## SIBEC / PEM IN THE DRY-BELT

Supporting documentation on the application of SIBEC and PEM in the dry-belt is provided in the following attached documents:

3. Uncertainty and Risk in SIBEC Estimates
4. Documentation of SIBEC Application in the current timber supply analysis
5. JMJ SIBEC / PEM Final Report

## 3. UNCERTAINTY AND RISK IN SIBEC ESTIMATES

### Introduction

This appendix briefly discusses several sources of potential uncertainty in SIBEC estimates as applied in the Okanagan TSA IFPA timber supply analysis. This discussion is primarily for MOF statutory decision makers to consider when interpreting the uncertainty in SIBEC estimates and the associated risk in using these estimates in the timber supply analysis. We precede this with a brief discussion of the basic elements relating to uncertainty in site index estimates and their application to yield prediction and timber supply analysis.

### General Uncertainty of Site Index

Generally, site index estimates have an inherent level of uncertainty because they estimate *future* height growth of trees. We cannot predict *future* tree growth (or anything else) with certainty, thus all *projections* related to site index, volume, and other inventory attributes contain some degree of uncertainty. There are four basic steps to reduce the uncertainty of applying site index estimates to a given area. Failure to implement any one of these steps could result in increased uncertainty and corresponding risk to statutory decision makers.

a. *Developing Site Index Estimation Tools*

   The tools to estimate site index should be developed using the best biological and statistical methods available. There has been a tremendous amount of work in North America in the last half-century refining methods to estimate site index. Forest researchers and practitioners in BC have made significant contributions in this area of forest science. This potential source of uncertainty is probably of least concern to statutory decision makers in BC of the four components discussed in this section.

b. *Applying the Site Index Tools*

   The process of applying site index tools is critically important to developing estimates that appropriately reflect a given area. The inappropriate application of good estimation tools can result in large biases and over- or under-estimates of site index. Conversely, the careful application of less perfected tools can reduce uncertainty by ensuring the site index estimates adequately represent the landbase, impacts of the uncertainty are estimated, and the estimates are checked periodically. Thus in any case, it is critical that site index is estimated from a representative sample of the area to where the estimates are applied. This generally means some form of random sampling in the area where the estimates are applied to avoid (or reduce) the many forms of selection and application bias than can otherwise impact the estimates. This is probably the greatest risk to statutory decision makers in BC of the four components discussed in this section.

c. *Linking to Yield Prediction Methods*

   Most applications of site index in BC do not use site index directly, but use these estimates of growth potential as inputs to other models to predict stand growth and yield for use in timber supply analysis. Consequently, it is critical that the site indices used in yield models are

developed in a way that is consistent with how the yield model was developed. For example, site indices that represent the average growth of a certain proportion of the tallest trees in a stand should be linked with yield prediction systems that use the same definition of how yield is modeled. This potential source of uncertainty is relatively low in BC because the two main yield models (VDYP and TIPSY) were developed using site indices that are similar to the ones estimated in most field site index sampling methods (this assumes there is no application bias from issue number two in this list).[1]

d. *Monitoring Site Index & Yield Estimates*
Even the best methods to estimate site index and apply them properly in a given area will have some residual uncertainty (largely associated with unknown factors and predicting the future). Therefore, it is good forest management and good business to ensure that site index and yield estimates are checked frequently and updated as required. Short-term uncertainty is best addressed by using good methods to develop and apply the site index estimates as discussed above; however, the reliability of site index (and all other) estimates diminishes over time and should be checked periodically to ensure timber supply analyses are based on representative information for the area of concern. The MSRM has developed a growth and yield monitoring system (called *Change Monitoring Inventory* (CMI)) that is designed to monitor site index and yield over time for this specific purpose. Several TFLs in BC have recently implemented CMI programs to ensure that site indices and yield estimates used in timber supply analysis accurately represent their landbase. This source of uncertainty is not of concern to statutory decision makers for this AAC application, but is of major concern for all subsequent determinations. Monitoring the site index and yield estimates over time can probably be considered as due diligence in forest management, AAC determinations, and other decision-making processes in BC.

**Risk in Applying Site Index**

The risk to statutory decision makers is that site index will be biased and will thus be higher or lower than the true (but unknown) site index. The ultimate consequence of over-estimating site index is that the AAC may be higher than would otherwise be determined. This could result in a higher short-term harvest level with a possible accompanying mid-term reduction when the over-estimate is discovered (e.g., through a CMI growth and yield monitoring program).

The ultimate consequence of under-estimating site index is that the sustainable harvest level may also be under-estimated. This would result in not capturing the benefits to society from timber harvesting that would have resulted if the correct site indices were used in the yield estimation and AAC determination process.

The major risk to statutory decision makers (and to society) of inaccurate site indices is primarily as they impact the AAC determination process. This is why it is (and has been for many years) standard practice to estimate the impact of under- or over-estimates of site index on timber supply analysis. This is routinely done by increasing and decreasing the managed stand volumes projected in timber supply analyses by

[1] This source of uncertainty may be of more concern where the site index and yield prediction link is compromised in the VRI Phase I adjustment process where height and age are adjusted from Phase II ground samples.

10% and examining the impact on forecasted timber harvest. However, a more appropriate process is to complete these sensitivities using information that reflects the uncertainty in site indices for the specific landbase in question, and to vary site index directly in the sensitivity analyses.

The consideration of risk in site index estimates should evaluate the:

a. Potential source of the uncertainty.
b. Likelihood of occurrence.
c. Potential impacts on the timber supply analysis process and associated decisions.

**SIBEC in the Okanagan TSA**

The MOF has endorsed the use of SIBEC in timber supply analysis, however, there are no documented standards yet in place on its application. There are also significant areas of concern when using SIBEC estimates that contribute to uncertainty in the estimates when applied to a given landbase for use in timber supply analysis, and include: subjective (biased) location of sample plots, no reliable estimates of accuracy or precision, no requirement for local data, and no mechanism to correct for bias and errors in the ecological map. The MOF has acknowledged these risks, but considers SIBEC estimates to be suitable for use in timber supply analysis.

Given this acknowledgement, there are sources of uncertainty that relate specifically to SIBEC estimates used in the current timber supply analysis that we feel potentially under-estimate the growth potential of regenerated stands in the Okanagan dry-belt, and therefore suggest an upward pressures in harvest flow. These include:

a. Sampling in older stands
b. Estimating site series averages with four samples
c. Application of SIBEC estimates across age classes
d. Availability of SIBEC data
e. Use of local data

*a. Sampling in older stands*

Over half of SIBEC plots used in the current timber supply analysis were taken in older stands (about 56% were in stands greater than 80 years and 32% greater than 100 years breast height age). With increased potential for suppression and repression in these older stands, the SIBEC estimates in these stands tend to under-estimate growth potential of managed stands, which is reflected in the average site indices assigned to the PEM entities.

*b. Estimating site series averages with four samples*

The minimum standard for SIBEC estimates to be included in the current timber supply analysis was defined as four SIBEC plots with a maximum sampling error of ±2.0 m in PEM entity. Due to the subjective plot location of the SIBEC method, there is no assurance that a given sample for a PEM entity represents the population of interest. Consequently, this compromises the ability to use means and sample errors to evaluate a sample for suitability in timber supply analysis, and the effect of this bias on timber supply is unknown.

The MOF has since indicated the minimum sample size will likely increase to seven plots per PEM map entity; however, in general, these are still subjectively located plots with no requirement for randomized local data. We tested the impact of an increased sample size on the SIBEC estimates in the current timber supply analysis, which did not result in any significant change in the estimates.

*c. Application of SIBEC estimates across age classes*

Standard practice by the MOF has been to apply SIBEC estimates only to very young and very old stands, and to depend on inventory site index for the remaining land base. We compared SIBEC and inventory site indices across all age classes, which showed the inventory site indices under-estimate site productivity across all age classes (relative to SIBEC estimates). Therefore, for the current timber supply analysis, SIBEC estimates were used (where available) in favor of inventory site index across all age classes for the regenerated stands. The result of this change in application, relative to MOF standard practice, has been an upward pressure in timber supply.

*d. Availability of SIBEC data*

For the current timber supply analysis, site index suitability criteria were selected to provide statutory decision makers with the best estimates with least corresponding risk. However, the suitability criteria used for this analysis resulted in only 44% of the THLB being assigned second generation SIBEC site indices, 16% based on species conversion equations, 9% from first generation SIBEC estimates, and the remaining 31% assigned inventory site index (where no other preferred site index information was available). We expect the overall site indices used from these different sources (especially inventory-based site index) will under-estimate the growth and productivity of regenerated stands.

*e. Use of Local Data*

Only 40% of the SIBEC data used for the timber supply analysis was from local samples, with the remaining 60% provided by the MOF. The SIBEC data collected in the Okanagan IFPA area used randomly selected grid points; however, the randomness was compromised by subjectively selecting trees for sampling in the general area to meet the SIBEC standards. The majority of the SIBEC data (provided by the MOF) represents a variety of unknown sources, which may or may not have been established in the Okanagan TSA. The effect of using the pooled data (as opposed to local data only) on the resulting timber supply is unknown.

*Comparing Against Other Site Index Projects*

The best way to know how well the SIBEC estimates represent the Okanagan TSA landbase is to randomly sample suitable areas and compare the results with the SIBEC estimates (i.e., to complete an SIA sampling approach). This was not done in the Okanagan IFPA area; however, a comparison with random samples in nearby ecologically similar areas provides data to speculate on how well the SIBEC data represent the growth potential of regenerated stands in the IFPA area.

To provide this information, we compared the SIBEC estimates against data collected by J.S. Thrower & Associates Ltd. in site index adjustment (SIA) projects in nearby ecologically similar areas. For the same site series within a given BGC subzone / variant, the SIBEC estimates developed for the Okanagan IFPA

consistently under-estimated SIA by about 1–3 m for lodgepole pine. The SIA data were taken from randomly located sample plots, thus do not include the many sources of bias from subjectively located sample plots. However, the SIA data were taken in areas outside the Okanagan TSA and thus may contain some bias when applied in the IFPA area. Consequently, we expect that the major risk for statutory decision makers in using the SIBEC data is that growth potential is under-estimated.