ASSOCIATION OF
BC FOREST PROFESSIONALS

2014 RPF Registration Exam
Take-Home Exam

This package contains examples of good answers for questions #1 and #2 that were submitted for the take-home portion of the 2014 RPF registration exam. Although the answers were chosen as the two better answers submitted in 2014, take note of the score each answer received and be advised that answers may contain errors. Please note that the examples were re-formatted for publication and do not conform to the criteria and formatting outlined in the exams procedures.

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1) Section 8(5) of the Forest Act permits partitions as part of AAC determinations. Examine the pros and cons of partitions as a policy mechanism and the challenges of implementation. Make recommendations on how to improve this mechanism.

Answer # 1 (scored 96 marks)

ALLOWABLE ANNUAL CUT PARTITIONING IN BRITISH COLUMBIA- A STUDY OF THE PROS AND CONS AND HOW THE POLICY CAN BE IMPROVED

February 28 , 2014

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INTRODUCTION

British Columbia (BC) is a province extremely rich in natural resources. One of the most important resources in the historic development of BC is timber and it has brought employment and economic benefits to all corners of the province (Ramlo 2012). Forestry continues to play a crucial role in BC's economy contributing 64,800 direct jobs and an additional 52,000 indirect jobs in 2008 (BC Ministry of Forests, Mines and Lands 2010). According to provincial economic data, forestry accounted for an annual average of 6.4% of all provincial economic activity since 1997 (Ramlo 2012). The BC forest industry faces many future challenges such as rising energy costs, climate change, pest outbreaks and potential fibre supply constraints (Ramlo 2012, BC Chamber of Commerce 2013, and Working Roundtable on Forestry 2009).

To assist in responsibly managing BC's dynamic and important forest resources, the province introduced a timber supply review (TSR) process in 1992 (BC MFLNRO 2013a). The ultimate goal of this process is to determine allowable annual cut (AAC) for BC's 38 timber supply areas (TSA's) and 34 tree farm licenses (TFL's) (BC MLFNRO 2013a). Section 8 of the *Forest Act* gives the chief forester the authority to set the provincial AAC every 10 years at a level deemed reasonable (BC MFLNRO 2013a). The AAC determination is an independent, politically-impartial decision that takes into account wood supply, social values, economic and environmental considerations (BC MFLNRO 2011a). In section 8 of the *Forest Act* the chief forester is also able to identify (within the AAC) a particular type of timber or specific area within a TSA. This mechanism is called a partition and can be a very important tool in directing forest operations at a large landscape level. This partition is an important multi-function tool that allows forest professionals to manage for certain special values on the landscape or monitor certain portions of the TSA's timber supply (BC MFLNRO 2011a). For example, a partition

could specify an upper harvest limit of a preferred timber type and prevent over-harvest of t higher value species, saving it for future timber supply. Although, the current partitioning process is working and achieves many important forest management goals, the process still has a few shortfalls. This paper will outline the pros and cons of partitioning and how the associated policy can be strengthened and better implemented in the future.

BACKGROUND

Prior to assigning a partition, a formal three step TSR takes place (BC MFLNRO 2013a). The first stage is data gathering and information sharing which produces a data package that summarizes forest inventory information. Once the data package is complete, First Nations consultation and public review takes place (BC MFLNRO 2013a). The second stage of the TSR is the timber supply analysis. Using a particular schedule of management activities, harvesting levels can be predicted for future decades using a computer model. This model allows for the input of various alternative scenarios in order to predict the effects of certain management strategies on future timber supply, timber production or forest structure (BC MFLNRO 2002). The results of the timber supply analysis are published and released in the form of a discussion paper and made available to the public for review and comment. In the third and final stage of the TSR, the chief forester actually determines the AAC for all TSA's and TFL's using all information gathered from the data package and public comment processes (BC MFLNRO 2013a). An important deliverable at this stage is the chief forester's rationale paper which explains, in depth, the reasoning and factors considered in his determination. During this TSR process the chief forester has identified specific forest management goals and can choose to implement a partition to accomplish these goals if necessary. Partitions can be used to manage

certain timber types, certain areas, certain terrain types or accomplish certain social, environmental and economic goals.

PROS OF ALLOWABLE ANNUAL CUT PARTITIONING

Partitioning is an important tool that allows forest professionals to manage a special portion of the timber supply area (BC MFLNRO 2011a). For example, in the Merritt TSA(2010), the chief forester created a 720,000m^3 non-pine partition. This means that, according to the harvest billing system no more than 720,000m^3 of non-pine species can be harvested (Snetsinger 2010a). In the rationale paper released by the chief forester, he explicitly mentions that the intention of the partition is not to encourage the harvest of healthy non-pine stands, but rather to accelerate the harvest of mountain pine beetle (MPB) infested stands (Snetsinger 2010a). Furthermore, in a 2008 viewpoint published by the Association of BC Forest Professionals (ABCFP), Jim Snetsinger recommends forest professionals remain focussed on the opportunities available to us (salvageable pine). He also states that mitigating impacts of the beetle will require continued, widespread activities on the land base including: promoting faster growth, efficiently rehabilitating affected stands and continuing to monitor the effects on mid-term timber supply (Snetsinger 2008, Snetsinger 2010a).

As shown in Merritt, partitions allow foresters to manage problem timber, such as MPB infested stands, and make use of it while it is still economically viable. Partitions also simultaneously allow managers to preserve a certain timber profile (such as a high value type) to help mitigate mid-term timber supply concerns. This has clearly been done in the Prince George TSA where an AAC uplift, combined with a partition on non-pine leading stands, has allowed forest managers to target pine dominant, MPB infested stands (Snetsinger 2011a). The partition in this TSA accomplishes 2 fundamental goals: 1) allowing licensees to target a certain timber

type that requires special management and, 2) preserving higher value spruce to address mid-term timber supply concerns. To support this decision, the chief forester produced a rationale paper which outlines his concern for non-pine species if licensees do not focus on targeting pine-leading, beetle infected stands (Snetsinger 2011a).

During the 2011 Prince George TSR, public comment brought biodiversity and First Nations concerns to the forefront and the chief forester reacted accordingly by placing a 160,000m^3 partition on deciduous stands. These deciduous stands are considered important habitat and are also used as water trees by First Nations people (Snetsinger 2011a). The chief forester also outlined another expectation- no more than 875,000m^3 come from spruce leading stands. This stipulation came as a reaction to public concern for marten, which require mature spruce as suitable habitat. The spruce partition also accounts for mid-term timber supply and will be preserved until the chief forester deems necessary (Snetsinger 2011a). In this example, the TSR process played an important role in communicating public concern, First Nations values and potential wood supply constraints. By adding multiple AAC partitions, the chief forester balances social, economic and environmental factors while ensuring responsible management of BC's forest resources.

The fact that the mountain pine beetle has greatly disrupted the interior British Columbia fibre supply is a well documented fact (Working Roundtable on Forestry 2009). In fact, the BC government estimates that the beetle has now killed a cumulative 710 million cubic metres and affected an area of 18.1 million hectares (BC MFLNRO 2012a). As discussed previously, this has spurred the chief forester to consider different management approaches (such as partitions) to deal with the high availability of lower quality dead or damaged wood. In the Quesnel TSA in 2011, a partition of 650,000m^3 of non-pine species was put in place to deal with MPB infested

stands (Snetsinger 2011b). This partition will eventually push licensees into the Kluskus Su Block (an area in the extreme western edge of the TSA) which has 7+ hour cycle times and very small diameter dead pine (Snetsinger 2011b). The silver lining of this situation is that this partition has encouraged licensees to adapt, innovate and create new markets for these marginally economical stands. Licensees in the Quesnel TSA have received extensive praise from the chief forester in his 2011 AAC Determination Rationale paper:

> "*Licensees are focussing the harvest on mountain pine beetle impacted pine-leading stands, have innovatively improved the utilization of the deteriorating pine through improvements to their processing facilities and have begun producing new products from poorer quality wood*"
>
> -Jim Snetsinger, 2011

Although now closed, the recently profitable Canadian Forest Products (Canfor) sawmill in Quesnel had adapted to the unprecedented low quality fibre supply by reconfiguring it's sawmill to produce entirely metric dimension lumber (Vancouver Sun 2010). Canfor had found a buyer in China willing to accept the mills entire annual output of 225 million board feet (Vancouver Sun 2010). The innovation does not end with Canfor. Tolko has also become involved in exporting a larger proportion of its lumber to Asia (Vancouver Sun 2010). Because of partitions, the Quesnel division was able to innovate, find new markets and ultimately turn a profit under this partition, while conserving non-pine fibre for future supply.

CONS OF ALLOWABLE ANNUAL CUT PARTITIONING AND IMPLEMENTATION CHALLENGES

Despite the many pros of partitioning, like any tool, there are also associated cons. Partitioning does a good job of allowing forest managers to target a certain timber type or area

within the AAC. However, isolating a certain, and sometimes very specific, portion of the A puts a lot of faith in Vegetation Resource Inventory (VRI) accuracy. It is imperative that the inventory be extremely accurate when placing a partition which pushes licensees to target a certain, specific profile. The number of staff exclusively dedicated to inventory in 2006 was 40 full time equivalents (FTE), in 2011 staff had been diminished to 27 FTE (a decrease of over 30%, and the lowest in 10 years) (Moss 2011). Low staff numbers present a significant challenge in maintaining current inventory and ensuring adequate and up to date information is readily available. From 1989 to 2012, overall average funding for the VRI program was 15.4 million dollars. Today, in comparison, it is significantly less at 8.4 million dollars (Moss 2011). If partitions are going to be implemented based largely on inventory numbers, forest professionals must ensure that inventory information is current and that there is an appropriate fibre supply available and accessible for licensees to comply with the partition. The timber profile that licensees have been instructed to pursue must actually be present in adequate volume on the landscape. The purpose of this paper is not to discuss whether the overall current inventory system is adequate or not, however it is worth noting because a major concern is that declining budgets and staff are going to complicate and add uncertainty to the already difficult decisions foresters have to make. Although 90% of BC is inventoried, only 26% is now inventoried to modern VRI standards (BC MFML 2010). Also, inventory currency, accuracy and coverage are seen as highly variable across the province (BC MFML 2010). Certain regions such as the BC interior have changed extremely rapidly with the large MPB outbreak (BC MFLNRO 2012a, BC Chamber of Commerce 2013) and these areas often need special management strategies such as AAC partitions. Therefore, managers need to be certain that inventory updates are keeping up with the quickly changing provincial timber profile (especially interior pine as it dies and ages).

The biggest challenge in partition implementation occurs when managers are dealing with outdated inventory and are not completely confident in the inventory itself.

Another weakness of partitions is that they are very heavily driven by market conditions. Partitions may push licensees into uneconomical timber or inaccessible areas and it is extremely difficult for licensees to support policy that does not make sense financially. In the case of the Nass TSA(2002), the chief forester placed a partition of 200,000m^3 on the Upper Nass region (an area that has no pre-existing infrastructure, extensive forest health issues and very marginal timber) (Pederson 2002). This effectively meant that licensees were supposed to target the Upper Nass for a significant portion of their AAC. The partition was put in place because the Upper Nass was contributing to the AAC determination but has not been contributing to the TSA's current fibre supply (Pederson 2002). For the 10 years, from 2002 to 2012, there was no harvesting in the Upper Nass despite the Chief Forester having placed a partition (Pederson 2013). The Nass TSA is a special case since operators only harvested 9% of the AAC in 2011 due to economic reasons and a lack of local processing facilities (Pederson 2013, Pederson 2002). This example demonstrates that if the partition is not conducive to sound economic practices for licensees then the partition will not accomplish its intended goal. The partition in the Nass did not help salvage spruce beetle killed timber, nor did it assist in providing incentive to develop infrastructure into the Upper Nass portion of the TSA. The challenge of AAC partitions come into play when overall industry outlooks are poor, which renders some partitions difficult or impossible to follow.

British Columbia has seen immense changes in its forest resources, some of which have occurred in relatively short time frames. For instance, in 2009, the mountain pine beetle killed an estimated 6.3 million hectares in a single year in 2010 (BC MFLNRO 2012a). In some cases

the forest resources are changing rapidly and in these cases forest managers must be able to with the appropriate policy in a timely manner. The downside of partitions is that they can only be implemented at the AAC determination during the TSR process. The TSR process legally must take place every 10 years (BC MFNRO 2013a). This means that in order for a partition to be implemented an entire, lengthy, costly timber supply review must be conducted (BC MFLNRO 2011). This may impede the chief forester of accomplishing certain goals since he may not wish to conduct a formal TSR earlier than the legislated 10 years simply to implement a partition.

RECOMMENDATIONS TO IMPROVE PARTITION IMPLEMENTATION

While the partition process is working very well in its current state, there is almost always room for improvement. A major downside of partitions is that, like the forest industry itself, they rely heavily on market conditions for their implementation success. There will be times, when market conditions are poor, and partitions will not achieve their intended goals, as seen in the Nass TSA. In these cases, the government could provide some additional incentives to licensees in order to assist them in abiding by the partition. For example, the chief forester will attempt to combat a forest health issue in an isolated region of a TSA; however, it is uneconomical for licensees to target this specific problem timber type. The government could assist with road building costs, or provide funding to develop a new main line into this previously un-accessible region. If the partition is forcing the licensees into uneconomical wood (heavily damaged, small piece size or un-preferred species) then some extra financial assistance could be provided for mill efficiency upgrades or market research. When paired with difficult or

uneconomical partitions, incentives could be a solution to help better implement a partition ensure it accomplishes its intended objective.

Declining inventory budgets could potentially hinder the efficacy of partition implementation. When forest managers use partitions to tackle a very specific problem timber type that has largely been quantified through the inventory process, then we must be absolutely confident that the inventory is accurate and current. Recent reports have highlighted declining funding and inventory resources (Moss 2011). This funding should be stabilized or increased and the goal of bringing the majority of the province up to date on modern VRI standards should be implemented (currently only 26% of the province inventoried to modern VRI standards). It is also essential that current inventory exists for all TFL's so managers can make the best possible management decisions using high quality data. The burden of inventory funding does not have to fall on the government's shoulders alone. A partnership between industry and government could help address monetary, inventory accuracy and currency concerns. This increased funding could greatly assist forest managers in partition implementation.

In order to address occurrences (such as MPB or fire) that can change the forest resources and landscape extremely quickly, forest managers must be able to react quickly with the appropriate policy. The chief forester can revisit the TSR earlier than 10 years and implement a partition at that time, but the process should be streamlined so that the chief forester can add a partition at anytime between TSR's. This would allow the chief forester to react quickly to changing forest conditions and implement a management strategy without having to conduct an entire, lengthy and expensive timber supply review.

CONCLUSION

The partition is working well in its current state and is an excellent tool that can accomplish a variety of goals in a variety of management situations. Partitions can help to preserve midterm timber supply and BC's interior has seen many non-pine partitions accomplishing this goal. During the TSR, the opportunity for public engagement brings new issues to light, such as specific biodiversity goals, which can later be addressed using partitions. Partitions can also work well to find an underutilized timber profile and encourage innovation and development of new and emerging markets (as seen in the Quesnel TSA). Partitions are an important tool that allows forest managers to consider all three pillars of sustainability (social, economic and environmental) and make corresponding management decisions that best account for all three factors. As forest professionals entrusted by the public (BC ABCFP 2012) to manage this extensive and immensely valuable resource, we must strive to do the best we can. In order to manage our forest resources in the best possible way, we must ensure that our budgets are sufficient to produce a high quality inventory product and maintain adequate ministry staffing levels province wide. We should also look at partitions in difficult economic situations and develop a plan offering assistance or incentive. We must continue to use partitions as an aid to research and develop new and innovative products. We should also do our best to ensure that partitions can be quickly and efficiently implemented and that there are no gaps in policy. Doing so will ensure that the public's extremely valuable forest resources are managed to provide social, economic and environmental benefits for many generations to come.

LITERATURE CITED

British Columbia Association of Professional Foresters. 2012. Forest Legislation and Policy Reference Guide. Vancouver, BC. 430pp.

British Columbia Chamber of Commerce. 2013. Provincial Issues- The Future of the Forest Industry. Victoria, BC. Accessed Feb 13th, 2014. http://www.bcchamber.org/advocacy/policy/provincial_gov/forests/future_of_the_forest_industry.html

BC Ministry of Forests, Lands and Natural Resource Operations. 2011a. Allowable Annual Cut Partitioning Guide. Forest Tenures Branch, Victoria, BC. Version 2.0. Accessed Feb, 2014. 38pp. http://www.for.gov.bc.ca/ftp/hth/external/!publish/web/publications/AAC-Partitioning-Guide-2.0.pdf

BC Ministry of Forests, Lands and Natural Resource Operations. 2012a. Facts About BC's Mountain Pine Beetle. Accessed Feb 25th, 2014. http://www.for.gov.bc.ca/hfp/mountain_pine_beetle/Updated-Beetle-Facts_May2012.pdf

BC Ministry of Forests, Lands and Natural Resource Operations. 2002. Timber Supply Analysis Brochure. Forest Inventory and Analysis Branch. Victoria, BC. Accessed Feb, 2014. http://www.for.gov.bc.ca/hts/pubs/brochure/tsa_bro.htm

BC Ministry of Forests, Lands and Natural Resource Operations. 2013a. Timber Supply Re
Backgrounder. Forest Inventory and Analysis Branch. Victoria, BC. Accessed Feb, 2nd,
2014 http://www.for.gov.bc.ca/hts/pubs/tsr/Timber%20Supply%20Review%20Backgrounder_Nov_2013.pdf

B.C. Ministry of Forests, Mines and Lands. 2010. The State of British
Columbia's Forests, 3rd ed. Forest Practices and Investment Branch, Victoria, B.C. 308pp.
Accessed Feb 8th, 2014.
www.for.gov.bc.ca/hfp/sof/index.htm#2010_report

Snetsinger, Jim. 2010a. Merritt Timber Supply Area, Rationale for Allowable Annual Cut (AAC)
Determination. BC Ministry of Forests, Mines and Lands. 50pp. Accessed Feb, 2014.
http://www.for.gov.bc.ca/hts/tsa/tsa18/tsr3/18ts05ra.pdf

Snetsinger, Jim 2011a. Prince George Timber Supply Area, Rationale for Allowable Annual Cut
(AAC) Determination. BC Ministry of Forests, Mines and Lands. 52pp. Accessed Feb 2014.
http://www.for.gov.bc.ca/hts/tsa/tsa24/tsr4/24ts11ra.pdf

Snetsinger, Jim. 2011b. Quesnel Timber Supply Area, Rationale for Allowable Annual Cut
(AAC) Determination. BC Ministry of Forests, Mines and Lands. 36pp. Accessed Feb 2014.
http://www.for.gov.bc.ca/hts/tsa/tsa26/2009_current/26tsra11.pdf

Jim Snetsinger 2011. Mountain Pine Beetle and Midterm Timber Supply. Association of Bi
Columbia Forest Professionals. Vancouver, BC. 1pp. Accessed Feb 15th, 2014.
http://www.abcfp.ca/publications_forms/BCFORmagazine/documents/BCFORPRO-2011-3_AllArticles/BCFORPRO-2011-3_Snetsinger.pdf

Penner, Derrick. Vancouver Sun. 2010. BC Lumber Industry Targets China. Vancouver, BC. Accessed Feb, 2014.
http://www2.canada.com/vancouversun/news/business/story.html?id=be53dffc-5ad1-48d9-bf19-381082b28151

Pederson, Larry. 2002. Nass Timber Supply Area- Rationale for Annual Allowable Cut (AAC) Determination. British Columbia Ministry of Forests. Victoria, BC. 48pp. Accessed Feb 18th , 2014.
http://www.for.gov.bc.ca/hts/tsa/tsa43/tsr2/rationale.pdf

Pedersen, Larry. 2013. Chief Forester Order Respecting the AAC Determination for the Nass Timber Supply Area. British Columbia Ministry of Forests. Victoria, BC. 5pp. Accessed Feb 20th, 2014.
http://www.for.gov.bc.ca/hts/tsa/tsa43/tsr_2013/43tspp13.pdf

Moss, Ian. 2011. A Progress Report on the 2006 ABCFP Status of Forest Inventory Recommendations: Detailed Findings and Comment. Association of British Columbia Forest Professionals. Victoria, BC. 28pp. Accessed Feb, 2014. http://www.abcfp.ca/publications_forms/publications/documents/Inventory_Detailed_Findings_and_Comments.pdf

Ramlo, Andrew. 2012. Challenges and Opportunities Abound for B.C. Forest Industry. Business in Vancouver. Vancouver, BC. Accessed Feb 17th, 2014. http://www.biv.com/article/20120911/BIV0329/309119983/-1/BIV/challenges-and-opportunities-abound-for-bc-forest-industry

Working Roundtable on Forestry. 2009. Moving Toward a High-Value, Globally Competitive, Sustainable Forest Industry. The Report of the Working Roundtable on Forestry 2009. 54pp. Accessed Feb, 2014. http://www.for.gov.bc.ca/mof/forestry_roundtable/Moving_Toward_a_Globally_Competitive_Forest_Industry.pdf

Answer # 2 (scored 95 marks)

Allowable Annual Cut Partitioning in British Columbia: A systematic review

A Professional Report Submitted in Satisfaction of the ABCFP Take-Home Exam Requirements

February 28 , 2014

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INTRODUCTION

Under section 8(5) of the *Forest Act*, the chief forester has the authority to specify certain portions of the allowable annual cut (AAC) that are attributable to a particular type of timber, type of terrain and/or area of Crown Land located within Timber Supply Areas (TSA) or Tree Farm Licences (TFL). In an effort to optimize timber supply, new AAC partitioning legislation and regulations focus partitions on high-value species, known as preferred timber. The majority of the AAC partitions in the Province provide harvest volume upper limits for these preferred timber types; non-pine stands in Mountain Pine Beetle infected areas and cedar leading stands on the coast (MFLNRO, 2013a). These partitions have been put in place to help delineate timber associated with mid-term timber supply issues (Waatainen, 2008; Snetsinger, 2011).

In an era of a declining timber supply with an increase in management constraints on the land base, AAC partitions need to be utilized more effectively and inventively. Partitions that are only used to "cap" or "limit" harvesting on high-value species can result in a negative impact on economic revenues from timber harvesting do to an inability to reach AACs (Hawkins et al., 2006; Mathely and Nelson, 2010; Sutherland, 2012; Crowley, 2014). The challenges associated with the implementation of AAC partitions and partition orders, specifically enforceability and monitoring (MFLRNO, 2013a), need to be remedied for this policy mechanism to become effective.

The objective of this report is to examine the pros and cons of AAC partitions, the challenges of their implementation in British Columbia, and to provide recommendations on how to improve this policy mechanism. Before the objectives of this report can be addresses, a description of what an AAC partitions is, who they affect, and where and how they are currently implemented needs to be discussed.

BACKGROUND

Successful forest management in British Columbia relies on the balance of social, economic, and environmental principles. One of the most important economic principles is the ability to provide a constant supply of timber to the market. A concept to help ensure this is achieved through both social and environmental means is allowable annual cut or AAC. AAC can be defined as the rate at which timber is made available for harvesting in response to social, economic, and environmental considerations (Pedersen, 2003). These considerations are sometimes conflicting and therefore the determination of an AAC can be defined as a "controversial topic", one that is "incredibly complex" (Pedersen, 2003). There are many important forest management principles and factors that are critical to all AAC determinations in British Columbia. Section 8 of the *Forest Act* requires the chief forester to utilize a variety of such principles when determining AACs for both TSAs and TFLs. The complexity and uncertainty associated with forest management principles require AAC determinations to involve a synthesis of information and analysis, and an assessment of the risks and uncertainties associated with forest management (ABCFP, 2012). Some of these important forest management principles are that current harvest rates should allow for a controlled transition to future harvest rates, they should not jeopardize the productivity of the forest, and they should not lead to large impacts on future timber supply (ABCFP, 2012). However, with market fluctuations creating poor economic conditions, current harvest rates have the potential to focus on higher quality and higher value stands, which could have a large impact on future timber supply. Overharvesting high-value stands could reduce the future economically viable harvesting opportunities (MFLNRO, 2013a).

To combat this, section 8 of the *Forest Act* was amended to provide the mea implement an AAC partition. These partitions set recommended harvest flows on portions of the AAC that are attributable to a particular type of timber, type of terrain and/or area of Crown Land, and are generally used when there is a requirement or need for special management on the land base, like overharvesting (ABCFP, 2012, MFLNRO, 2013a). The implementation of AAC partitions is at the discretion of the chief forester, and occurs at the same time as the AAC determination. Traditionally, partitions placed on harvest flows were to help deal will low-value timber (MFLNRO, 2013a). However, the new AAC partitioning legislation and regulations focuses on high-value or preferred timber. Coupled with the partitions that limit harvests on preferred timber, the *Forest Act* was amended and regulations introduced to allow the minister to implement these partitions at the licence level – referred to as a partition order (MFLNRO, 2013a). Without a partition order, the AAC partition alone only identifies a recommended limit of volume available from a timber type or species, and does not formally regulate the harvest of the timber type or species (ABCFP, 2012; MFLNRO, 2013a). However, in an AAC determination, the chief forester will give specific reason why an AAC partition was created and may indicate his/her expectations on how the harvest of the partition should be implemented (MFLNRO, 2013a; MFLNRO, 2013b). It is important to note the establishment of a partition order will usually only be required if a preferred timber of the AAC partition is at risk of being overharvested – partition orders are not common for AAC partitions that exist on low-value timber (MFLRNO, 2013a).

A partition order can be applied for up to a five-year term, which sets the limit of the harvested volume of specified timber. Forest licences and TFLs are the only forms of agreements that are subject to harvested limits set out in a partition order (MFLNRO, 2013a).

The harvest volume limits are proportional set, so each licencee's share of the AAC in a T
TFL will be proportional affected by the partition. The harvest volume limit calculation is as follows:

$$HVL = \frac{\text{Licencee AAC}}{\text{TSA/TFL AAC}} \times \text{AAC partition} \times \text{Length of term}$$

where the *HVL* is the harvested volume limit for the forest licence, *Licencee AAC* is the allowable annual cut authorized in the forest licence or available to the holder of the Tree Farm Licence, *TSA/TFL AAC* is the allowable annual cut determined under section 8(1) of the *Forest Act* for either the Timber Supply Area in question or the Tree Farm Licence in question, *AAC partition* is the allowable annual cut partition, and *Length of term* is the number of years the minister's order is in effect.

The licencee has the right to harvest all of the preferred timber up to the limit specific in the partition order. Compliance with a partition order is not optional, and the holder of that licence is responsible to ensure that the total harvested volume does not exceed the harvest volume limit over the term of the partition order (MFLNRO, 2013a). Currently, there are no reporting requirements of the licencee to the MFLNRO tracking their cut within a partition. If non-compliance with a partition order is assessed, a monetary penalty will be charged. This penalty is assessed after the term of the partition order has expired, even if the licencee exceeds their harvest volume limits prior to the expiry of the order. This is due to the fact that the current legislation only provides for the issuance of one AAC partition penalty (MFLNRO 2013a).

DISCUSSION

OBJECTIVES OF PARTITIONS

The current aim of AAC partitions are to provide a legislative policy mechanism for government to better mange timber harvest flow and ensure high-value stands are not overharvested in the short-term (Mathey and Nelson, 2010; ABCFP, 2012). As of late, the focus

of AAC partitions have been to provide harvest volume upper limits for preferred spec economic value: non-pine stands in the interior and cedar leading stands on the coast (MFLNRO, 2013a). In an attempt to reduce the associated negative impacts of the Mountain Pine Beetle epidemic, the chief forester has reduced some of the AAC uplifts and introduced AAC partitions in both the Prince George and Quesnel TSAs (Snetsinger, 2011). These partitions are aimed at maintaining the opportunity to continue salvaging pine while protecting non-pine stands needed to support mid-term harvest levels (Waatainen, 2008; Snetsinger, 2011; MFLNRO, 2013a). The chief forester has also implemented AAC partitions for cedar harvesting in coastal management units, like Haida Gwaii. By limiting the amount of current cedar harvesting, the mid-term timber supply has the potential to be improved, having more cedar available for harvest during times when non-cedar leading stands may not be economically viable to harvest (Sutherland, 2012). In Haida Gwaii, the AAC determination and its associated partitions were implemented in 2012 on TFL 58, TFL 60, and the Queen Charlotte TSA. The partition in Queen Charlotte TSA is a maximum harvest of 195,000 m3 of a total AAC of 512,000 m3 that can be attributable to cedar. Thus, only 38% of the AAC can come from cedar, in a TSA where the timber harvesting land based is dominated by cedar (Sutherland, 2012). By limiting the cedar harvesting in a TSA with a considerable cedar component, the majority of the cedar-leading stands will be conserved for the mid-term (Sutherland, 2012).

The trend toward including cedar partitions on the coast and non-pine partitions in the interior for AAC determinations is becoming more evident. However, the implementation of ministerial partition orders to make these partitions legally binding is not as evident. In the case of Haida Gwaii, these non-legal partitions depend largely on professional reliance, and cooperation among licencees to be successfully implemented.

ECONOMIC IMPLICATIONS OF PARTITIONS

The placement of significant additional constraints, like an AAC partition on licencees in the face of generally poor markets in addition to economic uncertainties associated with managing for a broad range of forest values (ecosystem-based management, land use plans, etc.), have the ability to negatively affect economic revenues from timber harvesting (Hawkins et al., 2006; Farley, 2010; Sutherland, 2012). Recent forest management changes, like ecosystem-based management increase the amount of constraints on the land base (for the protection of cultural values, wildlife ecosystems, sensitive ecosystems, riparian areas, etc.), which in turn decreases the timber available for harvest. These constrains are adding to the inability to reach AACs, which has been identified as a problem seen across the province, specifically on the coast. The implementation of upper limit partitions on species like cedar may compound this inability for licencees to reach their AACs. The ability of a licencee to substitute other types of species to make up for the reduction in preferred species is governed not only by the availability of that type species and the potential impact upon costs, but also by the existing management framework, like land use plans (Mathely and Nelson, 2010; Crowley, 2014). To help regulate the fear of over-harvesting preferred species, the development of strategies for the management of these species like cedar may be prove to be more effective within local land use plans where all affected parties and all local relevant information is available, rather than the establishment of inflexible AAC partition limits (Sutherland, 2012).

Rather than focusing AAC partitions on species, partitions on areas of Crown Land could help combat the economic implications of the current partitioning framework. For example, a partition placed on second growth timber would help ensure an orderly transition to eventual dependence on second growth harvesting (Pedersen, 2003; Sutherland, 2012; MFLNRO, 2013b;

MFLNRO, 2013c). Partitions that restrict harvesting on the spatial arrangement of timber also limit the impact on wildlife habitats and ecosystem health, which is consistent with the current forest management regime of managing for a broad range of forest values (Crowley 2014).

If the focus of an AAC determination is to sustain a stable timber supply in maintaining a competitive and sustainable forest industry, while being mindful of other forest values (Coleman, 2006; Farley, 2010), then the chief forester needs to be mindful of the negative impacts that species partitions have on economic viability, especially on the coast.

CHALLENGES OF IMPLEMENTATION

One challenge to the implementation of AAC partitions is the process at which to make them enforceable, a ministerial partition order. The current process of seeking a partition order from the Minister involves many administrative steps, which first must start at the district level. Once MFLNRO district staff build a case that warrants the implementation of a partition order, this information is then reviewed by MFLNRO regional staff, who then submit a partition order decision package to the MFLNRO regional executive director, who then submits the decision package to the assistant deputy minister. This package is then reviewed and forwarded to the minister for review and final sign-off (MFLNRO, 2013a). This lengthy process could be limiting the use of partition orders, as they could be seen as administrative burdens. This theory is consistent with the results of recent the Work Environment Survey, as current government staffing constraints are providing higher than normal workloads, effecting day-to-day business goals (MFLNRO, 2013d). Currently a core review is happening within the government of British Columbia, which is aimed to improve government's efficiency. One of the specific objectives of the Core Review is to "ensure that government is operating as efficiently and

effectively as possible by: eliminating overlap and duplication between ministries and with broader public sector; reducing red-tape and unnecessary regulations that hinder economic development; and restructuring government program delivery and governance models where costs can be reduced and outcomes improved for the public" (MEM, 2013). Keeping this objective in mind, specifically the aim to reduce unnecessary regulations, the current process of provoking a partition order should be changed to improve its efficiency and effectiveness.

Another challenge to the implementation of AAC partitions in the lack of a clear, accurate, fair and measureable monitoring protocol (Sutherland, 2012). The *Allowable Annual Cut Partitioning Guide* published by the government of British Colombia states, "the greatest challenge associated with any partition order is the ease in which the partition can be monitored by both industry and government" (MFLNRO, 2013a). With the current regime of partitioning AACs by species, partition orders must specify timber in such a way that the timber volumes can be tracked using existing systems such a the Harvest Billing System (MFLNRO, 2013a). This current tracking or monitoring of AAC partitions promotes only the use of partitions for species, not for areas or timber types. The current monitoring protocol is lacking the adaptability for the inclusion of other types of partitions. Monitoring protocols are put in place to track the implementation and process of policies and need to be incorporated in the development of the policy to ensure effectiveness. To ensure effectiveness in a partitioning monitoring protocol, appropriate variables to be measured need to be identified and this needs to happen in the development of the partition.

The lack of reporting requirements from licencees to the MFLNRO in tracking their level of cut within the partition is only compounding the inability to effectively monitor AAC partitions and partition orders. Having no legal reporting requirements provides no incentive for

the licencee to stay within their partition or manage the resource in the public's interest (N 2007). Currently, the MFLNRO assesses if the licencee has stayed within their harvesting limits identified in the partition order only after the order has expired. This is due to the fact that the current legislation only provides for the issuance of one AAC partition penalty (MFLNRO 2013a). This is promoting reactive instead of proactive government policies. If reporting requirements of the licencee were put in place, implementation monitoring of partitions would happen and any non-compliance of partition limits could be dealt with when they occur.

RECOMMENDATIONS AND CONCLUSION

The solution to improving the implementation of AAC partitions is not a simple one. A combination of strategies will be required in order to reach the maximum timber supply gains, especially in the midterm. While discussing the challenges associated with AAC partitions implementation, it is important to remember the objective and goal of this policy mechanism: to create a more sustainable timber harvest flow (MFLNRO, 2013a).

While the creation of new government policies may be required, professional reliance and stakeholder cooperation are the critical success factors for the most effective implementation of partitions on timber harvesting. The following are provided as recommendation to help improve the policy mechanism of AAC partitions:

1. The development of a clear, accurate and measureable monitoring protocol will increase the effectiveness of AAC partitions and partition orders. This will promote a policy mechanism that is proactive, rather than reactive.

2. By improving the process of evoking a partition order by reducing the administrative burden and unnecessary regulations, AAC partitions and their associated partition orders will become more enforceable.

3. Increase the utility of AAC partitions by including more than just partitions on high- species. By including partition on areas of Crown Land for example, could lead to an improvement in the negative effects associated with the economic implications of the current partitioning framework.

REFERENCES

ABCFP (2012). Forest Legislation and Policy Reference Guide 2012. Association of British Columbia Forest Professionals, Vancouver, BC.

Colmen, R. (2006). Economic and Social Objectives of the Crown. Letter from the Minister, July 4, 2006. Ministry of Forest and Range, Victoria, BC.

Crowley, M. (2014). Using Equilibrium Policy Gradients for Spatiotemporal Planning in Forest Ecosystem Management. IEEE Transaction on Computers, 63(1): 142 – 154.

Farley, J. (2010). Conservation through the economic lens. Environmental Management, 45: 26 – 38.

Hawkins, C.B.D, T.W. Steele and T. Letchford (2006). The economics of site preparation and the impacts of current forest policy: evidence from central British Columbia. Canadian Journal of Forest Research, 36: 482 – 494.

Mathey, A.-H. and H. Nelson (2010). Assessing forest management strategies under mountain pine beetle attack in Alberta: exploring the impact. Canadian Journal of Forest Research, 40: 597 – 610.

MEM (2013). Core Review Terms of Reference released. Ministry of Energy and Mines, Victoria, BC.
Accessed Jan 22, 2014 at: http://www.newsroom.gov.bc.ca/2013/07/core-review-terms-of-reference-released.html

MFLNRO (2013a). Allowable Annual Cut Partitioning Guide. Ministry of Forests, Lands and Natural Resource Operations, Victoria, BC.
Accessed on Jan 21, 2014 at: http://www.for.gov.bc.ca/ftp/hth/external/!publish/web/publications/AAC-Partitioning-Guide-2.0.pdf

MFLNRO (2013b). Apportionment and Proportionate Reductions Guidance for a Declining Timber Supply. Ministry of Forests, Lands and Natural Resource Operations, Victoria, BC.
Accessed Jan 21, 2014 at: http://www.for.gov.bc.ca/ftp/HTH/external/!publish/web/timber-tenures/apportionment-and-proportionment-reduction-guidance-for-declining-timber-supply-feb-4-2013.pdf

MFLNRO (2013c). Declining Timber Supplies and Allowable Annual Cut Management. Letter from the Deputy Minister, May 8, 2013. Ministry of Forests, Lands, and Natural Resource Operations, Victoria, BC.

MFLNRO (2013d). Work Environment Survey 2013. Ministry of Forests, Lands and Natural Resource Operations, Victoria, BC.
Accessed on Jan 31, 2014: https://gww.nrs.gov.bc.ca/flnr/files/flnr/media/Human%20Resources/WES2013_FLNR.pdf

Nelson, H. (2007). Does a Crisis Matter? Forest Policy Response to the Mountain Pine Beetle Epidemic in British Columbia. Canadian Journal of Agricultural Economics, 55: 459 – 470.

Pedersen, L. (2003). Allowable Annual Cuts in British Columbia: The Agony and The Ecstasy. Ministry of Forests, Victoria, BC.

Snetsinger, J. (2011). Mountain Pine Beetle and Midterm Timber Supply. BC Forest Professional. May – June 2011.

Sutherland, J. (2012). Rationale for Allowable Annual Cut (AAC) Determinations for Tree Farm Licence 58, Tree Farm License 60 and Timber Supply Area 25. Ministry of Forests, Lands and Natural Resource Operations, Victoria, BC.
Accessed Jan 21, 2014 at: http://www.for.gov.bc.ca/hts/tsa/tsa25/tsr3/AAC_Rationale_Haida_Gwaii_MUs_Sept_20_2012_final.pdf

Waatainen, J. (2008). Forestry Legislation and Greenhouse Gas. BC Forest Professional. September – October 2008.

ASSOCIATION OF
BC FOREST PROFESSIONALS

2) Several recent articles have highlighted concerns with post free growing stands. Discuss the implications of these concerns for long term forest management and make recommendations.

Answer # 1 (scored 92 marks)

Post free growing stands: concerns and recommendations for long term forest management

Association of British Columbia Forest Professionals

February 28, 2014

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Introduction

The following essay is written in response to the second question of the Association of BC Forest Professionals (ABCFP) 2014 Registered Professional Forester (RPF) take-home exam. The question (ABCFP 2014) is:

> "Several recent articles have highlighted concerns with post free growing stands. Discuss the implications of these concerns for long term forest management and make recommendations."

To answer this question I will analyze and summarize: a) the attributes of post free growing stands; b) some of the articles that highlighted the concerns surrounding post free growing stands; c) how the management of these stands relates to the practice of professional forestry; d) the implications of such concerns for long term forest management and; e) what steps could be taken to address these concerns.

The 2012 September-October edition of the BC Forest Professional Magazine (BCFP 2012) included several viewpoints describing the state of some forests (plantations) after they have been declared free-to-grow. A free-growing stand is declared as such based on the assumption that its trees have reached a critical point by which their total height and their height -relative to competing vegetation- is deemed sufficient enough to ensure they mature into healthy, productive forests, (thus, absolving the licensees from any further responsibility). However, some researchers have observed that several biotic and abiotic factors affect these "free growing" stands to the extent that they are no longer sufficiently well stocked. These findings have significant implications because, the assumption that a stand that was once declared free growing will remain so, affects several current and future aspects of forest management and ecosystem integrity.

Background

Concerns regarding the reforestation of BC forests have existed since the early 1900's but were not given proper consideration until 1956 when a royal commission report by Honourable Gordon Sloan found that the number of trees being planted was totally inadequate (Brown 1995). However, specific targets for the number of trees to be planted were not adopted until 1965 (Brown 1995), yet it wasn't until the enactment of the Silviculture Regulation (1987) that the licensees were mandated to establish "free-to-grow trees" as part of their stocking standard obligations (McWilliams and McWilliams 2009). Since then, other regulations and acts (Silviculture Practices Regulation 1994 and Forest Practices Code of British Columbia Act 1995) refined the criteria for achieving a 'free-to-grow' status. Currently the Forest and Range Practices Act (FRPA) through the Forest Planning and Practices Regulation (FPPR) set the legislative requirements necessary for a harvested area to be declared free-to-grow. Since the current legislation places greater onus on forest professionals, the success of present reforestation strategies is greatly influenced by the ability of forest professionals to implement sound forest management and stewardship principles.

A free growing stand is: "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" (FRPA 2008 in: McWilliams and McWilliams 2009). The "free to grow" concept is the culmination of a vast array of reforestation activities (*e.g.* seed and species selection, stocking density, site suitability, etc. for which all costs are incurred by the licensee) which aim at establishing ecologically and economically viable stands that should reflect sound forest management principles. In addition to being an administrative milestone for ensuring effective reforestation, a declaration of a stand as free-growing, assumes that the stand is on a trajectory toward a productive mature stand (Woods

and Bergerund 2008). Once a stand is declared free-to-grow, subsequent stand manage becomes the Crown's responsibility (McWilliams and McWilliams 2009). Currently, other than sporadic research projects, the Crown has no mechanism to monitor the health of post free-to-grow stands. Hence, if we are mistaken in our assumption that free growing stands lead to healthy, productive forests, this would pose a serious threat to the future health of forested ecosystems and a grave threat to the future economic expectations from these stands.

Some researchers (i.e. Woods and Bergerund 2008, Heineman et al. 2010 , Mather et al. 2010) have found that several stands that had been declared free-to-grow have been affected by various factors (primarily pathogens) to an extent that they would no longer meet the necessary conditions to culminate in healthy, productive, sufficiently well stocked forests (aka. free growing standards were no longer met). Even though, the abovementioned research has found that it is mainly lodge-pole pine stands which no longer meet free growing standards, it is highly disconcerting that under-stocked post free-to-grow stands were easily found. Furthermore, since this issue had been largely ignored by scientists and forest managers, it may only be the tip of the iceberg. However, BC's forest and forest professionals have proven to be very resilient; now that the issue has come to light, we can find ways to mitigate the situation and to prevent it from reoccurring.

Discussion

Reforestation is one of the most important activities that have been entrusted by the public to forest professionals. Much of the social licence (essential in BC, since most logging occurs on public land) that the public bestows on forest professionals, is based on the

understanding that harvested areas will be successfully reforested to stands that are as he and productive as the ones that were cut. If reforested areas experience a loss of quality and quantity (*eg.* under-stocked stands with undesirable species*)* compared to the original stands, forest professionals risk: breaching public trust, undermining the economic potential for future harvests, and degrading ecosystem integrity. Thus, we must act promptly and effectively to remedy any instances of poor forest management, like those observed in post free-to-grow stands that are no longer sufficiently well stocked.

Research Findings

As early as 2008 Woods and Bergerund's (2008) found that free growing declarations might be occurring to early –in the life of stands- to accurately project the future health and the productivity of these stands. These findings were later confirmed by Mather et. al. (2010) -and highlighted by Simard (2012)- when they observed that, throughout the whole Southern Interior, 27% of lodgepole pine plantations no longer met free growing standards within five years of being declared as such. Alarmingly, up to 70% of these free growing plantations, within the Interior Cedar Hemlock Biogeoclimatic Zone, had failed (Simard 2012). Also, Mather et al. (2010) found that only 5%, of the surveyed sites were within targeted stocking densities (1200 stems/ha), 15% were severely understocked (< 550 free-growing stems/ha), 48% of the stands fell within 100 stems/ha of the minimum (700 stems/ha) stocking standard, and 85% of stands were at least 200 stems/ha below target density. A special Committee on Timber Supply (2012) backed these concerns by noting that a significant shortage in mid-term timber supply requires due consideration to free-to-grow standards relative to the objectives of developing resilient forests and minimizing risks to the Crown upon declaration of a stand as free-to-grow. To put these findings into perspective, the Forest Practices Board (2003) considers that if a stand is

within 100 stems/ha of the minimum stocking density, it is considered to be at high risk [illegible] achieving its full productivity potential.

Practice of Professional Forestry in the context of post free-to-grow conditions

The Forest and Range Practices act (sec. 16 and 29) requires that a free growing stand must be established on harvested areas, in accordance with the specified stocking standards in the approved Forest Stewardship Plan, which must be approved and signed by a Registered Professional Forester (ABCFP 2013). The Foresters Act defines the practice of professional forestry, and it gives the Association of BC Forest Professionals (ABCFP) its regulatory mandate (ABCFP 2013); furthermore S.4(2)(b) of the same act, mandates the ABCFP "to advocate and uphold principles of stewardship of forests, forest lands, forest resources and forest ecosystems". As forest professionals we are bound by the Code of Ethics (Bylaw 11 ABCFP 2012) which states that we have a responsibility to the public (2.1). More specifically, the main bylaws (ABCFP 2012) relevant to this discussion, are: 3.)1 "*to advocate and practice good stewardship of forest land based on sound ecological principles to sustain its ability to provide those values that have been assigned by society";* 3.5) "*to work to improve practices and policies affecting the stewardship of forest land";* and 12.6.1) "*members demonstrate stewardship by balancing present and future values against the capacity of the land to provide for those values.*" To comply with the above bylaws, it is important to understand that forest stewardship (ABCFP 2012b) is:

> "The responsible use of forest resources based on the application of an ecological understanding at the stand, forest and landscape levels which maintains and protects ecosystem function, integrity and resilience. It is based upon an ethical responsibility to the land and people for current and future generations."

The above statues and definitions are highlighted since any failure in planted forest stands be considered a direct contravention to the legislative and obligatory responsibilities of forest professionals.

Considering that reforestation (or the lack thereof) was one of the first concerns that were strongly voiced by the public (Brown 1995), it is safe to assume that one of the values that have been established by society is that of healthy, productive forests with a physiognomy and ecological function similar to the pre-harvested stand. Also, failure to establish desirable post-harvest stands is an imbalance in present and future values, which undermines the capacity of the land to provide for the values assigned by society. Moreover, any failure in post-free-to-grow stands reflects a poor understanding of the stand and it also reflects an inability to protect ecosystem function, integrity and resilience, thereby contravening our ethical responsibility to the land and to future generations.

Implications to long term forest management

In order to analyze what the implications of the state of post-free-to-grow stands have for long term forest management, I need to clarify the concept of long-term forest management. Intuitively, this would be a question of time-scale, since long-term could be anything from a few years down the road to hundreds of years from now. However, the very nature of the practice of professional forestry – as discussed above- makes the clarification unnecessary since forest management in BC should, by *de facto*, be long-term forest management. This is stated in the concept of stewardship that balances present and *future* values as well as by the ethical responsibility to current and *future* generations. Thus, as per the statutory mandates of our profession, forest management is and should always include long-term forest management.

Establishing understocked stands with suboptimal species, for which no one -except Crown- can be held responsible, has grave implications for ecosystem function, integrity, and resilience. First, I will define the aforementioned terms:

- **Ecosystem functioning:** the flow of energy and materials through the arrangement of biotic and abiotic components of an ecosystem. It includes many ecosystem processes, such as primary production, trophic transfer from plants to animals, nutrient cycling, water dynamics and heat transfer. In a broad sense, ecosystem functioning includes two components, ecosystem resource dynamics and ecosystem stability. Diaz and Cabido (2001) and McGill et al. (2006)
- **Ecosystem resource dynamics:** the magnitude (how much) and rate (how fast) of inputs, outputs, and internal cycling of key resources, such as carbon, water and mineral nutrients, in an ecosystem dynamics overtime. Diaz and Cabido (2001) and McGill et al. (2006).
- **Ecosystem stability:** capacity of an ecosystem to persist in the same state (physical composition) or domain (syntaxonomic composition). It has two components, ecosystem resistance, the ability to persist in the same state in the face of a perturbation, and **ecosystem resilience**, the ability to return to its former state following a perturbation. Diaz and Cabido (2001), Holling (1973) and McGill et al. (2006).
- **Ecosystem integrity:** "First, ecosystems are said to maintain integrity when ecosystem structure and (or) processes stay at a predefined baseline level. Second, ecosystem integrity is preserved when a system is permitted to change unaffected by human influence. Third, the preservation of an organizing or self-correcting ability of an ecosystem ensures the preservation of ecosystem integrity. Fourth, the maintenance of ecosystem qualities deemed desirable by society will maintain ecological integrity". (Wicklum and Davies 1995).

I have chosen these definitions for discussion purposes in this essay; however, it is important to understand that these terms are still a highly debated subject. Some of the ongoing discussions can be found in Myers-Smith et al. (2012), Schwartz et al. (2000), and Wicklum and Davies (1995).

Post free-to-grow stands which have failed, will inevitably: a) be a detriment to primary production, trophic transfer from plants to animals, nutrient cycling, water dynamics and heat transfer; b) undermine the capacity of an ecosystem to persist in the same state and domain; c) change the magnitude and rate of inputs, outputs, and internal cycling of key resources; d)

diminish the ecosystem's ability to return to its former state following a perturbati lessen the organizing or self-correcting ability of an ecosystem; and, f) fail to upkeep the ecosystem qualities deemed desirable by society. Thus, by simplifying the physical and syntaxonomic composition of a stand, biodiversity levels will be undermined, thereby severely affecting the ecosystems' function (Schwartz et al. 2000). This change will negatively affect the resource dynamics of a stand, since an understocked stand cannot possibly supply the same levels of primary production, trophic transfers, nutrient cycling, water dynamics and heat transfer, as the original stand. Moreover, reductions in biodiversity levels and in ecosystem function may also negatively affect the ecosystem's resilience capacity (Petchey et al. 1999, Folke et al. 2004), and all of the above changes will ultimately undermine ecosystem integrity (Carignan and Villard 2002).

The abovementioned effects on ecosystem integrity, function, and resilience will inevitable come with an economic cost. Even though the Chief Forester's sensitivity analysis (used for determinations of the Allowable Annual Cut) considers delays and uncertainties in regeneration (Watts and Tolland 2013), it might not be robust, accurate and sufficiently updated to realistically consider the state of future stands (McWilliams and McWilliams 2009). The economic implications could be devastating, because current harvest levels might be erroneously high since they are based on unrealistic expectations -from today's young stands- which might not culminate with the quantity (volume) or quality (grades) necessary to justify such harvest levels. Unfortunately, if we continue in our present path, we will not fully understand the economic consequences until we begin to harvest the stands under question.

Recommendations

Considering the significance of the concerns and implications that failed post free-to-grow stands have on long-term forest management, it is imperative that forest professionals, government, and industry act decisively and promptly to begin mitigating the problems. Since the wellbeing of our forests is of utmost importance to the wellbeing of our society, the public also has a role to play in demanding a swift and effective response to the identified concerns. Hopefully, this is a discussion that is already happening within government and industry, whose policies and actions are vital toward successfully mitigating the identified concerns. The following recommendations might help further these discussions and provide a brief outline on how we can tackle the problem.

A comprehensive research program should be developed and implemented across the province to fully understand the scope of the situation, and to accurately assess the magnitude of the response needed to mitigate the problem. Part of this research program should be devoted to better understanding how climate change (Heineman et al. 2010), and other previously unforeseen factors, might exacerbate the problem. Forest professionals must re-evaluate their roles and responsibilities in defining and implementing stocking standards. A good starting point is to follow the principles of forest stewardship (ABCFP 2012b) which can be done by considering the questions set forth by Macaulay (2012). Specifically, we could build in redundancy (extra-trees with greater diversity) into the reforestation plans to allow for unforeseen mortality (Farnden 2012). Government policies could be improved to discourage silviculture foresters from seeing their role as achieving minimum free growing standards at a minimum cost (Waters 2011), and to discourage the overuse of a single leading species in regeneration, and to halt the reductions in planting densities, seedling stock sizes, and

intensity/frequency of site preparation (Farquharson 2011). Also, both industry and gover should invest more –when and where it has been proven to be successful/cost-efficient- in silviculture activities (fertilization, thinning and pruning, under-planting) for stands that no longer meet free growing standards. Lastly, small modifications to the tenure system could be implemented to extend the licensees liability for a stand well beyond the free growing declaration. In lieu of changes to the tenure system, this could be achieved by requiring a long-term financial deposit which would be sequentially reimbursed as the stands become successfully established.

Conclusions

The overall implications of unsuccessful post-free-to-grow stands to forest management (long-term forest management), is that we would be creating forests – at a stand level and landscape level- devoid of the necessary elements to maintain and protect ecosystem function, integrity and resilience. The implications are far-reaching, since forested ecosystems provide a wide array of services (Isbell et al. 2011) which society depends on and values. Failure to correct the situation puts forest professionals in direct contravention of our ethical and professional obligations, and it degrades the trust that the public confers upon our profession.

Unfortunately, mitigating the outlined problems is not an easy task. The problem with post free-to-grow stands is a great example of well-intended policies (stocking standards and regeneration) gone wrong due to financial frugalness, adversity to risk (*e.g.* choosing species that can safely reach free to grow in a timely manner, in a wide range of sites), and complacency. However, now that greater emphasis and responsibility is placed on the role of individual forest professionals, there is no excuse to take shortcuts or to ignore best management practices which adhere to the latest available scientific research.

References

ABCFP (2014) RPF Registration Exam Take-Home Exam Questions. Association of BC Forest Professionals. Vancouver, BC. Available at: http://www.abcfp.ca/members_area/enrollment_to_registration/registration_exam/documents/RPF_Take-home_Exam_2014.pdf

ABCFP (2013) Forest Legislation and Policy Reference Guide. Association of BC Forest Professionals. Vancouver, BC.

ABCFP (2012) ABCFP Bylaws. Association of BC Forest Professionals. Vancouver, BC. September 2012. Available at: http://www.abcfp.ca/regulating_the_profession/bylaws/documents/ABCFP_bylaws_20121012.pdf

ABCFP (2012b) Principles of Forest Stewardship. May 2012. Available at: http://www.abcfp.ca/publications_forms/publications/documents/Principles_of_Stewardship_2012.pdf

BCFP (2012) BC Forest Professional September-October 2012. Association of BC Forest Professionals. Vol 19 Issue 5. 31 pp. Vancouver, BC.

Brown, RG (1995) Public Influence on Reforestation in British Columbia. Ministry of Forest, Lands and Natural Resource Operations. Available at: http://www.for.gov.bc.ca/hfp/publications/00134/pi003.htm

Carignan, V. and M.-A. Villard (2002) Selecting indicator species to monitor ecol integrity: a review. Environmental monitoring and assessment 78:45-61

Diaz, S. and Cabido, M (2001) Vive la difference: plant functional diversity matters to ecosystem processes. Trends Ecol. Evol. 18: 646 -/655

Farquharson, D. (2011) Viewpoint: Mother Nature Suffers Fools Poorly: Early Stand Development in the South-Central Interior. BC Forest Professional. Sept-Oct 2011. Vol. 18 Issue 5. Vancouver, BC

Farden, C. (2012) Viewpoint: The Secret Life of BC's Forests. BC Forest Professional. September-October 2012. Vol 19 Issue 5. Vancouver, BC.

Folke, C., S. Carpenter, B. Walker, M. Scheffer, T. Elmqvist, L. Gunderson, and C. Holling (2004) Regime shifts, resilience, and biodiversity in ecosystem management. Annual Review of Ecology, Evolution, and Systematics:557-581.

Forest Practices Board (2003) Reforesting BC's public land – An evaluation of free-growing success. Special Report No. 16.

Heineman, J. L., D. L. Sachs, W. J. Mather, and S. W. Simard (2010) Investigating the influence of climate, site, location, and treatment factors on damage to young lodgepole pine in southern British Columbia. Canadian Journal of Forest Research 40:1109-1127

Holling C.S. (1973) Resilience and stability of ecological systems. Annu. Rev. Ecol. Syst. 4:1–23

Isbell, F., V. Calcagno, A. Hector, J. Connolly, W. S. Harpole, P. B. Reich, M. Sc... Lorenzen, B. Schmid, D. Tilman, and J. van Ruijven (2011) High plant diversity is needed to maintain ecosystem services. Nature 477:199-202.\

Macaulay, C. (2012) Viewpoint: The ABCFP's Principles of Forest Stewardship Stand Establishment: Let's Start Planning for the Long-Term! BC Forest Professional. September-October 2012. Vol 19 Issue 5. Vancouver, BC.

Mather, W. J., S. W. Simard, J. L. Heineman, and D. L. Sachs. (2010) Decline of planted lodgepole pine in the southern interior of British Columbia. The Forestry Chronicle 86:484-497.

McGill B.J., Enquist B.J., Weiher E., Westoby M. (2006) Rebuilding community ecology from functional traits. Trends in Ecology and Evolution 21: 178 –185.

McWilliams, J and McWilliams, E. (2009) A Review and Analysis of the Effect of BC's Current Stocking Standars on Forest Stewardship. Commissioned Paper Prepared for: ABCFP Stewardship Advisory Committee. Available at: http://www.abcfp.ca/publications_forms/publications/documents/Stocking_Standards.pdf

Myers-Smith, I. H., S. A. Trefry, and V. J. Swarbrick (2012) Resilience: Easy to use but hard to define. Ideas in Ecology and Evolution 5.

Petchey, O. L., P. T. McPhearson, T. M. Casey, and P. J. Morin (1999) Environmental warming alters food-web structure and ecosystem function. Nature 402:69-72.

Schwartz, M., C. Brigham, J. Hoeksema, K. Lyons, M. Mills, and P. Van Mantgem (2000) Linking biodiversity to ecosystem function: implications for conservation ecology. Oecologia 122:297-305.

Simard, S.W. (2012) Viewpoint: Free Growing: Caught in a Modern Kodak Moment. BC Forest Professional. September-October 2012. Vol 19 Issue 5. Vancouver, BC.

Special Committee on Timber Supply (2012) Growing Fibre, Growing Value. Legislative Assembly Province of British Columbia. August 2012. Available at: https://www.leg.bc.ca/cmt/39thparl/session-4/timber/reports/PDF/Rpt-TIMBER-39-4-GrowingFibreGrowingValue-2012-08-15.pdf

Waters, A. (2011) Viewpoint: Reigniting Passion for Silviculture: Minimum Free Growing Can't Be Our Goal. BC Forest Professional. Sept-Oct 2011. Vol. 18 Issue 5. Vancouver, BC.

Watts, S.B. and L. Tolland (2013) Forestry Handbook for British Columbia. The Forestry Undergraduate Society, Faculty of Forestry, The University of British Columbia. Vancouver, BC.

Wicklum, D. and R. W. Davies (1995) Ecosystem health and integrity? Canadian Journal of Botany 73:997-1000.

Woods, A. and Bergerund, W. (2008) Are Free-Growing Stands Meeting Timber Productivity Expectations in the Lakes Timber Supply Area. Forest and Range Evaluation Program Report Summary #16.

Answer # 2 (scored 91 marks)

EXPLORING POST FREE GROWING CONCERNS IN BRITISH COLUMBIA: WHE
CAN WE GO FROM HERE?

2014 Take-home Exam – Q2

CONTENTS

1.0 INTRODUCTION

The term ‘silviculture’, has been given various definitions, however the main concept revolves around the scientific and practical application of silvics at the site level, to manage species establishment, composition, growth, and stand structure (Smith et al. 1997). A large component of silviculture in forest operations is stand establishment post-harvest. There are various steps and stages within silviculture, with one in particular coming under heavy discussion in recent years.

Concern surrounds forest stands shortly after being declared ‘free growing.’ The Forest and Range Practices Act, defines a free growing stand as “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” (FRPA 2002). Studies indicate that several years after being declared free growing, depending on biogeoclimatic zone, that between 25 to 80% of stands are no longer maintaining the characteristics to be considered free growing (Mather et al. 2010).

There are various reasons and concerns for the prevalence of this outcome within the forest sector, both political and practical. This report will explore and discuss the implications, causes and improvements that may be taken to improve the current state of free to grow.

2.0 BACKGROUND

Free growing standards are used across the country, however we are at a time where improvements need to be made to the current standards. Making changes to the current system being used to set standards and guidelines for free growing assessments has the likelihood of causing several impacts. Changes may lead to different stand compositions, stand productivity

and yield, and increased cost to achieve a desirable forest stand utilizing various treatments (Martin et al. 2005).

Application of forest management is predicated on the Forest and Range Practices Act (FRPA 2002), which relies on forest professionals to apply sound judgment and act in the best interest for both the environment and public. However, in recent years due to cost related issues, forest professionals have aimed to fulfill their reforestation obligations with a formula of low cost and low risk. This has led to the overuse of lodgepole pine in the interior, with avoidance of cedar regeneration within parts of coastal British Columbia (Farnden 2009).

Exploration into possible changes has already begun, with the use of discussion papers and exploration of topics such as climate change, assisted migration, stocking standards, seed improvement programs and new approaches to performance standards (Martin et al. 2005).

3.0 DISCUSSION

The discussion will focus on three areas. First it will explore how the free-growing shortcomings may further impact British Columbia's forest inventory and what implications this may have on the AAC. Secondly, we will discuss reforestation practices and how they have contributed to the situation and areas that may receive improvement. Finally, a discussion on climate change and the tools available to foresters to improve silviculture practice and aid in mitigating negative impacts of the changing climate.

3.1 FOREST INVENTORY AND THE ACC

The AAC, is the amount of timber permitted to be harvested in the Province within a one-year period, which is to ensure sustainability and productivity of forestland. Section 8(8) of the Forest Act lists five criteria that the Chief Forester must take into consideration when

determining the AAC (Forest Act 1996). Subsection 8(A) criteria i, ii, and iii along with 8(1 critical when discussing the current free growing concerns.

Currently, in British Columbia approximately 715, 000 hectares (ha) of forestland has been identified as not satisfactorily restocked (NSR). This is a combination of past disturbances and backlogged logging, while the bulk (roughly 479, 000 ha) (Snetsinger, 2011) is a direct result of the mountain pine beetle infestation that began in the early 1990s, peaking in 2005. It is estimated that by 2017, that 752 billion cubic metres (58%) of merchantable pine will be lost (NRCAN 2014). In response to the endemic, logging operations are targeting over 5.1 million ha of land containing over 50% pine, with the intent of developing, harvesting and reestablishing between 2 and 2.9 million ha of this area.

Conducting these salvage operations is a necessary step in restoring the forests, however we are assuming that reforestation efforts are successful at a rate to which, we believe we will have an increased amount of wood in the future, to sustain current operations. In four of the most heavily hit areas of MPB, the AAC has been lifted as high as 78% above pre-outbreak levels. Although the Province has a high rate of free to grow passing blocks, ranging between between 75 to 100 percent within certain biogeoclimatic zones (Mathers et al. 2010), the concern lays within the several years following.

As mentioned previously, upward of 70% of blocks are failing only several years after free to grow assessments have been carried out (Mathers et al. 2010). If we combine the impact of current heavy logging, previous and current NSR areas, failing immature stands (beetle attacked), and the moderate to high rates of free to grow blocks failing, there is need for concern.

Many of the actions being carried out are addressing the short-term needs, however in the long term it is possible to have some fall out. The Province committed to spending $8 million a

year for 10 years, to renew outdated forest inventories. The project aims to survey upwards 35-million ha of forest that has been hit by mountain pine beetle (MFLNRO 2013). However, is it too little too late? The association of B.C. Forest Professionals indicated that 41.9% percent of forest inventories had not been updated since 1990, with 29.9% of the work having been completed before 1980, raising concern on our basis of AAC (ABCFP 2011).

Updating inventories is important, however the forest service has been drastically reduced in the past decade, having lost 1006 positions, or approximately a quarter of its workforce (Parfitt 2010). This has resulted in the permanent closure of offices, and reclassification of others. This has led to foresters being spread thin across parts of British Columbia.

In the mean time, the AAC will have to be adjusted to compensate for reduced salvage, mid-term supply and long term sustainability. Within the next 10-15 years the AAC will have to reduce to below pre-outbreak levels, with the reduction expected to last for 50 years, with an expected 20% reduction below pre-outbreak levels (Committee, 2012). The reduction of the AAC, is best offset by increasing the midterm supply (i.e. timber that could be available for harvest operations within the next 20-60 years).

Given the large amount of uncertainty within our forest inventory and increasing concern of the viability of reforestation practices, the next 5 to 10 years will be critical in establishing a baseline on the current state of our forests and how to proceed.

3.2 REFORESTATION PRACTICES

Reforestation is often viewed as a high cost activity, in part due to trying to achieve high survival on poor to good sites. This has led foresters to demand the quantification of potential

survival and integrity of their stock. Furthermore, due to policy, foresters are eager to meet free growing requirements in a fixed time frame, to avoid penalties of reduced annual allowable cuts and limitations to forested areas adjacent to cutblocks considered non-free-growing. As a result, forest companies seek inexpensive, fast growing and reliable seedling sources to aid in removing any liability to the crown as soon as possible (Folk and Grossnickle 1997). Farquharson (2011) outlines three cost saving measures licensees are practicing as follows: (1) limiting and or excluding site preparation, (2) reducing planting densities, and (3) utilizing smaller stock sizes, which yield a lower cost per seedling.

Traditional stocking standards promote an even-aged system, which has been suggested as a method to control the level of conifer sawlog production (Martin et al. 2005. Martin et al. (2005) discusses the current methodology and explores three new approaches to performance surveys in British Columbia. They are as follows: (1) the multi-block volume system, (2) the DFP system, and (3) the boreal mixedwood system. Although these various systems have the potential to yield improvements and savings, it is important to note that the implementation of a new system will likely increase cost over the short term, making change less appealing.

Creating even aged-single species plantations, we are implementing large-scale monoculture. Monoculture (i.e. monotypic stands) are defined as only having a single representative or a single species (i.e. pure lodgepole pine stands) (Hardin et al. 2001). Typically, the silviculture of monocultures is both simple and reliable in most cases. However, there is no particular reason why mixed plantations cannot be utilized. They are inherently more complicated to establish and manage, but the benefits are capable of surpassing the difficulties (Smith et al. 1997).

In British Columbia, rather than planting pure lodgepole pine stands, a greater perce of plantations, particularly in biogeoclimatic zones that have proven to be less favourable for lodgepole pine establishment, should be planted with a lesser comparative amount of pine to a greater number of a tolerant species that will start growth more slowly. The upper stratum should compose more than 25% of the total number of stems. This will allow the pine to occupy the upper strata, while the more tolerant species (perhaps Douglass Fir or Engelmann Spruce) has time to establish the lower strata. The lower stratum will usually maintain the ability to grow vigorously once the upper stratum has reduced rapid growth (Smith et al. 1997).

Mixed forests provide the opportunity to maintain diversity. Carnus et al. (2006) describes four components of biological diversity: (1) genetic diversity, (2) species diversity, (3) structural diversity, and (4) functional diversity. All four of these aspects can be addressed and applied at the operational level when utilizing mixed plantations.

As mentioned, there are various benefits to mixed species stands. Jactel and Brockerhoff (2007) completed a meta-analysis, which found that more diverse forests had a lower relative amount of risk to be damaged by grazers, insects and fungal pathogens. Other benefits include improved habitats (Brockerhoff et al. 2008), and improved soil and nutrient efficiency (Brandtberg et al. 2000 and Smith et al. 1997).

It is important to note that site conditions may provide limiting factors that facilitate monoculture. This is an acceptable outcome, if management is carried out to maximize the stands potential. Studies have shown conflicting results regarding the influence of silviculture treatments such as brushing and thinning. Commonly, these practices are considered to increase the merchantable yield from a stand once it matures, however Mather et al (2010), lists several studies which indicate the contrary. There is evidence that pine stands hit by hard pine rust can

be avoided by increasing initial planting densities, and densities of upwards of 2500 stems p hectare should be considered (Woods 2008).

Finally, to touch on the use of cheaper seedling stock, Sharma et al. (2010) provided important results. They found that the size of crop trees at the beginning for the growth period explained the greatest amount of variation in both volume and height, during the stand initiation phase, accounting for 55 to 70% of growth. Control of herbaceous completion is also crucial, with studies indicating possible reductions in growth potential of up to 80% (Wagner 2000). These two factors are important in both the application of monoculture and mixed wood stands.

3.3 RESPONDING TO IMPACTS OF CLIMATE CHANGE

The global climate system constantly changes, becoming a primary focus as climate has been identified as one of the primary controls on the geographic distribution of plants (Woodward 1987). Climate experts believe that on average temperature will increase between 2 to 5°C in North America, with northern latitudes expected to experience greater increases by the year 2100 (IPCC 2007).

Although it has been documented that some species have accommodated rapid climate change in the past (Pitelka et al. 1997; Kullman 1998), it is likely that without human intervention (assisted migration) many species will not survive as a result of not being able to migrate toward higher latitudes and altitudes quick enough (Malcom et al. 2002, Aitken et al. 2008 and Hoegh-Guldberg et al. 2008).

There are indications that climate change has already had an impact on species' geographical distributions (Parmesan, 1996; Walther et al. 2002). Possible shifts in distribution

suggest that some populations may become hindered by occupying areas not ideal for optim growth and survival (maladapted) (Hampe, 2004; Rehfeldt et al., 2003). Assisted migration of tree species and or populations has been proposed and discussed as a potential forest management option to combat climate change (i.e. maintain productivity and biodiversity) (Rehfeldt et al., 1999; O'Neil et al., 2008).

There are many predictive modeling options to aid in forecasting future distributions of species in response to changes in climate. Some of the options available in the field of modeling range from dynamic ecosystem and biogeochemistry models, spatially explicit mechanistic models, physiologically based and correlative bioclimatic envelope models. See Heikkinen et al. 2006, for examples and explanations of the modeling options listed.

In the field, two practices that should be carried out, focusing on lodgepole pine, given it will likely continue to be fairly heavily utilized species for reforestation, is provenance testing and seed improvement programs.

Provenance testing can be utilized to indicate populations that have the potential to perform better in given environments. It is possible to indicate populations to be planted in particular environments that will have the plasticity to respond positively and show optimized fitness. Populations that become too locally adapted to their environment tend to have lower levels of plasticity, which may be defined as a genotype's capacity to render varying phonotypes under a range of environmental conditions (Garzon et al., 2011).

In conjunction with this type of study, seed improvement programs can be complimentary. The collection of plus trees, from a variety of locations exhibiting various conditions, can be used in provenance trials, which can result in the identification of better seed allocation. A plus tree can be defined as a tree in which its outward appearance, is superior in comparison to the

average tree of the same species growing in or on a similar site (selection is soley based on physical appearance) (Isaac 1955).

4.0 CONCLUSION & FINAL REMARKS

Forest stewardship is defined as "utilizing forest resources responsibly, based on the application of ecology at the stand, forest and landscape levels, further based on an ethical responsibility to both the land and the people (ABCFP 2012).

Currently, I believe that forest practice, surrounding reforestation and free growing in particular, tries to fulfill forest stewardship but ultimately falls just short of the finish line. However, working in an industry with dedicated forest professionals I have no doubt that we will overcome our limitations, although it will take time, dedication and compromise.

There are several key areas for improvement that I feel will be crucial in achieving the goals of healthy and productive reforestation:

- Follow through with the proposed forest inventory project despite possible changes with political parties in power.
- Implement more stringent FTG survey methodology and or delay declaring FTG, since studies appear to indicate declaration occurring too early in stand development.
- Improve reforestation practices by the way of seed stock size, seed sources, initial planting density, species composition and silviculture treatments.
- Allocate resources into seed improvement and provenance testing programs. This has the potential to provide appropriate species populations for varying ecological sites.

Implementing these key points has the potential to help alleviate the impacts of previ
forest activity, that may result in reduced biodiversity, health, productivity and supply
amongst our forest lands here in British Columbia.

LITERATURE CITED

Aitken, S.N., Yeahman. S., Holliday, J.A.,Wang, T., and Curtis-McLane, S. 2008. Adaptation, migration or extirpation: climate change outcomes for tree populations. Evolutionary Applications. 1(1): 95-111.

Association of BC Forest Professionals (ABCFP). 2011. Assessment of the status of forest inventories in British Columbia: an update to the 2006 ABCFP review. Available at: http://www.abcfp.ca/publications_forms/publications/documents/Forest_Inventory_2012_FINAL2.pdf Accessed on February 8th, 2014

ABCFP. 2012. Principles of Forest Stewardship. Available at: http://www.abcfp.ca/publications_forms/publications/documents/Principles_of_Stewardship_2012.pdf Accessed Feb 8th, 2014

Brandtberg, P.O., Lundkvist, H., Bengtsson, J., 2000. Changes in forest-floor chem- istry caused by a birch admixture in Norway spruce stands. Forest Ecology and Management 130(1-3): 253–264.

Brockerhoff, E.G., Jactel, H., Parrotta, J.A., Quine, C.P., Sayer, J., 2008. Plantation forests and biodiversity: oxymoron or opportunity? Biodiversity and Conservation. 17(5): 925–951.

Carnus, J.M., Parrotta, J., Brockerhoff, E., Arbez, M., Jactel, H., Kremer, A., Lamb, D., O'Hara, K., & Walters, B. 2006. Planted Forests and Biodiversity. Journal of Forestry. 104(2): 65-77.

(Committee) Special Committee on Timber Supply, 2012. *Discussion Paper.* Available at: http://www.leg.bc.ca/timbercommittee/docs/SC_Timber_Supply_Discussion_Paper.pdf Accessed Feb 8th, 2014

Farnden, C. 2009. The missing context of silviculture. A response to growing opprotunities: a new vision for silviculture in British Columbia. BC Forest Professional Magazine. 16(5): 19-20, 28.

Farquharson, D. 2011. Mother nature suffers fools poorly: early stand development in the south-central interior. BC Forest Professional Magazine. 18(5): 14-15.

Folk, R.S., & Grossnickle, S.C. 1997. Stock quality assessment: Still an important compone operational reforestation programs. National Proceedings, Forest Conservation Nursery Associates. pp. 109-119.
Available at:
http://www.google.ca/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CCYQFjAA&url=http%3A%2F%2Fwww.rngr.net%2Fpublications%2Fproceedings%2F1997%2Ffolk.pdf%2Fat_download%2Ffile&ei=Wq4OU8_GL9XqoATViYH4Aw&usg=AFQjCNGMe7xsjZsor-ZIPGX3qHeaHiBMQQ&bvm=bv.61965928,d.cGU&cad=rja
Accessed February 9th, 2014

Forest Act, R.S.B.C. 1996.
Available at: http://www.bclaws.ca/Recon/document/ID/freeside/96157_00
Accessed on February 2nd, 2014

(FRPA) Forest and Range Practices Act (SBS). 2002.
Available at:
http://www.bclaws.ca/Recon/document/ID/freeside/00_02069_01#section29
Accessed February 1st, 2014

Garzon, M.B., Alia, R., Robson, T.M., & Zavala, M.A. 2011. Intra-specific variability and plasticity influence potential tree species distributions under climate change. Global Ecology and Biogeography. 20(5): 766-778.

Hampe, A. 2004. Bioclimate envelope models: what they detect and what they hide. Global Ecology and Biogeography. 13(5): 469-471.

Hardin, J.W., Leopold, D.J., & White, F.M. 2001. Harlow & Harrar's Textbook of Dendrololgy. 9th ed. McGraw-Hill, 1221 Avenue of the Americas, New York, NY. 534 pp.

Heikkinen, R.K., Luoto, M., Araujo, M.B., Virkkala, R., Thiller, W., & M.T. Sykes, M.T. 2006. Methods and uncertainties in bioclimatic envelope modelling under climate change. Progress in Physical Geography 30(6): 1-27.

Hoegh-Guldberg, O., Hughes, L., McIntyre, S., Lindenmayer, D.B., Parmesan, C., Possingham, H.P., and Thomas, C.D. 2008. Ecology: Assisted Colonization and Rapid Climate Change. Science 321(5887): 345-346.

IPCC. 2007. Climate change 2007: The physical science basis. Contribution of Working Group I to the fourth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK.

Isaac, L.A. 1955. Tentative Guides for the Selection of Plus Trees and Superior Stands in Douglas-Fir. PNW Old Series Research Notes. Vol. 122, 9 pp.

Jactel, H., & Brockerhoff, E.G. 2007. Tree diversity reduces herbivory by forest insects. Ecology Letters. 10(9): 835-848.

Kullman, L. 1998. Non-analogous tree flora in the Scandes Mountains, Sweden, during the ear Holocene!macrofossil evidence of rapid geographic spread and response to paleoclimate. Boreas 27(3): 153-161.

Malcom, J.R., Markham, A., Neilson, R.P., and Garacil, M. 2002. Estimated migration rates under scenarios of global climate change. Journal of Biogeography. 29(7): 835-849.

Martin, P.J., S. Browne-Clayton., Day. K., & Taylor, G. 2005. Improving Regeneration Performance Standards: Comments Based on Early Experience with Three New Approaches in British Columbia. Forest Research Information Paper.
Available at:
http://www.rngr.net/publications/tgl/improving-regeneration-performance-standards-comments-based-on-early-experience-with-three-new-approaches-in-british-columbia/at_download/file
Accessed February 9th, 2014

Mather, W.J., Simard, S.W., Heineman, J.L., & Sachs, D.L. 2010. Decline of planted lodgepole pine in the southern interior of British Columbia. The Forestry Chronical. 86(4): 484-497.

Ministry of Forests, Lands and Natural Resouce Operations (MFLNRO). 2013. Forest inventory strategic plan.
Available at:
http://www.for.gov.bc.ca/hts/vri/whatsnew/Forest_Inventory_Strategic_Plan_Feb22_FINAL.pdf
Accessed on February 8th, 2014

Natural Resources Canada (NRCAN). 2014. Mountain pine beetle (factsheet).
Available at:
http://www.nrcan.gc.ca/forests/insects-diseases/13397
Accessed on February 2nd, 2014

O'Neil, G., Hamann, A., and Wang, T. 2008. Accounting for population variation improves estimates of the impact of climate change on species' growth and distribution. Journal of Applied Ecology 45(4): 1040-1049.

Parfitt, B. 2010. Axed: a decade of cuts to BC's forest service. Canadian Centre for Policy Alternatives. Environment and sustainability.
Available at:
https://www.policyalternatives.ca/sites/default/files/uploads/publications/BC%20Office/2010/12/CCPA_BTN_forest_service_web.pdf
Accessed on February 8th, 2014

Pitelka, L.F. 1997. Plant migration and climate change. American Scientist. 85(5): 464- 473.

Parmesan, C. 1996. Climate and species range. Nature 382: 765-766

Rehfeldt, G.E., Tchebakova, N.M., Milyutin, L.I., Parfenova, Y.I., Wykoff, W.R., and Kouzin N.A. 2003. Assessing population response to climate in Pinus sylvestris and Larix spp. Of Eurasia with climate-transfer models. Eurasian Journal of Forest Research 6(2): 83-98.

Rehfeldt, G.E., Ying, C.C., Spittlehouse, D.L., & Hamilton Jr., D.A. 1999. Genetic responses to climate in Pinus contorta: nice breadth, climate change and reforestation. Ecological Monographs 69(3): 375-407.

Sharma, M., Bell, F.W., White, R.G., Morneault, A., & Towill, W.D. 2010. Seedling size and woody completion most important predictors of growth following free-to-grow assessment in four boreal forest plantations. The Forestry Chronicle. 86(2): 213-224.

Smith, D.M., Larson, B.C., Kelty, M.J. & Ashton, P.M.S. 1997. The practice of silviculture: Applied Forest Ecology. 9th ed. John Wiley and Sons, Inc. New York. 537 pp.

Snetsinger, J. 2011. Not satisfactorily restocked (NSR) area in BC. BC Forest Professional Magazine. 18(5): 19-20, 28.

Wagner, R.G. 2000. Competition and critical-period thresholds for vegetation management decisions in young conifer stands. The Forestry Chronicle. 76(6): 961–967.

Walther, G.-R., Post, E., Convey, P., Menzel, A., C. Parmesan, Beebee, T.J.C., Fromentin, J-M., Hoegh-Guldberg, O., and Bairlein, F. 2002. Ecological responses to recent climate change. Nature 416 (6879): 389-395.

Woods, A. 2008. Are free-growing stands meeting timber productivity expectations in the lakes timber supply area. FREP Report summary #16.
Available at:
http://www.for.gov.bc.ca/hfp/frep/site_files/extension/FRPA_Evaluator_Extension_Note_16.pdf
Accessed February 8th, 2014

Woodward, F.I. 1987. Climate and plant distribution. Cambridge University Press, Cambridge. 188 pp.