ASSOCIATION OF BC FOREST PROFESSIONALS

A Review and Analysis of the Effect of BC's Current Stocking Standards on Forest Stewardship

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Commissioned Paper

Prepared for:

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Prepared by:

Jeff McWilliams, RPF

Eleanor McWilliams, RPF

B.A. Blackwell & Associates Ltd.

Timberline Natural Resource Group

Ensuring BC's Forests Are In Good Hands.

EXECUTIVE SUMMARY

The ABCFP council requested that the Association's Stewardship Advisory Committee (SAC) produce a report on stewardship issues associated with BC's policies on stocking standards. This discussion document was prepared for the SAC as a step toward meeting that request. It contains a review of relevant legislation, policy and literature and the authors' opinions based on our collective experience and input from several RPFs. The intent is that this report generates discussion and provides the basis for debate.

In BC, stocking standards define the early stand development criteria that are used to evaluate the success of basic silviculture and, assuming our projections of future stand development are correct, provide a high probability that stands are progressing towards their associated long-term management goals. Stocking standards are intended to ensure that a stand begins on the right pathway to achieve those long-term goals. They also form reforestation 'contracts' between licensees and the government. These contracts are initialized pre-harvest, when the stocking standards are set, and they are fulfilled when the harvested area is considered 'free to grow' (i.e., the stocking standards have been met). Licensees are responsible for basic silviculture until the required stocking standards have been achieved, following which the stands revert to the Crown's responsibility until the forest is once again ready for harvest.

The ABCFP defines forest stewardship as *"the sustainable balancing of environmental, economic and social values."* The relationship of stocking standards to forest stewardship lies in their influence on how stands are regenerated. For stocking standards to have a positive effect on stewardship, environmental, economic and social values must be clearly incorporated into forest level goals and stand level objectives. The balancing of these values, within the goals and objectives, can then be reflected in the stocking standards. In this way achievement of stocking standards will be more strongly linked to good stewardship.

Stocking standards have a long history in BC with the first being introduced for forest management licenses (precursors to Tree Farm Licenses) in the late 1940s. Their creation was motivated by the goal of sustained yield and to address concerns about large areas deemed not satisfactorily restocked (NSR). Key changes to stocking standards and how they are applied include: the shift to being based on the Biogeoclimatic Classification System in the 1970s; the introduction of the well-spaced tree concept in the early 1980s; the 1987 regulatory and policy changes that resulted in licensees being responsible for reforestation costs and introduced the concept of free growing; and the ability for licensees to develop their own stocking standards as introduced under the *Forest Range and Practices Act* in the early 2000s. Key debates between licensees and the government have included both maximum density and minimum stratum size requirements when assessing stocking acceptability.

The process of setting stand level objectives, and in particular early stand objectives, fundamentally relies on our ability to predict the development of regenerating stands. We start with forest level goals for our desired mix of stands and use our current knowledge of stand development to set objectives for early stand conditions. It is imperative that we recognize the uncertainty around existing predictions of stand development and therefore the need to continually check the actual growth and development of our regenerated stands. This will enable us to improve our understanding and predictive capabilities, and in turn to improve stocking standards. The feedback loop must be closed. At this point it is not. Our failure to track the actual growth of regenerated stands beyond free-growing was identified by most foresters interviewed as one of the major problems in our current system.

There are numerous technical details that must be addressed when developing stocking standards, including: inventory and timber supply linkages; incorporation of site productivity estimates; future yield projections that are a function of the total number of trees as well as the spatial distribution of those trees; multiple conflicting objectives for land base stratification; assessment and projected impact of competing vegetation; retroactivity (standards developed today can be applied to blocks harvested and regenerated in the past); long-term monitoring linkages to ensure regenerated stands continue developing as predicted; and the balancing of government and industry risk in the decision making process. It is critical that we, as professionals, understand these key technical issues when developing, and assessing compliance with, stocking standards.

In the current tenure and policy environment, licensee foresters may find it difficult to balance their responsibilities to the public and their employers. The roles and relationships defined by tenure agreements the policy environment are fundamental to the responsibilities and motivations of the parties, and can have a significant impact on the perspectives and behavior of professional foresters.

While there is debate amongst foresters about the importance of fiscal responsibility compared to the importance of stewardship, in too many situations reforestation is being treated as a cost not an investment. Paraphrasing several foresters, *decisions made to get a stand to free growing are not necessarily the same as those that would be made to get a stand to rotation.* Furthermore, considering factors such as climate change, some foresters have questioned the intent and meaning of the free growing concept which pre-supposes that regenerated stands will continue to grow in a relatively stable environment.

Many foresters feel strongly about the importance of stand-level management. However, in most cases, the significance of regeneration performance is at the forest-level. By setting and achieving well-defined forest-level goals, we are able to demonstrate good stewardship. By using forest-level assessments, we have opportunity to strengthen the linkages between stocking standards and timber

supply assumptions and other forest-level objectives and allow ***flexibility*** in achieving them. Forest-level assessment of reforestation performance can be done in many different ways; support for this approach should not be equated with a preference for a given method.

Stockings standards have contributed to substantial improvements in stewardship. In addition to better linkages between stocking standards and forest and stand level objectives, there also needs to be short and long term accountability for the results and incentives to promote better performance. This will likely require tenure and forest policy reform (primarily to the stumpage system). As all of these components are interrelated, changes to one or two areas without consideration of the others, likely will not significantly improvement the results. Foresters need to be leaders in educating the public and the politicians about the issues and alternatives and be advocates for the changes which will promote better stewardship.

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1.0 INTRODUCTION

1.1 PREAMBLE

According to the *Foresters Act* [1], an object of the Association of BC Forest Professionals (ABCFP) is to advocate for and uphold principles of forest stewardship, forest lands, forest resources and forest ecosystems. In response, the ABCFP council has established a stewardship advisory committee (SAC) to prioritize stewardship issues and develop reports addressing those issues for council's consideration. The ABCFP council asked the SAC to produce a report on the stewardship issues associated with BC's polices on stocking standards. This discussion document is prepared for the SAC to meet that request. The report contains a review of relevant legislation, policy and literature. It also contains the authors' opinions, based on our collective experience and input from numerous RPFs.

1.2 TERMINOLOGY

Historically in BC there have been several slightly different definitions of stocking standards. For the purposes of this report, the phrase stocking standards will be used in the general sense unless specifically noted otherwise. It is important to note that other jurisdictions use different terms, such as regeneration standards or renewal standards, for what we refer to as stocking standards in BC. These terms will be used interchangeably with stocking standards in this report when discussing these other jurisdictions.

Stocking is a widely used term and has many different specific definitions but it generally is a measure of the number of trees, basal area, or volume per unit area, relative to a management objective.[2] In Alberta, for example, stocking is defined as the percentage of mil-hectare (1/1,000 of a hectare) plots containing at least one suitable tree. Alberta stocking standards, therefore, are considered to be one component of regeneration standards.

Regeneration, renewal, or stocking standards vary by jurisdiction, and generally include minimum, maximum, and/or average targets for species composition, health considerations, competition allowances, heights, stand densities and stocking. They may also, by definition, include prescribed methods (surveys) for assessing the achievement of these targets. For the purposes of this report we will reference the methods, or surveys, separately.

1 Consolidated to December 1, 2007.

2 For example, two stands could have the same basal area per ha, but one could have a greater number of smaller stems and the other, fewer larger stems. References to how well these stands were stocked would vary dependent on the management objective being saw logs or pulpwood.

1.3 BACKGROUND

Regeneration standards are not new and are not specific to the management of Crown forest land in BC. However, according to Armson[3], regeneration standards, which focus on ensuring adequate replacement of harvested crops on Crown land, are "largely a North American and particularly Canadian concern and in some quarters an obsession." Over the last 20 years in BC there has been a tremendous amount of effort put into administering and achieving regeneration standards. Together with improvements in knowledge and practices, the growth of third-party certification, and the professionalism of BC's foresters, this focus on standards has led to a significant improvement in reforestation results. However, like many aspects of the management of BC's forests, there has been no shortage of controversy and debate about the role of stocking standards in stewardship.

Stocking standards define the early stand conditions that professional foresters believe will provide the highest probability of the regenerating stands achieving long-term objectives for future forest conditions and yields of products and services. Since 1987, stocking standards have been the key government tool used to ensure harvested areas in BC are adequately restocked. Achievement of free growing[4] is the key point at which a licensee's basic reforestation obligations have been fulfilled, and subsequent stand management becomes the responsibility of the Crown. As basic reforestation is the key (or only) required management on harvested areas and is paid for by licensees (with silviculture costs mostly recovered from the government through the stumpage appraisal system), the choice and achievement of stocking standards are of significant interest to both industry and government.

Basic reforestation efforts and stewardship are significantly and directly affected by stocking standards. They are also affected by administrative penalties for non-compliance, regulations effecting the rate and distribution of harvesting (e.g., maximum block size, adjacency, green-up) and maintaining third-party certifications. Additionally, other legislation and policies in BC, such as the tenure and the stumpage systems, have indirect but large impacts on reforestation and stewardship.

As legislation requires that professional foresters be guided by defined ethics and standards to oversee management of BC's forests, foresters are involved in setting, approving and fulfilling stocking standards. These management activities have a significant impact on stewardship of BC's forests. The ABCFP defines stewardship as *"the sustainable balancing of environmental, economic and social values" and states, "the stewardship standard is a crucible through which all professional decisions are evaluated."* [5]

3 Armson, K.A. 2005. Regeneration standards: what has the past to show us? Presentation to the Interprovincial Meeting on Forest Renewal Standards and Silviculture Effectiveness Monitoring, Toronto, February 3, 2005

4 A free growing stand means "a stand of healthy trees of a commercially valuable species, the growth of which is not impeded by competition from plants, shrubs or other trees." Forest and Range Practices Act, consolidated to May 29, 2008.

5 ABCFP Standards of Professional Practice: Guidelines for Interpretation, January, 2002.

The vast array of ecosystem types and harvesting methods in BC results in a multitude of technical issues which affect the development of, and management towards, stocking standards. These technical issues will be summarized and recognized, but it is outside the scope of this report to propose solutions to these problems.

In the current era of professional reliance and the high level of public scrutiny of forest management in BC, foresters are under self-imposed and public pressure to interpret and act in accordance with their responsibilities to their profession, employer and the public. In some cases, these professional responsibilities may be difficult to balance, resulting in debate amongst foresters regarding the development, application and assessment of stocking standards and their impact on stewardship.

1.4 PROJECT GOAL AND OBJECTIVES

The overall goal of this project is to analyze and assess how the current BC legislative, regulatory and policy framework, in relation to stocking standards, impact our stewardship obligations and to provide recommendations for change as appropriate. The specific objectives of this project are to:

1. Document the history of stocking standard development in BC in order to provide a context for where we are today.

2. Summarize the current legislative, regulatory and policy documentation pertaining to BC stocking standards.

3. Review and summarize stocking standards policy in other provinces for comparison to the BC process.

4. Review and summarize the technical issues involved in choosing stocking standards, and highlight those that have policy implications.

5. Review and discuss the impacts of current stocking standards on stewardship.

6. Review and discuss linkages between stocking standards policy and other forest management policy, to determine if there are any potential inconsistencies in their implications for forest stewardship.

7. Provide recommendations, as may be appropriate, regarding possible changes to stocking standards or other policy that will help to ensure stewardship obligations are met.

1.5 ACKNOWLEDGEMENTS

The content of this report was compiled based on the authors' collective experience, interviews with numerous RPFs and a review of relevant legislation, policy and literature. A draft report was circulated to the SAC and several ABCFP members for review and comment.

The authors gratefully acknowledge the valuable input from all who were interviewed or who reviewed the draft report (names listed in Appendix I). We have strived to incorporate the opinions expressed. This valuable input has helped us to develop the recommendations put forward, and credit should be given where credit is due, but any fault remains solely with the authors.

2.0 HISTORY OF BC STOCKING STANDARDS POLICY, REGULATIONS AND REFORESTATION RESULTS[6]

Regeneration standards are not new and are not limited to the management of Crown forest land in BC. Whereas it was implicit that regeneration was an integral part of the formal systems of silviculture practices used by European foresters in the late 19th to early 20th centuries, there is no mention of regeneration standards or of a need for them. Instead, forests were managed according to yield tables which specified required species compositions and stocking levels for achieving given stand attributes (basal area or volume) over time. This approach effectively set specific targets to be achieved throughout the life of a stand.

According to Armson[3], the first mention of regeneration standards in Canada can be traced to concerns identified early in the 20th century that the natural forests were being exploited without adequate management and reforestation. Subsequently, many surveys were conducted to determine the state of Canada's regenerating forests. However, there were no long-term objectives to measure the survey results against, and so the assessments of the adequacy of regeneration were imprecise and open to interpretation. In Canada and in BC, there are strong links between historic changes to tenure and overall forest policy, and the evolution of stocking standards.

2.1 PRE-1987

The first stocking standards in BC were developed for the newly granted Tree Farm Licenses (TFLs) which were a new type of long-term, area-based tenure on the coast of BC. The standards were developed to address concerns about the amount of productive forest land that was not satisfactorily restocked on the coast, and on the recommendation that new tenures be created on the basis of sustained yield as identified in the Sloan Royal Commission of 1945. The First Edition of the UBC Forest Club's Forestry Handbook for British Columbia (1953) makes reference to standards for re-stocking cutover and burned-over lands in the Douglas-fir region.

6 Ralph Winter, RPF, provided significant valuable information for this section of the report.

Acceptable performance needed more than 31% of surveyed mil-acre plots (1/1000th acre) to be stocked.[7] A mil-acre plot was considered stocked if it had one or more established seedling (>=1 year old) of a commercial species. In addition, acceptable stocking had to occur within eight years of logging or burning, and areas of 10 or more acres that were not satisfactorily stocked needed to be delineated on a map.

Despite the new TFL reforestation standards and the start of a provincial government reforestation division that provided a significant increase in the annual area planted on the coast after 1940, Sloan noted a significant increase in the amount of not satisfactory restocked (NSR) areas on the coast and in the Interior in his second Royal Commission Report (1956). He recommended additional resources be assigned to planting and surveying activities. He also mentioned concern for the amount of 'brushed in' productive forest land, and he questioned the will of the industry to meet their reforestation obligations on TFLs and the will of the Forest Service to ensure they did.

From 1956 through the early 1970s, there were no significant changes to public regulation and policy related to reforestation. However there was a significant increase in logging activity and the Forest Service greatly expanded its reforestation program to deal with harvest sites that were not expected to re-stock naturally. In his 1976 Royal Commission report, Pearse noted that the central tenet of sustained yield was that forest land be maintained in a productive condition, and so it was very important that public policy provisions ensure the establishment of new crops on lands denuded by logging or fire. Pearse noted things were much better on TFLs, and stated that previous heavy reliance on natural regeneration needed to be replaced by artificial reforestation as the best way to improve future crops. Pearse summed up the situation by saying *"reforestation has become a major issue, and major cost, of forest administration."*

Pearse's recommendations respecting the financial aspects of reforestation dealt with the disparity of cost recovery between different tenures and related to government budgeting challenges. At this time, depending on the tenure agreement, the stumpage system allowed a licensee's reforestation costs to be deducted from stumpage due, while expenditures of the Forest Service on lands that were not subject to these tenures was financed directly through legislative votes. In Pearse's opinion, this discrepancy, amongst other factors, had resulted in significantly more planting and less backlog of un-stocked lands on TFLs than on other forest land.

In 1973/74, based on the newly developed Biogeoclimatic Ecosystem Classification (BEC) System, Karel Klinka and the Forest Service developed ecosystem-based site productivity and associated management strategies for the coast. Starting in 1976, the Ministry of Forests (MOF) initiated a massive ten-year classification program

7 This equates to 766 hexagonal spaced or 918 randomly spaced trees per ha.

throughout BC that resulted in the production of regional BEC maps and field guides (MOF, Research Branch, BEC website). From this point forward, the BEC system has been the foundation for ecosystem-based reforestation in BC.

In the late 1970s and early 1980s changes were made to the *Forest Act* and its regulations that would implement the key recommendation from the Pearce Royal Commission. These changes were related to tenure and to the initial implementation of multiple-use policies.

Also in the late 1970s to early 1980s, the MOF (as the Forest Service was now called) developed a new silviculture survey system based on the concept of well-spaced trees.[8] This system replaced the one that relied on the concept of stocked quadrants. The new survey system was developed to be consistent with evolving and significant policy changes to stocking standards, and to provide better feedback to silviculturists on potential future treatment options and requirements.

In 1983 the MOF developed its Basic Silviculture Stocking Standard Policy so that reforestation activities could help to ensure that harvested land was maintained in a productive condition, and that the land was thereby capable to support sustained yield and meet desired future forest conditions. This policy set the standards for reforestation stocking levels, including criteria for target and minimum stocking of well spaced trees and preferred and acceptable species for the main BEC site series. This policy also recognized the importance of brushing activities for newly regenerated areas, by introducing the requirements for production of free growing stands. Licensees were expected to follow these standards (with the exception of some TFLs which had stocking standards based on approved Management and Working Plans). The MOF ensured licensee compliance with the standards by requiring licensees' plans for basic silviculture activities be consistent with the standards and be pre-approved, prior to any approval of funding through rebates to stumpage.

By the mid-1980s the number of trees being planted was continually increasing, and brushing activities for plantations on richer sites were becoming a regular practice.

2.2 1987 – 2003

In 1987, due to a US countervail action against Canadian lumber exports, substantial changes were made to the *Forest Act*, and its regulations and policies with respect to harvest planning, reforestation responsibilities and financing. The keystone of changes that were specific to silviculture responsibilities was the newly introduced Silviculture Regulation.

8 This work was led by Mike Wyeth and Dr. Howard Stauffer.

The Silviculture Regulation required preparation and approval of a Pre-Harvest Silviculture Prescription (PHSP) prior to harvest activities. PHSPs had to *"…be adequate to ensure that the free growing crop of trees specified in the prescription is established to the standards and within the time limits set out in the prescription."* PHSPs required a commitment to BEC-based stocking standards, identification of the silviculture system to be used, demonstration that the licensee had adequate seed and/or vegetative propagules to reforest the harvested area, and the signature of a professional forester.

The Silviculture Regulation also defined the components of stocking standards, including "well-spaced trees" (healthy, potential crop trees which are ecologically suitable to the site and spaced greater than or equal to a defined minimum distance from other well spaced trees) and "free-to-grow trees" (well-spaced trees greater than a defined percentage taller than competing vegetation within a one metre radius of the tree trunk at a specified period after the commencement of harvest). Stocking standards were specified as:

- Target and minimum numbers of well-spaced trees per hectare
- The minimum allowable distance between well spaced trees
- Preferred and acceptable species
- Target leader growth
- Maximum density for lodgepole pine and Interior Douglas-fir
- Regeneration delay
- The earliest and latest dates for free-growing assessment

The key milestones for licensee compliance were regeneration delay (the maximum time from harvest start until stocking was required) and free growing (the time period from harvest until a free growing crop was required).

Stocking standards that were formalized in the Silviculture Regulation were chosen to foster development of ecologically-suitable, resilient, free growing stands as soon as possible after harvest, in order that the stands would produce specific ranges of products (including some larger diameter saw logs on most sites) at specified rotation ages. This was done to support the linkages between stocking standards and desired future forest conditions initiated with the 1983 Basic Silviculture Stocking Standard Policy

Other key changes to reforestation in the Silviculture Regulation involved:

- The collection, storage and use of tree seed.
- The requirements for surveys to be conducted to verify stocking and free to

grow.

- The annual reporting of harvesting and silviculture activities and the achievement of basic silviculture obligations.
- Requirements and provisions for amending PHSPs.
- Requirements for licensees to pay and to provide for anything necessary to achieve basic silviculture obligations. (This was by far the most significant change.)

During this time, correlated stocking standards were developed for the approximate 600 BEC site series in BC, and were based on analysis of the growth and yield effects of the key different stocking parameters using TASS[9] and on negotiations with industry. These standards were delivered through regional circular documents that became the benchmarks for stocking standards to be identified in PHSPs.

As part of the 1987 changes to how reforestation activities were financed, the process of directly rebating stumpage to licensees for their reforestation costs was abolished. From this point forward, basic reforestation costs became part of the stumpage appraisal system. Under both systems, the government was effectively paying for basic silviculture carried out by the licensees; however, the new process created some significant changes to the business of reforestation.

As part of the stumpage appraisal system, historical silviculture costs of the licensees in an identified geographic area were used to calculate regional allowances for silviculture. These, and other allowances for harvesting and administration, were deducted from the estimated revenue to be generated from a cutting permit (block or group of blocks) in order to determine the stumpage rate. So in theory, as long as a licensee's actual silviculture costs were equal to or below the historical costs assumed in the appraisal system, the Crown was effectively still paying reforestation costs. However, this was not always true. For example, in cases where stumpage was below the minimum, all or a portion of the silviculture costs could be paid by the licensee. This system has commonly led to regional disparities, and some licensees argue that the silviculture allowances (as with other cost allowances for harvesting and road building) are not accurately reflecting their actual costs (usually in comparison to another licensee or region) and they are effectively paying a portion of basic silviculture costs. However, in most cases, either these issues have been resolved over time, or they are considered minor by licensees who operate in multiple regions and/or reconcile stumpage appraisal and costs on an overall average basis.

The way companies account for their financing of silviculture activities also plays an important role in the management of reforestation responsibilities. As stumpage

9 Tree and stand simulator. Model developed by the BC Ministry of Forests and Range, Research Branch.

is paid at the time of harvesting, and reforestation costs can occur over the next 20 years (until free to grow), most large licensees typically treat silviculture costs as liabilities (as compared to annual expenses). Typically these liabilities are initialized on the basis of pre-harvest estimates for costs of treatments that are required to achieve free growing. Subsequently, as treatments are completed, the actual costs are used to reduce the liabilities. So by free growing, if all the original estimates were correct, the liability for a given block would be gone. However, due to changes in standards, costs, plans or unexpected results, this rarely happens. Therefore licensees are continually updating their estimates of remaining silviculture liabilities that are expected to impact their future financial results.

The net effect of this system is that licensees are financially motivated to minimize their reforestation costs and still meet the required stocking standards. This can have positive effects on overall reforestation results (where licensees develop more effective practices or minimize risks of not meeting the standards by trying to achieve free growing as soon as possible) or negative effects (where licensees reduce costs and manage towards the minimum standards and/or later achievement of free growing).

Overall, it can be argued that the 1987 regulatory and policy changes to silviculture were the most significant events affecting reforestation in BC history. From this point forward, forest companies were required to reforest harvested public land with ecologically suitable species and to ensure the new crops become free growing. Once a company had established a free growing stand it had fulfilled its basic silviculture obligations for that piece of ground and the new crop of trees became the responsibility of the Crown.

In 1994 the Silviculture Practices Regulation replaced the Silviculture Regulation. The key changes which affected basic silviculture were the:

- Requirement to use seed orchard seed, when it is available, for the species to be established.
- Addition of a standard for the minimum number of well-spaced trees of the ecologically preferred species per hectare.
- Addition of minimum free growing heights by species and site series.
- Addition of soil conservation standards and management requirements.
- Provision for administrative penalties for non-compliance with regeneration delay and free growing requirements (initially set at $10,000/occurrence).

To support implementation of the Silviculture Practices Regulation, regional stocking standards, and guidelines and procedures for their use, were released by the MOF. Importantly, these documents also laid out the provisions for deviations (with rationale) from the regional standards.

Until the 1990s, stocking standards development had been almost exclusively focused on even-aged, clearcut silviculture systems. Now, standards and survey procedures started to emerge for more complicated, non-clearcut silviculture systems (e.g., for multi-storied, un-even aged stands). Also, in some regions new standards were developed to accommodate non-timber values (e.g., grizzly bear stocking standards on the coast), to further regulate species composition (e.g., minimum stocking standards for western red cedar in the Queen Charlotte Islands) and to allow management for broadleaf stands (e.g., for alder on the coast, aspen in the Northeast).

In the early 1990s an initial policy dealing with minimum strata size was introduced, for adjudicating the achievement of silviculture obligations. Also about this time the 40 hectare maximum cutblock size was introduced in the Coast Region.

In 1995, the *Forest Practices Code of British Columbia Act* (the Code) was introduced. The initial version of the Code did not cause significant alteration to either stocking standards or the regulation of basic silviculture.

The Code specifics that directly affected stocking standards and basic silviculture included:

- In addition to standards for even aged silviculture systems (similar to the previous ones), stocking requirements were specified for uneven-aged and even-aged partial cutting systems and for intermediate cuttings (without regeneration objectives).
- Licensees were required by regulation to use the best genetic quality seed source available for reforestation.
- Maximum density (now regardless of species and region) and the requirement for spacing before free growing if the maximum density was exceeded were put into regulation.
- The role of compliance and enforcement was strengthened and administrative penalties for non-compliance with regeneration delay and free-growing requirements were increased substantially. Due diligence defense of administrative proceedings also became part of the Code.

The Code specifics that indirectly affected stocking standards and basic silviculture included:

- Silviculture Prescriptions (SP) replaced PHSPs and had to be consistent with Forest Development Plans (FDPs) and/or higher level plans.
- The retention silviculture system was introduced and defined.
- Maximum block sizes and green-up requirements were introduced.

- SPs were required to specify post-harvest site conditions that would accommodate known resource features and non-timber forest resources.

- The Forest Practices Board (FPB) was established and had the mandate to audit government and industry forestry practices, and to deal with complaints from the public regarding forest practices and government enforcement. In addition, the FPB was given the authority to carry out special investigations (FPB website).

Due to challenges with the perceived prescriptive nature of the Code, changes aimed at streamlining the regulatory process towards a more results oriented system occurred over the next five to seven years. In 2002, Site Plans replaced Silviculture Prescriptions and did not require MOF approval. To facilitate this change and to retain government control over stocking standards, the standards became a required component of FDPs. As a result, default stocking standards were created for the approximately 630 BEC site series in BC, based on the existing regional standards and standards in previously approved Silviculture Prescriptions. This was precursory to the changes brought in through the *Forest and Range Practices Act*.

As a result of significant changes to reforestation policy in 1987, there were substantial increases in: the number of trees planted; the proportion of harvested area planted; and the survival rate of planted trees. There was also a significant decrease in the average regeneration delay. The Code's regulation of adjacency and green-up requirements, and its significant penalties for not meeting basic silviculture obligations, provided additional impetus to these trends.

Beginning in 1996, the FPB started compliance audits of silviculture activities. For the first five to seven years the audits found substantial compliance with legislative requirements, although the population of free-growing cutblocks examined was very small.[10] These results showed that licensees' were promptly reforesting harvested areas consistent with the stocking standards. The next big test was whether these planted areas would become free growing.

In 2002 the FPB decided to investigate the achievement of free growing. The resulting Special Report[10], summarized the findings for 291 cutblocks, in six forest districts that were harvested between 1987 and 1992, all of which were required to be free growing by 2002. Even though the blocks were selected because they had a relatively high risk of not achieving free to grow, 99% of the net area to be reforested was found to be stocked and free of brush competition. Additional checks of the provincial MOF silviculture database showed that only about 4% of the non-field checked cutblocks had yet to achieve free to grow status. Overall, 85% of cutblocks were found to be free growing within the required timeframes. Finally, as noted by the FPB:

10 Forest Practices Board. 2003. Reforesting BC's public land – an evaluation of free-growing success. FPB Special Report 16. http://www.fpb.gov.bc.ca/special_reports.htm

"These early results from the first set of cutblocks harvested under the objectives of the Silviculture Practices Regulation are very encouraging. They are the net result of hard work and cooperation by licensee and government foresters, technicians, seedling producers and silviculture workers. The people involved deserve congratulations."

The FPB Special Report also mentioned several issues affecting compliance and causing challenges in the administration of basic silviculture obligations. These were:

- Minimum stratum size and issues of scale
- Amendments to stocking standards

When monitoring for compliance with required stocking standards, one of the key issues of contention between licensee and MOF foresters became that of scale. Historically, stocking standards were set at the standards unit (stratification of blocks based on site/stand conditions and/or planned treatments and/or stocking objectives) level. However, to promote more intensive management and more accurate reporting of variable forest conditions, many forest districts had developed policies around minimum stratum size for treatment and reporting. Typically minimum stratum size was two hectares or less, with additional criteria for areas with smaller dispersed irregularities. Usually there were few issues with minimum stratum size during the early stages of reforestation, as foresters would try to manage the harvest sites as intensively as possible. However, closer to free growing, problems relating to scale, to atypical sites (those not well reflected by the standards or not well understood) or to factors not in the direct control of foresters (cattle, ungulates, etc.), led to disagreements in several locations in the province. Commonly, these issues were resolved through amendments to the stocking standards or with inexpensive treatments. However, in some cases frustration developed where the cost/benefit ratios of remediation were high. Typical arguments were related to significance and scale, with many licensee foresters arguing that they were meeting or exceeding their stocking standards at the forest-level, and that it was not worthwhile to go back and fix these small problem areas from a cost/benefit perspective. On the other hand, MOF foresters argued they were upholding their interpretation of the law, and the original prescriptive agreement, and some were concerned that this averaging approach could be taken to extremes and negatively impact good forestry. Ultimately, these challenges and disagreements led to the development of forest-level approaches to stocking standards, and the Weyerhaeuser case[11] that resulted in a specific minimum stratum size being incorporated into regulation.

SPs and Site Plans contain many standards and cover activities and obligations that span a long time period. Amendments to these documents are very common as knowledge and practices change over time. SPs and Site Plans can be amended at any time prior to the expiry of free growing (with or without the requirement for

11 http://www.fac.gov.bc.ca/forestPracCode/2004for020a_025a.pdf

approval by the MOF), and this includes changes to stocking standards. Potentially significant stewardship issues can be associated with changes to ecologically suitable species, minimum stocking standards and extended free growing dates. Usually these kinds of amendments are for portions of cutblocks with atypical site conditions, or unanticipated problems of brush or forest health issues. In addition to the amount of effort required to administer the amendment process, adjudication of amendments has also led to questions relating to scale and significance for stewardship.

During the late 1990s and early 2000s, there were significant debates in BC concerning stocking standards and basic silviculture, and they included maximum density regulations and brushing requirements. Differences of opinion with respect to the significance of high-density natural lodgepole pine regeneration and the impact of certain deciduous trees on conifer growth pitted some Interior licensees against the MOF.

2.3 2003 - PRESENT

The *Forest and Range Practices Act* (FRPA) and associated regulations were introduced in 2003. One of government's objectives for the new legislation was to reduce administrative and operational costs for both industry and government while continuing to maintain high levels of environmental stewardship, public confidence and a strong compliance and enforcement regime.[12] FRPA was also developed with an emphasis on professional reliance. The FRPA legislation set up a two-year transition period between the Code and FRPA. By April 2005, FRPA was to be fully functioning.

FRPA replaced FDPs with Forest Stewardship Plans (FSPs). Stocking standards are now approved by the Ministry of Forests and Range (MOFR) as part of FSP approvals. FRPA also brought in several changes that affected stocking standards. First, the definition of stocking standards was officially modified. From Section 1 of the Forest Planning and Practices Regulation (FPPR), stocking standards mean the stocking standards that apply when;

a. Establishing a free growing stand; or

b. Meeting the residual stand requirements following an intermediate cutting or the harvesting of special forest products

Second, under Schedule 6, Section 1 of the FPPR, the factors to be used when developing stocking standards are laid out. These factors provide guidance to licensees when they are developing stocking standards and set the bounds for what

12 Ministry of Forest and Range. 2006. An overview reference for the evaluation of stocking standards under FRPA. Forest Practices Branch. October 4, 2006.

the MOFR can require from licensees. These factors are:

a. Where trees are to be established (even-aged management) – the economically valuable, ecologically appropriate species, numbers and distribution of those trees to be established; and,

b. Where trees are to be retained (uneven-aged management) - the economically valuable, ecologically appropriate species, characteristics, quantity and distribution of those trees to be retained.

c. For all standards – occurrence and extent of forest health factors and long-term forest health risks.

Third, under FRPA a licensee who has an obligation to establish a free-growing stand must establish a stand that:

a. Meets the applicable stocking standards by the regeneration date, and

b. Meets the applicable stocking standards by a date that is no more than 20 years from the commencement date.

Under FRPA, the 20-year interval is equivalent to the late free growing date under the Code and what was the early free growing date under the Code is now defined by the free growing heights.[12]

Also under FRPA, a free-growing stand is defined as a stand of healthy trees of commercially valuable species, the growth of which is not impeded by competition from plants, shrubs or other trees. Free-growing heights are still a requirement under FRPA but are specified separate from the stocking standards. The minimum ratio of height to brush that was required under the Code is no longer a content requirement.

Fourth, under Section 16 of the FPPR, licensees are required to specify in their FSP the situations and circumstances that determine when various stocking standards and their associated regulatory requirements will be applied (e.g., BEC, other site modifiers or non-timber objectives such as visual or wildlife).

Fifth, under Section 26 of the FPPR, when proposing FSP stocking standards for MOFR approval they must be consistent with the following key tests:[12]

- **Test 1 – Initial High-Level Test** – A high-level review of all the proposed stocking standards to ensure there are no obvious omissions or issues that will not allow for approval. This test is not intended to replace the tests that follow.
- **Test 2 – Ecological Suitability Test** – *The Reference Guide to FDP Stocking*

Standards[13] is considered the starting point for this test. Licensees can also use appropriately applied and credible new and emerging information.

- **Test 3 – Forest Health Test** – The key criteria for this test should be species acceptability based on known forest health factors.

- **Test 4 – Economically valuable supply of commercial timber** – Focuses on value (not volume) based on the proposed species and the associated potential risk with respect to future options for products and values. While this test acknowledges the difficulties associated with assessing these future values, the assumption is that maintaining or enhancing a mix of species is considered a reasonable strategy.

- **Test 5 – Consistency with Timber Supply Review** - To facilitate good forest management, stocking standards should be linked to local assumptions for the sustainability of timber flows over time. Accordingly, standards that are consistent with the latest timber supply review (TSR) should be considered acceptable.

Finally FRPA set up provisions for the Chief Forester to receive and approve stocking standards collectively across cut blocks (multi-block criteria – FPPR s 45).

In summary, FRPA was designed with emphasis on professional reliance and reduced administration. Relative to stocking standards, it provided flexibility for licensees to apply innovative approaches to existing and future challenges.

Initially, many licensees rolled over their existing FDP stocking standards into their FSPs. This was due to challenges to achieve timely FSP development and approval, and/or concerns with how the MOFR was going to interpret the approval requirements, More recently some multi-block (Fort St. John TSA, Weyerhaeuser (Southern Interior Forest Region)) and innovative (Morrice/Lakes IFPA, Rocky Mountain Forest District) stocking standards have been approved.

In 2005 the FPB updated the 2003 Special Report on Reforesting BC's Public Lands, based on a review of the provincial silviculture database. It found that provincially 92% of cutblocks had achieved free growing.[14] This update also noted that amendments were common for blocks that were declared free growing.

In 2007, the MOFR introduced new legislation to regulate minimum stratum size. This was based on the Forest Appeals Commission (FAC) 2005 decision in the Weyerhaeuser case[11], that the standards unit was the minimum stratum size for the purpose of assessing compliance with basic silviculture obligations. Under the amended FPPR licensees are required to meet their silviculture obligations on each

13 http://www.for.gov.bc.ca/ftp/hfp/external/!publish/Stocking%20Standards%20for%20FDPs/Reference_Guide.pdf

14 Forest Practices Board. 2007. Special investigation on amending prescriptions for achieving free-growing forests. http://www.fpb.gov.bc.ca/special/investigations/SIR17/SIR17.pdf

hectare within the net area to be reforested, unless otherwise specified in a FSP. One exception is, at free growing, areas less than one hectare and areas between one and two hectares but less than five percent of the standards unit (SU) do not need to meet the applicable stocking standards if the rest of the SU is free growing. In addition, the legislation allows licensees to submit declarations that free growing stand obligations have been met to the extent practicable. These declarations, with supporting rationale, and when approved by the MOFR, allow free growing to be achieved on areas that do not meet the stocking standards.

In addition to legislative changes, other recent developments have implications for stocking standards and basic silviculture. Of concern are recent observations of significant forest health issues that were previously unrecognized (not related to the mountain pine beetle) in free-growing stands of lodgepole pine and Douglas-fir in portions of the Interior. These observations have caused some foresters to worry about the extent of these problems and whether or not stocking standards, and the growing concept, are adequate to ensure that regenerated stands will meet our future forest expectations. These concerns are amplified when we consider how the potential impacts of climate change on forest health agents will affect our young conifer dominated forests.

Finally, concerns have been expressed that on some areas of the coast, reforestation of sites that were previously mixed western hemlock stands (with western red cedar or Douglas-fir) has excessively favoured western hemlock, or that the use of silviculture/harvesting systems that are associated with high levels of retention have resulted in poor quality stand regeneration.

3.0 STOCKING STANDARDS IN OTHER PROVINCES

3.1 ALBERTA

3.1.1 Current Situation

In cooperation with Alberta Sustainable Resource Development (ASRD), most of the Forest Management Agreement (FMA)[15] holders in Alberta are currently developing their own new regeneration standards, referred to as alternative regeneration standards. The existing standards are documented in the Alberta Regeneration Survey Manual.[16] The impetus to develop new standards resulted largely from the review of existing standards by the Alberta Reforestation Standards Science Council (ARSSC).[17] A key concern in the ARSSC report was that *"No verifiable linkage has been*

15 FMAs are area-based tenures.

16 Alberta Sustainable Resource Development. 2007. Alberta regeneration survey manual. ASRD Forest Management Branch, Edmonton, Alberta. http://www.srd.gov.ab.ca/forests/pdf/RSM_May_2007_final.pdf

17 Alberta Reforestation Standards Science Council. 2001. Linking regeneration standards to growth and yield and forest management objectives. Prepared for Alberta's Minister of Sustainable Resource Development. http://www.srd.gov.ab.ca/forests/pdf/ARSSC_Report.pdf

demonstrated between the 2000 Regeneration Standards' targets and the growth and yield (G&Y) curves of the regenerated stands and AAC calculations." The new regeneration standards include an explicit linkage to timber supply yield assumptions via setting of target mean annual increments by major forest types. Furthermore, the new survey systems are being designed to collect input data for growth and yield models, so that mean annual increment projections can be obtained and compared to targets. Significant work on the two major growth and yield models in the province, GYPSY[18] and MGM[19], is ongoing to facilitate the projection of early stand parameters.

3.1.2 Comparison to BC

There are several major differences between BC and Alberta:

- In contrast to BC, the vast majority of land managed for timber production in Alberta is under long-term area based tenure (FMAs). Furthermore, the ownership of all Crown timber on land subject to a forest management agreement, is, during the term of the agreement, vested in the holder of the agreement. [20]

- In BC licensees may adopt the existing default government standards if they choose not to develop their own. In Alberta, it is the government's intention that the existing government standards be phased out and replaced and they have encouraged all licensees to participate in the development of new standards.

- The new stocking standards under development in Alberta all incorporate a multi-block approach.

- In Alberta there is an explicit recognition of balancing regenerated species mixtures at the forest-level, and this is not the case in BC. In many areas of Alberta there are overlapping coniferous and deciduous cutting rights which have necessitated the need to ensure balanced regeneration of coniferous and deciduous species. Licensees are required to report on the area reforested to four major strata (coniferous, coniferous-deciduous, deciduous-coniferous, deciduous) relative to the area harvested in these four major strata. Allowable cut penalties can be assessed if areas are out of balance.[21]

18 Growth and yield projection system. This model development is lead by Dr. Shongming Huang at ASRD.

19 Mixedwood growth model. This model is being developed by Dr. Mike Bokalo, Dr. Ken Stadt, and Dr. Phil Comeau at the University of Alberta.

20 Alberta Forests Act. Part 2 16(2).

21 Alberta Sustainable Resource Development. 2006. Regeneration stratum declarations and allowable cut adjustments. ASRD Forest Management Branch Directive 2005-1. http://www.srd.gov.ab.ca/forests/pdf/Directive2005-01.pdf

3.2 ONTARIO

3.2.1 Current Situation

The Ontario Ministry of Natural Resources (OMNR) is currently developing new renewal standards, along with a new silviculture effectiveness monitoring program for the province.[22,23] Ministry staff hope to have draft documents prepared in 2008. The intent is to replace the existing standards because they do not differ between management intensities (basic, extensive, intensive) and the associated assumed yields in timber supply. The Silviculture Effectiveness Monitoring Manual for Ontario[23] states that regeneration standards must include: target and acceptable species; minimum heights of target and acceptable species; time frame to free-growing; stocking and/or density per hectare and survey methods.

3.2.2 Comparison to BC

The issues being addressed in Ontario during the development of their new standards are very similar to those being addressed in BC. Key concerns in Ontario include linking renewal standards to quantifiable stand and forest-level objectives, obtaining information to forecast future stand development and ensuring data collection programs are in place to provide feedback on stand development for future refinement of silviculture objectives and standards. Until the new programs are made public it is difficult to make further comparisons.

4.0 TECHNICAL ISSUES THAT AFFECT STOCKING STANDARDS

This report is focused on assessing how stewardship obligations are impacted by the current BC legislative, regulatory and policy framework related to stocking standards. In order to provide reasonable recommendations for future changes to stocking standards, it is critical to understand the key technical issues and limitations that impact the development of stocking standards. Without an understanding of technical issues, policy and legislation usually will be lacking.

Historically, stocking standards have been based on the best available information and have typically involved a negotiated component where detailed understanding has been lacking. As our ability to forecast future stand development has improved so has our ability to set stocking standards that provide assurance that regenerated stands will develop as predicted.

22 Shelagh Duckett, Regional forest health and silviculture specialist, Ontario Ministry of Natural Resources.

23 The current silviculture effectiveness monitoring manual can be found at http://www.mnr.gov.on.ca/MNR_E000271.pdf

4.1 INVENTORY AND TIMBER SUPPLY LINKAGES

Historically the development of stocking standards has always considered the yield projections assumed in timber supply. However, only in the FPPR has the requirement that stocking standards be consistent with timber supply assumptions been explicitly stated. FPPR Section 26 (3):

"The minister must approve the regeneration date, free growing height and stocking standards… if … (a) the regeneration date and the standards… (ii) is consistent with the timber supply analysis and forest management assumptions that apply to the area …"

Alberta Sustainable Resource Development (ASRD) has taken this a step further with the wording in the Alberta Forest Management Planning Standard.[24] Annex 1, Timber Supply Analysis and Growth and Yield, Section 4.0 (page 41) states:

"These standards describe the requirements for developing and monitoring yield projections and regeneration standards for use in forest management."

"Create valid and accurate relationships between regeneration standards and growth projections…"

Timber supply linkages in stocking standards clearly demonstrate due diligence in our management practices. Future projections can be translated into combinations of species mixtures, stand densities, spatial distributions and regeneration delays required in early stand development that will result in the assumed future stand conditions according to the best models available. Furthermore, there is increasingly the ability to design compatible silviculture surveys and models, so that the survey results for individual areas or groups of areas can be projected forward to produce estimates of future stand conditions to compare to timber supply assumptions.

The caveat is that there will always be uncertainty around model projections; particularly those using estimate of early stand conditions as inputs. There has to be recognition of this uncertainty in our management practices. At best, we can state that at the point in time the stand is assessed against the stocking standards it has a reasonable probability of achieving the future conditions assumed in the timber supply.

Regardless of whether or not stocking standards are achieved in regenerated stands, linkages to timber supply are also made by using the actual regenerated stand parameters as inputs to yield projections for subsequent timber supply analyses.

24 http://www.srd.gov.ab.ca/forests/pdf/Alberta_Forest_Management_Planning_Standard_Version_4_1_April_2006_Final_2.pdf

4.2 SITE PRODUCTIVITY ESTIMATES

Linking stocking standards to assumed future forest conditions in timber supply analysis requires site productivity estimates (typically site index). In most growth and yield models, future volumes projections are most sensitive to site index estimates. When setting stocking standards or assessing the achievement of standards it is critical to realize that in most cases the silviculturists do not have control over the site productivity (unless their treatments degrade the site). If the methodology used to set or assess achievement of stocking standards incorporates site index estimates one must be extremely careful not to confound the assessment of the silviculture practice with the assessment of site productivity, particularly for those standards that incorporate projections of future volumes. For example, if site index for a harvested area is estimated as part of the silviculture survey, and it is lower than that used to set the target volume which the stocking standards are based on, then even if the silviculture practices are as required to meet the target volume, the predicted volume from the survey results will be less than the target and the licensee will be penalized. The reverse is also true, an estimated site index higher than that used to set the target volume and associated stocking standards would allow the silviculturist to under perform and still reach the target volume.

4.3 GROWTH AND YIELD

For a given species on a given site, future stand yields are a function of the total number of trees established and the spatial distribution of those trees. Many stand level growth and yield models do not differentiate between different spatial distributions of trees. In other words there is no option to start the model with, for example, 1,200 clumped versus 1,200 randomly distributed trees per hectare. TASS can be started with any spatial distribution and attempts to address micro-site and genetic variability by assigning random vigour coefficients to individual trees. TIPSY [25] currently has the option to choose from three different spatial distributions (regular, random and clumped). To illustrate the impact of spatial distribution on future yield projections, consider a site index 20 m lodgepole pine stand with initially 1,000 total trees per hectare. A TASS projection of this stand, assuming it was a plantation, will result in approximately 300 m^3/ha at age 75. In contrast, changing the spatial distribution to clumped, reduces the volume projection to approximately 200 m^3/ha. In TASS, future volume is a function of the occupied growing space, which is defined by the total number of trees and their spatial distribution.

Regeneration targets of well-spaced trees, mean stocked quadrants or percent stocked mil-hectare plots are all aimed at ensuring the entire site is sufficiently occupied. This can also be viewed as attempting to minimize the number of holes in the regenerating stand. At lower numbers of total trees per ha, the more clumped the spatial distribution of the trees (i.e., the more holes in the stand), the smaller all of these measures will be. As total densities increase, the impact of spatial distribution

25 Table interpretation program for stand yields. Provides access to managed stand yield tables generated by TASS.

on measures such as well-spaced trees, mean stocked quadrants or percent stocked mil-hectare plots decreases. While these measures are definitely superior to a simple measure of total trees per hectare for measuring site occupancy, the ability to set targets is based on the available models which all have inherent assumptions about individual tree growth and stand dynamics. Model assumptions and limitations need to be recognized and acknowledged when setting regeneration targets. Consider, for example, the incomplete ability to model sites that have a limited, irregular distribution of micro-sites on which trees can be successfully established and grown to rotation.

Numerous TASS projections, including simulations of silviculture surveys on stands with different total densities and spatial distributions, have been used to estimate targets for well-spaced trees. However, this does not mean that well-spaced tree counts can be used as **inputs** to TASS or TIPSY. There is currently work underway to **output** well-spaced tree counts from TASS and TIPSY. To use well-spaced tree counts as inputs to TASS or TIPSY would require inferring a spatial distribution from the well-spaced and total tree counts. This can be approximated; however, there is not a unique solution. It can be demonstrated that more than one spatial distribution of a given total number of trees will produce the same number of well-spaced trees.

4.4 STRATIFICATION

Stratification can be done to meet many different objectives. In the most general sense, stratification is partitioning a land base into smaller areas to meet specific objectives. For silviculture purposes, stratification is often done to delineate different ecosystems, areas requiring different silviculture regimes and areas to which stocking standards will apply (standards units). In inventory it is done to delineate unique stand types (as defined by the inventory parameters). In sampling design, stratification is typically used to reduce variation (reduce variances and sampling errors). The sampling objective of reduced variation is often compatible with both inventory and silviculture objectives. However, stratifying to meet inventory and silviculture objectives may or may not be compatible. Silviculture objectives often require a finer stratification than required by inventory or stratification that overlaps inventory polygons.

Yet another reason for stratifying is for the assessment of stocking standards. Strata defined for this purpose delineate the areas over which survey results are averaged for comparison to stocking standards. These strata may or may not be the same as the strata defined for silviculture or inventory purposes. How to do this stratification has been a very contentious issue with the debate centered on minimum strata size. Recent amendments to the FPPR have clarified this process by clearly defining the minimum strata (Section 2.3).

From a technical viewpoint, if stocking standards are to be directly linked to timber supply assumptions (primarily yield projections of inventory polygons), then the

minimum strata size for assessing stocking standards should be equivalent to the minimum inventory polygon size. Furthermore, if stocking standards are linked to timber supply assumptions, ideally, if it were possible, stratification for assessing stocking standards should be done to inventory standards.

Conflicting stratification objectives between silviculture and inventory can hamper the ability to set and assess stocking standards that are linked to timber supply assumptions. Ideally, if stocking standards are linked to timber supply assumptions, then stratification for assessing achievement of stocking standards should be done to inventory specifications, as it is inventory polygons that the yield curves are assigned to in timber supply. Unfortunately, this ideal is further hampered by the fact that stable inventory polygons may not be evident at the time stocking standards are assessed. Typically, if the lone objective were to inventory regenerated stands, this would be done at a later point in stand development than is preferred to assess the achievement of stocking standards.

A key component of multi-block systems[26] is the assessment of regeneration performance at the forest, or multi-block level. This approach maintains individual block minimums (and these may be lower than in the traditional single block approach), but it also adds a multi-block check to ensure that on average over all blocks that average targets are being met. This alleviates the concern over too many individual blocks (strata) just passing minimum standards (as can happen if large void areas are averaged into individual strata) as if this happens in too many cases, the overall average targets will not be met.

4.5 COMPETITION ASSESSMENT

Competition assessments are essentially risk assessments. They estimate the likelihood that the chosen crop trees will have their subsequent growth jeopardized by other plants on the site. Thresholds are set based on the best available science to reflect the maximum competition that can be tolerated by the crop trees without resulting in significant growth reductions. Significant in this case being defined by the target growth rates for the crop trees. Current debate on the best approaches to competition assessment includes differences between crop tree-centered approaches versus stand-level assessments. Setting competition thresholds are complicated by the vast array of ecosystem types and plant communities that exist. Further complicating the issue are biodiversity requirements that may require a mixture of competing species to be managed on a single site.

4.6 RETROACTIVITY

When developing new stocking standards there must be recognition of the different silviculture practices that have occurred over time as standards that are developed

26 Martin, P.J., Browne-Clayton, S., McWilliams, E.R.G. 2002. A results-based system for regulating reforestation obligations. For. Chron. 78(4): 492-498.

today may be applied to blocks harvested 10 plus years ago. If stocking standards are linked to timber supply assumptions, and the timber supply assumptions adequately address differences in silviculture over time, then the issue of retroactivity becomes minimal.

4.7 LONG-TERM MONITORING LINKAGES

Meeting or exceeding long-term goals for regenerated stands is the ultimate measure of silviculture and management performance. However, waiting until stands reach this point to assess management performance is clearly not feasible. Stocking standards are set as a short-term performance measures along the pathway to the long-term goal and clearly need to be recognized as such. In addition to stocking standards, it is critical to have long-term monitoring programs, or frequent scheduled audits[27], in place to ensure that stands stay on track over time or timber supply assumptions are modified accordingly.

Long-term monitoring or audits will provide feedback on actual performance relative to predictions. Over the long term, with accumulated data, stocking standards can be adjusted and the confidence in them will improve. This should be a continuous process.

Long-term monitoring or any type of audit past the free-growing stage is currently not required in BC. In comparison the Alberta Forest Management Planning Standard, Annex 1 requires all FMA holders to:

"Monitor actual growth to guide adjustments to yield projections and regeneration standards in the future."

The requirement to *monitor actual growth* necessitates the establishment of long-term re-measured plots.

4.8 REGULATORY DECISION MAKING

Setting provincial stocking standards usually involve some negotiation between government and industry as a result of dealing with imperfect information. Part of the negotiations includes a distribution of risk between government and industry. In the context of stocking standards to measure industry performance in meeting silviculture obligations, industry and government risk can be defined as follows[28]:

Industry Risk - is a function of the probability of declaring a stand, or group of stands, as not free growing when they truly are, and the impact this has on

27 Monitoring here implies the use of long-term re-measured plots, while audits refer to point in time assessments with temporary plots.

28 These definitions are adapted from Bergerud, W. 2002. The effect of the silviculture survey parameters on the free-growing decision probabilities and projected volume at rotation. B.C. Min. For. Forest Science Program. Land Management Handbook 50. Available at http://www.for.gov.bc.ca/hfd/pubs/docs/Lmh/Lmh50.htm

subsequent penalties or calculations of cut level.

Government's Risk[29] - is a function of the probability of declaring a stand, or group of stands, as free growing when they truly are not and the implications this has on timber supply.

With any survey design there will be sampling error, which is a function of the natural variability, the sample design and the sample size. This means that a certain proportion of the time, stands that truly meet a target will be deemed not to meet the target simply due to sampling error. Conversely, a certain proportion of the time, stands that truly do not meet a target will be deemed to meet the target due to sampling error. A key consideration when designing a survey system and associated decision rules is how to balance government and industry risk. Bergerud provides an excellent detailed discussion of this topic.[28]

Even if we could eliminate sampling error, there are no guarantees that young stands that meet stocking standards will develop into the stands we assume they will. The best we can do is set stocking standards that provide a high probability that regenerated stands are on track to meeting long term expectations.

5.0 DISCUSSION OF THE IMPLICATIONS OF STOCKING STANDARDS ON FOREST STEWARDSHIP

5.1 WHAT ARE STOCKING STANDARDS AND WHAT ARE THEY FOR?

Setting measurable interim objectives, based on overall goals, is a critical component of a good management system. For forestry, this means it is necessary to have goals for the overall forest estate, which can then be translated into measurable stand-level objectives at different stages of stand development. Stocking standards reflect the objectives for early stand development.

In BC, stocking standards define the early stand development criteria used to evaluate the success of basic silviculture and, assuming our projections of future stand development are correct, provide a high probability that the stand is progressing towards the long-term management goals. Stocking standards are established in order to ensure the stand begins on what is believed to be the right pathway for achievement of those long-term goals. They also form the reforestation contracts between licensees and the government. The contract is initialized pre-harvest when the stocking standards are set and fulfilled when the harvested area is considered free to grow (i.e., the stocking standards are met). Licensees are

29 Note that the phrases "industry risk" and "government risk" are used here in the context of meeting silviculture obligations. Obviously there is also a risk to the licensee in terms of future AAC reductions if a stand or group of stands is declared as on target for meeting timber supply assumptions when they truly are not. In addition there is the risk to the licensee of spending more money than required to meet standards.

responsible for basic silviculture until the stocking standards are achieved following which the stands revert to the Crown's responsibility until the forest is once again ready for harvest.

In a legal context, stocking standards set the minimum criteria for licensee basic silviculture performance and therefore stewardship. Stocking standards affect stewardship by providing guidance on more desirable or optimum outcomes for future forest conditions including yield and product objectives by listing target stocking levels, preferred species mixes and by including provisions for the early achievement of free growing.

In BC, as in other jurisdictions where the majority of forest land is publicly owned, the need for regulation of third-party reforestation of harvested areas has resulted in the evolution of stocking standards to a significant component of public forestry policy.

5.2 WHAT IS THE RELATIONSHIP BETWEEN STOCKING STANDARDS AND STEWARDSHIP?

Based on the ABCFP's broad definition of stewardship (Section 1.3), we have attempted to describe our understanding of the key components of stewardship as it relates to stocking standards:

Stocking standards, which reflect the forest and stand-level objectives, are intended as the significant driver which influences basic reforestation results and therefore stewardship of the regenerating forest. Once the decision has been made on when and how to harvest an area, basic reforestation is the key intervention managed by foresters that impacts the quality of stewardship over the life of the regenerating forest.

A key component of the above description is that stocking standards reflect forest and stand-level objectives. Therefore, for stocking standards to be a mechanism for achieving good stewardship, the assumption is made that the forest and stand-level objectives will ensure good stewardship, i.e., *"the sustainable balancing of environmental, economic and social values."*

5.3 STOCKING STANDARDS HAVE HAD A POSITIVE EFFECT ON STEWARDSHIP

There have been significant improvements in regenerating forests since the major changes to reforestation policy in 1987 that made licensees responsible for basic reforestation to free growing. Key improvements relate to reductions in the amount of harvested area becoming backlog NSR, increased planting (relative to natural regeneration), reduced regeneration delays, increased use of genetically improved seed and a significant increase in brushing or tending of newly established regeneration. Compliance results from several widespread recent FPB investigations show that, according to the post-1987 regulations, the vast majority of harvested

cutblocks have achieved the free growing stocking requirements within the required time periods. Stocking standards have contributed to the improved basic reforestation results by setting objective, legally enforceable standards to measure performance against.

However, it is difficult to single out stocking standards as the prime reason for improved basic reforestation results in the last 20 years. During this time there have been significant improvements in the quality of seedlings produced by the nurseries and improvements in silviculture practices. Additionally pressure from environmentalists and the public on forest companies and the government to prove they were practising sustainable, environmentally responsible forestry, has been a significant driver in the improved performance.

5.4 TENURE, STOCKING STANDARDS AND STEWARDSHIP

Stocking standards requirements do not differ between area-based and volume-based licenses, and under both types of tenure, once stands have been declared free growing the responsibility for their management reverts back to the Crown. However, in area-based tenures such as TFLs and Woodlot Licenses, free-growing stands are retained within the license and therefore contribute directly to the licensee's future AAC and fulfillment of other forest-level objectives. This can provide an incentive to improve basic silviculture. Alternatively, free-growing stands resulting from harvesting under volume-based licenses in TSAs can have little direct future impact on the licensee who carried out the basic silviculture. As a result, for an individual TSA licensee (especially small ones), there is little incentive to improve regeneration performance above the requirements, especially relative to other licensees. The effect of these differences in tenure, all other things being equal, is that area-based licensees can be more motivated towards meeting long-term goals as they can receive some future benefits for their efforts. However, in the opinion of some foresters, this motivation has been reduced in recent years through changes to major licensee harvesting rights.

The overall effect of tenure on stewardship can be summarized with the analogy of the relationship between a landlord and a tenant. The Crown (landlord) owns the land and the forest. Licensees (tenants) have contracts (stocking standards) with the landowner to, amongst other things, reforest areas which they harvest to meet the agreed upon requirements. While it is reasonable to expect the tenant to look after basic maintenance and minor improvements and act responsibly while using the property, replacement of major assets and improvements to the property are the responsibility of the landlord. This relationship is fundamental to the responsibilities and motivations of the parties and can have a significant impact on the perspectives and behaviour of professional foresters.

Ownership of the trees covered by the tenure is also a significant factor influencing behaviour of the parties relative to stewardship. In BC, irrespective of tenure, the

Crown owns the trees. On the other hand in Alberta, FMA holders own the trees and are "entitled to reasonable compensation from any person who causes loss of or damage to any of the timber or improvements created by the holder."[30] While, timber taxation (stumpage) policies are different between BC and Alberta, it has been suggested that a similar kind of arrangement for area-based tenures in BC, would, be a positive incentive for improved reforestation practices.

5.5 REFORESTATION FINANCING, STOCKING STANDARDS AND STEWARDSHIP

Stumpage policies and the way many licensees account for basic silviculture financing may also affect licensee performance and stewardship. The net effect of these systems is that licensees generally treat reforestation costs as expenses and have financial motivation to minimize the costs required to meet the stocking standards. Although some would argue that risk adverse silviculture has lead to inefficiencies and higher than required costs. The financial motivation to minimize costs, especially if there is no other perceived significant future benefits of acting differently, will obviously not always promote the best stewardship and can put licensee professional foresters in a conflict situation. On one hand these foresters have an obligation to look after the business interests of their employer, the licensee. On the other hand they have to look after their professional obligations to promote good stewardship.

While there is debate amongst foresters about the relative importance of fiscal responsibility versus stewardship in the current system, one thing is clear; in too many situations reforestation is being treated as a cost not an investment. Paraphrasing several foresters, *decisions made to get a stand to free growing are not necessarily the same as those that would be made to get a stand to rotation*. The often cited examples of over-planting lodgepole pine in the Interior and not regenerating enough western red cedar on the coast are examples of the focus on reaching free growing as opposed to longer term objectives.

5.6 HARVEST CONSTRAINTS, STOCKING STANDARDS AND STEWARDSHIP

Other key regulatory drivers of basic silviculture performance can include maximum block sizes, adjacency and green-up constraints. These rules restrict the rate and distribution of harvesting and, in areas with valuable mature timber, they can promote prompt reforestation. Reduced regeneration delays result in reduced amounts of time to achievement of green-up, allowing adjacent timber to be harvested sooner. With the road systems largely in place from the previous logging, earlier availability of this wood can be an incentive for licensees to plant more area, more promptly. This behaviour may, or may not, contribute to good stewardship.

30 Alberta Forests Act, S.16(2)

5.7 THE IMPORTANCE OF SCALE IN ASSESSING STOCKING STANDARDS COMPLIANCE AND ITS AFFECT ON STEWARDSHIP

A key component of the assessment of stocking standards is the area (the strata) over which survey results are averaged for comparison to standards. Integral to this is the identification of under-stocked or non-stocked areas. The need for stratification is primarily based on the desire to demonstrate to the public that all harvested areas are being adequately reforested, and some may argue, to justify timber supply volume assumptions.

Currently, stocking standards are set at the block or standards unit (SU) (stand-level). After harvest, management and compliance monitoring often occur at a finer resolution than the SU. Existing regulation requires stratification to one to two hectares dependent on the block size (unless using a multi-block stocking standard). There have been differences of opinion between foresters relative to issues of scale surrounding compliance with stocking standards and stewardship. Commonly these challenges revolve around the significance of small areas relative to the whole forest. It is argued that the requirement to reforest each and every hectare to a minimum standard may result in a disproportionate amount of time and resources being spent on small areas to the detriment of the level of stewardship that could be achieved on the entire forest with a different allocation of resources. Conversely, there is concern that widespread averaging of results could lead to poor stewardship. The desire to assess stocking standards at the forest rather than stand-level resulted in the development and acceptance of a framework for multi-block stocking standards and the provision in the FPPR for licensees with approved multi-block standards to be exempted from the minimum stratum size requirement. The multi-block requirement that a defined group of stands meet an average target safeguards against too many individual stands being at minimum standards while allowing more flexibility on the allocation of silviculture investments.

Even with a forest-level view, stand-level stocking standards compliance is important on sites with specific, important values that are dependent on specific reforestation achievements (e.g., critical wildlife habitat). Also a stand-level approach is appropriate for small licensees who do not manage enough blocks or area to make the forest-level approach feasible or desirable.

Where feasible, forest-level assessment of compliance with stocking standards is preferred. This is not to de-emphasize the importance of site-specific management, but to recognize the overriding importance of achieving forest-level objectives and to allow flexibility in achieving them. The achievement of individual stand compliance across all blocks does not necessarily equate to the achievement of forest-level objectives. This is also not an endorsement of any one specific set of current multi-block standards, but rather a preference for measuring compliance at the forest level.

One example is the challenge of addressing species diversity. BEC-based stocking standards commonly include a wide range of potentially suitable species. Beyond this is no regulation of species composition at the stand-level. In a given management unit it may be possible based on stand-level stocking standards to reforest the vast majority of the area to a single species. While each stand may individually pass the stocking standards the cumulative effect at the forest-level would be a significant reduction in species diversity. This type of challenge can either be addressed with forest-level standards, or in a stand-level system of stocking compliance, with a reliance on foresters to ensure forest-level objectives are being achieved. Without formalized forest-level objectives, assessment of compliance is more challenging and open to professional interpretation.

A second example of the challenges associated with block-level compliance is ensuring the yields assumed in timber supply analysis are achieved. Stocking standards are linked to timber supply at the forest level and are therefore based on averages over analysis units. It is possible that multiple blocks could meet the minimum standards but contribute to a significant underachievement in the assumed yields in timber supply. Alternatively block specific reforestation results could be better than the assumptions in timber supply. Without a formalized forest-level approach to assessment of reforestation results it is very difficult to link the achievements with forest level assumptions and objectives.

The multi-block method currently in use in the Fort St. John pilot project is an example of a forest-level approach to stocking standards compliance. However, it is anticipated that other variations of this kind of approach can be developed. Under the current tenure system, these approaches most easily apply to TFLs and Woodlot Licenses where management responsibility resides with a single licensee. To be applicable to all, or portions, of TSAs requires the coordination and support of all of the affected licensees. This adds extra challenges and may limit the widespread development of forest-level approaches.

5.8 THE IMPORTANCE OF SITE-SPECIFIC STANDARDS

While it is appropriate for foresters to take advantage of the flexibility provided by FSP stocking standards and forest-level compliance, most foresters feel strongly about the importance of stand-level management. To promote good stand-level management, it is important that at the pre-harvest (Site Plan) stage foresters clearly identify the site-specific standards (from within the broader FSP standards) which apply based on the site and stand attributes present. An example of this would be the preferred species composition and distribution of the crop trees. Clear documentation of site-specific ecology and the accompanying stocking standards demonstrates clarity of management intent and is required to assess the effectiveness of future management. If, based on subsequent experience or unforeseen problems, changes to the specific site-level targets (within the range of the FSP standards)

or plans are required, they can be done with supporting stand and forest-level rationale.

5.9 THE IMPORTANCE OF FOREST AND STAND-LEVEL OBJECTIVES AND PLANNING TO STOCKING STANDARDS AND STEWARDSHIP

In order to achieve good stewardship (relative to reforestation), a key starting point is having well defined forest and stand-level objectives which are reflected in the stocking standards. The forest and stand-level objectives need to include timber and non-timber values and be based on the capability of the land to produce, and the economics of managing towards, desired forest conditions. While the current planning framework is consistent with this process, many foresters feel there are opportunities for improvement that would positively impact overall stewardship. However, these opportunities are linked to changes in other policy issues such as tenure.

There is a feeling amongst some foresters that there has been too much of a timber emphasis used to set forest and stand-level objectives and this has been to the exclusion of other values. There is also a concern that in some areas of BC, existing default stocking standards have been set to produce vastly superior managed forests, as compared with the existing natural forests, and that the required management levels to achieve these goals may not be economically viable. While the current regulatory and policy environment provides the flexibility for licensees to propose changes to stocking standards that reflect revised forest-level objectives, there are many challenges to be overcome.

5.10 CONSISTENCY BETWEEN STOCKING STANDARDS AND TIMBER SUPPLY ASSUMPTIONS

Stocking standards influence regeneration practices which in turn influence the performance of regenerated stands. In most timber supply analyses, the actual performance of the regenerated stands is used to initiate the future projections of those stands. In most cases, past performance is used to model the development of future stands. In this way, stocking standards indirectly influence future stand yield assumptions. The regulatory requirement for new stocking standards to be consistent with timber supply assumptions also suggests the reverse should be true; that is that stocking standards should be based in part on the assumed projections of future regenerated stands.

In most cases in BC, TIPSY is used to model regenerated stands for timber supply analysis, and as TIPSY does not accept well-spaced trees as an input, the practice has been to input total numbers of planted and natural trees. The spatial distribution of the trees accounted for in the well-spaced measure from silviculture surveys is not utilized. Instead, model default spatial distributions for planted and natural stands

are used. As timber supply analysis is typically updated every five to 10 years, any change in performance (as a result of changes to stocking standards or practice alone) is updated in timber supply assumptions on a regular basis. Given the other uncertainties in timber supply analysis, this has been and can continue to be a reasonable approach.

To develop well-spaced stocking standards based on timber supply yield assumptions requires detailed analyses of expected well-spaced trees from numerous combinations of stand densities and spatial distributions. This is required to equate the range of well-spaced trees needed to the total stand densities and spatial distributions used to generate the yield curves for timber supply analyses. This is because it can be demonstrated that more than one spatial distribution of a given total number of trees will produce the same number of well-spaced trees.

Volume projections in timber supply are a function of the yield curves and the area to which the yield curves are applied. Ideally, if stocking standards are linked to timber supply assumptions, then stratification for assessing achievement of stocking standards should be done to inventory specifications, as it is inventory polygons that the yield curves are assigned to in timber supply. However, conflicting stratification objectives, and conflicting timing (in many cases stable inventory polygons may not be evident at the time stocking standards are assessed) make this difficult to accomplish.

Until uncertainties associated with the development of free-growing stands, managed stand site productivities and accuracies of key inventories are minimized, it will be difficult to tighten the linkages between stocking standards and timber supply projections.

Under forest-level systems, there is the opportunity to strengthen the linkage between stocking standards and timber supply assumptions at the forest-level, as the average targets required to be met across a group of blocks can be equated to the forest-level assumptions for that group of blocks.

5.11 LONG-TERM MONITORING REQUIRED TO SUPPORT STEWARDSHIP

A strong, consistent message from foresters interviewed for this paper was that stocking standards alone cannot be relied upon to facilitate good stewardship of regenerated stands. For example, recent observations of significant forest health and quality problems with post-free-growing pine plantations in portions of the Interior, have lead to concerns that stocking standards and the free growing concept may not be adequately ensuring young stands will achieve longer term objectives. Stocking standards are a key component, but they are only a single-point-in-time check that regenerated stands are on track to achieving objectives. To support good stewardship and it is imperative that subsequent checks on regenerated free

growing stands be performed. This additional monitoring is necessary to check on the health and vigour of the stands, ensure timber supply assumptions for stand development continue to be accurate, and to provide feedback to licensee foresters on the effectiveness of past practices and, if necessary, to adjust stocking standards. Currently there are no requirements for the MOFR or licensees to check regenerated stand growth and development after free growing. Most foresters interviewed are very uncomfortable with this situation.

There are examples of long-term monitoring programs that have been voluntarily established. At least six TFLs in the province (5, 30, 33, 35, 37 and 52) have established growth and yield monitoring programs following protocols developed by the MOFR.[31] More recently, AAC determinations have included requests for monitoring programs. For example, the Deputy Chief Forester, in his AAC determination for TFL 55[32] stated:

"I request that the licensee monitor growth in natural and managed stands to assess its site productivity estimates and ensure the yield projections used in future analyses appropriately reflect volumes per hectare realized in harvesting operations."

As a result of this request that licensee is now in the process of implementing a growth and yield monitoring program.

5.12 STOCKING STANDARDS AND RISKS ASSOCIATED WITH CLIMATE CHANGE

The potential risks to our regenerating forests resulting from climate change include species no longer being adapted to the sites where they were established, decreased insect and disease resistance along with increases in insect or disease populations, and increased fire hazard. Based on recent observations of failures of some free growing stands in the Interior and concerns for the impacts of climate change, some foresters have questioned the intent and meaning of the free growing concept as it pre-supposes that a regenerated stand will continue to grow in a relatively stable environment.

Climate change is an issue that clearly needs to be addressed at the provincial and forest level. While the reality of climate change is no longer debated, the extent and severity of the impacts, particularly into the longer term still are uncertain. This makes setting stocking standards for establishing stands we hope to grow several decades even more challenging. This is an issue that needs to be addressed collectively by foresters to determine the best strategic responses. This will be a very challenging process requiring in depth risk analyses. Once alternatives have been

31 http://www.for.gov.bc.ca/hts/inventory/reports/gymonitor/index.html

32 Ministry of Forests. 2007. Tree Farm Licence 55. Rationale for allowable annual cut (AAC) determination. British Columbia Ministry of Forests. Victoria, BC. Effective March 8, 2007.

identified, negotiations between the MOFR and licensees can occur to share the risks and the associated costs and benefits of implementing the recommended changes.

5.13 THE ROLE OF THE PROFESSIONAL FORESTER IN STOCKING STANDARDS AND REFORESTATION STEWARDSHIP

Most foresters agree that stocking standards set the minimum criteria for basic silviculture performance and therefore stewardship. Most foresters however, do not support management towards the minimum requirements and work towards the targets.

Under the current tenure system, foresters involved in silviculture either work for the MOFR or for industry. In certain situations, there has been tension between these groups over issues of professionalism and stewardship relative to management of silviculture obligations. In many cases the tension is associated with the economics of managing towards target standards.

Typically, licensee foresters are primarily concerned with managing the costs and risks associated with basic silviculture obligations. In this process they also consider potential constraints to future harvest opportunities posed by adjacency, green-up and other factors. Based on experience, most foresters have learned that early reforestation to target levels, or above, using good planting stock minimizes the chances of costly brushing and re-planting and minimizes adjacency and visual constraints and speeds achievement of free growing. Where the costs of doing so are reasonable relative to the rest of the forest management costs and harvest values, this is good business. It also generally equates with good stewardship. In these situations, there is generally little conflict between licensee and MOFR professionals over stewardship.

The situation gets more challenging where there are significant costs to managing towards the targets (as opposed to the minimums) relative to other management costs and wood values and/or there are few perceived direct benefits of better management to the individual licensee. Foresters involved in these situations can feel very uncomfortable in weighing their responsibilities to stewardship versus their responsibilities to their employer. Ultimately these challenges arise as a result of the existing tenure agreements. In these instances the way to promote better stewardship is to advocate for changes in policy and legislation (i.e., tenure reform) that will improve the situation.

6.0 RECOMMENDATIONS

1. Stocking standards must be recognized as only one component of an overall adaptive forest management system that promotes good stewardship.

The ABCFP defines stewardship as “the sustainable balancing of environmental,

economic and social values." The effect of stocking standards on stewardship is their influence on how stands are regenerated. For stocking standards to have a positive effect on stewardship, the environmental, economic and social values must be clearly incorporated into forest-level goals and translated to stand-level objectives that can then be reflected in the stocking standards.

2. While stocking standards have contributed to substantial improvements in stewardship, currently other aspects of forest policy and regulation are limiting further significant improvements. Therefore, foresters should educate the public and politicians about the issues and help to develop alternatives.

This includes advocating for tenure and policy reform that would provide incentives to make management decisions on regeneration choices based on the objective of reaching rotation age targets as opposed to just free to grow targets. It also includes encouraging discussion, debate and policy development around the climate change issue and how the risks presented by climate change need to be incorporated into the development of stocking standards.

3. Processes and funding must be put in place to ensure that regenerated stands are monitored after free growing to provide feedback on actual stand performance.

Although there are several long-term monitoring programs that have been voluntarily established in TFLs, currently there are no requirements for the MOFR or licensees to check and record the growth and development of regenerated stands after free growing. Secure long-term government funding should be made available to facilitate implementation of this across the province. Stocking standards and reforestation practices are predicated on assumptions about how regenerated stands will grow in the future. It is imperative that these assumptions are checked and that constant feedback on actual stand performance is fed into the management decision-making process.

4. Forest-level objectives must be recognized in the process of achieving stand-level targets.

Under the current regulatory regime, stocking standards defined at the stand-level reflect both stand and forest-level objectives. However, it is possible to achieve stand-level targets on all blocks and not achieve forest-level objectives. As there are no regulations in place to check that forest-level objectives are being achieved (e.g., species diversity), it is the responsibility of the forester to ensure that they are.

5. Where feasible, forest-level assessments of regeneration performance should be promoted.

In most cases, significance of regeneration performance is at the forest-level. The setting and achievement of well-defined forest-level goals are the best way to demonstrate good stewardship. Forest-level assessments recognize the overriding importance of achieving forest-level objectives and allow flexibility in achieving them. Under forest-level assessments, there is the opportunity to strengthen the linkage between stocking standards and timber supply assumptions, as the average targets required to be met across a group of blocks can be equated to the forest-level assumptions for that group of blocks.

6. Continued improved linkage between stocking standards and timber supply assumptions should be supported.

It clearly demonstrates due diligence in our management practices to base stocking standards on assumed future stand conditions. Future projections can be translated into combinations of species mixtures, stand densities, spatial distributions and regeneration delays required in early stand development to result in the assumed future stand conditions according to the best models available. As improvements are made to existing growth and yield models, or new models are developed, there should be a parallel improvement in the linkages between stocking standards and future stand projections.

APPENDIX I

ABCFP members interviewed in the process of preparing this document:

Lorne Bedford, RPF

Norm Caldicott, RPF

Jeff Fisher, RPF

Mike Larock, RPF

Kelly Low, RPF

Pat Martin, RPF

Rick Monchak, RPF

Peter Nagati, RPF

Guy Newsome, RPF

Al Powelson, RPF

Brian Raymer, RPF

Rob Sandberg, RPF

Dave Weaver, RPF

Craig Wickland, RPF

Ralph Winter, RPF

Alex Woods, RPF

Mike Wyeth, RPF (retired)

ABCFP members who reviewed the draft report :

Bruce Blackwell, RPF

Bob Green, RPF

Craig Farden, RPF

Mike Larock, RPF

Sean Curry, RPF

Rick Monchak, RPF

Al Powelson, RPF

Rob Sandberg, RPF

Craig Wickland, RPF

ASSOCIATION OF
BC FOREST PROFESSIONALS
330-321 Water Street
Vancouver, BC V6B 1B8
Tel: 604.687.8027 Fax: 604.687.3264
E-mail: info@abcfp.ca
Website: www.abcfp.ca

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