

Vegetation Resources Inventory

Morice TSA - Project Implementation Plan for Photo Interpretation

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Table of Contents

Table of Contents.....	2
Section 1 - Introduction	3
Background Information.....	3
Overview of the VRI Process.....	3
State of the Current Inventory.....	4
Document Objectives.....	6
Morice Project Area Overview	6
Woodlots and Community Forest	9
Section 2 - Photo Interpretation Plan	9
Project Objectives	9
Target Area	10
Historical Data Sources.....	11
New Data Sources.....	11
Other Data Sources	12
Polygon Delineation.....	12
Integrating RESULTS Information.....	13
Attribute Estimation.....	13
Mapping	14
TRIM Base.....	14
Section 3 - Project Implementation.....	14
Project Pre-work meeting.....	14
Scheduling.....	14
Aerial Photography and Photo Scale	15
Project Manager	15
Personnel.....	15
Quality Assurance.....	15
Deliverables	16
References for Inventory Standards and Procedures	16
Costs.....	16
Section 4: Literature Cited.....	17
Project Sign-off Sheet.....	18
Appendix A: Project Map Sheet Area Summary	19
Appendix B: Delineation and Attribution Process in Mountain Pine Beetle Impacted Stands	22
Appendix C: Morice TSA PEM Completed to Date.....	24
Appendix D: Expanded Maps.....	25

Section 1 - Introduction

Background Information

Stakeholders for this unit include:

- Nadina District staff
- First Nations
- B.C. Timber Sales
- Local licensees including local woodlot owners and community forests.

Significant concerns have been raised regarding the mid-term timber supply given the enormous impact of the mountain pine beetle (MPB) on the pine component in this TSA. The current allowable annual cut (AAC) for the Morice TSA is 2,165,000 cubic metres, effective February 1, 2008, and remains in effect until a new AAC is determined. The Special Committee on Timber Supply has also identified Morice as one of the heavily impacted critical units with very high mortality in all of the mature pine stands. The Special Committee on Timber Supply summarized key messages from a series of local public hearings including the need to base decisions on an updated inventory (please see pgs 12, 14 and 25 in *Special Committee on Timber Supply Report*, August, 2012 at <http://www.leg.bc.ca/cmt/39thparl/session-4/timber/reports/PDF/Rpt-TIMBER-39-4-GrowingFibreGrowingValue-2012-08-15.pdf>).

The need for current and accurate forest inventory of the Morice TSA was identified as a critical information source to inform local decision making, including any future AAC determinations. As described in *Beyond the Beetle: A Mid-term Timber Supply Action Plan*, The Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) has responded to the committee's recommendations with a commitment to also review marginally economic forest types within each TSA, including Morice, which are defined as stands that may be assessed as achieving 100 cubic metres per hectare and which might justifiably be included in a partition with the THLB. More recently, MFLNRO has prepared a draft list of timber goals and objectives to guide provincial timber management in its *Provincial Timber Management Goals and Objectives*, June 25, 2013 (working copy). The provincial objectives, local targets and strategies provided for timber volume flow and for balancing timber with other values clearly rely on current and accurate inventory data as a critical foundation for success.

The present inventory consists of a mix of varying currencies and formats and was adequate for planning and timber supply purposes in a pre-MPB world but is obviously now in need of a re-inventory (for details please see State of the Current Inventory below). A re-inventory of the TSA would provide up-to-date and accurate information on live and dead volumes, stocking and growth rates to inform the mid-term timber supply. The re-inventory process starts by acquiring new imagery as the old air photos were acquired prior to MPB and subsequent harvest activities. The new 2013 digital air photos being acquired this field season will provide full coverage of the TSA and adjoining area. This new imagery will be used for photo interpretation of live and dead components of the inventory in concert with air and ground calls for calibration purposes.

Overview of the VRI Process

The Vegetation Resources Inventory (VRI) provides a 'strategic' level planning inventory at the

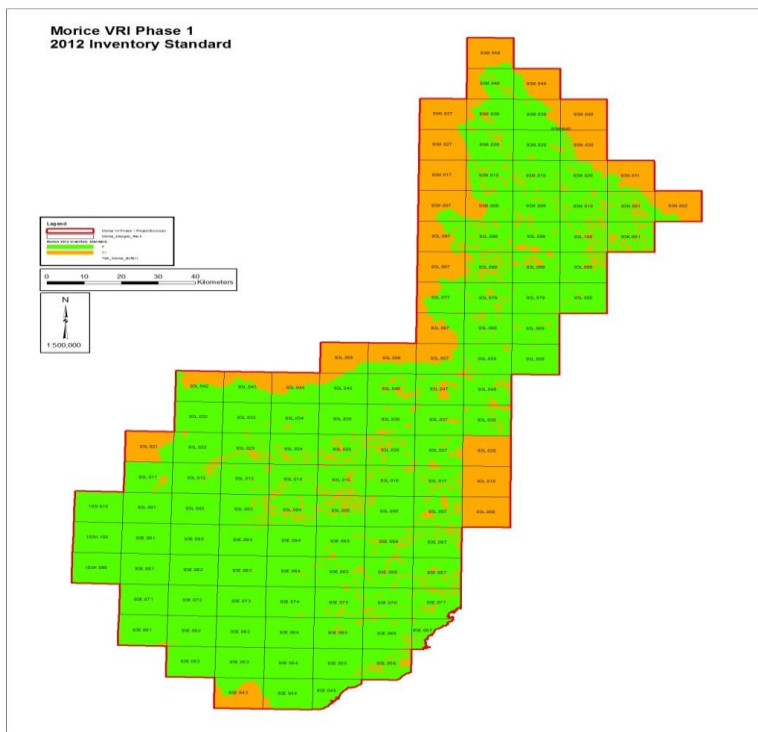
Inventory Plan for Photo Interpretation of the Morice TSA

management unit level (TSA or TFL) designed to answer two basic questions: where is the resource and how much is there. The VRI inventory standard consists of two phases that may be undertaken in combination or, in certain situations, individually. In phase I of the inventory, air photos are acquired, and polygons are delineated within an inventory unit in order to provide full ‘wall-to-wall’ coverage at the management unit level. Vegetation attributes of these polygons are estimated by photo interpreters. In phase II of the inventory, a subset of the polygons is randomly selected for ground sampling and Net Volume Adjustment Factor (NVAF) sampling. The purpose of phase II ground sampling is to verify our level of confidence in the phase 1 inventory and to provide supplementary information on stand characteristics (such as tree size distribution) that are not captured in phase 1. Phase II sampling is carried out using documented statistical procedures and standards. More details regarding the VRI process and the VRI standards and procedures are available at the MFLNRO Forest Analysis and Inventory Branch (FAIB) website: <http://www.for.gov.bc.ca/hts/vri/index.html>

State of the Current Inventory

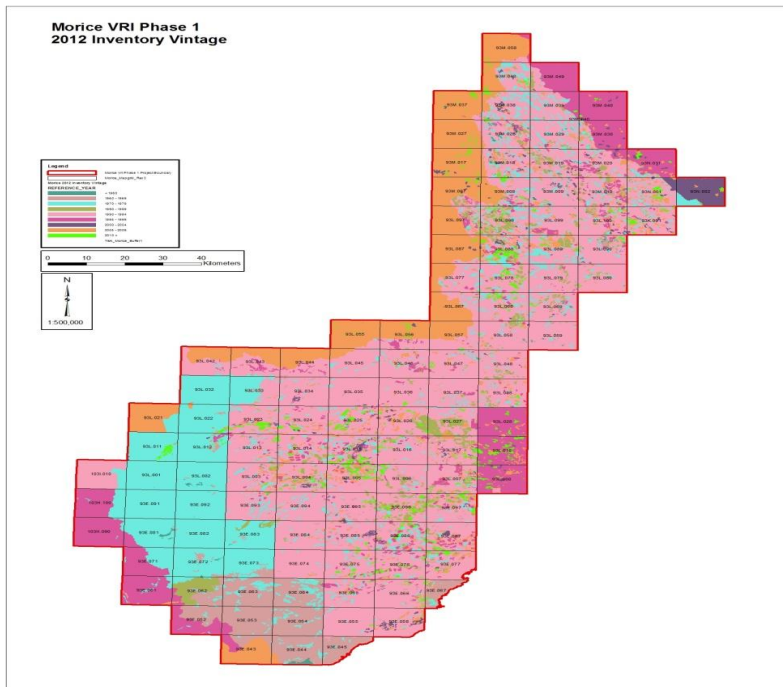
The forest cover attributes for the majority of the TSA conform to the old FIP format with less than 20% in the newer VRI standard (see Fig. 1 Morice TSA Inventory File Standard below). Prior to 2013, the most recent air photos used in the previous inventory were flown between 1990 and 1993, with photo interpretation completed in 1994 for the eastern and central portion of the TSA. There are significant portions of the western side of the TSA that date back to the 1970’s. In Tweedsmuir Park the inventory dates from the 1950s and approximately 14 full mapsheets (FMEs) date back to the 1960’s on the southwestern most part of the TSA (see Fig. 2 Morice TSA Inventory Dates below).

Fig. 1 – Morice TSA Inventory File Standard (Green mapsheets indicate older FIP or F type format and orange mapsheets show newer VRI or V type format. Small orange coloured areas throughout the unit are due to depletion updates which are classified as a V standard). **Note all figures are also available as full size maps in Appendix D**



Inventory Plan for Photo Interpretation of the Morice TSA

Fig. 2 – Morice TSA Inventory Dates (The majority of the more recent air photo acquisition and inventory is 1990 to 1994 vintage as shown by the pink mapsheets through the central portion of the TSA)



Free growing updates have not been completed yet and have not been integrated into the inventory file. Recent fires are also not reflected in the inventory unless this data has been submitted via RESULTS. The inventory file has been projected to 2012 and polygon volumes have been adjusted to reflect MPB mortality observed in the most recent forest health overview flight. The 2013 projected inventory will be available in Jan/Feb 2014.

Due to MPB impacts and uncertainty with an old inventory, a separate ground sampling project was initiated in the Morice TSA in 2012 and a preliminary analysis was carried out to provide some inventory information immediately prior to initiation of a full phase 1 VRI re-inventory of this management unit. A total of 50 young stand monitoring (YSM) samples were established in the immature population (stands 15 to 50 years of age) and 50 inventory audit samples were established in the mature population (stands 51 years plus in age). The size of this sample is relatively small however this sample data provides an indication of current, ground-based estimates of live timber volume, dead timber volume, stocking condition, and other timber characteristics that the Ministry can use to support near-term decision-making while the phase 1 VRI project is underway. While the separate ground sampling project provides population level volume estimates for mature stands, the phase 1 project will provide accurate and current spatial information on where this live/dead volume is located across the TSA in conjunction with other forest cover information such as species composition, stocking, age and height.

A summary of the VRI inventory volume analysis indicates the following;

- The volume audit sample suggests that the old phase I volume is underestimated by 25%. *However, this result must be interpreted with caution.* The sampling error associated with this estimate is very high ($\pm 24\%$) and does not meet the target sampling error level of $\pm 15\%$.
- In pine leading stands the phase I volume/ha and trees/ha have been adjusted for pine mortality in the corporate database using the BCMPB algorithm, however in the present phase 1 inventory live basal area is overestimated in this stratum because a significant dead pine component may still not be accounted for in the corporate database.
- Phase I age and, to a lesser degree, height in the mature stratum is generally overestimated.

Inventory Plan for Photo Interpretation of the Morice TSA

For more detailed information, please refer to the inventory volume audit report *Morice TSA Documentation of Vegetation Resources Inventory Analysis*, March, 2013.

A summary of the YSM analysis, based on preliminary findings from the plot establishment data indicates the following:

- Inventory ages were unbiased but inventory height was on average 2.7m less than ground measured height.
- Inventory basal area as estimated in the old phase 1 was significantly lower than the ground data indicates while trees per hectare were slightly higher in the phase 1 than ground data indicated.
- Phase 1 TIPSYS generated volumes were significantly lower than phase 2 ground volumes, reflecting the difference between ground measurements and old phase 1 estimates.
- Ground plot leading species and inventory leading species were the same for 39 out of 50 plots

For more detailed information, please refer to the YSM analysis report *Young Stand Monitoring in the Morice TSA: Plot Establishment Report*, September 2, 2013.

The above noted inventory volume audit and YSM results should be treated with caution since the sample size was relatively small for both populations. In addition, young stands are very dynamic in nature. A new phase 1 inventory will provide more current and accurate information on critical stand attributes such as volume, stocking, age and height as well as identifying location and will allow for refinement of these preliminary estimates. Since these initial comparisons were made with an old phase 1 inventory for both the mature and YSM populations. A new inventory will also provide more accurate and current information to help with the assessment of marginally economic stands by providing updated volume estimates for the live stand component down to the 100 cubic metres per hectare threshold while also separating any dead volume in these stands. Concurrent with this re-inventory, a new digital elevation model (DEM) will be delivered with 2 metre accuracy and new vegetation height mapping, which will benefit a wide range of stakeholders.

Document Objectives

This inventory planning document is a working document that states the critical reasons and objectives for carrying out a phase 1 VRI in the Morice TSA together with details on the area to be inventoried and key steps during the implementation of this phase 1 inventory project.

This plan identifies the target project area for new photo interpretation within the boundaries of the Morice Timber Supply Area (TSA), and includes the Lakes and Bulkley TSAs, TFLs 1 and 41 where the adjoining areas overlap with square edge map blocks. This plan also covers the stages required to be carried out for the successful completion of a photo interpretation project.

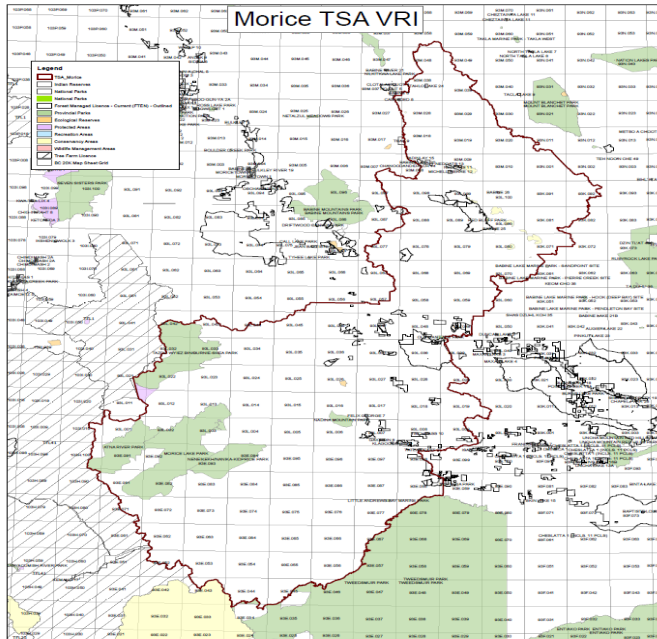
Morice Project Area Overview

The Morice TSA covers about 1.5 million hectares and is located in the northwestern part of British Columbia and is situated along the western edge of the province's Interior Plateau. It extends from the north end of Babine Lake in the north to Ootsa and Whitesail Lakes in the south. The topography in the TSA is gently rolling in the north and east, becoming mountainous in the southwest. The SBS biogeoclimatic zone predominates, followed by ESSF and some CWH. The area also includes minor percentages of MH, BAFA and CMA. The forest and range resources of the TSA are administered by the Nadina Natural Resource District located in Burns Lake (see Figure 3 Overview Map of Morice TSA below). The unit includes the towns of Houston, where most of the population resides and the

Inventory Plan for Photo Interpretation of the Morice TSA

smaller communities of Granisle and Topley. These communities are significantly dependent upon forest resources.

Figure 3: Overview Map of Morice TSA



According to 2008 estimates in the 2008 AAC determination, roughly 55% of the TSA is not available for timber harvesting purposes because it is reserved for parks, biodiversity and riparian management or because the productivity of the site is too low to support tree crops, leaving about 670,000 hectares or about 45% of the TSA land base in the THLB.

It is important to note that VRI phase 1 inventory projects are based on completion by square edge mapsheets, therefore the Morice inventory project area is not exactly the same as the Morice TSA area. The Morice inventory project is 1,721,673 ha because it encompasses some areas adjacent to the TSA on the western and northern side due to overlapping mapsheets (see Target Area under Section 2 for further details). Thus for planning purposes the following summaries are based on the total Morice inventory project area and not the TSA area (see Tables 1, 2 and 3 below).

Table 1 Morice Project Area Land Base Summary

Land Classification	Area (Ha)	Percent of Total Project Area
Total Project Area	1,721,673	100
Provincial Parks	131,591	7.6
Protected Areas and Reserves	16,785	1.0
TFL 1 and 41	98,337	5.7
Woodlots and Community Forest	41,465	2.4
Ownership (Cadastral and includes Indian Reserves, Private, Federal and Municipal)	107,500	6.2

Inventory Plan for Photo Interpretation of the Morice TSA

Table 2 Morice TSA Project Area Forested and Non-Forested

Descriptor	Area	Percent of Total Project Area
Non-forested	92,732	5.4
Non-productive (includes water)	510,423	29.6
Productive	1,118,518	65.0

Forests are mostly balsam (B, Bl), pine (Pl, Pli) and spruce (S, Sw, Sb and Sx). Most of the stands in the TSA are mature and old, age class 6 and older. (see Table 3 Morice Project Area Species Summary below for a more detailed breakdown of species). The MPB infestation in the Morice area began to rise sharply in 2005 and appears to have peaked in 2007 when about seven million cubic meters of pine was killed. From 2005 to 2012 about 29 million cubic meters of pine was killed by MPB. The majority of the volume killed was in mature pine-leading stands where pine accounted for more than 70 percent of the total volume. Since then annual mortality has declined back to pre-2005 levels. (Please refer to BCMPB Report at:

<http://www.for.gov.bc.ca/ftp/hre/external/!publish/web/bc/mpb/Year10/BCMPB.v10.BeetleProjection.Update.pdf>

. and the Morice TSA TSR Data Package at: http://www.for.gov.bc.ca/hts/tsa/tsa20/2013_tsr/20tsdp13.pdf)

Table 3. Morice Project Area by Species Summary

Leading Species	Area (ha)	% of Area
Balsam	423,641	39
Pine	335,544	31
Spruce	246,330	22
Deciduous	55,369	6
Hemlock	38,713	4
Other	177	0
Total forested all types	1,099,773	100

The sub-boreal spruce (SBS mc2 and dk) zone is the dominant BEC zone in the Morice project area accounting for approximately 53%, with the majority of the remaining area, some 30%, consisting of Engelmann spruce-sub-alpine fir (ESSF) sub-zones (see Figure 4 Morice Project Area BEC and Table 4 Summary of Morice Project Area by BEC Zone below). In the SBS zone MPB attack is predominant in the majority of pine leading stands. Recovery of unmanaged stands in the SBS zone is likely problematic in many stands based on preliminary analysis of data from research plots located within this BEC zone across the central interior. As much as 31% of pine-leading stands may fall below the 6 m² ha⁻¹ threshold for remaining live secondary structure in this zone. In terms of BEC zones in the Morice TSA, the SBS zone is at significant risk of having the poorest understory stocking based on proportion of plots with low post-beetle secondary structure basal area. Therefore, MPB-impacted stands in this zone probably pose the greatest risk for future timber supply. (please see *Current State of Knowledge Regarding Secondary Structure in Mountain Pine Beetle Impacted Landscapes – MPB Impacted Stands Assessment Project*, January, 2012, Coates, D and D. Sachs pg 11 at http://www.for.gov.bc.ca/hts/pubs/MPB_Impacted_Stands_Report_January_20_2012.pdf)

Figure 4. Morice Project Area BEC (Green SBS and dark blue ESSF BEC Zones predominate the unit)

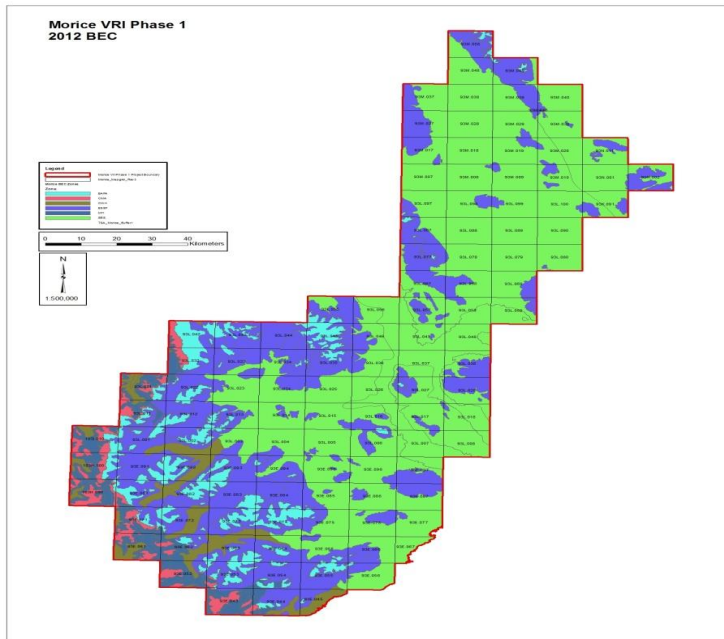


Table 4 Summary of Morice Project Area by BEC Zone

BEC Zone	ZONE_NAME	Morice TSA Project Area (ha)	Percent
SBS	Sub-Boreal Spruce	910,906	53
ESSF	Engelmann Spruce – Subalpine Fir	522,697	30
BAFA	Boreal Altai Fescue Alpine	113,210	7
MH	Mountain hemlock	77,807	5
CWH	Coastal Western Hemlock	59,398	3
CMA	Coastal mountain heather alpine	37,655	2
	Total	1,721,673	100

Woodlots and Community Forest

The new inventory will include any woodlots and community forest lying within the Morice project area. Any VRI completed during the MPB infestation period is now out of date and would need to be completely redone. Any photo interpretation calibration points established in these projects would be made available as part of any historical data source for use in the new inventory project.

Section 2 - Photo Interpretation Plan

Project Objectives

The overriding objective of this photo interpretation project is to update the Morice TSA inventory to account for the massive change due to MPB kill since the last inventory. The new inventory will provide current and more accurate information on both live and dead components for all pine leading and non-pine stands (polygons) within the Morice TSA outside of Tweedsmuir Park. An accurate re-delineation and re-attribution of the MPB killed pine leading stands is required in order to provide

Inventory Plan for Photo Interpretation of the Morice TSA

information to inform the mid-term TSR analysis in accordance with the direction of the Special Committee on Timber Supply. In addition, significant harvesting has taken place which needs to be reflected in the new inventory.

Please refer to the TSR background information and reports available at:

<http://www.for.gov.bc.ca/hts/tsa/tsa20/index.htm#documents>

To provide inventory information immediately, a separate ground sampling project was initiated in the Morice TSA in 2012 and a preliminary analysis was carried out prior to this plan being prepared, as discussed above in State of the Current Inventory under Section 1.

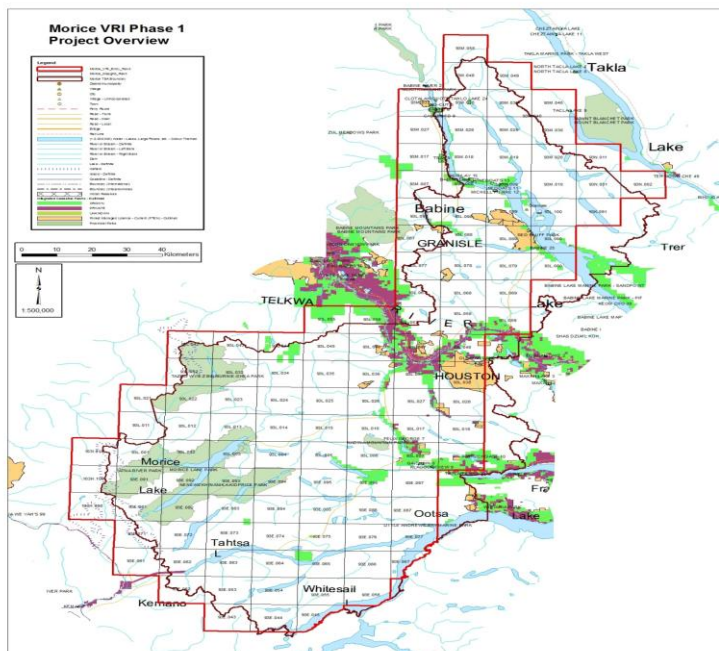
Target Area

The entire Morice TSA will be photo interpreted exclusive of Tweedsmuir Park but including the smaller protected areas of: Atna River Park, Morice Lake Park, Neneikeikekh/Nanika-Kidprice Park, Nadina Mountain Park and Tazdli Wyiez Bin/Burnie-Shea Park, and including woodlots, private land, small parks and community forests (see Fig. 5 Morice VRI Project Overview). A separate pilot study is being proposed to investigate methods for conducting a relatively inexpensive, high level and less intensive inventory for all of the area in Tweedsmuir Park. The park inventory will be based on satellite imagery, since critical information on stand volume, composition and mortality does not need to be collected within the park boundaries.

The total Morice **VRI project area** is 1,721,673 hectares (approximately 118 Full Map Equivalents based on 14,588ha/FME) and encompasses 120 BCGS 1:20000 full and some partial map sheets. A detailed map sheet and area summary is provided in the attached Appendix A.

Re-inventory of the adjacent Lakes TSA is now being carried out in the same year and all work will tie with the Morice VRI project along the eastern portion of the Morice TSA. The Ministry will arrange for the exchange of delineation and attribution files with the contractor for the Lakes TSA VRI project.

Fig. 5 Morice VRI Project Overview (project area is shown in red outline and includes Morice TSA and overlapping portions of Bulkley TSA, TFLs 1 and 41. Protected areas are shown in pale green)



Historical Data Sources

An estimate of 625 air and ground calls were established in the Morice TSA since the first forest inventory project in the early 1990's (see Table 4 Inventory Calibration Points below). An unknown number of the established data sources were destroyed over the years through harvesting and other disturbances. The actual number of data sources still available will be determined at the data source transfer stage which may be completed prior to the award of the VRI photo interpretation contract.

All data sources that were available in the last re-inventory project are documented on the earlier document photos. A digital spatial location of these points will be made available in ESRI shape file. Data sources available on the document photos will be reviewed by photo interpreters and data sources that are still relevant to a new inventory on the 2013 imagery will be transferred to a digital format provided by the Ministry.

Table 4: Inventory Calibration Points (established in major forest inventory projects in the Morice TSA).

Year	Air Calls	Ground Calls
1994	0	68
1995	0	12
1996	0	74
1997	44	84
2003	12	14
2006	39	41
2007	123	114
Total	218	407

Situations that would justify removal of existing data sources include a major disturbance (such as a large fire, harvesting or insect/disease damage), large stand structure changes, or as defined in the contract document. A large amount of disturbance has occurred in this unit. Thus the intent of this project will be to rely on the remaining historical information sources

New Data Sources

The contractor will establish a minimum of 15 ground calls and 20 air calls per map FME with the exact ratio of ground to air calls per FME still to be determined.

The ground call types will consist of 5-point and 3-point only, and use of any 1-point calls will be reviewed before any are approved in non-pine or non-MPB impacted stands. The type of ground call established in each polygon is based on the species complexity as described in the VRI Photo Interpretation Field Calibration Procedures. To provide reliable calibration data for photo interpretation of the residual live pine component and visible understory, a modified three-point ground calls will be implemented in the field calibration of the MPB impacted stands. The VRI three-point ground call will include 2 measured and 3 count plots to better capture the dead and live stand species composition. The ratio of 3-pt versus 1-pt ground call will be confirmed after a review of a sample of the 2013 photo images. Any deviation from these numbers must be agreed upon by the Ministry Project Manager and will be reflected in the field calibration plan.

Current inventory indicates approximately 31% of the project area is comprised of pine leading stands. Although pine leading stands traditionally do not require extensive field calibration to achieve reliable photo estimates, a higher than average ground and air calibration program will be required in the MPB stands to ensure reliable determination of live versus dead tree volume component which is a key focus of this inventory.

Inventory Plan for Photo Interpretation of the Morice TSA

Prior to the initiation of a field calibration program, a Field Calibration Plan (see Guidelines in Appendix D) is to be submitted to the Ministry Project Manager for approval.

As part of the deliverables, the Ministry requires a complete set of any new data sources be provided in a suitable digital format (as determined by the Ministry), including the geographical locations (UTM coordinates) of these data sources as well as the complete set of field attribute data collected.

A PEM has already been completed for the Morice TSA. The most recent site productivity data has recently been loaded into a provincial site productivity layer. The most recent PEM passed an accuracy assessment (AA) in accordance with current standards and procedures for this information and is available for use in this project (please see Appendix C).

Other Data Sources

The origin and estimated number of other historic data sources is still to be determined as of the date of this first draft (See Table 5 Other Data Sources below).

Table 5 Other Data Sources

Data Source Origin	Type	Number of Data Sources
Growth and Yield Permanent Sample Plots (PSP)	PSP	TBD
Community Forest- Ground Calls	XGV	TBD
Community Forest - Air Calls	XV	TBD
Terrestrial Ecosystem Mapping with tree data	TEM	See below*
Predictive Ecosystem Mapping with tree data Site Productivity Layer (MPB – Site Index)	PEM	See below*

*The VRI Phase 1 contractor will use the provincial site productivity layer information as a reference for site index (SI) where SI cannot be estimated from suitable live mature trees, i.e. in areas of high MPB mortality. This GIS database contains the latest PEM, TEM and SIBEC information for the Morice TSA by species. The provincial site productivity layer data and supporting information is available at:

<http://www.for.gov.bc.ca/hts/siteprod/provlayer.html>

ftp://ftp.for.gov.bc.ca/HTS/external!/publish/Provincial_Site_Productivity_Layer_June_2013/

Polygon Delineation

Polygon delineation is to be completed to VRI standards. Any deviation from these standards must be agreed to by the Ministry Project Manager.

It is critical in the MPB impacted stands to capture the residual live tree component; therefore throughout the delineation process the live trees must guide the line placement and the resulting polygon boundaries. Photo interpreters will not extrapolate visible understory to adjacent polygons. Only when understory is visible will it be summarized as a separate layer in each polygon.

The intent is to follow the process for delineating and attributing MPB impacted stands now underway in the Lakes TSA Phase 1 VRI (see Appendix B for details). Any amendment of this process would be based on an assessment of the Lakes project later in this fiscal.

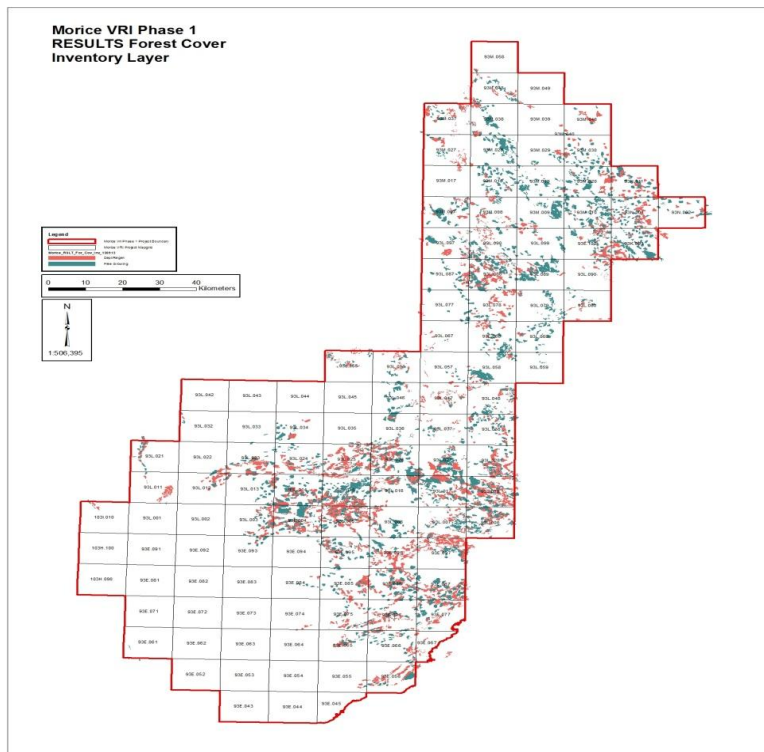
Integrating RESULTS Information

The integration of the RESULTS (Reporting Silviculture Updates and Land status Tracking System) spatial files and tree attribute data will be completed at the delineation and attribution stages of the project. The RESULTS database in the Morice TSA indicates there are 17,551 openings and of these:

- 8,373 openings are Depletion/Regenerations for an area of 96,181.65 ha
- 9,178 openings are Free Growing for an area of 110,664.04 ha

A total area of 206,846 hectares or about 12 percent of the project area consists of openings.

Fig. 6 Morice project area RESULTS Spatial File Coverage (depletion and regeneration shown in red and free growing shown in green)



An ESRI shape file for the RESULTS openings and tree attributes will be provided to the bidders attending a mandatory project viewing session in early spring, 2014. A significant portion of the RESULTS Depletions have been updated in the current Forest Inventory however there will still be some missing spatial and attribute data and some more recent openings in the 2013 air photos may not be found in the RESULTS data cut. Attribution of harvested areas that are not identified in the RESULTS spatial files will be completed in accordance with the procedures for Photo Interpretation Guidelines for Integrating RESULTS Information.

Attribute Estimation

This project will be undertaken in softcopy (digital photogrammetric) format.

The intent is to follow the process for delineating and attributing MPB impacted stands now underway in the Lakes TSA and the Kamloops TSA Phase 1 VRI (see Appendix B for details). Any amendment of this process would be based on an assessment of the Lakes project later on this fiscal.

Inventory Plan for Photo Interpretation of the Morice TSA

Photogrammetric tree heights will be taken where suitable at the discretion of the photo interpreter. There will be no quality assurance carried out of the photogrammetric heights as QA will involve digital height comparisons. TBC: Are we going to do any comparisons to the photogrammetric heights?.

Mapping

The Ministry has developed a format and database standards for the submission and storage of spatial and attribute data for VRI Photo interpretation. All new projects must be completed to this standard and submitted to the Ministry Project Manager following successful QA.

The Contractor will adhere to the most current version of the *VRIMS Personal Geodatabase Structure and Use and VRIMS Vegetation Cover Polygon Validation Rules* published by the Forest Analysis and Inventory Branch.

TRIM Base

A TRIM (NAD 83) format base files will be made available to the contractor at the project pre-work meeting.

There will be no changes made to the TRIM feature unless significant changes occurred to the polygonal features such as lakes and double-line rivers. The contractor must maintain a record of any TRIM changes and submit all changes to the Project Manager in ESRI shape file format. The changes will be passed on to GeoBC for TRIM update.

Section 3 - Project Implementation

Project Pre-work meeting

A project pre-work meeting is mandatory. The purpose of a project pre-work meeting is to bring together the Ministry Project Manager, VRI phase I contractor, MFLNRO representatives and quality assurance personnel prior to project start-up. This meeting will ensure that an efficient communication network is established, identify individuals responsible for all aspects of the project, allow discussion of any issues before project work commences and establish timelines for deliverables and data flow. Minor changes to the contract to complete the Phase I activities may be identified at this meeting.

A project pre-work checklist, signed off by all parties attending, will be used to organize and guide the meeting.

Scheduling

The project will progress over two fiscal years commencing in the spring or early summer of 2014 - 2015 fiscal. Two field seasons will be required for collection of photo interpretation field calibration data. TBC: calibration fieldwork and associated delineation and attribution will be initiated along the western side of the unit and will run west to east to eventually tie into blocks completed on the western edge of the Lakes TSA. Field calibration is to coincide with subsequent attribution of blocks as scheduled in the approved work plan.

Still to be confirmed: Approximately two thirds of the photo estimation work will be completed in 2014/15 and the remaining will be completed in 2015/16.

A delivery schedule outlining progressive delivery of products will be submitted by the contractor for each fiscal. The format of the delivery schedule will be agreed to at the project pre-work meeting.

Aerial Photography and Photo Scale

The present 2013 digital air photo acquisition is being administered by GeoBC on behalf of FAIB and therefore meets all standards and specifications as summarized below.

Digital frame camera imagery of the project area was acquired to GeoBC photo standards and specifications in the summer of 2013. Flight lines were oriented in an East-West (or opposite) direction and captured at 30cm GSD (ground scale distance). Softcopy image sets will be available as RGBnIr 4 band 8 bit JPEG compressed TIF with a ZI project file. This will allow for natural colour display of imagery as well as colour infrared display using the same image file and softcopy setup.

For projects utilizing digital softcopy photogrammetric technology, the minimum acceptable scale of the imagery shall be 1:20 000 for coastal areas; 1:20 000 for southern interior and central interior areas; and 1:30 000 for portions of the far northern interior. The use of digital imagery requires the use of a Ground Sampling Distance that is compatible to the minimal acceptable scale in hard copy. The Ministry must be consulted in regards to the appropriate photo-scales or Ground Sampling Distance to be implemented on a project. The year(s) of photograph acquisition for the project area must be included and approved as part of the Plan.

Project Manager

The Ministry Project Manager for the Morice TSA Phase 1 VRI project is Mathias Hulten, FAIB. Responsibilities include the following: coordinating the project; monitoring and communicating project progress with the local stakeholders; ensuring all contractors are qualified and certified; overseeing photo-interpretation activities; ensuring quality assurance is complete and delivered at each stage, and assisting in coordinating technical expertise where required.

Personnel

All VRI photo interpretation work must be completed by or directly supervised by a VRI Certified Photo Interpreter. At least 50% of the photo interpreters working on the project must be certified for VRI photo interpretation. All uncertified photo interpreters are to be directly supervised by a Certified Photo Interpreter working on that project.

Quality Assurance

An independent third-party quality assurance (QA) will be completed on all stages of the project in accordance with the VRI Photo Interpretation Quality Assurance Procedures and Standards.

Quality assurance intensity for each stage of the project is to be completed as follows:

Historical Data Source Transfer	5%
Delineation	5%
Field Calibration	5%
Attribution	5%

Quality assurance for digital map production will be conducted by the Province. Contractors will utilize “VEGCAP for Contractors” validation software to perform quality assurance on data files.

All QA findings and re-work instructions are communicated to the VRI contractor by the Ministry Project Manager.

Inventory Plan for Photo Interpretation of the Morice TSA

Deliverables

The VRI photo interpretation project deliverables for each stage of the photo interpretation project are outlined in the VRI Photo Interpretation Procedures and VRI Field Calibration Procedures for Photo Interpretation.

For a multi-year project, deliverables are required at the end of each year fiscal. To provide sufficient time for completion of independent third-party quality assurance and Ministry in-house mapping quality assurance, the final deliverables will be submitted at the end of February of each fiscal.

The most current VRI phase I standards documentation can be accessed from the following NFLNRO web site:

<http://www.for.gov.bc.ca/hts/vri/standards/photo.html>

Submission of all final deliverables will be signed-off by a qualified ABCFP registered Forest Professional.

Roles and Responsibilities

MFLNRO

Project Manager is the point of contact for the Ministry and provides overall communication of project activities with contractors and Nadina District staff and stakeholders via the Ministry SharePoint site.

VRI Contractor

Works with the Ministry Project Manager to ensure the planning, coordination and execution of project activities is consistent with the VPIP and contract requirements.

VRI QA Contractor

Works with the VRI Contractor and Ministry Project Manager to ensure that Quality Assurance reporting meet the VRI prescribed standards.

References for Inventory Standards and Procedures

All work will be carried out in accordance with the following British Columbia Government specifications, current at the time of contract signing.

- *Vegetation Resources Inventory Photo Interpretation Procedures*
- *Vegetation Resources Inventory Photo Interpretation Standards and Quality Assurance Procedures*
- *Vegetation Resources Inventory Field Calibration Procedures for Photo Interpretation*
- *Guideline for Integrating RESULTS Information* (currently contained within the VRI photo interpretation procedures)
- *Vegetation Resources Inventory – The B.C. Land Cover Classification Scheme and addendums*
- *VRIMS Personal Geodatabase Structure and Use*
- *VRIMS Vegetation Cover Polygon Validation Rules*
- *Vegetation Resources Inventory Preparing a Project Implementation Plan for Photo interpretation – Appendix D*

Costs

The anticipated cost for completing the project, excluding photo acquisition, but including quality assurance, data capture and field costs based on the level of field calibration to be completed, is

Inventory Plan for Photo Interpretation of the Morice TSA

\$2,064,000 dollars based on an estimated \$1.20/ha. The QA costs are estimated to be between 7% and 10% of the overall photo interpretation project cost for this unit. Note, these estimates are used for project budgeting purposes only, based on current average costs for similar projects, and should not be used for the purpose of submitting bids on any work that may be tendered.

Section 4: Literature Cited

Beyond the Beetle: A Mid-term Timber Supply Action Plan, October, 2012, MFLNRO, 16 pp.

Current State of Knowledge Regarding Secondary Structure in Mountain Pine Beetle Impacted Landscapes – MPB Impacted Stands Assessment Project, January, 2012, Coates, D and D. Sachs, 35 pp.

Morice TSA Documentation of Vegetation Resources Inventory Analysis, March, 2013, Prepared for MFLNRO by Jahraus Consulting Inc., 53 pp

Morice Timber Supply Area Timber Supply Review Data Package, July 2013, MFLNRO, 26 pp

Morice TSA Sample Selection Report, March 2012, Prepared for MFLNRO by Nona Phillips Forestry Consulting, 28 pp

Morice Timber Supply Area – TSA 20: Vegetation Resources Inventory Project Implementation Plan for Volume Audit Sampling, Young Stand Monitoring and Net Volume Adjustment Factor Sampling, March 21, 2012, Prepared for MFLNRO by Nona Phillips Forestry Ltd., 40 pp.

Morice Timber Supply Area: Rationale for Allowable Annual Cut (AAC) Determination, Feb. 1, 2008, MFLNRO, 57 pp.

Provincial-Level Projection of the Current Mountain Pine Beetle Outbreak: Update of the Infestation Projection Based on the Provincial Aerial Overview Surveys of Forest Health Conducted From 1999 Through 2012 and the BCMPB Model (Year 10), April 12, 2013, Prepared for MFLNRO by Adrian Walton, 13 pp.

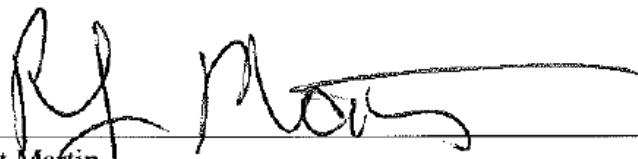
Provincial Timber Management Goals and Objectives, June 25, 2013, working copy, 20 pp.

Young Stand Monitoring in the Morice TSA: Plot Establishment Report, September 2, 2013, Prepared for MFLNRO by Forest Analysis Ltd., 28 pp

Project Sign-off Sheet

**Morice Timber Supply Area Vegetation Resources Inventory
Photo Interpretation Project Implementation Plan**

I have reviewed and approved the Morice TSA Vegetation Resources Inventory Photo Interpretation Project Implementation Plan.

 Nov 15/13
Pat Martin Date
Manager, Forest Inventory Section
Forest Analysis and Inventory Branch
Ministry of Forests, Lands and Natural Resource Operations

Appendix A: Project Map Sheet Area Summary

Map	Area (ha)	NP Area (FIP) (ha)	VRI Vegetative/Non Tree Area (ha)	VRI Non Forest Descriptor Area (ha)
093E043	14788.20	4,662.43	230.33	
093E044	14788.20	8,523.83	661.66	7.67
093E045	8963.42	5,990.18	344.47	
093E052	14753.69	11,006.43	378.09	301.27
093E053	14753.69	13,497.67	115.52	27.06
093E054	14753.69	9,334.79	210.40	
093E055	14753.69	8,374.35	1,168.36	6.38
093E056	14156.80	5,532.31	2,500.83	0.21
093E061	14719.13	7,763.46	722.62	583.64
093E062	14719.13	11,873.70	78.61	
093E063	14719.13	9,338.04	245.45	
093E064	14719.13	6,927.07	408.74	
093E065	14719.13	5,093.54	1,295.97	471.36
093E066	14719.13	3,372.11	2,354.89	802.99
093E067	6859.55	3,638.44	514.56	
093E071	14684.53	11,896.60	564.20	482.38
093E072	14684.53	11,302.88	378.75	18.07
093E073	14684.53	11,040.45	282.00	8.35
093E074	14684.53	10,930.30	276.74	
093E075	14684.53	4,451.37	1,948.86	615.70
093E076	14684.53	2,445.00	3,018.09	1,756.56
093E077	13716.23	5,824.05	2,345.41	559.40
093E081	14649.88	12,387.07	320.47	52.53
093E082	14649.88	11,899.35	90.88	8.30
093E083	14649.88	8,006.31	1,085.72	145.99
093E084	14649.88	5,565.24	891.30	4.10
093E085	14649.88	2,855.08	2,316.47	636.78
093E086	14649.88	2,010.13	4,460.42	2,412.82
093E087	14649.88	1,109.67	3,254.91	1,017.02
093E091	14615.19	9,661.11	710.45	89.65
093E092	14615.19	12,203.12	29.00	18.94
093E093	14615.19	6,748.03	674.55	393.05
093E094	14615.19	4,300.78	784.49	225.00
093E095	14615.19	1,847.33	2,988.00	1,889.15
093E096	14615.19	1,578.64	5,423.72	3,543.58

Inventory Plan for Photo Interpretation of the Morice TSA

093E097	14615.19	1,209.88	4,251.86	1,805.40
093K091	14265.70	3,174.08	2,037.06	1,029.99
093L001	14580.44	9,868.22	1,397.64	1.67
093L002	14580.44	9,595.93	417.81	44.78
093L003	14580.45	5,653.54	2,254.31	991.19
093L004	14580.44	1,868.09	3,036.51	1,749.13
093L005	14580.45	1,544.16	4,495.76	1,602.45
093L006	14580.44	2,192.93	2,149.24	1,446.34
093L007	14580.44	2,521.03	4,335.28	1,114.76
093L008	14580.44		5,421.60	
093L011	14545.66	11,895.03	2,212.83	62.07
093L012	14545.66	7,076.84	946.33	74.08
093L013	14545.66	4,974.19	1,660.44	1,041.71
093L014	14545.66	759.81	3,276.30	2,261.94
093L015	14545.66	973.26	4,476.93	2,946.72
093L016	14545.66	1,474.56	2,316.61	1,093.08
093L017	14545.66	2,168.29	4,880.77	2,963.11
093L018	14545.66		5,452.05	
093L021	14510.82	1,930.44	5.13	3.00
093L022	14510.82	6,480.12	1,016.46	121.08
093L023	14510.82	1,892.75	2,879.10	728.15
093L024	14510.82	1,317.00	2,309.04	532.52
093L025	14510.82	975.48	2,936.66	797.85
093L026	14510.82	2,087.90	2,958.49	1,505.26
093L027	14510.82	2,964.38	5,179.59	3,795.08
093L028	14510.82		2,860.44	
093L032	14475.94	10,852.93	303.01	20.99
093L033	14475.94	5,240.88	751.70	10.66
093L034	14475.94	3,068.57	1,470.96	709.30
093L035	14475.94	5,527.59	456.33	122.56
093L036	14475.94	760.61	1,698.05	788.94
093L037	14475.94	3,086.73	2,133.75	342.52
093L038	14475.94	1,251.41	2,370.91	791.47
093L042	14441.02	7,370.39	1,672.46	827.72
093L043	14441.02	6,614.29	2,549.08	1,526.79
093L044	14441.02	2,614.28	1,301.55	1,054.37
093L045	14441.02	9,578.30	660.07	78.76
093L046	14441.02	1,216.13	2,730.30	635.98
093L047	14441.02	3,190.69	3,639.33	973.58
093L048	14441.02	2,516.29	3,000.12	670.46
093L055	14406.04	381.59	1,733.04	978.74
093L056	14406.04	682.97	3,110.09	914.12
093L057	14406.04	1,118.44	2,001.76	316.73

Inventory Plan for Photo Interpretation of the Morice TSA

093L058	14406.04	1,208.58	1,967.55	837.99
093L059	14406.04	1,870.65	1,793.56	387.53
093L067	14371.03	858.13	1,476.66	223.17
093L068	14371.03	1,621.89	2,930.06	1,443.74
093L069	14371.03	2,752.69	1,919.55	522.28
093L077	14335.96	1,855.64	1,229.62	366.58
093L078	14335.96	2,111.83	2,614.08	1,485.45
093L079	14335.96	2,482.30	1,552.95	191.12
093L080	14335.96	3,911.00	1,193.12	951.43
093L087	14300.85	171.06	1,960.10	325.85
093L088	14300.85	1,673.22	5,296.23	2,535.70
093L089	14300.85	2,204.29	3,095.16	2,316.34
093L090	14300.85	7,070.79	1,501.15	1,149.64
093L097	14265.70	587.35	2,565.35	1,270.14
093L098	14265.70	1,412.79	4,141.78	3,007.98
093L099	14265.70	4,830.13	1,965.11	1,250.32
093L100	14265.70	4,563.21	1,274.60	931.32
093M007	14230.50	396.37	2,239.77	1,341.82
093M008	14230.50	1,631.22	2,073.18	1,150.70
093M009	14230.50	4,946.10	1,485.95	440.29
093M010	14230.50	1,775.02	2,948.64	2,156.25
093M017	14195.25		1,924.43	800.22
093M018	14195.25	2,048.01	1,931.84	1,412.37
093M019	14195.25	1,701.41	2,189.75	1,801.39
093M020	14195.25	1,674.25	3,221.59	1,765.62
093M027	14159.96	548.37	1,427.85	475.46
093M028	14159.96	2,724.15	2,292.15	1,377.74
093M029	14159.96	2,794.14	1,315.40	295.35
093M030	14159.96	376.00	2,019.83	5.33
093M037	14124.62	219.63	2,199.92	735.81
093M038	14124.62	2,484.30	1,553.83	343.43
093M039	14124.62	1,829.91	1,141.37	144.15
093M040	14159.13		862.11	
093M048	14089.24	1,388.63	2,350.61	236.38
093M049	14089.24	526.23	2,196.09	5.11
093M058	14053.82	430.54	2,837.68	1,124.56
093N001	14230.50	2,042.63	1,171.06	155.13
093N002	14230.50	86.68	1,449.98	89.97
093N011	14195.25	71.21	1,712.48	29.57
103H090	14649.88	11,564.81	1,359.09	1,262.24
103H100	14615.19	10,734.00	1,878.16	1,839.77
103I010	14580.44	14,580.42		
Total	1721707.65	510,420.44	234,081.07	92,738.24

Appendix B: Delineation and Attribution Process in Mountain Pine Beetle Impacted Stands

The Ministry is interested in collecting more attribute information on stands that have significant amounts of dead standing timber. This will apply to all stands, regardless of species, that the photo interpreters estimate have more than 30% mortality, based on density. In these stands, snags/ ha will be estimated as per the standards and the contractor will create a new “Layer D” and collect the following attributes on the dead standing timber:

- Species composition
- Age of leading
- Height of leading
- Basal area
- Stems/ ha
- Crown closure (estimated as % of stems/ha affected)
- Disturbance type

The main areas that will be included are insect infestation and wildfire. While Mountain Pine Beetle is by far the biggest agent that will affect the need for a dead layer, other agents and factors affecting mortality are included in the dead layer.

The following procedure is proposed where stands have been significantly affected by Mountain Pine Beetle. This is recorded below for information; procedures will be discussed and finalized with the contractor at the pre-work conference.

- In MPB killed stands, where the remaining stand would be classified as Vegetated Treed (VTU or VTW), use normal VRI delineation principles in determining boundaries between polygons, and record snags as appropriate for that polygon.
- In MPB killed stands, where the remaining stand would NOT be classified as Vegetated Treed (VNU or VNW), and WOULD HAVE been classified as Vegetated treed prior to MPB attack, separate polygons based on BCLCS level 5 and snag density. For example a MPB killed stand may now be classified as VNU, HE (or By, ST, SL), and would be delineated to that level, PLUS further delineation based on the number of snags remaining.
- The delineation guideline for snags would be +/- 200 snags per hectare. Basal area will be recorded based on live stems as per current procedures.
- Record the site index for the polygon that most closely approximates the new polygon boundary as the “estimated site index” (average or prorate as appropriate)
- If the polygon is VN but has a treed component (IE 8% crown closure), do not put an estimated site index, it will be calculated using the interpreted age and height, unless the stands is less than 30 years of age.

A significant proportion of the pine in the project area is now dead. In stands where there is approximately a 20% or greater loss in volume, it is appropriate to use live and dead trees for the 6 to 8 tree ground calibration tally standards. It is also appropriate to use a dead tree as a sample age/height tree in these situations, if a suitable live tree is not available in close proximity.

Inventory Plan for Photo Interpretation of the Morice TSA

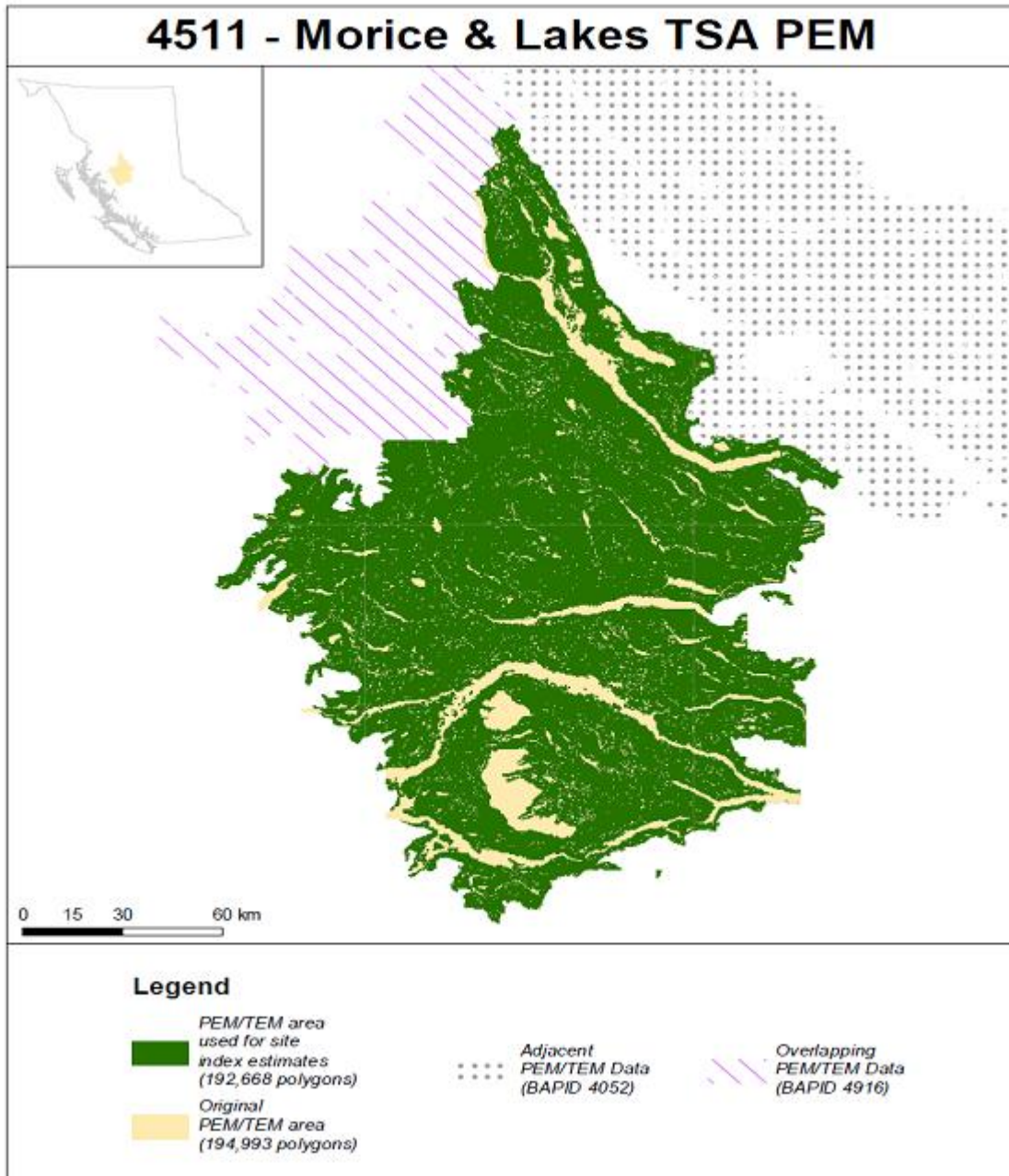
In affected stands, field data will be taken to determine the species composition post beetle, including understory and residual stands as appropriate.

There are a number of other insect outbreaks occurring in the TSA, if the contractor identifies further large scale outbreaks in areas that are not Pine leading, the above procedures may be extended to other species after discussion and approval by the Ministry project manager.

In polygons that have been heavily impacted by MPB, the field crew will take notes on the species composition, age, height, density of understory if it cannot be seen on the photo. This data will not be sampled and will be an ocular based estimate only. Where understory is visible on the photo, data will be collected as per standards – all layers will be considered. Pre-location of the calibration points prior to fieldwork must take this into account.

The determination on whether the understory can be seen for calibration polygons is a field determination based on the residual main canopy and the height, density and size of the understory,

Appendix C: Morice TSA PEM Completed to Date



Appendix D: Expanded Maps

Fig. 1

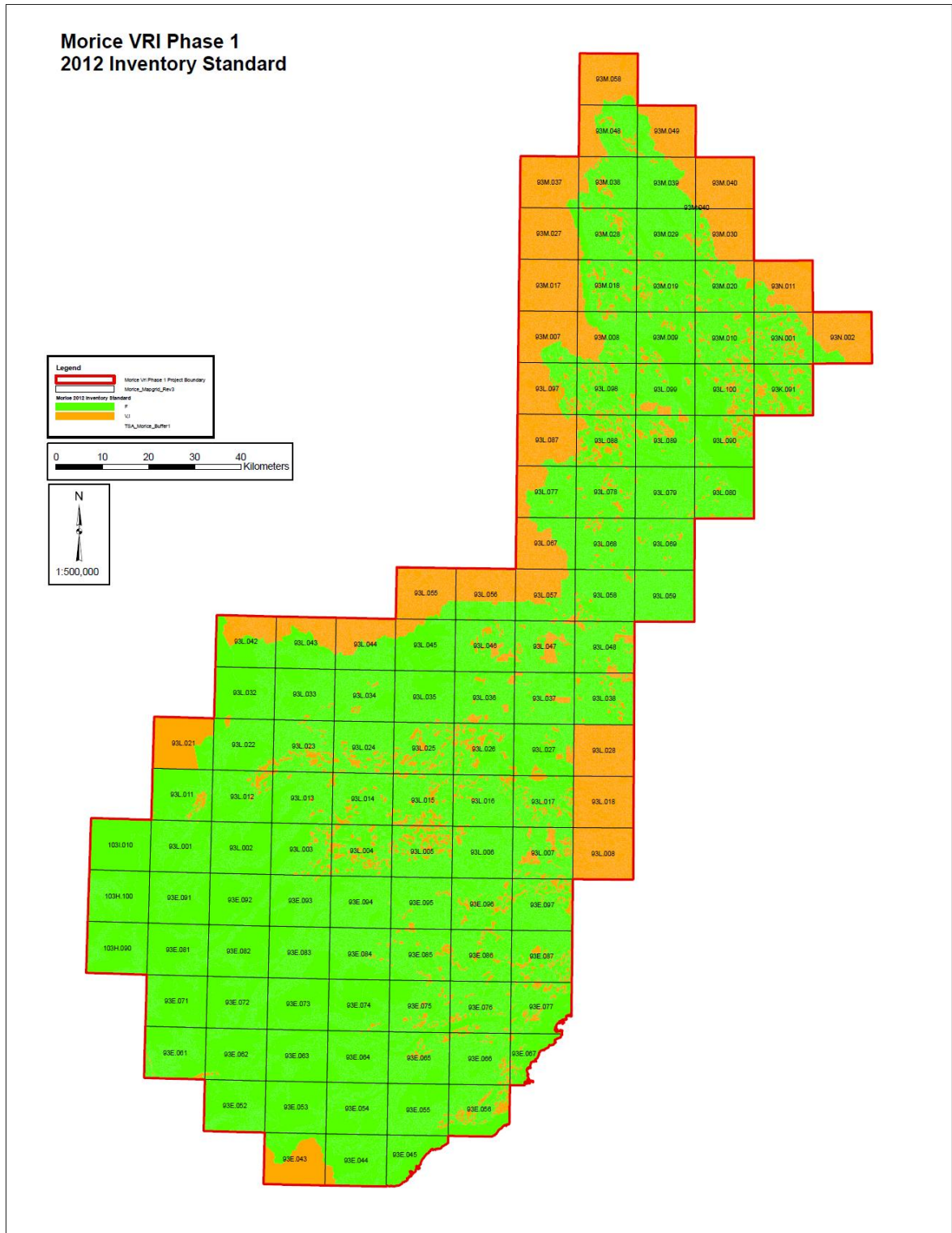


Fig. 2

Inventory Plan for Photo Interpretation of the Morice TSA

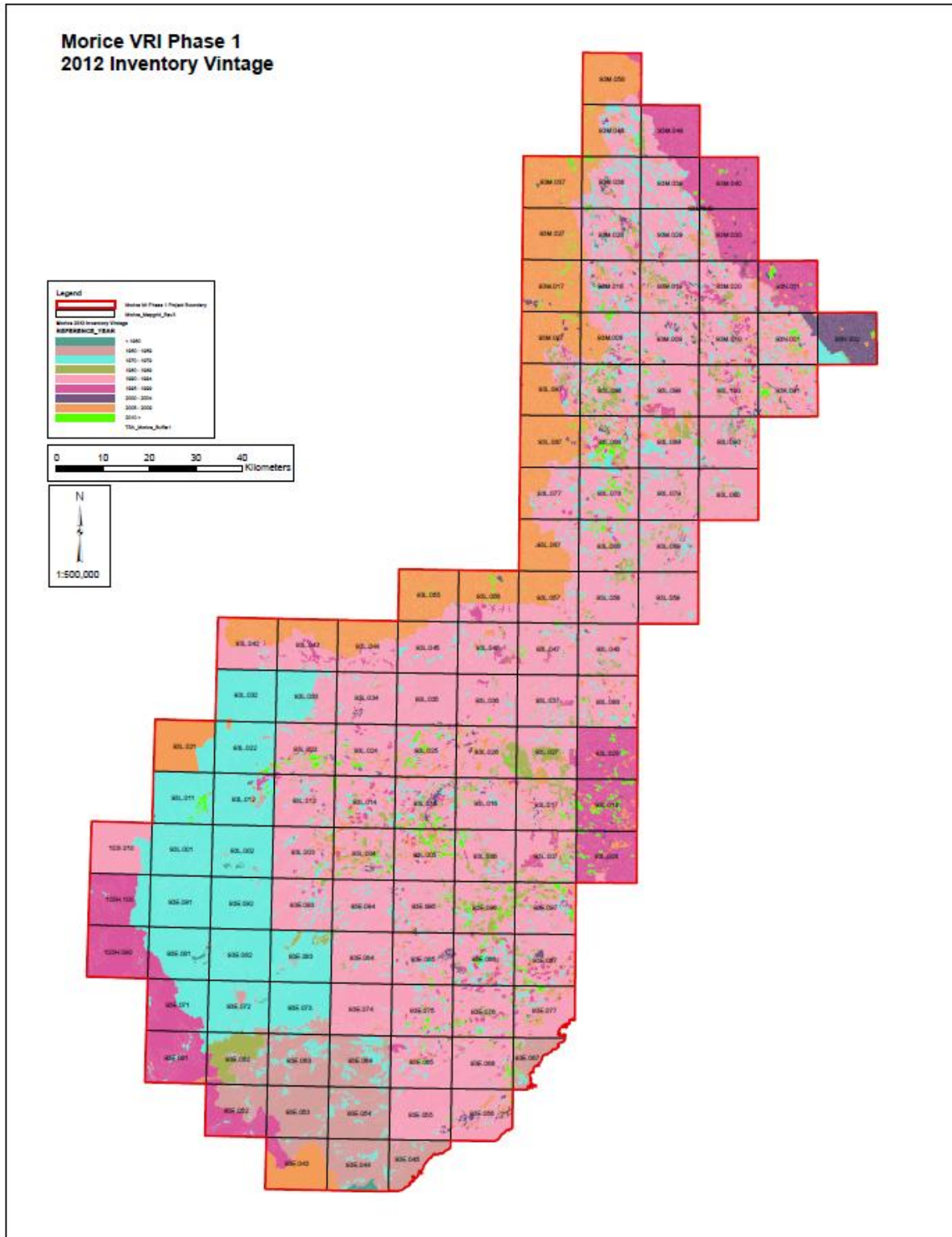


Fig. 3

Inventory Plan for Photo Interpretation of the Morice TSA

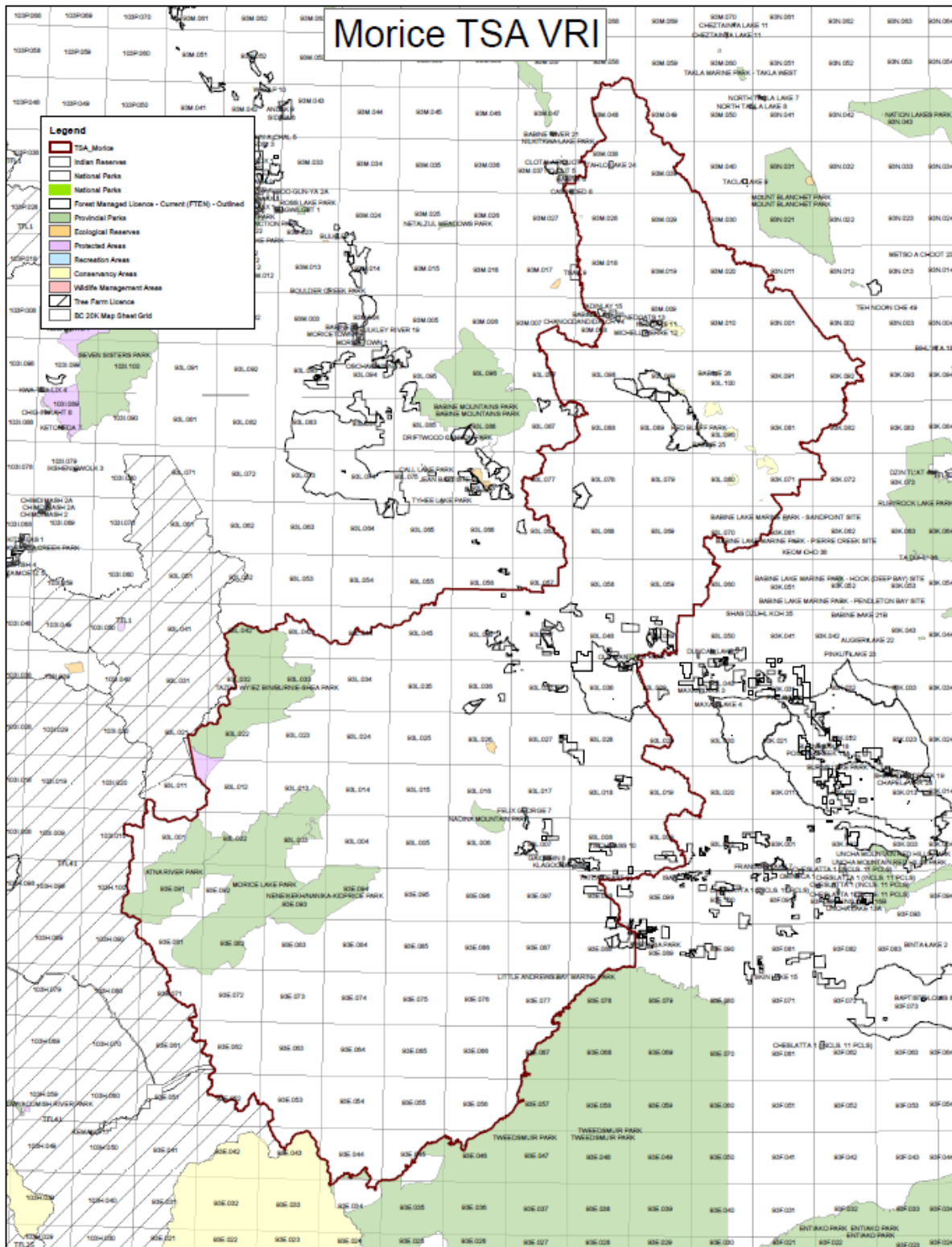


Fig. 4

Inventory Plan for Photo Interpretation of the Morice TSA

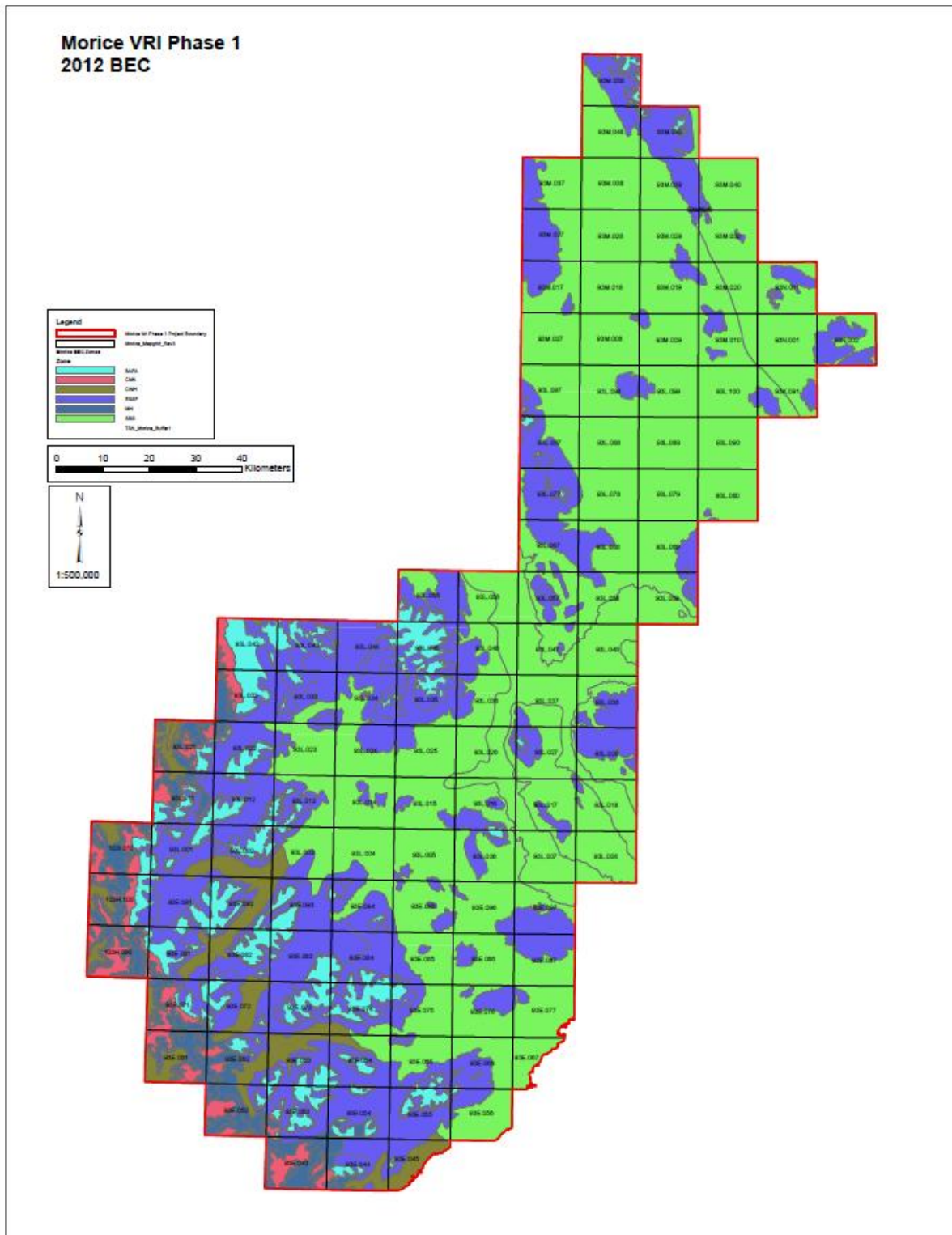


Fig. 5

Inventory Plan for Photo Interpretation of the Morice TSA

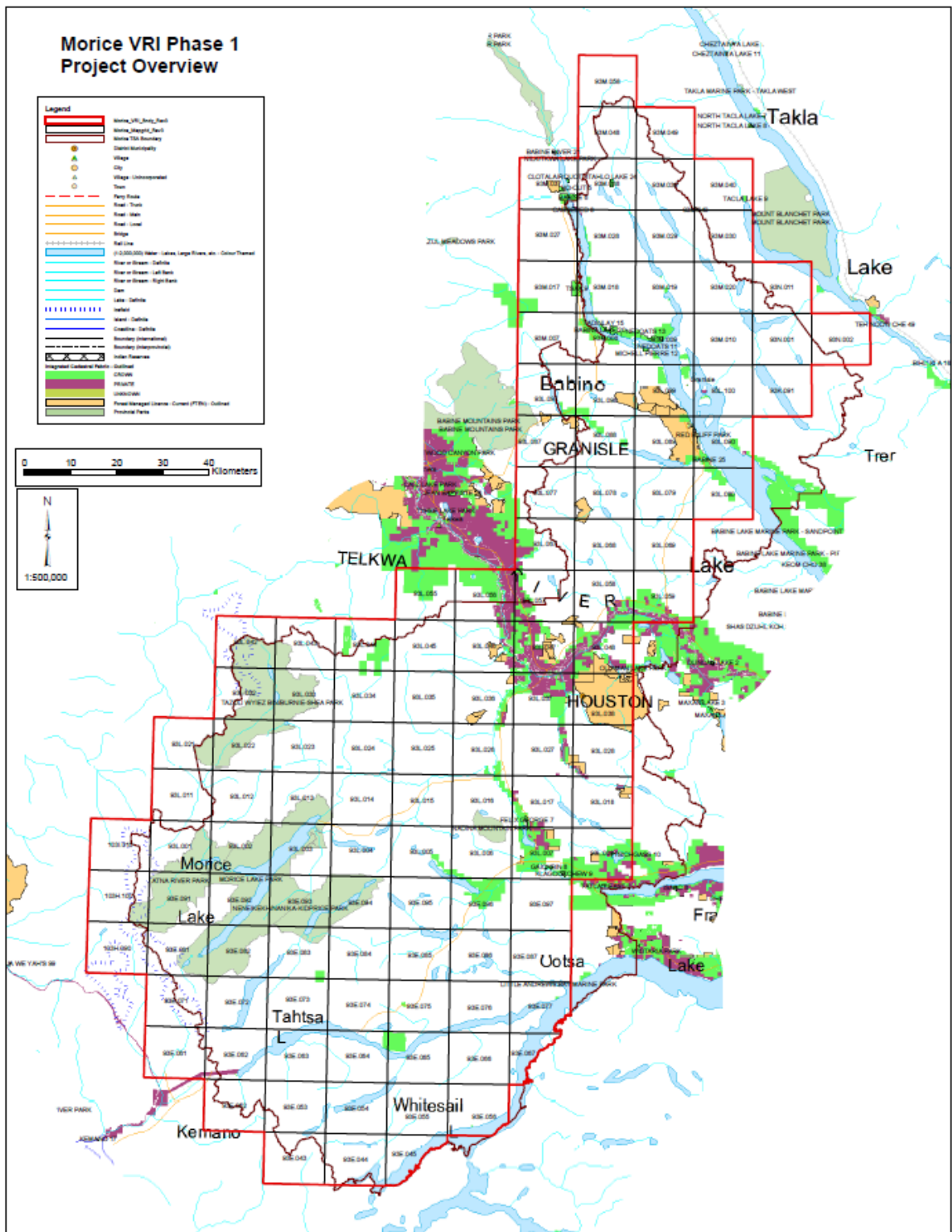


Fig. 6

Inventory Plan for Photo Interpretation of the Morice TSA

