Why We Need to Monitor Change In Our Managed Forests

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EXECUTIVE SUMMARY

This document describes the key business drivers to support establishment of a monitoring program for B.C.'s second growth stands. Two of the Ministry's stated goals are "maximum productivity of forest and range resources" and "well managed forest and range resources". There is presently a significant knowledge gap or information lag in regenerated stands between free growing declaration and the point at which these stands are re-inventoried many years later. Achieving either of these goals will not be possible without adequate information to assess actual stand performance. One of the Roundtable recommendations is "Review forest management and silviculture practices to ensure that they encourage maximum productivity, value and support forest resilience." Again, accurate, defensible information on the actual growth of B.C.'s managed stands is required if this recommendation is to be achieved.

The importance of existing and future managed stands to the mid-term timber supply has been significantly increased post mountain pine beetle (MPB) with the urgent need to obtain accurate information on the actual health and growth of these existing managed stands. Most management decisions in BC -, AAC determinations, silviculture investment decisions, carbon accounting, biodiversity planning, future forest ecosystem and climate change planning - are based in part on assumptions of future stand growth. In addition to timber supply, those making strategic silviculture investment decisions and the operational silviculturists implementing treatments on the ground need feedback on the actual performance of managed stands. This feedback or check is required during the earlier stages of stand development to ensure the treatments are achieving stated objectives and that the 250 million dollars in annual silviculture expenditures are being spent in the most efficient and effective way.

Timely investment of a small fraction of the money spent on forest management in BC on a well designed monitoring[1] program will provide a continuous feedback mechanism to the forest management decision makers to improve forest management. A fraction of one percent of the annual silviculture expenditure, for example $80,000 to $100,000 for an average sized management unit, would be sufficient to establish a monitoring program for second growth stands starting with the highest risk areas, with an ongoing cost of $15,000 per year. Furthermore, it is highly likely that the information obtained would result in silviculture spending efficiencies that would cover a significant portion of the monitoring costs. To move toward this goal, several key steps are also recommended, including the technical development of the sampling design and adherence to monitoring second growth in the higher risk and higher priority stands in-line with the direction of the Land Base Investment Plan (LBIP).

[1] For the purposes of this discussion, monitoring is broadly defined as the repeated measurement of forests over time to provide estimates of change.

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1. INTRODUCTION

1.1 BACKGROUND

The objective of this project was to develop a business case for monitoring second growth stands in consultation with Ministry inventory and monitoring specialists. The need to monitor change in B.C.'s managed forests has long been recognized however, in contrast to most previous monitoring efforts, this document proposes establishment of monitoring that is much more focused on second growth stands located in higher risk and priority management units where there has been little to no monitoring to date.. This business case identifies the key drivers that support establishment of a program to monitor second growth stands. The Intensive Forestry Monitoring Program was initiated in 1979 in an attempt to monitor the growth responses of stands treated under the Silviculture Forestry Program. The Silviculturally Treated Program was started in 1985 to provide information about silviculturally treated stands in the province. Unfortunately, both of these programs suffered from design flaws that limited the use of the data.[2] The recognition of these limitations and the need for information resulted in the formation of the Growth and Yield Monitoring Task Force (GYMTF) in 1996[3][4] which culminated in the design of the Change Monitoring Inventory (CMI) protocol.[5] Unfortunately, since the development of CMI, funding to implement the protocol has been limited largely to a few industry initiatives on TFLs. In 2008 a strategy and detailed work plan to implement province-wide monitoring across the entire land base were developed by the Ministry, in consultation with key stakeholders. This initiative, although well supported, stalled due to lack of funding and a lack of critical focus on higher risk areas. More recently, the Stand Development Monitoring (SDM) protocol[6] has been developed as a check of stand attributes assigned at free-growing, a check of forest health, and a process to provide yield estimates to assist in refining yield projections (please see Appendix III for a brief list of monitoring programs in other jurisdictions).

2. WHY MONITORING IS REQUIRED

2.1 TO DEMONSTRATE SUSTAINABILITY

Each year in BC thousands of hectares are harvested and reforested and the social license that allows this level of harvest is based on the assumption of sustainability. The Province ensures sustainability by spending approximately 200 million dollars annually on basic silviculture with the assumption that regenerated stands are "free-growing" (FG), but past this point there are no requirements to check stand stocking and growth. Presently this situation leads to a significant knowledge gap between free growing declaration and the point at which inventory captures younger stand attributes as part of the inventory update or re-inventory processes. Stand performance assumptions need to be periodically checked In order to backup or modify AAC determinations, silviculture investments, carbon sequestration estimates,

[2] JS Thrower & Associates Ltd. 1994. A review of operational growth and yield monitoring in British Columbia. Contract report to BC Ministry of Forests Inventory Branch.

[3] http://www.for.gov.bc.ca/hts/inventory/reports/gymonitor/growthyield/gymonitoring/gytf_iwg_tor_sept1996.pdf

[4] http://www.for.gov.bc.ca/hts/inventory/reports/gymonitor/index.html

[5] http://www.for.gov.bc.ca/hts/vri/standards/index.html

[6] http://www.for.gov.bc.ca/ftp/HFP/external/!publish/FREP/Indicators/FREP%20SDM%20Protocol_June15%202010%20final.pdf

watershed stability, biodiversity and habitat distributions, and any decision that requires an estimate of future forest conditions on FG and stand performance assumptions.

2.2 Fulfilling Responsibilities

To successfully fulfill each of the Forest and Range Resource Stewardship core responsibilities[7] requires accurate, defensible information on the change in our managed forests. There can be no assurance that forest management policies and practices are resulting in a sustainable resource without the information to demonstrate sustainability. A continuous feedback loop on the results of past and current practices is required in order to recommend practices and procedures to mitigate climate change impacts, ensure forest health and guide tree improvement. The mountain pine beetle (MPB) has accelerated the province's reliance on younger managed forests.

2.3 To Provide Critical Information for AAC Determinations

In management units with significant mature timber, AAC determinations are typically not that sensitive to changes in projected regenerated stand growth. However, as the proportion of regenerated stands increases so does the sensitivity of the AAC determination to regenerated stand projections. Post MPB, the significance of regenerated stand growth projections to AAC determinations has increased dramatically. The current uncertainty in actual regenerated stand growth causes a considerable risk that inappropriate AAC determinations will be made. This uncertainty results in the need to confirm or modify current timber supply review (TSR) assumptions as illustrated by the two examples in Appendix I.

2.4 To Check Site Productivity Estimates

Site productivity is primarily indicated by site index, which is a key driver in most growth and yield models. Changes in site index inputs for managed stand projections have significant impacts on future yield projections. In addition, a given site index estimate has an associated assumed height growth trajectory for top height trees which is implicitly used in growth and yield models such as TASS. Checking the actual growth of top height trees over time is a critical component in validating the operational application of existing growth and yield models that are used for timber supply analysis and silviculture decision-making.

2.5 To Continually Improve Basic Silviculture

Each year approximately 200 million dollars are spent on basic silviculture. The choice of regeneration treatment is based in large part on meeting prescribed stocking standards to achieve free-growing. The process of setting stand level objectives, and in particular early stand objectives (stocking standards), fundamentally relies on the ability to predict development of regenerating stands. It is imperative that the uncertainty around existing predictions of stand development is recognized and therefore the need to continually check the actual growth and development of regenerated stands past the FG stage. Data is needed to confirm that the anticipated returns on investment are being met or to change management direction accordingly.

2.6 Post Free-Growing Stands are the Responsibility of the Crown

[7] Ministry of Forests and Range. 2010. The objectives and tasks of functional change to realize our business response. February 1, 2010. (page 14).

Once regenerated stands are declared free-growing they become the responsibility of the Crown yet there is a significant knowledge gap and the assumptions will need to be verified on a number of business fronts. If these stands fail to meet expectations, and the decision is made to apply remedial treatments, these treatments will have to be funded by the Crown. The present lack of information on regenerated stand performance results in an unknown potential future liability to the Crown. The understory reports[8,9], various CMI and SDM work done to date all indicate that monitoring should be conducted to determine the extent of any such liability to the Crown. Three recent reports have stated serious concerns over the health of regenerated lodgepole pine stands and the need to monitor their performance.

2.7 To Ensure Wise Investments in Incremental Silviculture

Incremental silviculture investment decisions are based on return on investment and impacts on timber supply. Currently approximately 50 million dollars is spent in the province annually on incremental silviculture, including backlog reforestation and MPB rehabilitation, but there is little information to determine the additional volume and timing of wood that might become available as a result of these treatments. The responses to treatment are predicted with models available in Ministry software such as Tree and Stand Simulator (TASS) and the distributed software Table Interpolation Program for Stand Yield (TIPSY). The TASS / TIPSY models predict the response to various treatments after verifying results against the best available research data. These tests are best done when the stand conditions prior to treatment are correctly specified. Clearly, it is critical to have accurate estimates of the stand conditions prior to treatment. Operational analyses typically include information on pre-treatment stand condition from pre-treatment assessments. Provincial strategic analyses however, with no better data available, must simply assume the yield projections for managed stands are accurate.[10].[1112]

2.8 Tree Improvement

The province invests approximately 8 million dollars annually in tree improvement programs and the expectations of increased growth and improved pest and disease resistance have been incorporated into timber supply analyses for the past ten years. Tree improvement continues to be strongly supported through the Land Base Investment Plan. Information from second growth stands is needed to ensure accurate projections of these operational gains from tree improvement. Monitoring is required to determine if genetic gain assumptions (growth, pest & disease resistance) are realized in the field.

Furthermore, genetic gain estimates could increase or decrease as a result of climate change depending on species and geographic location. This increases the uncertainty and therefore increases the need for

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[8] Churlish Consulting Ltd., Jahraus & Associates Consulting Inc. 2010. 100 Mile House TSA understory sampling. Unpublished contract report.

[9] Churlish Consulting Ltd., Jahraus & Associates Consulting Inc. 2009. Quesnel TSA pine understory sampling pilot project. Unpublished contract report.

[10] Forest and Range Evaluation Program, 2009. Forest Stewardship Plan Stocking Standards Evaluation. FREP Report #19.

[11] Heineman, J.L., Sachs, D.L., Mather, W.J., Simard, S.W. 2010. Investigating the influence of climate, site, location and treatment factors on damage to young lodgepole pine in southern British Columbia. Can. J. For. Res. 40: 1109-1127.

[12] Mather, W.J., Simard, S.W., Heineman, J.L., Sachs, D.L. 2010. Decline of planted lodgepole pine in the southern interior of British Columbia. For. Chron. 86(4): 484-497.

monitoring, especially when select seed use is expected to increase as a climate change adaptation strategy. This adds an additional requirement to monitor to evaluate the effectiveness of current and new climate based seed use policies.

2.9 CLIMATE CHANGE

The purpose of the Future Forest Ecosystems Initiative (FFEI) is to adapt BC's forest and range management framework to a changing climate. Work conducted under this initiative includes research, modeling, policy analysis, policy change, communication, and monitoring. Sixteen indicators have been recommended for monitoring.[13] A network of systematically located permanent sample plots, such as those provided by the National Forest Inventory (NFI) or CMI programs have been identified as data sources for three indicators (ecosystem distribution and composition, ecosystem productivity, and species diversity). In addition, a network of independent plots that are representative of the second growth stand component would provide a valuable dataset to check predictions of climate change impacts on these younger stands.

2.10 CARBON ACCOUNTING

The inventory-based Carbon Budget Model (CBM-CFS3) developed by the Canadian Forest Service is the preferred model to account for total carbon stocks over time. CBM-CFS3 projections of carbon are sensitive to the merchantable volume equations input into the model, not only for projections of carbon accumulation in live biomass over time, but also for the initiation of dead organic matter pools. Key to ensuring accurate projections of carbon is utilizing accurate merchantable volume equations as model inputs. This requires monitoring of regenerated stands to ensure that they are growing as predicted. For example, select seed use is an eligible activity under the Pacific Carbon Trust, BC Forest Offset protocol. The correct merchantable volume curves for these genetically improved stands are required as a key input into the carbon model. This information is critical to ensure accurate carbon accounting which neither over- nor under-states the case for BC forests being effective agents for carbon sequestration.

3. COSTS AND BENEFITS OF MONITORING

Repeated measurements of forests over time require a significant long-term funding commitment. Historically in BC, the benefits have not been seen to justify the costs.[14] However with our increased reliance on managed stands, the rate of change in these managed stands, the risks of climate change and associated pest and disease problems, and the continued high levels of investment in these stands, there has never been a greater need to spend what amounts to a fraction of one percent of the approximately 250 million dollars spent annually on silviculture on a well designed monitoring program. A fraction of one percent of the annual silviculture budget would be sufficient to establish regenerated stand monitoring programs in all management units in the province. The cost to monitor representative second growth stands in a statistically sound manner is estimated at $80,000 to $100,000 per management unit, with an ongoing cost of $15,000 per year. This cost estimate includes sample planning, plot establishment and measurement of ground samples and summary analyses. Furthermore, the money

[13] Forest and Range Evaluation Program. 2009. Monitoring forest and rangeland species and ecological processes to anticipate and respond to climate change in British Columbia. FREP Report #20.

[14] Note that this is not the case in many other jurisdictions including the USA and Sweden (Appendix II)

invested will provide a substantial return in the form of greatly improved information in support of numerous management decisions.

There are already significant investments on how to implement different types of monitoring programs and any second growth monitoring program would capitalize on these investments. CMI was developed between 1995 and 2001 as a result of the significant body of work completed by the Growth and Yield Monitoring Task Force.. CMI programs have been established in 11 management units in the province. Two TFLs (35 and 52) have already had a second measurement of the plots. In addition to the management unit focus, considerable work has already been completed on a provincial level monitoring strategy.[15] This work was lead by Forest Analysis and Inventory Branch with input from Forest Resources Evaluation Program, forest health specialists, Future Forest Ecosystem Initiative, Canadian Forest Service National Forest Inventory specialists, carbon specialists, Forest Practices and Investment Branch and UBC researchers. SDM has been developed over the past few years to provide a tool for monitoring and updating the inventory of managed stands. An additional goal is to accurately capture the influence of forest insects and diseases and other natural disturbance agents on timber productivity.[16] The establishment of a provincially coordinated program to monitor change in B.C.'s forests can be a lasting legacy for future generations enabling them to better manage the province's future forests based on solid historical evidence of changes in the forest over time.

4. KEY NEXT STEPS

This document has articulated the need to monitor B.C.'s second growth stands as defined by the business drivers described above. Given the knowledge gap and the urgency to act, a number of key next steps have been identified in order to move forward as quickly and effectively as possible:

1. Convene a technical working group to
    a. Confirm the data that is to be captured,
    b. Explore all sample design options, and
    c. Review current technology, such as digital camera sampling (DCS), which could be used to augment ground sampling;
2. Confirm the priority units for establishing second growth stand monitoring in-line with LBIP investment priorities and use this list to guide the derivation of statistical sample lists and specific plans for each unit;
3. Conduct an operational monitoring pilot in one unit (to be determined from step 2 above) to assess the design and confirm cost estimates and Ministry staff time requirements;
4. If the monitoring pilot is successful, implement monitoring in priority management units as part of annual LBIS strategic planning and activities, including annual trend reporting.

[15] British Columbia's Forest Inventory Monitoring Program: A Program to Meet the Needs of the Chief Forester to Address Climate Change Issues. Work Plan. March 2009. Forest Analysis and Inventory Branch.

[16] Protocol for stand development monitoring. Version 1.2. June 10, 2010.

5. APPENDIX I – AFFECTS OF ASSUMPTIONS ON MID-TERM TIMBER SUPPLY

In the Prince George TSA the mid-term timber supply is highly sensitive to assumptions of managed stand growth.[17] Two recently completed sensitivity analyses clearly demonstrate this. Lowering the managed stand site indices from SIBEC estimates to the original inventory estimates results in the managed stand volume remaining unavailable until much later in the forecast and contributing significantly less to the long term harvest level. Forty years from now the future timber supply drops by 40% due to this change in managed stand growth assumptions. Removing the genetic gain assumed in the base case results in many managed stands not reaching the minimum harvest threshold by age 60 and therefore not contributing to the available harvest volume in the mid-term. This is particularly applicable 40-50 years out when there may be up to 18% less managed stand volume available for harvest. In the long term, uncertainty regarding genetic gain may represent a downward pressure up to 5%.

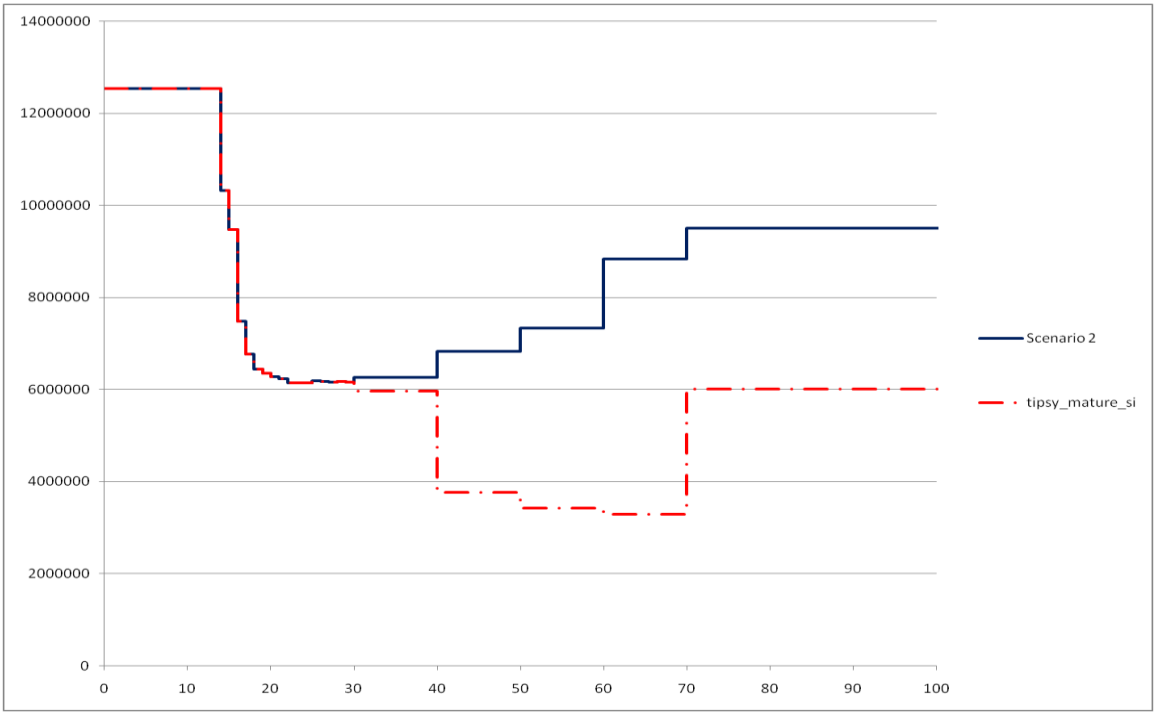

Figure 1. Prince George TSA. The blue line represents the projected future timber supply assuming SIBEC site index estimates for managed stands. The red line represents the projected future timber supply with the original inventory site index estimates.

[17] Barry Snowdon, personal communication, September 14, 2010.

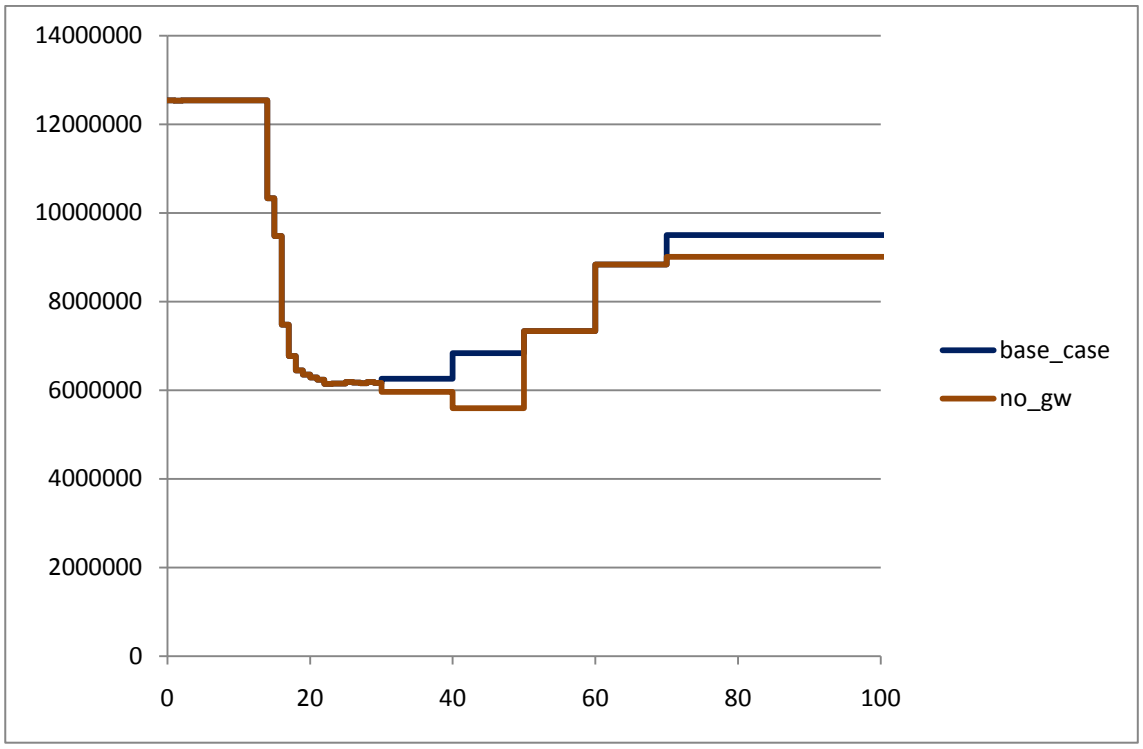

Figure 2. Prince George TSA. Future timber supply with and without genetic gain in managed stands.

In the Quesnel TSA managed stands make an increasingly significant contribution to the mid-term timber supply once MPB salvage is complete.[18] When existing and future managed stand yields were dropped by 20%[19], there is a 10% drop in harvest volume available between 2029 and 2038 and the average long-term harvest level drops.

Several AAC rationales have included requests from the Chief Forester to monitor growth in regenerated stands to assess site productivity estimates and ensure yield projections are accurate (Appendix I).

[18] Gordon Nienaber, personal communication, September 15, 2010.

[19] 20% could be argued to be conservative given that surveys of age class 2 stands showed a 39% mortality rate. (Forest Analysis and Inventory Branch. 2010. Quesnel TSA timber supply review data package. April 2009.)

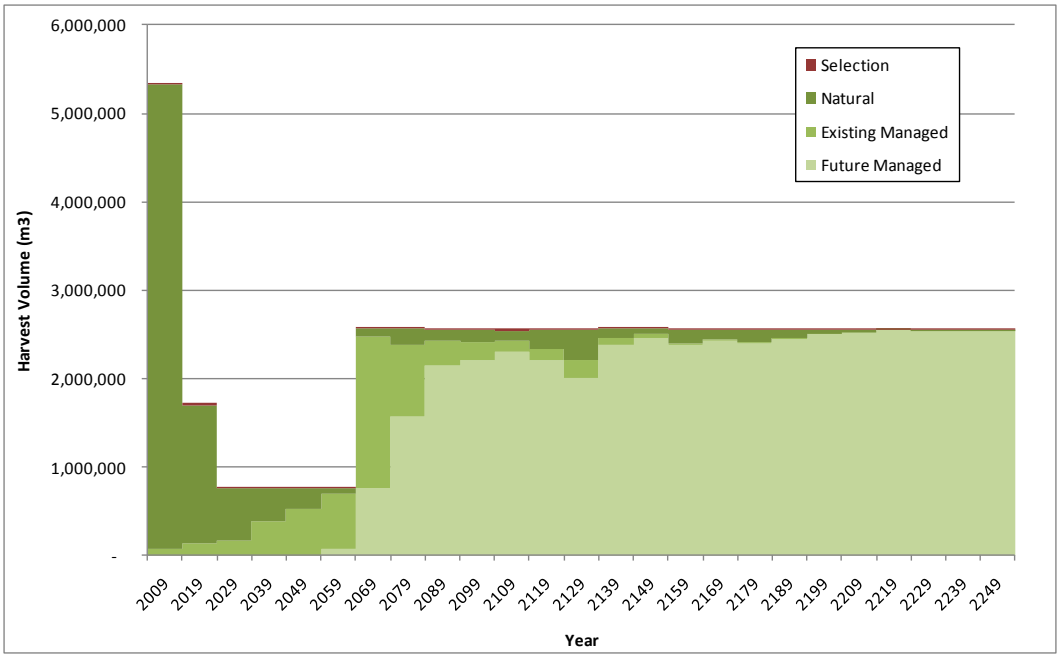

Figure 3. Quesnel TSA base case timber supply.

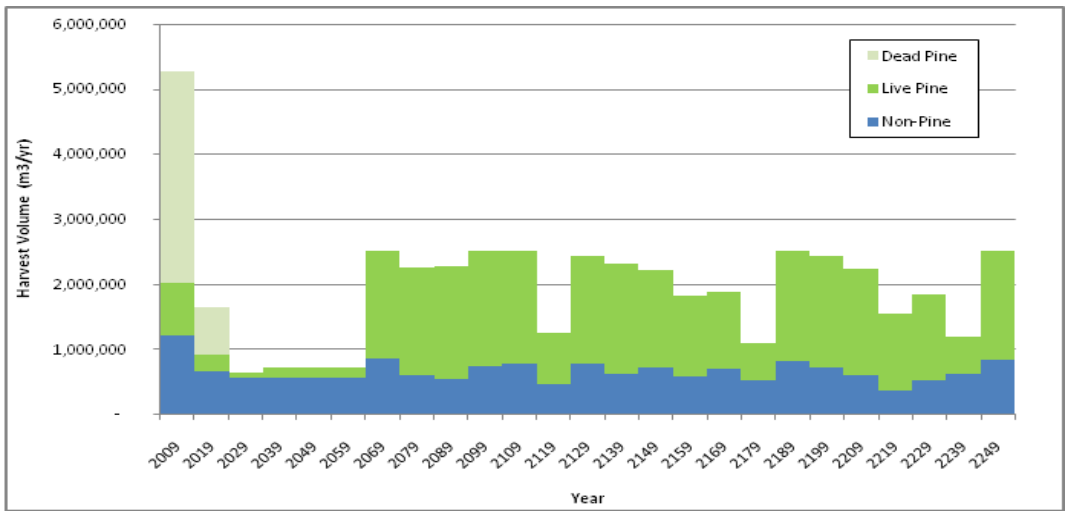

Figure 4. Quesnel TSA timber supply with a 20% reduction in existing and future managed stand yields.

6. APPENDIX II - EXAMPLES OF TFL AAC RATIONALES WITH REQUESTS FOR MONITORING UNDER IMPLEMENTATION

Ministry of Forests 2008. Tree Farm Licence 14. Rationale for allowable annual cut (AAC) determination. BC Ministry of Forests. Victoria, BC. Effective April 7, 2008. 37 pp.
"… monitor regeneration in partially cut pine-leading stands and provide an assessment of growth and yield implications for the next determination…"

Ministry of Forests 2006. Tree Farm Licence 18. Rationale for allowable annual cut (AAC) determination. BC Ministry of Forests. Victoria, BC. Effective March 9, 2006. 49 pp.
"…the licensee monitor performance in managed stands to confirm or revise that the estimated gains in growth and yield are correct given the risk to mid-term timber supply."

Ministry of Forests 2006. Tree Farm Licence 37. Rationale for allowable annual cut (AAC) determination. BC Ministry of Forests. Victoria, BC. Effective Oct 1, 2006. 50 pp.
"I request that the licensee continue to monitor its site productivity estimates to ensure the yield projections used in future analyses appropriately reflect volumes per hectare realized in harvesting operations."
"The operational adjustment factor applied to account for forest health impacts, especially root rot, on regenerated managed stands may have underestimated impacts on timber supply in the mid- to long-term. As the TFL transitions to second-growth forests, this concern becomes more pronounced. I therefore request that the licensee monitor performance in these stands relative to volume projections due to forest health impacts, especially root rot."

Ministry of Forests 2007. Tree Farm Licence 38. Rationale for allowable annual cut (AAC) determination. BC Ministry of Forests. Victoria, BC. Effective March 28, 2007. 57 pp.
"I request that the licensee (a) monitor growth in natural and managed stands to confirm the site productivity estimates for TFL 38 and (b) monitor risks from pests and disease – in particularly for root rot in fir plantations – to ensure the yield projections used in future analyses appropriately reflect volumes per hectare realized on the ground."

Ministry of Forests 2005. Tree Farm Licence 53. Rationale for allowable annual cut (AAC) determination. BC Ministry of Forests. Victoria, BC. Effective October 19, 2005. 46 pp.
"Monitor actual stand volume realized in comparison to predicted volumes in managed stands."

Ministry of Forests 2007. Tree Farm Licence 55. Rationale for allowable annual cut (AAC) determination. BC Ministry of Forests. Victoria, BC. Effective March 8, 2007. 50 pp.
"…monitor growth in natural and managed stands to assess its site productivity estimates and ensure the yield projections used in future analyses appropriately reflect volumes per hectare realized in harvesting operations."

7. APPENDIX III – MONITORING PROGRAMS THAT OTHER JURISDICTIONS HAVE IN PLACE

The United States Department of Agriculture (USDA) Forest Inventory and Analysis (FIA) program[20] maintains an approximately 5 km grid across all forestland in the United States (both private and public). This totals approximately 125,000 permanent sample plots, of which approximately 20% are re-measured annually. This program is strongly supported by the Society of American Foresters.[21] If we assume that approximately 2/3rds of BC is forested (63 million hectares), then a program equivalent to the USDA FIA implemented in BC would have approximately 25,000 permanent sample plots (PSPs) across the province.

Sweden has a permanent plot sample network that is approximately equivalent to an 8 km grid.[22] If we had something similar in BC we would have just fewer than 10,000 PSPs. In contrast, BC currently has 268 plots established provincially, a subsample of the 2,419 points on the 20 km NFI grid in BC.

[20] http://www.fia.fs.fed.us/

[21] http://www.eforester.org/fp/documents/Forest_Inventory_Analysis_5-26-06.pdf

[22] http://www.slu.se/en/collaborative-centres-and-projects/swedish-national-forest-inventory/inventory-design/tract-distribution/