Bulkley
Timber Supply Area

Vegetation Resources Inventory

Strategic Inventory Plan

PREPARED BY:

BULKLEY TSA STAKEHOLDERS COMMITTEE

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EXECUTIVE SUMMARY

This Vegetation Resources Inventory Strategic Inventory Plan (VSIP) outlines the Vegetation Resources Inventory (VRI) activities and products that address the forest management and inventory issues in the Bulkley Timber Supply Area (TSA). The stakeholders for this project include Pacific Inland Resources (PIR) a division of West Fraser Mills Ltd. (lead), Canfor Ltd, and the Ministry of Forests and Range

The following VRI activities and products are planned:

1. Conduct a softcopy Phase I VRI photo-interpretation (starting in late 2005), over the entire Bulkley TSA (including all parks and protected areas). The Phase I VRI will support timber-emphasis inventories, vegetation mapping, habitat mapping, riparian mapping, mountain pine beetle attacked shelf life modelling, and other applications.
2. Conduct bioterrain enhanced and operational VRI polygon delineation to address the bioterrain needs of the follow-up PEM, low site class balsam stands, lodgepole pine dominated stands with conifer understories, and younger (recent fire origin) balsam stands.
3. Integrate the VRI Phase 1 field calibration program with Predictive Ecosystem Mapping (PEM) transects to realize and maximize access efficiencies and improve the timing for the completion of a follow-up PEM project.
4. Update the TRIM II base mapping for the TSA concurrently with the Phase I VRI, including a roads and trails reclassification as required.
5. Conduct Phase II VRI timber emphasis ground sampling in the Vegetated Treed area of the Bulkley TSA to provide statistically valid timber volumes and polygon-specific tree attributes for the subsequent timber supply reviews and to address any scheduled monitoring that may be desired at a later date.
6. Conduct Net Volume Adjustment Factor (NVAF) destructive sampling on the Vegetated Treed area of the Bulkley TSA to provide statistically valid and localized decay factors for the TSA.

The approximate (estimated) number of ground sample plots and costs for the proposed VRI activities are given in Table 3 of this plan.

The above listed VRI activities and products will ultimately support timber supply objectives, a Predictive Ecosystem Mapping (PEM) project that will follow the completed VRI, and other resource specific interpretations.

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1.0 INTRODUCTION

1.1 Background

This VSIP outlines the VRI activities and products needed to address forest management and inventory issues in the Bulkley Timber Supply Area (TSA). The VSIP provides details for photo interpretation, timber emphasis ground sampling, and NVAF destructive sampling 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 Bulkley TSA Stakeholders Group (see Appendix I) is comprised of participants operating within the Bulkley TSA, including Pacific Inland Resources (PIR) – a division of West Fraser Mills Ltd. (lead), Canadian Forest Products (Canfor) Ltd., and the Ministry of Forests and Range (MoFR) represented by the Skeena-Stikine Forest District and the Northern Interior Forest Region.

1.2 Forest Cover Inventory Overview

The Bulkley TSA has undergone several inventories since the inventory of the provincial forests were first undertaken. It is the most recent forest cover inventory however that will be discussed briefly in this plan.

In 1993, in preparation for a forest cover inventory, the Prince Rupert Forest Region initiated the acquisition of 1:15,000 scale black and white aerial photographs of the Bulkley TSA. These aerial photographs were used by two inventory contractors (Forest Dimensions Inc. and Timber Tech.), between 1995 and 1997, to complete the forest cover inventory to the Ministry of Forests provincial inventory standards of the day.

The objective of the inventory audit in the Bulkley TSA was to assess the overall accuracy of the current Ministry of Forests inventory. The mature, immature, and non-forest components were tested. The following is an excerpt from the timber supply review determination report as relates to the current forest cover inventory.

> *The inventory data used for the timber supply analysis is based on a forest inventory conducted in 1995-1997 using 1993 aerial photographs. For the timber supply analysis, the inventory attributes were re-projected to 1998, but the depletions were current to winter of 1993/1994.*
>
> *An inventory audit for the Bulkley TSA was completed in 1995 but because the audit was conducted on an earlier inventory the results were not directly applicable to the new inventory. The field audit samples were re-compiled and applied against the new inventory volume estimates. At 12.5+cm diameter at breast height utilization, the audit volume was 36 cubic meters per hectare (12.2 percent) less than the inventory volume. This difference was statistically significant at the 95 percent confidence level. At 17.5+cm diameter at breast height utilization, the audit volume was 25 cubic meters per hectare (8.8 percent) less than the inventory volume. This difference was not statistically significant at the 95 percent confidence level. Since short term timber supply is affected by volume estimates of existing stands, I requested further analysis be done on the audit data. Consequently the data were re-compiled with new BEC-based taper and loss factors, a mixed utilization standard (12.5+cm diameter at breast height for predominantly pine stands, 17.5+ cm diameter at breast height for other species – the utilization standards used in the base case were*

> *12.5+cm diameter at breast height for predominantly pine stands and 15+cm diameter at breast height for all other stands), and stratification by sawlog and marginal sawlog/pulpwood. The results of this new analysis indicate that the difference between the audit and inventory volumes for the entire TSA are not different, and the two in fact are within 3 percent of each other. The volume in the sawlog component is overestimated by about 7 percent and the volume in the marginal sawlog/pulpwood component is underestimated by about 19 percent. However, neither of these differences are statistically significant at the 95 percent confidence level and I conclude that for this decision the inventory estimates for existing stand volumes are reasonable to use. Since about 60 percent of the volume harvested is in the sawlog type, I urge timely completion of the second phase of the ongoing vegetation resources inventory in the Bulkley TSA so that more accurate information can be used in future AAC determinations.*

Other comparisons between the inventory and the inventory audit results, such as species composition, age, or height accuracy, were not reported in the inventory audit report.

1.3 VRI Overview

The VRI is a two phased vegetation inventory process, approved by the Resources Information Standards Committee (RISC) 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, efficient, statistically defensible, and addresses issues raised by the Forest Resources Commission in its 1991 report, *The Future of Our Forests*, including:

1. Lack of statements of precision of the inventory.
2. Inadequate information on non-timber vegetation resources.
3. Lack of reliable estimates of growth rates and stand specific volumes.
4. Narrow focus on commercial timber volume and the timber harvesting land base.

The VRI consists of several components (see Appendix III for definitions):

1. Derived 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://srmwww.gov.bc.ca/risc/pubs/teveg/index.htm.

1.4 VRI Planning

The VRI planning process requires that a VSIP and VRI Project Implementation Plan (VPIP) are developed for defined units (e.g. TSA, TFL). A VSIP outlines the VRI products that will address local forest management issues and needs, and provides the strategic direction for implementing the inventory activities such that these needs will be met. A VPIP details the operational activities identified in the VSIP (e.g. Phase I VRI photo interpretation project, Phase II VRI ground sampling) and identifies project areas, priorities, plot location, yearly inventory costs, and roles and responsibilities. Guidelines for preparing the VSIP and VPIP are available on the Internet at http://srmwww.gov.bc.ca/tib/fia/vri.htm.

The VRI planning process is an important component of the overall VRI process and related activities (Figure 1 and Appendix III). 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 (preparation of a VSIP).
4. VRI operational planning (preparation of VPIP).
5. Implementation, including development and maintenance of procedures and standards;
    a). Management inventories;
    b). Database management; and
    c). Data interpretation.

The steps for preparing a VSIP include:

1. Licencee stakeholders work with MoFR staff to develop issue statements related to VRI.
2. The Bulkley TSA Stakeholder Group meets 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 or not (under current funding mechanisms); this discussion provides general direction for developing the VSIP. This discussion also affects the extent of photo interpretation, and the number and type of VRI plots; and
    d). Suggest the VRI tools to address currently fundable issues as well as those issues that may be funded in the future.
3. The Bulkley TSA Stakeholder Group is sent a list of broad issues for discussion at the stakeholders meeting or for solicitation of written input for review and feedback.
4. The Bulkley TSA Stakeholder Group prepares a preliminary VSIP, which is reviewed and discussed.
5. The Bulkley TSA Stakeholder Group prepares a final VSIP, which incorporates items agreed to in Step 4 and is signed off by the licencee committee members and the MoFR.
6. The 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 the VPIP.

1.5 Funding

The Bulkley TSA Stakeholder Group will develop criteria for setting VRI activity priorities and products identified during the planning process. Currently, funding for VRI activities are FIA eligible. Availability of Forests for Tomorrow and Federal mountain pine beetle funding has yet to be determined with respect to VRI and any mountain pine beetle issues that may arise in the future.

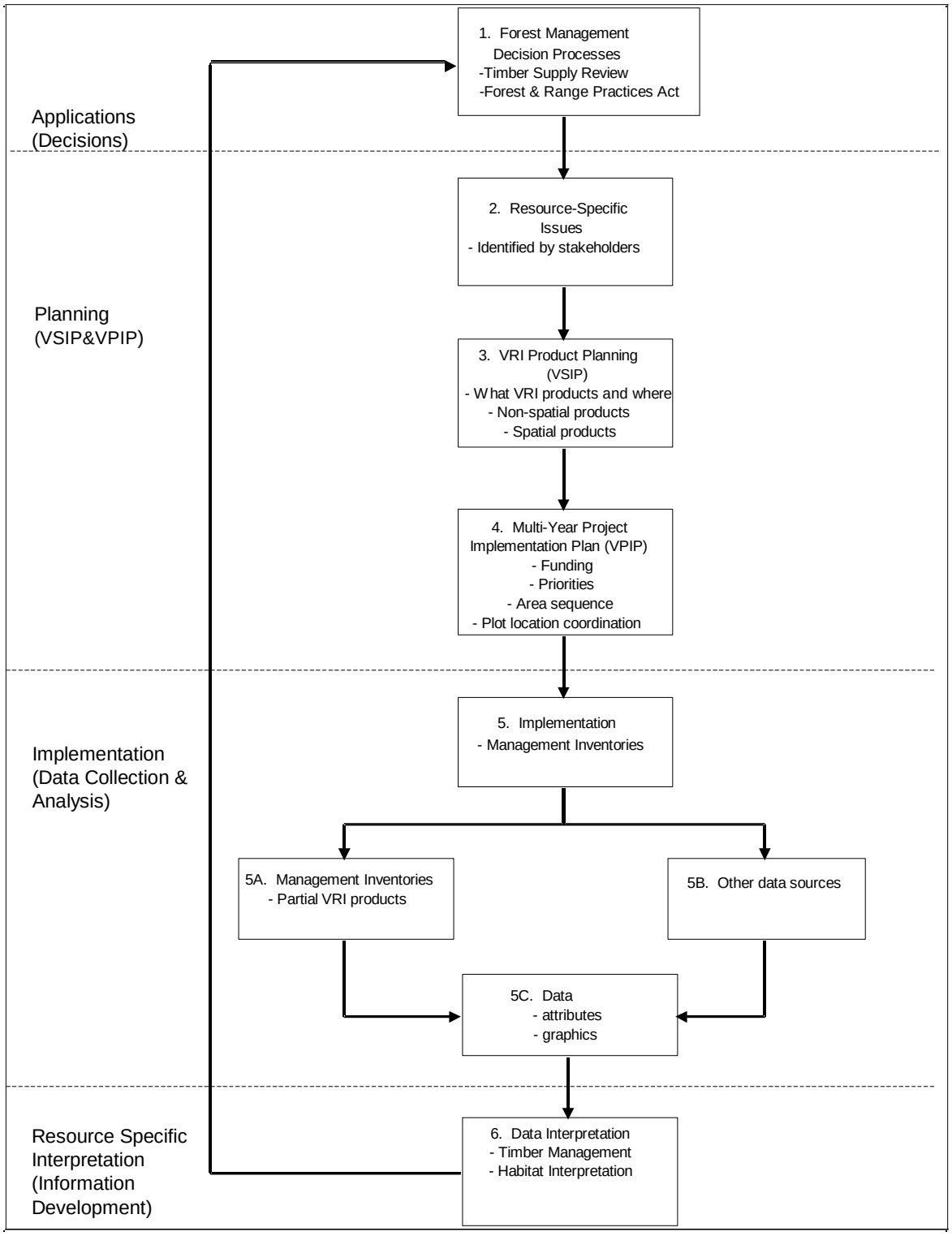

Figure 1 The VRI Management Inventory Process

2.0 BUSINESS CONSIDERATIONS

2.1 Land Base

The Bulkley TSA covers approximately 762,540 ha. (see Table 1 for a further breakdown of the land base). The main tree species in the forested land base are broken down by area as follows: sub-alpine fir (48%), lodgepole pine (25%), spruce (23%), hemlock (4%), aspen, birch, and cottonwood, forming minor components. In this 'plan', the assumption is made that the forested land base corresponds to the Vegetated Treed (VT) land base according to the BC Land Cover Classification Scheme, or BCLCS.

Table 1 Bulkley TSA Area Summary *

Landbase Classification	Area (ha)	Percent (%)
Total TSA area	**762, 540**	**100**
Not managed by the BCFS	95,232	12.5
Non-forest and non-productive	171,386	22.5
Total forested area managed by the BCFS	**495,922**	**65**
Reductions to Crown Forest		
-Non-commercial cover	6,312	0.8
-Inoperable	348	0.0
-Terrain stability in Copper LU	1,698	0.2
-Riparian areas	10,932	1.4
-Helicopter areas	7,388	1.0
-Cable areas	31,320	4.1
-Low productivity sites	44,551	5.8
-Problem forest types	19,020	2.5
-Existing road, trails, and landings	8,340	1.1
-Recreation areas	696	0.1
-Environmentally sensitive areas	7,836	1.0
-Newly created parks	9,499	1.2
-Special management zone 1	8,108	1.1
Total current reductions	**156,048**	**20.5**
Current timber harvesting land base (THLB)	**339,874**	**44.6**
Future reductions		
-Future roads	15,763	2.2
-Agricultural land reserves	4,841	0.6
Future timber harvesting land base	**319,270**	**41.9**

*Source: TSR II Analysis Report

2.2 Forest Management Considerations

No significant forest management issues in the Bulkley TSA were highlighted in the last timber supply review determination (TSR 2 Rationale for AAC determination update, January 1, 2002). The issues that were brought forward by the Bulkley TSA stakeholder group are summarized in Table 2 below.

Emerging data needs were considered to be relevant to the Bulkley TSA and could be addressed with a completed VRI.

1. A more 'operational' level Phase I VRI to address the issues around the partition, specifically refined delineation and more accurate, structure, species composition, age, height, and derived volume estimates to better define those stands that actually fall within the marginal sawlog and pulplog criteria as defined by the Harvest Method Mapping (HMM) parameters.
2. Refined delineation and calibration information collection in problem forest and low productivity types.
3. Forest health issues. Improve stand mapping and identification of lodgepole pine in the TSA in support of mountain pine beetle and pine needle blight hazard mapping and salvage opportunities.
4. VRI of the parks due to their contributions to TSA seral stage balances, habitat representation, and old growth management. A financial contribution from the Ministry of Environment, Parks Branch, to cover off a portion of the inventory costs has been discussed and agreed to in principle.
5. Growth and yield linkages. If designed properly from the outset, a VRI (phase I and II) can provide valuable attributes and sample data that can be used to enhance follow-up growth and yield programs.
6. A predictive ecosystem mapping (PEM) project is planned for once the bioterrain delineation based VRI is completed to spatially refine both productivity SI 50 and habitat supply.
7. Market certification requirements can be met through the VRI Phase II by providing a statistically defensible inventory that is subsequently used in timber supply analysis.
8. Localized decay factors (NVAF).

Table 2 Forest Management Issues for the Bulkley TSA Related to the Inventory

Issue	Remarks
1. Inventory attributes in polygons defined by the HMM as contributing to the partition (marginal sawlog and pulplog)	More accurate Phase I attributes will provide refined delineation and stand attribute information to better define marginal value and volume types.
2. Site productivity: determine extent of species conversion upon regeneration.	Measurements from Phase II plots can be used to check existing site index estimates. However, the data will not address the issue of stand productivity, nor will they correct deficient site curves. What the VRI will provide is an improved foundation for a PEM, a product that is better suited to address site productivity.
3. Site productivity: review low productivity stands including 30-80 year old western hemlock and sub-alpine fir regenerated fires.	Application of the Inventory.
4. Not Satisfactorily Restocked (NSR) areas:	Application of the Inventory.

Issue	Remarks
assess and quantify into the THLB.	
5. Problem Forest Types (PFT): assess and quantify the size of the PFT in the Bulkley TSA.	Application of the Inventory.
6. Roads, trails, & landings: review and refine deduction (base mapping updates) factors.	Application of the Inventory.
7. Regeneration, species conversion: assess and quantify extent of species conversion.	Application of the Inventory.
8. Decay, waste, and breakage factors for balsam, pine, and spruce types may be underestimated. Complete factor review is required.	Phase II / NVAF data will provide information on decay and waste.
9. Improved wildlife habitat information.	Refined delineation standards of VRI (and bioterrain consideration) in addition to more precise VRI Phase I attributes will provide additional stand attribute information for wildlife habitat and protected areas.
10. Need for a TSR acceptable PEM	The integrated (bioterrain based delineation) VRI will provide a more solid foundation for the follow up PEM project.

2.3 Summary of Inventory Issues

The following inventory issues (summarized) were identified by the stakeholders:

- All forest stands require better species composition and age/height estimation.
- Enhanced delineation (bioterrain based) of the VRI as well as training of VRI interpreters by PEM experts to ensure the desired accuracy of key PEM attributes (interpretation as well as integrated field calibration data collection)
- The current forest inventory for the Bulkley TSA is complete for disturbance updates to 2003.
- The inventory needs to be brought up to VRI standards and be more operational in detail than the current strategic level forest cover inventory.
- Better quantify non-recoverable (gross) losses from insects, disease, and wind-throw.
- Undertake VRI within provincial parks and protected areas, as they contribute to seral stage balancing, old growth management, and habitat and rare ecosystem representation.
- More accurate species composition and age attribute determination (first and second species attributes) for mixed species stands.
- Confirm accuracy of loss factors and taper equations.
- Obtain and maintain a full vegetation inventory to satisfy certification requirements.
- Maintain inventory data in a consistent and accessible format.
- More accurate age determination in sub-alpine fir stands.
- Assess inventory for evident age gap in the 30 to 80 year old range.
- Address the partition through improved and refined delineation and species composition, age, and height determination (field calibration) in those stands currently defined as marginal sawlog and pulpwood by the forest cover inventory.

Inventory audit results aside, the general belief of the Bulkley TSA Stakeholder Group is that the forest

cover inventory while not dated, does not meet their current and future needs as well as not being suitable as a strong foundation inventory for a PEM. Specifically, the stakeholders require the following from a replacement inventory (VRI):

1. A new inventory using the currently available 2003 1:35,000 scale colour aerial photographs (scanned) of the majority of the Bulkley TSA including all parks and protected areas and additional 2001 1:35,000 colour reconnaissance quality aerial photographs from the Morice TSA as well as other 'suitable' aerial photographs where these others don't exist (see Figure 2).
2. Inclusion of all parks and protected areas in the inventory area as these areas contribute to seral stage balances and old growth management. Currently the status of the existing inventory information available for parks in the Bulkley TSA is unknown.
3. Accommodating other resource values identified through a vegetation inventory (not just a timber inventory as currently exists).
4. More accurate species identification through increased field calibration.
5. Ecological attribute interpretation provided by the VRI to better support a PEM.
6. Improved stand structure identification, especially conifer understories, with a focus on where forest pest susceptible overstory species exist.
7. Through bioterrain based delineation and the concurrent collection of PEM suitable ecological data (PEM transects or equivalent), provide a more suitable PEM foundation inventory to achieve the requisite PEM accuracy for inclusion in TSR. While the proposed collection of PEM transects during the VRI Phase 1 will not provide for all of the PEM field data collection required, it will provide for a significant portion of the field data requirements, thereby accelerating the completion of a follow-up PEM project. The collection of PEM transects will be FIA funding dependant.

2.4 VRI Activities and Products

The following VRI activities and products are needed to address the forest management issues identified for the Bulkley TSA. These recommendations are based on the issues identified in Table 2 and Section 2.3, including the discussions at the stakeholders meeting.

1. Collect and update historical silviculture data, including correct positioning of external opening boundaries in softcopy.
2. Conduct a bioterrain based Phase I photo-interpretation for the entire Bulkley TSA. The Phase I database will support timber-emphasis inventories, habitat mapping, riparian mapping, and other applications over the TSA (including a follow-up PEM project).
3. Conduct Phase II timber emphasis ground sampling in the vegetated-treed areas of the Bulkley TSA, (excluding parks) to provide a statistically adjusted Phase I Inventory. The data will support the next timber supply review (TSR) in the Bulkley TSA in 2009.
4. In concert with the ground sampling, conduct Net Volume Adjustment Factor (NVAF) sampling to statistically adjust the volume attribute for hidden decay and taper equation bias.
5. Monitoring activities around mountain pine beetle issues such as the establishment of random sample locations to evaluate regeneration success and track future stand dynamics.

3.0 STRATEGIC INVENTORY PLAN

3.1 Overview

This section outlines a preliminary strategic inventory plan to develop the specific VRI products discussed in Section 2.4. The VRI products include 2003 scanned 1:35,000 colour aerial photographs (DiAP viewer set) over most of the Bulkley TSA in support of a new spatial vegetation inventory (Phase I

VRI) over the entire Bulkley TSA (acquired). In addition, conduct a timber emphasis sampling (VRI Phase II) program in the operable vegetated treed land base. These products can be obtained through completion of VRI photo interpretation and field calibration data collection, ground sampling, and statistical adjustment.

3.2 Photo-Interpretation (Phase 1)

3.2.1 Objective

The objective is to produce a VRI of the Bulkley TSA that will provide more accurate polygon information using a bioterrain based and more intensively field calibrated photo interpretation - especially in areas where specific management issues occur. The Phase I VRI product is a spatial database consisting of unadjusted photo-interpreted estimates based on field calibration data. Ground sampling, used to check and adjust the photo-interpreted estimates, is discussed as a separate process in Section 3.3.

3.2.2 Target Area

The entire Bulkley TSA should be updated to VRI standards through new photo interpretation (including all private land, woodlots, parks, and protected areas).

3.2.3 Target Attributes

All attributes listed on the VRI photo interpretation attribute form will be targeted. These attributes will be interpreted to the most current VRI photo interpretation standards. As the list of attributes is too extensive to list in this plan, for a complete listing of VRI attributes refer to the *Vegetation Resources Inventory Photo Interpretation Procedures* manual (version 2.4 March, 2002).

3.2.4 Methods

The Phase I inventory will be completed according to the most current MoFR (formerly MSRM) standards using softcopy technology. While 1:15,000 to 1:20,000 scale colour aerial photographs are the preferred scale and emulsion to use for VRI with softcopy technology, the scale of available viewer sets for the TSA is 1:35,000, which are at the upper limit of what is considered suitable. The aerial photographs for most of the Bulkley TSA were acquired in 2003 with the intention of supporting multiple uses, including the creation of high-resolution orthophotos of the TSA as part of a TRIM II project. As the images are already prepared as viewer sets on hard drives there are no costs associated with this. A portion of the Bulkley TSA not covered by the 2003 1:35,000 colour aerial photographs is covered by colour 1:35,000 aerial photographs acquired by Canfor in 2001 for the adjoining Morice TSA. While BMGS staff have indicated that a portion of the Morice aerial photos are not suitable (by BMGS standards) for orthophoto production or TRIM 2, they are suitable for 'reconnaissance' purposes and should provide the requisite coverage along the east edge of the Bulkley TSA as required. **(See addendum section 5.0)**

The coverage of aerial photographs (approximately) is summarized as follows:

Photo Coverage for 2001 (Canfor)	- 93,495.5 ha (12.3% of TSA)
Photo Coverage for 2003	- 663,053.0 ha (86.9% of TSA)
Color Imagery (not scanned)	- 5,991.5 ha (0.8% of TSA)
Bulkley TSA	**762,540 ha**

Figure 2 indicates the aerial photo coverage as currently exists for the Bulkley TSA.

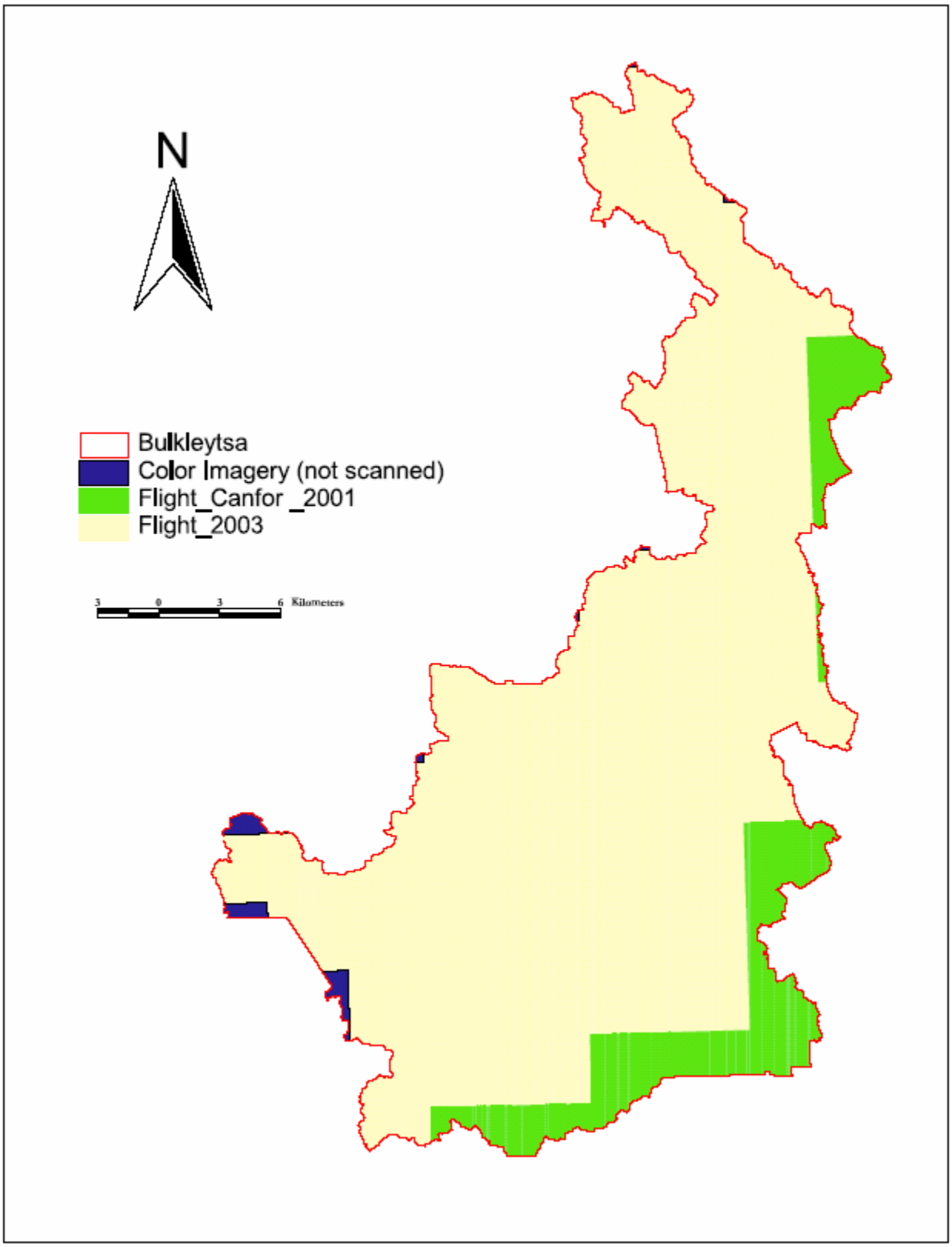

Figure 2 Existing Aerial Photo Coverage for the Bulkley TSA

As per current standards, air and ground field calibration will be established by the photo interpreters to gain local knowledge and improve VRI attribute estimation. Field calibration will predominantly target stands not calibrated in the previous inventory (not to their exclusion however) and in particular, those stands where the age and height information requires more focus.

The 1:35,000 colour aerial photographs will enhance identification of species composition and forest health issues both in the mature forest (mountain pine beetle, balsam and spruce bark beetles, and spruce budworm) and in the managed stands (pine needle blight).

3.2.5 Costs

Aerial photographs have already been acquired and are ready to be used for all but the approximately 12 map sheets along the eastern edge of the Bulkley TSA as mentioned previously. The alternative should the 2001 1:35,000 aerial photographs be wholly unsuitable, would be to acquire new aerial photos for those map sheets during the 2006 aerial photo acquisition season. If this is optioned, then arrangements for a contract to acquire these aerial photographs in 2006 should be investigated immediately to ensure a timely placement on the aerial photo contract list for 2006. Every indication points to the Morice TSA 1:35,000 aerial photos falling within the Bulkley TSA as being suitable for use in a VRI **(see addendum section 5.0)**.

The Phase I VRI costs will be more accurately determined once the exact parameters of the inventory are finalized, but based on an average recent TSA inventory (historical costs) with standard field visitation, an approximate cost of between $0.90 and $1.10/ha. can be expected. This does not include the acquisition of additional aerial photographs. If desired field visitation is increased (for a more operational Phase I inventory), this cost per hectare estimate would increase. How the VRI Phase I is to be completed requires further discussion and will be addressed with more detail in the VPIP.

A contracted third party quality assurance auditor may be required if the MoFR does not resume this responsibility. The approximate cost to quality assurance audit the delineation, field calibration, and attribute estimation major work phases is presented in Table 3.

3.3 Enhanced Timber Emphasis Sampling – Vegetated Treed (VT) Land Base

3.3.1 Ground Sampling Objectives

The main objective of the timber emphasis sampling is to:

Install an adequate number of Phase II VRI sample clusters (enhanced timber emphasis including the collection of site series information) to statistically adjust the photo interpreted timber inventory attributes in the operable Vegetated Treed (VT) areas of the Bulkley TSA, the operability line being defined by Trowbridge's ESSFu (upper forested) subzone. Enough samples need to be installed to achieve a sampling error of between 10 and 15% (95% probability) for overall net timber volume in the operable 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 Phase II ground samples are used to statistically adjust age, height, and volume attributes in the Phase I Inventory. The NVAF destructive sampling statistically adjusts for hidden decay and taper equation bias.

3.3.2 Target Population

The target population will be the operable vegetated treed (VT) portion of the TSA located on crown land managed by the BCFS (i.e. excluding parks and protected areas).

3.3.3 Sample Size

The Bulkley TSA, having both a coastal and interior influence, is a bit of a special case when it comes to designing a sample plan.

It has been suggested to split the land base first by splitting the Coast/Interior using the BEC. Not many (if any) transition TSA's have been sampled and adjusted, but the numbers are usually different when comparing coastal adjustments with interior ones. Using the three broad-level productivity zones, defined by the following grouping of BEC sub-zones in the TSA, would provide a reasonable split by species at the same time:

- ICH and CWH
- SBSdk and SBSmc
- ESSF

The second split would be by age. For each of the BEC sub-zones groups identified above, the following age breaks would be considered:

- Stands less than 30 years would **not** be sampled (TASS/TIPSY yield curves will be used).
- Stands in the 31-80 year old range (immature)
- Stands in the 81-120 year old range (mature)
- Stands in the 121+ year old range (old)

This breakdown provides nine strata. The recommendation is to **initially** install **approximately** 60 plots with equal probability across the target population. Any individual strata within the matrix that by area is too small would be combined with its most closely associated strata (BEC zone or age range). On completion of sampling, a preliminary analysis will be conducted and based on the results of this analysis to determine if more samples are required based on refined sampling objectives. The most substantial reason for this approach is the unknown effect that the coastal / interior complex will add to the adjustment. After the ~60 plots are installed and compiled there will be a clearer picture available.

In the end, it is estimated that as many as 80 sample clusters could be installed in the operable VT area. These samples would be distributed between the BEC zones and age ranges indicated above. The actual number of samples and their configuration will be determined with more precision in the VRI Phase 2 sampling plan.

3.3.4 Sampling Approach

VRI Timber Emphasis Plots (TEP) should be used to gather data following the current VRI Ground Sampling Manual, or be modified as such to address the statistical adjustment of the photo interpreted inventory as well as both short and long term monitoring of regeneration and stand dynamics. 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).

There are increased efficiencies to be gained through the enhancement of trees for the NVAF program at the time of the initial sample establishment (during ground sampling), rather than at the time of the NVAF destructive sampling. This should be considered by the stakeholders and be incorporated into the VPIP and Phase II / NVAF Sample Plan. Phase 2 certified timber samplers will provide detailed enhanced cruising (net factoring and call grading) of all trees in the auxiliary plot during ground sampling.

3.3.5 Sample Selection

Sample polygons would be selected using the MoFR 'probability of selection proportional to size with replacement (PPSWR)' procedure. The selection process would follow the procedures outlined in the document, *Sample Selection Procedures for Ground Sampling v3.3*, December 2002, and the related document *Errata 1.0*, April 2005, or a more current version if one is made available when sample selection begins.

3.3.6 Net Volume Adjustment Factor Sampling

As per the MoFR standards, the net volume adjustment factor (NVAF) sampling is mandatory for the inventory. However, the sampling procedures allow for some flexibility around the timing of NVAF call grading and net factoring. 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 initial estimates of net volume.

A minimum of 60 trees (50 live, 10 dead) are usually selected from at least 16 VT auxiliary plots. The finalized ground-sampling plan will provide additional details on stratification of destructive sampling plots. However, there are known concerns over sub-alpine fir taper and loss factors particularly in terms of live trees differing by BEC zonation (elevation and coast vs. interior locations) and for dead trees due to the balsam bark beetle infestation. The recommendation has been made by MoFR Branch staff to increase the sample size, specifically for sub-alpine fir, such that at least 20 trees are sampled per sub-alpine fir stratum.

Another issue is the Interior log grade as this is an issue within the interior of BC (and specifically within the Bulkley TSA) around the proportion of sawlog vs. pulp. It has been suggested that ground sampling could employ interior log grading standards and the sample trees be graded during the NVAF destructive sampling process to better address this relationship. This initiative should aid Revenue Branch in their assessment of interior call grading and Net Volume Adjustment Factoring, in the BC interior.

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

3.3.7 Implementation

The implementation process will proceed based on available funding and can be implemented based on a number of scenarios. All implementation scenarios will follow a common process. One possible implementation process will proceed as follows:

1. Assemble all polygons within the Bulkley TSA into one list; check to ensure no areas are missing or double counted.
2. Sort the polygon list according to the criteria: BC Land Cover Classification code, location within the operable land base (THLB), estimated leading tree species, age, and site index.
3. Select potential sampling points from the sorted list (see Section 3.3.5).
4. Systematically select the 16 NVAF sample points (15 treed and 1 non-treed whether or not volume is indicated) from the Phase 2 inventory ground samples.
5. Begin planning for field sampling.
6. Prepare a field sampling plan. Identify NVAF sample points and ensure they are field sampled early in the field season (late Spring 2007 or as snow melt and Spring thaw permits access).
7. Locate and measure ground sample clusters.
8. Monitor quality assurance of field data and procedures during field sampling. Arrange for independent 'audit quality cruisers' to sample auxiliary plots of NVAF samples.
9. Compile the data including computing averages of timber volume, basal area, and regression of photo-estimated volume to ground sample volume and the associated standard error of the regression.
10. Prepare NVAF tree sampling matrix. Begin NVAF destructive sampling.
11. Compile all data, do the statistical adjustments, and load final inventory results into the provincial database.

A VPIP for ground sampling (and NVAF destructive sampling) will be developed following MoFR guidelines in *Vegetation Resources Inventory Guidelines for Preparing a Project Implementation Plan for Ground Sampling*.

3.4 Costs

Costs associated with VRI Phase II include the VRI Phase II Sample Plan (~$8,000) and Phase II plot compilation and adjustment (~$10,000). Actual sampling costs are driven by plot access (truck vs. helicopter), but a reasonable estimate without knowing the plot distribution across the Bulkley TSA would suggest between $1400 and $1800 per plot plus approximately $6,000 for VRI sample quality assurance auditing (an independent contract).

Costs for NVAF sampling have traditionally run approximately $400 to $500 per tree, with a complete contract for 60 trees costing approximately $27,000. The stakeholders group can expect to pay approximately $500 a tree for the NVAF quality assurance third party audit (x 6 trees) or approximately $3000.

Table 3 provides a summary of the costs for all VRI project components.

Table 3 VRI Project Components Cost Summary

VRI Project Component	Unit Cost (est.)	Total (est.)
VRI Phase 1	$0.90 - $1.10 / ha.	$762,500
VRI Phase 1 QA Audit (Third Party)	~$0.03 / ha.	$23,000
VRI Phase 2 Sample Plan	~$8,000	$8,000
VRI Phase 2 *	$1400 - $1800 / sample	$108,500

VRI Project Component	Unit Cost (est.)	Total (est.)
VRI Phase 2 QA Audit (Third Party)	$1000 / sample	$6,000
VRI Phase 2 Compilation & Adjustment	~$10,000	$10,000
NVAF	$450 / tree	$27,000
NVAF QA Audit (Third Party)	$500 / tree	$3000
All VRI Projects	**-**	**$948,000**

* First 60 samples, exclusive of helicopter costs

3.5 Monitoring

The Ministry of Forests and Range are responsible for monitoring this VRI planning process and ensuring that the final VSIP and respective VPIPs are approved.

4.0 APPROVAL/SIGNING

I have read and concur with the Bulkley TSA VSIP dated November 21, 2005. 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. Modifications to this plan or more detailed plans need to be reviewed and approved by the signatories and then appended to this plan.

_____ per Pacific Inland Resources Inc.

_____ per Canadian Forest Products Ltd.

_____ per Skeena-Stikine Forest District (MoFR)

_____ per Northern Interior Forest Region (MoFR)

5.0 ADDENDUM TO SECTION 3.2.4 (06/01/17)

5.1 Background

In preparation for a TRIM II update project and this new inventory, 1:35 000 scale colour photographs were acquired in 2003 in consultation with BMGS and developed into DiAP *viewer* sets suitable for a softcopy inventory format. All but 12 map sheets within the Bulkley TSA were covered by these photographs. The remaining 12 map sheets were covered by 2001 1:35,000 aerial photographs from the Morice-Lakes IFPA orthophotograph project, which while deemed not suitable for TRIM II by BMGS, were deemed suitable for 'reconnaissance' work.

The scale of these aerial photographs was subsequently assessed by the MoFR in late 2005 (after sign-off of this VSIP) for their utility for this project and were deemed not suitable for conducting a softcopy based VRI based on pre-established regional image scale standards. Figure 2 details the 2001 and 2003 digital image coverage in the Bulkley TSA.

5.2 Addendum Approval/Signing

Due to the non-suitability of this existing imagery, there is a planned acquisition of 1:20,000 scale colour aerial photographs for the entire Bulkley TSA in the summer of 2006 to facilitate the forthcoming VRI.

To ensure that the approved Bulkley TSA VSIP and subsequent VPIP documents agree with each other, this addendum and sign-off has been added.

In accordance with the wording of section 4.0 of this VSIP document, I have read and concur with the Bulkley TSA VSIP addendum dated January 17, 2006.

per Pacific Inland Resources Inc.

per Canadian Forest Products Ltd.

per Skeena-Stikine Forest District (MoFR)

per Northern Interior Forest Region (MoFR)

APPENDICES

APPENDIX I – STAKEHOLDERS

List of Stakeholders in the Bulkley TSA.

Licencees	Participant
Pacific Inland Resources Inc.	Gary Quanstrom
Canadian Forest Products Ltd.	Carl Vandermark

Agencies	Participant
MoFR – Northern Interior Forest Region	Dick Nakatsu
MoFR - Skeena-Stikine Forest District	Barry Smith

APPENDIX II – GLOSSARY OF TERMS

Ground Sampling: Ground sampling is the field measurement of timber, ecology, range, and/or coarse woody debris values at one or more locations within each sample polygon. Sample polygons are selected using the probability proportional to size with replacement (PPSWR) method. To accommodate a wide variety of resources, various types and sizes of sampling units (e.g., fixed and variable plots, transects) are used to make the measurements.

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.

Land Cover 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 land cover (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).

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 –1:20,000) 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 units 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; and
- **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 – BULKLEY TSA MAP SHEET AREA SUMMARY

Map Sheet	Gross Area (ha)	Park / Eco-Reserve / Non-Crown Ownership Area (ha)	Non-Forest Area (ha)	Non-THLB Area (ha)	THLB Area (ha)
093L042	5,882		4,359	1,365	158
093L043	6,004		4,092	1,712	200
093L044	7,581		1,547	2,923	3,110
093L045	1,737		1,719	18	
093L051	4		4		
093L052	9,412		4,603	2,897	1,912
093L053	14,406		5,189	5,188	4,030
093L054	14,406		1,808	6,079	6,519
093L055	12,986		3,276	3,018	6,692
093L056	9,148	1,844	898	1,074	5,332
093L057	7,089	842	947	2,478	2,822
093L061	1,767	11	1,713	42	1
093L062	14,335	3	8,394	4,007	1,932
093L063	14,352		2,712	4,647	6,992
093L064	14,169	223	933	3,448	9,564
093L065	14,201	4,607	1,630	2,461	5,504
093L066	14,108	9,897	640	1,022	2,549
093L067	9,312	1,059	596	2,540	5,118
093L071	8,906	9	2,002	4,243	2,652
093L072	14,336	151	3,700	4,433	6,051
093L073	14,336	97	4,940	3,556	5,743
093L074	14,336	1,905	2,349	1,938	8,144
093L075	14,336	11,263	754	943	1,376
093L076	14,336	4,602	835	3,575	5,324
093L077	4,717		586	1,676	2,454
093L081	10,424		3,041	3,028	4,356
093L082	11,027		1,289	2,354	7,384
093L083	14,301	130	2,903	5,155	6,113
093L084	14,301	3,970	5,048	2,995	2,288
093L085	14,301	10,524	1,187	1,363	1,227
093L086	14,301	11,031	132	1,651	1,486
093L087	13,204	2,072	1,185	2,051	7,897
093L088	920		164		756
093L091	176		125	52	
093L092	3,106		451	440	2,216
093L093	14,266	1,191	1,969	3,338	7,768
093L094	14,266	5,485	703	4,199	3,878
093L095	14,266	3,250	388	1,960	8,667
093L096	14,266	12,177	9	299	1,780
093L097	8,766	1,221	1,439	320	5,786
093M002	160		121	39	

Map Sheet	Gross Area (ha)	Park / Eco-Reserve / Non-Crown Ownership Area (ha)	Non-Forest Area (ha)	Non-THLB Area (ha)	THLB Area (ha)
093M003	12,357		5,286	4,000	3,071
093M004	14,230	2,606	837	3,238	7,549
093M005	14,231		2,745	5,182	6,304
093M006	14,231	1,740	1,469	1,788	9,234
093M007	11,715		1,736	931	9,049
093M008	4,413	125	444	722	3,122
093M013	4,045	54	2,016	1,231	744
093M014	4,278	2	1,532	976	1,768
093M015	14,195		4,234	2,000	7,961
093M016	14,195		1,299	1,513	11,383
093M017	14,195	556	1,338	1,889	10,412
093M018	1,070	330	74	321	347
093M024	61		61		
093M025	10,754	324	1,935	3,932	4,563
093M026	13,460		5,630	4,009	3,822
093M027	13,578	18	978	3,322	9,261
093M028	346	0		214	132
093M035	106		32	41	33
093M036	6,563		2,320	1,836	2,406
093M037	13,666	913	1,120	1,840	9,792
093M038	2,018		406	240	1,372
093M045	475		90	224	160
093M046	12,962		1,457	2,881	8,624
093M047	14,089	1,550	1,452	570	10,518
093M048	5,107		1,698	978	2,432
093M055	2,191		183	293	1,715
093M056	12,462	1,435	698	2,036	8,293
093M057	14,054	2,232	1,129	1,307	9,387
093M058	12,270		2,877	4,141	5,252
093M059	136		111	25	
093M066	6,038	794	597	999	3,648
093M067	13,529		2,361	2,795	8,372
093M068	4,768		2,453	1,357	957
093M075	1,572		704	330	538
093M076	10,749		1,904	2,841	6,004
093M077	5,071		1,796	1,086	2,189
093M085	10,080		5,747	2,934	1,399
093M086	10,140		2,555	3,563	4,022
093M087	111		76	35	
093M095	7,076		4,344	2,732	
093M096	5,716		1,590	4,125	
094D005	61		5	56	

Map Sheet	Gross Area (ha)	Park / Eco-Reserve / Non-Crown Ownership Area (ha)	Non-Forest Area (ha)	Non-THLB Area (ha)	THLB Area (ha)
103I080	1,529	15	797	597	120
103I090	8,105		2,490	3,270	2,345
103I100	1,826		879	629	317
Total	**762,076**	**100,258**	**153,867**	**173,554**	**334,396**