Management of Biodiversity in the Prince George Timber Supply Area

Complaint Investigation #18042

FPB/IRC/235

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Glossary of Terms[1]

Biodiversity – The diversity of plants, animals and other living organisms in all their forms and levels of organization, including the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.

Crown Forest Land Base (CFLB) – Publicly owned land that is forested. It has generally been divided into: non-contributing land base (e.g., parks, inoperable forest and environmentally sensitive areas); and timber harvesting land base (i.e., suitable and available for timber harvesting). It does not include private land, federal land, municipal land and area-based tenures.

Landscape Unit – A planning area, generally up to about 100 000 hectares in size, delineated according to topographic features such as a watershed or a series of watersheds.

Merged Biogeoclimatic Units (mBEC) – A grouping of Biogeoclimatic Ecosystem Classification Units combined to facilitate implementation of the old forest objective. The groupings are based on common natural disturbance units.

Natural Disturbance Units (NDU's) – Areas based on differences in natural disturbance processes (e.g., fire, insects, wind, landslides and other natural processes), stand development, and temporal and spatial landscape pattern. They may include one or more mBECs.

Non-Spatial – The percentage of old forest within a geographic area identified by analyzing the vegetation resource inventory database.

Natural Range of Variability (NRV) – Often used to describe disturbance processes, and the ecosystem variability that these disturbances create. Ecosystems are thought to be more sustainable if we manage them so that their current disturbance regime falls within the natural range of variability (Gayton 2001).

Old Forest – In the *Prince George Biodiversity Order*, old forest means forests stands >120 or >140 years old (depending on Biogeoclimatic variant), determined from available forest inventory sources.

Old Growth Management Area (OGMA) – Mapped areas that contain or are managed to develop specific structural old-growth attributes, and treated as special management areas.

Old Interior Forest – An area of old forest, which is buffered from younger age classes or disturbances.

Recruitment – Identifying stands, either spatially or non-spatially, that do not currently meet the requisite old forest definition, but are intended to contribute to old forest retention objectives at some point in the future.

Spatial – Using forest inventories or field verification to locate and map areas containing, or managed to contain, old-growth attributes. Spatially defining these areas leads to their designation as legal or non-legal OGMAs. For the purpose of this report, spatial will also means to put on a map or mapped.

Young Forest – Forested areas that are between 0 and 20 years old.

[1] For other terms used in the report, the reader may wish to consult the "Glossary of Forestry Terms in British Columbia," available at: http://www.for.gov.bc.ca/hfd/library/documents/glossary/

Board Commentary

This investigation arose from a complaint by a resident of Prince George who was concerned about the management of biodiversity in the Prince George Timber Supply Area. The investigation examined compliance with the legal requirements of the *Order Establishing Landscape Biodiversity Objectives for the Prince George Timber Supply Area* (the Order). It also looked at whether implementation of the Order was consistent with the Implementation Policy that accompanied the Order.

The investigation found that licensees were complying with the legal requirements for managing biodiversity. However, those requirements were established almost twenty years ago and have not been formally reviewed or revised. In that time, the land base was severely affected by the MPB and salvage logging that followed, creating conditions that could not have been fully understood when the Order was established. The investigation identified several actions that can be taken to improve management of biodiversity.

The Board has previously commented on the value of public planning processes to establish clear objectives for the land base. The results of this investigation emphasize that those objectives cannot be frozen in time. Plans need to be regularly reviewed and updated to reflect changes in the natural environment, new information and knowledge, and to reflect societies changing values.

The Board has called for amendments to the *Forest and Range Practices Act* to incorporate tactical planning as a means to establish clear objectives for our forests and their many values.[2] One of the Board's proposed principles for tactical planning is "continuous improvement; monitoring of plan implementation and effectiveness is fundamental and is built into the process design to provide feedback to adapt and continuously improve plan outcomes over time."

The Board encourages this principle to be applied in the Prince George Timber Supply Area and across the province.

[2] https://www.bcfpb.ca/wp-content/uploads/2019/07/SR58-Tactical-Forest-Planning.pdf

Executive Summary

This is an investigation of a complaint about the management of biodiversity in the Prince George Timber Supply Area (PG TSA). The complainant is concerned that licensees may not be meeting the legal requirements of the *Order Establishing Landscape Biodiversity Objectives for the Prince George Timber Supply Area* (the Order), and that biodiversity may not be appropriately managed, due to the high level of mountain pine beetle harvesting that has taken place in the TSA.

To address this complaint, the investigation considered whether licensees are complying with the legal requirements of the Order and whether the old forest component of biodiversity is being managed consistent with government's Implementation Policy.

The Order establishes minimum retention objectives for old forest and old interior forest, and targets for young-forest patch size distribution across the TSA. Licensees must prepare a recruitment strategy if old forest or old interior forest are in deficit and the regional executive director must approve it.

The investigation found that forest licensees are complying with the old forest and old interior forest components of the Order. A licensee working group completes a non-spatial analysis annually for old forest and old interior forest targets, and licensees are preparing and submitting recruitment strategies consistent with the Order. These aspects of the Order are being met.

The licensee working group also completes a non-spatial analysis of young-forest patch size distribution every five years. The investigation did not determine whether the young-forest patch size distribution is meeting the objective in the Order. Young-forest patch size distribution cannot be measured by non-spatial analysis only. It must be evaluated by a qualified professional, taking into consideration other criteria such as shape and location of the patches across the landscape in relation to key values, including old forest retention areas and structural attributes of the patches themselves.

An Implementation Policy attached to the Order provides guidance for the implementation of the Order, but is not legally binding. The investigation identified several concerns with consistency of biodiversity management with the Implementation Policy. These include; adaptive management; definition of old forest; limitations of the data used in the analysis; and mapping old forest, old interior forest and recruitment areas. The investigation also found that biodiversity, as it relates to old forests, may be at high risk in the PG TSA.

Finally, the investigation determined that the opportunities to address old forest contribution to biodiversity are reduced as old forests are harvested. The risk to biodiversity will diminish if some or all of the old forests are mapped so that the legal requirements are defined spatially. This is especially important where the amount of old forest remaining is low. Mapping should not be based only on age, but must also consider other aspects of biodiversity and socio-economics implications.

The Board recommends that government spatialize old growth management areas where the immediate risks to old forest are the greatest, and review and update the requirements for biodiversity in the PG TSA.

Introduction

The Complaint

The Board received a complaint from a resident of Prince George about the management of biodiversity in the Prince George Timber Supply Area (PG TSA). The complainant is concerned that biodiversity values are not being appropriately addressed due to the high levels of mountain pine beetle (MPB) salvage harvesting in the TSA.

The complainant identified two main issues:

1. Forestry activities may not be meeting the legal requirements of the *Order Establishing Landscape Biodiversity Objectives for the Prince George Timber Supply Area*[3] (the Order).
2. The high level of MPB harvesting that has taken place in the PG TSA may mean that biodiversity is not being appropriately managed.

Biodiversity

The *Forest Practices Code of British Columbia Biodiversity Guidebook*[4] (biodiversity guidebook) defines biological diversity (or biodiversity) as the diversity of plants, animals and other living organisms in all their forms and levels of organization, and includes the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.

The underlying assumption of managing for biodiversity is that all native species and ecological processes are more likely to be maintained if managed forests are made to resemble those forests created by the activities of natural disturbance agents such as fire, wind, insects and diseases. These processes determine the composition, size, age and distribution of forest types on the landscape.

The biodiversity guidebook states that the more that managed forests resemble natural disturbance patterns, the more likely it is that all native species and ecological processes will be maintained. The habitat needs of most forest and range organisms can be provided for by:

- maintaining a variety of patch sizes, seral stages, and forest stand attributes and structures across a variety of ecosystems and landscapes;
- maintaining connectivity of ecosystems in such a manner as to ensure the continued dispersal and movement of forest and range-dwelling organisms across the landscape; and
- providing forested areas of sufficient size to maintain forest interior habitat conditions and to prevent the formation of excessive edge habitat.

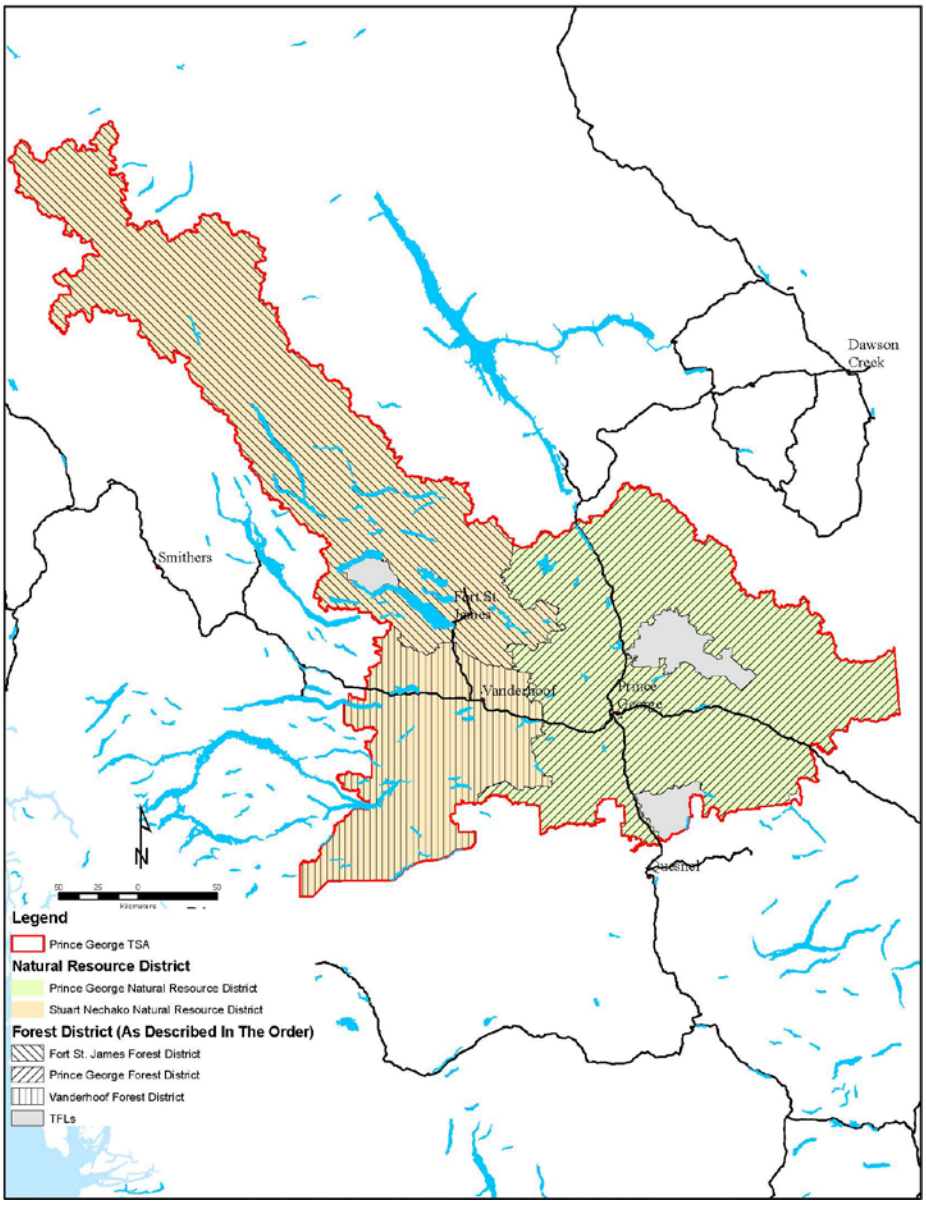
Managing for biodiversity is an integral part of forest management. Section 9 of the *Forest Planning and Practices Regulation* states that the objective for biodiversity at the landscape level is "…to *design* areas on which timber harvesting is to be carried out that resemble, both spatially and temporally, the patterns of natural disturbance that occur within the landscape."

[3] https://www2.gov.bc.ca/gov/content/industry/crown-land-water/land-use-planning/regions/omineca/prince-george-biodiversity-order

[4] *Forest Practices Code of BC Biodiversity Guidebook*. 1995. https://www.for.gov.bc.ca/hfd/library/documents/bib19715.pdf

Background

The Prince George TSA



Map 1. PG TSA – consists of the Stuart Nechako Natural Resource District (formerly the Vanderhoof and Fort St. James forest districts) and part of the Prince George Natural Resource District.

The PG TSA, located in north-central British Columbia, is approximately eight million hectares[5] in size and is the largest TSA in the province. The PG TSA includes the Stuart Nechako and part of the Prince George natural resource districts (NRDs) (see Map 1). At the time that the Order was written, the PG TSA consisted of the Fort St. James, Vanderhoof and Prince George forest districts. The Fort St. James (DJA), Vanderhoof (DVA) and Prince George (DPG) forest districts names will be used in this report when referring to aspects of the Order.

First Nations communities within the Prince George TSA include: Nak'azdli, Takla Lake, Tl'azt'en, Nadleh Whut'en, Stellat'en, Saik'uz, Lheidli T'enneh, Yekooche and McLeod Lake. Other First Nations

[5] Prince George Timber Supply Area Rationale for Allowable Annual Cut (AAC) Determination Effective October 11, 2017. ftp://ftp.for.gov.bc.ca/hts/external/!publish/timber_supply_review/TSA/Prince_George_24/TSR_2015/2017_Rationale/prince_george_tsa_rationale_2017.pdf

whose communities are outside of the Prince George TSA, but whose territories extend into the Prince George TSA include: the Cheslatta, Lhoosk'uz Dene, Ulkatcho, Skin Tyee, West Moberly, Halfway River, Gitxsan, Lake Babine, Tsay Key Dene, Red Bluff, Nazko, Tahltan, Blueberry River, Saulteau, Simpcw, Nee Tahi Buhn, Tsetsaut Skii Km La Ha , and Tsilhqot'in National Government. The Forest Practices Board would like to recognize the importance of their historical relationship with the land that continues to this day.

The PG TSA covers a diverse landscape of mountains and interior plateau. Approximately 3.0 million hectares of Crown forest land is available for harvesting. About half is dominated by lodgepole pine stands, and the remainder is made up of spruce, subalpine fir, Douglas-fir, cedar and deciduous stands. Many of the pine-leading stands were established 40 or more years ago following major fires. In about 2000, a major MPB outbreak began in the PG TSA.

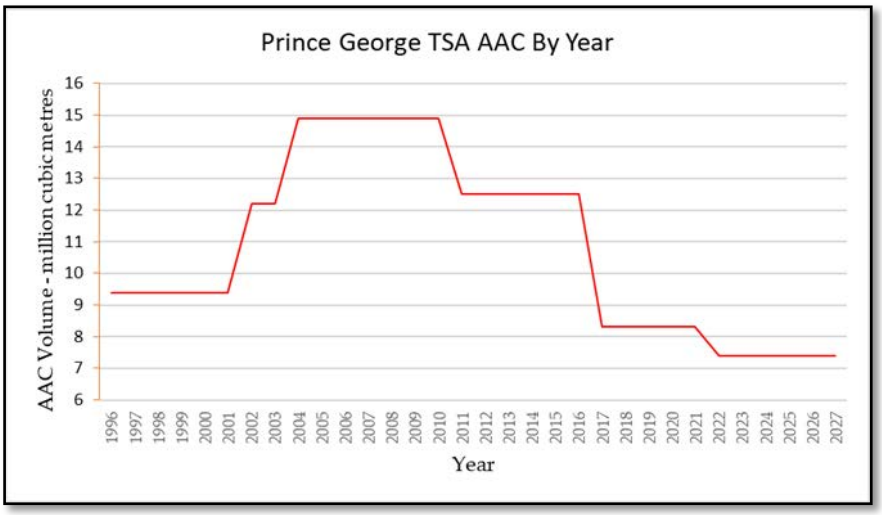


Figure 1. Allowable annual cut in the Prince George TSA 1996-2027.

In response to the infestation, harvesting activity increased dramatically to salvage forest stands damaged by the beetle. The allowable annual cut (AAC) for the PG TSA has been adjusted several times since 2000, from just over 9.3 million cubic metres to a peak of 14.9 million cubic metres in 2004 (see Figure 1). The AAC was lowered in 2011 to 12.5 million cubic metres. The current AAC is 8.3 million cubic metres for the period 2017 to 2022 and will then decrease to 7.4 million cubic metres for the following 5 years.

Biodiversity Management in the PG TSA

The biodiversity guidebook was the first attempt in British Columbia to provide guidance for managing biodiversity. The biodiversity guidebook incorporated the concept of Natural Disturbance Types and Landscape Unit Planning. However, it was a provincial strategy and did not necessarily work well for the emerging beetle outbreak in the PG TSA. Government could have implemented the biodiversity guidebook in the PG TSA, but instead it took a more progressive approach.

The mandate of the Ministry of Sustainable Resource Management[6] at the time was to incorporate the "best available science for the preparation of landscape level plans." This mandate coincided with the emerging science regarding natural disturbance units and natural range of variability in the PG TSA as described in "*Natural Disturbance Units of the Prince George Forest Region: Guidance for Sustainable Forest Management*" (DeLong 2002).[7] The regional executive director also provided direction to all district

[6] The Ministry of Sustainable Resource Management existed from 2000 to 2004 and later became the Integrated Land Management Bureau (2004 – 2009). The planning functions of the Integrated Land Management Bureau are now the responsibility of the Ministry of Forests, Lands, Natural Resource Operations and Rural Development.

[7] https://www.researchgate.net/publication/239785326_Natural_Disturbance_Units_of_the_Prince_George_Forest_Region_Guidance_for_Sustainable_Forest_Management

managers to use the DeLong 2002 science to establish objectives in partnership with forest licensees in the PG TSA.

In 2002, government established a landscape objectives working group (LOWG) made up of PG TSA timber licensees,[8] the Ministry of Forests' (the Ministry)[9] Regional Ecologist and representatives from the Northern Interior Region of the Ministry of Sustainable Resource Management.

In 2004, the LOWG published the *Prince George Timber Supply Area Landscape Level Biodiversity Objectives, Background Information and Supporting Documentation for the Process Involved in Developing the Recommended Biodiversity Objectives in the PG TSA*[10] (2004 Background Information). The 2004 Background Information stated that the objective of the LOWG was "…to strengthen the relationship between policy decisions, scientific research and industry needs with the use of a defensible, biodiversity-based platform including the natural range of variability (NRV). NRV reflects the characteristics inherent in natural disturbance patterns and is a tool in forest management to maintain biodiversity, habitat diversity and ecosystem processes." It provided an overview of the process involved in developing landscape level biodiversity objectives that incorporate an ecosystem-based management approach for old forest retention, old interior forest and young forest patch size distribution. It also contained a biodiversity risk assessment that compared the historic and existing amount of old forest on the land base.

Government incorporated much of the work done by the LOWG into an *Order Establishing Landscape Biodiversity Objectives for the Prince George Timber Supply Area*, which was approved on October 20, 2004. The legal objectives in the Order were developed collaboratively between the forest licensees in the PG TSA and the Ministry. The general public, stakeholders and First Nations also provided input through a public review and comment process. The goal was to balance the impact to timber supply in the immediate and long term while still managing biodiversity. The Preamble to the Order provides further insight (see Figure 2).

> This Order establishes landscape biodiversity objectives, across the PG TSA, for:
>
> A. old forest retention;
> B. old interior forest; and,
> C. young forest patch size distribution.
>
> These objectives were developed using current scientific information with respect to the natural range of variability within this geographic area. They are designed to balance the requirements of environmental and economic sustainability, while considering the expected impacts of the current MPB infestation.
>
> These objectives will be periodically updated to incorporate new knowledge and address changing environmental economic and social conditions.
>
> In ensuring that their plans are consistent with the objectives of this Order, licensees and BC Timber Sales, should consider the Implementation Policy, which supports this Order.

[8] Licensees include timber tenure holders and BC Timber Sales.

[9] From 1998 until now, the Ministry has changed its name several times: Ministry of Forests; Ministry of Forests and Range; Ministry of Forests, Mines and Lands; Ministry of Forests, Lands and Natural Resource Operations; and currently called the Ministry of Forests, Lands, Natural Resource Operations and Rural Development.

[10] https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/natural-resource-use/land-water-use/crown-land/land-use-plans-and-objectives/omineca-region/princegeorge-biodiversity-order/lowg_backgrounder_5_dec05.pdf

Figure 2. Preamble to the Order.

The Order establishes minimum retention objectives for old forest, old interior forest, and young-forest patch size distribution across the PG TSA. It identifies 49 geographic areas called "merged biogeoclimatic ecosystem classification units" (mBEC) where the objectives must be met. It also sets out processes for dealing with deficits and recruitment strategies.

The Order is supported by an Implementation Policy. The Preamble to the Order states that "… licensees and BC Timber Sales, should consider the Implementation Policy to help ensure that their forest stewardship plans and operational activities are consistent with the objectives of the Order.

A subset of the LOWG, called the licensee LOWG, or LLOWG, annually collects harvest, road and retention data from all PG TSA licensees and calculates the amount of old forest, old interior forest and total contributing forest land base (CFLB) area within each mBEC unit. The result is compared to the objectives of the Order to determine whether old forest and old interior forest objectives of the Order are being met. The Order specifies that licensees must prepare a recruitment strategy if an mBEC is in deficit of old forest or old interior forest, and the strategy must be submitted to and approved by the regional executive director.

The Order also specifies targets for different patch size categories for young forest. The LLOWG completes a patch size analysis every five years to determine if activities are trending towards the patch size targets. If not, the Order requires licensees to provide a rationale for why not.

The LLOWG reports the results of its analysis of old and old interior forest, and young-forest patch size, to licensees and the Ministry. The Ministry uses the report to monitor compliance with the Order.

The Investigation

To investigate the complaint, the Board examined compliance with the legal requirements of the Order, as well as whether implementation of the Order was consistent with the Implementation Policy. Because biodiversity is such a complex subject and the PG TSA is so large, the investigation focused its review on the old forest component of biodiversity at a strategic level by reviewing key components of the data analysis and relevant research and publications. The report does not address social and economic trade-offs that government considered when it developed the Order, nor does it address biodiversity from an operational or on-the-ground perspective.

The Board considered the following questions in this investigation:

1. Are licensees complying with the legal requirements of the Order; and
2. Is the old forest component of biodiversity being managed consistent with the Implementation Policy?

Are licensees complying with the legal requirements of the Order?

The mandate of the Forest Practices Board includes investigating complaints related to Parts 2 to 5 of the *Forest and Range Practices Act* (FRPA). This means that for topics like biodiversity, the Board investigates how broad land use and policy goals are implemented through FRPA. The Board does not have a mandate to investigate whether those choices themselves were appropriate. The Board recognizes that decisions such as how much old forest to protect are complex decisions that reflect consideration of multiple, and sometimes competing, public objectives. Good land use and policy decisions are essential ingredients to good forest management and influence the quality of BC's forest practices. Although they are not directly the subject of the Board's investigations, the Board can consider whether those decisions are clear, well informed, and made through transparent processes. The Board can also examine whether the intent of those broader land use and policy decisions is being achieved as they are implemented through FRPA.

Old and Old Interior Forest Objectives

The Board compared the old forest and old interior forest minimum retention objectives against the actual amount of old and old interior forest on the land base, as shown in the 2019 LLOWG analyses. The 2019 LLOWG analyses indicate that there is enough old forest in all but two mBEC units in the Prince George Forest District. Overall, the analyses shows that the PG TSA has about a one-million-hectare surplus of old forest and old interior forest retention (Table 1 and Appendix 1).

Under the Order, licensees are required to prepare a recruitment strategy when an mBECs is in deficit of old or old interior forests. The licensees submit the strategy to the regional executive director who reviews it, and if satisfied, approves it. Licensees should not be harvesting old forests in mBECs where there is a deficit until a recruitment strategy is approved.

Table 1. Summary of Analysis of Old and Old Interior Forests by District (Data source: 2019 LLOWG analysis)

Natural Resource District	Forest District	Crown Forest Landbase (ha)	Number of mBECs	Old Forest					Old Interior Forest	
				Minimum Retention (ha)	Existing (ha)	Number of mBECs in Deficit	Total Area of the Old Forest Targets in Deficit mBECs (ha)	Deficit Area (ha)	Minimum Retention (ha)	Existing (ha)
Stuart Nechako	Fort St. James (DJA)	1,845,386	17	443,626	1,110,909	0	0	0	148,304	809,121
	Vanderhoof (DVA)	1,845,386	7	162,797	301,441	0	0	0	38,414	125,734
Prince George	Prince George (DPG)	2,128,187	25	707,453	976,119	2	91,962	5,352	215,793	557,488
Total		**5,818,959**	**49**	**1,313,876**	**2,388,469**	**2**	**91,962**	**5,352**	**402,511**	**1,492,343**

The intent of the recruitment strategy provision is to achieve a forest condition that is consistent with the objectives in the shortest time practicable, with consideration for the timely and economic harvesting of timber. Licensees, with feedback from government, prepared six non-spatial and one spatial recruitment strategy between 2012 and 2014. The regional executive director has approved all seven recruitment strategies. These recruitment strategies cover the four mBECs in deficit.

Young Forest Patch Size Distribution Objective

The Implementation Policy recognizes that forest activities cannot replicate the natural patterns and habitat characteristics established by natural disturbances in the past. However, licensees should try to emulate them as closely as possible. The Implementation Policy states that the purpose of the young forest (stands between 0 and 20 years old) patch size objective is to create a pattern of young forest distributed across the landscape reflecting natural disturbance patterns. The 2004 Background Information identifies that proactive planning and management decisions must incorporate an appropriate balance between large openings and large, intact forested patches over time to achieve this outcome.

The Implementation Policy recognized that meeting the patch size distribution objective would be difficult in some cases, since there are other compelling forest management drivers, such as previous harvesting, forest health, fires and the management objectives for other resource values that may affect the ability to achieve patch size objectives.

The Order establishes targets for the percent of young forest in 9 natural disturbance sub-units (NDUs) and 4 young-forest patch size categories (less than 50 hectares, 51 to 100 hectares, 101 to 1000 hectares and greater than 1000 hectares). The young-forest patch size objective is a single value[11] for each NDU, as opposed to a range, so in most instances the existing condition will be above or below the target. The LLOWG performs the young-forest patch size analysis every five years. A landscape can be severely altered by harvesting, fire and beetle over that period. Regardless, the five-year period between patch analyses is reasonable because young stands age each year but the actual attributes of young stands do not change much from year to year.

The Order requires licensees to submit a rationale to government when young-forest patch size is not trending towards the objectives of the Order. The rationale must contain results or strategies that demonstrate the licensees are moving towards a forest condition that is consistent with the objective in the shortest time practicable, with consideration for the timely and economic harvesting of timber. However, neither the Order nor the Implementation Policy defines what "trending" means nor provides criteria to assess trending.

The LLOWG completed a young-forest patch size distribution analysis (patch analysis) in 2015. In September 2017, the chief forester issued, Omineca Region Guidance – Stand and Landscape-Level Retention for Harvesting in Response to Spruce Beetle Outbreaks, which included revised patch size calculations. The LLOWG ran an interim patch analysis in 2018 using the process in the 2017 chief forester's guidance, even though the objectives in the guidance are not legal. The LLOWG plans another patch analysis, scheduled for completion in 2020.

The patch analysis only provides the area of young forest in each patch size; it does not address other factors that must be considered to evaluate whether the pattern of young forest distributed across the landscape emulates natural disturbance patterns and habitat characteristics or is resulting in a fragmented landscape. For example, assessing if patch sizes emulate natural patterns must also consider the distribution in terms of patch shape and location across the NDU in relation to key values and old forest retention areas (size, shape and location), as well as structural attributes of the patches themselves. In addition, there is no upper size limit to patch sizes over 1000 hectares. Consequently, the patch analysis does not address young forest patches from a biodiversity perspective.

[11] A recommended practice is to set a range for patch size objective for all seral stages to better achieve the objective.

The Board compared the 2015 LLOWG young-forest patch size analysis with the 2018 interim young-forest patch size analysis to determine if forestry activities are approaching the patch size objectives in the Order (refer to appendix 4). The Board did not assess if the young-forest patches reflect the natural process based on other attributes such as shape and pattern across the landscape, or internal retention. The Board considered the young-forest patch size was approaching the objectives of the Order if the variance from the Order in the 2018 patch analysis was closer to the objectives in the Order than the variance in the 2015 patch analysis (refer to Table 2).

Table 2. Example of Evaluating "Trending" (by comparing the patch distribution analysis from 2015 and 2018 with the objectives in the Order)

Fort St. James FD - Young Forest Patch Target Size Distribution (%) For Patches < 50 ha						
		2105		**2018**		
NDU	Target	Patch Size Analysis Results	Variance from Patch Size Objective in the Order	Interim Analysis	Variance from Patch Size Objective in the Order	Approaching Young Forest Patch Size Objectives In The Order
Moist Interior - Mountain	20.0%	22.7%	2.7%	17.9%	-2.1%	Yes
Omineca - Mountain	20.0%	17.7%	-2.3%	15.4%	-4.6%	No
Omineca - Valley	5.0%	11.7%	6.7%	10.1%	5.1%	Yes

In general, the percent of NDUs approaching the patch size objectives in the Order is higher for the smaller patch size categories (less than 50 hectares and 50 to 100 hectares) and is lower for the larger patch size categories. Refer to appendix 4 for more detail.

The analysis also shows that in NDUs that have a high component of lodgepole pine (i.e., ecosystems that experience frequent stand initiating events) the young forest objectives for 101 to 1000 hectare and greater than 1000 hectares patches is increasing and getting further from the objectives in the Order. This is expected, since most harvesting has been salvaging of MPB damaged stands. However, the analysis also shows that the young forest objectives for 101 to 1000 hectare and greater than 1000 hectares patches is also increasing and getting further from the objectives in the Order for the moister stand types with less lodgepole pine (ecosystems that experience infrequent stand initiating events). The young forest patch objectives for patches over 1000 hectares in the moist ecosystems are already exceeded in all of the NDUs for the Prince George and Vanderhoof forest districts. This is a concerning trend since these stands have a higher component of green timber.

Finding

Licensees are complying with the legal requirements of the Order with respect to old forests and old interior forests. Licensees have prepared recruitment strategies where there are deficits of old forest, and those strategies have been approved by government.

The Board cannot make a determination of whether the young-forest patch distribution is trending to patch size objectives in the Order. There is no definition of what trending means or how it is measured. The Board considers that young-forest patch distribution cannot be measured by analysis only. It must be evaluated by a qualified professional in consideration of other criteria including shape and location of the patches across the NDU in relation to key values and old forest retention areas, as well as structural attributes of the patches themselves.

Is the old forest component of biodiversity being managed consistent with the Implementation Policy?

Old forests are one of the key elements of biodiversity. The amount of old forest is usually much lower in managed forests than in unmanaged forests. This is due, in part, to a general strategy of harvesting the oldest forests first. Consequently, managing old forests is an important factor when considering the risk to biodiversity over the long term. The investigation reviewed whether implementation of the Order with respect to old forest is consistent with the Implementation Policy.

The Implementation Policy provides non-legal guidance for the implementation of the Order. The Implementation Policy includes definitions, rationales, roles and responsibilities, administrative processes such as the buffering process for interior forest and patch size, and apportionment between licensees. It also identifies that adaptive management principles would apply to the implementation of the Order.

Adaptive Management

The LOWG supported the need to periodically update the Order to incorporate new knowledge and address changing environmental, economic and social conditions. The 2004 Background Information states "…the LOWG committee supports a continuous improvement and adaptive management approach that provides the flexibility to incorporate new information, address risk and uncertainties, incorporate better knowledge/understanding and apply lessons learned." In addition, the preamble to the Order states that, "These objectives will be periodically updated to incorporate new knowledge and address changing environmental economic and social conditions." Finally, the Implementation Policy also commits to an adaptive management strategy. This is consistent with the *Forest Practices Code - Landscape Unit Planning Guide* (1999) which states that plans must be reviewed and amended as required to ensure their effectiveness. These reviews should occur regularly to reflect the results of monitoring initiatives, adaptive management, and new information.

The Implementation Policy indicates that adaptive management includes periodic review (as a minimum, a review will coincide with timber supply review process in the PG TSA) and, where needed, incorporation of changes. These include changes to administrative boundaries, natural disturbance unit boundaries, old forest retention and young forest patch size targets, cumulative impact analysis for all biodiversity elements, demonstrated ability to maintain quality old growth values on the landscape, the need for spatially located old forest retention areas, inclusion of new and better inventory information, and age and structural attributes that define old forests. Some of these are discussed below.

Since the Order came into effect, the landscape has been severely altered by fire, harvesting, and the MPB. The economically viable beetle damaged stands have largely been harvested, and harvesting is now moving to non-pine leading stands. In addition, spruce bark beetle (IBS) is emerging as a forest health threat to spruce leading stands throughout the TSA and harvesting is now targeting the IBS outbreaks occurring in the PG TSA, with heavy focus within the Prince George Forest District's mBECs.

Although there have been significant changes to the landscape and increased knowledge, the Order has never been updated.

Definition of Old Forest

The ecology of old forests is complex and highly variable between forest ecosystems and sites. Old forest attributes are qualitative and are generally defined as stands that are structurally complex with large old living trees, large dead snags, fallen dead trees, multi-layered canopies, horizontal patchiness and hummocky micro-topography. These old forests are an important component of biodiversity, since they provide unique habitat and ecological function for the many organisms that exist within the forests of BC.[12]

Old forest attribute information is not accurately captured in the forest inventory, so the age at which forests generally achieve the old forest attributes is the most common way to classify old forests in BC. Although age can be a reasonable surrogate for old forest, the age must be one at which there is a reasonable likelihood that old forest attributes have developed within the stand.

The 2004 Background Information states that the LOWG committee used the DeLong 2002 report as the foundation for the development of the recommended landscape level biodiversity objectives in the PG TSA. However, the Order did not base old forest age entirely on the DeLong 2002 report. The old forest age in the Order is a negotiated age that tried to balance the need to achieve a balance between economic concerns and ecological integrity, while considering the expected impacts of the current MPB infestation. It was recognized that the application of the NRV research, "in its entirety," could have significant impact on the timber flow and harvesting opportunities.

Old forest age as defined in the Order is not consistent with the biodiversity guidebook or the *Order Establishing Provincial Non-Spatial Old Growth Objectives.*[13] The Order defines old forest as greater than 120 years for ecosystems that experience frequent stand initiating events (i.e., fire and beetle) and greater than 140 years for ecosystems that experience infrequent stand initiating events. However, both the biodiversity guidebook and the *Order Establishing Provincial Non-Spatial Old Growth Objectives* define the age at which a stand is recognized as old as over 140 years for ecosystems that experience frequent stand initiating events and over 250 years for ecosystems that experience infrequent stand initiating events.

Decreasing the age from greater than 140 years to greater than 120 years in the Order provides better opportunities to capture large, intact and higher quality patches of old forest while providing licensees with the operational flexibility needed to manage the MPB situation. Many of the stands in these ecosystems are even-aged pine leading stands. A 2004 research paper looked at MPB and old-growth forest characteristics in the moist interior plateau of the Vanderhoof Forest District.[14] The research paper found that pure pine stands greater than 140 years on low productivity sites will likely not have unique old growth habitat values. The report also goes on to say that mature stands over 120 years old on higher productivity sites are likely to provide more old growth attributes than older stands on lower productivity sites. Consequently, it is conceivable that some pine stands between 120 and 140 years will have similar old growth attributes as pine stands greater than 140 years. These factors likely influenced the decision to use 120 years as the age for old forest in these ecosystems.

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[12] Forest Practices Board, *Conserving Old Growth forests in BC - Implementation of old-growth retention objectives under FRPA*, Special Investigation Report, 2012. https://www.bcfpb.ca/reports-publications/reports/conserving-old-growth-forests-in-bc-implementation-of-old-growth-retention-strategies-under-frpa/

[13] https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/natural-resource-use/land-water-use/crown-land/land-use-plans-and-objectives/bc-biodiversity-mngt/bc_non-spatial_old_growth_fpc_30jun2004.pdf

[14] https://www.semanticscholar.org/paper/Mountain-pine-beetles-(Dendroctonus-ponderosae)-and-Holt/06687704fb6bddc79734d60f947b7dc10b45565e https://www.semanticscholar.org/paper/Mountain-pine-beetles-(Dendroctonus-ponderosae)-and-Holt/06687704fb6bddc79734d60f947b7dc10b45565e

No similar rationale was found to support decreasing the age for ecosystems that experience infrequent stand initiating events from greater than 250 years to greater than 140 years (a 110-year change in stand age) in all instances. Delong et al. (2004)[15] found some overlap of old forest attributes between stands 141 to 250 years old and stands greater than 250 years old. However, his report also indicates that forest cover inventory age is not reliable by itself to identify stands with more well-developed old forest attributes for biodiversity. Consequently, not all stands over 140 years old should be considered as contributing to old forest objectives, based on inventory age alone.

Data Used in the Analyses

One of the difficulties in implementing non-spatial old forest minimum retention objectives is the lack of consistency and accuracy of spatial datasets and adjustments to the Crown forest land base and timber harvesting land base.[16] The non-spatial analyses used to monitor achievement of old forest retention objectives is only as reliable as the data inputs. Updating of the spatial inventory includes changes due to harvesting, forest fires and beetle. In addition, the location and extent of contributing Crown forest landbase, BEC and mBEC units will constantly be refined, reflecting the most recent available information about ecosystems. These updates may be considered improvements to the inventory but they also will affect the analyses.

Age in the vegetation resource inventory[17] (VRI) is the main attribute used by the LLOWG when determining how much old forest or old interior forest exists within a geographic area and whether licensees are compliant with the Order. VRI is a strategic inventory of the province's vegetation and is comprised of polygons of similar forest stand attributes.[18] The VRI polygons and data are used strategically at a TSA level for timber supply analysis purposes and are not meant for operational planning, but they are used as such because there is no other data available. Base data for the VRI polygon is established by estimating the average age, species composition, height and volume of the stand in the polygon. Consequently, actual stand attributes, including age, in a polygon may vary.

There are also several VRI data sets covering the PG TSA and not all of them are updated at the same time. Consequently, a newer version of VRI may apply attributes to some stands that are not consistently applied in older VRI versions. This can also impact the analysis. Consequently, the analysis for the same mBEC may have significantly different results over the span of a year and may have a significant impact on operational planning and activities.

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[15] S. Craig DeLong, S.C., P.J. Burton, M. Harrison. 2004. *Assessing the relative quality of old-growth forest: An example from the Robson Valley, British Columbia*. BC Journal of Ecosystems and Management. Vol 4 No. 2 http://www.forrex.org/jem/2004/vol4/no2/art8.pdf

[16] Forest Practices Board. 2012. Conserving Old Growth forests in BC - Implementation of old-growth retention objectives under FRPA Special Investigation. Report #FPB/SIR/36. Available at https://www.bcfpb.ca/reports-publications/reports/conserving-old-growth-forests-in-bc-implementation-of-old-growth-retention-strategies-under-frpa/

[17] The vegetation resources inventory identifies where the resource is located and how much of a given vegetation resource (for example, age, height volume and species) is within an inventory unit.

[18] Forest Practices Board. 2018. Harvesting of Young Stands in BC. Report #FPB/SIR/48. Available at https://www.bcfpb.ca/wp-content/uploads/2018/05/SIR48-Young-Stand-Harvesting-1.pdf

Mapping Old Forest and Recruitment Areas

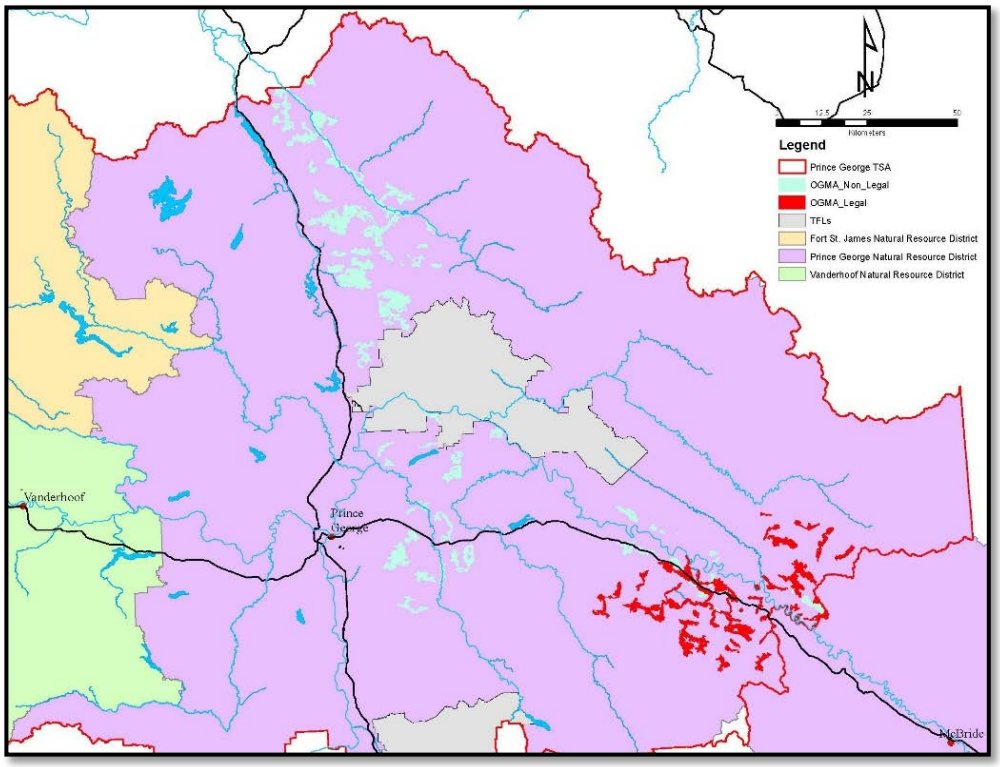
Based on the provincial old growth coverage from the British Columbia Geographic Warehouse[19] (BCGW), old forest retention is mapped to meet all or a portion of the retention objectives at the landscape unit (LU) and BEC variant level in 20 out of 24 natural resource districts in the province. The practice of spatially identifying old forest allows planners and decision maker to fully evaluate the quality of the old forest that is protected. This includes the biodiversity values of the old forest, and the overlap between old forest and other non-timber values such as wildlife habitat and culturally important areas. Spatialized old forest areas also guide other activities on the landbase such as construction of pipelines or tenures under the *Mines Act* or *Land Act*.

The Order does not require old forest and old interior forest minimum retention objectives or recruitment strategies to be spatially mapped, although some OGMAs have been mapped in some portions of the Prince George Forest District (Map 2). The legal OGMAs on Map 2 were established prior to the Order and are composed of old growth forests. There are non-legal OGMAs that are part of a recruitment strategy for the A4 mBEC in the Prince George District and, in some cases, they do not include old forests even when old forest is available within the mBEC.

The LLOWG completes an analysis for the entire PG TSA to determine if the minimum retention objectives are met within the mBECs. The non-spatial analysis identifies old forest based on inventory age only. This is consistent with the Order, but is only a coarse filter approach. Even though a stand meets the minimum age requirement for old forest, that does not necessarily mean the area is suitable. Other factors also need to be assessed by a qualified professional.

Minimum retention objectives for old forest and old interior forest are designed to capture old and old interior forests with appropriate attributes to optimize value for biodiversity. The 2004 Background Information notes that, even though age is a component in the preliminary identification of old forest, there is risk that essential biological values may not be captured without appropriate structural assessments and spatial identification. Therefore, it is important to assess stands in a broader context using factors other than just age, such as stand attributes, patch size, connectivity, rare ecosystems, etc. Most of these factors have long-term biodiversity values that are not identified or protected through non-spatial analysis.

[19] The British Columbia Geographic Warehouse is the corporate repository for land, resource and geographic data that supports a variety of business requirements for the natural resource sector, other government agencies, industry and the public.



Map 2. OGMAs mapped in portions of the Prince George Forest District.

Non-spatial analysis of old forest, old interior forest and recruitment strategies provide less certainty that the most suitable old forests with appropriate attributes (as opposed to fragmented slivers of low-quality forest) are retained, or that the recruitment areas will not be logged at a future date. Mapping these areas provides protection for long-term biodiversity values that does not exist if only non-spatial analysis is used.

However, the Board recognizes that a dynamic approach to planning is essential, especially in ecosystems that experience frequent stand initiating events. A dynamic approach to planning may include spatializing some or all old forest areas, so that site-specific resource values can be considered in addition to age. In mBECs that are approaching old forest targets, a spatial approach becomes more important. A dynamic approach should also provide for a clear and efficient process to shift old forest across the mBEC in response to events such as fire and disease. Following natural disturbance, designated old forest areas should be assessed by a qualified professional before a decision is made on whether to harvest that stand and replace it elsewhere on the landscape.

Qualifications to map old forests and recruitment areas

Licensees have flexibility on how to meet old forest and old interior forests objectives across the mBECs. When the Order was first established, this made sense as most harvesting was targeting the massive pine beetle outbreak. The flexibility in the Order was considered reasonable since it allowed licensees to act decisively and there were significant amounts of old forest available.

However, managing old forest and recruitment areas becomes more complex as the amount of old forest on the landbase decreases to the lower end of the NRV and harvesting moves into non-pine leading stands. In these circumstances, qualified professionals should map old forest, old interior forest and recruitment areas to address biodiversity values. It is important that the mapping process involve a team of qualified professionals, including ecologists, biologists and foresters.

Risk to Old Forest Biodiversity Elements

The 2004 Background Information states that the basic assumption regarding risk to biodiversity is that the further one moves from the NRV, the higher the risk to biodiversity. Conversely, the risk to biodiversity diminishes if variables such as the amount of old forest and patch size are similar to the NRV. To assess the risk to biodiversity, the Board needed to compare the Order to current information on biodiversity.

An important current information source on the NRV relevant to the PG TSA is the Land Units and Benchmarks for Developing Natural Disturbance-based forest Management Guidance for Northeastern British Columbia[20] (Delong 2011). The Benchmarks in Delong 2011 are similar to those in the DeLong 2002 report. Delong 2011 reflects the best available research on natural disturbance in the area at the time. Although Delong 2011 was published after the Order was implemented, it is a reasonable expectation that the most up-to-date information and research is considered when making forest management decisions.

The NRV approach outlined in Delong 2011 provides an ecological and scientific basis to help make forest management decisions. It identifies that natural disturbance units (NDU) naturally contain a proportion of stands greater than 140 years and a proportion greater than 250 years. Delong 2011 addresses the NRV by providing an estimate of the range in percent of the total forested area within the NDU that has not had a stand replacement event for a specified time period. Ideally, forest management should result in a landscape that is within the NRV.

However, maintaining the NRV is challenging and must be implemented while also considering other significant factors. For example, forest managers must also identify and integrate socio-economic conditions into forest management decisions.[21] In addition, management decisions must adapt to changing situations on the landbase, such as beetle outbreaks and fire, as well as changing economics and government priorities. The targets for old forest retention in the Order were negotiated (similar to how the age of old forest was established) and tried to balance the requirements of environmental and economic sustainability, while considering the expected impacts of the current MPB infestation; they were not based entirely on the DeLong 2002 report.

During the investigation, the Ministry informed the Board that it had completed an ecological risk assessment for internal purposes. The Board also completed an ecological risk assessment for the Prince George NRD portion of the PG TSA by comparing Delong 2011 benchmarks to the Order using age class information provided by the Ministry.

A biodiversity risk was assigned based on the 2004 Background Information, which identified four categories of risk based on what percentage of stands in the mBEC meet the NRV retention objectives. If the unit has less than 30 percent of the NRV target then the mBEC is at very-high risk; 31 to 50 percent the risk is high; 51 to 70 percent the risk is medium; and if the unit has more than 70 percent of the NRV target, the risk is low.

When the average NRV and age of Delong 2011 benchmark (140 years and 250 years) was used, the ecological risk was very-high or high on 20 of the 25 mBECs in the PG TSA portion of the NRD. When the minimum NRV and age was used, 16 mBECs were at high or very high risk in the PG NRD.

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[20] https://www.for.gov.bc.ca/hfd/pubs/Docs/Tr/Tr059.pdf

[21] Range of natural variability: Applying the concept to forest management in central British Columbia, 2004. https://jem-online.org/index.php/jem/article/view/258 https://jem-online.org/index.php/jem/article/view/258

(Appendix 2). However, when the Order criteria for old forest age is used, the ecological risk is moderate to low on all mBECs. The Boards findings are similar to the Ministry's findings.

This analysis indicates that the current ecological risk to biodiversity is much higher when it is assessed using recent ecological research versus the Order. In addition, it appears that a critical difference between the current legal Order and the research is the age at which forests are considered old and the amount of old forest retained. Refer to Appendix 3 for differences between key criteria in the Order and Delong 2011 benchmarks.

Findings

The Board evaluated whether the old forest component of biodiversity in the PG TSA is being managed consistent with the intent of the Order by reviewing whether licensees are consistent with the Implementation Policy, and other guidelines and research related to managing old forests. While the investigation found there was compliance with the Order, it also found that the Order has not been periodically reviewed, and potentially updated, as intended. As a result, the investigation determined there may be a risk to biodiversity, but also identified opportunities to reduce this risk.

1. Adaptive management

   The Order was to be periodically updated to incorporate new knowledge and address changing environmental, economic and social conditions. Since the Order came into effect, there have been significant changes to the landscape and improved knowledge on managing biodiversity. However, the Order was never amended to incorporate the new information.

2. Definition of old forest

   Age is an important factor since it is a surrogate to define when a stand attains old forest attributes. However, the forest cover inventory age is not reliable by itself to identify stands with more well-developed old forest attributes for biodiversity.

   The Board considered it reasonable to decrease the age of old forest from greater than 140 years to greater than 120 years (a 20-year decrease) in ecosystems where research indicates old forest attributes are likely to develop at an earlier age. However, decreasing the age of old forest from greater than 250 years to greater than 140 years (a 110-year decrease) is not reasonable in all instances in ecosystems where old forest attributes are not likely to develop at the earlier age. Some stands between 141 and 250 years may contain some or all of the old forest attributes, but it cannot be assumed that all stands greater than 140 years do.

3. Data limitations

   Inventory updates, including changes to the spatial data and VRI attribute data, will affect the results of an analysis. It is important to address the impact this may have on operational planning and activities.

   Age is the main attribute when determining how much old forest or old interior forest exists within a geographic area. The VRI is used when assessing compliance with the Order but this is a strategic inventory and the stand age may not always be accurate. In addition, there are several VRI data sets covering the PG TSA and not all of them are updated at the same time.

   Reliance on inaccurate or outdated forest inventory information increases the risk that the land base does not actually contain the required amount of old forest. The risk is further elevated when a non-spatial analysis concludes that the land base is nearing deficit or is in deficit of old forest.

4. Mapping old forest, old interior forest or recruitment areas

   An important aspect of managing old forest and old interior forest is using qualified professionals to identify and map old forest, old interior forest and recruitment areas. This will help ensure that the most suitable old forest stands are captured, and are dispersed appropriately to maximize their value to biodiversity. Mapping old forest and recruitment areas is necessary to ensure they are not harvested or affected by other resource developments and to allow recruitment areas to develop old forest attributes over time. This is an important consideration in the PG TSA, which has been heavily harvested and where more than one licensee may operate within an mBEC unit. However, it is also important that, given the risk of fire disturbance in some ecosystems, old forest may be managed through dynamic set of spatial reserves that move around the landbase over time

   Mapping old forest, old interior forest and recruitment areas requires a level of specialized knowledge that not every forest professional has. Therefore, mapping should involve a team of qualified professionals, including ecologists, biologists and foresters, and First Nations. A qualified professional should assess any mapped retention or recruitment area prior to changing the management strategy for the area.

5. Risk to biodiversity

   In 2004, the LOWG made the decision to accept the risk to biodiversity through implementation of the Order. Since that time, the Order has not been updated to address changes to the landscape that may affect the risk to biodiversity, or whether the ecological, economic and social considerations in 2004 remain reasonable. Periodic review is particularly important considering the level of impact that the MPB and resulting salvage harvest has had and the transition to areas with less MPB.

   When the average NRV and age of the 2011 Benchmark was used, the ecological risk was very-high or high on 20 of the 25 mBECs in the PG NRD, and very-high or high on 16 mBECs where the minimum NRV was used. This is different from ecological risk that is implied from using the criteria in the Order, which indicates that the ecological risk is low in all mBECs.

Conclusions

This investigation examined a complaint about whether forestry activities in the PG TSA are in compliance with the *Order Establishing Landscape Biodiversity Objectives for the Prince George Timber Supply Area* (the Order) and whether biodiversity values are being appropriately managed given the high levels of disturbance from MPB and fires in the PG TSA.

Are licensees complying with the legal requirements of the Order?

The investigation considered whether forestry activities are in compliance with the Order. The Board assessed compliance from both an analytical and administrative perspective. The investigation found that forest licensees are compliant with the Order. The Order establishes minimum retention objectives for old forest and old interior forest, and targets for young forest patch size distribution across the PG TSA. Licensees must prepare a recruitment strategy if an mBEC is in deficit of old forest or old interior forest and the Regional Executive Director must review it, and if satisfied, approve it.

A licensee working group completes a non-spatial analysis annually and licensees are preparing and submitting recruitment strategies where deficits exist in mBECs, consistent with the Order. Government has reviewed and approved seven recruitment strategies. The results of the analysis completed by

LLWOG and approved recruitment strategies indicate that these aspects of the Order are being met. The process used by the LLOWG is a good model for coordinating implementation amongst several licensees.

Meeting the patch size distribution objective is difficult since the target is a single value and there are other variables including previous harvesting, forest health, fires and the management objectives for other resource values that may affect the ability to achieve patch size objectives. The Board cannot make a determination of whether the young forest patch distribution is trending to patch size objectives in the Order. There is no definition of what trending means nor how it is measured. In addition, the Board considers that young forest patch distribution cannot be measured by analysis only. It must be evaluated by a qualified professional in consideration of other criteria including shape and location of the patches across the NDU in relation to key values and old forest retention areas (including old forest patch size), as well as structural attributes of the patches themselves.

Is the old forest component of biodiversity being managed consistent with the Implementation Policy?

Biodiversity is a broad concept and the Board focused its review on the old forest component of biodiversity at a strategic level.

The investigation identified several concerns with biodiversity management in the PG TSA. These included; adaptive management; definition of old forest; limitations of the data used in the analysis; and mapping old forest, old interior forest or recruitment areas. The investigation found that biodiversity, as it relates to old forests, may be at high risk in the PG TSA.

As old forests are depleted, the opportunities to address old forest contribution to biodiversity diminish. The investigation identified that the risk to biodiversity will diminish if some or all of the old forests and old interior forests, and recruitment area objectives are mapped so that the legal requirements are defined spatially. This is especially important for ecosystems that experience infrequent stand initiating events, and where the amount of old forest remaining is low. Mapping should not be based only on age, but must also consider other aspects of biodiversity, and socio-economic implications.

Recommendations

In accordance with section 132 of FRPA, the Board recommends that government:

1. Promptly spatialize old growth management areas where the immediate risks to old forest are the greatest; and
2. Review and update the requirements for biodiversity in the PG TSA. This should be consistent with emerging partnerships with First Nations, following a transparent process for public involvement, and considering the potential implications of climate change on forest management.

In accordance with section 132 of FRPA, the Board requests that government indicate whether it accepts or does not accept these recommendations and the actions it intends to take to address them by May 30, 2021.

Appendix 1: 2019 Analysis of Old Forest and Old Interior Forest Age as Defined in the Order (data source: 2019 LLOWG analysis)

mBECs highlighted in brown have a minimum Old Forest age of 121, mBECs highlighted in yellow have a deficit of old forest.

	Forest District / Unit Label	Natural Disturbance Unit	CFLB	Minimum Age of Stands to be Counted as Old Forest (years)	Minimum Percent of the CFLB to be Retained as Old Forest	Minimum Percent of the Old Forest TARGET that must be Old Interior Forest	Old Forest Minimum Retention Area (ha)	Old Forest in Existing Stands (ha)	Old Interior Forest Minimum Retention Area (ha)	Old Interior Forest in Existing Stands (ha)
Fort St. James Forest District	DJA / E1	Moist Interior - Mountain	16,319	141	41	40	6,691	7,753	2,676	7,095
	DJA / E2	Moist Interior - Plateau	18,580	121	17	10	3,159	10,998	316	4,977
	DJA / E3	Moist Interior - Plateau	47,863	121	17	10	8,137	24,207	814	16,414
	DJA / E4	Moist Interior - Plateau	170,790	121	12	25	20,495	44,380	5,124	13,459
	DJA / E5	Moist Interior - Plateau	160,794	121	12	25	19,295	62,440	4,824	24,658
	DJA / E6	Northern Boreal Mountains	110,475	141	37	40	40,876	92,460	16,350	80,150
	DJA / E7	Northern Boreal Mountains	30,409	141	37	40	11,251	26,780	4,501	21,372
	DJA / E8	Northern Boreal Mountains	34,431	141	26	25	8,952	28,657	2,238	21,982
	DJA / E9	Omineca - Mountain	24,887	141	58	40	14,435	20,947	5,774	18,774
	DJA / E10	Omineca - Mountain	96,988	141	41	40	39,765	85,650	15,906	78,053
	DJA / E11	Omineca - Mountain	353,261	141	41	40	144,837	255,886	57,935	228,218
	DJA / E12	Omineca - Valley	10,264	121	16	25	1,642	5,235	411	1,809
	DJA / E13	Omineca - Valley	11,989	141	23	40	2,757	11,274	1,103	9,429
	DJA / E14	Omineca - Valley	64,766	121	16	25	10,363	47,667	2,591	35,927
	DJA / E15	Omineca - Valley	99,473	121	16	25	15,916	75,396	3,979	58,751
	DJA / E16	Omineca - Valley	236,753	121	16	25	37,880	125,762	9,470	68,724
	DJA / E17	Omineca - Valley	357,344	141	16	25	57,175	185,419	14,294	119,329
Vanderhoof Forest District	DVA / D1	Moist Interior - Mountain	141,439	141	29	40	41,017	48,173	16,407	29,287
	DVA / D2	Moist Interior - Plateau	42,290	121	17	25	7,189	16,770	1,797	9,181
	DVA / D3	Moist Interior - Plateau	150,983	121	17	10	25,667	38,829	2,567	11,741
	DVA / D4	Moist Interior - Plateau	46,647	121	12	25	5,598	14,731	1,399	4,432
	DVA / D5	Moist Interior - Plateau	179,908	121	17	10	30,584	48,567	3,058	14,769
	DVA / D6	Moist Interior - Plateau	226,892	121	12	25	27,227	67,799	6,807	27,975
	DVA / D7	Moist Interior - Plateau	212,621	121	12	25	25,514	66,573	6,379	28,349
Prince George Forest District	DPG / A1	Boreal Foothills - Mountain	8,316	141	33	40	2,744	7,124	1,098	6,037
	DPG / A2	McGregor Plateau	12,742	141	26	40	3,313	7,155	1,325	5,173
	DPG / A3	McGregor Plateau	67,077	121	12	25	8,049	20,623	2,012	4,622
	DPG / A4	McGregor Plateau	206,769	141	26	10	53,760	49,295	5,376	15,448
	DPG / A5	Moist Interior - Mountain	13,478	141	29	40	3,909	4,534	1,564	2,303
	DPG / A6	Moist Interior - Mountain	16,344	141	29	40	4,740	7,124	1,896	3,573
	DPG / A7	Moist Interior - Plateau	4,959	121	17	10	843	2,757	84	1,128
	DPG / A8	Moist Interior - Plateau	9,162	121	12	25	1,099	1,867	275	395
	DPG / A9	Moist Interior - Plateau	32,152	121	12	10	3,858	5,499	386	1,912
	DPG / A10	Moist Interior - Plateau	39,145	121	17	25	6,655	11,515	1,664	4,585
	DPG / A11	Moist Interior - Plateau	124,930	121	12	25	14,992	34,237	3,748	9,274
	DPG / A12	Moist Interior - Plateau	172,430	121	12	10	20,692	47,547	2,069	14,617
	DPG / A13	Omineca - Mountain	357,733	121	12	25	42,928	86,281	10,732	22,148
	DPG / A14	Wet Mountain	125,190	141	50	40	62,595	108,950	25,038	94,705
	DPG / A15	Wet Mountain	15,604	141	84	40	13,108	13,118	5,243	10,823
	DPG / A16	Wet Mountain	34,089	141	26	25	8,863	14,502	2,216	7,417
	DPG / A17	Wet Mountain	118,720	141	50	25	59,360	84,854	14,840	48,901
	DPG / A18	Wet Trench - Mountain	43,925	141	80	40	35,140	38,383	14,056	29,275
	DPG / A19	Wet Trench - Mountain	64,085	141	48	40	30,761	55,791	12,304	44,846
	DPG / A20	Wet Trench - Mountain	93,734	141	80	40	74,987	86,242	29,995	71,389
	DPG / A21	Wet Trench - Mountain	112,750	141	48	40	54,120	66,309	21,648	44,566
	DPG / A22	Wet Trench - Valley	27,530	141	53	40	14,591	17,631	5,836	9,616
	DPG / A23	Wet Trench - Valley	145,047	141	53	40	76,875	91,831	30,750	59,308
	DPG / A24	Wet Trench - Valley	127,340	141	30	10	38,202	37,315	3,820	10,791
	DPG / A25	Wet Trench - Valley	154,933	141	46	25	71,269	75,633	17,817	34,634

Appendix 2: Risk to Old Forest of the PG NRD Portion of the PG TSA Using the 2011 NRV Benchmark for Old Forests

Ecological risk by comparing the 2011 NRV Benchmark from Delong 2011 mid and minimum NRV objectives to the existing age class distribution by mBEC. The mBECs highlighted are those where old is defined as greater than 140 years.

A biodiversity risk was assigned based on the 2004 Background Information, which identified four categories of risk based on what percentage of stands in the mBEC meet the NRV retention objectives. If less than 30 percent of the existing stands meet the NRV target then the mBEC is at very-high risk, 31 to 50 percent the risk is high, 51 to 70 percent the risk is medium and if more than 70 percent of the stands meet the NRV target the risk is low.

mBEC	Natural Disturbance Unit	Total CFLB Area (ha)	Total Current Area >250 years (ha)	Total Current Area >140 years (ha)	Min Age of Old Forest (years)	NRV Percent of the CFLB to be Retained as Old Forest (Min Mid Max)	Min NRV Area Required (ha)	Mid NRV Area Required (ha)	Min Retention Surplus / (Deficit) (ha)	Mid Retention Surplus / (Deficit) (ha)	Current Old Forest Remaining as a % of Min NRV Target	Ecological Risk Rank Based on Min NRV	Current Old Forest Remaining as a % of Mid NRV Target	Ecological Risk Rank Based on Mid NRV
A1	Boreal Foothills - Mountain	8,316	666	7,024	251	15-20-25	1,247	1,663	(581)	(997)	53%	Med	40%	High
A2	McGregor Plateau	12,742	137	6,946	251	26-32-39	3,313	4,077	(3,176)	(3,940)	4%	Very High	3%	Very High
A3	McGregor Plateau	67,077	202	18,517	141	43-52-61	28,843	34,880	(10,326)	(16,363)	64%	Med	53%	Med
A4	McGregor Plateau	206,769	1,637	51,910	251	26-32-39	53,760	66,166	(52,123)	(64,529)	3%	Very High	2%	Very High
A5	Moist Interior - Mountain	13,478	57	3,232	251	23-30-37	3,100	4,044	(3,043)	(3,987)	2%	Very High	1%	Very High
A6	Moist Interior - Mountain	16,344	467	7,464	251	23-30-37	3,759	4,903	(3,292)	(4,436)	12%	Very High	10%	Very High
A7	Moist Interior - Plateau	4,959	0	1,356	141	17-25-33	843	1,240	513	116	161%	Low	109%	Low
A8	Moist Interior - Plateau	9,162	9	891	141	17-25-33	1,558	2,290	(667)	(1,399)	57%	Med	39%	High
A9	Moist Interior - Plateau	32,152	0	2,908	141	17-25-33	5,466	8,038	(2,558)	(5,130)	53%	Med	36%	High
A10	Moist Interior - Plateau	39,145	452	12,810	141	17-25-33	6,655	9,786	6,155	3,024	192%	Low	131%	Low
A11	Moist Interior - Plateau	124,930	54	15,460	141	17-25-33	21,238	31,233	(5,778)	(15,773)	73%	Low	49%	High
A12	Moist Interior - Plateau	172,430	25	25,334	141	17-25-33	29,313	43,107	(3,979)	(17,773)	86%	Low	59%	Med
A13	Mountain	357,733	687	57,223	141	17-25-33	60,815	89,433	(3,592)	(32,210)	94%	Low	64%	Med
A14	Wet Mountain	125,190	18,113	104,616	251	74-77-80	92,641	96,397	(74,528)	(78,284)	20%	Very High	19%	Very High
A15	Wet Mountain	15,604	1,116	12,273	251	74-77-80	11,547	12,015	(10,431)	(10,899)	10%	Very High	9%	Very High
A16	Wet Mountain	34,089	593	14,069	251	74-77-80	25,226	26,248	(24,633)	(25,655)	2%	Very High	2%	Very High
A17	Wet Mountain	118,720	22,615	82,875	251	74-77-80	87,853	91,415	(65,238)	(68,800)	26%	Very High	25%	Very High
A18	Wet Trench - Mountain	43,925	1,526	36,063	251	70-73-77	30,747	32,065	(29,221)	(30,539)	5%	Very High	5%	Very High
A19	Wet Trench - Mountain	64,085	17,274	55,141	251	70-73-77	44,860	46,782	(27,586)	(29,508)	39%	High	37%	High
A20	Wet Trench - Mountain	93,734	6,774	84,103	251	70-73-77	65,614	68,426	(58,840)	(61,652)	10%	Very High	10%	Very High
A21	Wet Trench - Mountain	112,750	1,595	64,805	251	70-73-77	78,925	82,308	(77,330)	(80,713)	2%	Very High	2%	Very High
A22	Wet Trench - Valley	27,530	4,891	18,561	251	63-67-72	17,344	18,445	(12,453)	(13,554)	28%	Very High	27%	Very High
A23	Wet Trench - Valley	145,047	33,999	93,122	251	63-67-72	91,380	97,182	(57,381)	(63,183)	37%	High	35%	High
A24	Wet Trench - Valley	127,340	961	36,940	251	63-67-72	80,224	85,318	(79,263)	(84,357)	1%	Very High	1%	Very High
A25	Wet Trench - Valley	154,933	20,903	73,378	251	63-67-72	97,608	103,805	(76,705)	(82,902)	21%	Very High	20%	Very High
Data Source	Order	2019 LLOWG Analyais	2019 FLNRO	2019 FLNRO	Biodiversity Guidebook	Delong 2002 & 2011								

Appendix 3: Comparison of the Order and Expected Conditions of NRV from Delong 2011

		ORDER			2011 BENCHMARK		
District / Unit Label	Natural Disturbance Unit	Minimum Age of Stands to be Counted as Old Forest (years)	Minimum Percent of the CFLB Retained as Old Forest	Minimum Percent of the Old Forest TARGET that must be Old Interior Forest	Minimum Age of Stands to be Counted as Old Forest (years)	NRV Percent of the CFLB Retained as Old Forest (Min Avg Max)	NRV Percent of the CFLB Retained as Old Forest When Old Defined as >141 (Min Avg Max)
DJA / E1	Moist Interior - Mountain	141	41	40	251	23-30-37	41-51-61
DJA / E2	Moist Interior - Plateau	121	17	10	141	17-25-33	
DJA / E3	Moist Interior - Plateau	121	17	10	141	17-25-33	
DJA / E4	Moist Interior - Plateau	121	12	25	141	17-25-33	
DJA / E5	Moist Interior - Plateau	121	12	25	141	17-25-33	
DJA / E6	Northern Boreal Mountains	141	37	40	251	20-27-35	37-48-60
DJA / E7	Northern Boreal Mountains	141	37	40	251	20-27-35	37-48-60
DJA / E8	Northern Boreal Mountains	141	26	25	251	20-27-35	37-48-60
DJA / E9	Omineca - Mountain	141	58	40	251	39-44-50	58-62-69
DJA / E10	Omineca - Mountain	141	41	40	251	39-44-50	58-62-69
DJA / E11	Omineca - Mountain	141	41	40	251	39-44-50	58-62-69
DJA / E12	Omineca - Valley	121	16	25	141	23-31-40	
DJA / E13	Omineca - Valley	141	23	40	251	8-12-17	23-31-40
DJA / E14	Omineca - Valley	121	16	25	141	23-31-40	
DJA / E15	Omineca - Valley	121	16	25	141	23-31-40	
DJA / E16	Omineca - Valley	121	16	25	141	23-31-40	
DJA / E17	Omineca - Valley	141	16	25	251	8-12-17	23-31-40
DVA / D1	Moist Interior - Mountain	141	29	40	251	23-30-37	41-51-61
DVA / D2	Moist Interior - Plateau	121	17	25	141	17-25-33	
DVA / D3	Moist Interior - Plateau	121	17	10	141	17-25-33	
DVA / D4	Moist Interior - Plateau	121	12	25	141	17-25-33	
DVA / D5	Moist Interior - Plateau	121	17	10	141	17-25-33	
DVA / D6	Moist Interior - Plateau	121	12	25	141	17-25-33	
DVA / D7	Moist Interior - Plateau	121	12	25	141	17-25-33	
DPG / A1	Boreal Foothills - Mountain	141	33	40	251	15-20-25	33-41-49
DPG / A2	McGregor Plateau	141	26	40	251	26-32-39	43-52-61
DPG / A3	McGregor Plateau	121	12	25	141	26-32-39	
DPG / A4	McGregor Plateau	141	26	10	251	26-32-39	43-52-61
DPG / A5	Moist Interior - Mountain	141	29	40	251	23-30-37	41-51-61
DPG / A6	Moist Interior - Mountain	141	29	40	251	23-30-37	41-51-61
DPG / A7	Moist Interior - Plateau	121	17	10	141	17-25-33	
DPG / A8	Moist Interior - Plateau	121	12	25	141	17-25-33	
DPG / A9	Moist Interior - Plateau	121	12	10	141	17-25-33	
DPG / A10	Moist Interior - Plateau	121	17	25	141	17-25-33	
DPG / A11	Moist Interior - Plateau	121	12	25	141	17-25-33	
DPG / A12	Moist Interior - Plateau	121	12	10	141	17-25-33	
DPG / A13	- Mountain	121	12	25	141	17-25-33	
DPG / A14	Wet Mountain	141	50	40	251	74-77-80	84-86-89
DPG / A15	Wet Mountain	141	84	40	251	74-77-80	84-86-89
DPG / A16	Wet Mountain	141	26	25	251	74-77-80	84-86-89
DPG / A17	Wet Mountain	141	50	25	251	74-77-80	84-86-89
DPG / A18	Wet Trench - Mountain	141	80	40	251	70-73-77	80-84-88
DPG / A19	Wet Trench - Mountain	141	48	40	251	70-73-77	80-84-88
DPG / A20	Wet Trench - Mountain	141	80	40	251	70-73-77	80-84-88
DPG / A21	Wet Trench - Mountain	141	48	40	251	70-73-77	80-84-88
DPG / A22	Wet Trench - Valley	141	53	40	251	63-67-72	76-80-84
DPG / A23	Wet Trench - Valley	141	53	40	251	63-67-72	76-80-84
DPG / A24	Wet Trench - Valley	141	30	10	251	63-67-72	76-80-84
DPG / A25	Wet Trench - Valley	141	46	25	251	63-67-72	76-80-84

Appendix 4: Young Forest Patch Order Targets and the LLOWG 2015 and 2018 Young Forest Patch Analysis

The table shows the target percent specified in the Order of young forest patches by patch size for each NDU, and the LLOWG in 2015 and 2018 young forest patch analysis by patch size for each NDU.

			Patch Size (ha)			
	Natural Disturbance Unit (NDU)	mBEC Units	< 50	50-100	100-1000	> 1000
Fort St James District	**Order Target for Young Forest Patches - % by NDU & Patch Size**					
	Moist Interior - Mountain	E1	20.0%	10.0%	30.0%	40.0%
	Moist Interior - Plateau	E2, E3, E4, E5	5.0%	5.0%	20.0%	70.0%
	Northern Boreal Mountains	E6, E7, E8	5.0%	5.0%	30.0%	60.0%
	Omineca - Mountain	E9, E10, E11	20.0%	10.0%	30.0%	40.0%
	Omineca - Valley	E12, E13, E14, E15, E16, E17	5.0%	5.0%	30.0%	60.0%
	2015 LLOWG Young Forest Patch Analysis - % by NDU & Patch Size					
	Moist Interior - Mountain	E1	22.7%	35.0%	3.9%	38.4%
	Moist Interior - Plateau	E2, E3, E4, E5	5.8%	6.9%	15.0%	71.4%
	Northern Boreal Mountains	E6, E7, E8	N/A	N/A	N/A	N/A
	Omineca - Mountain	E9, E10, E11	17.7%	27.8%	25.9%	28.5%
	Omineca - Valley	E12, E13, E14, E15, E16, E17	11.7%	14.5%	39.2%	34.6%
	2018 LLOWG Young Forest Patch Analysis - % by NDU & Patch Size					
	Moist Interior - Mountain	E1	17.9%	1.7%	76.7%	3.7%
	Moist Interior - Plateau	E2, E3, E4, E5	4.8%	5.4%	14.0%	75.9%
	Northern Boreal Mountains	E6, E7, E8	N/A	N/A	N/A	N/A
	Omineca - Mountain	E9, E10, E11	15.4%	28.4%	21.7%	34.5%
	Omineca - Valley	E12, E13, E14, E15, E16, E17	10.1%	10.3%	27.5%	52.1%
Prince George District	**Order Target for Young Forest Patches - % by NDU & Patch Size**					
	Boreal Foothills - Mountain	A1	no targets set			
	McGregor Plateau	A2, A3, A4	10.0%	5.0%	45.0%	40.0%
	Moist Interior - Mountain	A5, A6	20.0%	10.0%	30.0%	40.0%
	Moist Interior - Plateau	A7, A8, A9, A10, A11, A12, A13	5.0%	5.0%	20.0%	70.0%
	Wet Mountain	A14, A15, A16, A17	20.0%	10.0%	60.0%	10.0%
	Wet Trench - Mountain	A18, A19, A20, A21	20.0%	10.0%	60.0%	10.0%
	Wet Trench - Valley	A22, A23, A24, A25	20.0%	10.0%	60.0%	10.0%
	2015 LLOWG Young Forest Patch Analysis - % by NDU & Patch Size					
	Boreal Foothills - Mountain	A1	no targets set			
	McGregor Plateau	A2, A3, A4	10.4%	13.2%	27.6%	48.9%
	Moist Interior - Mountain	A5, A6	7.7%	14.9%	32.0%	45.3%
	Moist Interior - Plateau	A7, A8, A9, A10, A11, A12, A13	5.1%	4.0%	10.9%	80.0%
	Wet Mountain	A14, A15, A16, A17	23.9%	40.4%	35.7%	0.0%
	Wet Trench - Mountain	A18, A19, A20, A21	29.3%	42.1%	20.1%	8.6%
	Wet Trench - Valley	A22, A23, A24, A25	24.8%	32.1%	33.5%	9.7%
	2018 LLOWG Young Forest Patch Analysis - % by NDU & Patch Size					
	Boreal Foothills - Mountain	A1	no targets set			
	McGregor Plateau	A2, A3, A4	8.5%	9.0%	34.8%	47.7%
	Moist Interior - Mountain	A5, A6	4.3%	6.1%	35.7%	53.9%
	Moist Interior - Plateau	A7, A8, A9, A10, A11, A12, A13	4.3%	3.2%	9.2%	83.3%
	Wet Mountain	A14, A15, A16, A17	17.9%	28.6%	42.4%	11.1%
	Wet Trench - Mountain	A18, A19, A20, A21	22.1%	20.6%	42.4%	14.9%
	Wet Trench - Valley	A22, A23, A24, A25	25.7%	26.2%	32.4%	15.7%
Vanderhoof District	**Order Target for Young Forest Patches - % by NDU & Patch Size**					
	Moist Interior - Mountain	D1	20.0%	10.0%	30.0%	40.0%
	Moist Interior - Plateau	D2, D3, D4, D5, D6, D7	5.0%	5.0%	20.0%	70.0%
	2015 LLOWG Young Forest Patch Analysis - % by NDU & Patch Size					
	Moist Interior - Mountain	D1	6.1%	9.1%	10.5%	74.3%
	Moist Interior - Plateau	D2, D3, D4, D5, D6, D7	6.4%	3.8%	10.5%	79.2%
	2018 LLOWG Young Forest Patch Analysis - % by NDU & Patch Size					
	Moist Interior - Mountain	D1	4.8%	5.1%	9.2%	80.9%
	Moist Interior - Plateau	D2, D3, D4, D5, D6, D7	6.4%	3.6%	10.0%	80.0%

Appendix 5: Source of Definitions

- **Biodiversity** – *The Forest Practices Code of British Columbia Biodiversity Guidebook* (Biodiversity Guidebook)
- **Crown Forest Land Base** – the *Order Establishing Landscape Biodiversity Objectives for the Prince George Timber Supply Area* (the Order)
- **Landscape Unit** – Biodiversity Guidebook
- **Merged Biogeoclimatic Units (mBEC)** – the Order
- **Non-spatial** – *Conserving Old Growth Forests in BC, Implementation of Old-growth Retention Objectives under FRPA*, Special Investigation, FPB/SIR/36 (June 2012)
- **Natural Disturbance Units** – (DeLong. 2002), 2011 Benchmark, the Order
- **Natural Range of Variability (NRV)** – *Ground Work: Basic Concepts of Ecological Restoration in British Columbia*. Southern Interior Forest Extension and Research Partnership, Kamloops, B.C. SIFERP Series 3 (Gayton, D.V. 2001)
- **Old Forest** – the Order
- **Old Growth Management Area (OGMA)** – Biodiversity Guidebook
- **Old Interior Forest** – the Order
- **Recruitment** – *Conserving Old Growth Forests in BC, Implementation of Old-growth Retention Objectives under FRPA*, Special Investigation, FPB/SIR/36 (June 2012)
- **Spatial** – *Conserving Old Growth Forests in BC, Implementation of Old-growth Retention Objectives under FRPA*, Special Investigation, FPB/SIR/36 (June 2012)
- **Young Forest** – the Order

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