Kingcome TSA
Vegetation Resources Inventory Phase II

Project Implementation Plan

Version 3.1

Prepared for
Kingcome Timber Supply Area licensees including:

Mill & Timber Products Ltd.
International Forest Products Ltd.
Richmond Plywood
Western Forest Products Ltd.
Weyerhaeuser Company Ltd.

Project: MTP-006

June 28, 2004

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Vancouver – Kamloops, BC

Executive Summary

This report outlines the updated Vegetation Resources Inventory (VRI) Phase II project implementation plan (VPIP) for the Kingcome Timber Supply Area (TSA). This document incorporates discussion from the January 28, 2003 stakeholder meeting and will be submitted to the Ministry of Sustainable Resource Management (MSRM) and Ministry of Forests for approval prior to field sampling. The stakeholders include Mill & Timber Products Ltd., International Forest Products Ltd., Western Forest Products Ltd., Weyerhaeuser Company Ltd., and Richmond Plywood.

The primary objective of the Phase II ground sampling is to install an adequate number of timber emphasis plots (TEPs) to adjust the Phase I inventory in the Vegetated Treed (VT) landbase ($\geq$ 30 years) in the Kingcome TSA and achieve a target sampling error ±15% (95% probability) for net timber volume in the "target population". The target population includes the operable VT landbase ($\geq$ 30 years) in the TSA operability zones 1, 3, and 4, and the VT landbase ($\geq$ 30 years) in zone 2 (excluding stands older than 140 years with volume less than 250 m^3/ha).

The Phase II (timber emphasis) sampling proposed will be implemented over two or more years. Approximately 60 TEPs will be established in stands $\geq$30 years in the target population during the 2003 field season. The results from this sample will be used to determine the 2004 sample size required to achieve a target sampling error of ±15% (95% probability) for net timber volume in the operable VT landbase. Coarse-woody debris measurements will also be taken in all these TEPs.

The 2003 TEP sample will be used to determine whether additional sampling is required in the mature (> 120 years) stands, lowland western redcedar (Cw) stands, and in the operable VT landbase. Additional TEPs will be installed in the 2004 field season.

Dead Cw volume constitutes a relatively large component of the total volume in the Kingcome TSA. The stakeholders will pilot new sampling methods to produce more accurate dead Cw and yellow cedar (Yc) volume estimates than would be provided under existing VRI sampling methods. Additional measurements of dead Cw and Yc will be taken in all the TEPs.

The proposed net volume adjustment factor (NVAF) was updated during a May 26, 2004 conference call between the Kingcome TSA licencees and the MSRM and MOF. The Kingcome TSA and TFL 45 NVAF programs will be combined to produce localized decay and taper equation estimates for both Management Units. Eighty (80) trees (65 live and 15 dead potential) will be selected for destructive sampling. Forty-six (46) of the live trees are from the Kingcome TSA and 19 are from TFL 45. All 15 dead potential western redcedar and cypress will be sampled on the Kingcome TSA only.

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1. INTRODUCTION

1.1 BACKGROUND

The Vegetation Resources Inventory (VRI) is a three-phase process used to develop management unit forest inventories. In Phase I (Estimation Phase), aerial photos are used to delineate polygon boundaries in an inventory unit and assign attributes to these polygons. In Phase II (Ground Sampling Phase), sample locations are randomly generated and plots are installed throughout the inventory unit to produce ground estimates for each sampled polygon. In the final phase (Statistical Adjustment Phase), a ratio adjustment for different attributes is developed between the ground and photo estimates, and the Estimation Phase estimates are adjusted to reflect the results of the ground sample.

In Timber Supply Review (TSR) 1 (1996) for the Kingcome Timber Supply Area (TSA), the provincial Chief Forester indicated that timber volumes in the Kingcome TSA were unreliable and should be updated. In response, the Ministry of Forests (MOF) initiated a new Phase I for the TSA. In TSR 2 (2002), the Chief Forester indicated that, although the Phase I was ninety-five percent complete, there was still uncertainty in the inventory and the VRI process should be completed.

In 1998, Port McNeill Forest District stakeholders prepared a Phase II ground sampling plan for the District.[1] In 2003, the TSA stakeholders will continue improving the reliability of the timber volume estimates in the TSA by installing Phase II timber emphasis plots (TEPs) and completing net volume adjustment factor (NVAF) sampling. The licensee group includes Mill & Timber Products Ltd., International Forest Products Ltd., Western Forest Products Ltd., Weyerhaeuser Company Ltd., and Richmond Plywood. Other interested parties include the Ministry of Sustainable Resource Management (MSRM), Terrestrial Information Branch (Coast Forest Region), and the MOF (Timber Supply Branch and Port McNeill Forest District).

1.2 PROJECT OBJECTIVE

The objective of this project is for the Kingcome TSA VRI stakeholders to:[2]

1. Update the 1998[2] Phase II sampling plan (TEP and NVAF) to account for changes in stakeholder business needs and VRI standards.
2. Develop a VRI project implementation plan (VPIP) to guide TEP and NVAF activities.

This VPIP incorporates the results of the January 28, 2003 stakeholder meeting and details the Phase II sampling (TEP and NVAF) activities in the Kingcome TSA.[3]

1.3 TERMS OF REFERENCE

This report was prepared by A.Y. Omule, *PhD RPF* (technical advisor) and Hamish Robertson, *RPF* (project manager) of J.S. Thrower & Associates Ltd. (JST). The client contact is Stan Price, *RPF* of Price Huber and Associates who is acting on behalf of Mill & Timber Products Ltd. This report will be submitted to MSRM and MOF for approval prior to field sampling.

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[1] J.S. Thrower & Associates Ltd. 1998. Port McNeill Forest District Vegetation Resources Inventory Ground Sampling Plan Final Report. Contract report prepared by JST for the MOF, Victoria, BC. 39 pages.

[2] The stakeholders decided to focus on the VRI. Establishment of a monitoring program and other data gathering activities will be addressed separately. The VRI sample locations could also be used for these other initiatives.

[3] Memo dated January 31, 2003 from Hamish Robertson of J.S. Thrower & Associates Ltd. to the Kingcome TSA VRI stakeholders.

2. STUDY AREA

The Kingcome TSA encompasses 1,139,200 ha on northern Vancouver Island and the mainland coast. The TSA is located in the Port McNeill Forest District of the Coast Forest Region. The TSA consists of a wide range of ecological conditions represented by at least four biogeoclimatic (BGC) zones (CWH, MH, IDF and ESSF) and the CWH is the most dominant. The main tree species are western hemlock (Hw), amabilis fir (Ba), and western redcedar (Cw), with small amounts of Sitka spruce (Ss), Douglas-fir (Fd), cypress (Yc), mountain hemlock (Hm), and red alder (Dr). The total TSA productive forestland is approximately 586,000 ha (Figure 1).

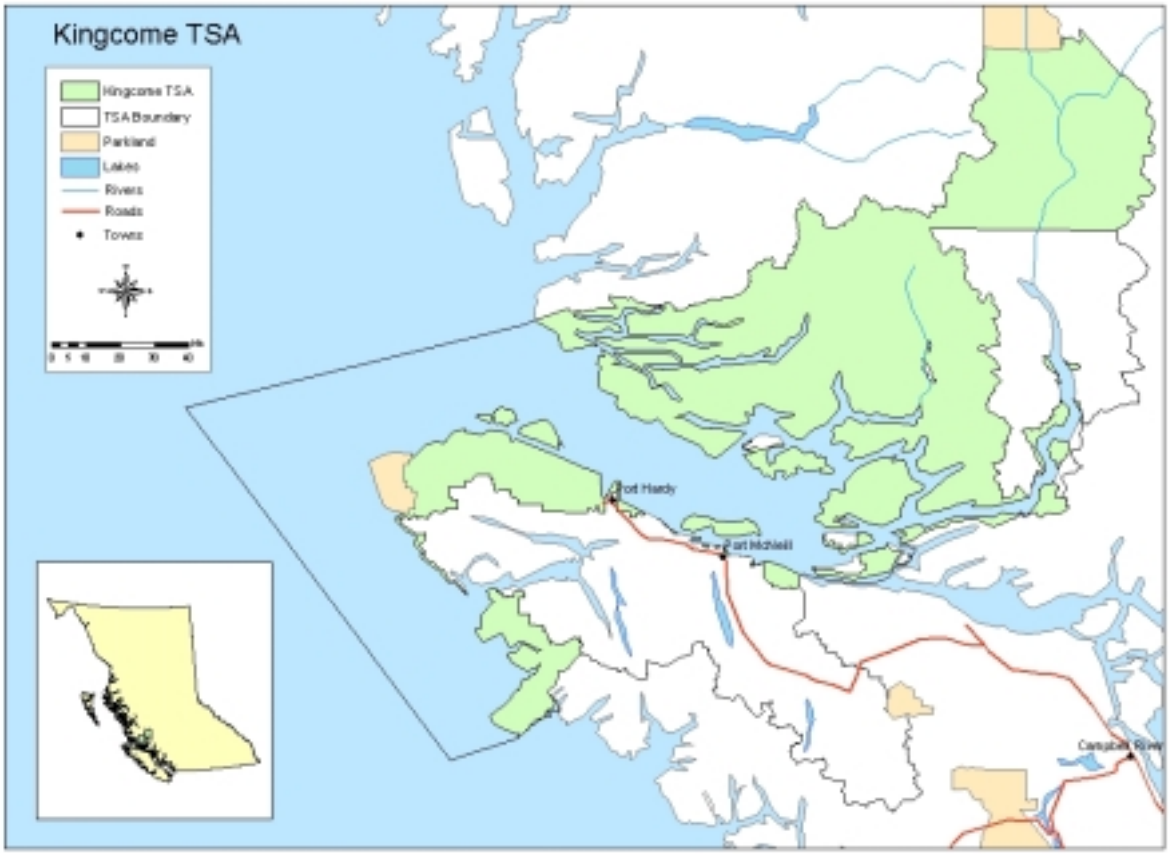

Figure 1. Map of the Kingcome TSA.

3. TIMBER EMPHASIS GROUND SAMPLING PLAN

3.1 OVERVIEW

This section summarizes the most important elements of the timber emphasis ground sampling plan, including objectives, sample size, and sampling approach. These elements were updated from the 1998 VPIP and include discussions from the January 28, 2003 stakeholder meeting.

3.2 INVENTORY OBJECTIVES

The primary objective of the timber emphasis ground sampling is to:

> *Install an adequate number of TEPs to adjust the Phase I inventory in the Vegetated Treed (VT) landbase (≥ 30 years) of the Kingcome TSA, aiming to achieve a target sampling error ±15% (95% probability) for net timber volume in the "target population".*

The target population includes the operable VT landbase (≥ 30 years) in the TSA operability zones 1, 3, and 4, and the VT landbase (≥ 30 years) in zone 2 (excluding stands older than 140 years with volume less than 250 m^3/ha). [4] Net timber volume is defined as gross volume (17.5 cm utilization) less stumps, tops, decay, waste, and breakage. Deductions for decay and waste will be estimated through call grading/net factoring and NVAF sampling. Deductions for breakage will be estimated using loss factors.

The MSRM recently increased flexibility around an acceptable sampling error such that ±15% is now an acceptable standard. This higher sampling error results in slightly reduced confidence in the final volume estimates but a more reasonable program cost (fewer plots are required). While ±15% is still acceptable for timber supply, a reduced sampling error may be required in the future if timber supply projections are highly sensitive to volume changes.

The secondary objectives are to produce:

1. *A suitable sampling error (approximately ±15% [95% probability]) for net volume in stands greater than 120 years in the target population.*
2. *Accurate volume estimates in the lowland Cw stands.*
3. *Accurate dead Cw volume estimates.*
4. *Volume estimates of coarse woody debris (CWD).*

The statistical adjustment of the Phase I will provide reliable estimates of overall timber volumes and reasonably accurate polygon estimates for TSR 3. These improvements will address the Chief Forester's concerns from TSR 1 and 2 that the inventory information needs to be updated so that forest management activities on the TSA are driven by accurate forest cover information.

[4] The TSA was divided into five operability zones (1-5) in 1993; these zones were later adapted for TSR 2. Zone 5, which is the portion of the TSA in the Kleenaklini (north of TFL 45), will not to be sampled since this area is considered inoperable, extreme terrain, and highly unlikely to be included in the future timber harvesting landbase.

3.3 SAMPLED POPULATION

The sampled population for the timber emphasis inventory (primary objective) is the Crown VT landbase (which approximates the productive forest landbase)[5] in the TSA (excluding zone 5).[4] This population will be divided into four sub-populations based on the operability definition applied in TSR 2 and polygon age, and will be sampled at different times (Table 1).[6] To meet the secondary objectives, sub-units will be created within sub-population (1) (Table 1) to assess lowland Cw stands and mature (>120 years) stands in the operable VT landbase. Criteria for defining the lowland Cw stands sub-unit will be developed in 2003 and this may involve using a geographic definition in combination with BGC criteria.

Table 1. Sampled population and TEP sampling in the Kingcome TSA.

Polygon Age	*Operability*	
	Operable VT	*Inoperable VT*
≥ 30 years	(1) Sampled 2003-2004 (target population)*	(3) Sampled 2004+
< 30 years	(2) Not sampled	(4) Not sampled

* Includes the inoperable areas in zone 2 (except for stands > 140 years old with volume ≤250 m^3/ha).

The 2003 and 2004 sampling will focus on the target population.[7] Additional sampling in the lowland Cw and mature stand sub-units will be performed in 2004 following analysis of the 2003 field results. The completed Phase I database will be used to define the operable VT population and the two sub-units to be sampled.

3.4 SAMPLE SIZE

3.4.1 Overview

At the stakeholders' meeting there was significant debate over sampling only the operable VT landbase or the entire VT landbase. Of the two, the entire VT landbase is the most stable landbase but results in a significant number of plots installed outside the stakeholders' population of interest. The operable VT landbase is relatively stable and provides the most cost-effective landbase for the licensees to sample. Thus, the

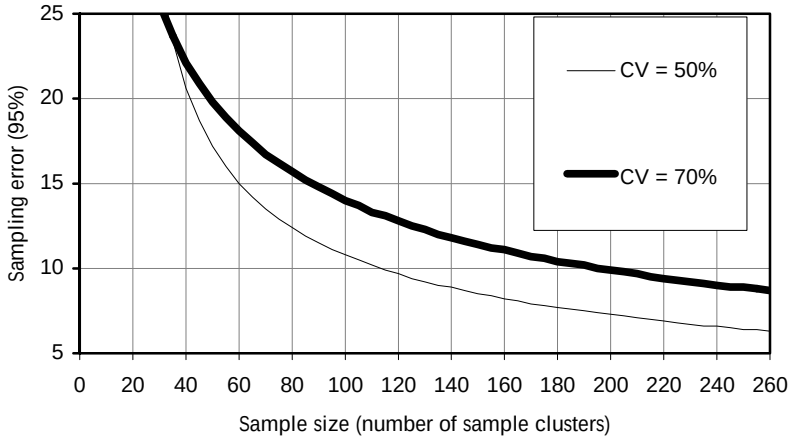

Figure 2. Sample sizes for TEP sampling in the Kingcome TSA.

[5] The productive forest landbase is the total TSA area minus non-productive forest areas, non-forest areas, and areas not managed by the MOF.

[6] The VT landbase in Zone 2 will be sampled in 2003-2004 (excluding stands older than 140 years with volume less than 250 m^3/ha). For areas not sampled, the unadjusted Phase I attributes will be used.

[7] The operable VT landbase (≥ 30 years) in the TSA operability zones 1, 3 and 4, and the VT landbase (≥ 30 years) in zone 2 (excluding stands older than 140 years with volume less than 250 m^3/ha).

stakeholders determined that sampling should focus on the operable VT landbase, but additional sampling in the inoperable VT landbase should be considered for 2004 and beyond.

3.4.2 Target Population

Installing 90 TEPs in the target population[7] should achieve the target sampling error for net volume of ±15% (95% probability) assuming a coefficient of variation (CV) of 70% (Figure 2).[8] Since the estimate of the CV is uncertain, a two-pass approach will confirm the number of TEPs for the operable landbase (≥30 years). In the first pass (2003 field season), an initial stand-alone batch of approximately 60 TEPs will be installed in the operable landbase.[9] Prior to the second pass in 2004, the 2003 field data will be analyzed to compute the required number of additional plots needed to achieve the target sampling error.

3.4.3 Inoperable VT Landbase

The target sampling error and sample size for the inoperable VT landbase (≥ 30 years) have not been determined. These commitments will be discussed with MSRM after the first year of field sampling.

3.4.4 Mature Polygons

The stakeholders want more precise volume estimates for the mature (>120 years) polygons in the target population (Section 3.2). Following 2003 sampling, the licensees will assess the sample error for this part of the population to determine if the confidence level is suitable for timber supply analysis. Part of this will include input from the MOF (Coast Forest Region) timber supply contact.

3.4.5 Lowland Cw Polygons

The stakeholders want more precise volume estimates for the lowland Cw (including Yc) polygons (Section 3.2). After examining the variability of volume in polygons from the 2003 sample, a reasonable target sampling error and sample size will be defined for the lowland cedar polygons.

3.5 SAMPLE SELECTION

Sample polygons will be selected from a list of Phase I polygons[10] using the MSRM standard stratified probability proportional to size with replacement (PPSWR) with proportional allocation. The stratification is by Leading Species or Species Groups and then by Volume Class. The selection process is as follows:

1. Stratify the VT target population into strata by Leading Species or Species Groups.
2. Create three sub-strata based on total polygon volume (low, medium, and high volume) in each Leading Species stratum.
3. Allocate samples to Leading Species strata and sub-strata proportional to area.
4. Apply PPSWR to each volume sub-stratum.

The list of sample polygons for the target population (2003-2004 sampling) and the graphical comparisons of the sample and sampled population are in Appendices II and III, respectively. The samples for the sub-units will be selected after the 2003 sampling.

Sample points within the selected polygons will be selected using the provincial 100-m grid (based on the Universal Transverse Mercator [UTM]). The grid is overlaid on a sample polygon and a sample location is

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[8] The assumed CV of 45% assumed in the original sample was increased to 70% since the VRI data from neighboring management units (e.g., Sunshine Coast) suggest that the CV in the Kingcome may have been initially under-estimated.

[9] Select three additional batches of 10 plots each to be used in case more plots can be installed than budgeted.

[10] The stakeholders approved the process for reviewing the Phase I file for sample selection on March 31, 2003.

selected at random from the grid intersections in the polygon using a Geographic Information System (GIS).

3.6 FIELD MEASUREMENTS

3.6.1 Overview

The objective of the field program is to complete TEP and CWD sampling at each plot location. Sampling will follow the current version of the *Vegetation Resources Inventory Ground Sampling Manual,*[11] and the appropriate VRI Card Types (1, 2, 3, 6, 7, 8, 9, 10, and 11). All crew leaders will be VRI-certified, and all sampling will meet or exceed minimum VRI standards.

3.6.2 Timber Emphasis Sampling

The ground samples will be VRI TEPs. The standards have been modified slightly so that the distance between the Integrated Plot Centre (IPC) and auxiliary plots decreased from 50 m to 30 m (Figure 1). This is necessary because the terrain on this TSA is extreme and the Phase I polygons are small.

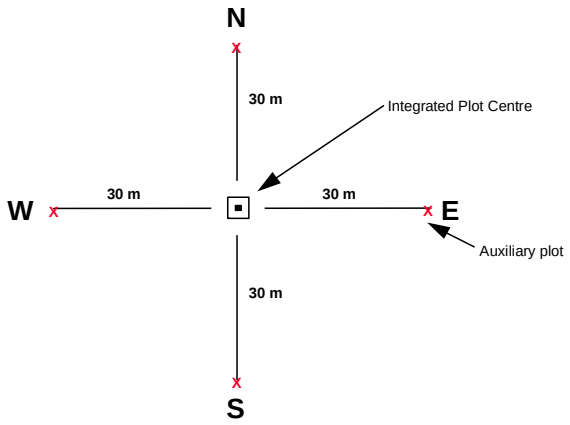

Figure 3. VRI timber emphasis plot layout.

3.6.3 NVAF Enhancement

Three auxiliary plots from each of the 35 clusters targeted for NVAF sampling will be enhanced in the 2003 field season (see Section 4). These trees will form the tree list for destructive sampling in 2004.

3.6.4 Coarse Woody Debris

Standard VRI sampling procedures for collecting CWD data will be modified slightly to accommodate coordination with helicopter pick-up. A sub-sample of the CWD transect will be measured depending on available time. These data collection methods were successfully implemented on the TFL 45 VRI Phase II sampling program.

3.7 DEAD CW VOLUME PILOT PROJECT[12]

3.7.1 Overview

Dead Cw volume comprises a relatively large component of the total volume in the Kingcome TSA.[13] This dead volume is not included in the inventory for timber supply analysis, yet is accounted for in appraisal and cut control calculations. It is possible that the inventory has underestimated the dead Cw volume or, conversely, the cutting permit tree class and loss factor process over-estimates dead volume.

3.7.2 Objective

The objective of this pilot project is use sample methods to obtain more accurate estimates of dead Cw and Yc volume than would otherwise be provided by existing VRI sampling procedures.

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[11] The VRI ground sampling procedures are available at: http://www.for.gov.bc.ca/RIC/Pubs/teVeg/gsp/index.htm

[12] This section was prepared with contributions from Norm Shaw, *ACE* of BCIT.

[13] Based on preliminary analysis of the Inventory Audit data provided by Keith Tudor, MSRM Terrestrial Information Branch.

3.7.3 Sampling Methods

Currently, the TEP process collects measurements for dead volume at the IPC only. The stakeholders propose modifying the sampling procedures to enhance all dead[14] Cw and Yc in the auxiliary plots to generate accurate volume data. Currently, the VRI process measures volume and grade directly without first classifying the tree as "Dead Potential" (Tree Class 3) or "Dead Useless" (Tree Class 4). The cruiser will classify each dead Cw and Yc as Tree Class 3 or 4 so that post analysis can allow for comparison to cutting permit cruises.

For all TEPs, the sampling of dead Cw and Yc will proceed as follows:

1. Measure all dead Cw and Yc trees in the IPC as per usual timber emphasis sampling.
2. Enhance all dead Cw and Yc trees (standing and fallen) in the auxiliary plots.
3. Visually classify each dead tree in IPC and auxiliary plots as Tree Class 3 or Tree Class 4 based on valuation cruising rules.[15] Record the classes in Column S1 of VRI card Types 8 and 11.
4. Record all other measurements as usual on VRI Card Type 8 and 11. Dead trees (standing and fallen) will be recorded during a second sweep of the plot and this non-standard data will be recorded below the line separating the standard from non-standard data.[16]

3.7.4 Analysis

This process will allow post-analysis by:

1. Total gross and net volume of dead wood.
2. Definition of potential and useless dependent on net factored values.
3. Definition of potential and useless dependent on grade (value).
4. Definition of potential and useless dependent on cutting permit definitions.

These proposed methods vary from regular VRI sampling procedures because the percent sound wood per tree is compiled by summing individual gross and net log volumes. This allows reporting by overall gross and net volume, reclassification into cutting permit tree classes by actual percent remaining or cruiser-called classification, and allows reporting by recoverable value expressed by grade.

The overall tree percent sound wood is compiled as a weighted sum of the individual log percent sound weighted by the log length. The net volume per hectare will be compiled by summing the net volumes of all the dead trees for the entire operable landbase and by tree classes. Attempts will also be made to adjust the dead wood volume if suitable proxy variables from Phase I can be found. The analysis of the dead volume component will be done such that it can be separated from the standard live tree components. This separation will, for example, permit examination of the sensitivity of including or excluding the adjustment for useable dead Cw volume in timber supply analysis.

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[14] The definition of 'dead' means that the tree is 'uprooted' so that overlap of dead fallen trees in the IPC and CWD line transect can be distinguished for overall totals of dead wood.

[15] Ministry of Forests Valuation Cruising Manual (March 1983), pages 10-11.

[16] These procedures for recording additional information 'below the line' for non-standard auxiliary plot information were used successfully during the Okanagan Innovative Forestry Practises Agreement VRI Phase II sampling in 2002.

These new methods will add some time and cost to the TEP plot establishment. They should, however, provide more accurate information on dead Cw and Yc volumes. This information will support policy discussions on potential inclusion of dead Cw and Yc volume in the existing inventory for timber supply analysis.

3.8 FIELD CREWS

The field crews have not yet been selected to complete Phase II sampling, but should be selected by the stakeholders in the next fiscal. Most plots on this project are accessible by helicopter from Port McNeill or Port Hardy. In order to minimize plot costs, an A-Star (with a six person plus pilot carrying capacity) will deliver three crews daily. If this process is not followed, the project will not be completed within the projected budget.

3.9 MENTORING & AUDITING

The mentor/auditor has not yet been selected for this project. The mentor will work with the field crews during the first days in the field and as long as needed, providing quality control on their initial plots.

The auditor will audit approximately 10% of the plots to *VRI Ground Sampling Quality Assurance Standards*.[17] Because of the high cost associated with helicopter access, the auditor should be given the flexibility to determine the number of plots audited. This decision should be made in conjunction with the Project Coordinator since the field program will be signed off by a Registered Professional Forester.

Note that crews may be required to revisit failed plots at their own expense (including helicopter expenses).

3.10 CORE COUNTING

Tree age from sample cores will be counted by the field crews completing the fieldwork. Ages will be counted in the lab using a microscope and will be sent to the Project Coordinator with validated field data.

3.11 DATA ENTRY

The consultant will enter plot data into VIDE (VRI data entry program) and provide validated data to the Project Coordinator at the end of the field season. Global Positioning System (GPS) data will be post-processed by the contractor, entered into VIDE, and delivered with the data to the Project Coordinator.

[17] Minimum standards for VRI sampling are located on the internet at:
http://srmwww.gov.bc.ca/risc/PUBS/TEVEG/VRI QA/VRI_Ground_Sampling_2K2/QA Standards for VRI-02.pdf

4. NET VOLUME ADJUSTMENT FACTOR SAMPLING PLAN

4.1 NVAF PROGRAM UPDATE: JUNE 2004

The Kingcome TSA and TFL 45 NVAF programs are being combined to increase the cost-efficiency of both programs, while providing appropriate localized estimates of decay and taper into the upcoming Timber Supply Review programs on both land bases. The proposed methods for completing this pilot project were discussed in a May 19, 2004 conference call with the licensees, MSRM, Terrestrial Information Branch and MOF Resource Analysis Branch personnel, and JST for approval of the methods. The new piloted methods are documented in Appendix III replace the discussion points in Section 4. (NOTE: Only this paragraph is updated in this section of the June 2004 edition – see Appendices IV & V)

4.2 OVERVIEW

This section summarizes the most important elements of the NVAF sampling plan, including objectives, sample size, sample selection, and stem analysis approach.[18] The methods were extracted and slightly modified from the earlier version of the VPIP and the recent stakeholders meeting. The actual NVAF methods may change from the methods proposed since the MSRM is investigating new methods to achieve the same NVAF results for a reduced cost[19]

4.3 OBJECTIVE

The objective is to complete stem-analysis sampling to derive NVAFs to adjust cruiser-called net volume to account for hidden decay, waste, and taper equation bias.

4.4 SAMPLE SIZE

The original target of destructively sampling 250 trees[1] was reduced to 115 trees from 35 TEPs because sampling is now focused on the operable landbase of the Kingcome TSA in polygons $\geq$30 years. The proposed NVAF methods included 80 mature (>120 years) live trees (30 Cw, 20 Hw, and 30 Other), 20 immature trees (proportionally distributed by species), and 15 dead trees (10 Cw and 5 remaining species). The NVAF sample will be selected from 8 immature TEPs and 27 mature TEPs. This sample size and distribution may change before destructive sampling occurs in 2004..

These sample distribution and selection methods will be reviewed to ensure that the NVAF sample is representative of the population. The number of dead Cw sample trees is relatively high because these data are needed to support the dead Cw volume pilot project (Section 3.7). The 35 TEPs are a subset of the 60 TEPs planned for 2003 sample. Three auxiliaries in each TEP of the 35 TEPs will be enhanced to create the tree list. This sample size and distribution[20] may change before the destructive sampling in 2004.

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[18] Available on the Internet at: www.for.gov.bc.ca/RIC/PUBS/OTHER/netvolume/index.htm

[19] As discussed between Guillaume Therien (JST) and Sam Otukol, *PhD RPF* and Will Smith, *RPF* of MSRM on April 24, 2003. The proposed methods will be added as an Appendix to this document and will be approved by MSRM and MOF prior to sampling.

[20] The decision to change sample size and distribution should consider factors including ensuring an adequate number of sample trees for the hemlock species.

4.5 SAMPLING APPROACH

The NVAF sampling approach follows MSRM procedures. The NVAF sampling involves five steps:

1. Randomly select sample clusters for NVAF enhancement.
2. Randomly select two auxiliary plots in the selected TEP and enhance trees by call grading and net factoring trees.
3. Create a tree matrix using data from the enhanced auxiliary plots.
4. Select sample trees from the tree matrix.
5. Complete destructive sampling of the sample trees.
6. Analyze data to develop net volume adjustment factors.

4.6 DESTRUCTIVE SAMPLING

Destructive sampling is planned for the 2004 field season. Trees targeted for destructive sampling will be selected from the 2003 sample. Field contractors, the NVAF mentor, and auditor have not been selected. These decisions will be made following the 2003 field season and will be communicated to MSRM.

5. IMPLEMENTATION PLAN

5.1 SCHEDULE

This project will be implemented over a period of at least two years. VRI TEPs will be installed in multiple batches. The first batch will consist of approximately 60 TEPs (based on expected field budget), and one batch will be completed at the end of the field season (large enough to provide meaningful estimates of the CV). Subsequent batches (2004 and beyond) will focus on achieving the target sample error in the target population and defined sub-units.

The project activities will be implemented in 2003 as follows (Figure 4):

2003 Field Season

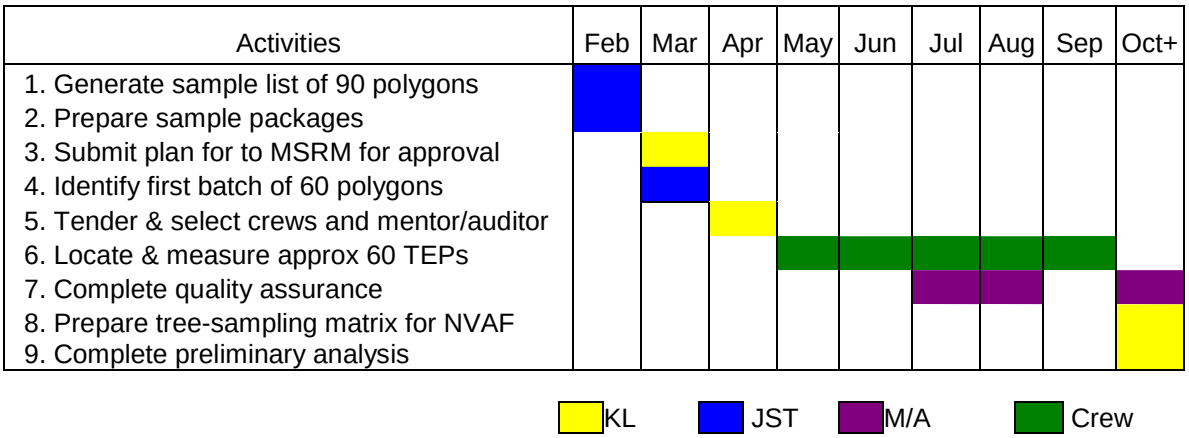

Figure 4. Proposed ground sampling implementation schedule for 2003.

Figure 4 Activities:

1. Generate a sample list of 90 polygons (in batches of 50, 10, 10, 10, and 10) and select sample locations within selected polygons (February). Select a random sub-sample of 35 polygons for NVAF sampling from the first two batches (JST).
2. Prepare sample packages for all selected polygons (March) (JST).
3. Submit the VPIP for approval by the MSRM and MOF (March) (Kingcome Licensees – KL).
4. Identify first batch of 60 sample polygons (and more batches depending on budget) from the sample list for sampling in 2003 (March) (JST).
5. Tender and select contract field crews and an independent mentor/auditor (April) (KL).
6. Locate and measure TEPs in the selected polygons and enter and validate data (May - September) (Field contract crew).[21]
7. Conduct quality assurance (10% check) (April-September) (Mentor/Auditor – M/A).
8. Prepare a tree-sampling matrix and select the NVAF sample trees (October) (KL consultant).
9. Complete preliminary data analysis and summary reports. The analysis should include preliminary estimates of average net timber volume, regression of photo-estimated volume to ground sample

[21] A mentor session between the MSRM staff (or contractor mentor) and contract field crews is required under VRI ground sampling standards prior to VRI timber emphasis and NVAF fieldwork commencing.

volume, and associated standard errors. It will also include estimation of the CV of net volume and a revised sample size for 2004 sampling (October-December) (KL consultant).

The project activities in 2004 will include:

1. Locate and measure VRI sample clusters in selected polygons and enter and edit data.
2. Conduct quality assurance (10% check).
3. Validate and compile the data from completed plots.
4. Conduct data analysis and adjust inventory and prepare maps and inventory summary reports.

5.2 SAMPLE PACKAGES

JST will prepare sample packages prior to beginning fieldwork. The packages will include the most current stereo-pair photos, a laser copy of the document photos, plot location maps (1:10,000) and access maps (1:20,000) clearly indicating sample cluster location and polygon boundaries, and overview maps (1:100,000) for general polygon location. Maps will be plotted showing the VRI grid overlays and selected sample locations.

5.3 FIELD PROGRAM

Fieldwork will be completed using VRI measurement protocols and certified crews. The Project Coordinator will manage the fieldwork contracts and quality assurance. Sampling will occur during the 2003 and 2004 field seasons.

5.3.1 Project Support

Field supplies such as aluminum stakes, field maps, photos, field cards (or electronic field data recorders), and equipment (including GPS) will be provided by the contract field crews.

5.3.2 Quality Assurance

A qualified person, selected by the Kingcome Licensees, will complete the QA. The VRI QA standards require inspection of at least 10% of the samples, however, we recommend auditing approximately 10% of the samples. The field contract crews will be responsible for the quality control of their own work.

5.3.3 Core Counting

The contract crew completing the fieldwork will count tree age from sample cores. Ages will be counted in the lab using a microscope and will be sent to the Project Coordinator with the validated field data from each batch.

5.3.4 Data Entry

Each contract crew will enter their own plot data into VIDE and provide validated data to the Project Coordinator. GPS data will be post-processed by the contractors, entered into VIDE, and delivered with age counts and field data to the Project Coordinator.

5.4 DATA ANALYSIS AND ADJUSTMENT

The Licensees are responsible for all phases of data compilation and analysis. They may get a contractor to compile and verify the data, and complete the statistical analysis and database adjustment, subject to available budget.

5.5 ROLES AND RESPONSIBILITIES

The *MSRM* and MOF will be asked to approve the sample plan.

The Licensees' *Project Coordinator* will:

- Coordinate the project.
- Select the field contractors and auditor/mentor.
- Liaise with MSRM and MOF.
- Ensure selected samples are valid.
- Monitor and communicate project progress.
- Ensure all contractors are qualified and certified, and manage fieldwork contracts.
- Monitor the budget.
- Ensure the sample packages are assembled and complete.
- Oversee ground-sampling activities.
- Ensure QA is complete.
- Assist in coordinating technical expertise where required.
- Provide MSRM with all relevant project data, including ground sample data, maps, sample selection files and documentation, and the adjusted database, according to standards and timelines agreed with the MSRM.

The *Fieldwork Contractors* will:

- Complete field sampling.
- Conduct internal quality control.
- Enter the sampled data.

The *Mentor/Auditor* will:

- Complete QA work for 10% of the VRI samples.
- Enter and validate the sample data.
- Prepare the QA report.

5.6 APPROXIMATE COSTS

Estimated costs for the 2003 field season are provided in Table 2. The projected cost of the field program (only) is $240,000. This cost projection does not consider project management costs (to be determined) and analysis costs (approx $10,000). The budget is based on three field crews in the helicopter each day and assumes that all plots on the mainland coast and half the plots on Vancouver Island are helicopter plots. Helicopter costs are based on Vancouver Island Helicopters A-Star rates of $1,600/hr with four-hour minimums.[22]

Table 2. Estimated 2003 costs for field program only.

2003 Sampling Phase	Cost
Field Sampling (3 crews)	$93,000
Heli costs	$98,000
Internal QC (Contractor)	$21,000
Mentoring & QA	$22,000
Data Entry	$3,000
Core Counting	$3,000
Total	*$240,000*

These approximate costs, which are intended to give a rough idea of the total project field cost for 2003, will change depending on how the project is managed.

[22] Field staff completing a similar VRI Phase II sampling on TFL 45 suggest that four-hour minimums should be expected for this project.

6. PROJECT APPROVAL

I have read and concur with the Kingcome TSA VRI Project Implementation Plan, dated March 2003. It is understood that this is an agreement-in-principle and does not commit the signatories to completing the inventory activities outlined within the plan. Significant modifications to this plan need to be reviewed and approved by the signatories.

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Director, Terrestrial Information Branch
Ministry of Sustainable Resource Management

_____

Director, Timber Supply Branch
Ministry of Forests

APPENDIX I – GLOSSARY OF TERMS

Ground Sampling

VRI ground sampling (Phase I) is the field measurement of timber, ecology, range, and/or coarse woody debris values at one or more locations within each sample polygon. To accommodate the wide variety of resources, various types and sizes of sampling units (e.g., fixed and variable plots, transects) are used to make the measurements.

Landcover Classification

The BC Landcover Classification Scheme (BCLCS) was designed specifically to meet the requirements of the VRI, in addition to providing general information useful for "global vegetation accounting" and "integrated resource management". The BCLCS is hierarchical and reflects the current state of the landcover (e.g., presence or absence of vegetation, type and density of vegetation) and such fixed characteristics as landscape position (i.e., wetland, upland, alpine). There are two main classes of polygons: Vegetated and Non-Vegetated.

Net Volume Adjustment Factor (NVAF) Sampling

NVAF sampling provides factors to adjust net tree volume estimated from net factoring and taper equations. The adjustment accounts for hidden decay and possible taper equation bias. NVAF sampling involves detailed stem analysis of sample trees, calculation of actual net volume, and calculation of the ratio between actual net volume and estimated net volume (where estimate net volume is obtained from net factoring and taper equations).

Photo-Interpretation (Phase I)

Photo-interpretation (Phase I) involves the subjective delineation of polygons and the photo estimation of attributes for all polygons in an inventory unit. Medium scale aerial photographs (1:15,000) are most often used in the photo-interpreted estimates inventory. However, if the existing photo-based inventory is acceptable, the database can be translated into VRI format and upgraded to include the additional VRI attributes.

Post-Stratification

Post-stratification involves the division of an inventory unit into mutually exclusive sub-populations (strata) *after* ground sampling has been completed. Samples that fall in each post-stratum are analyzed separately and the results are applied to the corresponding population post-strata.

Pre-Stratification

Pre-stratification involves the division of an inventory unit into mutually exclusive sub-populations (strata) *before* ground sampling to provide estimates for specific areas, or to increase the confidence in the overall estimates by considering the special characteristics of each stratum.

Sample Size

The sample size for an inventory is the minimum number of ground samples to be established in an inventory unit to meet specified target precision or cost. Calculation of a theoretical target sample size requires an estimate of the CV of the key attributes of interest under the proposed sampling procedures and a statement of the precision desired in these attributes.

The formal process for determining sample size for an inventory unit is to anticipate the results (e.g., target sampling error for timber volume) and then determine the approximate sample size corresponding to this desired result. This process would, for example, involve the following steps:

1. Set the target accuracy for the overall inventory unit accuracy to *E* for timber volume (i.e., the sampling error, or half the confidence interval associated with a given probability, e.g., ±15% at the 95% probability level). The number of samples should be adequate to meet the target precision.
2. Estimate the population coefficient of variation (CV_{sample}) of the attribute of interest based on a small sample. This CV_{sample} is defined as a relative measure of the average difference between a polygon ground measurement (assumed the true value) and its corresponding estimate from the inventory.
3. The following formula would then be used to estimate sample size:

$$n = [\frac{t * CV_{sample}}{E}]^2$$

where *t* is the "*t*-value" associated with a given probability and degrees of freedom, and CV_{sample} is a sample-based estimate of the population CV.

The sample size calculations suggested here are general guidelines, not exact requirements. The sample size used in practice is usually a trade-off between the calculated sample size and the expected cost, timing, credibility, flexibility, and comparability of the inventory. The size of the population is usually large enough that it does not affect sample size. The calculated sample size may be increased arbitrarily to allow for post-stratification, increased credibility, more flexibility, and a better starting point for growth projections.

Statistical Adjustment

Statistical adjustment (or analysis) is the process of adjusting the values of the photo-interpreted estimates variables using the ground sampling observations. For each sampled polygon, the ground observations are compared to the photo-estimated values to develop an adjustment factor. This factor is then applied to all polygons in the photo-interpreted estimates database to produce the final adjusted database.

Sub-unit

The term sub-unit describes the inventory unit within a management unit. A sub-unit may be defined by a specific geographic area (e.g., operable landbase) or stand type (e.g., problem forest types) within the management unit.

Target Population

The target population is the unit from which the samples are chosen. For management inventories, the inventory unit is a TSA, TFL or other geographic area or specific attribute set, depending upon the sampling objectives.

Target sampling error

Target sampling error expresses the desired accuracy of the attribute of interest (e.g., timber volume). It is usually expressed as a percentage value at a given probability level (e.g., ±15 at the 95% probability level). This means that 95% of the time we are confident that the volume estimates are within 15% of the

actual volume. Target sampling error is used to calculate the minimum sample size for subsequent ground sampling; see ***Sample Size***.

Vegetation Resources Inventory (VRI)

The VRI is an improved vegetation inventory process for assessing the quantity and quality of BC's vegetation resources. The VRI process is designed to include a flexible set of sampling procedures for collecting vegetation resource information. The VRI is essentially a toolbox of procedures, which include:

- BC Landcover classification scheme (BCLCS).
- *Photo-interpreted estimates (Phase I)*: the delineation of polygons from aerial photography and the estimation of resource attributes.
- *Ground sampling (Phase II)*: the establishment of plot clusters in selected polygons to measure timber, ecological, and/or range attributes. The data are used for the adjustment of the photo-interpreted estimates for all polygons in an inventory unit or management unit.
- *NVAF Sampling*: Stem analysis sampling of individual trees for net volume adjustment.
- *WPV Sampling*: Intensive sampling of selected polygons to determine the error between the estimated attribute values and the "true" attribute values.
- *Change Monitoring Inventory (CMI).*

The VRI can be deployed over the entire province (provincial VRI) measuring timber and non-timber resources, or over a large management unit (management VRI) measuring selected resources in specific portions of the landbase. The VRI sampling process produces spatial and non-spatial databases that can be used in multiple resource management applications including timber, ecosystem, and wildlife habitat management.

APPENDIX II – PHASE II SAMPLE SELECTION

Batch	Plot No	Sample	Map ID	Poly ID	Spp	Age	Area (ha)	Volume (m^3/ha)
1	1	Cw-Low	102I079	921	Cw	354	6.8	345.1
1	2	H-Low	092L079	1201	H	51	8.4	273
1	3	Cw-High	092K071	997	Cw	506	5.3	695.9
1	4	H-High	092M039	443	H	354	86.1	692
1	5	Cw-Low	092L094	1160	Cw	406	6.7	311.5
1	6	Cw-High	092M005	146	Cw	354	3.1	648.7
1	7	Cw-High	092L086	284	Cw	356	83.1	631
1	8	H-Med	092L069	828	H	66	25.2	450.3
1	9	Yc-Med	092M005	281	Yc	354	72.4	333.3
1	10	Cw-Low	092L094	288	Cw	406	5.2	321.3
1	11	Cw-Med	092L100	61	Cw	306	11.3	444.2
1	12	Cw-Med	092L072	524	Cw	506	8.3	524.9
1	13	Cw-Med	102I080	624	Cw	404	40.2	516.7
1	14	Cw-Med	092M013	577	Cw	329	18.3	457.8
1	15	Cw-Low	092M013	10	Cw	264	19.1	265.2
1	16	Cw-Low	092L071	919	Cw	306	17.1	366.3
1	17	H-Med	092L095	325	H	206	1.6	419.8
1	18	Cw-Med	092L069	432	Cw	506	24.9	501.7
1	19	H-Med	092K061	193	H	289	37.9	539.2
1	20	ZC-Hig	092M018	686	Ss	354	23.6	1138.2
1	21	H-High	092L081	421	H	306	18.4	901.8
1	22	Cw-High	092M017	626	Cw	313	17.4	771.1
1	23	Cw-Low	102I079	793	Cw	354	32.6	268.7
1	24	H-Low	092L085	651	H	206	2.3	323.2
1	25	Cw-Low	092L073	276	Cw	306	12.9	355.9
1	26	Cw-Med	092L072	47	Cw	306	12.9	443.2
1	27	H-Low	092L069	630	H	66	11.2	218.1
1	28	ZH-Hig	092L099	733	Dr	54	29.5	373.8
1	29	H-High	092L086	162	H	76	8.3	617.4
1	30	Cw-High	092L081	305	Cw	306	83.0	693.6
1	31	H-High	092M039	79	H	353	226.1	758.3
1	32	Cw-Low	102I080	14	Cw	303	3.9	270.2
1	33	Cw-High	092M006	584	Cw	304	7.8	554.8
1	34	H-High	092L053	36	H	86	64.6	623.6
1	35	Cw-Low	092L071	919	Cw	306	17.1	366.3
1	36	H-Low	102I070	257	H	30	17.7	172.7
1	37	ZH-Med	092L090	488	Dr	76	3.3	192.8
1	38	H-High	102I080	570	H	353	24.5	674.6
1	39	H-Med	092L068	139	H	45	14.2	420.6
1	40	Cw-High	092M005	625	Cw	354	18.8	692
1	41	H-High	092M038	718	H	354	6.7	638.8
1	42	Yc-Hig	092L057	272	Yc	356	7.5	566.5
1	43	Cw-High	092M005	260	Cw	304	48.0	661.4
1	44	H-Low	092M015	235	H	38	89.7	135.1
1	45	Cw-Med	092L071	196	Cw	306	63.7	393.9
1	46	H-Med	102I069	747	H	110	6.9	467.7

1	47	Cw-High	092M016	68	Cw	353	9.8	575.3
1	48	Cw-Med	102I079	304	Cw	354	22.8	416.3
1	49	H-Med	092L073	430	H	206	22.7	416.1
1	50	Cw-Med	092L085	710	Cw	356	16.9	466.7
2	51	H-Hig	092L032	1096	H	234	45.9	822
2	52	H-Hig	092L059	7	H	86	3.5	608.4
2	53	C-High	092M006	532	Cw	304	16.5	573.5
2	54	C-Med	092M004	489	Cw	324	18.7	516.7
2	55	H-Low	092L095	77	H	36	23.8	120.2
2	56	H-Med	102I070	174	H	114	12.9	505.5
2	57	C-Low	092M015	327	Cw	303	13.2	227.7
2	58	C-High	092L095	762	Cw	356	2.1	553.7
2	59	Z-Hig	092L070	691	Yc	506	7.4	488.4
2	60	C-Med	092M003	127	Cw	407	24.3	503.8

APPENDIX III – LANDBASE SUMMARIES

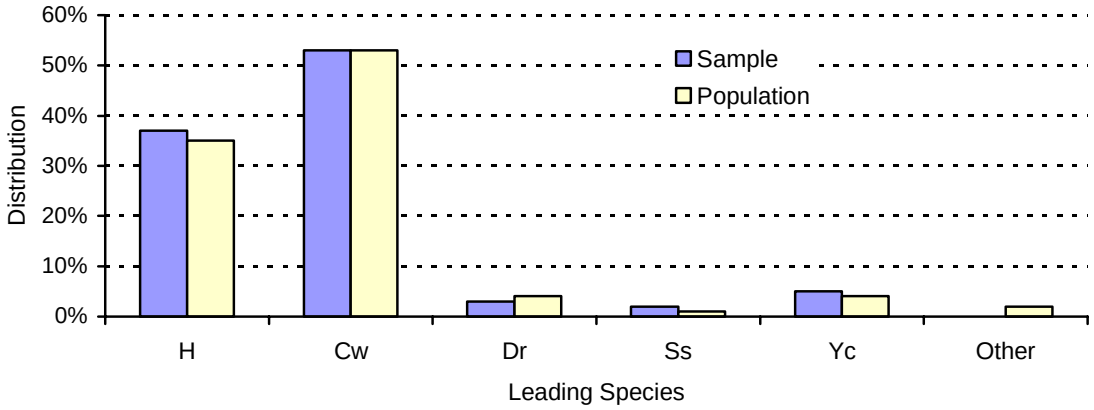

Figure 5. Comparison of the sample and population species distribution for the Kingcome TSA.

Figure 6. Comparison of the sample and population age class distribution for the Kingcome TSA.

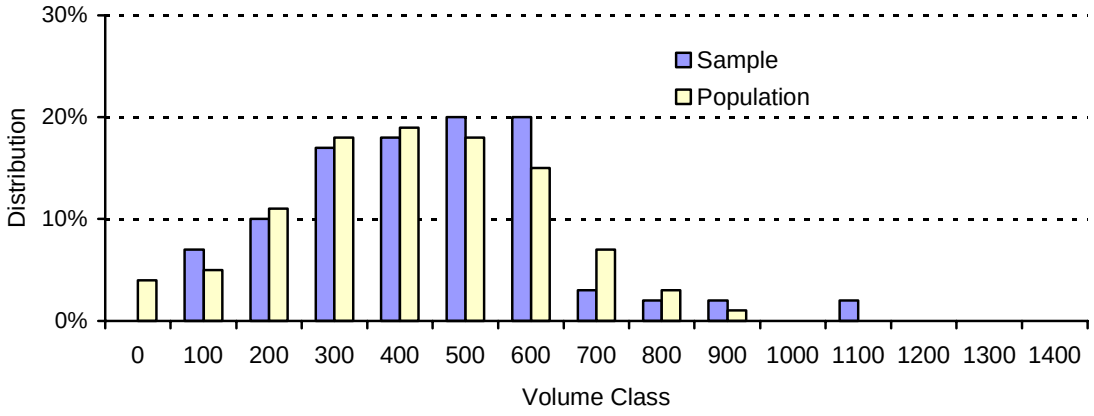

Figure 7. Comparison of sample and population volume classes for the Kingcome TSA.

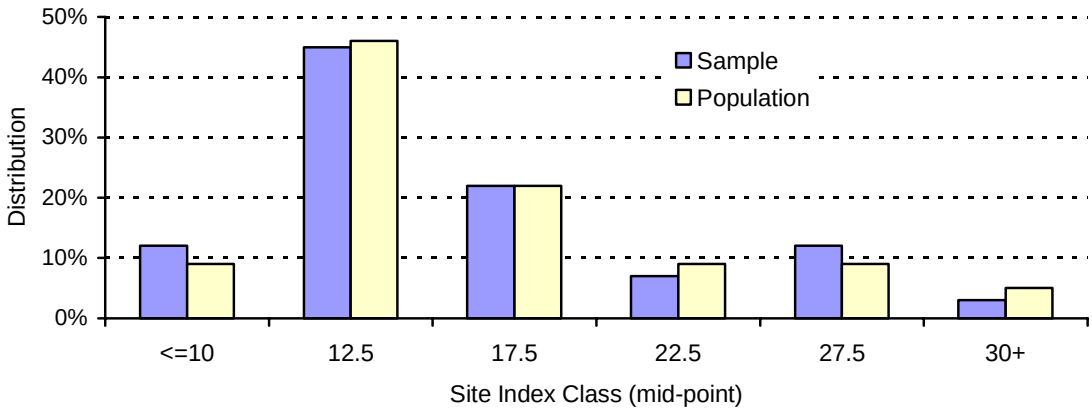

Figure 8. Comparison of sample and population site index classes for the Kingcome TSA.

APPENDIX IV – KINGCOME TSA & TFL 45 PILOT NVAF PROGRAM: PROPOSED METHODS

BACKGROUND

The Kingcome TSA spans northern Vancouver Island and BC's Mid Coast, with the majority of the area on the mainland coast. International Forest Products Ltd. (Interfor) TFL 45 is located on the Mid Coast, bordering the south and east boundary of the Kingcome TSA. Interfor is also the largest licencee in the Kingcome TSA, containing approximately half of the allowable annual cut from the TSA.[23]

In 2003, Interfor implemented the first part of a NVAF program on the TFL with the remaining portion intended for completion in 2004. The Kingcome TSA licensees are implementing a NVAF program scheduled for completion in 2004. Until recently, both NVAF programs were to be implemented separately with 60 trees destructively sampled in each Management Unit.

On a May 26, 2004 conference call[24], the TSA licensees leading the VRI initiative (Interfor, Western Forest Products Ltd., and Mill & Timber Ltd.) proposed to the MOF (Resource Analysis Branch) and MSRM (Terrestrial Information Branch) that the TSA and TFL 45 NVAF programs be combined to produce regional rather than local NVAF ratios. In a supporting memo titled, *Kingcome TSA/TFL 45 NVAF Merger Proposal,* the proposal rationale, data summaries for both MU's, and the proposed combined NVAF program were introduced to the government personnel. Following discussion, the MSRM and MOF agreed that the proposal could be implemented as a VRI pilot program.

The methods in this section of the report are intended to replace earlier commitments agreed to in the June 2003 version of the *Kingcome TSA Vegetation Resources Inventory Phase II, Project Implementation Plan, Version 2.1* and the August 2003 version of the *Tree Farm Licence 45 Net Volume Adjustment Factor Sampling Sample Plan.*

NVAF SAMPLING OBJECTIVE

The objective is to complete destructive sampling to derive NVAFs to adjust cruiser-called net volume to account for hidden decay, waste, and taper equation bias on the combined Kingcome TSA and TFL 45 MUs.

SAMPLE SIZE

The NVAF program will destructively sample 65 live and 15 dead potential C&Y according to the live tree matrix shown in Table 3. The proposed matrix contains 25 C&Y and 32 H and 8

Table 3. Kingcome TSA & TFL 45 NVAF sample allocation.

Stratum	Landbase	C & Y	H	B	*Total*
Mature	Kingcome	20	14	6	*40*
	TFL 45	4	10	1	*15*
Mature Total		*24*	*24*	*7*	*55*
Immature	Kingcome	1	4	1	*6*
	TFL 45	0	4	0	*4*
Immature Total		*1*	*8*	*1*	*10*
Total		*25*	*32*	*8*	*65*

[23] http://www.for.gov.bc.ca/ftp/hth/external/!publish/apportionment/Kingcome.pdf

[24] Participants on the conference call included Albert Nussbaum, RPF (MOF Resource Analysis Branch), Keith Tudor, RPF, Will Smith, RPF, Sam Otukol, PhD RPF (all of MSRM, Terrestrial Information Branch), Gerry Sommers, RPF (Interfor), Stan Price, RPF (consultant on behalf of Mill & Timber), and Guillaume Thérien, (analyst) and Hamish Robertson, RPF (project manager) of JST.

B to reflect the importance of both species on both MU's.[25] Forty-six (or 71%) trees are located in the Kingcome TSA; TFL 45 was given a slightly heavier weighting to increase the influence that these trees will have on the overall result. Fifty-five (55) (or 85%) of the trees are Mature and 10 trees are Immature (selected randomly)(Table 5).

The live:dead potential volume ratio on the Kingcome TSA is approximately 6:1. The licensees intend to sample 15 dead potential C&Y, all randomly selected from the Kingcome TSA.

SAMPLING PROGRAM

The NVAF sampling approach will follow MSRM procedures. In the Kingcome TSA and TFL 45 Phase II programs, Kerley & Associates Ltd. field crews completed field sampling.[26] Sample selection and analyses of both landbases will be completed by JST. The 2003 NVAF sampling on TFL 45 was completed by McColl Forestry Services (Joel McColl and Garret Stone). Given the difficult terrain, the high cost of sampling (most trees are accessed by helicopter), and their familiarity with the TFL 45 locations, it was determined that McColl and Stone should complete the combined destructive sampling program.

The NVAF sampling involves four steps:

1. Update sample packages for the combined program.
2. Complete destructive sampling of the sample trees.
3. Complete quality assurance of the sample trees.
4. Complete analysis to develop net volume adjustment factors overall and for the Kingcome TSA and TFL 45 (provided there is sufficient FIA funding).

DESTRUCTIVE SAMPLING

The destructive sampling is planned for the 2004 field season. The intent is to begin sampling as soon as Forest Investment Account (FIA) funding is secured and be completed before the fire season impacts field sampling. Trees targeted for destructive sampling will be selected from the 2003 Kingcome TSA Phase II sample and the 2003 TFL 45 NVAF sample list. All sampling will be completed to MSRM, NVAF sampling standards.[27]

Table 4. TFL 45 trees sampled in 2003 and included in 2004 sample.

Sample	Auxiliary Plot	Tree No.
14	West	6
19	East	2
19	West	5
71	South	5

The NVAF tree selection for the TFL 45 sample was slightly different from the standard procedure because an NVAF program had already been initiated in 2003 on the TFL. Sixty (60) NVAF sample trees were initially selected and 11 of the 60 trees were destructively sampled. For the 2004 NVAF project, it is more efficient to select the 19 trees (Table 3) randomly from the list of 60 trees rather than from the

[25] To gain more accurate dead Cw volume estimates in the Kingcome TSA, the VRI Phase II target population included an operability zone 2 definition for polygons older than 140 years with more volume than 250 m^3/ha were included in the population. For TSR 3, its likely that the operability zone 2 definition will be more restrictive removing some of the Cw polygons used in this project.

[26] Phase II sampling on TFL 45 was completed by Olympic Resources Management whose field operations department became Kerley & Associates Ltd.

[27] NVAF sampling standards can be found at http://srmwww.gov.bc.ca/tib/vri/vri/standards/nvaf/nvaf_2k4.pdf.

Phase II sample list. Four of the 11 trees already sampled were selected in the new 2004 NVAF sample (Table 4).

QUALITY ASSURANCE

Quality assurance will be completed by Ken Richardson, RPF of JST on approximately 10% of the NVAF sampled trees. The timing of the audit will be coordinated with the field samplers to minimize helicopter cost. Ken will produce a field report detailing the results of the audit. The audit will be submitted to the TSA licencees and Will Smith at the completion of the field sampling.

DATA ANALYSIS & REPORTING

Provided there is sufficient FIA funding for the 2004-2005 fiscal year, Guillaume Thérien of JST will complete the NVAF compilation and analysis. As per discussions with the MOF and MSRM, the analysis will be completed for the combined MU's and for each MU to provide levels of comfort for upcoming Timber Supply Reviews on both landbases. JST will provide a memo detailing the results of the overall NVAF program and for each MU.

JST will complete the statistical adjustment of the Phase I inventory provided there is sufficient FIA funding for the 2004-2005 fiscal year.

APPENDIX V – KINGCOME TSA & TFL 45 NVAF SAMPLE LIST

Table 5. NVAF tree list by plot number.

VRI ID	Sample No.	Auxiliary Plot	Tree No	Spp	Live/ Dead	DBH	Height (m)	Completed (Yes/No)[a]	Maturity
0331	2	W	1	Hw	L	14.7	14	No	Immature
0331	2	W	6	Cw	L	13.8	11	No	Immature
0331	4	N	7	BA	L	99.8	53	No	Mature
0331	6	E	1	Cw	DP	150	13.2	No	Mature
0331	10	E	4	Cw	L	43	21.4	No	Mature
0331	10	S	1	Cw	L	54	24.7	No	Mature
0331	12	E	14	Cw	L	49.9	18.5	No	Mature
0331	12	E	15	Cw	L	29	15	No	Mature
0331	13	W	3	Cw	DP	66	12.9	No	Mature
0331	15	E	5	Cw	L	84.2	28.4	No	Mature
0331	15	E	7	Cw	L	26.4	18.4	No	Mature
0331	15	E	10	Cw	DP	58.7	9.7	No	Mature
0331	16	N	1	Yc	L	14.8	11.4	No	Mature
0331	16	S	8	Yc	L	36.3	19.8	No	Mature
0331	20	N	3	Hw	L	27.3	16.7	No	Mature
0331	20	W	7	Hw	L	107.7	49.8	No	Mature
0331	20	W	10	Hw	L	66.8	36.4	No	Mature
0331	22	E	6	Cw	DP	120	15	No	Mature
0331	22	S	1	Cw	L	65	29.6	No	Mature
0331	22	S	2	Cw	DP	80	27	No	Mature
0331	22	S	4	Cw	DP	75	17.3	No	Mature
0331	23	E	10	Hw	L	48.3	23	No	Mature
0331	25	N	9	Cw	DP	44.5	18.5	No	Mature
0331	26	W	8	Yc	DP	19.9	3	No	Mature
0331	31	W	2	Hm	L	56.8	33.6	No	Mature
0331	32	S	1	Hw	L	32.7	15	No	Mature
0331	32	W	2	Cw	L	76.9	8.6	No	Mature
0331	32	W	6	Yc	L	22	12	No	Mature
0331	34	S	1	Hw	L	70.7	56	No	Immature
0331	35	N	8	Hw	L	40.2	22.9	No	Mature
0331	36	E	7	Ss	L	28.9	23.4	No	Immature
0331	38	N	5	Cw	L	162	37.7	No	Mature
0331	38	N	10	Hw	L	21.1	12.6	No	Mature
0331	38	N	12	Cw	L	117.4	40.1	No	Mature
0331	40	W	2	Yc	DP	35	25.1	No	Mature
0331	40	W	5	Yc	DP	37	24.3	No	Mature
0331	42	E	5	BA	L	13.8	5.7	No	Mature
0331	42	N	1	Hw	L	38.7	19.3	No	Mature
0331	42	N	3	Yc	L	59.9	21.5	No	Mature
0331	43	S	1	Cw	L	19.5	10.4	No	Mature
0331	43	S	9	Yc	DP	40	17	No	Mature
0331	44	N	3	Cw	DP	90	3.5	No	Immature
0331	44	W	3	Hw	L	26.2	14.9	No	Immature
0331	46	N	3	Hw	L	51.2	21	No	Immature
0331	47	E	1	Dr	L	34	23.9	No	Mature
0331	47	S	2	Hw	L	25.1	19	No	Mature
0331	47	S	3	Hw	L	41.7	27.8	No	Mature
0331	47	S	6	Dr	L	26.1	21.4	No	Mature
0331	48	W	1	Cw	L	69.4	26.5	No	Mature
0331	48	W	9	Cw	DP	95	22	No	Mature
0331	50	E	1	Yc	L	57.1	34.3	No	Mature
0331	50	E	2	Cw	DP	104.5	23	No	Mature
0331	50	W	6	Yc	DP	31.2	7	No	Mature

VRI ID	Sample No.	Auxiliary Plot	Tree No	Spp	Live/ Dead	DBH	Ht (m)	Completed (Yes/No)[a]	Maturity
0331	50	W	7	Cw	L	45	20	No	Mature
0331	50	W	8	Cw	L	51.7	28.5	No	Mature
0331	61	E	4	Hm	L	16.7	12.3	No	Mature
0331	61	E	7	Cw	L	94.3	26	No	Mature
0331	62	E	1	Hw	L	91.6	46.8	No	Mature
0331	62	E	4	Hw	L	159	53.4	No	Mature
0331	62	W	4	Ba	L	45.6	33	No	Mature
0331	62	W	6	Ba	L	69.9	41.1	No	Mature
4561	5	W	4	Hw	L	50.5	42.6	No	Immature
4561	5	W	6	Hw	L	38.6	36.6	No	Immature
4561	14	W	6	Hw	L	51.8	33.5	Yes	Immature
4561	16	S	10	Hm	L	59.1	41.4	No	Mature
4561	19	E	2	Cw	L	37.3	20.6	Yes	Mature
4561	19	E	5	Yc	L	129.5	27.6	No	Mature
4561	19	W	5	Hm	L	129.2	40.9	Yes	Mature
4561	31	N	2	Cw	L	110.1	51	No	Mature
4561	31	W	5	Ba	L	50.7	32.8	No	Mature
4561	36	E	8	Hw	L	65	31.9	No	Mature
4561	36	N	3	Hw	L	92.8	27.4	No	Mature
4561	38	E	7	Hw	L	44.1	39.1	No	Mature
4561	48	S	3	Hm	L	115.1	34.9	No	Mature
4561	63	E	4	Hw	L	52.6	24	No	Mature
4561	63	S	3	Hm	L	80.5	30.4	No	Mature
4561	71	S	5	Hw	L	28.5	23.1	Yes	Immature
4561	72	S	3	Cw	L	92.1	39.8	No	Mature
4561	72	S	4	Hw	L	30.5	17.7	No	Mature
4561	79	W	5	Hw	L	61.9	38.1	No	Mature

[a] Yes denotes that the tree was destructively sampled as part of the 2003 TFL 45 NVAF program.