

**Tree Farm License 47,
Bonanza Lake & Johnstone
Strait Management Units**

Vegetation Resources Inventory

**Photo Interpretation
Project Implementation Plan**

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**ON BEHALF OF:
TFL FOREST LTD**

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1 INTRODUCTION

1.1 Background Information

Tree Farm License (TFL) 47 is held by TFL Forest Ltd. (TimberWest). TFL 47 is comprised of three management units (MU's); Bonanza Lake, Johnstone Strait, and Moresby Island. Although all three MU's are officially held in the name of TimberWest, the Moresby Island MU is effectively under the control of Teal Cedar Products Ltd. by way of a management agreement between the two companies.

The BC Ministry of Forest issued a Rationale for Annual Allowable Cut Determination (AAC) for TFL 47 (BC MoF, August 1, 2003). In their determination of the AAC, the Ministry "strongly suggests that the licensee considers carrying out a re-inventory of the Johnstone Strait and Moresby Island MU's" primarily due to a concern that the base inventory information is over 30 years old.

In response to the Ministry's concern, TimberWest is planning to undertake a Vegetation Resources Inventory (VRI) for the Bonanza Lake and Johnstone Strait MU's of TFL 47 using softcopy technology.

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:

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://www.for.gov.bc.ca/hts/vri/standards/index.html> .

1.3 Document Objectives

The objective of this VPIP is to outline and describe the VRI Phase I activities scheduled for completion in the Bonanza Lake and Johnstone Straits Management Units. It provides some basic land base information and some background information from the previous Annual Allowable Cut (AAC) Rationale document (August 2003). This document describes the individual phases of the inventory plan including polygon delineation, field calibration, final attributing, digital mapping, deliverables and sign-off. The VPIP also describes the quality control and assurance requirements that will ensure all work is done to provincial VRI mapping standards. The VPIP provides a project implementation plan that describes scheduling, air photo type and scale, project personnel, estimated costs and quality assurance.

In addition to the information provided in this VPIP, other higher level plans and related planning documents have been prepared and are indicated as links under the appropriate headings. Please refer to the documents for the additional information.

1.4 Landbase

The Bonanza Lake and Johnstone Strait MU's of TFL 47 cover 139,867 ha of land (Table 1.1) as of the last timber supply analysis. The main tree species in the forested landbase (based on stand leading species) are hemlock (62%), Douglas-fir (24%), cedar (7%), and alder (6%). In this report, we assume that the forested landbase corresponds to the Vegetated Treed (VT) landbase (BC Landcover Classification Scheme, or BCLCS).

Table 1.1 - Landbase by Forest Cover.¹

	Bonanza Lake MU (ha)	Johnstone Strait MU (ha)	Total Area (ha)	%
Forested	32,252	93,365	125,617	90%
Mature	15,200	50,000	65,200	47%
Immature	17,052	43,365	60,417	43%
NSR	270	500	770	1%
Non commercial	3	2	5	0%
Non productive	5,495	7,980	13,475	10%
<i>Grand Total</i>	38,020	101,847	139,867	100%

Note: The split between mature and immature is approximate and not the same as splitting out old growth.

1.5 Inventory Documentation and Archive

The status of forest cover inventory on the TFL, the most basic and important input to timber supply analysis, is summarized in Table 2 below.

¹ Data from Management Plan No 3 Timber Supply Analysis Information Package.

Table 2 Inventory status

Unit and Grouping	Approximate Area (ha)	Vintage	Notes
Johnstone Strait			
Immature and younger mature	85,000 ha	1970 inventory of entire unit, approx. 102,000 ha	Stands below 250 years of age were classified, and older stands were classified and sampled for volume. Sampling was random. Site index was based on the age/height relationship of dominants and co-dominants. Data was stored in ten-year age classes and six site classes.
Old growth	10,000 ha	1983 re-inventory	The 1983 re-inventory was targeted at old growth. In 1996 a forest inventory audit found no statistical difference in overall volume estimates.
Deciduous	7,000 ha	1994 re-inventory	Deciduous stands targeted.
Bonanza Lake			
Immature	24,000 ha	1970 inventory of entire unit, approx. 38,000 ha	The 1970 inventory was of the full area but a 1980 inventory audit raised questions with respect to the mature portion.
Mature	14,000 ha	1989 re-inventory	The 1989 re-inventory was targeted at old growth. Air photos from 1988 were stratified and classified using extensive volume sampling. 1999 forest inventory audit found no statistical difference in overall volume estimates.

1.5.1 Johnstone Strait Management Unit

Based on discussions with TimberWest staff, the following can be said of the forest inventory of the Johnstone Strait Management Unit. It is old. The second growth inventory is the oldest, and this is the major portion of the unit. It has been handed down from company owner to company owner four times and endured conversions and transformations. Age in the old growth is unreliable and the source of age in the second growth is unknown. Old growth heights are stratum averages. Second growth heights are model predictions based on average site index of the site class.

1.5.2 Bonanza Lake Management Unit Inventory

This section provides a chronology of activity on the Bonanza management unit, associated with the 1989 re-inventory.

- Inventory to address old growth.
- New 1988 1:15,000 scale colour photos for the entire area were pre-stratified.
- In 1989 the entire area was retyped on mylars from 1:70,000 black and white TRIM photographs (date of photos unknown), including classification by species and net volume codes (four classes). Transfer to the 1:10,000 scale mylars was accomplished using a Stereo-Metrograph and a random map sheet grid. The result was a three to five fold increase in number of polygons over the 1988 photos.
- 1989 field work (cruise plots established on strips) was internally check cruised but no MoF checking was done.
- Cruise strips and plots were plotted on the mylars and cruised stands classified by species and net volume code. With no stereo photos, or photos with typing matching the mylar, the cruisers "used judgment" at typing and classification changes. These edits represented 40% of the inventory.
- In 1990 the type lines were digitized by matching planimetric detail on the mylars to TREE² base maps.
- In 1990 the 1989 cruise plots in mature stands were assigned to one of 45 strata by species and net volume code, and a total net volume compiled. The site index for each stratum was calculated using a weighted average of sample trees.

In 1994 it was decided to migrate the inventory to B.C. Ministry of Forests standards.

- In 1995 the process began again with the 1988 photos.
- All available cruise plots were plotted onto the 1988 photos (1970 inventory plots, 1977 growth and yield plots, 1978-1983 Crown Forest plots, 1989 mature and immature plots).
- All stands were classified by species in percent, gross volume, age as date of establishment (stands over 250 years = 1690, immature based on measurement), height in metres, site index (mature based on age = 250, immature conversion to base metric base 50 from imperial base 100 classes I to V), crown closure by percent, and basal area. Cruise plot data was used, stands not cruised were interpreted.
- In 1996 a pseudo-transfer technique used to transfer the lines from the 1:15,000 photos to 1:10,000 1987 orthophotos (NAD 83 but not TRIM based). UTM coordinates of the TREE base maps were identified on the orthophotos using planimetric detail.
- Polygon linework on the typed orthophotos was digitized using the TREE UTM coordinates as control. Linework, sample plots, and strip numbers were captured into TREE base maps. Polygons were matched to cruise plots.
- In 1996 the TREE base maps were shifted to TRIM.
- Although the full unit had been typed on the 1988 photos, it was decided in 1996 that the 1970 inventory of immature stands was at a resolution more appropriate to timber supply and 24,000 ha of this inventory was merged with the 14,000 ha

² Basemaps created using preliminary TRIM triangulation in NAD'83.

of mature stands inventoried on the 1988 photos. This was what was placed on the TRIM base.

- Updates for 1988 to 1996 were undertaken based on division operational maps. These could be checked with new orthophotos based on 1:50,000 1995 photography.

1.6 Inventory Audit

The Ministry of Forests undertook an inventory audit of each management unit (Johnstone Strait in 1996 and Bonanza in 1999). The results suggested that volume prediction is acceptable, but that assessment was of overall volume prediction and may disguise volume prediction at any sub-strata (such as by species or site grouping) level. Indeed, on the Johnstone Strait unit the inventory appeared to underestimate volume, and on the Bonanza unit it was the opposite situation. In neither case however was the difference found to be statistically significant. Further analysis of this would involve investigation using the inventory audit data. Also adding uncertainty to this study is the methodology used to compile the inventory volumes used in the comparison of inventory values to ground based estimates. Inventory estimates were based on analysis unit volumes prepared for timber supply from strata based volume over age curves.

In the 2003 AAC rationale document, the B.C. Chief Forester strongly suggested and requested that TimberWest consider carrying out a re-inventory for the Johnstone Strait Management Unit prior to the next timber supply analysis.

In preparation for the new inventory on the Johnstone Strait and Bonanza Lake MU's, 1:15 000 color photos are scheduled to be flown (weather pending) in 2006. The inventory will be completed using digital softcopy photogrammetric technology.

2 PHOTO INTERPRETATION PLAN

2.1 Project Objectives

The objective of this VRI inventory is to improve the polygon delineation and attributing in the TFL. 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 in a separate document.

2.2 Target Area

All TFL lands outside of the Class 'A' parks identified in the Johnstone Strait MU will be updated to VRI standards through new photo interpretation (including woodlots and TL areas). Some small non-TFL areas found within larger TFL parcels will be mapped for completeness. The target area is shown below in Figure 2.0

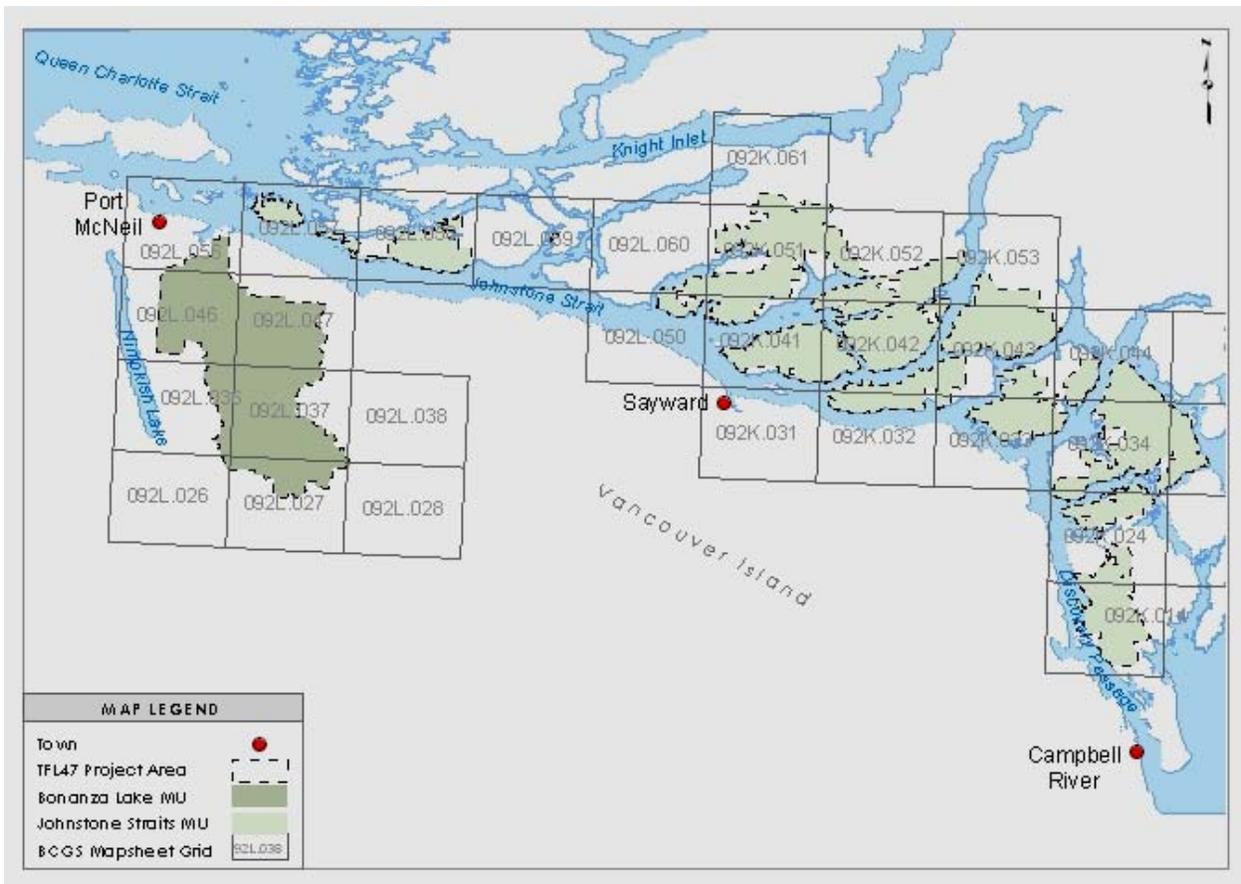


Figure 1.0 TFL 47 Target Area

2.3 Polygon Delineation

Provincially Certified Photo Interpreters will complete VRI Phase I polygon delineation (which will be based on the BC Land Cover Classification Scheme) according to the most current MoFR VRI standards.

For silviculture openings, external boundaries will be delineated as per new photos for vegetation. Internal boundaries will be maintained for all non free-to-grow stands. Silviculture opening numbers will be maintained. Silviculture information provided by the licensee will be used.

The Licensee will provide a list of free growing polygons and these areas will be re-delineated with the free growing information utilized as reference material for polygon descriptions.

All delineation will be quality control checked and audited to ensure adherence to project objectives and MoFR Standards.

2.4 Calibration Data Sources

Calibration data sources are field data reference points established across the land base such as ground calls, air calls, ground observations, ground samples and cruise plots. Field data measurements or estimates at these points are used to assist in the delineation and interpretation of forest vegetation and terrain types.

No calibration data from previous inventory work is available for the Johnstone Straits MU. For the Bonanza Lake MU, cruise plot data is available from the 1989 re-inventory work. The data includes original field cards (hardcopy only), digital copy (.E00 file) of a plot location map, and typed 1:15,000 air photos. A total of 4265 plots were established during the 1989 re-inventory; 3548 were in old growth, 705 in second growth and 12 in non-productive areas. Plots were both full measure and count plots at an approximate ratio of 1:1.

The benchmark for the number of calibration points, both ground calls/observations and air calls, required to support VRI photo interpretation has been set by MOFR at a minimum of 20 and 30, respectively, per full map sheet equivalent, made up of existing and new points. This will be met or exceeded depending on funding availability. As noted above, there are no existing calibration data available for the Johnstone Strait

MU, so it is expected that the larger proportion of new calibration points will be established in this unit.

2.5 Field Calibration

It is the intention for classifiers to complete the delineation, fieldwork and final attributing of the mapsheets assigned to them. In the TFL, calibration fieldwork will be completed in the form of ground calls, ground observations and air calls in priority areas such as:

- second growth types
- stands having complex species composition
- deciduous-coniferous mixes
- stands not previously sampled
- polygons larger than 20 ha in size
- multi-layered or uneven aged stands
- a cross-section of stand stages of development
- all significant terrain types
- some vegetated treed and non-treed wetland types

Ground and air calls will be established according to VRI fieldwork procedures and standards and delivered in both hardcopy and a digital format.

For more information on VRI air call and ground call procedures refer to:

- Ground Call (Ground Calibration) Data Collection Procedures and Standards (version 3.0, March 2004).
- Air Call (Air Calibration) Data Collection Procedures and Standards (version 2.0, March 2003).

2.6 Attribute Estimation

All attribute estimation will be to MoFR VRI standards and it is expected that the same interpreters will complete all phases of work for a particular set of mapsheets. Initial delineation will be re-assessed during the final classification phase to ensure consistency and that VRI standards are met. All VRI attribute files will be validated through VEGCAPS and delivered in a format consistent with Ministry standards.

2.7 Digital Map Procedures

All VRI mapping will be done to provincial mapping standards and specifications. The graphics file will be checked for the integrity of the file structure to guarantee that no corrupt elements or missing pointers internally are present. A check on the parameters entered in each layer or theme will be done. This will confirm that the data meets the criteria defined in the Ministry standards and specifications. A log report will indicate the type of errors found on each level.

Completed VRI digital graphic files will be submitted in standard digital format and all digitizing must be done to TRIM digitizing standards.

In order to produce the Vegetation Information File (VIF), the overlay themes must have closed shapes and unique nodes before information is combined to produce a resultant file.

The Ministry of Forests is in the process of creating a revised format for the submission and storage of spatial and attribute data for the VRI program. The new format and database standards will be available by April 3, 2006. VRI photo interpretation projects initiated after March 31, 2006 are to be completed to the new standard.

All final products relevant to the work completed in a fiscal work will be delivered to the MoFR at the end of that year.

2.8 Deliverables

Deliverables will include the following:

- Digital map and attribute data in VRIMS format (copy to TW and MoFR)
- All new document photos (to TW)
- Data sources used (to TW)
- Archival data and photos provided by MOFR (to MoFR)
- 3rd party QA reports (copy to TW and MoFR)

2.9 Photo Scale

The photo scale and type used for the project will be 1:15,000 color, scanned at 10 microns so that interpretation can be completed using softcopy techniques.

3 PROJECT IMPLEMENTATION

3.1 Scheduling

We propose to complete the Phase 1 of the VRI of TFL 47 (Bonanza Lake and Johnstone Strait MU's) over a two to three-year period (pending funding). Activities for the first year will include:

- Air Photo Acquisition;
- Air Photo Scanning; and
- Preparation of pre-set models.
- Polygon delineation (using traditional or softcopy techniques);
- Analysis of data sources (Gap Analysis); and,
- Sample Plan design

Activities for the second year and third year are expected to include:

- Field Data Collection;
- Polygon Descriptions;
- Final Digital Mapping; and,
- Final Deliverables

Table 3.1 provides a summary of delivery schedule, by phase.

Table 3.1 - Summary of Estimated Delivery Schedule by Phase for TFL 47

Fiscal Year	Photos flown and Scanned	Viewer Set Preps.	Polygon Delineation	Sample Design	Field Data Collection	Polygon Descriptions	Final Digital Mapping and Deliverables	Quality Control
06/07	ASAP	ASAP	Aug 31	Dec 31	n/a	n/a	n/a	Continuous
07/08	complete	complete	complete	complete	June 30	Sept 30	Nov. 30	Continuous

3.2 Cost Estimate

Estimated costs for Phase I VRI tasks are presented below in Table 3.2.

Table 3.2 – Cost Estimate by Phase for TFL 47

VRI Task	Estimated Cost
Phase I – 1:15,000 Color Photo acquisition/scanning/AT*	\$0.73 per hectare = \$102,000
Phase I – Polygon Delineation and Attribute Estimation, including calibration calls**	\$1.25 per hectare = \$175,000
Estimated PHASE I COSTS	\$1.98 per hectare = \$277,000

*Air photo/scanning/AT work has been tendered; estimated costs are based on low bid received.

**Based in part on cost per hectare for Phase I VRI in TFL 46 (completed in 2005).

3.3 Project Coordination

Doug Reeve, RFT (Project Administrator)

TimberWest Forest Investment Account Coordinator

The project coordinator will at a minimum;

1. Coordinate the project, including tendering of the VRI work to Qualified Contractors and arranging for 3rd party QA;
2. Monitor and communicate project progress;
3. Liaise with the contracted project manager to ensure all expectations are met.

3.3.1 Certified Photo Interpreters

At least 50% of the photo interpreters must be VRI certified and all non-certified individuals must have successfully completed the Basic VRI Photo Interpretation Course. Non-certified interpreters must work directly under the supervision of a certified interpreter for training and quality control. All supervising certified interpreters are responsible for the quality of work completed under their certification.

3.4 Quality Control and Quality Assurance

A certified photo interpreter having at least 5 years of coastal photo interpretation experience in BC will conduct quality control on 2-5% of each phase of the project. Documentation of all quality control checks will be maintained and made available to the Project Coordinator.

As part of the quality control program, the VRI contractor will hold a field data collection workshop in the project area at the commencement of the fieldwork program. The purpose of the workshop is to make sure that all individuals involved in the field

data collection, monitoring and/or evaluation have a common understanding of the standards, specifications, and procedures that will be employed in the TFL. It will also ensure that all vegetation attributes are collected in a consistent and accurate manner.

Attending will be:

- Project Manager and Project Supervisors
- VRI interpreters
- Contracted resources

Invited to attend will include:

- Project Coordinator
- Quality Assurance Contractor
- MoFR Representative

At the beginning of the fieldwork, the project VRI Supervisor will accompany each interpreter in the field for a day and check their work as the plots are being established. Any errors or discrepancies will be corrected on site until the work meets the required standards of the supervisor.

The Project Supervisor will accompany the interpreters on their first flight plan to ensure that air call estimates are complete and correct. All subsequent air calls will be flown with two certified photo interpreters, in the helicopter, so that the second interpreter can check all estimates. The Project Supervisor will also ensure that the photo interpreters establish the air calls and a majority of the ground calls on their assigned mapsheets.

An independent contractor will be retained to conduct an independent and comprehensive quality assurance program. This contractor will ensure the VRI contractor produces a consistent and reliable product. The third party Quality Assurance Contractor will have a minimum of 5 years' VRI delineation, fieldwork and final attributing experience in Coastal BC and will check all phases of the VRI s follows:

- Delineation – approximately 2% check of polygons for 80% of mapsheets
- Fieldwork – approximately 7.5% check of ground calls and air calls representative of the project area
- Final Attributing – approximately 2% check of polygons for 80% of mapsheets

The project coordinator will ensure the contractor(s) conducting the inventory provides adequate and ongoing internal quality assurance (QA) of all deliverables. The results of all quality control and quality assurance will be recorded on approved QA/QC forms. Copies of all third-party QA reports will be submitted to MoFR as each batch of work is completed.

For more information, please refer to the following:

- Quality Assurance Procedures for Photo Interpretation (version 2.0, March 2004)

3.5 REFERENCE MATERIAL

Each member of the inventory team will have the following reference material available for the duration of the project:

- TFL 47 VRI Strategic Inventory Plan (2006)
- TFL 47 VRI Project Implementation Plan (2006)
- VRI BC Land Cover Classification Scheme (2002)
- VRI Photo Interpretation Procedures (2002)
- VRI Quality Assurance Procedures for Photo Interpretation (2004)
- VRI Photo Interpretation Standards (1998)
- VRI Ground Call Data Collection Procedures and Standards (2004)
- Air Call Data Collection Procedures and Standards (2003)
- MSRM Vector Cleaning Specifications (1997)
- MOF Forest Inventory Manual
- MOF Biodiversity Guidebook
- MOF Color Stereogram, Handbook
- MOF Black and White Stereogram Handbook
- Several tree and plant field guide books

4 APPROVAL/SIGN-OFF OF VPIP

Government sign-off contacts are:

Agencies	Contact
Ministry of Forests and Range	Jon Vivian
MOF Campbell River Forest District	Rory Annett

Licensee Contacts:

Licensees	Contact
TFL Forest Ltd. (TimberWest)	Bruce Storry

I have read and agree that the activities and products outlined in this proposal will meet the Ministry of Forests and Range business needs.

Manager

Manager, VRI, Forest Analysis and Inventory Branch, Ministry of Forests and Range
or designate