Morice Timber Supply Area

Vegetation Resources Inventory

Strategic Inventory Plan

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March 2007

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EXECUTIVE SUMMARY

The Vegetation Resources Inventory (VRI) strategic inventory plan (VSIP) documents the outcomes of the Morice TSA stakeholders meeting and outlines the important business considerations related to inventory on the land base. VRI activities are identified that will satisfy the needs of the stakeholders, based on priorities set out by the business considerations.

A one million cubic meter AAC uplift has been proposed for ten years in the Morice TSA to mitigate timber losses to Mountain Pine Beetle (MPB). It is crucial that the Chief Forester be provided with current and improved inventory information on the Morice TSA. Also, by gathering current inventory information the stakeholders have a unique opportunity to potentially mitigate timber supply impacts with better informed management decisions. Given the current state of MPB attack in the Morice TSA, the stakeholders have the opportunity to make decisions during the MPB epidemic and expedited AAC implementation, rather than after the MPB attack has subsided, as is the case in other MPB impacted TSAs.

The business considerations for completing a new inventory as identified by the stakeholders in the January 9, 2007 stakeholders meeting are a requirement for improved information on:

- Mid-term timber supply;
- Inventory update for TSR (including information on potentially changing species compositions);
- Understory in MPB attacked stands;
- Height, age and site index;
- Dead volume;
- CWD to provide decision support on landscape-level biodiversity and sustainable forest management planning;
- Levels of MPB attack, changes to current attributes and volumes in MPB impacted stands; and
- Problem forest types.

The Morice TSA stakeholders assessed the need to complete a Phase I program within the TSA and determined that given the current state of the MPB attack, they will postpone this activity for approximately five years.

The stakeholders determined that a Phase II Ground Sampling and Net Volume Adjustment Factor (NVAF) program will provide improved information to address the business considerations. A Phase II/NVAF program will be implemented to address the above business considerations.

A Change Monitor Inventory (CMI) program will be implemented on the TSA. CMI is an important tool to provide information on the mid-term timber supply. This program will gather information for providing validation of models used in timber supply analysis, and can quantify stand attributes in younger aged stands. Information from the CMI program could also be used for decision support with regards to timber supply (in the target population) for short term AAC decisions.

Approximately 100 timber emphasis VRI Phase II plots will be established, approximately 100 trees will be destructively sampled for NVAF, and approximately 50 CMI plots will be installed. The approximate cost for completing these activities, including statistical adjustment is $492,000. The goal is to complete the ground sampling program by the end of the 2007/2008 fiscal year; however this is contingent on the availability of Forest Investment Account (FIA) funding. Recent Forest Investment Account (FIA) funding levels for the Morice TSA would accommodate the Phase II and CMI programs to be completed in one year. A Phase I will be completed once the MPB outbreak subsides on the TSA, likely in 2012.

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1. INTRODUCTION

1.1 BACKGROUND

This Vegetation Resources Inventory (VRI) Strategic Inventory Plan (VSIP) outlines VRI activities and products needed to address forest management and inventory issues in the Morice Timber Supply Area (TSA). The VSIP provides details for photo interpretation, ground sampling, and statistical adjustment of the inventory. Following VSIP approval, the next steps include preparation of VRI project implementation plans (VPIP), and implementation of these VPIPs.

The Morice TSA stakeholders group is comprised of participants operating within the Nadina Forest District, including the Morice & Lakes Innovative Forestry Practices Agreement (IFPA) Technical Team (including Canadian Forest Products Ltd. (Canfor), Houston Forest Products Ltd., Babine Forest Products Ltd., BC Timber Sales (BCTS), Fraser Lake Sawmills, and the Ministry of Forests and Range (MoFR) represented by Forest Inventory and Analysis Branch (FAIB), the Nadina Forest District and the Northern Interior Forest Region.

The stakeholders are as follows:

- MoFR (FAIB, Region, & District)
- BCTS
- Ministry of Environment
- BC Parks
- Canfor
- Houston Forest Products
- Babine Forest Products
- Fraser Lake Sawmills

This VSIP follows a conference call with stakeholders that took place on January 9, 2007. The following is a list of attendees for this meeting:

- Jim Burbee (Tweedsmuir)
- Jim McCormack (Canfor)
- Richard Vossen (Babine FP)
- Jason Platzer (Babine FP)
- Jaret Van der Geissen (Houston FP)
- Tom Olafsen (Fraser Lake Sawmills)
- Chris Hunter (BCTS)
- Dick Nakatsu (MoFR – PG)
- Gary Johansen (MoFR – FAIB)
- Laurence Bowdige (MoFR – FAIB)
- Hamish Robertson (Timberline)
- Hugh Carter (Timberline)
- Gyula Gulyas (Timberline)

1.2 VRI OVERVIEW

The VRI is a vegetation inventory process that has been approved by the former 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.*[1]

The VRI consists of several components:[2]

1. Photo Interpreted Estimates (Phase I).
2. Ground Sampling (Phase II) – timber emphasis, ecology, coarse woody debris.
3. Net Volume Adjustment Factor (NVAF) sampling.
4. Change Monitoring Inventory (CMI).
5. Statistical Adjustment.

One or more of these components can address specific forest management or inventory issues. For more detailed information, VRI manuals are available on the MoFR – Forest Analysis and Inventory Branch website.[3]

1.3 VRI PLANNING

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

The VRI planning process is an important component of the overall VRI process and related activities (Figure 1). The intent 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);[4]
2. Identifying forest management issues;
3. VRI strategic planning (prepare a VSIP);
4. VRI operational planning (prepare VPIP); and
5. Implementation, including development and maintenance of procedures and standards:
    a. Management inventories;
    b. Database management;
    c. Data interpretation.

The steps for preparing a VSIP include:

1. Licencee stakeholders work with MoFR staff to develop issue statements related to the VRI.

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[1] Forest Resources Commission. 1991. The Future of Our Forests – Executive Summary. Unpublished, Victoria. 41 pp.

[2] A glossary of technical terms is provided in Appendix I.

[3] http://www.for.gov.bc.ca/hts/vri/

[4] The Morice TSA Sustainable Resource Management Plan 3(SRMP) was completed in October, 2005.

2. Licencee stakeholders work with MoFR staff to develop issue statements related to the VRI.
3. All agencies and stakeholders meet to refine issues and discuss why these issues need to be funded. The purpose of this meeting is to:
    a. Introduce the VRI tools and process;
    b. Identify new issues and address existing ones;
    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.
    d. Suggest the VRI tools to address currently fundable issues as well as those issues that may be funded in the future.
4. Meeting minutes are prepared and circulated to all participants for review and feedback.
5. A final VSIP is prepared. This VSIP incorporates items agreed to in Step 2 and 3 and is signed off by committee members.
6. VPIP process begins.

The VPIP details the activities identified under the VSIP (Phase I Photo Interpretation or Phase II Ground Sampling) by providing project areas; priorities; scheduling; identifying the population and strata for sampling; and sample size. The steps for preparing the VRI Phase I & Phase II/NVAF VPIPs include:

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

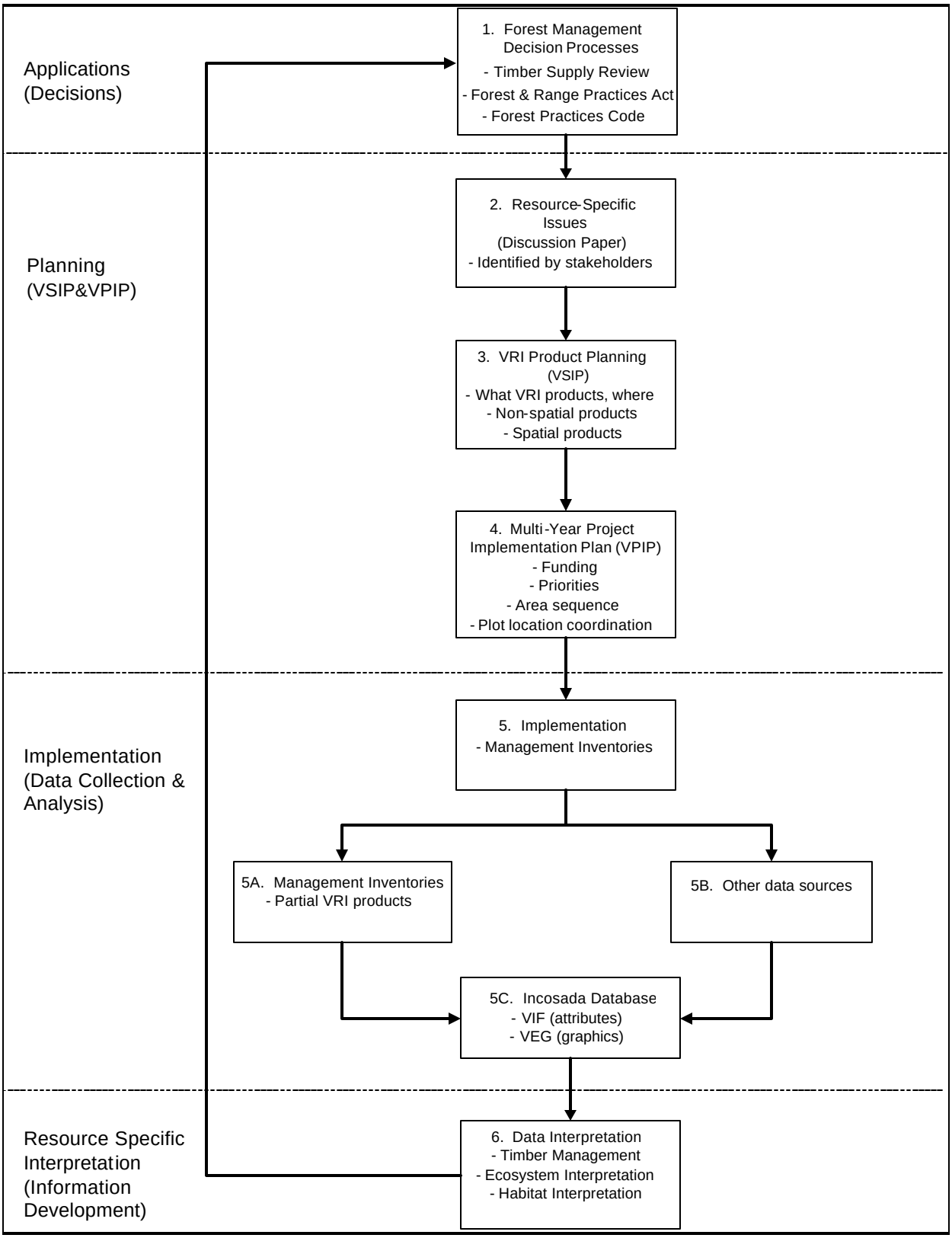

Figure 1. VRI planning process.

1.4 VRI METHODOLOGY

1.4.1 Phase I – Photo-Interpretation

Prior to commencing a Phase I VRI, a *VPIP for Photo Interpretation* must be completed and approved by the MoFR. This plan details photo acquisition requirements, the VRI Phase I process, standards for adherence, and a photo interpretation plan to implement the Phase I of the VRI.

Phase I is the photo interpretation phase of a VRI and entails polygon delineation and attribute estimation by certified photo interpreters using aerial photographs or digital images. The delineation identifies the location of the forest resources and the attribute estimation component provides estimates of numerous attributes including land cover type, crown closure, tree species, height, age, stand structure, basal area, density, slope position, moisture and nutrient regime, snags, shrubs, herbs, and bryoids. Estimation of attributes from field reference points is based upon field procedures using a combination of air and ground calibration points.

1.4.2 Phase II – Ground Sampling

Prior to commencing a Phase II VRI, a *VPIP for Ground Sampling* and NVAF destructive sampling plan must be completed and approved by the MoFR. This plan details the Phase II sample selection process and standards for adherence.

Specifically the Phase II VPIP plan will:

- Detail the Phase II project and sampling objectives;
- Detail the NVAF project and sampling objectives;
- Identify target and sample populations, sample selection, and sample size details;
- Quantify additional sample data that needs to be collected to address information gaps;
- Include discussion of the field program;
- Discuss the proposed data compilation, analysis, and statistical adjustment;
- Include the proposed implementation schedule.
- Include the estimated costs associated with the Phase II/NVAF program; and,
- Include a section of deliverables for the MoFR.

The samples (samples are "plot clusters" and consist of a main plot and up to four associated auxiliary plots) selected for the Phase II ground sampling is based on the delineated polygons and attributes estimated during Phase I. Samples are selected randomly using a two-step process. First, polygons are selected proportional to area. Second, a random point is selected within the polygon. Comparison between the sample and target population are provided for key inventory attributes.

1.4.3 Net Volume Adjustment Factor

As per MoFR VRI standards, all new VRI's must complete an NVAF sampling program in addition to the Phase II. This sampling involves detailed stem analysis of sample trees that have been randomly selected from the Phase II auxiliary plots. The NVAF is used to correct the VRI estimates of net close tree utilization for all species.

1.4.4 Statistical Adjustment

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

1.4.5 Change Monitoring Inventory

A Change Monitoring Inventory (CMI) program takes measurements at timed intervals with the intent of monitoring change over time of key forest inventory attributes. These change estimates can then be compared to predictions derived from growth and yield models. One of the objectives of the CMI program is to act as an early warning system if assumptions used in growth and yield models are inaccurate. The CMI will only indicate that there is a problem with the model(s); it will not give information about the source of the problem. Specific studies can be undertaken to investigate the source of the problem identified by the CMI program.

1.5 FUNDING

Funding for VRI activities is provided by the Forest Investment Account (FIA) Land Base Investment Program.

2. BUSINESS CONSIDERATIONS

2.1 LAND BASE DESCRIPTION

The Morice TSA is situated in northwestern B.C. in the Northern Interior Forest Region (Figure 2) and covers approximately 1.5 million hectares (Table 1). The timber harvesting land base (THLB) in Timber Supply Review (TSR) 2 was 683,962 ha (46% of the TSA).[6]

The Morice TSA lies along the western edge of B.C.'s Interior Plateau, with the Cascade Mountains to the west. Extending from the northerly tip of Babine Lake in the north to Ootsa and Whitesail lakes in the south, the TSA has a gentle, rolling landscape in the north and east, becoming more mountainous in the southwest. Major rivers include the Bulkley, Morice and Nadina. The climate is transitional between coast and interior, with cool summers and cold winters.

The forests of the Morice TSA are fairly diverse. Within the land base currently considered available for timber harvesting (THLB), lodgepole pine (Pl) occupies more than 50% of the land base. The two other major species are hybrid spruce (Sx) and subalpine fir (Bl). Trembling aspen, amabalis fir, western hemlock, and mountain hemlock also occur in minor amounts. Over 70% of the forests in the TSA are currently mature and old (age class 6+); over time the forest will consist more predominantly of younger stands (less than 120 years) as a result of harvesting.

At the time of TSR2, 64% (or 961,000 ha) of the TSA land base is considered productive forest. Currently about 71% of this forested land base is considered available for harvesting (46% of the total TSA land base) (Table 1.).

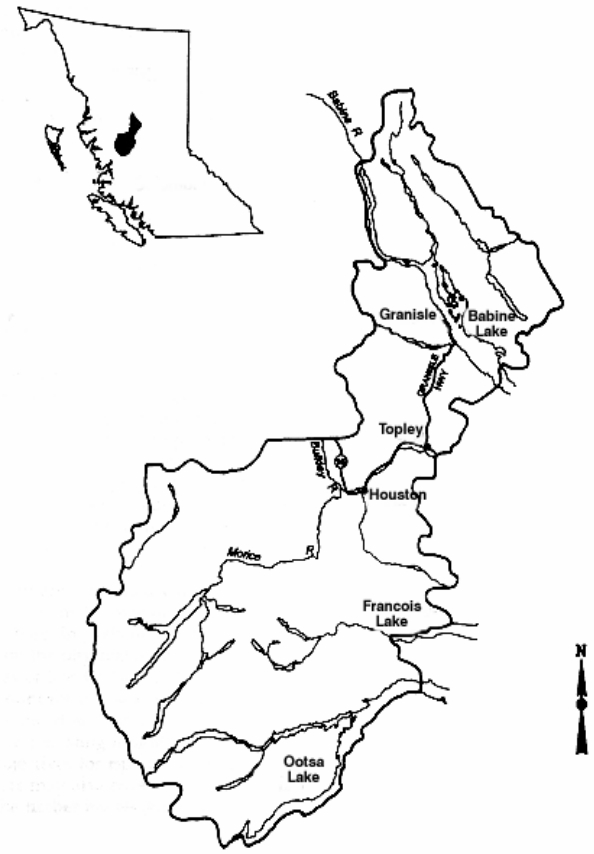

Figure 2. Overview map Morice Timber Supply Area.[5]

Table 1. TSR 2 THLB net-down process.

Land Class	Area (ha)	% of TSA
Total TSA	1,500,349	
Non Crown Ownership	59,527	4%
Agricultural Leases	21,130	1%
Crown Ownership	1,419,692	95%
Non-Forested	457,784	31%
Forested	961,908	64%
Non-THLB	277,946	19%
THLB	*683,962*	*46%*

[5] This map was copied from the MOFR Forest Analysis and Inventory Branch Website

[6] BC Ministry of Forests. 2002. Morice Timber Supply Area Analysis Report. Unpublished Report, February 2002. p. 4.

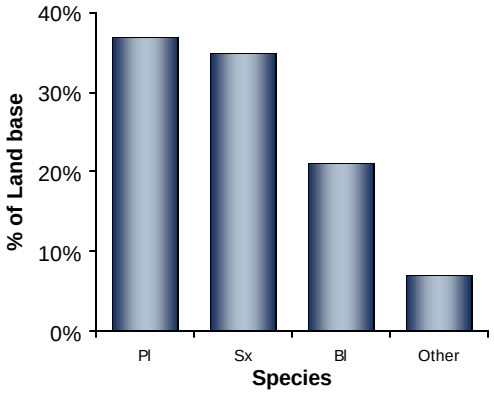

Figure 3. Species distribution in the vegetated treed portion of the Morice TSA.

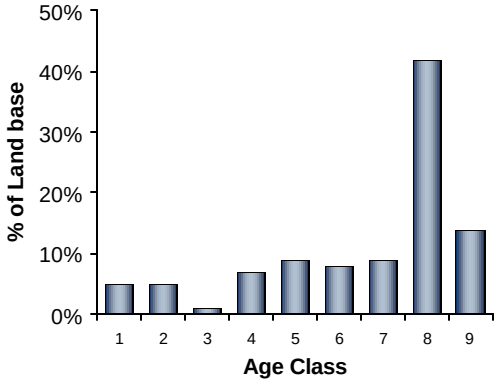

Figure 4. Age class distribution in the vegetated treed portion of the Morice TSA.

2.2 First Nations

There are six First Nations with traditional territory within the Morice TSA, as well as 17 Indian reserves. The First Nations are the Lake Babine Nation, Cheslatta Carrier Nation, Broman Lake Band, Nee-Tahi-Buhn Band, Skin Tyhee Band Nation, and Wet'suwest'en Hereditary Chiefs. Only the Lake Babine Nation has year-round communities within the TSA, located at Fort Babine and at the Tachet reserve in Topley Landing. All of the above First Nations have filed Statements of Intent with the British Columbia Treaty Commission, claiming traditional territories that cover almost all of the Morice TSA. Once the treaties or related agreements have been finalized, they will be considered in a future Timber Supply Review.[7]

2.3 Current Forest Cover Inventory

The most recent photography used in the Morice TSA was flown in 1993 with photo interpretation completed in 1994. Inventory updates were a concern of the Chief Forester in the 2002 AAC Determination[8] and as a result there have been continual updates through the Land and Resource Data Warehouse (LRDW). A retrofit of the existing inventory and implementation of a Phase II ground sampling program were proposed in 2001; however, both initiatives were not funded.

The 1997 inventory audit of the Morice TSA forest inventory showed that there was no statistical difference between the inventory and ground volumes, heights, and ages for both the forested and operable land bases. The Chief Forester expressed concern around a possible underestimation of site productivity in the inventory.

[7] BC Ministry of Forests. 2002. Morice Timber Supply Area Analysis Report. Unpublished Report, February 2002. p. 9.

[8] BC Ministry of Forests. 2002. Morice Timber Supply Area Rationale for AAC Determination. Unpublished Report, October 2002.

More recently Timberline Natural Resource Group[9] has initiated a basic study related to taper differences for Pl in the Northern Interior.[10] Also a piece size inventory[11] was completed for Canfor (Houston) to provide operational information on the existing inventory.

2.4 FOREST MANAGEMENT CONSIDERATIONS

More than 50% of polygons in the Morice TSA THLB are Pl-leading. The TSA also has a large component of mixed stands where Pl contributes to the timber supply. Mountain Pine Beetle (MPB) infestations were first detected in 2003-2004 in the southern portion of the TSA and currently the infestation is moving north in the TSA.

A one million cubic meter AAC uplift has been proposed for ten years in the Morice TSA to mitigate timber losses to Mountain Pine Beetle (MPB). It is crucial that the Chief Forester be provided with current and improved inventory information on the Morice TSA. Also, by gathering current inventory information the stakeholders have a unique opportunity to potentially mitigate timber supply impacts with better informed management decisions. Given the current state of MPB attack in the Morice TSA, the stakeholders have the opportunity to make decisions during the MPB epidemic and expedited AAC implementation, rather than after the MPB attack has subsided, as is the case in other MPB impacted TSAs.

The Morice TSA stakeholders identified the mid-term timber supply as their most important issue. The MPB is attacking pure and mixed Pl stands which currently forms a significant component of the midterm timber supply. The stakeholders seek improved information from these stands, particularly improved estimates of MPB shelf-life, species composition, merchantability of residual MPB stands, post MPB status of immature pine stands, dead wood volumes, and their understory components.

The following forest management issues have been identified and discussed by the stakeholders:

[9] Completed by J.S. Thrower & Associates Ltd. prior to merging with Timberline Forest Inventory Consultants.

[10] This is a broad study comparing actual tree taper to that of the provincial taper equations. This study is using 115 NVAF trees from across the Northern Interior. The results of this study have not yet been completed.

[11] A piece size inventory provides information on log size distribution for mill planning using operational cruise plots.

ISSUE	PHASE I IMPACT	PHASE II IMPACT	COMMENTS
1. Midterm Timber Supply (Approx. 2015-2060)	Low	High	The performance of prediction models used for timber supply is not fully understood in complex, non-salvaged, stands where MPB attacked trees affect understory growth. Results from simulation studies in Northwestern B.C. suggest that true understory yields may not be as predicted in areas attacked by MPB (particularly for the first 10 years after attack).[12] Using inaccurate yield curves or models to predict midterm timber supply would significantly impact the licencees' and MoFR's ability to carry out accurate strategic planning. There will be a range of residual stand conditions resulting from MPB impacted forests.[9] Implementation of a monitoring program either through Change Monitor Inventory (CMI) and/or remeasurement of VRI plots is crucial to assess the validity of models and/or yield curves being used for estimation of mid-term timber supply in these residual stands. CMI can also provide information on live/dead volume in stands making up the midterm timber supply.
2. Understory estimates in MPB attacked stands.	Low	High	The stakeholders believe that understory in MPB impacted stands could add to future timber. Currently, fine resolution, spatial estimation of understory is outside the scope of VRI, thus no standard procedures have been developed. Innovative methods for determining fine resolution, spatial, understory will need to be assessed before implementation of either a Phase I, or a Phase II/CMI program. This could be done in conjunction with the Predictive Ecosystem Mapping (PEM) completed for the TSA. The stakeholders have proposed to use LIDAR[13] to map understory, but the project has not yet received MoFR approval.

[12] Coates, K.D. and E.C. Hall. Implications of Alternate Silvicultural Strategies in Mountain Pine beetle Damaged Stands. BC Forest Service Technical Report. April, 2005.

[13] LIDAR is currently not fundable under FIA.

3. Inventory Adjustment	Low	High	The licencees believe that an inventory adjustment will allow them to improve operational and strategic planning. The stakeholders estimate that the MPB attack will not subside until approximately 2012, as such a VRI Phase I Photo Interpretation project is not recommended at this time. The licencees need improved information on potentially changing species compositions (particularly for pending AAC determinations) as understory could become a significant component of mid term timber supply in MPB impacted stands. The licencees also seek improved information on merchantability of residual MPB stands and post MPB status of immature pine stands. Addressing these issues in MPB impacted stands should be considered when developing the VPIPs. A Phase II/NVAF program will provide improved information to adjust the existing inventory, and thus provide current estimates for TSR. Remeasurement of VRI plots could provide information for future adjustments to the inventory once the MBP attack subsides.
4. MPB Shelf-life	Low	High	The Federal and Provincial Government have initiated studies to improve shelf-life estimates of MPB attacked stands. A Phase II/NVAF program could either contribute information used for predicting or potentially localize prediction of shelf-life for the Morice TSA. Information on date of MPB attack and foliage conditions are factors to consider when predicting shelf-life attributes.[14] Other field measures such as check depth and bark retention may prove to be indicators of quality degradation in MPB attacked stands.[15] The licencees will asses the utility of collecting this information in the Phase II VPIP.

[14] Discussion with Will Smith (January 2007) regarding preliminary results of the Provincial shelf-life initiative.

[15] Final analysis still needs to be completed to determine the utility of these field measures for shelf-life prediction.

5. Dead Wood estimates in MPB attacked stands.	Low	High	The stakeholders require improved estimates of dead volume (particularly Pl attacked by MPB) in the inventory. Collecting information on dead standing stems in all plots in a Phase II/NVAF cluster would provide information on the amount of deadwood in the TSA.[16]
6. Long-term timber supply (2060+)	High	High	Improved information about long-term timber supply is required to support strategic planning initiatives. An accurate Phase I and well implemented Phase II program will provide greater confidence in long term timber supply predictions. CMI program results can help develop or modify yield curves and confirm timber supply projection assumptions. CMI is also an effective way of quantifying attributes in managed stands or post harvest regenerated stands, and can potentially be used to adjust the inventory.[17]
7. Problem Forest Types (PFT)	Low	High	Some areas within the TSA were deemed to be "low sites" (or PFTs) in the last TSR. This is likely an artifact of the inventory, rather than the actual performance of these stand types. The licencees completed a study[18] to improve the inventory attributes associated with 61,000ha Bl leading, 13,000ha Sx leading, and 26,000ha Pl leading.[19] This portion of the land base could be considered as a separate stratum when completing the Phase II VPIP.
8. Site productivity	Low – Med	Low - Med	In the 2002 AAC determination the Chief Forester suggested that site productivity might be under-estimated for managed stands. The on-going SIBEC program will provide improved information on site productivity. Phase I and Phase II VRI programs establish improved estimates of height and age from managed stands which are used to calculate improved estimates of site index.

[16] The MoFR has suggested that this may become a standard VRI procedure in the near future.

[17] This is currently outside of the VRI standards.

[18] Morice & Lakes IFPA, 2003. Analysis of Low Site Polygons. http://www.moricelakes-ifpa.com/publications/index.htm

[19] The results of this study indicated that the current inventory does not accurately reflect the characteristics of low site polygons. In particular the study indicates that site index is underestimated for all species and net volume is underestimated for spruce, pine, and balsam polygons.

9. Landscape level biodiversity	Low	High	Biodiversity estimates are an important component of Forest Stewardship Plans. The TSA stakeholders have several programs to address coarse woody debris (CWD); however improved information is needed on stand structure, seral stage distribution, and age estimates for old growth. The Phase II program should provide improved estimates of these attributes; however the utility of this information should be assessed to ensure it is consistent with the stakeholders' information.
10. Fish and Wildlife	Med	Med	Habitat attributes can be obtained through a Phase I program, PEM, and collection of stand attributes in a Phase II program.
11. Historical and Archaeological	Med	Low	A predictive model has been implemented in the TSA. Improved Phase I estimates provide more reliable information feeding into predictive models.
12. Operable land base	N/A	N/A	A no-harvest zone exists in the southern part of the TSA and may be excluded from the Phase II ground sampling program due to high expense and potential safety concern. The licencees suggested that areas classified as non-contributing may be included in the ground sampling program to address possible reclassification. Including the non-contributing land base in the Phase II program will be addressed during creation of the Phase II VPIP.
13. Operational needs	Med – Low	High	The licencees have implemented several operational programs to help support their strategic and mill planning requirements. Their intent is to determine and create linkages between the existing programs and the inventory. These initiatives will be further discussed in the Phase II VPIP.
14. Environmentally Sensitive Areas	Low	Low	In the 2002 AAC determination there were concerns about terrain stability mapping in some areas of the TSA. Many of these areas are in the no-harvest zone of the TSA. This is issue is not addressed through VRI.

15. Taper	Low	High	The stakeholders have concerns about the taper equations used for Pl on the TSA. Canfor has led a study to assess the existing taper estimates in Pl. An NVAF program has the potential to identify issues related to taper and could provide good information for use in future taper studies.[20]
16. Parks	Med – Low	N/A	There are some parks adjacent to and within the TSA. The Phase I VPIP would identify those parks considered as part of the target population.
17. First Nations	N/A	N/A	Not discussed at the stakeholders meeting.

2.5 SUMMARY OF INVENTORY ISSUES

The completion of VRI activities could provide better information on:

- Mid-term timber supply;
- Inventory update for TSR (including information on potentially changing species compositions in merchantable stands, impact of merchantable volume thresholds for residual MPB stands, and productivity impact of MPB on immature stands);
- Understory in MPB attacked stands;
- Height, age and site index;
- Dead volume;
- CWD to provide decision support on landscape-level biodiversity and sustainable forest management planning;
- Levels of MPB attack, changes to current attributes and volumes in MPB impacted stands; and
- Problem forest types.

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[20] A significantly increased sample size would be required for the species of interest to confidently identify any issues with taper.

3. STRATEGIC INVENTORY PLAN

3.1 OVERVIEW

This section outlines the strategic inventory plan to develop the VRI program. The main product of the VRI program is a statistically unbiased vegetation inventory. For the Morice TSA this requires Phase II Ground Sampling, NVAF, and Statistical Adjustment. In addition, a CMI program will be initiated to monitor second-growth stand performance (in stands <50 yrs) and potentially validate models and yield curves. This CMI program could be used to adjust the inventory, but this is outside current MoFR standards.

The Morice TSA stakeholders decided to delay a Phase I program until after the MPB attack has subsided (approximately 5 years). The current inventory suitably addresses the stakeholders' information needs; however, an adjustment should be completed based on the results of a Phase II program before the next TSR (upon approval of request for uplift or 2012).

3.2 PHASE II - GROUND SAMPLING

3.2.1 Objective

The primary objective of the Phase II ground sampling program is to provide ground estimates to adjust the volume, age, and height of the existing inventory with a ±10% sampling error at a 95% confidence level. Secondary objectives of Phase II ground sampling are to develop improved information on MPB impacted stands, and to facilitate collection of other stand attributes to support strategic and operational planning needs.

3.2.2 Target Population

The target population is the Vegetated Treed (VT) area within the TSA, 30 years or older. If the BC Land Classification Scheme (BCLCS) information is unavailable, VT will be defined as polygons where a leading species exists and crown closure is greater than or equal to 10%. Exclusion of the no-harvest zones (i.e., inoperable areas), and inclusion of non-contributing areas in the target population will be discussed during development of the Phase II VPIP.

3.2.3 Sample Size

The coefficient of variation (CV) for the ratio of means calculated from the inventory audit for mature volume was 39%.[21] MoFR recommends increasing the CV by 10% to 49%, meaning that approximately 100 samples are required to achieve the target sampling error of ±10%.

3.2.4 Sampling Approach

Phase II certified samplers will install all VRI Timber Emphasis Plots (TEPs), plus CWD, and succession data to VRI ground sampling standards.[22] The need to collect ecological data (and by whom)[23] should be assessed during the development of the Phase II VPIP. Sampling will follow a two-stage approach which should be completed in a single field season. The first stage will be

[21] The CV of the ratio of means was calculated using the 1997 Morice inventory audit results for the analysis of mature volumes.

[22] http://ilmbwww.gov.bc.ca/risc/pubs/teveg/vri_gs_2k4/vri_gs_2k4.pdf

[23] If only a limited amount of ecological information is needed a TEP certified field sampler may be used instead of a fully eco-certified field sampler. By using a TEP certified crew to collect this information significant cost can be saved.

focused at installing a minimum number of TEPs (approximately 40) to support the information needs of the NVAF program, as well as providing enough information to allow for an interim analysis to assess the remaining plot requirements to achieve the target sampling error. The second stage will be to install enough TEPs to achieve a target sampling error of ±10% at a 95% confidence level. This approach will be refined and updated in the Phase II VPIP. If the information needs are satisfied for the NVAF enhancement early in the field season, the NVAF tree selection and destructive sampling could run concurrently with the establishment of the remaining VRI plots.

3.2.5 Sample Selection

Sample locations will be selected using the standard MoFR methods. First, polygons will be selected using the probability proportional to size with replacement (PPSWR) method. Second, a random point will be selected within the selected polygon using the provincial 100-m grid. If no 100-m grid point falls within the selected polygon, the grid will be halved until at least one point falls within the polygon.

3.3 NET VOLUME ADJUSTMENT FACTOR

3.3.1 Objective

The objective of the NVAF component is to estimate NVAF ratios with a sampling error of ±7.5% at a 95% confidence level. A NVAF program will provide improved information that could also be used provide improved estimates for MPB shelf-life[24], dead wood volumes, and taper.

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. This ratio is used to statistically adjust the estimate of net merchantable volume of VRI ground samples.

3.3.2 Sample Size

The MoFR recommends a minimum sample size of 100 NVAF trees of which 90 are live and 10 dead[25]. The final sample size and distribution by species will be determined during development of the Phase II VPIP. The relative species distribution (in terms of net merchantable volume) will be estimated and the actual sample size for each species group determined based on the species distribution.

The stakeholders specifically noted that Pl tree taper is an area of uncertainty and believe that current taper equations do not adequately model trees in the Morice TSA. A NVAF program with an increased Pl sample size (dead and alive) may identify taper issues and provide information for use in future studies.

3.3.3 Sample Selection

[24] Depending on the outcome of the current shelf-life study.

[25] Based on an email provided by Will Smith (Feb. 8, 2007) suggesting that the sample size requirements for live and dead trees will change to 10 dead and 90 live for the 2007/2008 fiscal year.

The number of VRI Phase II plots that will be enhanced for NVAF sampling will be determined following discussion with MoFR and will be updated in the VRI Phase II VPIP.

Following completion of the first stage of the Phase II ground sampling program, a tree matrix will be built with all trees from the auxiliary plots of the NVAF-enhanced samples. The sample in each matrix cell will be selected systematically with a random start after sorting the tree list by species and diameter at breast height (DBH).

3.4 CHANGE MONITORING INVENTORY

3.4.1 Objective

CMI is an important tool for tracking growth performance and improving the modeling assumptions for second-growth stands. CMI will be used to monitor the and validate models predicting mid-term timber supply, develop or modify current yield curves, quantify attributes in stands < 50 years and potentially adjust the inventory for these stands.[26]

3.4.2 Target Population

The stakeholders intend to implement a CMI program to provide improved information on their mid to long-term timber supply. Typically the target population for these programs would include only areas that have been harvested in the last 40 years. This population may be to narrow to address the information needs related to understory and mid-term timber supply. Expansion of the target area to partially harvested, and/or Pl stands susceptible to MPB attack, with a high likelihood of viable understory, should be considered before implementing the CMI ground sampling program.

3.4.3 Sample Size

An effective sample size for CMI would be a minimum of 50 plots as it must be both cost-effective and large enough to allow for post-stratification. It is expected that the sample size will increase as the number of stands coming into the target population increases.

3.4.4 Sample Selection

Sample selection will follow the CMI standards at the time of selection. For continuity and consistency, it is recommended that the Phase II VPIP and CMI VPIP be completed concurrently; however funding limitations may require that the two plans be completed independently.

[26] This is currently outside the scope of VRI; however it could be discussed following compilation of plots and during the adjustment phase of the VRI.

3.5 ESTIMATED COSTS

The costs provided below include the approximate costs for a Phase I VRI. The total project cost for a Phase II Ground Sampling program is approximately $336,500. The total project cost for a CMI program is approximately $130,500. If the licencee decides to complete a Phase I program the total approximate cost will be $1,765,000.

Table 2. Estimated costs for VRI activities in the Morice TSA.

VRI Activity	Units	Estimated Unit Cost ($/Unit)	Total Estimated Cost ($)	Estimated Projected Fiscal Year
PHASE I (PHOTO INTERPRETATION)				
Photo Acquisition[a]	1,500,000	$0.20/ha	$300,000	2007/2008
Phase I VPIP	1		$10,000	2012/2013
Polygon Delineation and Attribute Estimation[b]	1,500,000	$1.00 – $1.30/ha	$1,725,000	2012/2013
Quality Assurance			$30,000	2012/2013
Sub-Total			*$2,065,000*	
PHASE II (GROUND SAMPLING)				
Phase II VPIP	1	$10,000	$10,000	2006/2007
Sample Packages			$8,000	2006/2007
VRI Plots (TEP)	100	$1,600	$160,000	2007/2008
Helicopter			$35,000	2007/2008
Interim Analysis			$10,000	2007/2008
Quality Assurance	10	$1,500	$15,000	Ongoing
Sub-Total			*$238,000*	
STATISTICAL ADJUSTMENT				
Data Compilation	1	$1,000	$1,000	2007/2008
Adjustment & Report	1	$20,000	$20,000	2007/2008
Sub-Total			*$21,000*	
NVAF				
VPIP update / Tree Selection	1	$2,500	$2,500	2007/2008
Destructive Sampling	100	$500/tree	$50,000	2007/2008
Helicopter			$15,000	2007/2008
Quality Assurance		$5,000	$5,000	Ongoing
NVAF Analysis and Reporting	1	$5,000	$5,000	2007/2008
Sub-Total			*$77,500*	
CMI				
CMI VPIP[c]	1	$7,500	$7,500	2006/2007
Sample Packages	50		$8,000	2006/2007
Plot Establishment	50	$1,600	$80,000	2007/2008
Helicopter			$20,000	2007/2008
Quality Assurance	5	$1,500	$7,500	Ongoing
Analysis & Installation Report	1	$7,500	$7,500	2007/2008
Sub-Total			*$130,500*	
Phase II Ground Sampling Total Estimated Cost			***$336,500***	
CMI Ground Sampling Total			***$130,500***	

Estimated Cost	
Phase I Total Estimated Cost	***$1,765,000***
Total Estimated Cost	***$2,232,000***

[a] Photography and orthos will be funded through the Federal MPB process rather than through FIA.
[b] Includes variable costs for air and ground calibration calls and helicopter.
[c] This cost assumes that the Phase II VPIP and the CMI VPIP are completed at the same time.

SIGN-OFF SHEET

I have read and concur that the Morice TSA VRI Strategic Inventory Plan dated March, 2007 meets current VRI standards. 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.

_____ _____

Jon Vivian, R.P.F. Manager, *Date*

Vegetation Resources Inventory Section,
Forest Analysis and Inventory Branch,

Ministry of Forests and Range

_____ _____

Morice & Lakes IFPA (lead proponent) *Date*

APPENDIX I – GLOSSARY OF TERMS

Ground Sampling

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

Landcover Classification

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

Net Volume Adjustment Factor (NVAF) Sampling

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

Photo-Interpretation (Phase I)

Photo-interpretation (Phase I) involves the subjective delineation of polygons and the photo estimation of attributes for all polygons in an inventory unit. Medium scale aerial photographs (1:15,000) are most often used in the photo-interpreted estimates inventory.

Post-Stratification

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

Pre-Stratification

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

Sample Size

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

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

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

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

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

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

Statistical Adjustment

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

Sub-unit

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

Target Population

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

Target sampling error

Target sampling error expresses the desired accuracy of the attribute of interest (e.g., timber volume). It is usually expressed as a percentage value at a given probability level (e.g., ±10 at the 95% probability level). This means that 95% of the time we are confident that the volume estimates are within 10% of the actual volume. Target sampling error is used to calculate the minimum sample size for subsequent ground sampling; see ***Sample Size***.

Vegetation Resources Inventory (VRI)

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

- BC Landcover classification scheme (BCLCS).
- *Photo-interpreted estimates (Phase I)*: the delineation of polygons from aerial photography and the estimation of resource attributes.
- *Ground sampling (Phase II)*: the establishment of plot clusters in selected polygons to measure timber, ecological, and/or range attributes. The data are used for the adjustment of the photo-interpreted estimates for all polygons in an inventory unit or management unit.
- *NVAF Sampling*: Stem analysis sampling of individual trees for net volume adjustment.
- *Change Monitoring Inventory (CMI)*: Assessing performance of existing models and acts as an early detection system for issues in managed stands.

The VRI can be deployed over the entire province (provincial VRI) measuring timber and non-timber resources, or over a large management unit (management VRI) measuring selected resources in specific portions of the land base. 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.