

Retention measures to address ecological values in Mountain Pine Beetle affected forests in BC

A Discussion Paper with Recommendations

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Working DRAFT

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Forward

This document is a working draft containing the most current information available at the time of printing. Where information from on-going research and monitoring projects becomes available, this document will be updated accordingly. For the interim, this document is meant to be considered, and ultimately implemented, in areas where salvage is taking place in Mountain Pine Beetle affected areas. All comments and feedback on its contents and practicality should be directed to Chris Ritchie Provincial Beetle Response Project Manager, Environmental Stewardship, Prince George (chris.ritchie@gov.bc.ca).

Executive Summary

British Columbia is currently experiencing the largest Mountain Pine Beetle (MPB) epidemic that has ever been recorded. In a catastrophic event such as this, there is an expectation to recover some of the merchantable timber. In this case, this has received priority to reduce economic loss due to decay.

Large-scale salvage operations will result in conditions that differ from those that would be created by a MPB epidemic alone. Poorly planned and executed large-scale salvage operations and treatments in retained areas have the potential to cause significant negative effects on non-timber values. This paper is a compilation of existing literature from across the province related to the MPB epidemic and recommends retention practices that will help maintain biodiversity values during large-scale salvage logging.

For the purpose of this document, retention planning refers to the identification of the areas and types of forest cover no longer in a sanitation or control management regime that will not be salvage-logged or treated even if attacked by mountain pine beetles. The objective of retention planning is to ensure that sufficient forest cover and structure is maintained across the landbase to address non-timber values (in this case biodiversity, wildlife, fish and water/hydrological values) that might otherwise be compromised by accelerated, salvage harvesting.

Since it is neither desirable, nor likely possible, to harvest all pine beetle damaged stands, it is important to plan retention to enhance value or minimize disturbance to ecological attributes. Retention can be planned at the landscape level or the stand level, but it should ultimately be planned together to produce the best results.

General guidelines have been given regarding retention in salvage logged areas. In addition, guidelines have been provided by staff from different agencies for a selection of non-timber values. The following Forest Districts and Timber Supply Areas addressed in this document:

- Cariboo Region –Williams Lake, 100 Mile House;
- Quesnel;
- Prince George (Vanderhoof, Fort St. James and Prince George);
- Lakes (Nadina);
- Thompson Region – Merritt, Kamloops; and
- Okanagan Region – Okanagan-Shuswap, Arrow-Boundary, Cranbrook (Rocky Mountain).

The key non-timber values that have guidelines provided include:

- Riparian Areas
- Wildlife Trees
- Coarse Woody Debris
- Access Development
- Wildlife Habitat Features

- Mule Deer
- Northern Caribou

A properly designed and informed approach to retention planning will reduce the negative impacts to non-timber values over the landscape during salvage operations while minimizing constraints to economic objectives. Use of this document in conjunction with other available literature will assist professionals to provide a solid retention strategy thus minimizing the impacts to biodiversity and ecological values over the long-term.

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1.0 Introduction

British Columbia is currently experiencing the largest recorded Mountain Pine Beetle (MPB) epidemic. In 2005, approximately 8.5 million ha of red-attacked stands were surveyed (MoFR 2005). If the infestation continues as it has since 1999, over 80% of the volume of lodgepole pine (*Pinus contorta*) trees will be killed by 2013 (Eng et al. 2005; Snetsinger 2005).

In a catastrophic event such as this, there is an expectation to recover some of the merchantable timber, and in this case, this has received priority to reduce economic loss due to decay. In the most heavily affected areas, beetle suppression activities have been accepted as not effective in controlling MPB. In these areas, the objective now is to recover as much timber value as possible. The Chief Forester has determined Allowable Annual Cut (AAC) uplifts in several Timber Supply Areas and Tree Farm Licences to reduce the economic loss through salvage of dead pine (Snetsinger 2005). In his determinations he has included a recommendation that retention increase proportionately with opening size to approximately 25% retention on openings >1000ha to mitigate the impacts of the increased cut on biodiversity and non-timber values (Eng 2004). Various discussions and deliberations of the recommended amount of retention are ongoing.

Large-scale salvage operations will result in conditions that differ from those that would be created by an outbreak alone. Poorly planned and executed large-scale salvage operations and treatments in retained areas have the potential to cause significant negative effects on non-timber values. Some of these effects could include (Lindenmayer et al. 2004):

- Counteracting many of the biological/ecological benefits of major disturbance (e.g., large areas of un-roaded forests, increased forage for browsing ungulates);
- Removal of large quantities of “biological legacies” which negatively impacts taxa that require or benefit from the legacies (e.g., northern caribou lichen source);
- Impaired ecosystem recovery; and
- Reduction of habitat for some taxa that may be maladapted to the cumulative effects of two disturbance events in rapid succession.

2.0 Purpose and Scope

This paper is a compilation of existing literature from across the province related to the MPB epidemic and the recommended retention suggested for biodiversity values during large-scale salvage logging.

There is a minimal amount of literature that deals specifically with the effects of large-scale salvage harvesting on biodiversity values. Several informal discussion papers and grey literature exist which include guidelines/recommendations regarding salvage

logging and retention for different non-timber values. This literature and communications from around the province and beyond have never been put into one concise document. This paper attempts to synthesize this information and provide conclusions and recommendations in a clear and concise manner. All of the recommendations within this report have been taken from existing literature and are cited accordingly. This paper relies heavily on a report (Manning et al. 2005) which is currently in draft form. That report has a much different scope although many of the retention guidelines overlapped and were very useful for this paper. As well, the recommendations produced by Bunnell et al. (2004) were developed specifically for North Central BC but in many cases they may be extended to other areas of the province.

Although the information for this paper was gathered from around the province and beyond, it is meant to be applicable to the three timber supply areas (TSAs) and forest districts most effected by salvage logging: the Lakes TSA (Nadina District), Prince George TSA (Vanderhoof, Fort St. James and Prince George Districts), and Quesnel TSA. It is also relevant to the following MOE regions and forest districts:

- Cariboo Region –Williams Lake, 100 Mile House;
- Thompson Region – Merritt, Kamloops; and
- Okanagan Region – Okanagan-Shuswap, Arrow-Boundary, Cranbrook (Rocky Mountain).

The Cariboo-Chilcotin Land Use Plan (CCLUP) contains special guidance around how to deal with various disturbance agents including bark beetles (Rick Dawson¹ pers. comm. 2005). Guidance provided in this document is to be used in conjunction with the information contained in the CCLUP when planning retention in the Cariboo region (<http://srmwww.gov.bc.ca/car/planning/cclup/>).

For the purpose of this document, retention planning refers to the identification of the areas and types of forest cover and structure that will not be salvage-logged or treated even if attacked by mountain pine beetles. Some retained areas can and should be treated, and these opportunities should be planned along with areas that will not be treated.

The objective of retention planning is to ensure that sufficient forest cover and stand structure is retained across the landbase to ensure non-timber values (in this case biodiversity, wildlife, fish and water/hydrological values) are not compromised by accelerated, large-scale salvage harvesting.

¹ Rick Dawson, SRM Officer, Planning, Williams Lake BC.

3.0 Objectives

The objectives of this paper are to:

1. Provide ministries, forest licensees and other stake holders a consistent and comprehensive reference on conducting MPB salvage treatments and making timber decisions while managing for fish, wildlife and their habitats, water quality and quantity and biodiversity.
2. Provide a synthesis of the best available information on measures to reduce impacts to specific environmental values through retention.

4.0 Policy and Planning

Forests considered for salvage harvesting because of insect damage need provisions for stand level biodiversity (MWLAP 2005). Forestry operations within insect killed stands must be consistent with current Acts (e.g., *Forest Practices Code Act (FPC)* and *Forest and Range Practices Act (FRPA)*) and related regulations as they pertain to managing for biodiversity at the stand and landscape levels.

Implementation of the *FRPA* is structured on the legislated and non-legislated aspects of the Act. Non-legislated guidance forms a basis to support and justify forest management decisions, and provides due diligence in following the strategies and achieving the results specified in Forest Stewardship Plans. Several documents exist that can aid in determining an acceptable level of retention on salvage blocks. These documents should be used in conjunction with this paper. Wherever higher level policy/plans exist, they will take precedent over what is recommended here. Some documents and policies (guidance) that are useful include:

- Biodiversity Guidebook (MoF and BCE 1995)
- Guidance on Landscape and Stand Level Structural Retention on Large-Scale MPB Salvage Operations (Snetsinger 2005)
- Landscape Unit Planning Guide (MoF 1999)
- Riparian Management Guidebook (MoF and BCE 1995)
- Coarse Woody Debris Guidance (in draft not yet released) (MoFR 2005)
- Provincial Wildlife Tree Policy and Management Guidelines (MoF and MELP 2000)
- Omineca Regional Wildlife Tree Patch (WTP) Retention Guideline (MWLAP 2005)
- Quesnel Forest District Enhanced Retention Strategy for Large Scale Salvage of Mountain Pine Beetle Impacted Stands (QFDERSC 2006)
- Maintaining Habitat Structure and Wildlife Diversity During Salvage Harvesting of Mountain Pine Beetle Attack Areas in the Southern Interior Forest Region (Klenner 2005)

5.0 General Guidelines

Since it is neither desirable, nor likely possible, to harvest all pine beetle damaged stands, it is important to plan retention to enhance value or minimize disturbance to ecological attributes (Eng 2004). Retention can be planned at the landscape level or the stand level, but should ultimately be planned together to produce the best results.

Landscape level retention planning involves map-based assessments of areas that are needed to meet seral and patch size objectives while stand level retention involves spatial planning at the cutblock level. The better landscape level retention is planned, and distributed across the landbase, the more it can be identified as contributing to stand level retention. General guidelines for retention planning at the landscape and stand level include:

1. Identify the biodiversity and ecological values at risk along with the specific objectives for bark beetle management and retention planning (OSFD 2005);
2. Fuel management objectives should be considered along with conservation objectives in order to provide opportunities for fuel breaks (OSFD 2005);
3. The amount and distribution of retention will vary according to the conditions and values in each geographic unit. If the only opportunity for retention is dead pine and it can be demonstrated that the retained dead pine would not mitigate the risks to biodiversity and non-timber values, lower levels of retention may be rationalized (Bunnell et al. 2004; Eng 2004; OSFD 2005);
4. Wherever practicable, retained areas should be representative of the natural forest types (OSFD 2005);
5. Priority should be given to areas containing primarily mixed species live stands and low risk stands to increase the likelihood of live tree maintenance in the retention patch over the long-term (OSFD 2005); and
6. Retention plans should identify the following:
 - Large areas that should not be harvested or treated (OSFD 2005);
 - Areas that should not be harvested but could be treated (OSFD 2005; Wood² pers. comm. 2005);
 - A road system to minimize access development (Knapik³ pers. comm. 2005)
 - Areas (if any) that are available for selective removal of pine infested trees only (OSFD 2005); and
 - Areas that will be logged (either already dead or if they become infested) (OSFD 2005).

² Colene Wood RPF, Ecosystems Forester, Ministry of Environment, Ecosystems Branch, Victoria, BC.

³ Mike Knapik, Ecosystem Biologist, Ministry of Environment, Ecosystem Section, Nelson, BC.

Higher level plans (including Sustainable Resource Management Plans; Land Use Plans; and Land and Resource Management Plans) should describe landscape level management objectives such as patch size distribution, landscape connectivity, seral stage targets and access management (Manning et al. 2005). Eng (2004) suggests that at the very least: retain what was originally planned under these existing landscape level plans, especially spatially designated Old Growth Management Areas (OGMAs) where they have been identified in Land Use Plans.

5.1 Landscape and Stand Level Retention Planning

Landscape level salvage and retention planning should develop harvest objectives that integrate biodiversity and non-timber values. Successful planning should indicate retained areas that provide these values and where possible are forests that are not economical to harvest. Detailed guidance of how to achieve this at the landscape level is beyond the scope of this paper, although work on such guidance is in progress (Wood pers. comm. 2005). A selection of guidelines was extracted from several papers and is compiled below to be used as broad, general recommendations.

Stand level retention refers to the in-block forest cover to be retained during salvage for an entire rotation or longer (OSFD 2005). At the minimum, stand level retention contributes to vertical habitat structure, medium to long-term CWD, connectivity and hydrological buffering to a harvest block.

General guidelines for landscape and stand level retention and salvage harvesting operations include:

1. Specify the biodiversity and non-timber objectives that need to be met through retained areas (i.e., results or strategies from FRPA and in higher level plans, forest stewardship plans and other forest management and land use plans that are consistent with government objectives) (Wood pers. comm. 2005);
2. Salvage preference should be given to areas with >70% pine. Avoid salvage in areas where intermixed pine represents <60% of the species mix. Mixed species stands should be retained wherever possible to contribute to the mid-term selected timber supply and landscape and stand level biodiversity objectives (Bunnell et al. 2004; Eng 2004). Although reasonable for the northern region, this percentage may be high in the Kootenay region, especially in fire interface zones. Consideration must be given to wildfire risks to adjacent communities (Knapik pers. comm. 2005);
3. Consider a partial cutting regime to salvage in stands containing 30 to 70% pine (Klenner⁴ pers. comm. 2006)

⁴ Walt Klenner, Research Wildlife Habitat Ecologist, Ministry of Forests, Kamloops, BC.

4. Stands that are well-stocked with pole sized regeneration of species other than pine should have a low priority for salvage as these stands will develop old-growth features and commercial value faster than ones without a non-pine understory (Eng 2004);
5. The following areas should be selected for long-term retention defined as one or more timber rotations (OSFD 2005; Eng 2004):
 - a. The non-harvestable landbase (NHLB) including inoperable sites and problem (non-merchantable) forest types; and
 - b. Legislated portions of the landbase including OGMAs, wildlife habitat areas (WHAs), riparian management areas (RMAs), cultural heritage areas, lakeshore management zones, and other areas identified in land-use plans such as enhanced riparian reserves.
6. The following areas should be selected for at least short-term retention (i.e., 30 years) until the MPB epidemic has passed and harvested areas are sufficiently greened up to address resource values at risk. These areas should not be harvested especially if other retention does not sufficiently conserve the non-timber values (OSFD 2005):
 - a. Immature forests that are unlikely to be attacked by the MPB;
 - b. Stands containing lower percentages of pine; and
 - c. Stands within the THLB that are economically inaccessible at the present time.

Specific guidelines for stand level retention include:

1. Retain species other than lodgepole pine during logging (e.g., these might form wildlife tree patches if retained for one rotation) (Bunnell et al. 2004);
2. Provide small buffers of dead lodgepole pine around retained inclusions of other tree species or around stands of non-pine leading species (Bunnell et al. 2004; DeLong et al. 2004);
3. Consider the use of alternative harvesting practices in order to retain non-pine species. Structural retention could easily be achieved across more widespread areas by removing up to 75% of the merchantable volume and leaving the remainder for structural complexity (OSFD 2005; Klenner pers. comm. 2006);
4. Unharvested “legacy trees” should be retained either singly or grouped into clumps or patches wherever they do not affect worker safety (OSFD 2005);
5. Additional specific strategies that should be considered for stand level retention and impact mitigation include the following (OSFD 2005):
 - a. Protection of understory trees and advanced regeneration (preference to species that are ecologically adapted to the site);

- b. Protection of deciduous trees where practicable; and
- c. Enhanced coarse woody debris retention.

Klenner (2005) contains some excellent conceptual examples of different retention practices and options for suitable dispersed structural diversity within a MPB salvage area.

6.0 Riparian Management

Riparian areas are readily recognized as special habitats and are found adjacent to rivers, streams, lakes, ponds, wetlands or other sites having high water tables (MoF 2004). They are often associated with specific flora, fauna, physiography, or micro-climate processes not common in the adjacent stand or landscape. They are composed of vegetation that requires more moisture than the adjacent upland areas. Riparian systems, particularly in drier areas, are extremely important to wildlife because of their high site productivity and more complex habitat structure (usually containing downed wood, snags, shrubs and mixed tree species composition). More specifically, riparian areas provide:

- secure, linear travel corridors for wildlife providing valley bottom and cross-elevational connectivity for daily and yearly migrations, as well as, meeting long term dispersal and recolonization needs (Furness 1993);
- a buffered micro-climate compared to adjacent areas (i.e., warmer winter and cooler summer) (Furness 1993);
- food, cover or water which are valuable to species that inhabit the area, or to species that travel to the area for those requirements (Furness 1993);
- a greater diversity of plant species and greater structural heterogeneity, thereby providing greater opportunities than the adjacent uplands (Furness 1993);
- peak flow mitigation and function as hydrological storage and release (Heinrichs⁵ pers. comm. 2005);
- mitigate stream temperature increases (Hudson 2003); and
- structural and functional attributes necessary for fish habitat (Furness 1993).

Many species are statistically more abundant or productive in riparian areas. Within the Lakes, Quesnel and Prince George TSAs, 92 of 182 species utilize the unique habitats provided by the vegetation and stand structural diversity available in riparian areas (Bunnell et al. 2004). Therefore, appropriate riparian management will mitigate potential negative effects on many species that depend on deciduous trees, cavity sites and late seral stages (Bunnell et al. 2004).

Riparian areas located adjacent to streams are also very important to stream health and function as well as fish habitat. These areas:

- contribute important nutrients to the stream through leaf litter and Large Woody Debris (LWD) (MoF 2004);

⁵ Rick Heinrichs, Ecosystem Specialist, Ministry of Environment, Ecosystem Section, Smithers, BC.

- regulate stream temperature by providing shade to the stream from adjacent vegetation and areas of shallow groundwater and perennially saturated soils (areas of heat exchange) (Hudson 2003; MoF 2004); and
- maintain stream bank integrity while providing locations for sediment deposition (MoF 2004).

The increase in AAC has prompted concern for hydrologic issues that have arisen or may arise due to the expedited harvest. Large-scale salvage operations may adversely affect peak flow characteristics and unacceptably increase erosion, sediment delivery and bedload movement. Additionally, open slope failures may occur as the root mat decomposes over the next 10-20 years (Eng 2004). Large-scale salvaging may specifically affect the hydrologic cycle through changes in (MoF 2004):

- canopy interception;
- transpiration;
- soil moisture storage;
- ground water levels and recharge;
- snow fall and melt;
- runoff and peak flows;
- stream and stream bank stability; and
- erosion and sedimentation.

6.1 Riparian Management Area (RMA) Retention

Riparian Reserve Zones (RRZ) are defined as those areas directly adjacent to a water body (e.g., lake, stream, wetland, river) where there is usually no harvesting permitted (exceptions may be approved on an individual basis) (see Forest Planning and Practices Regulation 51(1-3)

<http://www.for.gov.bc.ca/tasb/legsregs/frpa/frparegs/forplanprac/fppr.htm>). Riparian Management Zones (RMZ), are defined as areas beyond the RRZ boundary that require special management objectives (e.g., machine-free area, selective harvesting). There can also be a designated RMZ without a RRZ. Collectively, the RMZ and the RRZ make up the Riparian Management Area (RMA).

6.1.1 Riparian Reserve Zone (RRZ)

Riparian reserve zone retention is required legally on defined classes of streams, rivers, lakes and wetlands and provides protection for several stream values and functions. This retention contributes many benefits to the aquatic body by maintaining terrestrial habitat complexity as well as enhancing aquatic health and habitat. Although there should be no harvesting within the RRZ, if there is a special circumstance and some salvage harvesting is approved, consider the following suggestions:

- Follow current legislation for guidelines when harvesting near streams or rivers (see Forest Planning and Practices Regulation 47(4); <http://www.for.gov.bc.ca/tasb/legsregs/frpa/frparegs/forplanprac/fppr.htm>) (Manning et al. 2005);

- Avoid mechanical or other similar disturbances within 20 m of S3 (fish bearing streams with widths >1.5m and < 3.0m) and S4 streams (fish bearing streams with widths <1.5m) (Manning et al. 2005; Bunnell et al. 2004);
- All dead wildlife trees that do not pose a risk to worker safety should be left within the RRZ. If low value wildlife trees and dangerous trees have to be felled for worker safety reasons, then these stems should be retained on site as CWD or as future instream large woody debris (LWD) (Manning et al. 2005); and
- Reserve hardwood tree species from harvest (Manning et al. 2005; Bunnell et al. 2004).

6.1.2 Riparian Management Zone (RMZ)

As with the RRZ retention, RMZ retention will add significant benefits to aquatic health. Refer to the Riparian Management Area Guidebook for a more complete discussion of the specific benefits of retention (MoF and BCE 1995). Where harvesting is proposed within a RMZ, guidelines for retention and salvage harvesting are as follows:

- Ensure no harvesting occurs in unstable terrain, and develop engineering solutions where required to maintain slope stability (Eng 2004);
- Promote downed wood and tree retention practices that maintain high levels of large downed wood both spatially and temporally within the RMZ. CWD has additional value in riparian areas as habitat for a greater number of wildlife and plant species (Manning et al. 2005);
- All dead wildlife trees that do not pose a risk to worker safety should be left within the RMZ. If low value wildlife trees and dangerous trees have to be felled for worker safety reasons, then these stems should be retained on site as CWD or as future instream large woody debris (LWD) (Manning et al. 2005);
- In locations that have had previous forest harvesting within the RMZ, some form of riparian restoration may be considered (Manning et al. 2005);
- Reserve hardwood tree species from harvest (Manning et al 2005; Bunnell et al. 2004); and
- Special attention is suggested in areas where there are known high densities of fish species that are sensitive to salvage logging, and for which the province has a high stewardship responsibility. Bunnell et al. (2004) provides a sensitivity rating and maps for the most sensitive species but also refer to local MoE staff for the most current knowledge regarding sensitive areas and susceptible fish species (Manning et al. 2005; Bunnell et al. 2004).

The following sections on wildlife trees and coarse woody debris reiterate the importance of retention in riparian areas. When salvage logging in or near riparian areas, all three habitat elements should be considered in conjunction with one another (i.e., aquatic, riparian and terrestrial).

7.0 Wildlife Tree Management

7.1 Wildlife Trees

Wildlife trees are trees that provide habitat or habitat features for a wide variety of organisms. They are very important components of stand structure and can be characterized by several different factors (refer to Appendix A for a comprehensive list). In short, wildlife trees are best described as live or dead trees that provide one or more of the following opportunities to wildlife:

- cavity or arboreal nesting habitat;
- natal denning habitat;
- roosting or perch sites;
- territory marking sites; and
- foraging sites.

A total of 47 terrestrial vertebrate species within the Lakes, Quesnel, and Prince George TSAs use cavities for nesting or denning sites (Bunnell et al. 2004).

Wildlife utilization of snags is dependant on three features: size, species and stage of decay. Dead trees, or snags, and over mature trees provide wildlife with immediate habitat opportunities, as described above. Younger immature to mature trees are less likely to provide immediate cavity nesting opportunities, but may still be needed as foraging sites. Size is important because certain species require large diameter trees to nest in. In other words, small diameter trees have limited usefulness while larger trees offer wildlife a broader range of use (Furness 1993). However, the greatest value of structural retention for species that require mature and old forest structural characteristics will be 30+ years from now when the cutblock is in early immature condition with a mix of legacy trees. Mature forest requiring species may then be able to use these stands for more than just perching (Klenner pers. comm. 2006).

Tree species is important to consider during retention planning as certain wildlife use opportunities are limited due to the characteristics of specific trees. For example, large hollowed out cedar and Douglas-fir root wads are large enough to house black bear dens for the winter. Bears and fisher will use large cottonwood (*Populus balsamifera trichocarpa*) trees for resting on strong branches and denning in hollowed out trunks. In fact, fisher are very ecologically sensitive to microhabitats within MPB impacted stands that contain large cottonwood as they provide critical habitat for them in these areas (Weir 2003). In general, deciduous (black cottonwood, aspen *Populus tremuloides* and paper birch *Betula papyrifera*) provide the best nesting and denning, roosting and foraging opportunities, for the most diverse amount of species and are therefore considered to be the preferred wildlife tree species (Furness 1993). The problem with retaining all deciduous trees is that they have a much shorter life-span, both as living

trees and as standing or down deadwood, so retention should focus on a good balance of both deciduous and coniferous species.

A total of 45 vertebrate species within the Lakes, Quesnel and Prince George TSAs show a marked preference for hardwood trees or stands, most of which are birds (32) (Bunnell et al. 2004). A few cavity nesting birds seek areas that are predominantly hardwood (e.g. most of the cavity nesting waterfowl, northern flicker, red-breasted sapsucker, black-capped chickadee) (Bunnell et al. 2004). Even where hardwoods occur sparingly, most primary excavators seek out hardwoods as nest sites. Hardwoods are sought because they frequently incur heart rot while still maintaining a sound external shell.

Although there are 32 different species of cavity-nesting birds within the Lakes, Quesnel and Prince George TSAs, only 6 are large, strong primary excavators capable of excavating holes that other bird, bat and other small mammal species use. Five of those six preferentially excavate in hardwood species (Bunnell et al. 2004).

Pileated woodpeckers (*Dryocopus pileatus*) and yellow-bellied sapsuckers (*Sphyrapicus varius*) are important keystone species in the forest ecosystems located in Lakes, Quesnel and Prince George TSAs as they are very strong primary cavity excavators. Their feeding and nest excavations provide habitat for several of the secondary cavity users. Because of their importance to forest ecosystem function, the following recommendations are provided to ensure available habitat for these particular species (from Manning et al. 2005):

- Provide some large coarse woody debris (CWD) pieces > 5 m in length and > 50 cm diameter on the cutblock. Some of this material should be partly elevated, or arranged in small loosely packed piles for slower decay and longer use. This in turn will provide habitat for carpenter ants (*Camponotus pennsylvanicus*) and other insects which are food for woodpeckers;
- Because of the large home range sizes of pileated woodpeckers and yellow-bellied sapsuckers, provide at least 2 large diameter conifer per ha across the landscape for roosting, nesting or feeding habitat (spruce or Douglas-fir > 70 cm dbh, tree classes 2-5 recommended); and
- Retain large diameter (>30 cm dbh) trembling aspen as nesting habitat.

As mentioned, by providing habitat for primary cavity excavating birds, a variety of secondary cavity users benefit. Secondary cavity nesting species such as bats, birds and mustelids, depend on the holes primary cavity nesters excavate. Thus, the retention of riparian and upland hardwoods and the maintenance of hardwood components are critical to sustaining biodiversity in landscapes with high levels of salvage harvesting.

Stage of decay is also very important to immediate availability as cavity nesting habitat, and as increased availability of insects. Decay fungi soften the heart wood making the tree more accessible to primary cavity excavators. Also, decayed trees can be weak causing the tops to break during wind storms or under snow pressure. These broken tops

provide an excellent surface for large stick nests and provide good perching and roosting sites.

Few, if any, species specifically choose or rely on pure lodgepole pine stands when other suitable habitat is available. However, when there is a pine beetle-killed stand, the black-backed woodpecker is very specialized at using this post-disturbance habitat (Stadt 2001). This woodpecker often uses lodgepole pine forests primarily because it responds strongly to insect outbreaks and likes to nest near its food source (Bunnell et al. 2004). Red squirrels and northern flying squirrels will also use lodgepole pine forests frequently for foraging, although these stands are not critical to their habitat requirements (Bunnell et al. 2004). It should be noted however, that standing forests that produce cone crops and mushrooms are critical for these squirrels and in turn, these species are valued prey for a variety of predators.

7.2 Dispersed Wildlife Trees

Wildlife trees are generally retained in patches but can also be retained as individuals called dispersed wildlife trees (DWTs). Worker safety is an issue when retaining individual wildlife trees. If a wildlife tree is determined to be safe by a certified assessor then it can be left on its own. If it is deemed dangerous, it must be left within a patch which is why patches are so often used. The patches serve as a no-work zone around a dangerous tree which is also likely a good wildlife tree. Guidelines for individual wildlife tree retention are as follows:

1. Retain large coniferous trees (in the upper 10% of the diameter range distribution) that have one or more of the following characteristics:
 - a. Evidence of wildlife use
 - b. Presence of heart rot decay
 - c. Large diameter (>100cm dbh)
 - d. Stem scars or cracks
 - e. Loose sloughing bark
2. Retain larger deciduous trees (>30cm dbh) such as trembling aspen, black cottonwood, and paper birch, especially in riparian areas (Manning et al. 2005; Bunnell et al. 2004);
3. Leave some trees in the more advanced decay stages (classes 5-8, often referred to as “soft snags”) as habitat for the weak primary cavity excavating bird species [e.g., nuthatches (*Sitta* spp.), chickadees (*Poecile* spp.) and some sapsuckers (*Sphyrapicus* spp.)]. For operational and safety reasons, trees of this condition are best retained within WTPs and other treed reserves (Manning et al. 2005).
4. Where necessary, a certified danger tree assessor should use the danger tree assessment procedures found in the provincial “Wildlife/Danger Tree Assessor’s course” (WTCBC 1997) to evaluate potential tree hazards and risks to workers in areas where there are standing dead or defective trees. These techniques will

determine how to retain standing dead or defective tree structure in a safe manner in both harvesting and silviculture operations (Manning et al. 2005).

As well as retaining potential cavity sites with DWTs, it is also possible to create suitable sites during salvage logging. Where non-pine tree species are not available for retention, there may be the opportunity to create feller-buncher-cut stubs from beetle-killed pine stems (Manning et al. 2005). There is evidence that stubs are used by cavity-nesting birds (Harris 2001), however they seem to prefer stubs with >35 cm dbh. Harris (2001) also found that 95% of the nests were created in an area clearcut of pine, leaving only the stubs. As well, all the nesting occurred in holes that were present prior to harvest. When creating stubs during salvage operations:

- Tall stumps or stubs should be created where other species have not been reserved from harvest and they should be restricted to trees >30cm dbh or where cavities already exist (Bunnell et al. 2004);
- Trees selected for stubbing should be cut at approximately 4-6 m high. Look for trees which already have existing stem damage or decay (e.g., scars, cracks, cavities, conks) as candidates for stubbing (Manning et al. 2005); and
- Ensure all stubs are assessed for worker safety as only stubs cut from wildlife tree classes 1, 2, or 3 are safe to work around without being assessed by a certified wildlife danger tree assessor.

See <http://www.for.gov.bc.ca/hfp/wlt/> for more information on dangerous tree assessment procedures in B.C.

7.3 Wildlife Tree Patches

Most of the areas that are within the scope of this paper fall under the Natural Disturbance Type (NDT) 3 classification (MoF and BCE 1995). NDT3 is indicative of large scale natural forest disturbances patterns. These large natural disturbances are generally large stand renewing events such as wildfire or forest insect infestations. When occurring naturally, these large scale disturbances often leave remnants of the former forest. In managed forests we now try to mimic these disturbances by leaving residual trees which are retained as wildlife tree patches (WTPs).

WTPs are areas or patches of trees with special characteristics that provide valuable habitat for the conservation and enhancement of wildlife. These retained old forest remnants provide very important stand level habitat features. Dead trees (snags), tree and vegetation species diversity, vertical and horizontal structural diversity and a source of coarse woody debris are just a few of the more important elements they provide that enhance fish and wildlife habitat.

The Biodiversity Guidebook (BGB) (MoF and BCE 1995) and the Landscape Unit Planning Guide (MoF and MELP 1999) contain methodology to identify the percentage

of the cutblock area that is required to be retained as WTPs (MWLAP 2005). Emphasis should be placed on choosing areas with the highest wildlife values. Flexibility is allowed in the placement of the WTP either within or along the cutblock edge. Ideally, WTPs are designed to persist within the stand or in the adjacent regenerating stand/forest for at least one rotation. Trees within the WTP may die during this time from various causes but they are expected to continue to provide excellent habitat and biodiversity values.

Wildlife tree patch planning for salvage operations should be linked to the higher level plans. Use the existing criteria for WTP location (MoF and BCE 1995; MoF and MELP 2000) as the initial guidelines when designing WTPs. Further recommendations for WTP retention in salvage areas include:

- Choose predominantly non-pine areas as candidates for WTPs. Where present, retain a variety of tree species including deciduous (Manning et al. 2005);
- WTPs should be focused if possible on non-infected patches as these are the areas WTPs are supposed to mimic (MWLAP 2005);
- The WTP should be at least large enough to buffer key dangerous wildlife trees from adjacent work areas and provide some undisturbed habitat. In general, consider 2 tree lengths as a minimum radius but larger where possible (Manning et al. 2005); and
- Consider attaching WTPs to existing buffers adjacent to streams, wetlands and lakes, thus creating or enhancing connectivity.

8.0 Coarse Woody Debris

Coarse woody debris (CWD) is defined as dead, woody material on the forest floor that is greater than 7.5 cm in diameter and in various stages of decay (MoFR 2005). From the stand structure and biological habitat it provides, to the energy (nutrient) exchanges it is a part of; CWD is undeniably a vital component to forest ecosystem function (Stevens 1997). More specifically critical functions of CWD provides in lodgepole pine dominated forest ecosystems that are generally described as nutrient poor sites with coarse soil include (Rick Dawson⁶ pers. comm. 2005):

- Water retention;
- Nutrient retention and habitat for nitrogen fixing bacteria and fungi; and
- An energy and nutrient source for the soil ecosystem.

Within the Lakes, Quesnel and Prince George TSAs, 27 vertebrate species (22 of which are mammals) used CWD (Bunnell et al. 2004). None of these species show strong

⁶ Rick Dawson, SRM Officer, Planning, Williams Lake, BC.

positive associations with lodgepole pine. However, two species do make use of the CWD provided by lodgepole pine stands and they are identified as species of special concern. The fisher is red-listed by the Conservation Data Centre (CDC), and often uses CWD for dens. The wolverine is blue-listed by the CDC, is a species of “special concern” by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and is an opportunistic user of CWD (Bunnell et al. 2004).

It is believed that CWD is most effective for wildlife habitat when diameters are over 30 cm (Bunnell et al. 2004). Large logs (in length and diameter) last longer, hold more moisture, contribute more organic material to the soil and provide habitat for a greater number of species. Species such as marten and fisher use CWD for denning and resting and would require pieces about 50 cm in diameter which are very rare in lodgepole pine stands (Bunnell et al. 2004). However, downed wood greater than 30 cm in diameter will be very effective at sustaining biodiversity, particularly if it is layered or jack-strawed providing vertical structure. As for wildlife trees, tree species other than pine, and especially hardwoods, will most likely provide this important habitat element, although a mix of deciduous and coniferous is optimal. Some smaller mammals and birds associated with salvaged stands (early seral associates or habitat generalists), positively respond to pieces around 15 cm or more in diameter (Bunnell et al. 2004).

We know that legacies of CWD should be left on all blocks (Lindenmayer et al. 2004). The general management approach is to mimic nature. The more managed stands mimic natural disturbances, the higher the likelihood that critical processes and wildlife habitat will be maintained. Under natural conditions, most beetle-killed stands would have high levels of CWD, thus it is intuitive to leave an abundance of dead standing or downed woody material in stands heavily impacted by MPB. FRPA retention defaults for CWD retention express minimum CWD levels. Meeting only these minimums [see Forest Planning Practices Regulation (FPPR) Section 68 (1a and b)] is not sufficient for natural mimicry of beetle killed salvage areas.

For salvage areas of lodgepole pine, there could be considerable amounts of CWD produced during the harvest. Commonly though, CWD is piled and burned during salvage operations. Mindful of the need for worker protection and fire hazard abatement, CWD could be clumped in piles (tangles) which might be expected “naturally” (Ritchie⁷ pers. comm. 2005). The retention of piles within salvage blocks can provide structural and functional diversity. Planned CWD piles can serve the same function as; snags by providing insect habitat, and bird foraging and perching opportunities; as CWD by providing a modified microclimate, nesting and denning habitat; and as deciduous or immature conifer patches by providing escape cover (Furness 1993). The structural feature, although not naturally created, will be used as habitat and may be a key element that allows for more rapid recolonization of the site by species.

The concept of “retention clumps” for CWD management has been pioneered in the Skeena Region (Lloyd 2004). Areas roughly 10m by 30m are identified for CWD

⁷ Chris Ritchie, A/Provincial Beetle Response Project Manager, Environmental Stewardship, Prince George, BC.

retention where live trees, snags and stubs are retained, downed material is deposited, and skid trails are avoided. Clumps could be located throughout the block to maximize their habitat values (e.g., within 100m of the standing forest edge and no more than 250m apart) while minimizing economic impacts (e.g., place on difficult to reforest micro-sites like rocky or wet spots). It is unlikely that “too much” CWD would be left on a block to achieve ecological objectives if the block was subject to salvage harvest (Ritchie pers. comm. 2005).

Based on discussions above the following is recommended for CWD retention during stand-level salvage:

1. Retain any CWD greater than 15 cm in diameter where it lies (Bunnell et al. 2004);
2. Levels of merchantable wood as CWD retention should be close to the waste billing benchmarks which vary by site (John Wai⁸ pers. comm. 2005):
 - a. 4 m³ on dry sites;
 - b. 10 m³ on mesic sites; and
 - c. 20 m³ on wet sites.
3. Retain CWD on site in a way that mimics its natural distribution of randomness and connectivity, with some clumping and layering (Ritchie pers. comm. 2005);
4. Where present, maintain and or recruit a mixture of both coniferous and deciduous CWD. Coniferous CWD decays slower than deciduous CWD, providing ecological benefits for a greater period of time. Deciduous CWD provides important short-term ecological benefits (Bunnell et al. 2004; Manning et al. 2002; Manning et al. 2005);
5. Where safe to do so, retain some standing live trees and dead trees (snags), and or mechanically harvested stub trees on site to provide sources of recruitment CWD. Retain larger diameter trees where present (recommend >50 cm dbh) (Manning et al. 2002; Manning et al. 2005);
6. Retain and or recruit a range of naturally occurring CWD ground cover on cutblocks, well distributed across the forest floor on site. Depending on the site (i.e., forest type and stand age), the amount will vary widely (Manning et al. 2005);
7. Retain and or recruit some larger CWD pieces, >5 m long and >40 cm diameter. Larger material decays more slowly, holds more moisture, presents less of a fire hazard, and provides more habitat value to a greater number of wildlife species for a longer period of time (Manning et al. 2002; Manning et al. 2005);
8. Maintain some CWD in loosely layered, low-height (< 1 m) piles of up to 3 m in width. Some longer pieces (> 5 m) of CWD should radiate from the pile to

⁸ John Wai Residual Forester and Log Salvage Policy Forester – Revenue Branch, Victoria, BC.

- provide linear travel corridors for small mammals (Manning et al. 2002; Manning et al. 2005);
9. Where mechanically harvested stub trees are left in cutblocks, consider arranging loosely stacked CWD piles around stubs, using the stub as the “central axis” of the pile. Stub trees used in this context should be cut as high as possible with the feller buncher, at least 5 m in height (Manning et al. 2002; Manning et al. 2005);
 10. Where practical, process the timber on site rather than at the landing. This approach can be applied over the whole cutblock and will minimize CWD accumulations at roadsides and landings (Manning et al. 2002; Manning et al. 2005);
 11. Retain any log grades which have been identified in higher level plans or operational plans, to fulfill CWD objectives on an area-specific basis. For example, the following log grades should be retained as CWD:
 - a. Grade 6 undersized logs, and firmwood reject logs which have < 50% of the gross log scale as sound wood;
 - b. Grade 5 dead and dry lumber reject logs which are rejected as lumber grade and were dead and dry when harvested (Manning et al. 2002); and
 12. CWD piles can be located almost anywhere on the block, but it is most efficient to situate them around existing structural elements or machine-free zones with special attention to clump retention in Riparian Reserve Zones (MoFR 2005).

9.0 Access Development

An increase in salvage will increase the amount of access structures. Where salvage is to occur in previously unharvested areas, new access routes will need to be established. Where salvage will take place in previously developed areas, the reactivation of old roads may be necessary with the addition of new spur roads. All of this will result in an increase in traffic on existing roads. The impact of roads and other access structures have been documented to have negative impacts to biodiversity and other non-timber values associated with salvage logging (Stadt 2001).

Roads affect terrestrial and aquatic ecosystems in several ways. They can (Trombulak and Frissell 2000):

- increase animal mortality from construction and vehicle collisions;
- modifying animal behavior;
- alter the physical and chemical environment;
- impact habitat fragmentation, connectivity, displacement and quality;
- facilitate the spread of exotic species; and
- increase the alteration and use of habitats by people.

The linear corridors created by roads can result in altered predator-prey dynamics by improving the hunting efficiency of predators (James and Stuart-Smith 2000). This effect continues even with full deactivation of roads. Caribou are particularly sensitive to

altered predator-prey relationships. Human hunting pressure is also increased with greater road density on a landscape. Additionally, grizzly bear, wolves, wolverine, fisher, and lynx, are all negatively affected by road development associated with salvage operations (James and Stuart-Smith 2000; Trombulak and Frissell 2000).

Roads also create significant impacts on streams and aquatic habitats. They can change the hydrology of a watershed and affect peak and low flows (Beaudry 1997). Peak flows refer to the maximum flow rate that occurs within a specified period of time, usually on an annual or event basis. Forest harvesting can increase peak flows as it can allow for greater accumulations of snow, reduced sublimation and accelerated snow melt. The road interception of groundwater also accelerates the flow to the valley bottom (Heinrichs pers. comm. 2005). Increased peak flows can cause stream channel de-stabilization leading to decreased water quality. Salvage harvesting can easily increase peak flows from a 10 year event to a 100 year event. This places considerable importance on the maintenance of drainage infrastructure (MoF 2004).

Increased peak flows may require larger or better engineered stream crossings to handle the flows. Destabilized watersheds or systems may have increased channel instability and movement resulting in increased channel armoring or risk of channel avulsions. Stream crossing on systems which fail to identify the instability may face greater risk of failure due to bedload movement or sharply peaked flows (Ritchie pers. comm. 2005).

New stream crossings are intimately linked to the building of new roads and can significantly impact riparian habitat through their effects on erosion, sediment loading, fish passage, and hydrologic flow. Most surface erosion issues associated with forest harvesting are linked to road and drainage structures – their construction, installation, maintenance, and de-activation. With increased harvest levels there is the potential for increased road density within a watershed. Increased road density leads to an increase in permanent access structures, which leads to an increased number of stream crossings and an associated potential to limit fish passage (MoF 2004). Harvest patterns that reduce the number of stream crossings reduce both the maintenance burden and the risk of failure, thus lowering the risk of damage to ecosystem function (DeLong et al. 2004).

The natural hydrological regime has been altered by loss of healthy trees that are intercepting precipitation (rain and snow) prior to it reaching the ground and evapo-transpiring water from the soil into the atmosphere. Loss of healthy forest cover may result in raised water tables, increased surface runoff, and increased peak flows. Increased surface water will likely enter road drainage systems. If not properly designed and maintained, un-anticipated flow regimes (e.g., flashier water movement, or increased flow volume) may overwhelm road ditches, water bars, culverts or catchment basins. This can increase erosion and sediment generation to receiving waters. As much as 90% of erosion and sediment load in nearby streams comes from roads constructed for timber harvesting (Anderson et al. 1976).

Based on the discussion provided above, the following are guidelines related to retaining non-timber values when developing access for MPB salvage logging:

1. Develop access management plans as they are crucial to mitigate the potential damage to fish and wildlife (Eng 2004). Licensees should plan harvesting on a watershed or landscape scale to minimize road construction and road density (MoF 2004);
2. A thorough stream crossing inventory should be completed and areas with fish passage issues should be replaced as per the Fish-stream Crossing Guidebook (MoF 2002);
3. Development of access structures should adhere to all existing regulations and should be decommissioned as soon as possible after operations have ceased (Eng 2004);
4. Negative impacts to wildlife can be reduced through aggressive access management and deactivation by deconstructing the additional roads and trails created for salvage purposes and removal of the linear corridors. Strategies to achieve this objective include recontouring and replanting of roads (Stadt 2001);
5. Develop erosion control plans to minimize erosion and sediment from overland and channelized drainage water and maintenance of drainage systems and structures (MoF 2004);
6. For areas with high peak flow index, special road construction techniques should be developed to maintain drainage networks and minimize erosion and sedimentation (Beaudry 1997);
7. Licensees should consult MoE or MoFR staff for streamflow data or regional unit area runoff estimates to calculate peak flows in proposed salvage watersheds to plan drainage structures (MoF 2004); and
8. Areas with high erosion hazard should be assigned a high priority for future road surveys, road deactivation programs and slope stability activities (Beaudry 1997).

10.0 Wildlife Habitat Features

Site-specific, non-replaceable ecological features, such as wildlife habitat features (WHF), warrant special consideration when planning for salvage in MPB killed stands. Provision for the identification and management of WHFs is given by the *Forest and Range Practices Act* (FRPA), under section 11 of the *Government Actions Regulation* (GAR). A WHF is defined as one of the following types of specific biodiversity elements and localized components of wildlife habitat. They include:

- A significant mineral lick or wallow (see section 7.3);
- A fisheries sensitive feature (see sections 6.0 and 7.3);

- The nest of a bald eagle, osprey or great blue heron, or a category of species at risk bird (see sections 7.2 and 7.3); and
- Additional features as determined by government (Government Actions Regulation Section 11(1-3))
(<http://www.for.gov.bc.ca/tasb/legsregs/frpa/frparegs/govact/gar.htm#section11>)

Regulation requires that a primary forest activity does not damage or render ineffective a wildlife habitat feature. Retention of pine and other species in MPB killed stands may help achieve the strict definition in the regulation and provide a “buffer” to factors surrounding the feature. For example, an ideal method to protect a mineral lick or a large stick nest would be to locate it within a WTP, or a fisheries sensitive area might be best protected within the RMA. Retention planning can accommodate many biodiversity values within a single retained area simultaneously.

WHFs are one of the tools that the province will use to manage residences of species at risk. “Species at risk” means a “*species identified within a category established under the GAR*”. Recommended management guidelines are currently being developed for the WHFs described above and for the localized features listed below. These localized WHFs have been identified in consultation with government and licensee representatives but are not legally designated. Consultation with appropriate MoE, or MoFR staff is necessary to identify and apply prescriptions that address site specific values and constraints.

Localized WHFs include:

- Large stick nests (non-specified species)
- Sharp-tailed grouse leks
- Ungulate natal areas
- Grizzly bear ground dens
- Grizzly bear mark trees
- Black bear den trees
- Snake hibernacula
- Bat hibernacula and maternity roosts
- Hot springs associated with species or plant communities at risk, or are unique to the local area
- Non-classified wetlands and ephemeral ponds associated with species at risk

11.0 Mule Deer

Mule deer are generalist herbivores that both graze and browse. They are often found in open forested areas or parklands with adjacent grasslands, and also inhabit drier, timbered slopes and river breaks (Bunnell et al. 2004) Mule deer reach the northern limit of their continuous high density populations in the Cariboo region. Further north their

populations are typically more isolated and associated with specific habitat conditions that allow them to survive winter (Armleder⁹ pers. comm. 2005).

The removal of large forest structure, as a result of salvage harvesting, shifts species composition to species preferring open habitat (Blake 1982, McIver and Starr 2000 *in* Stadt 2001). Salvage logging reduces the hiding cover required by deer by removing tree cover. However, salvage harvesting could also increase the availability of young seral habitat thereby increasing summer forage for deer. However, summer range has never been limiting for mule deer in B.C. (Armleder 2005 pers. comm.). In some locations, deer populations are little impacted by salvage harvesting because the area of the epidemic is not central to their winter range, which is dominated by Douglas-fir stands (Armleder and Dawson 1992). Thus, salvage of beetle killed trees in these summer range areas may have little impact on mule deer where they utilize more open, young seral forest habitats.

In the Lakes, Bulkley and Morice TSAs however, lodgepole pine is central to most mule deer winter ranges. Mature lodgepole pine stands often provide the only snow interception structure in many of the winter ranges in the Sub-Boreal Spruce (SBS) biogeoclimatic zone, and therefore can be critical winter structures in these areas (Heinrichs pers. comm. 2005).

Provided that riparian areas and trees other than lodgepole pine are left unharvested, salvage logging should have few negative impacts on most seasonal mule deer ranges. The exception, of course, is in mule deer winter range. Winter range is defined as areas on the landscape where mule deer move in response to snow accumulation (UWRTAT 2004). Generally, ungulates do not tolerate snow depth greater than chest height and are impeded when snow is knee-deep (Kelsall and Prescott 1971 *in* UWRTAT 2004). Mule deer desire vigorous growth of preferred forage species in, or in association with, shallow snow conditions (generally <25 cm) (UWRTAT 2004).

Leaving dead trees maintains minimal thermal, snow and security cover thereby accomplishing little for mule deer winter range (Armleder pers. comm. 2005). While understory growth may be enhanced, it is only of value to wintering deer if it is available i.e. not buried by, or made inaccessible by the snowpack. Mule deer rely on snow interception cover during winter on any ranges that experience more than 25 cm of snowpack (Armleder et al. 1994).

Based on the discussion provided above, the following recommendations are provided for managing mule deer habitat values during salvage harvesting:

- Where known winter ranges occur within MPB killed lodgepole pine slated for salvage, any harvesting must be consistent with legal objectives or general wildlife measures (Ritchie pers. comm. 2006).

⁹ Harold Armleder, Research Wildlife Habitat Ecologist, Ministry of Forests, Forest Sciences, Williams Lake, BC.

- In the Cariboo region and southward where mule deer winter ranges are commonly Douglas-fir dominated, selective salvage of dead pine should be allowed, provided that there is little or no impact on the Douglas-fir component (Dawson et al. 2002; 2005);
- In the Lakes and Prince George TSAs, any decisions about ungulate winter ranges should be made on a site-specific basis. The remaining forested winter ranges of the Lakes, Morice and Bulkley TSAs are predominantly pine and deciduous therefore remnants are critical for retention in most cases (Eng 2004; Heinrichs pers. comm. 2005).

Dawson et al. (2002, 2005) provide specific recommendations for managing mule deer winter range in the face of MPB within the Cariboo region. Manning et al. (2005) provide general salvage harvesting recommendations for mule deer. The following guidelines have been modified from these sources and have specific application to MPB salvage situations:

- Minimize the width (< 120 m) of clearcuts to provide accessible security cover for foraging;
- Security cover patches should be a minimum of 100-300 m wide for deer;
- Minimize the amount and size of roads, skid trails and landings in important forage habitat;
- In general, harvest considering the topographic profile - deer tend to use ridges and topographic breaks frequently, these areas should be avoided where possible;
- Retain vegetation or incorporate topographical relief into cutblock layout that visually screens ungulates from roads and access points;
- Retain large, old Douglas-fir trees to provide snow interception and thermal cover, litterfall, and substrate for arboreal lichen. Douglas-fir foliage litterfall becomes increasingly important as winter food, especially as snow deepens (Waterhouse et al. 1991, 1994);
- Reduce slash to a depth of < 20 cm on 75% of treatment areas in important foraging habitat (Waterhouse et al. 1990);
- Minimize harvest or damage to residual Douglas-fir stems to $\leq 15\%$ for stems 22.5-37.5 cm dbh and $\leq 5\%$ for stems > 37.5 cm dbh (including skid trail development) of the pre-harvest basal area of stems in each of these two diameter class groupings (Dawson et al. 2002); and
- In predominantly lodgepole pine stands, surviving remnants are critical for retention, thus dead pine trees should be removed using a small group selection

approach leaving scattered dead pine unsalvaged if it means harvesting or damaging any live trees (Heinrichs pers. comm. 2005).

12.0 Northern Caribou

The northern population of woodland caribou is listed as Threatened or Special Concern on Schedule 1 of the Federal Species at Risk Act and Blue-listed by the CDC. The woodland caribou is an Identified Wildlife Species (BCMWLAP 2004) in British Columbia, and a designated ungulate for which an ungulate winter range may be required (Bunnell et al. 2004).

The northern ecotype ('northern woodland caribou') occurs in the mountains of western and northern British Columbia. It is by far the most abundant ecotype in British Columbia, numbering about 16,000 individuals (Heard and Vagt 1998). The Itcha-Ilgachuz herd in the western portion of the TSA now numbers about 2800¹⁰ animals (Wright¹¹ pers. comm. 2006). Distribution of the Tweedsmuir herd overlaps with the southwest extremity of the Vanderhoof Forest District (Bunnell et al. 2004).

Northern caribou migrate to low elevations in winter, where they feed on terrestrial and arboreal lichens, but spend spring and summer at high elevations. Some caribou remain at high elevations in winter at windswept, exposed areas where the ground is bare (Shackleton 1999). Most winter ranges include areas of terrestrial lichens underneath a canopy cover of lodgepole pine.

A portion of the area that is affected by the pine beetle epidemic provides that type of winter habitat for woodland caribou. Salvage harvesting may severely impact the availability and productivity of terrestrial lichens that are northern caribou's main winter forage in this area (McLennan et al. 2001). Forest harvesting and site preparation, can have significant and long lasting effects on forest floor vegetation. In some instances these activities create conditions that allow the cover of lichens to increase through physiological responses of altered light, temperature, and moisture conditions. Conversely, in most instances these activities cause conditions that dramatically decrease lichen abundance and quality through mechanical damage and increased solar radiation (Miege et al. 2001). In the past, most forest harvesting methods were detrimental to the survival of terrestrial forage lichens (Williston and Cichowski 2002).

The negative effects of harvesting lodgepole pine where there is significant lichen available can be mitigated by harvesting during winter months (Williston and Cichowski 2002). Without a substantial snow pack and frozen soil to protect the vegetation at the forest floor, moving machinery across the lichen mats will disrupt them and reduce important winter forage. Recolonization of lichens on heavily disturbed sites has been

¹⁰ From census done June 2003.

¹¹ Randy Wright, Wildlife Biologist, Fish and Wildlife Science and Allocation Section, MOE, Williams Lake, BC.

shown to take far longer than on sites with little surface disturbance (Williston and Cichowski 2002).

Although caribou will use clearcuts for travel and bedding, their use for winter foraging is very limited in the first years after harvesting. The time required for lichens to recover and for clearcuts to become valuable for winter foraging needs to be investigated. Caribou tend to prefer foraging under the canopy of an open mature forest and prefer traveling through less open stands with a shallower snow pack (Cichowski 1993). Lichen dispersal, establishment and growth are slow and it may take decades before the quantity of terrestrial lichen within a clearcut is comparable to that in old stands.

Dense young lodgepole pine stands regenerated across the landscape following natural disturbance or harvesting make travel difficult for caribou. A proliferation of roads constructed to facilitate the salvage harvesting also creates access problems for caribou. Roads provide much easier access for predators and hunters, especially in winter when roads are ploughed (McLennan et al. 2001). Caribou are particularly susceptible to wolf predation because they have relatively low reproductive rates and do not use escape terrain as do other ungulates with low reproductive rates (e.g., mountain goats and sheep). A wolf population may be able to eliminate a caribou population over time (Seip 1992).

The provisions for the AAC uplift recognize that there are special caribou management areas within the TSAs. There is considerable speculation about the impacts of both beetle attack and forest harvesting on the quality of caribou habitat. It is possible that the beetle damage and any subsequent harvesting could encourage the growth of terrestrial lichens used as a food source by caribou because of reduced crown closure. Conversely, canopy removal will result in deeper snow packs that could restrict feeding opportunities. Additionally, logging may cause physical damage to lichens and physiological damage through increased solar radiation. A conservative approach would dictate that no harvesting in caribou habitat areas occurs until the fundamental difference in the possible outcomes is resolved (Eng 2004). It is also probable that no single answer is possible because lichens react differently with small changes in the environment sometimes at a finer scale than a biogeoclimatic subzone.

The following guidelines are pertinent for areas where salvage harvesting is not excluded through a higher level plan or where more specific guidance has been approved (Youds et al. 2002).

1. Retain lower elevation (midslope) open canopied (25-55% canopy closure) mature and old pine and pine/spruce stands that contain abundant terrestrial lichen (especially *Cladina* spp.) as winter forage, even if the pine is dead, as the opening of the canopy will create more light and more lichen in the short term (Manning et al. 2005; Williston and Cichowski 2002).
2. Wherever possible, do not allow access on exposed, windblown alpine slopes with abundant terrestrial lichen (Manning et al. 2005).
3. Protect caribou from access-related impacts by developing a road/access management plan which should include road deactivation recommendations. Try

- to minimize road access to and habitat fragmentation of winter ranges and Wildlife Habitat Areas for caribou (Manning et al. 2005).
4. To reduce the barrier effects of roads, road design (height) should accommodate the ability of caribou to have a clear line of sight to habitat on the other side of the road, at least along portions of the road at regular intervals and where topographically feasible (Manning et al. 2005).
 5. On sites with significant terrestrial lichen cover, care should be taken to minimize surface disturbance. In these stands, winter logging when sufficient snow cover is present will be required (Manning et al. 2005; Williston and Cichowski 2002, Youds et al. 2002).
 6. Wildlife tree patches should be considered for areas with high caribou forage lichen abundance (such as eskers) that occurs within proposed salvage blocks. These lichen patches should be buffered from openings by approximately two tree-lengths and be joined to the surrounding forested matrix by a corridor to allow caribou access to lichen sites without having to cross large openings (Williston and Cichowski 2002).
 7. Partial cutting (for instance 30% removal) could be considered in the lichen buffers and access corridors if harvesting is not expected to reduce the wind-firmness of the remaining trees or to reduce canopy snow interception resulting in snow accumulations that impede caribou movements (Manning et al. 2005; Williston and Cichowski 2002).
 8. Harvesting methods that reduce the amount of slash left on a block also curtail the loss of terrestrial forage lichens and provide easier travel for caribou. Whole tree harvesting with roadside processing is one way to minimize the slash on harvested blocks (Williston and Cichowski 2002). Another approach is to pile the slash during processing at the stump to minimize slash contact with lichen (Youds et al. 2002).
 9. Retain all green trees not attacked by MPB on caribou winter range where beetle mortality is significant (<50 % attack) (Youds et al. 2002).

13.0 CONCLUSION

It is clear from the lack of literature and research available, that there are significant gaps in knowledge regarding environmental impact of large-scale salvage harvesting. The relative merit of retaining unharvested areas during salvage operations is a subject of much debate. The Government of Canada has provided the Province of British Columbia with financial assistance of \$100 million to help mitigate the impacts of the mountain pine beetle infestation. The Province has prepared a strategy – the Mountain Pine Beetle Emergency Response: Canada-B.C. Implementation Strategy – that outlines how the \$100 million will be used over the next three years to help deal with the economic, environmental and social challenges created by this natural disaster (http://www.for.gov.bc.ca/hfp/mountain_pine_beetle/can_bc_implement.htm).

The Ministry of Forests and Range has developed a Mountain Pine Beetle Stewardship Research Strategy (<http://www.for.gov.bc.ca/hre/pubs/docs/MPBResearchStrategy.pdf>) in which it has identified specific research gaps. This strategy identifies the research knowledge gaps that must be addressed to resolve the Mountain Pine Beetle (MPB) stewardship research issues. It also recommends a process for allocating funding, collaborating and communicating these issues. Under the domain of wildlife, ecology, range and biodiversity the Research Strategy identifies the following gaps as high priority for research:

- Impacts of alternative patterns of salvage harvest and no harvest at the landscape and stand scales on critical habitat for plants and animals; and
- Impacts of alternative patterns of salvage harvest and no harvest at the landscape and stand scales on ecological functioning.

Research undertaken to fill some of those gaps would help to provide clear direction on the most efficient strategies for retention planning while managing for non-timber values. However, there is considerable concern that the research may not be completed in time to influence forest management in the most heavily impacted areas. Perhaps some long-term monitoring programs can be implemented to gain knowledge that can then be applied to any other disturbance of this magnitude.

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15.0 Relevant Websites

Forest Stewardship for Mountain Pine Beetle Salvage

http://www.for.gov.bc.ca/hfp/mountain_pine_beetle/stewardship/index.htm

Mountain Pine Beetles in British Columbia

http://www.for.gov.bc.ca/hfp/mountain_pine_beetle/

Ministry of Forests and Range Mountain Pine Beetle Stewardship Research Strategy

http://www.for.gov.bc.ca/hfp/mountain_pine_beetle/MPBResearchStrategy.pdf

Cariboo-Chilcotin Land Use Plan Caribou Strategies including Mountain Pine Beetle

<http://srmwww.gov.bc.ca/car/planning/cclup/#caribou>

<http://srmwww.gov.bc.ca/car/planning/cclup/biodiv/index.html>

Cariboo-Chilcotin Mule Deer Planning including Mountain Pine Beetle

http://wlapwww.gov.bc.ca/car/env_stewardship/ecosystems/mdwr_strat/mgmtplan.html

Mountain Pine Beetle Emergency Response Canada-B.C. Implementation Strategy

http://www.for.gov.bc.ca/hfp/mountain_pine_beetle/can_bc_implement.htm

Ministry of Forests and Range Mountain pine beetle UPDATE

http://www.for.gov.bc.ca/hfp/mountain_pine_beetle/2005MPBsurvey.pdf

Information on dangerous tree assessment procedures in B.C.

<http://www.for.gov.bc.ca/hfp/wlt/>

Government Actions Regulation on Wildlife Habitat Features

<http://www.for.gov.bc.ca/tasb/legsregs/frpa/frparegs/govact/gar.htm#section11>

Appendix A - Wildlife Tree Characteristics

This section was taken directly from MWLAP (2005).

Wildlife trees (WTs) are important components to stand structure and are characterized by a number of factors including:

- 1) trees considered large size for site. Trees from the top 10% of the diameter distribution for the stand should be included as WT's. The minimum size of suitable wildlife trees is 25 cm in diameter for deciduous trees and 35 cm in diameter for conifers at breast height (DBH).
- 2) evidence of wildlife use (e.g. nesting cavities or dens) or tree structure suited for wildlife use (suitable for large nest, hunting perch sites, etc.).
- 3) species type. While wildlife tree patches (WTPs) should be representative of the harvested stand, some trees have better general qualities as WT's, especially to serve as dispersed wildlife trees. The preferred species list is:
 - A) Large Douglas-fir "veterans" or large Cottonwood trees.
 - B) Mature Douglas-fir, preferably with some surrounding trees left intact to help protect the root integrity and windfirmness of the Douglas-fir.
 - C) Subalpine-fir, preferably with some surrounding trees left intact to help protect the root integrity and windfirmness of the subalpine-fir.
 - D) Clumps of aspen containing individual aspen greater than 25 cm DBH.
 - E) Windfirm individual conifers or deciduous trees.
 - F) Coniferous or deciduous stubs.
- 4) declining or dead condition. Indicators of decay include:
 - internal decay (heartrot or natural/excavated cavities present)
 - crevices present (loose bark or cracks suitable for bats)
 - large brooms present (mistletoe)
 - current insect infestation
- 5) relative scarcity of tree species. While not the primary purpose of WT retention, and sometimes at odds with the representation objectives, "rare" or uncommon trees should be retained on the block.