Soo
Timber Supply Area

Vegetation Resources Inventory

Strategic Inventory Plan

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EXECUTIVE SUMMARY

This Vegetation Resources Inventory (VRI) Preliminary Strategic Inventory Plan (VSIP) outlines the VRI activities and products that address forest management and inventory issues in the Soo Timber Supply Area (TSA 31). The stakeholders have identified the need for an updated inventory as one of their highest priorities. The stakeholders for this project include British Columbia Timber Sales, Halray Logging Ltd, International Forest Products, Squamish Mills Ltd, Richmond Plywood Corporation Ltd, Terminal Forest Products Ltd, and the Ministry of Forests and Range.

The benefits of a new inventory are numerous. The resulting information will assist in;

- ongoing operational planning;
- provision of better estimates of the current and future timber supply; and
- helping to address numerous forest management issues within the TSA.

Examples of management issues that exist for the TSA include;

- the productivity and volumes of stands;
- classification of non forested polygons and improved species composition; and
- height and age estimation of stands below the minimal harvest age (approximately 50% of the stands)[1]

Information relating to these issues will be significantly clearer following the completion of an inventory.

The following VRI activities and products are planned:

1. Conduct a Phase I photo-interpretation over the entire Soo TSA. The Phase I database will support timber-emphasis inventories, habitat mapping, ecosystem mapping, riparian mapping, and other applications.
2. Conduct Phase 2 timber emphasis ground sampling in the Vegetated Treed area of the TSA to provide statistically valid timber volumes and polygon-specific tree attributes for the subsequent timber supply reviews. The ground sampling will include Net Volume Adjustment Factor (NVAF) sampling to check loss factors and taper equations.

[1] Soo TSA Analysis Report, Ministry of Forests, August 1999

3. Conduct more accurate polygon descriptions and timber emphasis ground sampling the Soo TSA to improve species composition descriptions and spatial data for these stands.

These VRI activities and products will support timber supply objectives and other resource specific interpretations. They may be implemented in smaller units (e.g., Management Zones) across the TSA. They may also be jointly implemented to address common management issues within the Coast Region.

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1. INTRODUCTION

1.1 Background

This Vegetation Resources Inventory (VRI) Strategic Inventory Plan (VSIP) outlines VRI activities and products needed to address forest management and inventory issues in the Soo Timber Supply Area (TSA 31). The VSIP provides details for photo interpretation in the TSA. After VSIP approval, the next steps are the preparation of project implementation plans (VPIPs) based on this VSIP, and the implementation of the VPIPs.

The Soo VRI Committee is comprised of willing participants operating within the Soo Timber Supply Area, including International Forest Products Ltd., British Columbia Timber Sales, Terminal Forest Products Ltd, Canadian Forest Products Ltd., Western Forest Products Inc, Squamish Mills, and the Ministry of Forests and Range.

The completion of numerous high profile projects (i.e. murelet, owls, OGMA's) in the Soo TSA over the past three years will undoubtedly lead to increased downward pressure on the allowable annual cut. Coupled with the dissatisfaction of the forest cover attributes for reasons outlined in this report, the Soo DFAM has identified a VRI as a top priority.

1.2 VRI Overview

The VRI is a vegetation (forest) inventory process that has been approved by the Resources Inventory Committee (RIC) to assess the quantity and quality of BC's timber and vegetation resources. The VRI estimates overall population totals and averages, as well as individual polygon attributes, for timber and non-timber resources. Its design is simple, reasonably efficient, statistically defensible, and addresses issues raised by the Forest Resources Commission in its 1991 report, The Future of Our Forests.

The VRI consists of several components (Appendix II):

1. BC Land Cover Classification Scheme (BCLCS)
2. Photo Interpreted Estimates (Phase I)
3. Ground Sampling (Phase II) – timber emphasis, ecology, coarse woody debris
4. Net Volume Adjustment Factor (NVAF) sampling
5. Within Polygon Variation (WPV) sampling

6. Statistical Adjustment

One or more of these components can address specific forest management or inventory issues. For more information, VRI manuals are available through the Internet at http://ilmbwww.gov.bc.ca/risc/pubs/teveg/index.htm.

1.3 VRI Planning

The VRI planning process requires that a Strategic Inventory Plan (VSIP) and Project Implementation Plan (VPIP) are developed for defined units (e.g. TSA, TFL). A VSIP outlines VRI products to address forest management issues and provides strategic direction for implementing the inventory activities. A VPIP details the operational activities identified in the VSIP (e.g., ground sampling or photo interpretation projects) and identifies project areas, priorities, and roles and responsibilities.

The VRI planning process is an important component of the overall VRI process and related activities (Figure 1). The intent of the VRI planning process is to ensure that baseline products meet a range of applications and they are efficiently implemented. These processes and activities include:

1. Forest management decision processes (land integration planning).
2. Identifying forest management issues.
3. VRI Strategic planning (prepare a VSIP).
4. VRI operational planning (prepare VPIPs).
5. Implementation, including development and maintenance of procedures and standards;
   a). Management inventories;
   b). Database management;
   c). Data interpretation.

The steps for preparing a VSIP include:

1. Licensee stakeholders work with MOFR staff to develop issue statements related to VRI.
2. The Soo Licensees, including all agencies and stakeholders, meet to refine issues and discuss why these issues need to be considered fundable. The purpose of this meeting is to:
   a). Introduce the VRI tools and process;
   b). Table new issues and issues recorded to date;

c). Discuss issues that can be funded under current funding mechanisms (this discussion provides general direction for developing the VSIP, and also affects the extent of photo interpretation and the number and type of VRI plots);

d). Suggest the VRI tools to address currently fundable issues as well as those issues that may be funded in the future.

3. Soo Licensees meeting minutes are prepared and circulated to all participants for review and feedback.
4. Soo Licensees prepare a final VSIP, which is signed off by committee members.
5. VPIP process begins.

The steps for preparing a VPIP include:

1. Review and update VSIP recommendations
2. Secure funding
3. Identify project activities, geographic areas, and costs
4. Specify roles and responsibilities for project implementation
5. Prepare VPIP

2. METHODOLOGY

VRI is a MoFR approved process consisting of the following components:

2.1 Phase I – Photo Interpretation

Prior to commencing the Phase I of a VRI project, a Vegetation Resource Inventory Project Implementation Plan (VPIP) for Photo Interpretation must be completed and subsequently approved by the Ministry of Forests and Range. This plan will detail photo acquisition requirements, the VRI Phase I process, standards for adherence, and a photo interpretation plan to carry out the Phase I of the VRI.

Phase I is the photo interpretation phase of a VRI and entails polygon delineation and attribute estimation by certified photo interpreters through the use of aerial photographs or softcopy images. The delineation identifies the location of the forest resources and the attribute estimation component provides estimates of numerous attributes including land cover type, crown closure, tree species, height, age, stand structure, volume, basal area, density, slope position, moisture and nutrient regime, snags, shrubs, herbs, and bryoids.

Estimation of attributes from field reference points is based upon field procedures using a combination of air and ground calibration points.

2.2 Phase II - Ground Sampling

Prior to commencing Phase II, a Vegetation Resource Inventory Project Implementation Plan (VPIP) for Ground Sampling must be completed and subsequently approved by the Ministry of Forests and Range. This plan details the Phase II sample selection process and standards for adherence.

Specifically the Phase II VPIP plan will;

- detail the Phase II project and sampling objectives;
- target and identify sample populations and sample selection and sample size details;
- include discussion of the field program;
- discuss the proposed data compilation, analysis, and statistical adjustment; and,
- include the proposed implementation schedule.

The samples (samples are "plot clusters" and consist of a main plot and up to 4 associated auxiliaries) selected for the Phase II ground samplings are based on the delineated polygons and attributes estimated during Phase I. Samples are selected randomly and are based on achieving a resultant sampling error of less than 15 percent for forest stand volume that are proportionally distributed across the different target populations.

The VPIP will also include details on a proposed NVAF program (see section 2.2.1) including sample size and sample selection.

2.2.1 Net Volume Adjustment Factor (NVAF) Sampling

As per the Ministry of Forests and Range Vegetation Resource Inventory standards, all new Ground Sampling Vegetation Resource Inventories must complete Net Volume Adjustment Factor Sampling.

This sampling involves detailed stem analysis of sample trees that have been randomly selected from the Phase II plots. The NVAF is used to correct the VRI estimates of net close tree utilization for all species and the NVAF adjusted VRI ground sample volumes are used to correct the VDYP yield table model. Additional detail is described in section 4.3.6.

2.2.2 Final Compilation, Analysis and Statistical Adjustment

Adjustment to the Phase I using the results of Phase II sampling data for the entire VRI project area is the final VRI phase. The NVAF information is utilized to adjust the Phase II sample estimates for hidden decay and taper equation bias and the Phase II plot estimates are used to adjust the Phase I photo interpretation attribute estimates. The final product is a statistically valid new inventory, supported by re-adjustment of photo-estimated attributes based on ground samples.

2.3 Funding

The Soo Licensees develops criteria for setting VRI activity priorities and products identified during the planning process. Inventory funding, or follow-up resource-specific management interpretations, is excluded from the planning process since funding mechanisms may vary. Currently, funding for VRI activities are FIA eligible.

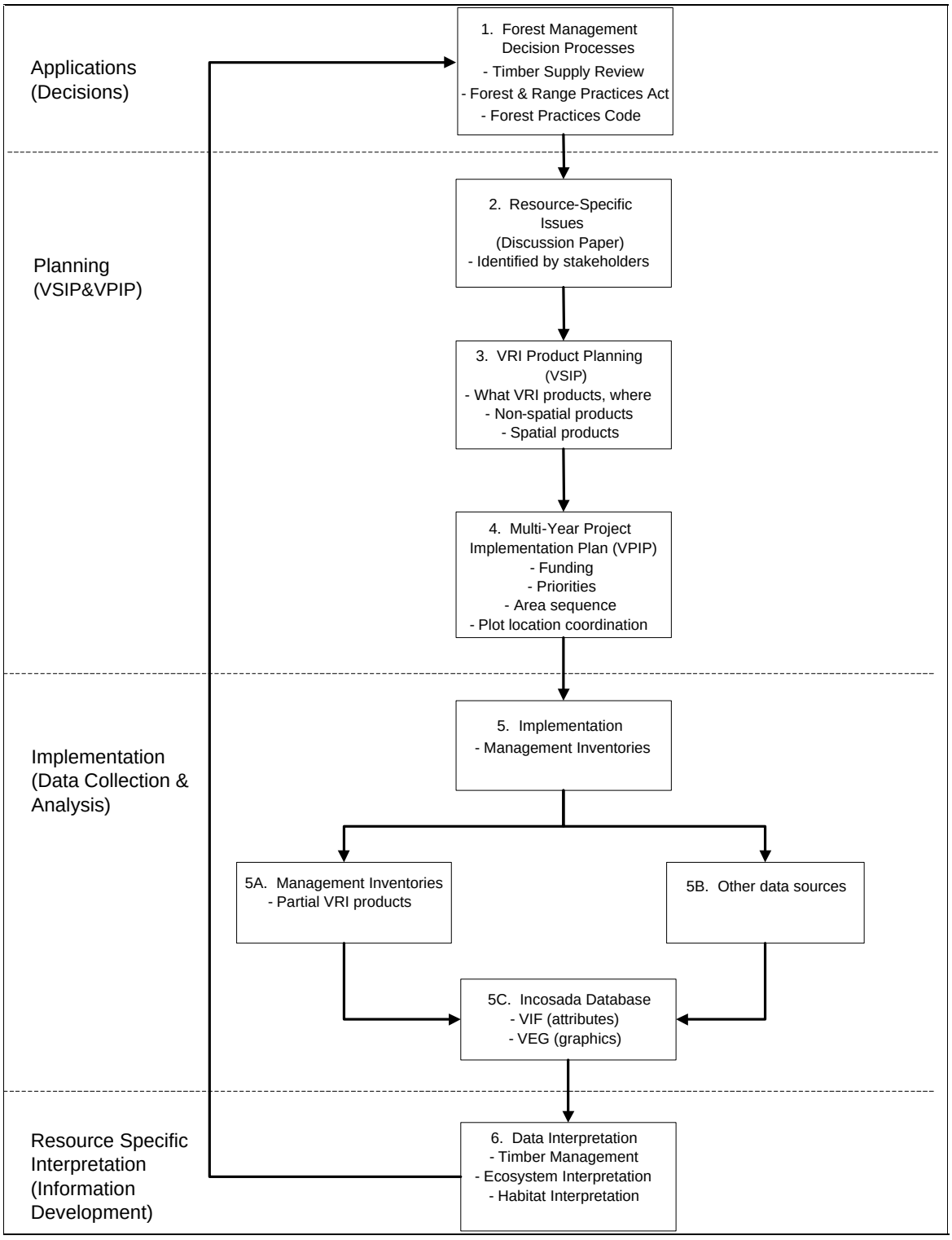

Figure 1. The VRI management inventory process.

3. BUSINESS CONSIDERATIONS

3.1 Landbase

The Soo TSA lies within the Coast Forest Region. The TSA covers approximately 826,000 hectares and is part of the Squamish Forest District, one of eight districts in the Coast Forest Region.

The TSA includes many parks, such as Porteau Cove, Shannon Falls, Murrin, Brandywine, Nairn Falls, Birkenhead Lake, Joffre Lake, Stawamus Chief, Alice Lake, Pinecone-Burke, Indian Arm and portions of Garibaldi and Golden Ears Provincial Parks. New provincial parks and protected areas created as a result of the Lower Mainland Protected Areas Strategy include the Upper Lillooet River, Callaghan Lake, Sockeye Creek (now part of Birkenhead Park), Tantalus and the Brackendale Eagle Reserve.

Of the 826 160 hectares in the TSA, 43 856 hectares are not managed directly by the MoFR, including the parks, ecological reserves, private land and various special use permit areas. An additional 483 392 hectares or approximately 59 percent are non-productive including rock, swamp, alpine areas and water bodies. Productive forest land managed by the MoFR is 298 912 hectares or approximately 36 percent of the total area. Further reductions applied to the productive forest land base result in 123 392 hectares or approximately 41 percent of the productive forest land considered to be available for timber harvesting.

The Soo TSA has a variety of terrain, ranging from the rugged coastal mountains to the valley bottoms of the Pemberton valley and the Squamish river estuary. This ecologically diverse TSA contains five biogeoclimatic zones, reflecting the significant range in climate and elevation. These zones are Coastal Western Hemlock (CWH), Mountain Hemlock (MH), Englemann Spruce Subalpine Fir (ESSF), Interior Douglas-fir (IDF), and Alpine Tundra (AT).

As identified in Table 2 - Forested Landbase By Species, the main tree species in the THLB are Douglas fir, balsam, and hemlock. In this report, we assume that the forested landbase corresponds to the Vegetated Treed (VT) landbase (BC Landcover Classification Scheme, or BCLCS).[2]

[2] Soo TSA, Rationale for Allowable Annual Cut, Ministry of Forests October 2000

Table 1. Landbase By Forest Cover

Area description	**Hectares**	**Percentage of Total TSA Area**
Total TSA Area	826 160 ha	100 %
Total Productive Forest Land	298 912	36.2 %
Reductions:		
Areas of low productivity	22 530 ha	2.7 %
Newly created parks	11 221 ha	1.4 %
Environmentally Sensitive Areas	17 117 ha	2.1 %
Deer Management Zone	4 071 ha	0.5 %
Riparian	6 326 ha	0.8 %
Problem Forest Types	3 166 ha	0.4 %
Non Commercial Cover (Brush)	685 ha	0.1 %
Inoperable Area	99 075 ha	12.0 %
Wildlife Tree Patches	2 072 ha	0.3 %
Roads, trails, landings	7 200 ha	0.9 %
No Harvest Zone	2 057 ha	0.2 %
Total deductions from the Timber Harvesting Land Base	**175 520 ha**	**21.4 %**
Timber Harvesting Land Base **(Total TSA area – Total Reductions)**	123 392 ha	14.9 %

The species profile and age distribution for the TSA is provided in Table 2.[3]

Table 2. Forested Landbase by Species

Leading species	Area (ha)	THLB%
Douglas-fir	65,000	52.5
Balsam	24,600	20.2
Hemlock	23,500	18.9
Cedar	7,400	6.2
Spruce	1,700	1.4
Deciduous*	700	0.6
Pine	250	0.2
Grand Total		100.0

*black cottonwood

[3] Soo TSA Analysis Report, Ministry of Forests (August 1999)

3.2 Forest Management Considerations

Significant forest management issues in the Soo TSA were highlighted in the last timber supply review determination (TSR 2 – Jan 1, 2002). These issues are summarized in Table 3.

Table 3: Forest Management Issues

	Issue	VRI Implication		Remarks
		Photo-Interpretation (Phase I)	Ground Sampling (Phase II)	
1	Operability criteria: re examine the distribution:	Required	Required	VRI may provide additional information to use in confirming the distribution of merchantable timber in the TSA.
2	Stand & Landscape Biodiversity:	Required	Required	Spatial data derived from the photo interpretation and ground sampling may provide additional information useful in delineating wildlife tree patches, ungulate winter ranges, seral stage and stand attributes.
3	Riparian management:	Required	Required	Spatial data from photo interpretation may provide additional information for riparian area designation.
4	Disturbance Update:	Required	Not Required	Spatial and tabular data from RESULTS and/or licensees to be incorporated into the updated VRI database.
5	Land use planning:	Required	Required	Updated forest cover data provided by the VRI could be used to in the process of identifying areas of interest specific to the land use objective at hand. VRI data is also required to complete accurate timber supply calculations for each of the Landscape Units in the TSA.
6	Visual Quality Objectives:	Required	Optional	VRI will provide updated spatial information useful in effectively assessing visual impact of timber harvesting activities.
7	Critical Wildlife Habitat (goat, grizzly,):	Required	Required	This requires better polygon estimates and delineation provided through a Phase I VRI. The MOE is completely supportive of a new inventory as they require better polygon estimates and delineation based on the VRI standards.
8	Archaeological Assessment (incorporate information into next TSR):	Required	Required	There is potential to use VRI data in modeling.
9	Productivity	Required	Required	Old growth site index bias is an acknowledged problem in the forest inventories of BC. Conclusions from various OGSI and SIBEC projects have indicated that site productivity has generally been underestimated by the inventory file data. In the Soo TSA, no local studies were completed prior to the last TSR to assess the accuracy of the site productivity estimates. As a result, no site productivity adjustments were applied in the base case of the analysis.

3.3 Current Forest Cover Inventory

The Soo TSA was inventoried in 1992. The inventory file has been updated to 1997. In 2003, the licensees initiated a project to update the inventory to VRI standards. The first step was to capture new photography. To date, approximately 70% of the TSA has been flown with 1:15,000 color aerial photos. Appendix III summarizes the current completion status to the summer of 2005 of the Soo TSA aerial photography program.

Inventory updates have not been completed since 2001 according to the Land Information BC website. The MoFR are completing an "ad hoc" update for TSR 3 using Landsat imagery, forest cover and FDPs. They use the imagery to develop the depletion polygons. They then create an age class distribution and apply it to these polygons. The regular updates still need to be completed.

The re-inventory is proposed as an upgrade of the existing inventory using the new aerial photographs and utilizing all useable historical data sources where applicable. All applicable historical data sources will be transferred to the new aerial photographs.

Prior to the last AAC determination an inventory audit was initiated an on the mature component of the inventory. The audit reviewed tree height, age and volume for mature forest stands. Audit results for the mature component of the inventory suggest that the inventory volumes, which reflected those used in the analysis, are statistically acceptable for the land base as a whole.[4] While these audited attributes from the current forest cover are important, there are recognized weaknesses with this information (see section 3.4) and it is vital the inventory is upgraded to help deal with issues facing the forest stakeholders today.

[4] AAC Rationale for Soo TSA, Ministry of Forests (October 1, 2000)

3.4 Summary of Inventory Issues

The following inventory issues were identified by stakeholders. The relevant VRI required for improvement (Phase I or Phase II/NVAF) has been noted in parenthesis.

1. All forest stands require better species composition, growth type group height, and age estimation (i.e. especially those stands that are below the minimal harvest age) (I).
2. Inaccurate individual polygon descriptions exist in deciduous types, urban areas and private lands (I).
3. Volume estimates from VDYP models need to be checked. Previous volume estimates are based on forest cover attributes, and the overall timber inventory appears to be under-estimated.[5] (I)
4. Key attributes are not considered accurate by the licensees –a function of the forest cover data collection standards not meeting the needs of the end user today (I and II/NVAF).
5. The current forest inventory file has not had an full disturbance update in several years (I).
6. Inventory needs to be brought up to VRI standards (i.e. all vegetated area outside the productive forest is not classified to VRI standard) (I and II/NVAF).
7. Improved operability line delineation is required (I and II/NVAF).
8. Silviculture history and free growing information requires significant improvement (I).
9. Non-recoverable (gross) losses from windthrow, insects, and disease needs to be quantified (I and II/NVAF).
10. Check and update species composition labels for deciduous and deciduous-coniferous mixed stands (I).
11. Confirm accuracy of loss factors and taper equations (II/NVAF).
12. Collect more detailed information to support wildlife habitat supply (I and II/NVAF).
13. Seek greater depth of knowledge to support certification (I and II/NVAF).
14. Desire an overall improved data management (I and II/NVAF).

3.5 VRI Activities and Products

The following VRI activities and products are needed to address the forest management issues identified for the Soo TSA. These recommendations are based on the issues

[5] AAC Rationale for Soo TSA, Ministry of Forests (October 1, 2000)

identified in Table 3 and Section 3.4, including the discussions at the stakeholders meeting.

1. Acquire new photography (currently being completed).
2. Work is required to collect and clean-up past silviculture information (Part of Phase I).
3. Conduct a Phase I photo-interpretation for the entire Soo TSA. The Phase I database will support timber-emphasis inventories, habitat mapping, ecosystem mapping, riparian mapping, and other applications over the TSA.
4. Conduct Phase II timber emphasis ground sampling in the vegetated-treed areas of the TSA, to provide statistically valid timber volumes and polygon-specific tree attributes. This data will support the next timber supply review (TSR) in the Soo TSA currently scheduled to begin in December 2007.
5. In concert with the ground sampling, conduct Net Volume Adjustment Factor (NVAF) sampling to check loss factors and taper equations for several tree species.

A preliminary strategic inventory plan to address the above identified products is outlined in Section 4.

4. STRATEGIC INVENTORY PLAN

4.1 Overview

This section outlines a preliminary strategic inventory plan to develop the specific VRI products as discussed in Section 3.5. The VRI products include a new spatial vegetation inventory (Phase I) over the entire Soo and a timber emphasis inventory primarily in the operable portion of the vegetated treed landbase. These products can be obtained through completion of VRI photo interpretation, ground sampling and statistical adjustment.

4.2 Photo-Interpretation (Phase I)

4.2.1 Objective

The objective of a VRI Phase I is to improve TSA polygon information – especially in areas where specific management issues occur – using photo interpretation. The VRI product is a spatial database consisting of unadjusted photo-interpreted estimates.

Ground sampling, used to check and adjust the photo-interpreted estimates, is discussed as a separate process (Section 4.3).

4.2.2 Target Area

The target area for populating the Phase I database with attributes is the entire Soo Timber Supply Area landbase, including woodlots, parks, and proposed protected areas. Small, isolated private lots may be also included but large regions of private land will be excluded. There will be no re-delineation of parks or proposed park areas.

4.2.3 Target Attributes

All attributes listed on the VRI photo interpretation attribute form will be targeted. These attributes will be interpreted to current VRI photo interpretation standards utilizing the maximum amount of information from the historical data sources to decrease the costs of field work.

4.2.4 Methods

Provincially Certified Photo Interpreters will complete the Phase I polygon delineation and attribute estimation according to the most current MoFR VRI standards. It is anticipated that the 1:15 000 color photos will assist in the identification of species composition which is a concern in the current forest inventory, and will further assist in the identification of deciduous stands, and improve classification of Non Forested Polygons.

There are five general categories of data that are estimated during the attribute estimation of polygons:

1. Ecology: Data to be collected is to include surface expression, modifying process, site situation and slope position, alpine designations, and soil nutrient regime.

2. Land Classification – Land cover component: Data to be collected is to include treed (broadleaf, coniferous, mixed) terrain identification if trees are absent including snow, water, rock, and soil moisture regime.

3. Site Index – Data to be collected is to include species, source, and site index.

4. Tree Attributes – Data to be collected is to include crown closure, tree layer, vertical complexity, species and age of leading and second species, basal area, density, and snag frequency.

5. Non-treed attributes- Data to be collected is to include: Shrub height and crown closure, herb type and percent cover, and bryoid percent cover.[6]

Air and ground field calibration will be established by the photo interpreters to gain local knowledge and improve VRI attribute estimation. Prior to any field sampling plan, a comprehensive analysis of existing inventory data sources and cruise plot information will be completed. This analysis will identify where knowledge gaps currently exist and will ensure that future Phase I VRI data collection will occur only in the most important priority types.
This approach will ensure that the limited resources allocated to the field data collection program will be effectively spent.

4.3 Timber Emphasis Inventory – Vegetated Treed Areas

4.3.1 Ground Sampling Objectives

The main objective of the ground sampling timber emphasis inventory is to:

> Install an adequate number of Phase II VRI sample clusters to statistically adjust the photo interpreted timber inventory attributes in the Vegetated Treed (VT) areas of the TSA, to achieve a sampling error between 10 and 15% (95% probability) for overall net timber volume in the VT area, and reasonably accurate individual polygon adjusted estimates.

Net timber volume is gross volume less stumps, tops, decay, waste, and breakage. Decay and waste will be estimated using VRI call grading/net factoring and NVAF sampling. Breakage will be estimated using existing loss factors.

The licensees intend to complete a Phase II VRI program once the Phase I is complete. The original design of the VRI Phase II plot was intended to provide an unbiased estimate that could be revisited over time. At this point, few VRI programs have utilized the Phase II plots as monitoring plots.[7]

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[6] TFL 18 VSIP, Canfor (March 2005)

[7] J.S. Thrower and Associates Ltd. personal communication

4.3.2 Target Population

The target population will be the vegetated treed (VT) portion of the TSA located on crown land that is also considered operable by the operability linework. The operable area within the TSA will be priorized for ground sampling as it provides cost effective VRI ground sampling and focuses sampling activities in the portion of the landbase that is particularly important to the stakeholders.

4.3.3 Sample Size

The estimated number of sample clusters that will be installed in the VT area is yet to be determined because the decision to implement a new Phase II program will need to be discussed between the licensees and MFR Forest Analysis and Inventory Branch and documented in the Phase II VPIP.

Table 4. Approximate distribution of plots.

Leading species	Area %	Number of Plots
Douglas-fir	52.5	tbd
Balsam	20.2	tbd
Hemlock	18.9	tbd
Cedar	6.2	tbd
Other**	2.2	tbd
Grand Total	100	tbd

** Pine, Spruce and deciduous

Once determined, these samples would be distributed among leading-species strata proportional to their area (Table 4).

4.3.4 Sampling Approach

VRI Timber Emphasis Plots (TEP) should be used to gather data following the current VRI Ground Sampling Manual. These TEPs could provide a sampling framework for additional sampling, such as monitoring (where a subset of the TEPs would be re-measured over time).

4.3.5 Sample Selection

Sample polygons would be selected using the MOFR probability of selection proportional to size with replacement (PPSWR). The selection process would follow the procedures outlined in the document, "Sample Selection Procedures for Ground Sampling v3.3", which was produced by the Ministry of Sustainable Resource Management, Terrestrial Information Branch, in December 2002.

4.3.6 Net Volume Adjustment Factor Sampling

As per the MSRM standards, the net volume adjustment factor (NVAF) sampling is mandatory for the inventory. 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; it will be used to statistically adjust the estimate of net merchantable volume of VRI ground samples.

The objective of the NVAF portion of the inventory is to complete destructive tree sampling and obtain local information for hidden decay, waste, and stem taper in order to statistically adjust the cruiser calls for net volume.

In the ground sampling phase of the NVAF process, ground sampling crews will provide detailed enhanced cruising (net factoring and call grading) of all the trees (live, dead, standing or fallen) within the selected auxiliaries at the same time as they are conducting regular timber emphasis sampling within the TSA. Once the enhanced data is collected then the NVAF enhanced tree data will be compiled in a tree matrix and a sample design for selected trees will be developed.

A minimum of 60 trees (50 live, 10 dead) will be selected from at least 17 VT polygons. The finalized ground-sampling plan will provide additional details on stratification of destructive sampling plots.

All NVAF planning and implementation will follow the Net Volume Adjustment Factor Sampling Standards and Procedures, MSRM, Version v4.0, March 2004.

4.3.7 Within Polygon Variation Sampling (WPV)

WPV sampling provides data to estimate the overall individual-polygon error. It is assessed as the difference between adjusted polygon value and "true" value for that polygon based on intensive sampling. Typically, 10 to 20 polygons selected from a target population are intensively cruised using a combination of 20 to 50 full measure and count plots per sample polygon. WPV sampling will not be implemented at this time.

4.3.8 Implementation

The timber inventory should be coordinated with photo-interpretation work and be implemented as follows:

Step 1- a small batch of sample clusters (e.g., 40) should be installed over the target population in the first field season (or first half of field season). Re-calculate the sample size based on new CV estimates.
Step 2- install remaining plots in the second field season (or the second half of a field season), if required.

A VPIP for ground sampling should be developed following MOF guidelines in Vegetation Resources Inventory Guidelines for Preparing a Project Implementation Plan for Ground Sampling.

4.4 Monitoring

MOFR is responsible for monitoring this VRI planning process and ensuring that the final VSIP is approved.

4.5 Timelines and Deliverables

Fiscal Year	Project Area (Landscape Units)	Photo Preparation	Polygon Delineation	Sample Design	Field Data Collection	Polygon Descriptions	Digital Map Production & Deliverables	Quality Control
2005	Budget dependant	Fall 2005	Fall 2005	Fall 2005	Fall 2005	Oct 2005-March 2006	Oct 2006-March 2006	On going
2006	Budget dependant	Spring 2006	Spring 2006	April 2006	June-Sept 2006	Oct 2006-March 2007	Oct 2006-March 2007	On going
2007	Budget dependant	Spring 2007	Spring 2007	April 2007	June – Aug 2007	Sept 2007-March 2008	Oct 2007 – March 2008	On going

4.6 Estimated VRI Costs

VRI Task	Estimated Cost*
Phase I – 1:15,000 Color Photo acquisition	$138,000
Phase I – Polygon Delineation and Attribute Estimation*	0.85 to $1.25 per hectare = $0.7 million to $1.03 million
Phase I – Air and Ground Calibration*	$100 - $150/air call $250 - $300/ground call
Phase I – Air and Ground Calibration Helicopter Cost	Dependent upon the sample plan air calls and ground call access**
TOTAL PHASE I COSTS	
Phase II –VPIP, Sample Packages, Analysis, Adjustment, and Report	$50 000.00
Phase II - Sampling	$100 000.00
Phase II – Sampling Helicopter Cost	$50 000.00
NVAF VPIP update, Compilation, Analysis and Reporting	$25, 000.00
NVAF Sampling Helicopter Costs	$25,000.00

*assumes 826, 000 hectares

**Neither VRI nor the previous reinventory standards (manuals) specify how many calibration points are required in a mgt unit to support photo interpretation. Each case is unique and depends on:

- the amount and composition of productive forest
- amount of existing, usable calibration data
- distribution of existing calibration data
- knowledge and skill of the interpreter(s) and their familiarity with the area
- lots of other considerations, including available budget.

MOF set "benchmarks" for the number of air calls and ground observations with measurements (these replaced the earlier ground calls) that would be established. These were not a Standard, but more a "Best Practise" to ensure that the interpreters had adequate data to be confident in their attribute estimates. Note, also, that this "benchmark" specified that the air and ground calls were done by the individual interpreters in the areas they were assigned, to calibrate themselves for later work with the photos. [8]

[8] Email document from Derek Challenger, MoFR, June 23, 2005

APPENDIX I – STAKEHOLDERS

Table 5. List of stakeholders in the Soo TSA.

Agencies	**Participant**
MOFR Terrestrial Information Branch	Jon Vivian
Licensees	**Participant**
BC Timber Sales	Leonard Feldes
Halray Logging Ltd.	Mike Wallace
International Forest Products Ltd.	Ian Robertson, Gerry Sommers
Richmond Plywood Corporation Ltd.	Tom Cole
Squamish Mills Ltd.	John Lowe
Terminal Forest Products Ltd.	Dave Marquis
Weyerhaeuser Company Limited	Rob Harder

APPENDIX II – GLOSSARY OF TERMS

Inventory Unit

An inventory unit is the target population from which the samples are chosen. The inventory unit could be a specific a geographic area (e.g. TFL or TSA) where a specific set of attributes is needed. The size of the inventory unit depends upon the sampling objectives.

Landcover Classification

The BC Land Cover Classification Scheme (BCLCS) was designed specifically to meet VRI requirements, 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.

Management VRI

Management VRI are specialized inventories that provide detailed information required for specific resource management, i.e., day-to-day forest management. One or more VRI sampling procedures may be used for management inventories. Management inventories may focus on specific resource types (e.g., timber, range, ecology), geographic areas (e.g., landscape unit, TFL), attribute sets (e.g., Douglas-fir leading stands, age class 4+). They may use one or more of the following tools (e.g., photo-interpretation, ground sampling, NVAF sampling).

National Forest Inventory (NFI)

The NFI provides information on Canada's resources across all provinces and allows the Federal Government a consistent framework for reporting on Canada's inventory, including reporting on the Criteria and Indicators and the Kyoto protocols. The inventory unit for the NFI is the entire country, although it is implemented province-by-province. BC's provincial CMI system will provide the data needed for the NFI as well as provincial reporting.

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 estimated net volume is obtained from net factoring and taper equations). The NVAF (and VRI net factoring) replaces the existing loss factors for inventory applications. It does not, however, replace the loss factors for revenue applications.

Photo-Interpretation

Photo-interpretation involves subjective delineation of polygons and photo estimation of attributes for all polygons in an inventory unit. Medium scale aerial photographs (1:15,000) are most often used in photo-interpretation. However, if 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 dividing 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 to improve the precision of the inventory's overall averages and totals.

Pre-Stratification

Pre-stratification divides 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 special characteristics of each stratum.

Resource-Specific Interpretations

Resource-Specific Interpretations (RSI) use the Resource Inventory Committee (RIC) standard VRI baseline data products (provincial CMI or management inventory), in combination with other data sets and analysis (outside of that required to produce VRI), to produce information to address specific-resource management issues (e.g., TSR review, important ecosystems and habitats). These interpretations include ecosystem interpretations and habitat interpretations.

Sample Size

The sample size for an inventory is the minimum number of ground samples to be established in an inventory unit to meet the target precision.

Statistical Analysis

Statistical analysis or adjustment is the process of adjusting the values of the photo-interpretation variables using ground sampling observations. Ground observations are compared to photo-estimated values to develop adjustment factors by species groups. These factors are then applied to the polygons in the photo interpretation database to produce the final adjusted database.

Sub-unit

Sub-unit describes the inventory unit within an Inventory Unit. For example, if the inventory unit is defined as the Vegetated Treed area in a TSA, then 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 Vegetated Treed area in the TSA.

Target Precision

Target precision expresses the amount of variation in key attributes (e.g., timber volume) desired in the final results. Target precision, usually expressed as the coefficient of variation (CV), is used to calculate the minimum sample size for subsequent ground sampling. The current target precision for timber volume is $\pm$10% (90% or 95% probability); stakeholders define the probability (uncertainty) level.

Vegetation Resources Inventory (VRI)

VRI is an improved vegetation inventory process for assessing 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:

- Photo-interpretation: the delineation of polygons from aerial photography and the estimation of resource attributes.
- Ground sampling: the establishment of plot clusters in selected polygons to measure timber, ecological, and/or range attributes.
- NVAF Sampling: stem analysis sampling of individual trees for net volume adjustment.

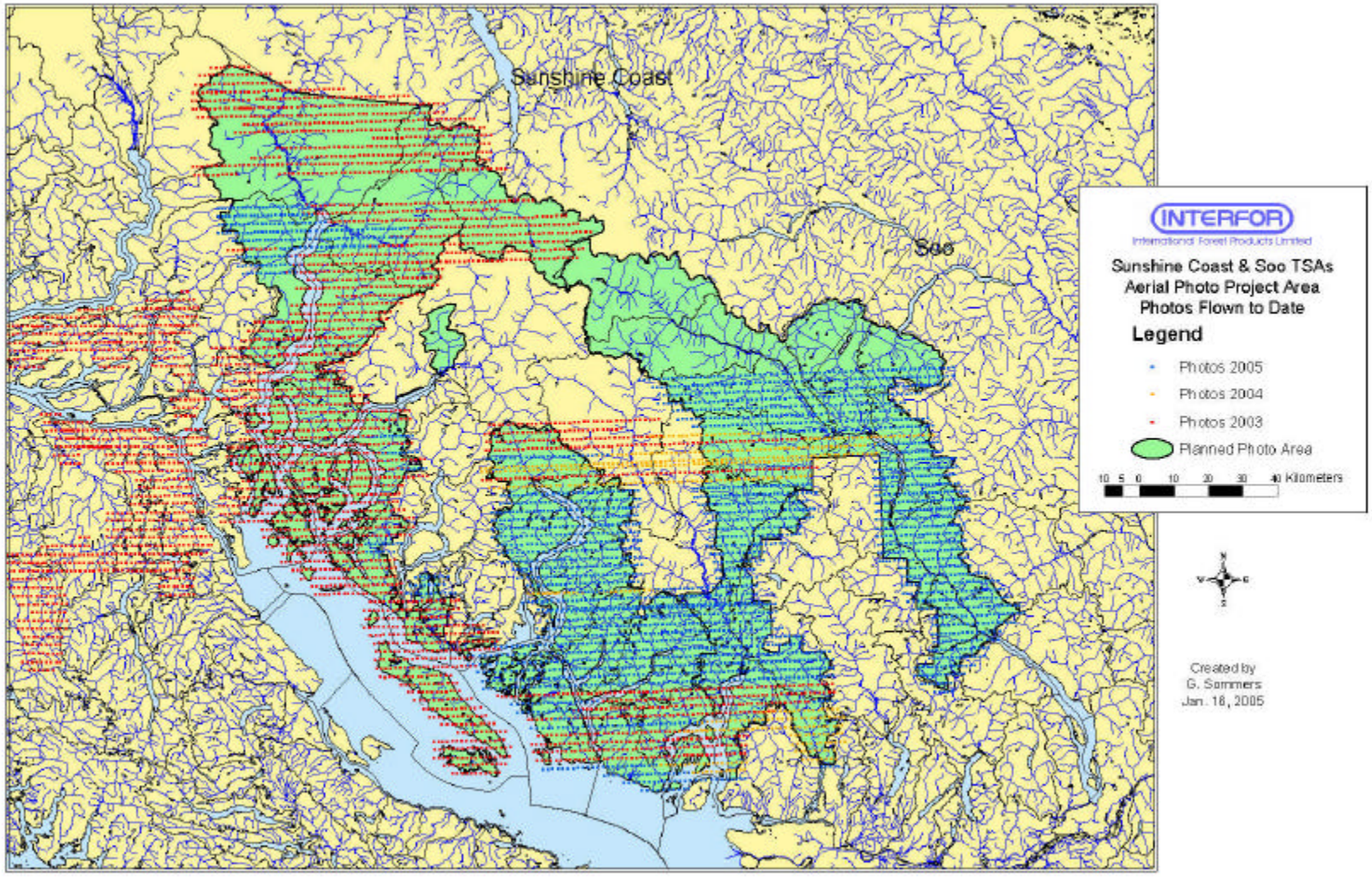
- WPV Sampling: intensive sampling of selected polygons to determine the error between the estimated attribute values and the "true" attribute values.
- Statistical Adjustment: the adjustment of the photo-interpreted estimates for all polygons in an inventory unit or management unit using the values measured during ground sampling.

The VRI can be deployed over the entire province 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.

Within Polygon Variation Sampling

WPV sampling provides information for expressing the true individual polygon error, assessed as the difference between the adjusted polygon value and the "true" value for that polygon. The "true" value for the polygon is an estimate derived from a small sample of polygons that are intensively sampled on the ground.

APPENDIX III – FLIGHT INDEX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Sunshine Coast & Soo TSAs
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Photos 2004
Photos 2003
Planned Photo Area
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Created by
G. Sommers
Jan. 18, 2005