



## **TFL 14 - SPILLIMACHEEN MONITORING OPTIONS REPORT**

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## EXECUTIVE SUMMARY

In order to advance their forest management and business objectives for Tree Farm Licence 14 (TFL 14), Tembec Inc. (Tembec) undertakes a variety of programs and activities. It is prudent to have a monitoring and evaluation process to ensure that activities contribute positively to those objectives.

Tembec has implemented a *Silviculture Strategy* and, within a corporate audit and monitoring program, is moving to implementation of a silviculture monitoring program. Monitoring of *Silviculture Strategy* activities ensures activities are carried out as planned and provides a check on expected growth and yield benefits.

Monitoring is expected to take place on two levels. Administrative monitoring involves auditing business records to evaluate the question: **“Are we doing what we said we would do?”** Growth and yield monitoring on the other hand provides hard data to answer the specific question: **“Are our stands growing as we think they are?”**

After defining monitoring and discussing the benefits to, and role of, monitoring, the currently available protocols for monitoring are presented. And finally, in preparation for discussion of the monitoring program for TFL 14, management objectives associated with the TFL are discussed. This facilitates design of a monitoring program that meets Tembec’s needs on TFL 14.

Documented are Tembec’s monitoring needs across the full range of issues presented by the *Silviculture Strategy*, the management planning process, and Forest Stewardship Council (FSC) certification.

By its nature, monitoring requires a long-term commitment to a process which can be costly but which can result in successful achievement of Tembec’s management objectives. The business case for monitoring is based on evaluating success of programs, improving management through links and feedback to higher level planning, and addressing continuous improvement. Market share and corporate survival are addressed by demonstrating results to deal with public expectations, facilitation of certification, and identification and minimization of risk.

Administrative monitoring is to be delivered as an internal function of Tembec. Administrative monitoring associated with the *Silviculture Strategy* is a base level to which there is a range of choices on which other programs may be addressed. Recommended is a full range of administrative monitoring to ensure achievement of management, silviculture, ecological and economic objectives. Annual costs of the program would be about ten person days of Tembec staff time, and \$6,000 for remote sensing data capture. In addition to these annual costs, Tembec would incur the cost of 17 person days and \$11,000 in contracting fees to undertake a management planning cycle review (every five years).

A growth and yield monitoring program addressing post-harvest regenerated stands is recommended. This would involve an annualized cost of \$20,000 to \$40,000 depending on sampling intensity.



## TABLE OF CONTENTS

<b>1.0</b>	<b>BACKGROUND AND AUTHORITY .....</b>	<b>1</b>
<b>2.0</b>	<b>INTRODUCTION TO MONITORING.....</b>	<b>2</b>
2.1	WHAT IS MONITORING?.....	2
2.1.1	<i>Administrative Monitoring .....</i>	<i>3</i>
2.1.2	<i>Growth and Yield Monitoring.....</i>	<i>3</i>
2.2	WHY MONITOR?.....	3
2.3	THE ROLE OF A MONITORING PROGRAM .....	4
<b>3.0</b>	<b>EXISTING MONITORING PROTOCOLS.....</b>	<b>7</b>
3.1	ADMINISTRATIVE MONITORING .....	7
3.1.1	<i>Tembec Forest Management Audit Program.....</i>	<i>7</i>
3.2	GROWTH AND YIELD MONITORING .....	7
3.2.1	<i>Management Unit Level.....</i>	<i>7</i>
3.2.2	<i>Sub-unit Level.....</i>	<i>7</i>
3.2.3	<i>Stand Level.....</i>	<i>8</i>
3.2.4	<i>Required Components of Growth and Yield Monitoring.....</i>	<i>8</i>
3.3	CHANGE MONITORING INVENTORY.....	9
3.4	OTHER SURVEY METHODS .....	10
3.4.1	<i>Comparing Operational Yields to TIPSYS Predictions .....</i>	<i>10</i>
3.4.2	<i>Regeneration Performance Assessments.....</i>	<i>10</i>
<b>4.0</b>	<b>OBJECTIVES .....</b>	<b>11</b>
4.1	OBJECTIVES FOR THE MANAGEMENT OF TFL 14.....	11
4.1.1	<i>Silviculture Objectives .....</i>	<i>12</i>
4.2	SILVICULTURE STRATEGY OBJECTIVES .....	13
<b>5.0</b>	<b>COMPONENTS OF THE MONITORING PROGRAM .....</b>	<b>14</b>
5.1	MONITORING OF THE SILVICULTURE STRATEGY .....	14
5.1.1	<i>Translating Silviculture Strategy Objectives to Monitoring Needs.....</i>	<i>14</i>
5.1.2	<i>Administrative Monitoring .....</i>	<i>14</i>
5.1.3	<i>Growth and Yield Monitoring.....</i>	<i>16</i>
5.2	FOREST MANAGEMENT PLANNING PROCESS .....	17
5.2.1	<i>Translating Management Objectives to Monitoring Needs.....</i>	<i>17</i>
5.3	FOREST STEWARDSHIP COUNCIL (FSC) CERTIFICATION .....	19
<b>6.0</b>	<b>ADMINISTRATIVE MONITORING OPTIONS.....</b>	<b>21</b>
6.1	OPTION 1 – SILVICULTURE STRATEGY ADMINISTRATIVE MONITORING.....	21
6.1.1	<i>Annual Implementation Review.....</i>	<i>21</i>
6.1.2	<i>Management Plan Cycle Review.....</i>	<i>21</i>
6.2	OPTION 2 – COMPREHENSIVE ADMINISTRATIVE MONITORING.....	21
6.2.1	<i>Annual Implementation Review.....</i>	<i>22</i>
6.2.2	<i>Management Plan Cycle Review.....</i>	<i>22</i>
<b>7.0</b>	<b>GROWTH AND YIELD MONITORING OPTIONS.....</b>	<b>23</b>



7.1	BENEFITS AND COSTS OF A G&Y MONITORING PROGRAM .....	23
7.2	G&Y MONITORING OPTIONS FOR TEMBEC .....	24
<b>8.0</b>	<b>RECOMMENDED MONITORING PROGRAM.....</b>	<b>27</b>
8.1	LINKS TO STRATEGIC PLANS AND POLICY.....	27
8.2	LISTS OF BUSINESS SYSTEMS REQUIRED FOR DELIVERY .....	27
8.3	OPERATIONAL PLANNING REQUIREMENTS .....	28
8.4	INFORMATION NEEDS.....	28
8.4.1	<i>Area of Epidemic Outbreaks and Volume Losses.....</i>	28
8.4.2	<i>Loss of Area to Access Structure.....</i>	28
8.4.3	<i>VQO Compliance .....</i>	28
8.5	ADMINISTRATIVE MONITORING RECOMMENDATIONS .....	28
8.6	G&Y MONITORING RECOMMENDATIONS .....	29
8.6.1	<i>Monitor the growth and yield of all PHR stands.....</i>	29
8.6.2	<i>Develop a G&amp;Y monitoring program as part of an overall strategy.....</i>	30
8.7	ESTIMATED COSTS.....	30
<b>9.0</b>	<b>DISCUSSION.....</b>	<b>32</b>
<b>10.0</b>	<b>REFERENCES.....</b>	<b>33</b>

## LIST OF TABLES

TABLE 5.1 TRANSLATING <i>SILVICULTURE STRATEGY</i> OBJECTIVES TO NEEDS .....	14
TABLE 5.2 INCREMENTAL SILVICULTURE ADMINISTRATIVE MONITORING ITEMS .....	16
TABLE 5.3 POTENTIAL G&Y MONITORING ITEMS.....	17
TABLE 5.4 TFL OBJECTIVES AND POTENTIAL MONITORING NEEDS.....	18
TABLE 5.5 FSC MONITORING ITEMS.....	20
TABLE 7.1. THREE MAIN G&Y MONITORING OPTIONS FOR TEMBEC ON TFL 14.....	25
TABLE 8.1 RECOMMENDED ADMINISTRATIVE MONITORING PROGRAM.....	29
TABLE 8.2 COST ESTIMATES.....	31

## LIST OF FIGURES

FIGURE 2.1 MONITORING PROCESS .....	2
FIGURE 2.2 MP 8 MANAGED STAND YIELDS SENSITIVITY.....	4
FIGURE 2.3 MANAGEMENT SYSTEM.....	5
FIGURE 2.4 MONITORING SYSTEMS.....	6
FIGURE 4.1 ACHIEVING OBJECTIVES.....	11

## LIST OF APPENDICES

APPENDIX I – ADMINISTRATIVE MONITORING ELEMENTS
APPENDIX II – GROWTH AND YIELD MONITORING ELEMENTS
APPENDIX III – MONITORING ELEMENTS – IMPLEMENTATION DELAYED
APPENDIX IV – G&Y MONITORING EXAMPLES
APPENDIX V – COMPACT DISC (INCLUDING REPORT AND BACKGROUND DOCUMENTS)



## 1.0 BACKGROUND AND AUTHORITY

In order to advance their forest management and business objectives for Tree Farm Licence 14 (TFL 14), Tembec Inc. (Tembec) undertakes a large variety of programs and activities. It is prudent to have a monitoring and evaluation process to ensure that activities contribute positively to those objectives.

In March of 2001 Tembec prepared a *Silviculture Strategy* for TFL 14. This strategy was based on consultation with many stakeholders and developed through forest level timber supply analysis (commonly referred to as an Incremental Silviculture Type 2 analysis). Potentially beneficial management regimes were evaluated for impacts on fibre flow, product quality, and to a limited extent wildlife habitat. The strategy recommended a monitoring program to ensure implementation and effectiveness.

Tembec has implemented the *Silviculture Strategy* and, within a corporate audit and monitoring program, is moving to implementation of the silviculture monitoring program. Monitoring of *Silviculture Strategy* activities ensures activities are carried out as planned and provides a check on expected growth and yield benefits.

Tembec has requested Timberline Forest Inventory Consultants Limited (Timberline) prepare a monitoring program for activities on TFL 14. Timberline has arranged for Eleanor McWilliams of J.S. Thrower and Associates to contribute expertise in growth and yield monitoring including statistics and sampling design.

Monitoring of *Silviculture Strategy* activities will inevitably be interrelated with other monitoring issues, specifically management planning, timber supply review, and Forest Stewardship Council (FSC) certification. While this project will attempt to ensure that the silviculture monitoring program will link with other monitoring efforts, all monitoring needs for certification cannot be addressed. To do so would require objectives, and criteria and indicators from the Tembec FSC implementation program.

There are a few issues which should be addressed as monitoring elements but which are identified as beyond the scope of this project and are to be carried forward to future work: partial cutting; stand succession; and survey rationalization.



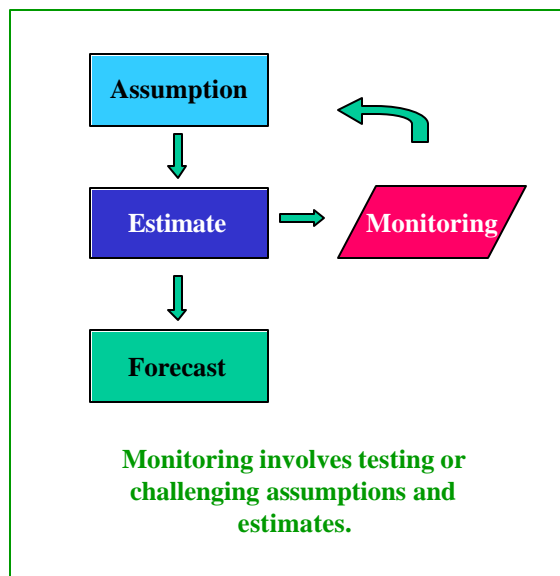
## 2.0 INTRODUCTION TO MONITORING

This section provides a brief introduction to monitoring and why monitoring is important.

### 2.1 WHAT IS MONITORING?

The term “monitoring” is used in many ways, but in general it is measuring or observing specific variables over time, usually for the purpose of checking the status of a system or entity. The critical step in defining a specific type of monitoring is defining clear objectives. Monitoring provides the feedback loop to check assumptions and estimates used to make management decisions. It also can act as a check to ensure activities are carried out as planned. For example:

- We said we would treat 500 ha. – Did we?
- We assume managed stand yields provide  $x$  volume at  $y$  years of age – Do they?



For clarification, while it is theoretically possible to monitor treatment response<sup>1</sup>, the need for an unbiased sample of both control and treated areas, and the unlimited combinations of treatments to capture makes this process beyond the practical application of monitoring. It is simpler to monitor the growth after treatment in treated stands and compare this to the expected growth.

Monitoring is expected to take place on two levels. Administrative (or implementation) monitoring involves auditing business records to evaluate the question: “**Are we doing what we said we would do?**” Growth and yield (G&Y) monitoring (a form of effectiveness monitoring) on the other hand provides hard data to answer the specific question: “**Are our stands growing as we think they are?**”

Figure 2.1 Monitoring process

<sup>1</sup> Treatment response is defined as the incremental growth due to a treatment. It is the difference between how the treated stand grew after treatment and how it would have grown had it not been treated.



### 2.1.1 Administrative Monitoring

Administrative monitoring refers to the use of business tools such as activity and financial tracking systems to assure compliance with corporate strategy, policy, and procedures. Administrative monitoring can be thought of as implementation reporting.

The administrative monitoring component of this program has been designed for internal delivery by Tembec, using existing business processes and tools. It allows for re-evaluation of strategies against changing corporate objectives.

### 2.1.2 Growth and Yield Monitoring

In B.C., the Growth and Yield Monitoring Task Force (GYMTF) defined growth and yield monitoring as:

*“The process of observing the growth and yield of a forest and comparing this with the predicted growth and yield of that forest to assess risk and uncertainty around predictions.”*

It could also be called checking growth and yield estimates for a defined population. Much work has been done by the GYMTF over the past few years in defining methodologies related to monitoring.<sup>2</sup> Government standards and protocols are in place and will be utilized on TFL 14. The G&Y monitoring component of this project has been designed for administration by Tembec and annual delivery by contract personnel.

## 2.2 WHY MONITOR?

### *Evaluate Success*

Society entrusts the stewardship of public resources to its forest managers. This delegation of authority will remain in place only if achievement of the public's goals can be demonstrated. For example, society is demanding a shift in forest management toward ecologically based management with emphasis on maintaining biological diversity. There must be a process that includes targets and the measurement of success in achieving those targets.

Success at every level of activity must be measured. There are many more practical examples of the need to measure the success of routine programs. Are we achieving regeneration targets? Are road building programs meeting environmental requirements? Are we achieving target harvest profiles of species and product?

### *Improve Management*

Monitoring of activities and outcomes closes the management loop consisting of 1) stating objectives, 2) setting targets, 3) planning programs, 4) undertaking activities, 5) measuring success, and back to the start in restating objectives and targets. This is a continuous improvement scheme that can be the basis for meeting objectives, linking to commitments and higher level plans, and maintaining standards and competitive position.

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<sup>2</sup> Numerous reports produced by the GYMTF can be found at <http://www.for.gov.bc.ca/resinv/g&y/Projects.htm>





### Support Planning

Strategic planning includes several core business needs: resources inventory, growth and yield projection, and forest level modelling. By providing feedback on the estimates and assumptions used, G&Y monitoring will improve the efficacy of strategic planning through continuous improvement. Analysis can demonstrate results or outcomes to address public expectations.

### Manage Risk

Monitoring reduces risk in strategic planning. In the timber supply review process AACs are determined based on assumptions, many of which are not supported by empirical data. We must monitor and test those assumptions or risk unexpected changes in harvest levels. Figure 2.2 is drawn from the timber supply analysis produced in support of TFL 14 Management Plan No. 8. It presents the sensitivity of analysis results to uncertainty associated with managed stand yields. Monitoring managed stand yields will reduce this uncertainty and allow harvest levels to be set while minimizing the need for contingencies.

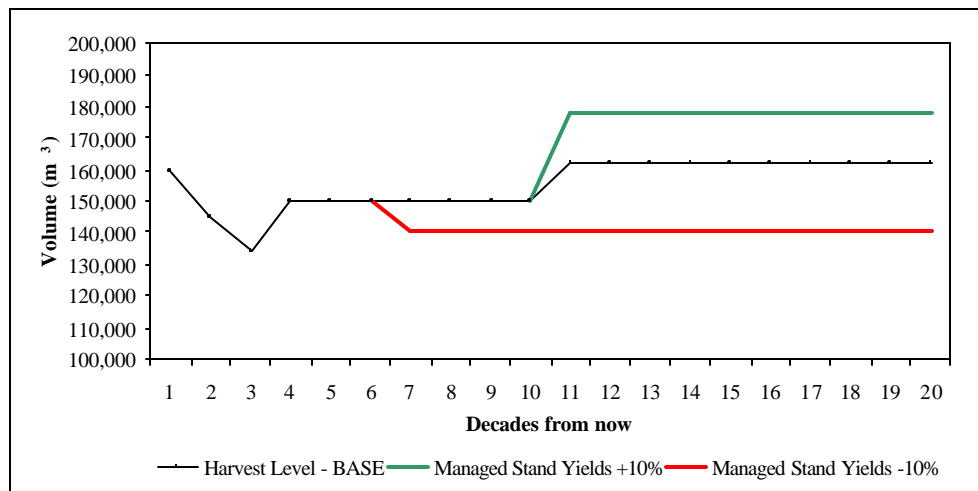


Figure 2.2 MP 8 managed stand yields sensitivity

## 2.3 THE ROLE OF A MONITORING PROGRAM

Monitoring for silviculture (both administrative and G&Y) fits within a management system. Management objectives are translated into operating plans including objectives for harvesting and silviculture as well as other resource concerns. It is through planned activities that objectives are met and monitoring provides the feedback mechanism to ensure that objectives are both met, and still relevant. Tembec has in place business and data management systems to support a monitoring program:

- Forest Management System (FMS), a spatial management and silviculture record keeping system;
- Corporate geographic information system (GIS) for spatial storage and retrieval of resource data; and



- An accounting and financial tracking system.

Figure 2.3 graphically illustrates the relationship between components of the management system.

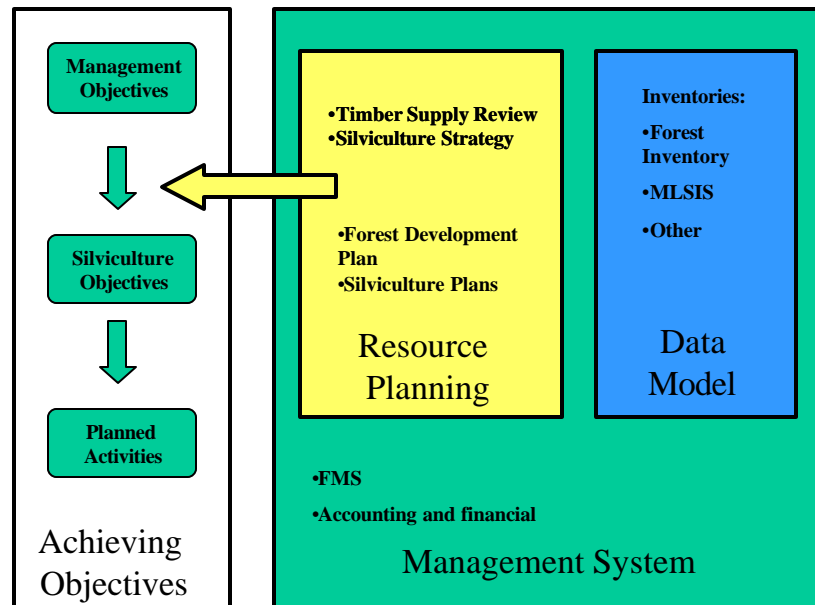
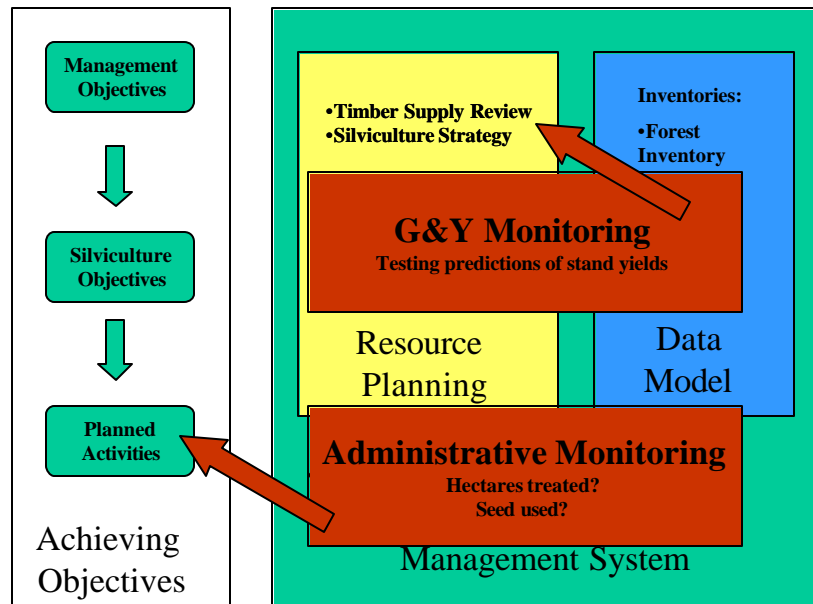


Figure 2.3 Management system

With Tembec business, forest management, and silviculture objectives for TFL 14 as a starting point, this project has designed a monitoring program for the TFL.

Figure 2.4 presents the to silviculture monitoring systems in context of the management system.



**Figure 2.4 Monitoring systems**

The silviculture monitoring program:

- Directly addresses implementation of the *Silviculture Strategy* via the *administrative monitoring component*;
- Ensures procedures are compatible and facilitate other audit and monitoring needs;
- Provide direction on establishment of processes and procedures;
- Meets the needs of Tembec in providing information necessary to guide adaptation of management activities; and
- Obtains feedback on the growth and yield of managed stands via G&Y monitoring.

Silviculture monitoring must be part of a management system including planning, delivery, reporting and monitoring.



### 3.0 EXISTING MONITORING PROTOCOLS

Monitoring protocols encompass both administrative monitoring (programs used for forest management audit and operations reporting) and G&Y monitoring.

#### 3.1 ADMINISTRATIVE MONITORING

The Nelson Forest Region undertook a review of implementation of silviculture strategies across the Region (Symtree, 2001). The report provided feedback on the utility of the provincial incremental silviculture strategy program but is only a first step in development of an administrative monitoring program on a management unit such as TFL 14.

Existing protocols for administrative monitoring fall within the field of management audit, the review of which is beyond the scope of this project.

##### 3.1.1 *Tembec Forest Management Audit Program*

It is recommended that Tembec bring together the various monitoring and audit programs that it requires. Based on this, the degree to which existing management audit and quality control certification programs should be assimilated with management and silviculture monitoring should be considered.

#### 3.2 GROWTH AND YIELD MONITORING

Much work has been done in B.C. over the past few years in defining methodologies related to G&Y monitoring. Conceptually three levels of G&Y monitoring have been defined: management unit, sub-unit, and stand level. The level is defined by the monitoring objectives and the target population. The management unit level protocol has been developed and is currently being tested (e.g. Weyerhaeuser's TFL 35). Sub-unit and stand level monitoring have not been tested. Government standards and protocols for management unit monitoring will be utilized on TFL 14.

##### 3.2.1 *Management Unit Level*

At the management unit level the typical objectives are to check average projected change or yield in attributes such as volume, species composition, top height, and site index used in timber supply analysis. The check is usually restricted to overall management unit averages and possibly averages of the one or two most predominant stand types. The typical target population is the entire management unit or all regenerated stands on the management unit.

##### 3.2.2 *Sub-unit Level*

At the sub-unit level the typical objectives are to check average projected change or yield in attributes such as volume, species composition, top height, and site index for a specific group of stands. The target population is a spatially defined subset of one or more management units. For example, a watershed, or a group of stands similarly treated during a defined time period. This level of monitoring can provide estimates of growth after treatment for stand groups not available at the management unit level because of low sample intensity.



### ***3.2.3 Stand Level***

At the stand level the typical objectives are to provide feedback on individual stand performance. At this level there are multiple plots established in a single stand. The target population is a single stand. At this level the use of modified silviculture surveys has been proposed, primarily to collect data consistently over time to allow for a comparison of one survey results to the next and build up a data base on early stand development.

### ***3.2.4 Required Components of Growth and Yield Monitoring***

The following sections describe the required components of a G&Y monitoring program.

#### ***Objectives***

The objectives of a G&Y monitoring program should be clearly stated and include definitions of what is to be measured, where it is to be measured, and why it is to be measured. These requirements are provided for in the monitoring element tables in Appendices I through III.

#### ***Target Population***

The target population defines the stands that one wishes to sample. It must be defined with up-to-date spatial information. Examples include all post-harvest regenerated stands on the TFL or all Lodgepole pine leading stands juvenile spaced between 1990 and 2000.

#### ***Sample Method***

Describe how the samples will be selected, including definition of the sample frame (the list of sampling units) and the type of sampling. It is strongly recommended to keep this procedure as simple as possible to allow for future flexibility. In addition, one of the most critical elements of a G&Y monitoring program is that the sample represents the entire area of interest being monitored. Subjectively located plots are not suitable for this purpose. Plots must be randomly or systematically located.

#### ***Sample Size***

In general a minimum sample size of 30 is recommended. This will usually be sufficient for high level checks of attributes for an entire population in aggregate. However, if there is a desire to post-stratify larger sample sizes will be needed. Sample size is determined based on:

- Sample costs and budgets;
- Interest in post-stratification;
- Variability of the differences between actual and predicted or expected values of the attributes of interest; and
- The hypotheses to be tested and the desired Type I and Type II errors.<sup>3</sup>

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<sup>3</sup> The Type I error is the probability of rejecting the null hypothesis when it is true (often referred to as the 'p value'). The Type II error is the probability of accepting the null hypothesis when it is false. The power of the test is equal to one minus the Type II error.



### *Variables to be Measured or Estimated*

The variables to be measured or estimated will largely be defined by the program objectives. For example if an objective is to compare actual to predicted yields then all variable required to calculate stand yields will need to be measured.

### *Plot Design and Field Procedures*

Plot designs and field procedures should be based on existing protocols where possible. The BC MoF change monitoring procedures<sup>4</sup> provide most of the options necessary.

### *Data Management*

Procedures must be developed to compile and store collected data. These should be based on existing procedures where possible. The Terrestrial Information Branch of the Ministry of Sustainable Resource Management has indicated that it will make its compilation code for VRI and monitoring plots available in the spring of 2002.

### *Data Analysis*

How the data will be analysed and used should be well defined prior to the initiation of the program. Examples of graphical and statistical analysis procedures have been developed by J.S. Thrower & Associates Ltd.<sup>5</sup>

### *Presentation and Use of Results*

Define how the results will be used and incorporated into future planning. One option that has been used is to plan the re-measurement schedule to coincide with Management Plan cycle so that data is available at least two years prior to the Management Plan submission date.

## **3.3 CHANGE MONITORING INVENTORY**

The Terrestrial Information Branch (TIB) of the B.C. Ministry of Sustainable Resource Management has added a new protocol to the VRI system known as change monitoring inventory (CMI).<sup>4</sup> Essentially it consists of a fixed area plot (as opposed to the variable radius plot used in the VRI) used to track change over time. The main application for CMI is in implementation in B.C. of the National Forest Inventory.

This plot type may be applied in growth and yield monitoring on TFL 14.

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<sup>4</sup> B.C. Ministry of Forests. 2000. Change Monitoring Inventory Ground Sampling Procedures for the Provincial Change Monitoring and the National Forest Inventory, Draft Version 1.0 July 2000. MOF, Victoria, B.C.. 201 pp.

<sup>5</sup> J.S. Thrower & Associates Ltd. 2000. Statistical estimation methods for provincial change inventory. Version 2.0. Unpubl. Rep. submitted to B.C. Min. For., Res. Inv. Br. 28 pp.



### 3.4 OTHER SURVEY METHODS

#### 3.4.1 *Comparing Operational Yields to TIPSYS Predictions*

A case study of a multi-plot method applied to a single stand is presented by Martin, 2001. Focus of the method is stand management regime building for stands for which initial establishment conditions are known. Although it represents an option for stand level monitoring, this method could be expanded to the forest level. An interesting component of this project is the concept of using results to modify operational adjustment factors (OAFs) applied to the model predictions.

FMS can provide the required model inputs for specific stands from the Tembec silvicultural records. The study indicated that the results were most sensitive to age and height inputs which translates to a priority for FMS work.

#### 3.4.2 *Regeneration Performance Assessments*

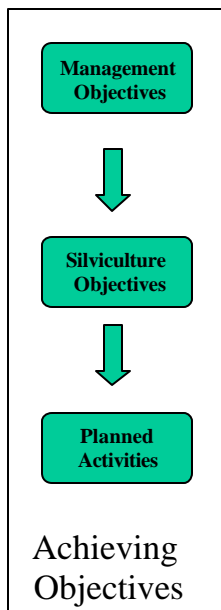
The Nelson Forest Region has suggested that under the situation of limited funds it may not be possible to gather the information required to monitor growth and yield. In the place of a statistical sample design using relatively expensive plot measurements, a system of regeneration performance assessments could be used. Such a system would utilize a large number of relatively simple plots. A large data set could be compiled but without an unbiased sampling plan, its applicability could be questioned. This approach would likely be more applicable to stand management than forest or sub-unit monitoring.



## 4.0 OBJECTIVES

This section reviews the pertinent TFL management and the silviculture strategy objectives to provide background for developing the silviculture monitoring objectives. Potential silviculture monitoring objectives are also outlined to provide a basis for discussion.

### 4.1 OBJECTIVES FOR THE MANAGEMENT OF TFL 14



The following is drawn from TFL 14 Management Plan No. 8 (it has been modified only to use the Tembec name, instead of Crestbrook as was the company name at the time):

*Tembec's primary goal is to maintain a long-term, economically viable forest products operation while practicing sound integrated resource management. In setting this goal Tembec recognizes its commitments to forest stewardship, the environment, social values and to meeting various government policies and objectives. To assist in facilitating this objective, Tembec is committed to operating its facilities in a cost effective and profitable manner. This will also allow the company to provide stable employment for our employees and contractors, as well as the resultant socio-economic benefits to the local communities and the Province of British Columbia. Where possible, Tembec will pursue a course of continued growth within the industry.*

**Figure 4.1 Achieving objectives**

Tembec's main management objectives are paraphrased below.

- To practice and demonstrate **responsible stewardship** of the forest land using balanced resource management which ensures that there is a sufficient area of productive forest land available to provide a sustainable timber supply, while incorporating the requirements of wildlife, fisheries, water production, grazing, views, cultural, recreational and unique ecological values.
- To adhere to the **Forest Practices Code** for all activities conducted on TFL 14 and to harvest the annual allowable cut (AAC) according to the conditions of the management plan, approved cutting permits and government regulations.
- To manage forest **ecosystems** in a fashion that provides for ecosystem integrity, biodiversity, water quality, and wildlife habitat requirements along with the production of timber.
- To continue the integration of public and commercial use of the licence area for a wide spectrum backcountry and wilderness **recreational experiences**.





- To achieve ‘partial retention’ to ‘modification’ **visual quality objectives** on the Columbia Bench west of the Columbia River. In the modification zones, visual impacts will be mitigated through visual landscape design of the cut block size, configuration, and on block reserves.
- To harvest to utilization levels required by the licence document and potentially implement a program to significantly increase **utilization** of decadent and undersized trees.
- To manage **forest health** concerns by the identification and timely harvesting or appropriate treatment of threatened or damaged stands.
- To construct, maintain, and deactivate **roads** and other access structures following applicable guidelines and standards as required to facilitate economic timber extraction and environmental considerations while minimizing withdrawals from the timber harvesting land base.
- The reduction of non-recoverable losses through **salvage** of significant insect and disease attacked and wind or snow thrown timber.

#### **4.1.1 Silviculture Objectives**

Tembec has objectives specific to silviculture which are particularly appropriate to consider in monitoring of the *Silviculture Strategy*.

- To use appropriate silviculture systems including seed trees, shelterwood cuts, selection harvests, clear cuts, and patch clearcuts after giving consideration to harvesting and non-timber resource objectives; and
- To regenerate all harvested or denuded operable forest lands promptly, in accordance with the legislated provincial standards, in order to maintain the productive fibre growing capacity of the land base. To achieve this objective, several strategies have been identified:
  - Greater species diversity will be promoted during the regeneration phase;
  - Multi-species plantations will be established where silviculturally feasible and reliable;
  - A regime of natural regeneration in conjunction with planted alternate species may be prescribed in openings where appropriate;
  - Plantation densities will be managed to target stocking levels as a minimum; and
  - Juvenile stands will be managed to promote conifer species diversity and ensure a well-stocked healthy stand is present at rotation, post-spacing densities will be higher than past treatments to mitigate potential *mortality*.
- To capitalize on intensive silvicultural activities for the purposes of managing stand structure, and to take advantage of fibre supply opportunities such as pulplogs; and



- To complete, and where possible implement, the current Silviculture Type II Analysis for the TFL that is intended to guide available incremental and basic silvicultural expenditures to the most efficient and effective use possible.

## 4.2 SILVICULTURE STRATEGY OBJECTIVES

The *Silviculture Strategy* drew management objectives from the TFL Management Plan and through discussions with Tembec staff.

It also provided the following strategic objectives for silviculture:

- Maintain a distribution of seral stages across each landscape unit;
- Maintain, within their respective resource emphasis areas, 350, 1500, and 3300 ha of deer, elk, and moose winter range at all times;
- Maintain a sustainable harvest level of 160 000 m<sup>3</sup>/yr, rising to a sustainable level of 170 000 m<sup>3</sup>/yr or higher approximately 100 years from now;
- Improve available timber supply in decades 7-11 and 20;
- Use silvicultural practices to manage stand structure and density through each seral stage to keep forest pest incidence to endemic levels, managed stand yields to within 10% of their biological potential, and unsalvaged losses less than 5% of the harvest level; and
- Achieve a minimum average harvested stand dbh of 25 cm in the long term.



## 5.0 COMPONENTS OF THE MONITORING PROGRAM

Documented in this section are Tembec's monitoring needs across the full range of issues presented by the *Silviculture Strategy*, the management planning process, and Forest Stewardship Council (FSC) certification.

Section 5.1 deals with *Silviculture Strategy* issues, as these are central to the program. Sections 5.2 and 5.3 deal with management planning processes and FSC. These topics may not be addressed initially, but should be considered, as the issues are not unrelated.

### 5.1 MONITORING OF THE SILVICULTURE STRATEGY

#### 5.1.1 *Translating Silviculture Strategy Objectives to Monitoring Needs*

The *Silviculture Strategy* objectives are translated to a few concrete concepts in the following table. Introduced for each objective is a program or monitoring need to begin the process of focusing on developing a monitoring program.

**Table 5.1 Translating *Silviculture Strategy* objectives to needs**

<b>Silviculture Strategy Objectives</b>	<b>Program and Monitoring Needs</b>
Maintain a distribution of seral stages across each landscape unit.	Set desired distribution and report current and forecasted future status.
Maintain, within their respective resource emphasis areas: 350; 1,500; and 3,300 ha of deer, elk, and moose winter range respectively at all times.	Use this MP No. 8 definition and report status periodically.
Maintain a sustainable harvest level of 160 000 m <sup>3</sup> /yr, rising to a sustainable level of 170 000 m <sup>3</sup> /yr or higher approximately 100 years from now.	Report on ability to achieve these levels.
Improve available timber supply in decades 7-11 and 20.	Report on ability to achieve these levels.
Use silvicultural practices to manage stand structure and density through each seral stage to keep: <ul style="list-style-type: none"><li>• Forest pest incidence to endemic levels;</li><li>• Managed stand yields to within 10% of their biological potential; and</li><li>• Unsalvaged losses less than 5% of the harvest level.</li></ul>	Report epidemic outbreaks; Monitor managed stand yields;  Determine how to measure this and implement.
Achieve a minimum harvested stand diameter (dbh) of 25 cm in the long-term.	Report estimates of dbh from future harvest forecasts.

#### 5.1.2 *Administrative Monitoring*

Administrative monitoring refers to the use of business tools such as activity and financial tracking systems to assure compliance with corporate strategy, policy, and procedures. The following questions (based largely on L.P. Atherton, 2001) define the administrative monitoring needs of the *Silviculture Strategy*. These will drive a subjective text and checklist section of the periodic monitoring report.



- Do the objectives and strategies remain relevant and appropriate?
- To what extent has each strategy been implemented?
- Is each strategy functioning as intended?
- How is the *Strategy* influencing allocation of funds?
- If funding has been limited, has it been directed to priority activities?
- Did the treated stands meet the criteria specified in the strategy (e.g., age, species, density, location, etc.)?
- Are the additional information needs identified in the strategy being addressed?
- Were there any unanticipated outcomes or effects that warrant changing a strategy?
- Is the progress towards the objectives and targets proportionate with the level of effort?
- Can progress be attributed to some other outside factor rather than activities under the strategies?
- Have actual costs been in keeping with estimated costs?

Table 5.2 presents a list of strategies (based on from the *Silviculture Strategy*) that could benefit from administrative monitoring. Tembec has dropped a pruning strategy, originally included in this list. For each strategy a monitoring plan is presented.


**Table 5.2 Incremental silviculture administrative monitoring items**

<b>Incremental Silviculture Strategy</b>	<b>Administrative Monitoring Item</b>
Monitor the progress of the Ministry of Forests' tree improvement program to ensure: <ul style="list-style-type: none"> <li>Yield gains of at least 25% for spruce, and 10% for lodgepole pine, western larch and Douglas-fir species are achieved, and</li> <li>Sufficient improved seed is available to meet TFL 14 planting program needs by the year 2010.</li> </ul>	Check latest gain estimates and seed production targets from the MoF tree improvement program for the class "A" seed used on the TFL.
Maintain the timber harvesting land base by surveying 200 ha/year and brushing 20 ha/year of existing backlog plantations to ensure they reach free growing status.	Ensure planning includes survey and layout of candidate areas and budgets allow treatment as prescribed. Use FMS to report accomplishments.
Maintain the timber harvesting land base by restoring areas destroyed by fire or pests.	Planning and update system required to identify these areas. Planning systems and budgets must allow treatment to avoid NSR and maintain stand productivity at biological potential.
Implement G&Y monitoring program to ensure the expected yields and quality will ultimately be attained.	Ensure budgets to fund program as prescribed.
Maintain the incremental silviculture analysis base case harvest and timber quality forecasts by juvenile spacing 250 ha/year over the next 10 years, 150 ha/year thereafter.	Ensure planning includes survey and layout of candidate areas and budgets allow treatment as prescribed. Use FMS to report accomplishments.
Increase the mid-term harvest level by 4 000 m3/yr through 200 ha/year of late rotation fertilization and 150 ha/year of mid-rotation fertilization of suitable Douglas-fir and lodgepole pine stands.	Ensure planning includes survey and layout of candidate areas and budgets allow treatment as prescribed. Use FMS to report accomplishments.

Monitoring reporting of these issues may include textual, tabular, and graphic representation of specific targets and actuals (percent of target hectares spaced *etc.*).

### 5.1.3 Growth and Yield Monitoring

The following G&Y monitoring strategy was proposed by the *Silviculture Strategy*:

- Survey 400 ha/year of post free growing juvenile stands to monitor their productivity and health to ensure their expected yields and quality will ultimately be attained.



Furthermore, the following are drawn from the *Silviculture Strategy* section “Further Information and Research Needs”:

<i>Confirming Managed Stand Yield Estimates</i>	<i>Compare actual managed stand yields at mid to late ages with stand-level model yields.</i>	<i>Establish permanent sample plots - 20/year at \$600/plot over 3 years. Establishment approx. \$40,000. Monitoring extra cost and long term.</i>
<i>Measure Early Plantation Height Growth</i>	<i>Develop an early height growth measurement research project in improved larch and spruce plantations, and in Pl plantations using B+ seed, to produce statistically valid data for early height growth curves.</i>	<i>Some initial work already completed for experimental trials. Field portion will be timely.</i>

The strategies described above are not considered appropriate as currently formulated. Table 5.3 restates strategies to match our current approach to G&Y monitoring.

**Table 5.3 Potential G&Y monitoring items**

<b>Incremental Silviculture Strategy</b>
Implement G&Y monitoring program in managed stands to ensure that their expected yields and quality will ultimately be attained.
Implement G&Y monitoring program in stands treated under incremental silviculture.
Link G&Y monitoring plots with inventory.
Modify silviculture surveys to provide data on early stand growth.
Check growth and yield of specific treatments.

Identification of the target population is key to success. Exploration will be required to determine the populations and stratifications of populations most appropriate.

## 5.2 FOREST MANAGEMENT PLANNING PROCESS

### 5.2.1 Translating Management Objectives to Monitoring Needs

The many and various management objectives on the TFL are translated to a few concrete concepts in the following table. Introduced for each concept is a program or monitoring need to begin the process of focusing on developing a monitoring program.


**Table 5.4 TFL objectives and potential monitoring needs**

Concept	Program and Monitoring Needs
<b>Management Factors</b>	
Take a long-term approach.	In all monitoring activities address present and future states.
Adhere to the Forest Practices Code and conditions of the management plan, approved cutting permits and government regulations. Harvest to utilization levels required by the licence document. Construct, maintain, and deactivate roads and other access structures following applicable guidelines and standards.	Institute a continuous forest management audit program.
Achieve visual quality objectives.	Practice visual design in planning and monitor results through recreation inventory update.
Identification and timely harvesting or appropriate treatment of threatened or damaged stands. Salvage of significant insect and disease attacked and wind or snow thrown timber.	Include risk management in strategic planning. Institute a timely update system to locate damage and track treatments.
<b>Economic Factors</b>	
Economically viable forest products operation. Stable employment. Continued growth.	Measure the volume and value of products generated from the TFL.
Sufficient area of productive forest land available to provide a sustainable timber supply.	Track timber harvesting land base area and its inherent productivity to achieve a target timber supply.
Provide a wide spectrum of backcountry and wilderness recreational experiences.	List known recreational use.
<b>Ecological Factors</b>	
Sound integrated resource management.	Identify multi-resource needs, ensure process addresses them, identify targets, monitor and project status.
Maintain ecosystem integrity, biodiversity, water quality, and wildlife habitat requirements.	Identify indicators and targets and monitor by measurement and projection.
<b>Silviculture Factors</b>	
Use appropriate silviculture systems.	Include in stand planning documents rationale for system choice. Report areas managed by silviculture system. Monitor planned vs. actual system employed.
Regenerate all harvested or denuded operable forest lands promptly, in accordance with the legislated provincial standards.	Institute a continuous forest management audit program.
Juvenile stands will be managed to promote conifer species diversity.	Report species diversity from silviculture surveys.
Implement the Silviculture Type II Analysis which is intended to guide available incremental and basic silvicultural expenditures.	Identify prescribed activities which support the projected harvest levels and monitor their implementation.



### 5.3 FOREST STEWARDSHIP COUNCIL (FSC) CERTIFICATION

Tembec has made a corporate commitment to FSC certification and chosen TFL 14 as a pilot landbase for implementation. Monitoring systems proposed in this report will be designed to be compatible with FSC certification, although the mandate of this project is not to design a full FSC monitoring program.

Principle 8 of the B.C. standards of the FSC deals with monitoring and assessment. The opening statement is:

*“Monitoring shall be conducted – appropriate to the scale and intensity of forest management – to assess the condition of forest, yields of forest products, chain of custody, management activities and their social and environmental impacts.”*

Key to FSC requirements are that the monitoring process is documented, consistent, and repeatable. FSC requires the monitoring records to be compiled in a secure and accessible monitoring database and that the system has an integrated quality assurance program. The results of monitoring are to be incorporated into the implementation and revision of the management plan.

Appendices I through III, which present the full list of monitoring items, is designed to fulfill FSC requirements.

Elements of FSC certification that we will not deal with in this report:

- Chain of custody; and
- High value conservation forests.

Table 5.5 presents specific monitoring items drawn from FSC Principle 8.




**Table 5.5 FSC monitoring items**

<b>Forest Stewardship Council Principle 8</b>	<b>Monitoring Item</b>
Yield of all forest products harvested	Data regarding the yield of forest products harvested from the management unit (e.g., volume, species and grade) sufficient to assess performance with respect to management objectives.
Growth rates, regeneration and condition of the forest	Data are collected and maintained concerning growth rates, regeneration, forest health, productivity, condition of the forest, and disturbances resulting from forest operations or other causes.
Composition and observed changes in the flora and fauna	Data are collected and maintained related to composition and observed changes in the flora and fauna as a result of forest operations and other disturbance. The condition of habitat of red- and blue-listed species <sup>1</sup> , and endangered species and species of special concern <sup>2</sup> is monitored, consistent with recovery and/or species management plans.
Environmental and social impacts of harvesting and other operations	Data are collected and maintained related to the condition of sensitive or community watersheds including, as applicable, sediment sources, equivalent clearcut area (ECA), channel stability and riparian condition. Monitoring addresses social impacts resulting from management activities.
Costs, productivity, and efficiency of forest management	Costs and production associated with harvesting, including stumpage payments are documented to enable evaluation of forest management efficiency.

Source: Forest Stewardship Council

<sup>1</sup> as per B.C. Conservation Data Centre

<sup>2</sup> as per Committee on the Status of Wildlife in Canada

Measurements for monitoring should reflect ecosystem structure, composition, and function. using maps, charts, and spatial metrics.



## 6.0 ADMINISTRATIVE MONITORING OPTIONS

Administrative monitoring is to be delivered as an internal function of Tembec. Options one and two presented below identify *Silviculture Strategy* monitoring and comprehensive monitoring as two distinct choices. In fact there is a range of choices involving a decision on which programs may be addressed at the present time in the monitoring system.

### 6.1 OPTION 1 – SILVICULTURE STRATEGY ADMINISTRATIVE MONITORING

Option 1 consists of an annual implementation review and a 5-year review of outcomes. It is limited to items directly related to the *Silviculture Strategy*.

Appendix I is a compendium of monitoring elements covering all management programs. Items related directly to the *Silviculture Strategy* are highlighted in blue.

#### 6.1.1 Annual Implementation Review

Section 5.1.2 above provides a list of implementation questions to be addressed on a regular basis. An annual review addressing these questions as part of regular silviculture planning is recommended. The effort (2-3 person days) is a minimal increment to ongoing planning.

#### 6.1.2 Management Plan Cycle Review

Appendix I identifies 17 monitoring elements related directly to the *Strategy* to be addressed at each management plan cycle. Eight elements are the responsibility of the TFL Silviculture Forester. The required data will be available through existing information systems and likely involve a couple of weeks work to report.

The other seven elements are the responsibility of the TFL Forester. Five of these elements will be reported through the timber supply analysis and require some additional scope with regard to output reporting. The other two, although reported on a five-year cycle, will require ongoing programs to ensure capture of required information. These involve determining the area of epidemic outbreaks and the volume of losses salvaged and unsalvaged. If handled as administrative issues, these will require vigilance and funding for mapping and sampling on an *ad-hoc* basis. Epidemic outbreaks and unsalvaged losses could be handled as growth and yield issues under a system of continuous forest inventory, however such a program involves a complete revisit of forest inventory objectives and systems.

### 6.2 OPTION 2 – COMPREHENSIVE ADMINISTRATIVE MONITORING

Incorporating all aspects of monitoring of the *Silviculture Strategy* (Option 1), Option 2 is an expansion to all TFL programs and would include the remaining elements in Appendix I. This option is a rebuild of existing management audit and monitoring programs on the TFL as required to encompass the following programs:

- Management program;
- Silviculture program;
- Growth and yield; and



- FSC certification.

FSC certification will be difficult to implement immediately. Appendix III presents a list of administrative monitoring issues that Tembec has identified to delay until further information is available.

#### ***6.2.1 Annual Implementation Review***

In addition to Option 1 elements, the annual review would cover many items such as access structures, area of disturbance, and habitat performance and silviculture systems. Please see Appendix I for a full list of items.

#### ***6.2.2 Management Plan Cycle Review***

In addition to Option 1 elements, the management plan cycle review would include performance on visual quality objectives. A periodic update of the landscape inventory would provide change information through the updated “existing visual condition” attribute data.



## 7.0 GROWTH AND YIELD MONITORING OPTIONS

A G&Y monitoring program can be a valuable corporate asset that provides a continuous stream of information for timber supply analysis, silviculture decision making, and demonstration of sustainable forest management practices for certification. G&Y monitoring can occur at different levels of resolution, depending on needs of the forest manager, the level of certainty of existing G&Y estimates, the regulatory regime, and the target population (See Appendix IV for examples).

The first step in designing a G&Y monitoring program is to clearly define business needs and program objectives. For example, a business need could be to periodically measure the actual G&Y of managed stands to ensure that the management objective of maintaining the productive fibre growing capacity of the land base is met. A specific G&Y monitoring objective could then be to monitor the change in volume, wood quality, species composition, and site index of post-harvest regenerated (PHR) stands.

A key function of G&Y monitoring is to check G&Y estimates and predictions used in management. It is therefore important to identify the level of confidence in current estimates and predictions, and the potential for loss (or gain) associated with incorrect values.<sup>6</sup> In some cases, even though confidence in certain estimates is low, the implications of the estimates being wrong are minor. Conversely, we may have reasonable confidence in other estimates, but the implications of being wrong are significant. Consider for example if managed stand yields are 10% below what is projected in timber supply. In Tembec's case, this could result in a harvest reduction of 20,000 m<sup>3</sup>/year. At a market price of \$65/m<sup>3</sup>, the cost to purchase the equivalent volume is \$1,300,000. Conversely, if there was 20,000 m<sup>3</sup>/year more to harvest than expected, Tembec could sell this extra wood for \$1,300,000 or profit from processing the extra fibre. The increased certainty provided by a G&Y monitoring program will allow Tembec to more accurately plan for future wood supply needs from quota and purchase programs.

### 7.1 BENEFITS AND COSTS OF A G&Y MONITORING PROGRAM

A properly designed G&Y monitoring program will provide Tembec the following benefits:

- 1) Data to check G&Y projections used in timber supply and silviculture decisions. This will increase confidence in projections and lower the risk associated with uncertain assumptions;
- 2) A method to report on indicators needed under various certification schemes and sustainable forest management (SFM) plans that will withstand scientific and technical scrutiny from third-party auditors;

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<sup>6</sup> Risk assessment includes both the potential magnitude of the loss and the probability of that loss occurring. For example, timber supply sensitivity analyses can tell us the impact of managed stand yields being +/- 10%, but the risk is also a function of the probability of the yields being +/- 10%. G&Y monitoring data reduces the risk by lowering the probability of yield projections being incorrect.



- 3) Information on stand development trends that can be linked with silviculture history to improve silviculture decisions and maximize the return on silviculture investments;
- 4) Data for model development and calibration, site index adjustments, and forest-level inventories; and
- 5) Data to improve estimates of future stand structures and resulting product mixes and quality.

The largest costs in a G&Y monitoring program are plot establishment and remeasurement. Permanent 400 m<sup>2</sup> G&Y monitoring plots<sup>7</sup> cost about \$2,500 to establish and \$1,000 to remeasure (depending on the variables measured, stand structure, and access). Additional costs include sample design, data management, analysis, and interpretation. Plot establishment and remeasurement costs are a function of sample size that in turn is a function of the target population and the need to post-stratify the data.

## 7.2 G&Y MONITORING OPTIONS FOR TEMBEC

We believe the three most viable G&Y monitoring options for Tembec are to:

- 1) Monitor the G&Y of all stands in the timber harvesting landbase;
- 2) Monitor the G&Y of only PHR stands; and/or
- 3) Monitor the G&Y of only stands treated under the Type II silviculture strategy.

These options are discussed in Table 7.1 below. The attribute descriptions in this table are first approximations and can be refined if Tembec decides to proceed with a G&Y monitoring program.

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<sup>7</sup> Permanent re-measured plots with tagged trees allow for the components of net growth (survivor growth, ingrowth and mortality) to be determined. They also provide more accurate estimates of change than temporary plots as tagging the trees reduces the chance of trees being missed on some measurements and not on others. Temporary plots are less expensive to establish, but are less accurate, and the components of net growth cannot be determined.



**Table 7.1. Three main G&Y monitoring options for Tembec on TFL 14.**

Attribute	Option 1	Option 2	Option 3
Target Population	Entire THLB (53,000 ha).	All post-harvested regenerated stands.	All stands treated under Type II <i>Silviculture Strategy</i> .
Possible Objectives	Check average projected change or yield in attributes such as volume, species composition, top height and site index used in timber supply analysis.	Check average projected change or yield in volume, species composition, top height, site index, <i>etc.</i> as used in timber supply analysis.  Check overall averages and possibly averages of the one or two most predominant stand types.	Check average projected change or yield in attributes such as volume, species composition, top height, and site index used in timber supply analysis and silviculture decision-making.  Check averages for each of the silviculture treatments.
Possible Sample Designs	2 or 2.5 km grid over the entire TFL. Establish plots at all grid points in the THLB. Re -measurements every 5-10 years.	1 or 1.5 km grid over the entire TFL. At all points falling within the target population plots are established. Re -measurements every 5 - 10 years.	800 m grid over the entire TFL. At all points falling within the target population are established. Plots are preferably established prior to treatment and re-measured post-treatment.
Plot Design	Permanent 400 m <sup>2</sup> plots with tagged trees to provide accurate estimates of change.	Permanent 400 m <sup>2</sup> plots with tagged trees to provide accurate estimates of change.	Permanent 400 m <sup>2</sup> plots with tagged trees to provide accurate estimates of change.
Sample Size <sup>8</sup> and Approx. Field Costs <sup>9</sup>	A 2.0 km or 2.5 km grid gives 133 or 85 plots in the THLB. Total plot establishment costs \$332,500 or \$212,500. Remeasurement costs about \$133,000 or \$85,000 every 5 to 10 years.	<b>1 km grid:</b> 95 plots established by 2006 (\$237,500). Establish 27 more plots by 2001 and remeasure original 95 (\$162,500). By 2016 establish 28 more plots and remeasure existing 122 (\$192,000). Average cost 2002 to 2016 about \$39,500/year.  <b>1.5 km grid:</b> 42 plots established by 2006 (\$105,000). By 2011 establish 12 additional plots and remeasure original 42 (\$72,000). By 2016 establish 12 additional plots and remeasure existing 54	800 m grid gives one plot/ 64 ha. Treating 500 ha/yr gives 7-8 plots/year. Establish 38 plots by 2006 for about \$95,000. By 2011, establish 38 more and remeasure existing 38 plots for \$133,000. By 2016 establish an additional 38 and remeasure existing 76 plots for \$171,000. Average cost between 2002 and 2016 about \$26,600/year.

<sup>8</sup> Current and future sample sizes are determined by taking the current and projected future areas of the target population and dividing by 625 for a 2.5 km grid, 400 for a 2 km grid, 100 for a 1 km grid, 64 for a 800 m grid and 25 for a 500 m grid.

<sup>9</sup> Assuming \$2,500/plot establishment costs and \$1,000/plot re -measurement costs.



Attribute	Option 1	Option 2	Option 3
		(\$84,000). Average cost 2002 to 2016 about \$17,400/year.	
Use of Data for Checking G&Y Estimates and Predictions <sup>10</sup>	Feedback to timber supply analysts to check overall average predictions and expectations. Limited ability to check PHR stands.	Feedback to timber supply analysts to check overall average predictions and expectations. A 1 km grid will provide a high enough sample intensity to check spaced and fertilized stands separately. A 1.5 km grid will provide only limited ability to check spaced and fertilized stands separately.	Feedback on stands treated under the <i>Silviculture Strategy</i> to timber supply analysts and silviculturists. Data for average conditions, not individual stands. Data used to check model predictions for treated stands to ensure stands are growing as expected.

<sup>10</sup> Data from all three options could be used for model development and calibration, site index adjustments, forest-level inventories and provide information on indicators for certification schemes, for the portion of the THLB sampled.



## 8.0 RECOMMENDED MONITORING PROGRAM

The following design guidelines were followed in preparation of a recommended monitoring program:

- Efficiently meets the needs of Tembec in assuring implementation of silviculture strategies;
- Utilizes existing Tembec business systems where possible;
- Benefits from the experience of current monitoring programs and precedents;
- Meets government standards and will achieve government acceptance;
- Uses existing and accepted protocols where possible;
- Reflects appropriate criteria and indicators for measurement; and
- Facilitates an adaptive management approach.

Recommended is a combination of administrative monitoring and G&Y monitoring designed to provide as much value as possible with limited funding.

The administrative monitoring program is really a reorganization of existing efforts and information processes that can be delivered efficiently internally by Tembec. The G&Y monitoring program, although new and incremental to current programs, is designed in a stepwise fashion to confirm or refute assumptions and allow for extension to investigate any problems that should be identified.

### 8.1 LINKS TO STRATEGIC PLANS AND POLICY

The monitoring program addresses business needs in the areas of:

- Increasing shareholder value;
- Kootenay Boundary Higher Level Plan;
- Management Plan No. 8;
- Forest Practices Code compliance;
- Forest Stewardship Council certification;
- Silviculture program including surveys, plans and implementation; and
- Business planning such as spending priorities.

### 8.2 LISTS OF BUSINESS SYSTEMS REQUIRED FOR DELIVERY

The following systems are used to link objectives to planning activities and/or provide information to the administrative monitoring program:

- TFL 14 forest cover inventory and associated data sets;
- Tembec Forest Management System (FMS) – spatial silviculture information system including survey results;
- Tembec sustainable forest management system (SFMS) audits;





- Tembec Roads Management System (RMS);
- Tembec Silviculture Accrual reports; and
- Tembec annual reporting processes including royalty billings and cut control reporting.

### 8.3 OPERATIONAL PLANNING REQUIREMENTS

Commitments to existing programs include continued emphasis on annual reporting and continuation of the five year planning cycle including forest level analysis.

Commitments to operational planning which are incremental to current business programs include:

- Additional collation of information already available through annual reporting;
- Additional collation of information already available through the timber supply analysis;
- New data collection programs for information capture to determine:
  - Area of epidemic outbreaks; and
  - Volume of losses salvaged and unsalvaged.

### 8.4 INFORMATION NEEDS

The following sections describe new information needs that have been identified.

#### 8.4.1 *Area of Epidemic Outbreaks and Volume Losses*

We recommend a change detection process in order to identify area lost temporarily to epidemic losses. Catastrophic losses through wind throw or defoliation can be captured through comparison of digital remote sensing data. Landsat data provides appropriate scale at a very reasonable cost. Although the results are required on a five-year basis, annual update is probably advisable. Creation of a change layer for integration to the inventory would provide look-up of associated volumes.

#### 8.4.2 *Loss of Area to Access Structure*

Area permanently lost to access structures should be reported through the roads information system but may also benefit from the update process described in Section 8.4.1.

#### 8.4.3 *VQO Compliance*

Five year feed back on compliance with visual quality objectives requires an update of the landscape inventory to revisit existing visual condition. This would take place every five years.

### 8.5 ADMINISTRATIVE MONITORING RECOMMENDATIONS

Given the low incremental cost, Tembec should proceed with the comprehensive monitoring program including all items listed in Appendix I. Also included would be a full range of FSC monitoring including items listed in Appendix III, however full implementation in the first year will not be possible.



It bears repeating here that this recommendation involves a rebuild of existing management and audit programs. The result should be a more streamlined and integrated product.

Implementation in the first year should be considered a pilot project. Through execution of the program Tembec will be able to confirm information availability and data formats as well as evaluate utility of the chosen indicators.

The program would consist of the components described in Table 8.1

**Table 8.1 Recommended administrative monitoring program**

Program Components	Responsible Staff Member	Product
Annual <i>Silviculture Strategy</i> Implementation Review	Silviculture Forester	Implementation Review Report (answer questions in Section 5.1.2).
Annual Performance Review	TFL Forester	Report on access structures, utilization, disturbance, economic indicators, silviculture program results.
Management Plan Cycle Review (periodic – 5yrs)	TFL Forester has overall responsibility with individual responsibilities shared with the Silviculture Forester	Report incorporated into the management plan process; program effectiveness with regard to epidemics, unsalvaged losses, visual quality objectives, landbase, sustainable harvest, ecological indicators, silviculture outcomes.
Change Detection Program (annual)	TFL Forester	Annual data collection and reporting within the Management Plan Cycle Review.
Landscape Inventory Update (periodic – 5yrs)	TFL Forester	Report on performance on visual quality objectives through existing visual condition as reported in the updated inventory.

## 8.6 G&Y MONITORING RECOMMENDATIONS

### 8.6.1 Monitor the growth and yield of all PHR stands

We recommend that Tembec monitor only the G&Y of post-harvest regenerated stands (Option 2). This is the most cost-effective option to reduce the risk associated with G&Y projections on the TFL, provide feedback on silviculture decisions, and demonstrate SFM principles to third parties.

There is more uncertainty in projections for PHR stands than natural stands. The costs of establishing plots in natural stands (Option 1) are probably not worth the benefits at this time. These stands can be periodically re-inventoried with temporary plots as necessary. Option 3 would provide detailed information on the G&Y of silviculturally treated stands, but not other PHR stands. This would make the cost disproportionately high relative to the amount of area and the potential impact of incorrect estimates on forest management and timber supply. Better ways to reduce the risk associated with silviculture investments include using the best research



available, supporting new research where needed, and completing comprehensive stand and forest-level financial analyses to ensure limited funds are invested wisely.

#### ***8.6.2 Develop a G&Y monitoring program as part of an overall strategy***

The G&Y monitoring program can provide information for other uses on the TFL such as to: 1) enhance the forest inventory; 2) calibrate G&Y models; 3) adjust site indices for PHR stands; 4) build and check habitat supply models; and 5) link with silviculture surveys.<sup>11</sup> Accordingly, we recommend that Tembec complete a G&Y strategy to guide the strategic use of the G&Y data, and the overall development and use of all G&Y, inventory, and other technical information for the TFL. This overall strategy will help identify where linkages among programs can help Tembec reduce costs and improve the return on the investment in these programs. The strategy will also help Tembec develop clear goals for the G&Y program, such as providing information to increase the AAC, reduce silviculture costs, and increase the precision of strategic planning.

### **8.7 ESTIMATED COSTS**

Table 8.2 provides estimated Tembec effort and contracting costs associated with recommended program elements. All costs and levels of effort are limited to that which is incremental to current business activities.

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<sup>11</sup> Modified silviculture surveys can be used to monitor early stand growth.


**Table 8.2 Cost estimates**

Description	Tembec Effort	Incremental External Cost
<b>Administrative - Annual Implementation Review (annual costs and effort)</b>		
TFL Silviculture Forester	2- 3 days	0
<b>Administrative – Annual Performance Review (annual costs and effort)</b>		
TFL Forester - report on access structures, utilization, disturbance, economic indicators, silviculture program results	5 days	0
Change detection program (area of disturbance, access structures, epidemic outbreaks and volume losses)	2 days	\$6,000
<b>Administrative - Management Plan Cycle Review (incremental<sup>12</sup> 5 year cycle effort and costs)</b>		
TFL Silviculture Forester	10 days	0
TFL Forester	2 days	0
Timber supply analysis <sup>13</sup>	2 days	\$5,000
Landscape Inventory Update for VQO compliance	3 days	\$6,000
<b>Growth and Yield</b>		
Growth and yield of post harvest regenerated stands (PHR)	Ad-hoc staff support	\$20,000 to \$40,000 per year
Growth and yield strategy	Ad-hoc staff support	\$10,000 to \$20,000 one time only

Note: Administrative costs include Appendix I items only.

<sup>12</sup> Fifth year costs are incremental to annual costs in the fifth year.

<sup>13</sup> Effort and costs associated with expanded scope of analysis outputs.



## 9.0 DISCUSSION

Silviculture strategies are generally seen as a positive development in the linking of activities to objectives, the use of strategic planning in directing silviculture programs. Administrative monitoring ensures that programs are carried out according to plan, G&Y monitoring tests if the assumptions behind the planning are correct. This is an important feed back loop in forest management planning.

By its nature, monitoring requires a long-term commitment to a process which can be costly but which can result in successful achievement of Tembec's management objectives. The business case for monitoring is based on evaluating success of programs, improving management through links and feedback to higher level planning, and addressing continuous improvement. Market share and corporate survival are addressed by demonstrating results to deal with public expectations, facilitation of certification, and identification and minimization of risk.

Growth and yield monitoring is expensive. Costs increase with the number of monitoring items, increasing population sizes, and increased stratification of the population. It is not possible, with limited funds to address all issues. G&Y monitoring is best approached in a coarse way initially. This allows overall evaluation of assumptions as well as some information on possible trouble areas for closer scrutiny.

By addressing all monitoring needs Tembec has the opportunity to expand on the integrated information systems it already possesses. It is an opportunity to start redesigning the data model for future management and planning.



## 10.0 REFERENCES

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## APPENDIX I

### ADMINISTRATIVE MONITORING ELEMENTS

Shaded rows indicate *Silviculture Strategy* elements associated with Option 1 described in Section 6.1.

Monitoring Element	Responsibility and Procedure	Rationale	Indicator	Frequency and Intensity	Baseline or Target
Management Factors					
Implement <i>Silviculture Strategy</i>	TFL Silviculture Forester Information available through FMS and Annual Reports.	SFM – Management Plan commitments SS	Predefined questions to answer.	Annual planning cycle at TFL level	Positive responses to questions
Access structures	TFL Forester Reported by RMS and SFMS audits.	SFM – Legal requirement of FPC, Management Plan commitments.	Proportion of roads or bridges to code, at risk (Nelson Region definition)	Annual status at TFL level	Requirement driven
Utilization standards	TFL Forester Reported by waste and residue surveys and stumpage and royalty billings in Annual Reports.	SFM – Management Plan commitments	Volume in non-compliance	Annual status at TFL level	Requirement driven
Demonstrate action to limit forest pest incidence to endemic levels	TFL Forester Manage stand structure, report outbreaks, risk evaluation. Mature assessed by beetle management program, juvenile through silviculture survey program.	SS	Area of epidemic outbreaks	Management plan cycle at TFL level	No epidemic outbreaks, require definition of epidemic
Unsalvaged losses	TFL Forester Manage stand structure, report losses, integrate into planning	SS	Volume of losses	Management plan cycle at TFL level	Maximum 5% of harvest
Visual quality objectives	TFL Forester Practice visual design, continuous landscape inventory update	SFM – Management Plan commitments	Levels of compliance	Management plan cycle by Landscape Unit	Requirement driven
Area of Disturbance	Areas disturbed by forest operations or otherwise. Periodic soil disturbance surveys, assessed at time of layout, FMS total harvest area.	FSC	Area of disturbance	Annually	None
Economically viable forest operation, efficiency of forest management	TFL Forester Costs, productivity associated with harvesting	SFM – Management Plan commitments, FSC	Employment levels Species of harvest Volume of products (Grades of products, value of products deferred)	Annual at TFL level	10 year average

Notes:

SS – Silviculture Strategy; SFM – Sustainable Forest Management, FSC – Forest Stewardship Council, FPC – Forest Practices Code,

FMS – Forest Management System, SFMS – Sustainable Forest Management System, THLB – Timber Harvesting Landbase, MP 8 – Management Plan 8



Monitoring Element	Responsibility and Procedure	Rationale	Indicator	Frequency and Intensity	Baseline or Target
Stable productive land base (roads, landings, trails).	TFL Forester Total netdowns, i.e. permanent access structures in Annual Report.	SFM – Management Plan commitments SS – assumes retention of landbase	Aggregate THLB productivity	MP cycle	MP 8 assumptions
Maintain sustainable harvest levels	TFL Forester Within the TFL timber supply review process – determinations and cut control reporting.	SS, FSC, MP *	Harvest volume levels	Management plan cycle at TFL level	MP8 – 160,000 in short-term, 170,000 in long-term
<b>Ecological Factors</b>					
Distribution of seral stages as measure of biodiversity	TFL Forester Within the TFL timber supply review process. Seral definitions based on age or stand structure.	SS, SFM – Management Plan commitments	Report current and forecasted status (tabular and spatial).	Management plan cycle at Landscape Unit level	Desired distribution to be determined (likely FPC)
Deer winter range	TFL Forester Within the TFL timber supply review process. As defined by forest cover or ecological inventory. Possibly survey based.	SS	Area of desired habitat	Management plan cycle at resource emphasis zone level	FPC, MP 8 - 350 ha
Elk winter range	TFL Forester Within the TFL timber supply review process. As defined by forest cover or ecological inventory. Possibly survey based.	SS	Area of desired habitat	Management plan cycle at resource emphasis zone level	FPC, MP 8 - 1,500 ha
Moose winter range	TFL Forester Within the TFL timber supply review process. As defined by forest cover or ecological inventory. Possibly survey based.	SS	Area of desired habitat	Management plan cycle at resource emphasis zone level	FPC, MP 8 - 3,300 ha
<b>Silviculture Factors</b>					
Appropriate silviculture systems	TFL Silviculture Forester Stand planning documents; annual field review. Total area by silviculture system reported in FMS and Annual Report.	SFM – Management Plan commitments	Proportion judged to be acceptable (objective assessment problematic).	Annual	100%
Prompt regeneration	Institute a continuous forest management audit; FMS and Annual Report.	SFM – Management Plan commitments, FSC	Area regenerated Timing of regeneration	Annual	Requirement driven
Promote conifer species diversity where ecologically possible	TFL Silviculture Forester FMS reporting of species present from silviculture surveys.	SFM – Management Plan commitments, FSC	Species composition	Annual Reporting of information collected periodically	

Notes:

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Monitoring Element	Responsibility and Procedure	Rationale	Indicator	Frequency and Intensity	Baseline or Target
Tree improvement program	TFL Silviculture Forester MoF Tree Improvement Branch supplies values.	SS	Yield gains Seed availability	Management plan cycle at TFL level	<i>Silviculture Strategy</i> assumptions
Silviculture survey program	TFL Silviculture Forester Silviculture accruals reports, FMS and Annual Reports.	SS	Backlog area surveyed	Management plan cycle at TFL level	Survey based needs.
Brushing program	TFL Silviculture Forester Silviculture accruals reports	SS	Area treated	Management plan cycle at TFL level	Survey based needs.
Salvage area regeneration	TFL Silviculture Forester Planning and update system required, budgets to allow treatment. FMS to report accomplishments.	SS	Proportion of area treated	Management plan cycle at TFL level	Maintain THLB
Growth and yield monitoring	TFL Silviculture Forester Ensure budgets will fund program	SS	Program proceeds	Management plan cycle at TFL level	Program proceeds
Juvenile spacing	TFL Silviculture Forester Ensure planning includes candidate areas and budgets allow treatments. FMS to report accomplishments, Annual Reports.	SS	Area treated	Management plan cycle at TFL level	250 ha/year from 10 years, 150 ha/year thereafter
Late-rotation fertilizing	TFL Silviculture Forester Ensure planning includes candidate areas and budgets allow treatments. FMS to report accomplishments, Annual Reports.	SS	Area treated	Management plan cycle at TFL level	200 ha/year
Mid-rotation fertilizing	TFL Silviculture Forester Ensure planning includes candidate areas and budgets allow treatments. FMS to report accomplishments, Annual Reports.	SS	Area treated	Management plan cycle at TFL level	150 ha/year

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## APPENDIX II

### GROWTH AND YIELD MONITORING ELEMENTS

Monitoring Element	Responsibility and Procedure	Rationale	Indicator	Frequency and Intensity	Baseline or Target
Silviculture Strategy					
Managed stand yields	TFL Silviculture Forester	SS, FSC	Age, height, productivity, health, condition, volume	Management plan cycle at TFL level	
Managed stand yields reflecting incremental silviculture treatment	TFL Silviculture Forester	SS	Age, height, productivity, health, condition, volume	Management plan cycle at sub-unit level	
Fertilizing	TFL Silviculture Forester	SS	Age, height, productivity, health, condition, volume	Management plan cycle at sub-unit level	
Spacing	TFL Silviculture Forester	SS	Age, height, productivity, health, condition, volume	Management plan cycle at sub-unit level	
Brushing	TFL Silviculture Forester	SS	Age, height, productivity, health, condition, volume	Management plan cycle at sub-unit level	
Tree improvement	TFL Silviculture Forester	SS	Age, height, productivity, health, condition, volume	Management plan cycle at sub-unit level	
Managed stand quality	TFL Silviculture Forester	SS	Age, height, productivity, health, condition, volume	Management plan cycle at TFL level	

Factors in decision to choose appropriate elements:

- Money available;
- Planning priorities
- Legislation and certification requirements;
- Previous work; and
- Relationship with other licencees.

Notes:

SS – Silviculture Strategy; SFM – Sustainable Forest Management, FSC – Forest Stewardship Council, FPC – Forest Practices Code,

FMS – Forest Management System, SFMS – Sustainable Forest Management System, THLB – Timber Harvesting Landbase, MP 8 – Management Plan 8



## APPENDIX III

### MONITORING ELEMENTS – IMPLEMENTATION DELAYED

Monitoring Element	Responsibility and Procedure	Rationale	Indicator	Frequency and Intensity	Baseline or Target
Implementation Delayed					
Flora and Fauna	Changes in composition and distribution as a result of operations or other disturbance	FSC			
Water quality	Sensitive or community watersheds physical and social impacts. Source of information; ECAs, IWAPs, fisheries inventories.	SFM – Management Plan commitments, FSC			
Rare and endangered species	Condition of habitat monitored for consistency with recovery or species management plans	FSC			
Wildlife habitat		SFM – Management Plan commitments			

Notes:

**SS** – Silviculture Strategy; SFM – Sustainable Forest Management, FSC – Forest Stewardship Council, FPC – Forest Practices Code,

FMS – Forest Management System, SFMS – Sustainable Forest Management System, THLB – Timber Harvesting Landbase, MP 8 – Management Plan 8



## APPENDIX IV

### G&Y MONITORING EXAMPLES

To provide a basis for discussion, examples of management unit, sub-unit and stand level monitoring are presented along with a summary of the primary differences between them. This information is taken directly from a report written by J.S. Thrower & Associates Ltd. for Resources Inventory Branch, B.C. Ministry of Forest.<sup>14</sup>

The following sections provide examples of G&Y monitoring programs.

#### MANAGEMENT UNIT

A management unit G&Y monitoring pilot project is being done on Weyerhaeuser Company Ltd.'s TFL 35 near Kamloops.<sup>15</sup> The objective of the program is to '*Monitor the change in volume, species composition, top height, and site index in PHR stands on TFL 35*'. The intent is that data from the monitoring program will be compared with predicted values of the same attributes used in timber supply analysis. The target population is all PHR stands 15 years of age or older on the TFL. The target population will expand in the future as more stands are harvested, regenerated, and exceed 15 years of age. The sampling design is based on a 1-km square grid over the entire TFL creating a sample intensity of one plot per 100 ha of PHR stand area. Plots are established when a grid point falls in a PHR stand 15 years or older. The plots are 400 m<sup>2</sup> circular, permanent plots where all trees are tagged for future remeasurement at approximately five-year intervals. The MOF CMI procedures were used with a few minor additions.<sup>16</sup>

At the end of the 2001 field season 64 plots had been established. Of these, 31 plots are in PI leading stands. The data will provide a high-level check on timber supply analysis assumptions for PHR stands. The sample intensity will allow a check of the overall averages for PHR stands and for PI leading PHR stands. There will not be sufficient sample sizes to individually check any other stand types. After the first measurement, the data can be used as an inventory audit of the PHR stands. It will also provide quantification of the incidence and severity of forest pests at a relatively low sample intensity. The sample intensity is not sufficient to: 1) permit a detailed check of projections of stand growth after treatment; 2) monitor guidelines and FPC requirements; or 3) be used in conjunction with compliance monitoring.

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<sup>14</sup> J.S. Thrower & Associates Ltd. 2001. Silviculture information needs and growth & yield monitoring. Unpubl. Rep. submitted to B.C. Min. For., Res. Inv. Br. 26 pp.

<sup>15</sup> J.S. Thrower & Associates Ltd. 2000. Pilot test of a growth and yield monitoring program for Weyerhaeuser's TFL 35: Sample plan. Unpubl. Rep. to Weyerhaeuser Company Ltd., Kamloops, B.C. 16 pp.

<sup>16</sup> Branch measurements were taken to assess wood quality and extra site trees were measured.



## SUB-UNIT

The following hypothetical example of G&Y monitoring at the sub-unit level is based on a real issue in the Okanagan TSA. There are concerns and considerable debate over maximum density spacing of PI stands in the TSA. Central to the debate are projections of stand volume and wood quality following juvenile spacing. Currently TASS and TIPSY are used to project stand volume for spaced stands. A G&Y monitoring program could be used to check these model projections of stand volume and wood quality in spaced PI stands. The target population could be all PI leading stands in the TSA spaced between 1980 and 2000. A small sample of 50 plots could be used (assuming a small budget). A list of all stands in the target population could be compiled and sorted by age, site index, and then samples selected. The MoF CMI procedures could be used with the addition of branch measurements and increment cores. The plots could be re-measured every five years.

The plot data collected would provide a check that the spaced stands are growing as projected after treatment (treatment response information will not be obtained). This would allow a check of TASS that is used to make treatment decisions and provide projections for timber supply analysis. Ultimately the information could be used to check the suitability of maximum density guidelines. As well, information could be collected about the incidence and severity of forest pests in this population of treated stands. The sample intensity in this example is insufficient to be used in conjunction with compliance monitoring.

## STAND LEVEL

The following is also a hypothetical example. In the Vernon Forest District, there is a concern about the volumes and health of planted PI stands in the ICH. The objectives of a stand level G&Y monitoring program in this case could be 1) to check that the yields and diameter distributions of planted PI stands on the ICH sites are as projected by TASS and 2) to generate hypotheses of possible causes if yields and diameter distributions are not as expected. The target population could be all ICH sites planted with PI between 1980 and 2000 with a sample size of 30 stands. A list of all stands in the population could be compiled and stands could be randomly selected with probability proportional to the area of the stand.<sup>17</sup> Each selected stand could then be systematically surveyed with plots located on a 100-m grid. Plots could be 0.005 ha (3.99-m radius) and all trees 4 cm dbh and greater could be measured for height, diameter, branch attributes, and incidence and severity of pests.

Another option for doing pest surveys could be to record incidence and severity along a strip centered on the grid lines between the plots. At each plot center a 0.01 ha (5.64-m radius) site index plot could also be established and the site series recorded. Plot centers could be permanently marked and the GPS coordinates recorded for each. The intent could be to re-survey the stands, using the same plot centers, every five years.

After each measurement, average stand volumes and diameter distributions could be compared to projected stand volumes to audit inventory yields. In addition, the difference between two yield measurements is an estimate of the net growth of the stand. This net growth could also be

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<sup>17</sup> This results in each ha of planted PI in the ICH having an equal probability of being chosen.



compared to projected net growth. The multiple plots on a grid in each stand would allow for analysis of within stand variation as well as the ability to post-stratify using criteria such as volumes, pest incidence, site series, and site index. Correlations between plot volumes and levels of pest incidence and severity could be analyzed to formulate hypotheses about possible cause and effect relationships.

For the target population, the data collected could be used to 1) check timber supply analysis assumptions; 2) provide detailed information on pest incidence and severity; and 3) allow the formulation of hypotheses regarding cause and effect relationships between stand yields and pest incidence and severity. Ultimately the data collected will provide information to check guidelines allowing PI as a suitable species on ICH sites in the Vernon District.

## SUMMARY OF OPTIONS

### Conceptual levels of G&Y monitoring to meet silviculturists' needs

	Management Unit	Sub-unit	Stand Level
Target Population	TSA or TFL.	A spatially defined subset of one or more management units. For example, a watershed, or a group of stands similarly treated during a defined time period.	Individual stands.
Typical Objectives	Check average projected change or yield in attributes such as volume, species composition, top height, and site index used in timber supply analysis. Usually check overall management unit averages and possibly averages of the one or two most predominant stand types.	Check average projected change or yield in attributes such as volume, species composition, top height, and site index for a specific group of stands.	Provide feedback on individual stand performance.
Sample Design	Low-intensity random or systematic sample. This typically results in no more than one plot in a single stand and not all stands are sampled. Re-measurements every 5 - 10 years.	Random or systematic sample that typically results in no more than one plot in a stand; not all stands are sampled. Re-measurements 5 -10 years. Target population is sampled with higher intensity than if included in a larger population such as a management unit.	Random or systematic sample with multiple plots in a single stand. Re-measurements or a new sample every 1 - 10 years.
Plot Design	Typically permanent plots with tagged trees to provide accurate estimates of change.	Typically permanent plots with tagged trees to provide accurate estimates of change. Could use temporary, re-locatable plots to reduce cost.	Probably temporary plots, as permanent plots may be too expensive. Plot centers may be re-locatable to reduce re-measurement variability.
Use of Data	Feedback mostly to timber supply analysts to check overall average predictions and expectations. Sample intensity is too low to provide feedback on uncommon stand types. Projections of managed stands can be used to check models for silviculture planning if sufficient data are available.	Feedback is to timber supply analysts and silviculturists on specific stand groups (sub-units). Data are provided for average conditions and not individual stands. This level of monitoring can provide estimates of growth after treatment for stand groups not available at the management unit level because of low sample intensity.	Feedback provided on performance of individual stands. The primary focus is feedback to silviculturists; however, data can be summarized for use in timber supply analysis.



## **APPENDIX V**

### **COMPACT DISC**