

# Are Free-Growing Stands Meeting Timber Productivity Expectations in the Lakes TSA?

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## ABSTRACT

The current administrative milestone for ensuring effective reforestation is the free-growing declaration. When the free-growing milestone is achieved, it is assumed that the young managed stand is on a trajectory that will result in a productive mature stand. Currently, there are no monitoring procedures in place to determine if free-growing stands are meeting these expectations. The purpose of this study was to examine whether the reliance that has been placed on this policy is supported by stand performance from a timber yield perspective.

The specific objectives of the project were to answer the following questions:

- (1) Is there a significant discrepancy between Table Interpolation Program for Stand Yields (TIPSY) projected volume at current age (based on values at the time of the free-growing declaration) and actual current volume?
- (2) Is there a significant discrepancy between TIPSY projected volume at rotation age (80 years), based on values at the time of the free-growing declaration, and current volumes projected to rotation by TIPSY?
- (3) Is the species composition of leading species (the dominant species on site in terms of both height and density) significantly different from that of the free-growing declaration?
- (4) Is there a significant discrepancy in site index estimate between the free-growing declaration estimate and the current estimate based on the growth intercept method?
- (5) Is there a significant discrepancy in well-spaced stocking of the dominant crop trees between free-growing declaration values and current stocking?
- (6) Is there a significant change in forest pest incidence from the time of the free-growing declaration to present conditions?

Sixty randomly sampled free-growing stands were evaluated in the Lakes Timber Supply Area (TSA) in central B.C. Sample stands were grouped into two classes based on the number of years since free-growing declaration: half were declared 1987-1994 (early), and the other half declared 1995-2001 (late). All sampled stands were greater than 15 ha in size, and were surveyed using 15 - 3.99 m radius survey plots.

We used the silvicultural planning model TIPSY to estimate projected volume at a rotation age of 80 years. The mean projected volumes at rotation based on free-growing declaration values were not significantly different from volume projections based on 2005 stand attributes for either the early or late groups. Based on declaration attributes the mean projected volumes for the early and late groups were 327 and 316 m<sup>3</sup>/ha, respectively. Using 2005 stand attributes, projected volume for the early and late groups were 324 and 314 m<sup>3</sup>/ha, respectively. These projected values closely match the projected values from the most recent Timber Supply data package for the Lakes TSA. The mean density of both well-spaced and free-growing stems has remained relatively stable since declaration with both the early and late groups at or close to 1000 well-spaced stems per hectare (wsp/h).

The only significant difference for the late group was the marked increase in forest pest incidence, which was also found in the early group. Over 27% of all declared free-growing pine leading stands had >20% hard pine rust incidence, with pine leading stands representing 90% of the sampled managed stands. The increase in pest incidence is probably due to a combination of increased recognition, as well as real increases in forest pests. The vast majority (84%) of pest affected trees in stands that no longer pass the minimum stocking level of 700 fgsp/h based on the LCL test are in the 4m+ height class. In 2005, one of the stands in the early group was identified as being attacked by mountain pine beetle, with 70-75% of the trees infested. As of November 2007 an additional ten stands in the early group have been attacked by the insects, though the incidence of attack in these stands is much less.

## INTRODUCTION

The current administrative milestone for ensuring effective reforestation is the free-growing declaration. This licensee obligation to create a free-growing stand is one of the few measurable results under the Forest and Range Practices Act. According to the Forest Practices Board Special Report No. 16 (2003), “free-growing requirements ensure that reforested stands remain successfully reforested.” That is the intent of the policy, but how can we be sure of success without monitoring programs in place? Once a stand is declared free-growing, the Crown not only assumes responsibility for the stand, but also assumes that the stand will remain healthy and productive until ready for harvest. Timber supply reviews throughout the province base predictions of managed stand productivity in large part on the stand conditions (species, density and regeneration delay) assumptions associated with free-growing declarations. Under the Ministry of Forests and Range’s stewardship mandate, it is essential that these assumptions be tested.

In the years since the inception of free-growing in 1987, there have been few reviews of the policy despite there being over 2.5 million ha\* of Crown forest land designated as such. This is largely due to the fact that the majority of the stands created under the policy are only now being declared free-growing. Until this study, the most recent reviews were conducted by the Forest Practice Board (FPB) in 2003 and 2006. The 2006 FPB report looked at free-growing status for all cut-blocks required to achieve free-growing between 1987 and March 31, 2004 based solely on reviews of the RESULTS database with no field checks. The 2003 FPB report was based on a comprehensive overview of free-growing stands in six forest districts located throughout the province. Due to its extensive nature, this FPB study was based primarily on an office review of administrative milestones using the Ministry of Forests and Range’s Integrated Silviculture Information System (ISIS). Most of the field examinations conducted during the FPB review consisted of low-level aerial assessments from helicopters (FPB 2003). In contrast, our study involves an intensive examination of stand conditions on the ground. In that respect, our study is the first detailed examination of the application and assumptions of free-growing policy at the field level.

In the 2003 FPB study, only stands established after the free-growing policy came into effect in 1987 were examined as their focus was on licensee obligations. Our study includes all stands declared free-growing from 1987-2001, within a single timber supply area - the Lakes TSA (Figure 1). The stands we examined were not created under FRPA legislation so we can not state for certain how this key measurable result is currently being achieved.

Figure 1. Location of the Lakes Timber Supply Area.

By including all stands classified as free-growing in RESULTS for the Lakes TSA, however, we were able to fully explore the “free-growing” concept. We were also able to examine a longer post-declaration period to determine if these free-growing stands are still meeting timber productivity expectations.

The example of a “successful free-growing stand of trees” (Figure 2) is representative of many lodgepole pine leading stands in central B.C., including some of those surveyed in this study. The photograph illustrates several possible shortcomings associated with free-growing policy. If this is a free-

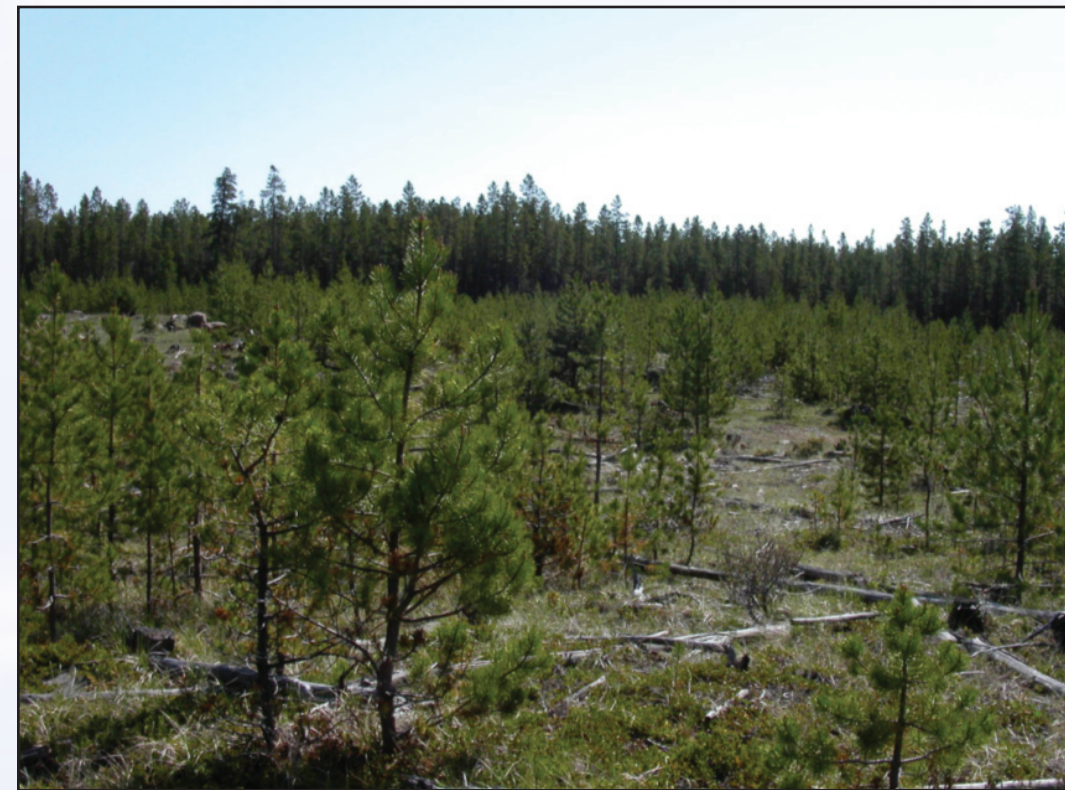


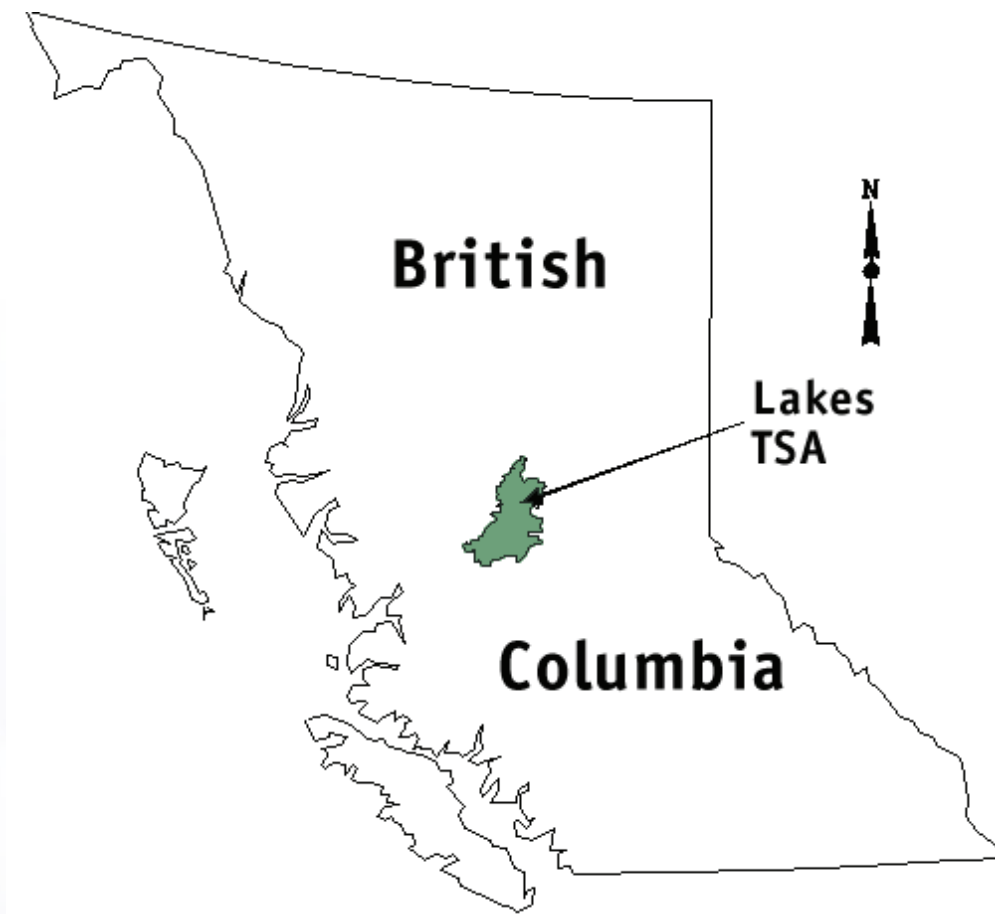
Figure 2. This photo illustrates what some may consider to be a “successful free-growing stand of trees” Forest Practices Board Special Report No. 16 (2003).

Interpolation Program for Stand Yields (TIPSY) which forms the basis of more than 95% of the growth and yield projections of managed stands in BC including those used in most timber supply reviews (TSRs). It was for this reason that we focussed our study of free-growing stand performance using TIPSY as a basis for comparison. We designed our study in such a manner that we could compare several aspects of TIPSY projections of early stand growth to measurable current stand conditions. The degree of reliance that the Crown has placed on TASS/TIPSY mirrors the extent of trust placed on Free-Growing policy. We believe both of these fundamental components of the current forest management framework deserve a thorough review.

The specific objectives of this project are to answer the following questions:

- (1) Is there a significant discrepancy between TIPSY projected volume at current age (based on values at the time of the free-growing declaration) and actual current volume?
- (2) Is there a significant discrepancy between TIPSY projected merchantable volume at rotation age (80 years) based on values at the time of the free-growing declaration and current volumes projected to rotation by TIPSY?
- (3) Is the current species composition of leading species (the dominant species on site in terms of both height and density) significantly different from that of the free-growing declaration?
- (4) Is there a significant discrepancy in site index estimate between the free-growing declaration estimate and the current estimate based on the growth intercept method?
- (5) Is there a significant discrepancy in well-spaced stocking of the dominant crop trees between free-growing declaration values and current stocking?
- (6) Is there a significant change in forest pest incidence from the time of the free-growing declaration to present conditions?

This report covers the initial pilot study of what will be a series of examinations of post free-growing stands throughout the province. It is hoped that the results from this larger forest health/effectiveness evaluation project will lead to improvements in forest policy, management and timber supply predictions.



growing stand as stated in the FPB report, is this stand really meeting our growth and yield expectations? There are clearly several sizeable voids in this stand already, which will increase in size given the number of dead and dying lodgepole pine trees visible in the photo. This stand is also apparently quite young. Can we predict with confidence that this stand is on a healthy productive trajectory towards a final harvest that will meet our projected yield expectations?

In this study, we examine if the free-growing declaration point-in-time assessment is an accurate predictor of future stand productivity and if assumptions of stand performance are valid. The growth and yield model TASS (Mitchell 1975) and the associated computer application Table

## RESULTS AND DISCUSSION

### REPRESENTATION OF THE FREE-GROWING STAND POPULATION

The disturbance dates for the entire population of stands declared free-growing in the Lakes TSA for the period 1987-2001 ranged from 1922 to 1995. The vast majority of these stands were harvested during the 1980s (Figure 3). It is not clear, however, why some stands disturbed in much earlier decades were considered free-growing and had opening numbers assigned to them. A stand disturbed in the 1920s should now be ready for harvest. Over 40% of stands declared free-growing in the period 1987-1994 had disturbance dates earlier than 1960 (Table 1). Only 2.1% of stands declared free-growing in the period 1995-2001 had disturbance dates earlier than 1960.

We limited our sample population to stands with disturbance dates later than 1960. Our stand selection criteria captured 73% of the population of stands declared free growing from 1995-2001 and 45% of the earlier age group (Table 1). By sampling 30 stands in each declaration period, our sampling intensity was 12.9% for the period 1987-1994 and 5.8% for the period 1995-2001. Over 73% of all stands declared free growing in the Lakes TSA have gross opening areas greater than 15ha.

Period Declared FG	Total Population	Disturbed post 1960	Disturbed post >15 ha	Disturbed post 1960 and >15 ha	Sampling Intensity
1987-1994 (early)	523	309	397	233	12.9%
1995-2001 (late)	714	699	527	521	5.8%

Table 1. Sample population criteria relationship with total population of stands declared free growing in the Lakes TSA in the period 1987-2001.

The greatest number of stands declared free-growing in a single year during the period examined occurred in 2001. This is an expected result. Stands created under free-growing policy would have been at most 14 years old in that year.

### UTILITY OF FREE-GROWING SURVEY DATA

Since the inception of free-growing policy, data collected has been used primarily as an administrative check of licensee performance in meeting their obligations. Despite the vast quantities of detailed tree and stand data, free-growing declarations contribute little specific information to forest estate models. The inventory labels recorded in free-growing declarations are one of the few values that are used in higher level models. These labels, however, are merely based on ocular estimates of species composition applied to total tree tallies at a portion of the survey plots. Actual tallies of well-spaced or free-growing trees are not currently used for any purpose other than to confirm that the stocking standards have been achieved. Site index estimates from free-growing declarations are used in the Vegetation Re-Inventory Management System (VRIMS) update of the vegetation files which are subsequently used in managed stand assumptions in timber supply reviews. Timber supply analysts, however, tend to lump these values into analysis units to such an extent that it is virtually impossible to tie on the ground stand performance for a given stand to predicted productivity estimates in timber supply projections (Doug Beckett, pers. comm.).

There appears to be an opportunity to improve our ability to model managed stand productivity by making better use of free-growing data. In the future, free-growing declarations recorded in RESULTS and stocking standards will be tied directly into timber supply reviews (Brian Raymer, pers. comm.) VRIMS will be in production in the fall of 2007 (<http://www.for.gov.bc.ca/hts/vcu/vrims/index.htm>) (Ralph Winter, pers. comm.)

### LAKES TIMBER SUPPLY AREA, TSR FOREST MANAGEMENT ASSUMPTIONS

Our primary goal in this project was to determine if the timber productivity expectations that have been placed on free-growing stands in the Lakes TSA are being met. We conclude our report with a brief comparison between our results and the corresponding forest management assumptions contained in a recent timber supply review conducted on the Lakes TSA (TSR 2) (Table 10). Over 91% of the timber harvesting landbase (THLB) of the Lakes Timber Supply Area is dominated by two BEC variants the SBSmc2 (42.1%) and the SBSdk (49.1%). (<http://www.for.gov.bc.ca/hts/tsa/tsa14/tsr2/analysis.pdf>). In order to simplify comparisons between our results and those of the TSR report we have focused on these two variants. As 90% of our sample stands were lodgepole pine dominated we have compared our results to the TSR analysis units that were pure pine rather than mixed pine and spruce. (<http://www.for.gov.bc.ca/hts/tsa/tsa14/tsr2/analysis.pdf> (page 121)).

	Early (averaged over Dec. and 2005)	Late (averaged over Dec. and 2005)	TSR Pure pine SBS mc2 (all sites)	TSR Pure pine SBS dk (all sites weighted evenly)
Projected volume (m <sup>3</sup> /ha) at age 80	325	315	323	330
Site Index (m)	20.2	19.9	20.0	21.8
Conifer stocking (tsph) (2005)	3565	3326	2800	2800

Table 2. Comparison of TIPSY projected merchantable volume at age 80 years, site index and total conifer stocking between the mean determined from 60 randomly selected free-growing stands in the Lakes TSA declared by group (early: 1987-1994 and late: 1995-2001) and the same attributes according to the Lakes Timber Supply Report (TSR 2).

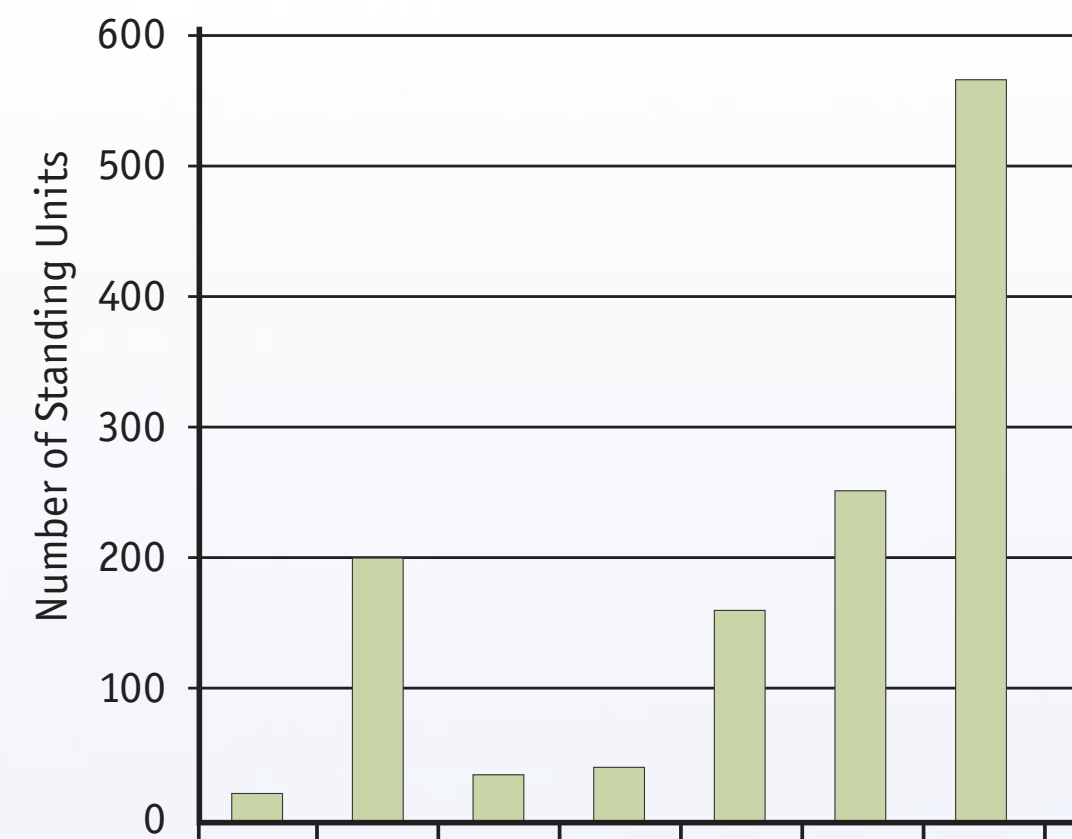


Figure 3. Number of free-growing stands declared in the period (1987-2001), grouped by decade of disturbance.

Our results generally mirror the forest management assumptions in the Lakes Timber Supply Report TSR 2 (Table 10). The mean site index values that we determined are very similar to the adjusted site index values found in the TSR 2 report. The projected volume estimates also differ little. Given the strong relationship between site index and TIPSY volume projections and the fact that our site index estimates matched those of TSR it is not surprising that our volume estimates were similar. Both TSR projections and our projections came from the same model, using virtually identical input variables. The largest differences involve total conifer stocking and again indicate that the extent of natural ingress that is occurring in managed stand of the Lakes TSA may be underestimated in TIPSY.

The Lakes TSR 2 base case scenario included an Operational Adjustment Factor (OAF 1) of 20% rather than the provincial default of 15%. That increase in the OAF 1 value was designed to account for the impact of hard pine rusts in lodgepole pine dominated stands of the Lakes TSA (Woods et al 2000). Our assessment of free-growing stands in the Lakes TSA supports that revised OAF 1 factor in TSR 2. (<http://www.for.gov.bc.ca/hts/tsa/tsa14/tsr3/rationale.pdf>). The Lakes TSR 2 base case scenario did not account for mountain pine beetle attack in managed stands.

## CONCLUSIONS

We introduced this report with a photograph of a stand that did not appear to be meeting expectations of productivity despite being declared free-growing. Our results suggest that the situation in the Lakes TSA is more positive, despite the high incidence of hard pine rusts. We found that on average, free-growing stands in the Lakes TSA are currently meeting expectations. Mean values for well-spaced and free-growing densities are remaining relatively stable post-declaration despite the high incidence of hard pine rusts. All field surveys for this study took place outside of the rust sporulation window of mid-May to mid-July when rust infections are most visible. It is likely we underestimated current rust incidence as a result. It is quite possible that the original free-growing declarations were also conducted outside of the peak visibility window for hard pine rusts.

If we consider the one mountain pine beetle stand identified in 2005 to be NSR, (a fair statement) then 11 of the 60 or 18.3% of declared free-growing stands in the Lakes TSA are no longer meeting the minimum stocking threshold of 700 fgsp/h based on the lower confidence limit rule. The majority of pest affected trees in these failing stands are in the tallest height class, 4m+. There is, however, further uncertainty regarding the future health of age class 2 and 3 lodgepole pine stands in the Central Interior due to the current beetle epidemic (MacLauchlan 2005). Our November 2007 aerial survey of the stands we first sampled in 2005 identified ten additional stands attacked by mountain pine beetle. We do not know if these recent beetle attacks were severe enough to reduce stocking below 700 fgsp/h. In 2005, in the early declared group, 23.3% of the free-growing stands no longer met minimum stocking requirements. Although only 13% of the late group were in the same condition, perhaps it is only a matter of time before they too are considered at higher risk.

There are no formal monitoring procedures in place for post free-growing stands. As a result, there are no set stocking thresholds for stands at this stage of development. In our analysis, we used a minimum acceptable stocking threshold of 700 fgph, but perhaps that value is inappropriate for stands that have an average age since disturbance of 27 years as our early group did. The minimum acceptable stocking threshold of 700 fgph was designed for free-growing stands typically aged 10-15 years.

We return to the question “Does the Free-growing assessment provide an accurate estimate of future stand productivity?” Our comparison of current stand volumes to TIPSY projections for 2005 indicated that there may be a divergence between TIPSY projections and actual stand performance as stands age. Our analyses also suggest that free-growing declarations may occur too early in the life of stands to provide an accurate projection of future stand productivity. The likelihood of making overly optimistic projections of stand productivity increases the earlier stands are declared free-growing as the influence of forest health factors is not yet realised.

Our study involved an intensive examination of stand conditions on the ground. The Forest Practices Board Special Report No. 16 (2003), due to its extensive nature, was based primarily on an office review of administrative milestones. Our study demonstrates the importance of more intensive on-the-ground monitoring of free-growing stands. We intend to conduct similar assessments in other TSAs.

## RECOMMENDATIONS

- (1) Although the majority of free-growing stands in the Lakes TSA are currently meeting timber productivity expectations, those that are not were dominated by lodgepole pine and had low initial densities that were further compromised by forest health agents. We recommend that within the SBS zone of the Lakes TSA in areas where species options are limited to lodgepole pine, either the initial planting densities be increased to 2500 fgph or natural regeneration of pine be encouraged to achieve the same density by regeneration delay. In areas where species options are not limited, we recommend increased species diversity.
- (2) Silviculture survey training/accreditation should include mandatory updating of forest health agent field identification training to ensure that free-growing surveys accurately capture the incidence of forest pests. We also recommend closer field inspections of contract survey work to ensure forest health agents are properly identified.
- (3) TIPSY should be revised to accommodate well-spaced stocking values instead of total trees which would better utilize free-growing survey data for TIPSY projections and TSRs. If TASS/TIPSY was able to project the volume of the well-spaced trees throughout a rotation, field verification of the model would be much easier. We believe mid-rotation field verification of TASS/TIPSY would improve the level of confidence in timber supply projections.
- (4) Performance measures should be set for TSAs that include a requirement that an acceptable minimum proportion of stands remain free growing. In order to accomplish this, we recommend a minimum stocking threshold for post free-growing stands be established that better represents stands at this stage of development (i.e., a minimum of 700 fgph is possibly not appropriate for a 35-year-old stand).
- (5) Our analyses suggest that free-growing declarations occur too early in the life of stands to provide an accurate projection of future stand productivity. A mid rotation assessment of stand productivity and forest health would provide more confidence. Recommend that government fund post free growing surveys on a portion of stands.
- (6) Policy makers should re-consider the use of the Lower Confidence Limit decision rule for determining free-growing status.
- (7) Policy makers should consider how well free-growing policy will continue to uphold the ministry’s stewardship mandate given the uncertainty associated with the direct and indirect impacts of climate change. A free-growing designation pre-supposes that young trees will continue to grow and thrive in a relatively stable environment.