 1=Upper, 2=Middle, 3=Lower, 4=Flat.

Soil Depth: 1=Thin 0-50 cm, 2=Shallow 51-200 cm, 3=Deep >200 cm.

Soil Drainage: 1=Rapid, 2=Good, 3=Moderate, 4=Imperfect, 5=Poor, 6=Very Poor.

Soil Texture: 1=Llouldery >64 mm, 2=Rubbly >2 mm, 3=Gravelly 2-64 mm, 4=Sandy 0.4-2 mm,

5=Fine Sandy 0.06-0.4 mm, 6=Silty 0.004-0.06 mm, 7=Clayey <0.04 mm.

Soil Erosion: 1=Gullying, 2=Rilling, 3=Surface Erosion.

Surficial Material: 1=Morainal, 2=Sedimentary, 3=Organic, 4=Rock.

Exposed Rock: 0=.None, 1=Light, 2=Moderate, 3=Heavy, 4=Rock Bluffs or Cliffs.

E.P.A.: 0=N/A, 1=High Constraint, 2=Mod. Constraint.

Aspect: 1=North, 2=South, 3=East, 4=West.

Undergrowth: 1=Light, 2=Medium, 3=Heavy, 4=Very Heavy.

Windfall: Average Percent of Trees.

Defoliator/Bark Beetle/Mistletoe: 0=None, 1=Light, 2=Moderate, 3=Heavy, 4=Past Occurrence.

Understory: Number of Stems of Commercial Species Below Minimum D.B.H. on 1.13m Plot.

Certified that this is a true statement of sampling done by me: ________________________________

Checked by: ________________________________ and ________________________________

### Leading Major Only

<table>
<thead>
<tr>
<th>Species</th>
<th>Pt. 1</th>
<th>Sp.</th>
<th>Age</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A.M.H.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tx A.M.H.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**INVENTORY TALLY SHEET**

Ministry of Forests
Inventory Branch

<table>
<thead>
<tr>
<th>SAMPLE STRIP DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>REGION NUMBER</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>3</td>
</tr>
</tbody>
</table>

**TREE CLASS**
- 1: Residual
- 2: Suspect
- 3: Dead Potential
- 4: Dead Useless
- 5: Veteran

**QUANTITY CODE**
- 0: None
- 1: One Q
- 2: Two Q
- 3: Three Q

**HEIGHT SOURCE**
- M: Measured
- E: Estimated
- C: Calculated

**TOTAL AGE IN YEARS**

**TOTAL AGE IN LAST 10 YEARS (cm)**

**ADDITIONAL TREES (Out of Plot)**

**SAMPLE TREE MEASUREMENTS**

**REMARKS:**
INVENTORY TALLY SHEET
Ministry of Forests
Inventory Branch

SAMPLE STRIP DATA

<table>
<thead>
<tr>
<th>CARD T.</th>
<th>REGION NUMBER</th>
<th>COMPARTMENT NUMBER</th>
<th>SAMPLE NUMBER</th>
<th>KING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>11</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TREE CLASS | PATH CODE | QUALITY CODE | KNOT CODE Quarters (Q) With Knots | CROWN CLASS |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Residual</td>
<td>I</td>
<td>0</td>
<td>None 3 Three Q</td>
<td>2 C-Dominant</td>
</tr>
<tr>
<td>2 Suspender</td>
<td>B</td>
<td>0.5-1.0</td>
<td>One Q 4 Four Q</td>
<td>3 Intermediate</td>
</tr>
<tr>
<td>3 Dead Potential</td>
<td>C</td>
<td>1.0-2.0</td>
<td>Two Q 6 Any Branch Over 10 cm</td>
<td>4 Overtopped</td>
</tr>
<tr>
<td>4 Dead Useless</td>
<td>D</td>
<td>2.0-4.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Veteran</td>
<td>F</td>
<td>4.0-6.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

HEIGHT SOURCE: M = Measured, E = Estimated, C = Calculated.

<table>
<thead>
<tr>
<th>POINT NO.</th>
<th>TREE NO.</th>
<th>SPECIES</th>
<th>D.B.H. (cm)</th>
<th>TOTAL HEIGHT (m)</th>
<th>CROWN CLASS</th>
<th>TREE CLASS</th>
<th>PATH REMARKS</th>
<th>QUALITY REMARKS</th>
<th>LOG NO. of 1st KNOTS</th>
<th>TOTAL AGE IN LAST 10 YEARS (cm)</th>
<th>RADIAL INCREM.</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
<td>17</td>
<td>18</td>
<td>19</td>
<td>20</td>
<td>21</td>
<td>22</td>
<td>23</td>
</tr>
<tr>
<td>24</td>
<td>25</td>
<td>26</td>
<td>27</td>
<td>28</td>
<td>29</td>
<td>30</td>
<td>31</td>
<td>32</td>
<td>33</td>
<td>34</td>
<td>35</td>
</tr>
<tr>
<td>36</td>
<td>37</td>
<td>38</td>
<td>39</td>
<td>40</td>
<td>41</td>
<td>42</td>
<td>43</td>
<td>44</td>
<td>45</td>
<td>46</td>
<td>47</td>
</tr>
</tbody>
</table>

ADDITIONAL TREES (Out of Plot)

SAMPLE TREE MEASUREMENTS

<table>
<thead>
<tr>
<th>TREE NO.</th>
<th>SP</th>
<th>D.B.H.</th>
<th>TOP</th>
<th>BOTT.</th>
<th>TOT.</th>
<th>S.D.</th>
<th>S. DEG</th>
<th>H.D.</th>
<th>HT.</th>
<th>CORR.</th>
<th>TOTAL HT.</th>
<th>AGE</th>
<th>BOR. HT.</th>
<th>BOR. SUR.</th>
<th>TOTAL AGE</th>
<th>PITH</th>
<th>VEI</th>
</tr>
</thead>
</table>

REMARKS: ..........................................................................................................

.............................................................................................................
Sample Inspection.

The Tally Inspection Sheet is designed to measure the performance of the people involved in producing field samples and to help correct or improve the performance of the field crews.

It is just as important to find the reason for errors in measurement as to find the errors themselves. It is essential to pinpoint the items which require instruction and the items requiring more care.

The inspector should look at his inspection not only as a "sample of a sample" but also as a means to correct the original sample record. Therefore, if care has been taken by the original sample crew, a minimum remeasurement is required. If a few items are inaccurate, check more of these. If the sample is not satisfactory, it must be remeasured.

To satisfy the minimum requirements for a sample inspection the following table can be consulted. Suppose in point number one we check the d.b.h.'s and the heights of two trees whose heights were originally estimated and the d.b.h. and height on a tree whose height was originally measured. Then on point number two, we check the d.b.h.'s and heights on two measured trees and one estimated tree. By alternating from point to point, we meet the minimum requirements as shown in table number (1).

Applicable requirements of Chapter 8 also still apply.
TABLE 1

<table>
<thead>
<tr>
<th>Original Origin</th>
<th>Measured Heights</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Total Checked</th>
</tr>
</thead>
<tbody>
<tr>
<td>HT.</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>D.B.H.</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>Estimated Origin</td>
<td>Measured Heights</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HT.</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>D.B.H.</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>No. Trees Checked per Point</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>18</td>
</tr>
</tbody>
</table>

*the sequence may be reversed

Total Hts. checked = 9
Total D.B.H. checked = 18
Total trees checked = 18

TABLE 2

<table>
<thead>
<tr>
<th>Item</th>
<th>Allowable Error</th>
<th>Item</th>
<th>Allowable Error</th>
<th>Minimum number of trees to check</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample plotting</td>
<td>±3 mm</td>
<td>No. of trees</td>
<td>None</td>
<td>All</td>
</tr>
<tr>
<td>Type homogeneous</td>
<td>None</td>
<td>Tree Species</td>
<td>None</td>
<td>15</td>
</tr>
<tr>
<td>Sample data</td>
<td>None</td>
<td>D.B.H.*</td>
<td>±1%</td>
<td>15</td>
</tr>
<tr>
<td>Stand data</td>
<td>None</td>
<td>Path</td>
<td>1 tree</td>
<td>15</td>
</tr>
<tr>
<td>Environmental</td>
<td>None</td>
<td>Quality</td>
<td>1 tree</td>
<td>6</td>
</tr>
<tr>
<td>Tie point location</td>
<td>10 m</td>
<td>Sample Tree Ht.</td>
<td>±3%</td>
<td>3</td>
</tr>
<tr>
<td>Tie point details</td>
<td>None</td>
<td>Tree Ages</td>
<td>±2%</td>
<td>3</td>
</tr>
<tr>
<td>Tie line flagged</td>
<td>-</td>
<td>Measure estimated heights</td>
<td>±6%</td>
<td>6</td>
</tr>
<tr>
<td>S.R.P. located</td>
<td>±1% H.D.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Points located</td>
<td>±1% H.D.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*D.B.H.'s include checks on measured heights, estimated heights plus a minimum of one tree per plot.
Tally Inspection Sheet Description

Card Types 1 & 2 - Enter the original sample information in the shaded areas and the check information below in the appropriate column.

Sample Inspection Summary - Sample Plot - check the sample location on the relevant photo pair and map. The original sample reference point should be within 3 mm of the check. The bearing should be ±1°.

"Type Homogeneous" - The sample photo should be inspected to make sure that all points fall in the same type.

Sample Data - Check the original estimate of "strip" and "stand" crown closure, and the species composition. If there is a discrepancy in any of these, note as an error.

Environmental Factors - Note if there are any discrepancies between the original and check.

Tie Point Location - ±10 m - If in error, note the distance and bearing from the correct location. If the tie point is not adequately flagged, note as an "error".

Tie Point Details - Make sure that the details written on the tie tree are correct.

Tie Line Flagged - It should be possible to see from one flag to the next on the tie line. If this is not the case, then check "error" for this item.

Sample Reference Point Located - The allowable error is ±1% H.D.
Points Located - The allowable error is ±1% from point to point.

No. of Trees - This item should be recorded as an "error" if any tree has been incorrectly included on or excluded from the original sample record. Record as "-" if the tree was missed or "+" if it should not have been tallied. If possible, note the reason for the error, i.e., obstruction, borderline.

Tree Species - All trees should be checked to make sure they have been correctly identified. If any trees are given the wrong species symbol note in remarks, i.e., 2 B called F.

D.B.H. - The allowable error is ±1%. Record number of trees with d.b.h. error/total number of diameters checked. Note a reason in "remarks" if possible, i.e., tag heights low.

Path - Note: the number of trees incorrect path/number of trees checked. Remark if there is a pattern, i.e., missing scars lower 1/3.

Quality - Note: \[
\frac{\text{number of trees with incorrect quality}}{\text{number of trees checked}} \]
Again, if there is a pattern, note it, i.e., poor estimated log height.

Sample Tree Heights - The allowable error is ±3%.

Note: \[
\frac{\text{number of trees with incorrect height}}{\text{total measure heights checked}} \]

Tree Ages - The allowable error is ±2%.

Record: \[
\frac{\text{number of trees incorrect age}}{\text{number of ages checked}} \]
The "blank" spaces are provided for the inspector to list other items which might be checked. For instance, if the tree tags do not face the point center, then record "tree tags" in the "item" column and "not facing point center" in remarks.

The right hand side of the summary (tree number, species, etc.) is designed to compare the estimated heights on the original record with measured heights. A minimum of 6 estimated heights should be measured. In the "error" column record the error as + or − in metres.

"Name" & "Title" - Enter the names of the persons who were involved in planning and office checking as well as doing the sample.

Sample Inspector's Remarks - A brief statement should be made on the quality of the sample and a list of items which require improvement. There may be conditions in the field which affect the sample's accuracy and these should be mentioned.

The completed tally inspection results should be thoroughly discussed with the tallyperson and compassperson. The tallyperson should correct the original sample record and sign the inspection sheet. All of the persons involved with plotting, office checking, or planning the sample should be made aware of the accuracy of their work.
### Sample Strip Data

<table>
<thead>
<tr>
<th>REG. NO.</th>
<th>COMPARTMENT NUMBER</th>
<th>SAMPLE NUMBER</th>
<th>KIND</th>
<th>P.S.Y.</th>
<th>F.I.Z.</th>
<th>STAND ESTABLISHMENT YEAR</th>
<th>HEIGHT (m)</th>
<th>S.D.H. LIMIT (cm)</th>
<th>PLOT SIZE</th>
<th>SAMPLE CREW CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
</tr>
</tbody>
</table>

**Sample Strip**

<table>
<thead>
<tr>
<th>MEASUREMENT DATE</th>
<th>CROWN CLOSURE %</th>
</tr>
</thead>
<tbody>
<tr>
<td>YEAR</td>
<td>MONTH</td>
</tr>
<tr>
<td>37</td>
<td>38</td>
</tr>
</tbody>
</table>

**Stand Data**

<table>
<thead>
<tr>
<th>SPECIES COMPOSITION OF STAND (NEAREST 10 %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP</td>
</tr>
<tr>
<td>47</td>
</tr>
</tbody>
</table>

### Sample Strip Environmental Factors

<table>
<thead>
<tr>
<th>CARD TYPE</th>
<th>% (10')</th>
<th>SLOPE</th>
<th>SOIL</th>
<th>EXPOSED POSITION</th>
<th>DRAINAGE DEPTH</th>
<th>TEXTURE</th>
<th>EROSION</th>
<th>S.U.RFACE</th>
<th>MAT</th>
<th>E.GROWTH</th>
<th>WIND</th>
<th>DEFOLIATOR</th>
<th>BARK</th>
<th>MISTLETOE</th>
<th>U.S. STORIES</th>
</tr>
</thead>
</table>

**Sample Strip Location**

<table>
<thead>
<tr>
<th>AERIAL PHOTOGRAPHY</th>
<th>FLIGHT NUMBER</th>
<th>PHOTO NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>39</td>
<td>40</td>
<td>41</td>
</tr>
</tbody>
</table>

### Sample Inspection Summary

<table>
<thead>
<tr>
<th>ITEM</th>
<th>CORR.ERROR</th>
<th>REMARKS</th>
<th>ITEM</th>
<th>NO. IN ERROR</th>
<th>REMARKS</th>
<th>TREE NO.</th>
<th>D.B.H.</th>
<th>EST. HT.</th>
<th>MEAS. HT.</th>
<th>ERROR (m)</th>
<th>CROWN CLASS</th>
</tr>
</thead>
</table>

**Sample Inspector's Remarks:**

This sample has been discussed with me.

The original sample sheet has been corrected.

**Signature of Tallyperson:**

**Noted by:**

**Project Sup. or designate:**
## SAMPLE TREE MEASUREMENTS

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**REMARKS:**
# Sub-Unit Survey Tally Inspection Sheet

**Ministry of Forests**

**Inventory Division**

## Sample Strip Data

<table>
<thead>
<tr>
<th>Card T.</th>
<th>Region Number</th>
<th>Compartmenl Number</th>
<th>Sample Number</th>
<th>Kind</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
</tr>
</tbody>
</table>

**Tree Class**

<table>
<thead>
<tr>
<th>1</th>
<th>Residual</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Suspect</td>
</tr>
<tr>
<td>3</td>
<td>Dead Potential</td>
</tr>
<tr>
<td>4</td>
<td>Dead Unfit</td>
</tr>
<tr>
<td>5</td>
<td>Veteran</td>
</tr>
</tbody>
</table>

**Path Code**

- 1: Spin Grain
- 2: Present
- 3: 1.5-5.5
- 4: 10^6

**Quality Code**

- 0: None
- 1: One
- 2: Two
- 3: Over
- 4: Major

**Knot Code**

- 0: One
- 1: Two
- 2: Three
- 3: Four

**Crown Class**

- 1: Dominant
- 2: Co-Dominant
- 3: Intermediate
- 4: Overgrown

**Height Source**

- M: Measured
- E: Estimated
- C: Calculated

## Sample Tree Measurements

<table>
<thead>
<tr>
<th>Tree No.</th>
<th>SR</th>
<th>D.B.H.</th>
<th>Top</th>
<th>Bottom</th>
<th>Total</th>
<th>S.D.</th>
<th>S.D.</th>
<th>H.D.</th>
<th>H.T.</th>
<th>CORR.</th>
<th>Total HT</th>
<th>Age</th>
<th>Bore HT</th>
<th>Knots</th>
<th>Total Age</th>
<th>Value</th>
</tr>
</thead>
</table>

## Remarks:

---

[Signature]
7.7 DOUBLE SAMPLING

7.71 BASIC CONCEPT

The basic concept of double sampling is discussed in Section 5.24 of the Sampling and Classification Manual.

By using low level photography we hope to derive a correlation between ground measurements and photo measurements. Once correlations are achieved it is possible to utilize low level photography to sample a much larger area with fewer ground checks. Approximately 5 to 10 percent of all sample strips should be prepared for double sampling.

7.72 OFFICE PREPARATION

A flight plan of samples to be flown should be put together on air photos of a suitable scale. The sample number, location and direction should be shown on the photos. Draw up a list of samples to be flown showing sample number, air photo number and the number of frames to be exposed.

7.73 FIELD PREPARATION

To identify a sample from the air a white linen flag is hoisted into the crown of a sample tree prior to the flight, usually during the sample inspection. A stem map showing the point center and the relative positions of the tagged trees as well as any large rocks or logs or creek that flows through the plot. The point number and north should also be shown on the stem map.

7.74 LOW LEVEL FLIGHT

When approaching the flagged sample, the pilot aligns his direction of travel with that of the sample. When the helicopter is directly over the flag a pair of stereograms is exposed. The pilot then continues through the stand and several more stereograms are exposed. When the stand has been photographed the roll number and number of exposed frames are recorded on the sample listing.

See Appendix C for a "Summary of Operational Guidelines for 70 mm Fixed Base Photography".
INSTRUCTIONS FOR
WIDE-SCALE RELASKOP

DESCRIPTION OF WIDE SCALE

The main area of the scale resembling the shape of a stave, consists of alternating white and black bars (Fig. 10). The width of this scale is referred to as a “field of measurement”. The right margin of the field of measurement consists of 4 narrow bars, 2 white and 2 black. These 4 bars form the “quarter field”, which has the same width as the large white bar adjoining to the left. This width is equivalent to one RELASKOP Unit (RU), i.e., to the basal area factor 1 (1 m²/ha in the metric system) in variable plot cruising. The width of the quarter field corresponds also to the plot radius factor 50, or to about 2 percent of the scale “p” (Fig. 10). Width of each of the 5 black and 5 white bars to the left may be assumed to be the same as that of the quarter field or the first large white bar.

The stave-like taper of both ends of the group of bars corresponds to the reduction of width with the cosine of any angle of inclination in sighting at an object. The group of bars is being dissected horizontally by the measuring edge at a point that depends on the degree of tilt needed for sighting. Where the bars are being dissected by the measuring edge, a corrected measuring scale is formed as if the observed tree-diameters were projected vertically into the horizontal field of vision. The effect of all this is to automatically convert slope distance to horizontal distance.

To the right of the quarter field are two scales. The one marked “P” gives per cent slope and the other marked “D” gives degree of angle (Fig. 10).

The zero corner of the measuring field is formed by the boundary between the quarter field and the first white bar (Fig. 10). Full units are read from the right to left, while quarter units are read from the zero corner to the right. To facilitate counting full units from the zero point to the left, each bar carries a number. The number of each bar re-appears along the bar’s left border at intervals that are equivalent to the distance of the 5-degree intervals on scale “D”. These numbers are hatched and slightly smaller (e.g., numbers pointed at by the two lower pairs of arrows in Fig. 11) than the subsequently discussed “Ladder numbers” to avoid confusing these two different kinds of numbers.
Bars 2 to 10 contain tangent scales for measuring tree diameters at steps of one meter below and above the observer's horizon. These height scales, referred to as "ladders", appear as rows of points in the right portion of a bar. They are marked by numbers from 1 to 9, and by symbols from 10 on upward. The values 10, 20, and 30 are marked by squares that stand on one corner and have point in the center. The values 15 and 25 are represented by small rings. Intermediate values can be obtained quickly by counting from the nearest value of 5. Maximum height of each ladder is "30", or 70 degrees plus or 60 degrees minus, respectively.

Ladder values indicate meters above or below the horizon, if observations are made at the appropriate distance from the tree. The appropriate horizontal distances "a" from stem to eye of the observer (see Fig. 2 and 12) are given as even meters from 4 to 20. The numbers appear in circles at the zero point of the ladders (Fig. 12). The appropriate ladder can even be found without reference to the number at zero point. Doubling the position number of each bar indicates the appropriate base line for the respective bar-ladder. For instance, the ladder for a = 12 m can only be in the sixth bar, for a = 14 m in the seventh bar, and so on.

HOW TO MEASURE BASAL AREA WITH WIDE SCALE RELASKOP

Tree count in dense forests usually requires large factors for basal area. These are readily available in the Wide Scale RELASKOP.

The square of the number of RELASKOP units u used for tree count is the basal area factor k in m²/ha (k = u²).

When measuring width 0 - 1, k = BAF 1; 0 - 2, k = BAF 4; 0 - 3, k = BAF 9;
0 - 4, k = BAF 16; 0 - 5, k = BAF 25; 0 - 6, k = BAF 36, and so forth.

The same rule applies for the quarter bands; for 1 RU/4, k = 1/16; for 2 RU/4, k = 4/16 = ¼; for 3 RU/4, k = 9/16 m²/ha. Likewise, this also applies for combinations of whole RU and quarters, as for instance: For (2 + ¼) RU = 9/4 RU, k = 81/16m²/ha.

Since determination of diameter at breast height generally is of little value in old-growth or tropical timber, tree counts to obtain basal area will employ measuring heights from 4 to 10 meters above ground. Finding the desired height for measurement is accomplished most expediently by means of a bamboo pole placed vertically beside the tree. An even fraction of the measuring height, chosen as large as possible, should be indicated on the pole by two clearly visible marks (for instance, i = 4 m at measuring heights of 4, 8, 12, or 16 meters). The known rod-interval (in this example i = 4) is measured with the P scale as accurately as possible (for instance, with 23%) and then multiplied for the desired measuring height (for instance, 23 x 3 = 69%). The percent value thus obtained (69 in this example) is used to measure from the foot point of the tree (either ground or stump) upwards and to indicate the desired measuring height (12 meters in this example). For sighting above and below the line of eye level, values of the P scale have to be added. However, if foot level and height measurement are within the same scale, the difference has to be calculated.
The rod interval obtained in p per cent (p = 23 in this example) also can be used directly for d-measurements. Since 1 RU = 2% and i/p gives the length that is equivalent to 1 per cent of the respective distance, then 1 RU = 2 i/p (800/23 cm in this example). With this method, there can be made from one point at a tree count as well as a determination of diameters at heights not accessible directly from the ground.

If horizontal distance to the point of observation is determined with a tape to obtain a highly accurate determination of diameter, the height of the measuring point is found at as many per cent units as per cent of the distance is contained in the measuring height.

HOW TO MEASURE TREE DIAMETERS AT ANY HEIGHT

USING WIDE SCALE RELASKOP

Measurement consists of two steps, finding the desired height of the stem and measuring the actual diameter. Angles are employed in both steps. Since angles give only relative values, they have to be supplemented by an absolute measure. The base line "a" is best suited as an absolute measure. An even value in meters from 4 to 20 is recommended because it allows use of the already described ladders and it simplifies computation of diameter. The length of the selected base line should be measured with a tape.

The closer the observer is to the diameter to be measured the greater will be the accuracy of measurement with the RELASKOP. However, too steep a sighting should be avoided. For instance, a diameter at 10 meters above the observer's horizontal eye line should not be measured from a distance of 4 meters, but from 10 or 12 meters.

The following rules apply to the determination of diameter: The left edge of the stem should coincide with the edge of one of the bars in such a fashion that the right edge of the stem falls into the quarter field. First the full RU to the left of zero are counted and then the remainder in the quarter bars (RU/4), or estimated fractions thereof to the right of zero.

RU and RU/4 are converted to centimeters by using the distance of the base line. If distance in meters is a, then 1 RU = a/2 cm (Conversion is simple, since suggested a-values are even and therefore result in even centimeters for 1 RU/4). See example in Figure 12: Base line is 18 meters; point of measurement is situated 5 meters above eye level. 1 RU = 36 cm, 1 RU/4 = 9 cm. The left edge of the stem coincides with the edge of bar 7, or 7 RU to the left of zero. From zero to the right edge of the stem one reads 1 RU/4 = 0.6 RU/4, 7 RU x 36 = 252 cm; 1 RU/4 = 9 cm; 0.6 RU/4 = 5.4 cm. Adding together these values shows that the diameter is 266.4 cm.

Double ladder distances can be employed for measurements of very tall trees. In this instance, the ladder units are equivalent to 2 meters instead of 1 meter. The per cent scale "P" has to be used to determine the height of the measuring point when difficult terrain or other circumstances do not permit working with any of the base lines (2 to 20 meters), indicated along the zero line. This scale indicates the desired height, below or above eye level, as a percentage of the length of the base line. For example: a = 25 m, 1% = 25 cm. If 7 meters above eye level is desired as a point of measurement, the sight has to be raised until 700 cm; 25 cm = 28 units of "P" are indicated by the measuring edge. Thus, 1 RU is equivalent to 50 cm, and 1 RU/4 = 12.5 cm. (What
Fig. 11 Wide Scale Terms and Symbols. MM = measuring edge. 0 = zero point of the scale. From the zero point whole RELASKOP units (RU) are counted to the left, and quarter units (RU/4) are counted to the right. 1, 2, 3, ..., 11 = Numbering of bars and their left edges or corners (along M-M). Numbers to designate bars are hatched and are pointed at by the four lower horizontal arrows. V = the right limit of the quarter field. The encircled even numbers 4, 6, 8, ..., 20 indicate horizontal distances in meters that have to be used with the ladder scales in the bar above the encircled number. Each encircled number is double that of the number of the appropriate bar (e.g., bar 2 for a = 4, bar 3 for a = 6, and so on). The ladders consist of points, rings and diamonds. Ladders are numbered only from 1 to 9. The values 10, 20 and 30 are marked by the diamonds, the values 15 and 25 are marked by rings. In this illustration, the scale is so dissected by the measuring edge that for distance a = 4 the ladder value is h = 3. Consequently, one reads therefore h = 15 at a = 20. All values are in meters, but other units of length may be used instead.

falls into the quarter field is estimated best as tenths of an RU rather than as RU/4 or fractions thereof; e.g., 0.4 RU, instead of 1 RU/4 + 0.6 RU/4. Doing so simplifies conversion: 7.4 RU × 50 = 370 cm).
Fig. 10 — Wide-scale Relascope:

Diameter Measurement.

- The tree is being measured from 18 m horizontal distance.
- Heights are read on the band with the circled 18.
- The reading to the foot of the tree was -2 m. The point of measurement is at +5 m, i.e. at 7 m up the tree.
- The hands are arranged to give a whole number of RU's (7) to the left of zero. The fraction to the right of zero is estimated as 0.4 RU. Total, 7.4 RU.

- At 18 m distance, 1 RU = 2% of 18 m = 36 cm. 7.4 RU's = 36 x 7.4 = 266 cm approx.
NOTES ON THE WIDE SCALE RELASCOPE

The Relascope will be used primarily to measure the basal area at the points designated in selected timber types.

To become familiar with the instrument, practice using it and read "Relaskop".

Here are a few reminders:

1. Only the wide bands will be used for basal area measurement. These bands are numbered from right to left (see diagram).

2. The basal area factor is equal to the number of bands squared. Always measure from the right corner of band one to the left corner of the selected band.

3. A tree is "in" if it appears to be wider than the width of the bands selected and "out" if it appears to be narrower.

4. Slope corrections are not required for basal area measure as long as the "brake" is released, because the instrument is calibrated to correct for slope.

5. "Line" trees must be checked by determining the horizontal distance from the plot centre to the germination point at 1.3 m for the tree in question and using the "Horizontal Least Distance" tables provided to check whether the tree is "in" or "out". Make sure that the table used is the correct one. For instance, if three wide bands are used, use the B.A.F. = 9 table.
- using bands 1-3, B.A.F. = 9, the above tree would be "out".

- using bands 1 and 2, B.A.F. = 4, the tree would be "in".

<table>
<thead>
<tr>
<th>Total No. of Bands</th>
<th>Band Numbers</th>
<th>Basal Area Factor (B.A.F.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1 (1)^2</td>
</tr>
<tr>
<td>2</td>
<td>1,2</td>
<td>4 (2)^2</td>
</tr>
<tr>
<td>3</td>
<td>1,2,3</td>
<td>9 (3)^2</td>
</tr>
<tr>
<td>4</td>
<td>1,2,3,4</td>
<td>16 (4)^2</td>
</tr>
</tbody>
</table>
Appendix B

Fixed Base, Large Scale Aerial Photography

General Information

In contrast to sequential photography with a single camera, fixed-base photography uses two identical, synchronized cameras to obtain a stereogram from each exposure. The cameras are mounted at a fixed distance apart (6.1 metres) in a tubular aluminum boom, which is attached to three points on the underside of a helicopter.

The fixed distance between the cameras is known as the air base (B; B=6.1 metres) and is used in the calculation of photo scale and of flying height (H) above the ground. To determine photo scale, either divide flying height (H) by the known focal length of the camera lenses (f), or divide the air base (B) by the photo base (Pb). The photo base (Pb) is the air base (B) represented at a reduced scale on a stereogram: it is the distance between one pair of crosses when a pair of photo frames is viewed in stereo. A grid of twenty-five crosses (10 mm apart) is superimposed on the frame (film) during each exposure by allowing light to pass through a reseau plate placed between the camera lens and the film. When a pair of frames are viewed in stereo, 50 separate crosses are visible in 25 discrete pairs from which the photo base (Pb) can be measured. The larger centre crosses mark the respective centres of the frames (principal or nadir point).

To view a pair of frames in stereo, measure the distance between
the stereoscope lenses the same as the eye base, and then place the pair of frames under the stereoscope so that the distance between the centre crosses is approximately the same as that between the centres of the stereo lenses: a pair of frames positioned with sides touching gives a distance between centre crosses that corresponds to an eye base of 70 mm. To obtain accurate measurements, it is important to follow this procedure.

Position of Photos for Stereo Viewing

Frame A

Frame B

Frame AB in Stereo

Pb = Photo Base of Centre Point
Calculations of Photo Base, Flying Height, and Photo Scale

Note: In the measurement of individual trees, small changes in the elevation of the land bring about relatively large changes in photo scale. Photo base (Pb) is used to determine photo scale. Since the accuracy of tree measurements is dependent on that of photo scale, it is extremely important to take the most accurate measurements of photo base (Pb) as close as possible to the object being measured.

To calculate the photo base (Pb), first check whether the ground is visible: if visible, use any measuring device on which a millimetre scale is engraved; if not visible, use a parallax bar:

Place the stereoscopic pair of frames under the stereoscope, adjust the distance between stereo lenses and between centre crosses of the frames to your eye base, obtain stereo vision, secure the frames flat, turn the vernier scale until it reads 10.0, land the dot on the surface of the ground in an opening close to the left hand cross of a pair and near to an object to be measured, place the left hand dot on the centre of the left hand cross, record this first reading on the vernier scale, secure the parallax bar firmly (do not move it), turn the micrometer screw until the right hand dot lands over the centre of the right hand cross, and record the second reading on the vernier
scale. The photo base (Pb) is equal to the difference between the first and second vernier readings.

To calculate the flying height (h):

\[
H = \frac{f \times B}{\text{Pb}}
\]

where \( f \) = focal length of camera lenses
\( B \) = air base
\( \text{Pb} \) = photo base

Example:

let \( f = 100.59 \) mm
\( B = 6.10 \) m

and \( \text{Pb} = 3.00 \) mm

therefore

\[
H = \frac{100.59 \times 6.10}{3.00} = 204.533 \text{ m}
\]

To calculate the photo scale(s)

\[
\text{photo scale(s)} = \frac{H}{f}
\]

where \( f \) = focal length of camera lenses
\( H \) = flying height above ground

Example:

let \( f = 100.59 \) mm
\( H = 204.533 \) m

therefore

\[
S = \frac{204.533}{100.59}
\]

\( S = 1.2033; \) that is \( 1 \text{ mm} : 2.033 \text{ m} \)

Measurements of Individual Tree Heights

Refer to the previous section (Calculations of Photo Base, Flying Height, and Photo Scale), measure the photo base (Pb) at the same elevation and near to the tree to be measured, stereoscopically.
land the dot on top of the tree, and record this third reading on the vernier scale. The difference between this third reading and the first ground reading equals a measurement of the differential parallax (dp). Calculate the flying height (H) when the photo base (Pb) and flying height (H) are known and when the elevation of the terrain is level, each successive tree can be measured as follows: stereoscopically fuse the two dots at the bottom of the tree (ground level), record the first reading on the vernier scale, place the left dot on the top of the tree, turn the micrometer screw until the right dot fuses with the left on the top of the tree, and record the second reading on the vernier scale. The difference between the first and second reading is known as the differential parallax (dp).

Compute tree height (h) as follows:

\[
h = \frac{H^2 dp}{H dp + fB}
\]

where
- h = tree height (object height)
- H = flying height above ground
- dp = differential parallax
- B = air base (6.1 m)
- f = focal length of camera lenses

Note: This formula is a modified version of the universal one. Modification is necessary because of the great difference in scale that exists between the top and the bottom of a tree in frames taken at a low flying height above the ground and with a relatively short air base.

let \( H = 204.533 \) m

\( B = 6.1 \) m

\( f = 100.59 \) mm

and \( dp = 0.578 \) mm

therefore

\[
h = \frac{(204.533)^2 \times 0.578}{(204.533 \times 0.578) + (100.59 \times 6.1)} = 33.04 \) m

Note: to expedite calculations of tree height, use a set of parallax height reading tables.
Appendix C

Summary of Operational Guidelines for 70 mm Fixed Base Photography

Define Objectives

1. For what purpose(s) is 70 mm required?
2. Will the photographs be used for measurements and/or interpretation?
3. What type of film will be required to satisfy objectives? (black and white, colour, colour infra-red).
4. What flying height and scale is required?
5. Will coverage be spot photography or continuous strip?

Pre-flight Plan Requirements and Information

1. Outline the area to be flown on a suitable map for navigation.
2. Design and prepare each flight plan as per Section 3.0 in Forest Classification Manual.
3. Start and end flight on the most recent aerial photographs.
4. Start the flight plan next to a geographic point that is recognizable on aerial photographs and from the air.
5. Orientate flights along contours whenever possible.
6. Use white signal flags as ground markers for efficient ground/air correlation.
7. Organize flight plans to satisfy similar objectives.

Photographic Constraints

1. Weather conditions.
2. Light restrictions.
3. Type of film.
Service provided by the Photo Mensuration Section

1. Processing of film or printing.
2. Roll and frame numbering.
3. Quality control measurements.
4. Short write up for identification.
5. Measurements on request if staff available.
6. Instruction and advise for measurements.

General Conditions

1. Flying on short notice is only possible if the required film is in stock in Victoria.
2. 70 mm aerial film is not a stock item with Kodak dealers and must be ordered from the U.S.A.
3. Helicopter must have high skid gear and at present must be a Jet Ranger.
4. All flying requests must be made well in advance.
5. Vertical measurements using fixed base photography (6.1 metre air base) should not be attempted if the flying height is greater than 300 metres.
Fig. 7 (left)
Wide-scale Relascope:
Scales, full length.

Fig. 8 (below)
Rod length or diameter.

9 = angle measured at eye, which depends on the width of the band.

\[
t = \text{length of target (rod)},
\]
\[
d = \text{diameter of tree, or of a cylindrical target}.
\]

In the original relascope, the band width is such that:

\[
\frac{d}{2} = \tan \frac{\theta}{2}
\]

In the wide-scale relascope:

\[
\frac{4}{2} = \sin \frac{\theta}{2}
\]

When \( t \) or \( d \) are less than \( \frac{a}{10} \), the difference between these results is negligible, and \( t \) or \( d \) can be used indiscriminately to measure a target rod or a diameter.

Fig. 7 shows the scales in full, and Fig. 8 shows part of them enlarged. On the extreme right there are two scales, P and D. These give the angle of slope as a percentage and in degrees respectively. To the left of scale P there are four narrow bands, as in the standard relascope. Thus there are 11 bands, 6 white and 5 black, each of which is like band one in the standard model. Let us say that each of them measures one relascope unit (1 RU) while each narrow band measures \( \frac{1}{8} \) RU.

There is a slight difference in the mathematical basis on which the width of the bands is calculated, as compared with the standard relascope. In the standard instrument the band width is related to the tangent of the half angle. This leads to negligible errors when the true diameter is small in relation to the distance, as it is with the standard instrument. In the wide-scale instrument it becomes necessary to relate the band width to the sine of the half angle. See Fig. 8. The practical consequences are generally unimportant. The error in measuring a rod, as opposed to a tree diameter, is only about 0.1% at RU = 4, but would rise to about 0.5% at RU = 10.

The wide scale must be used in relation to its zero position, which is the junction between the four narrow bands and the eleven wider ones. Whole units are read to the left, fractions to the right of zero, and it would not be correct to take e.g. the 6th or the 7th band as being equal to 1 RU by itself.

The bands are numbered by small hatched figures in the left hand part of each band, from 1 to 11, running from right to left in straight lines opposite each 5° on the D scale.

Basal area sweeps can be made, in theory, with any number of bands. The multiplying factor is the square of the RU’s. E.g., if 4 RU’s are used, multiply the count by 16 to get the basal area in ft²/ft². If (rather improbably) 25 RU’s were used, the factor would be 1/25.

Distance measurements are essentially the same as in the standard instrument. As before, two narrow bands give a diameter in centimeters, the same as the distance in meters. 1 RU is twice this amount, or we can say 1 RU = 2% of the horizontal distance. E.g., a distance of 12 m, 1 RU = 24 cm and one narrow band = 6 cm.

Distance measurements at a given height are a little different. The procedure is to stand at a convenient horizontal distance, measured with a tape (or optically, see below) which should be an even number of meters from 4 to 20. Each band from band number 2 to band number 10 is marked with one of these distances (4, 6, 8, ..., 20) in a conspicuous circle at the lower number at the horizontal position. Since the distance is only twice the aerial number of the band there is no difficulty in identifying the band in any other position. Using the band corresponding to the chosen distance, look for the numbered points indicating heights. These are the fairly large numbers in the right hand part of each band. Points 1 to 4 and 6 to 9 have dots beside them, 10, 20 and 30 are dots surrounded by squares set diagonally without numbers, and 15 and 25 are circles without numbers. Using these points to find the desired height, allowing for the reading to the foot of the tree, the diameter is read off in the usual way. Fig. 10 illustrates the whole procedure.

Any of the set distances, and the resulting height readings, may be doubled for tall trees, or heights may be found on the P scale as a percentage of the distance.

Rangefinding, to fix a chosen horizontal distance, as when taking diameter measurements, may be done by methods similar to those used with the standard relascope, although there are no rangefinder scales.

A horizontal rod may be used as target, held at right angles to the line of sight. It is recommended that a rod 1/10th as long as the desired distance should be made to coincide with 5 bands. If this is done
Fig. 9 — Wide-scale Relascope:

Main scales in part enlarged.

- The serial numbers are the hatched numbers in the left hand side of each main band, running from right to left. Two sets of these are seen, of which the upper one is in full, from 1 to 11.
- The zero point is the top right corner of band number 1.
- Whole RU's from 1 to 11 are measured from zero to the top left corner of each band.

- Fractions are measured to the right of zero. Although the narrow bands are quarters, it is often more convenient to estimate to the nearest 0.1 RU.

- The standard horizontal distances for height measuring are twice the serial number of each band, in metres. See circled numbers which appear in Fig. 7 and Fig. 10.
- The numbers and symbols indicating heights appear in the right hand side of each band. As they appear above, at 4 m distance the height is 3 m, at 8 m it is 6 m, at 12 m it is 9 m, at 16 m it is 12 m (un-numbered dot) and at 20 m it is 15 m (un-numbered circle).

Note the special symbol indicating 10's.

Fig. — Wide-scale Relascope:

Diameter Measurement.

- The tree is being measured from 16 m horizontal distance.
- Heights are read on the band with the circled 18.

- The reading to the foot of the tree was -2 m. The point of measurement is at +5 m, i.e. at 7 m up the tree.

- The bands are arranged to give a whole number of RU's (7) to the left of zero. The fraction to the right of zero is estimated as 0.4 RU. Total, 7.4 RU.

- At 18 m distance, 1 RU = 2% of 18 m = 36 cm. 7.4 RU's = 36 x 7.4 = 266 cm approx.
The attached tally sheets specify all the measurements which must
be taken at each ground sample. Codes for the different variables
are indicated on the tally sheets, although detailed explanations
for most of the variables can also be obtained in the Forest
Classification and Sampling manual.

Some details of the tally sheets are summarized below as follows:

<table>
<thead>
<tr>
<th>Card Type</th>
<th>Columns</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2-42</td>
<td>Filled in by the tally person.</td>
</tr>
<tr>
<td>1</td>
<td>2-3</td>
<td>Inventory reference region number, e.g., R 4 as 04.</td>
</tr>
<tr>
<td>1</td>
<td>4-6</td>
<td>Compartment number, e.g., C 1 as 001.</td>
</tr>
<tr>
<td>1</td>
<td>7</td>
<td>Compartment letter, if applicable, e.g., A.</td>
</tr>
</tbody>
</table>
| 1         | 8-10    | Consecutive sample number. Samples are numbered
          |         | consecutively from 1 for each compartment. Check
          |         | Project listing for last number used. There must be absolutely no duplication. |
| 1         | 11      | Kind of sample, i.e., 0 = initial measurement,
          |         | 1 = remeasurement, 2 = second measurement, etc. |
| 1         | 12-14   | Project number. |
| 1         | 15      | Project sub-code. |
| 1         | 16      | Forest Inventory Zone. |
| 1         | 17-20   | Date of stand establishment, i.e., current date in
          |         | years, minus average age of dominants and
codominants, based on leading species, e.g.,
<pre><code>      |         | 1978 - 120 = 1858. |
</code></pre>
<table>
<thead>
<tr>
<th>Card Type</th>
<th>Columns</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>21-23</td>
<td>Height, i.e., the average total height of dominants and codominants, based on the leading species, to one decimal.</td>
</tr>
<tr>
<td>1</td>
<td>24</td>
<td>Site code, i.e., G = good, M = medium, P = poor, L = low.</td>
</tr>
<tr>
<td>1</td>
<td>25-27</td>
<td>Diameter at b.h. limit; the minimum measured d.b.h. will be 7.5 cm.</td>
</tr>
<tr>
<td>1</td>
<td>28-30</td>
<td>Plot size: enter the appropriate number of relascope bands. This must be kept blank if the sample is not a point sample.</td>
</tr>
<tr>
<td>1</td>
<td>30-33, 31-34</td>
<td>Plot size: if sample is not a point sample, then enter the area of the plot in hectares; if the sample is a point sample, enter the total length of the strip in kilometres, (from ft. 1 to ft. 6).</td>
</tr>
<tr>
<td>1</td>
<td>35-36</td>
<td>Sample crew code, must be unique number for each tally person.</td>
</tr>
<tr>
<td>1</td>
<td>37-42</td>
<td>Measurement date for the sample.</td>
</tr>
<tr>
<td>1</td>
<td>43-68</td>
<td>Filled in by the classifier.</td>
</tr>
<tr>
<td>1</td>
<td>43-44</td>
<td>Crown closure percent measured on 1:10,000-scale photos for the strip.</td>
</tr>
<tr>
<td>1</td>
<td>45-46</td>
<td>Crown closure percent measured on 1:10,000-scale photos for the type island or stand.</td>
</tr>
<tr>
<td>1</td>
<td>47-68</td>
<td>Species composition of stand.</td>
</tr>
<tr>
<td>1</td>
<td>69-70</td>
<td>Disturbances</td>
</tr>
<tr>
<td>2</td>
<td>2-11</td>
<td>As per card type 1.</td>
</tr>
<tr>
<td>2</td>
<td>12-14</td>
<td>Slope percent and position.</td>
</tr>
<tr>
<td>Card Type</td>
<td>Columns</td>
<td>Details</td>
</tr>
<tr>
<td>-----------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>2</td>
<td>15-19</td>
<td>Soil data, according to the specifications of the Resource Analysis Branch (determined in the field).</td>
</tr>
<tr>
<td>2</td>
<td>20-21</td>
<td>According to R.A.B.</td>
</tr>
<tr>
<td>2</td>
<td>22-28</td>
<td>According to E.P.A. Guidelines.</td>
</tr>
<tr>
<td>2</td>
<td>29-30</td>
<td>Aspects, e.g., 10 = N, 13 = NE, 00 = Flat.</td>
</tr>
<tr>
<td>2</td>
<td>31-36</td>
<td>As coded.</td>
</tr>
<tr>
<td>2</td>
<td>36-38</td>
<td>1.13 m radius plot.</td>
</tr>
<tr>
<td>2</td>
<td>39-46</td>
<td>Sample strip location.</td>
</tr>
<tr>
<td>3</td>
<td>2-11</td>
<td>As per card type 1</td>
</tr>
<tr>
<td>3</td>
<td>12</td>
<td>Sample point number.</td>
</tr>
<tr>
<td>3</td>
<td>13-14</td>
<td>Sample tree number.</td>
</tr>
<tr>
<td>3</td>
<td>15-16</td>
<td>Species code, as per Classification and Sampling Manual, except Cottonwood (Ct).</td>
</tr>
<tr>
<td>3</td>
<td>17-20</td>
<td>Diameter at b.h. of each &quot;in&quot; tree.</td>
</tr>
<tr>
<td>3</td>
<td>21-23</td>
<td>Total height of each &quot;in&quot; tree, either measured, estimated or entered from curves.</td>
</tr>
<tr>
<td>3</td>
<td>24</td>
<td>Source of height estimation.</td>
</tr>
<tr>
<td>3</td>
<td>25-47</td>
<td>As per Sampling and Classification Manual, except dead or broken top, which is now 3, and the knot code is reversed. Also, the total age and radial increment columns are filled in only when appropriate.</td>
</tr>
</tbody>
</table>

**Compass Sheet**

Compass sheet on the back of tally sheet is for the sample. Tie line into the sample will be put on separate compass sheet which can be available for classifier's use.