Strategies for Maintaining or Recruiting Habitat in Areas Affected by Mountain Pine Beetle and other Catastrophic Events

April 1, 2006

Report prepared for: **Ministry of Environment**
Ecosystems Branch
Victoria, B.C.

Report prepared by: **Manning, Cooper and Associates**
Victoria, B.C.

This page left blank intentionally

Strategies for Maintaining or Recruiting Habitat in Areas Affected by Mountain Pine Beetle and other Catastrophic Events

Report prepared for: **Ministry of Environment**
Ecosystems Branch
Victoria, B.C.

Prepared by:

E. Todd Manning[1] FIT, William J. Golding[2] RPF, Jay Baker[3] and Aaron M. Deans[4]

Edited by:

Marnie, Martin,[5] Mike Fenger[6] RPF and Colene Wood[7] RPF

[1] Manning, Cooper and Associates, Victoria, BC
[2] Silvicon Services Inc., Smithers, BC
[3] Silvicon Services Inc., Smithers, BC
[4] Manning, Cooper and Associates, Victoria, BC
[5] Consultant, Prince George, BC
[6] Consultant, Victoria, BC
[7] Ministry of Environment, Victoria, BC

This page left blank intentionally

Errata Notice

During March to June 2006, website URLs will be converted from the former Ministry of Water, Land and Air Protection, and Ministry of Sustainable Resource Management, to represent the new responsibilities of the Ministry of Environment. Actual URLs referenced in this document may lead to the revised URL, or the user may have to search websites for the respective documents referenced in this document.

Executive Summary

Nine habitat objectives have been identified which can be managed (i.e., maintained or recruited) during:

a. large-scale salvage of Mountain Pine Beetle (*Dendroctonus ponderosae*) attacked lodgepole pine (*Pinus contorta*), primarily in the Sub-boreal Spruce (SBS) and Sub-boreal Pine-Spruce (SBPS) biogeoclimatic zones; **OR**
b. reforestation, restoration, or rehabilitation of insect/disease attacked, unharvested forests.

Recommendations in this report can be applied when and where the management objectives in the above situations include maintaining and/or recruiting habitat for a particular species or maintaining various habitat attributes or elements. Management objectives are developed as part of land use planning and operational planning, including planning silviculture and restoration treatments where no harvesting will take place. The recommendations focus on strategies to achieve the specific habitat objective in specific circumstances, and may need to be modified for different BEC subzones or different site conditions. It is expected that the chosen strategies would be clearly identified in Forest Stewardship Plans for harvested areas or within project plans for non-harvested areas.

These habitat objectives were chosen because of their particular biological, ecological or management significance in forests affected by Mountain Pine Beetle attack and other catastrophic events.

This report recommends strategies to maintain and/or recruit the following habitat:

1. Structure and function in riparian management areas (RMAs).

2. Landscape level biodiversity functions/objectives (including seral stage distribution and landscape connectivity).

3. Coarse woody debris (CWD).

4. Wildlife tree patches (WTPs).

5. Elements for the general range of primary cavity excavating birds.

6. Elements for Northern Goshawk reproduction and foraging.

7. Elements for Mule Deer winter range (applicable to even-aged silvicultural systems management).

8. Elements for Northern Caribou winter range.

9. Elements for Grizzly Bear forage and security cover.

The recommended strategies should be considered as guidance associated with sustainable forest management. In the context of this report, guidance is *generally accepted information and non-legislated management recommendations based on the best available data and expert opinion.*

This report is intended to be a companion document to provincial and regional forest management guidance that has been developed for managing selected species and habitats. It provides a summary of current knowledge, recommends strategies for the habitat objectives listed above, and is compatible with existing silviculture standards (e.g., *Establishment to Free Growing Guidebooks*). Information on habitat restoration practices is also provided.

A section has been included which provides a review and discussion of ecological principles and management guidelines for large-scale salvage of Mountain Pine Beetle affected landscapes. This section was authored in 2005.

Acknowledgements

The authors would like to thank Colene Wood (Ministry of Environment, Ecosystems Branch) for initiating and supporting this project. Vanessa Craig (EcoLogic Research), Marvin Eng (Ministry of Forests and Range, Research Branch), and Mike Fenger (consultant). Doug Beckett and Dale Seip (Ministry of Forests and Range, Northern Interior Forest Region) provided valuable review comments or suggestions.

This report was prepared by Todd Manning and Aaron Deans (Manning, Cooper and Associates), and Bill Golding and Jay Baker (Silvicon Services Inc.), with primary editing by Colene Wood. Alex Inselberg and Todd Manning conducted photo compilation.

Cover photos: Alex Inselberg (Grizzly Bear); Ministry Forests Research Branch (pine beetle salvage).

Table of Contents

1.0 Introduction 1

2.0 Methodology 3

3.0 Key Habitat Objectives 6

3.1 Riparian Areas 6

3.2 Landscape Level 9

4.0 Additional Work 12

5.0 Specific Strategies and Practices to Meet Habitat Objectives 12

5.1 Coarse Woody Debris 12

5.2 Wildlife Tree Patches (WTPs) 17

5.3 Primary Cavity Excavators 25

5.4 Northern Goshawk (*Accipiter gentilis atricapillus*) Reproduction and Foraging 32

5.5. DeerMule Deer (*Odocoileus hemionus hemionus*) Winter Range - Even-aged Silviculture Systems 37

5.6. Caribou – Northern Ecotype (*Rangifer tarandus*) Winter Rang 44

5.7. Grizzly Bear (*Ursus arctos horribilis)* 48

6.0 Selected References 58

7.0 Ecological Principles for Large-scale Salvage of Mountain Pine Beetle-Affected Landscapes 59

7.1 Ecosystem-based Practices 59

7.2 Recommended Guiding Principles for Management 60

7.3 References 62

8.0 Glossary of Terms 66

Appendix 1. Biogeoclimatic Subzones of British Columbia 72

List of Figures

Figure 1: Red-attack Mountain Pine Beetle-killed trees. A large-scale landscape disturbance agen. 2
Figure 2: Riparian habitats with varied deciduous components are diverse habitats for wildlife....6
Figure 3: Landscape and elevational connectivity provide wildlife movement corridors. Riparian areas are good linear travel corridors 7
Figure 4: Brushing may be required to reduce shrub and herb competition to conifer seedlings....8
Figure 5: Where present, a varied and diverse stand structure and plant communities are important to maintain across the landscape....9
Figure 6: Wildfire and insects are natural disturbance and regeneration agents in forest ecosystems that affect seral stage and patch size distribution across landscapes....11
Figure 7: Coarse woody debris decay classes....14
Figure 8: Coniferous CWD decays more slowly than deciduous CWD, and provides habitat for a longer period of time 155
Figure 9: Bat roosts in large stem cracks in tremblilng aspen (left and right photos), and under loose sloughing bark in pine (below photo) 19
Figure 10: Coniferous wildlife tree decay classes....21
Figure 11: Deciduous wildlife tree decay classes....21
Figure 12: Wildlife trees provide important habitat for various bird species, including Great Horned Owls....21
Figure 13: Diverse stand structure provides CWD, varied shrub understory and a range of tree classes, sizes and species....22
Figure 14: Wildlife trees provide forage habitat for Pileated Woodpeckers and other primary cavity excavators 29
Figure 15: Mixed-wood stands provide good nesting and foraging habitat for primary cavity excavators....29
Figure 16: Forested cover provides bedding, shelter and security habitat for Mule Deer 43
Figure 17: Terrestrial lichen (*Cladina* spp.) – a preferred winter food source for Northern Caribou....47
Figure 18: Planting and spacing regimes can mimic naturally occurring patchy, foraging habitat....55
Figure 19: Patchy and clumpy forest mosaic with shrubby openings provide forage and security habitat 55
Figure 20: Patchy and clumpy forest mosaic with heavy understory provide good security habitat....56
Figure 21: Patchy and clumpy forest mosaic with varied shrub and regeneration understory provides foraging and security habitat....56

1.0 Introduction

The magnitude of Mountain Pine Beetle *(Dendroctonus ponderosae)* (MPB) attack is unprecedented in British Columbia's recorded history. There are significant impacts to short, mid and long-term timber supply, with corresponding impacts to habitat supply. There are serious habitat supply issues that would occur even without large-scale salvage of dead pine. The recommended strategies in this report are intended to reduce or mitigate undesired impacts associated with the epidemic and the rapid large-scale salvage that follows, and to use silviculture and restoration practices to reduce the risks to biodiversity, water, fish, wildlife and habitat. The strategies have been developed for harvesting, access development, silviculture, restoration and protection activities, which can be applied at various phases of seral development.

Legal direction for managing habitat for fish, wildlife and biodiversity comes from forest legislation (e.g., *Forest and Range Practices Act, Wildlife Act*) and higher level plans. This document provides more detailed direction that, when applied in addition to statutory requirements, should produce the desired results.

This report recommends strategies for maintaining nine habitat or species management objectives (see list below). These objectives have been previously identified provincially as having particular biological, ecological or management significance[8], and have been revised to be applicable in forested areas that are impacted by the MPB and other catastrophic events.

The scope of this report covers the following related to habitat objectives:

1. structure and function in riparian management areas (RMAs);

2. landscape level biodiversity functions/objectives (including seral stage distribution and landscape connectivity);

3. coarse woody debris (CWD);

4. wildlife tree patches (WTPs) including managing for bat species;

5. elements for the general range of primary cavity excavating birds;

6. elements for Northern Goshawk reproduction and foraging;

7. elements for Mule Deer winter range (applicable to even-aged silvicultural systems management);

8. elements for Northern Caribou winter range; and

9. elements for Grizzly Bear forage and security cover.

The guidelines contained in this report are specifically intended to apply to areas where:

a. large-scale salvage of Mountain Pine Beetle (*Dendroctonus ponderosae*) attacked lodgepole pine (*Pinus contorta*), primarily in the Sub-boreal Spruce (SBS) and Sub-boreal Pine-Spruce (SBPS) biogeoclimatic zones; **OR**
b. reforestation, restoration, or rehabilitation of insect/disease attacked, unharvested forests.

[8] http://wwwenv.gov.bc.ca/wld/documents/fia_docs/mca_silvbmp.pdf

Recommendations in this report can be applied when and where the management objectives in the above situations include maintaining and/or recruiting habitat for a particular species or maintaining various habitat attributes or elements. Management objectives are developed as part of land use planning and operational planning, including planning silviculture and restoration treatments where no harvesting will take place. The recommendations focus on strategies to achieve the specific habitat objective in specific circumstances, and may need to be modified for different BEC subzones or different site conditions. It is expected that the chosen strategies would be clearly identified in Forest Stewardship Plans for harvested areas or within project plans for non-harvested areas.

Figure 1: Red-attack Mountain Pine Beetle-killed trees. A large-scale landscape disturbance agent. *Photo*: BC Ministry of Forests, Research Branch.

This report is a companion document to the various provincial and regional forest management guidelines that have already been developed, or will be developed, for managing selected species and habitats. In particular, it has been developed from an earlier provincial report (Manning, Cooper and Assoc. Feb. 2004; URL: http://wwwenv.gov.bc.ca/wld/documents/fia_docs/mca_silvbmp.html), which describes silviculture strategies for maintaining 10 key provincial habitat objectives across the province.

Sections 4 and 7 of this report have references listed, and Section 6 lists additional selected references. Forest managers are expected to consult these, local and regional higher-level plans and associated guidelines and operating procedures, as well as local resource experts when managing selected species or habitat attributes.

Section 7 provides review and discussion of ecological principles that have been suggested to apply to large-scale salvage of Mountain Pine Beetle affected landscapes. This section was authored in 2005.

Recommendations contained in this document could be refined as more field trial results are analysed and additional management objectives are identified.

2.0 Methodology

The strategies recommended in this document are based on consultations with forest resource managers (wildlife and habitat biologists, and silviculture foresters), and literature and web-based reviews of species and habitat management guidelines and silviculture practices. Section 3 contains information and recommendations for managing riparian zones and managing at the landscape level. Section 5 is organized to cover in detail each of the remaining seven habitat objectives.

Where necessary to achieve a habitat objective, the recommendation is to modify the existing *Establishment to Free Growing* standards. These free growing standards are for even-aged management, and usually the habitat objective focuses on manipulation of stocking densities and spatial distribution, tree species selection and modifiers for canopy gaps and clumpiness that can be expected in uneven-aged management.

Even-aged systems are generally most appropriate for managing large-scale disturbance events in the SBS and SBPS ecosystems where the current Mountain Pine Beetle epidemic is occurring, as these are in natural disturbance types with frequent large-scale disturbances that tend to create even-aged stands. This does not preclude the use of alternative silvicultural systems on a limited and ecologically suitable basis. Although the management experience is mostly even-aged forests, stand manipulation may provide much needed diversity that could improve future forest and ecosystem health.

Recommended strategies have been written for seven habitat objectives (i.e., not in this format for riparian and landscape level objectives) using the following format:

1. **Habitat Objective** – a description of the specific habitat objective covered in the section.

2. **General Measures** – briefly describes the importance of linking information and objectives found in higher-level plans with specific operational plans, prescriptions and practices at the stand level. (Not all habitat objectives include this part in the section).

3. **Forest Types or BEC Zones** – these are the BEC units which generally have high or moderately high habitat capability ratings[9] for a particular species or species group. This information was obtained from provincial habitat benchmark ratings for selected wildlife (MELP 1998), distribution and seasonal abundance of selected wildlife (Stevens 1995), and personal communications with various species and habitat management experts.

   Where ecologically appropriate, some subzones were grouped together. BEC subzones were restricted to those within the SBS and SBPS zones, primarily because these are the areas where extensive lodgepole pine forests occur and where the current MPB outbreak and large-scale salvage operations are occurring. Management guidelines intended for a finer scale of habitat resolution were not attempted (i.e., site series is too specific and habitat objectives may not be achievable at this scale).

[9] Habitat capability is the ability of the habitat, under optimal natural seral conditions, to provide life requisites (e.g., reproduction, foraging, security cover) of a species. The benchmark is the highest capability habitat for the species in the province, against which all other habitats for that species are rated. Habitat capability ratings with a high value represent 100-76% of the provincial best habitat; a moderately high value represents 75-51% of the provincial best habitat. Capability ratings are very useful because they provide an index of that ecosystem's ability to meet the life requisites and associated habitat attributes of a given species for a specified season (e.g., Caribou winter range, see page 11 http://www.env.gov.bc.ca/wld/documents/recovery/mtcaribou_rcvrystrat02.pdf).

Obviously, some wildlife species will be found in BEC units not listed in the management account for that particular species or species group. In these cases, if habitat management for that species is an objective, then the corresponding management guidelines should be followed in conjunction with any additional local or regional information and guidelines.

4. **Management Guidelines** –recommended strategies for achieving specific habitat objectives during harvesting, access development, site preparation, reforestation, brushing, spacing/thinning/pruning, restoration, and protection from insects/disease, fire and damage.

5. **Silvicultural Regimes** – recommends specific regimes (ie, series of treatments and practices) by BEC zones and categorized according to soil moisture regime (e.g., xeric to hygric sites).

6. **Monitoring Standards – Establishment to Free Growing** –tables relate to the columns of the same name in the *Establishment to Free Growing Guidebooks* (MOF 2000), and provide the following information:

   a. **Zone** – applicable BEC zone;

   b. **Subzone** – applicable BEC subzones;

   c. **Moisture Nutrient Regime** – applicable soil moisture and soil nutrient regime;

   d. **Species Selection** – preferred trees important for meeting the habitat objectives. This modifier provides information on which tree species are important to a particular habitat objective. For example, a broadleaf species such as black cottonwood (*Populus balsamifera trichocarpa*) could be considered a preferred species in BEC unit x, y, & z. Typically, prescriptions tend to list only those species that are preferred in the primary column of the existing stocking standards. Where no tree species preference is indicated, this column is blank, and it is the discretion of the forest manager to select the preferred species.

   e. **Stocking Standard Modifier** – refers to the multiplicative factor that should be applied to the existing stocking standards in the *Establishment to Free Growing Guidebooks*. For example, the existing stocking standards (well-spaced/ha) for CWHvm1 01 site series in the *Establishment to Free Growing Guidebook, Prince Rupert Forest Region*, equals TSSpa **900**, MSSpa **500**, MSSp **400**[10]. The equivalent stocking standards (well spaced / ha) for areas with maintenance and/or recruitment of Grizzly Bear foraging and security habitat objectives would have a 0.67 stocking standard modifier (multiplicative) applied. Therefore, modified stocking standard equals TSSpa **600**, MSSpa **335**, and MSSp **270.**

      The primary reason for using a multiplication factor rather than just stems/ha values, is to allow for the grouping of a range of site series thereby significantly reducing the size and complexity of the stocking standards.

   f. **Regen Delay** – the regeneration delay that can be modified to affect a stand attribute related to a particular habitat objective. A value of +1 would increase the delay by one

[10] TSS = target stocking standard; MSS = minimum stocking standard; pa = preferred and acceptable; and p = preferred.

year where as a value of –1 would decrease the delay by one year. If no adjustments are recommended, "same" is entered in the column. The regen delay will only be adjusted in rare situations.

g. **Assessment Time Frame** – the time frame for assessing regeneration and free growing which can be modified to affect a stand attribute related to a particular habitat objective, applied in the same manner as for Regen Delay. If no adjustments are recommended, "same" is entered in the column.

h. **Min. Tree Ht.** – minimum tree height described relative to existing stocking standards tables. If no changes are recommended, "same" is entered in the column.

i. **% Tree Over Brush** – this variable, though adjusted infrequently, recommends changes to the column of the same name on the existing stocking standards tables.

j. **Min. Inter Tree Distance** – minimum and maximum inter-tree spacing values are specified on the existing stocking standards tables. Recommended changes are shown in this column. These values work in concert with any spatial distribution descriptors (e.g., cluster distribution tables, see description below).

k. **Maximum Density** – describes maximum density (stems/ha) at free growing, above which stand tending is recommended. This density includes preferred and acceptable tree species, plus additional tree species relative to the key habitat objective. Where applicable to achieve habitat objectives, additional information such as the "minimum percentage of canopy gaps" may be described, e.g., minimum 20% canopy gaps, based on random systematic free growing survey plots.

   Some of the above stocking standard information will be the same as that found in the *Establishment to Free Growing Guidebooks* (MOF 2000), while other components of the table are revised to achieve specific stand structural attributes, e.g., patchy or clumpy regen distribution to create openings for development of forage shrubs, or a closed, multi-layered canopy for snow interception and thermal cover.

l. **Cluster Distribution** – these tables provide target information on stocking densities (trees/ha) and the corresponding trees per cluster to achieve a specified cluster density (either "x" clusters/ha or "y" metres triangular inter-cluster spacing). This information is applicable when trying to achieve regeneration that is unevenly distributed across the treatment unit. This will create patchy or clumpy regeneration in clusters of crop trees with gaps in between that will fill with non-crop tree species (e.g., berry producing shrubs) under suitable ecological conditions.

7. **Monitoring Standards** – beyond free growing seral stage, describes additional silviculture practices and relevant information (e.g., silvicultural systems, retention targets, etc.) for achieving the key habitat objectives during the three major phases of forest development – establishment (if not shown in table format), juvenile and mature.

8. **Selected References** – literature citations and/or website addresses are provided related to each habitat objective.

3.0 Key Habitat Objectives

3.1 Riparian Areas

Figure 2: Riparian habitats with varied deciduous components are diverse habitats for wildlife. *Photo*: Alex Inselberg.

Riparian areas are readily recognized as special habitats, and are often associated with specific flora, fauna, physiography, or microclimate processes not common in the adjacent stand or landscape. Because of their high site productivity and more complex habitat structure (usually containing downed wood, snags, shrubs and mixed tree species composition), riparian areas are often the most heavily used wildlife habitats. These areas often act as linear travel corridors for wildlife, providing valley bottom and cross-elevational connectivity. Riparian areas usually have a buffered microclimate compared to adjacent areas (i.e., warmer in winter and cooler in summer).

Figure 3: Landscape and elevational connectivity provide wildlife movement corridors. Riparian areas are good linear travel corridors. *Photo*: Alex Inselberg.

General strategies for maintaining and/or recruiting riparian habitat and function are:

1. Choose silviculture treatments and equipment that minimize ground disturbance within riparian areas in order to minimize introduction of non-native plant species and to maintain natural water movement.

2. Maintain and/or recruit natural levels of coarse woody debris within the riparian area. CWD has additional value in riparian areas as habitat for a number of wildlife and plant species.

3. Within riparian areas, leave all dead wildlife trees that do not pose a risk to worker safety to provide future instream large woody debris (LWD). If low value wildlife trees and danger trees have to be felled for worker safety reasons, then these stems should be retained on site as CWD.

In riparian management areas where there has been forest harvesting or heavy MPB or spruce beetle attack, some form of riparian restoration may be considered.

The following strategies are recommended specifically for the management of riparian areas where large-scale salvage is planned:

1. Follow riparian management area guidelines when harvesting near streams and rivers (see Forest Planning and Practices Regulation 47(4); http://www.for.gov.bc.ca/tasb/legsregs/frpa/frparegs/forplanprac/fppr.htm).

2. Avoid mechanical or other disturbances in or within 20 m of streams classified as S3 and S4.

3. Reserve hardwood tree species in riparian and upland areas from harvest or other treatments (e.g., herbicide applications).

4. Retain areas where there are high densities of fish species that are sensitive to logging, and for which the province has a high stewardship responsibility (e.g., Bull Trout, Dolly Varden).

5. Retain unharvested riparian buffers around wetlands and lakes; consider wider buffers where spruce is predominate or understory species are present.

6. Consider planting in riparian areas disturbed by harvesting or under planting in unharvested areas (e.g., to reach a higher percentage of conifers or desired species mix).

7. Avoid log storage within lakes.

More detailed information on riparian management area guidelines and recommended management practices for riparian zone silviculture and restoration treatments can be found in *Recommended Riparian Zone Silviculture Treatments* (Bancroft and Zielke, 2002; see: http://www.for.gov.bc.ca/hfp/publications/00077/riparian_guidelines.pdf), and the *Riparian Management Area Guidebook* (MOF and MELP, 1995). The *Recommended Riparian Zone Silviculture Treatments* also provides overall guidance on the following riparian related variables and functions, and is organized by stream classification and type of forestry activity within or adjacent to the riparian management zone (regeneration, stand tending):

1. conifer large woody debris (LWD) recruitment for channel morphology;
2. small organic debris (SOD);
3. bank stability;
4. shading (water temperature control); and
5. riparian habitat (includes presence of unique ecosystems and species-specific management requirements).

Figure 4: Brushing may be required to reduce shrub and herb competition to conifer seedlings. *Photo*: Alex Inselberg.

3.2 Landscape Level

Maintenance and/or recruitment of landscape level biodiversity elements and ecological values are essential to overall ecosystem functioning. The recommended strategies will not achieve the desired results without due consideration for landscape processes and associated planning at the landscape scale. However, implementation of strategies does not need to occur on all portions of a landscape, but only in those areas which have been identified or zoned in higher level plans for a specific objective (e.g., Special Management Zones), and/or in areas where the habitat capability ratings for that objective are high or moderately high.

Landscape level management objectives such as patch size distribution, landscape connectivity, seral stage targets, and access management are described in higher-level plans, including Sustainable Forest Management Plans, Land Use Plans, and Land and Resource Management Plans. It is important to reference higher-level plan objectives for a landscape unit or other planning area within specific operational plans, silviculture strategies and silviculture prescriptions. Where regional level plans and guidelines have been developed for the management of various habitat objectives, then these should be used in conjunction with this document.

Landscape level objectives may be re-examined owing to large-scale MPB attacks. Such re-examination should precede and be considered in silviculture planning, typically in silviculture strategies. Where possible, objectives should be expressed spatially, and then various silviculture regimes can be applied and evaluated across a management unit.

Figure 5: Where present, a varied and diverse stand structure and plant communities are important to maintain across the landscape. *Photo*: Alex Inselberg.

The following steps should be followed to achieve habitat objectives within a particular landscape planning area most effectively (much of this work is done as part of developing the Forest Stewardship Plan and subsequent operational planning):

1. Confirm presence of special management areas, e.g., Old Growth Management Areas (OGMAs), Ungulate Winter Ranges (UWRs), Wildlife Habitat Areas (WHAs), and how these may link to achievement of key habitat objectives.

2. Determine whether species at risk are found in the planning area, then find out if these require special management considerations (e.g., *Identified Wildlife Management Strategy 2002*, or specific recovery plans), or if they can be linked to other stand- or landscape-level management initiatives (e.g., an established Northern Goshawk WHA which can also contribute to old seral targets for a particular landscape unit). For more information on planning and management guidelines for IWMS species, see http://www.env.gov.bc.ca/wld/identified/strategy_info.htm.

3. Confirm any higher-level plan objectives that may assist implementation of the desired habitat objective (e.g., landscape unit target limits for old seral forest).

4. Use forest inventory data, aerial photographs and GIS mapping tools to determine current and projected landscape level targets (spatially and temporally) for:

   a. seral stage distribution (i.e., relative proportions of young, mature and old forest);

   b. patch size distribution (includes opening sizes and forested patch sizes);

   c. landscape level connectivity (includes inter-patch connectivity and cross-elevational and cross-valley connectivity). This often provides travel and dispersal corridors for wildlife;

   d. access (i.e., road density, amount of active road systems) which influences habitat fragmentation and human disturbance; and

   e. visual cover (provides forested security cover for wildlife, especially in areas with abundant human access).

   How well these five landscape variables maintain natural habitats significantly influences achievement of key habitat objectives. For example, an inadequate access management plan resulting in a highly fragmented landscape (i.e., one with only small, isolated patches of mature and old seral forest) means a landscape at high risk for Caribou.

   Ideally, the above analysis should be conducted as part of developing a management unit silviculture strategy. Where this has not yet occurred post-beetle attack, rationales for silviculture regimes and prescriptions should be documented and shared amongst licensees, BCTS and MOFR, in preparation to develop a silviculture strategy.

5. Contact local government agency personnel responsible for habitat and wildlife management planning activities for additional information not readily available.

6. Identify any special landscape features (e.g., sensitive soils and slope stability concerns).

7. Identify any critical habitats (e.g., ungulate winter ranges, significant mineral licks, wetlands).

Some general stand-level biodiversity management principles to be considered include:

1. Maintain a varied species composition in regenerating stands by:

    a. leaving natural residuals (conifers and hardwoods) and advance regeneration;
    b. planting species mixes where ecologically appropriate;
    c. brushing to achieve species mixes; and
    d. varying planting with natural regeneration.

2. Maintain forest floor structure and understory diversity by:

    a. leaving patches of undisturbed habitat (these could be wildlife tree patches, riparian reserves, variable retention patches, gully management zones, etc.);
    b. minimizing soil disturbance and compaction; and
    c. using patchy planting and juvenile spacing practices to promote herb and shrub production (as ecologically appropriate).

See the Integrated Land Management Bureau (ILMB) website for further information on landscape planning (http://ilmbwww.gov.bc.ca/ilmb/lup/index.html).

Figure 6: Wildfire and insects are natural disturbance and regeneration agents in forest ecosystems that affect seral stage and patch size distribution across landscapes. *Photos*: Doug Ellis (left); BC Ministry of Forests Research Branch (right).

4.0 Additional Work

Based on the key habitat objectives, related silviculture regimes, and the strategies that have been identified in this report, recommendations for additional work are provided below.

1. Development of silviculture recommendations for management of Northern Caribou (*Rangifer tarandus*) winter range. Various approaches to the management of pine-lichen woodlands and the response of terrestrial lichens to disturbance (e.g., canopy gaps, silviculture regimes, prescribed fire) should be evaluated to help develop silviculture strategies for Northern Caribou winter ranges.

2. Evaluation of the use and effectiveness of WTPs and other wildlife tree retention techniques. These techniques include variables such as size (area) and composition of WTPs (tree species and decay classes, basal area); distribution and density (stems/ha) and condition (age class, decay class) of individual leave trees retained post-harvest; and types of wildlife tree creation techniques (e.g., fungal inoculation).

3. Evaluation of the effectiveness of CWD management strategies. Variables to consider are the amount, condition (species and decay class), and distribution of CWD retained post-harvest. Operational, economic (i.e., utilization) and forest health variables (e.g., insects, fire protection) must be considered in the context of this evaluation.

4. Analysis of the economic and operational impacts of strategies and associated recommendations to the free growing guidelines (see section 5.0). Forest management modeling using various growth and yield or other software (e.g., *TIPSY, PROGNOSIS, VDYP*) should be employed in order to evaluate the timber supply impact of the key habitat objectives (and associated strategies such as reduced stocking standards or lower spacing densities) necessary for a management unit. Through such work new yield curves can be developed that could be utilized during future Timber Supply Reviews (TSRs). By utilizing the new yield curves during TSR for the specific regeneration analysis units affected by the various management practices, the full effect (i.e., Timber Supply Area, allowable annual cut impacts) of these strategies can be evaluated on a localized level and across a management unit.

5. Evaluation of restoration techniques in addition to reforestation and stand treatment techniques to speed the recovery of ecosystem function (e.g., hydrologic function).

5.0 Specific Strategies and Practices to Meet Habitat Objectives

5.1 Coarse Woody Debris

Habitat Objective
Retain and/or recruit coarse woody debris (CWD).

General Measures
1. Retain CWD on site in a way that mimics its natural distribution of randomness and connectivity, with

some clumping and layering.

2. Where present, maintain and/or recruit a mixture of both coniferous and deciduous CWD. Coniferous CWD decays more slowly than deciduous CWD, providing ecological benefits for a greater period of time; however, deciduous CWD provides important short-term ecological benefits.

3. 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 for interior regions.

Management Guidelines

Harvesting

1. 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.

2. Retain and/or recruit a range of CWD piece sizes (diameter and length) and decay classes (intact and hard to partially decayed; log decay classes 1-3 preferred, see Figure 7).

3. 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.

4. 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 provide linear travel corridors for small mammals.

5. Where mechanically harvested stub trees are left in cutblocks, arrange 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.

6. Where practical, buck, limb and top trees 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.

7. Forest managers usually classify stand damage due to windthrow as catastrophic or non-catastrophic. Catastrophic windthrow will generally be harvested if it can be done safely. Usually, some of this blowdown is left on site due to breakage, riparian management restrictions or economic inaccessibility, and will serve as future CWD. Non-catastrophic blowdown should be left unsalvaged and is a welcome source of continuous CWD input during the rotation of a stand.

Site Preparation

1. Minimize piling and windrowing. However, if piling, minimize pile sizes and mix piling with scattered debris.

2. Minimize burning of piles and accumulations, but balance this practice with consideration for undue fire or forest health hazards.

3. If broadcast burning is required, burn under conditions (i.e., cooler and moister) which remove fine fuels but maintain CWD and the organic soil layer.

4. Wherever possible, maintain CWD in place – don't disturb it with heavy equipment.

Reforestation

Vary target stocking levels and inter-tree distances, and use clumped planting patterns to accommodate accumulations of CWD and reduction of plantable spots on some portions of the cutblock.

Stand Tending

To provide recruitment of CWD over the life of the stand and into the future:

- designate wildlife tree patches (WTPs) in spacing and commercial thinning areas;
- use variable thinning densities within stands; and
- minimize removal of non-competing deciduous stems.

Silviculture Regimes

Management for the CWD conditions described above must first be considered at the landscape level. Specific stand level management tactics that will create the desired CWD conditions through rotation are extremely varied. In general, existing stand level stocking standards as described in the *Establishment to Free Growing Guidebooks* will not prohibit forest managers from achieving suitable CWD conditions. Stand level management strategies and tactics that work towards providing the conditions described in the General Measures and Management Guidelines sections above should be implemented across the landscape in a manner that meets landscape level objectives as well as site level objectives.

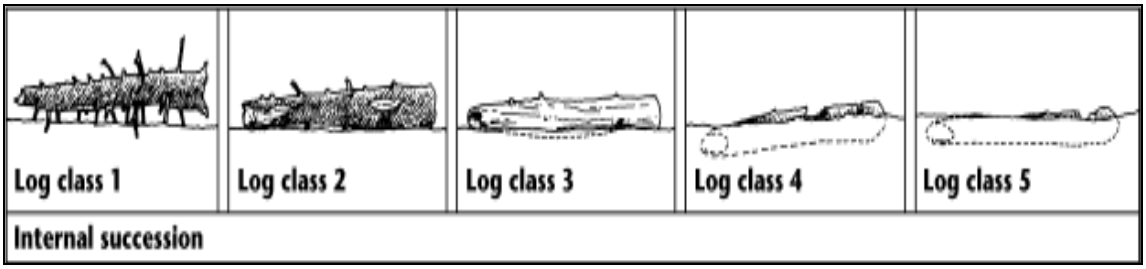

Figure 7: Coarse woody debris decay classes. *Source*: Wildlife Tree Committee (2001)

Monitoring Standards

Establishment (Age 0-4 Years) Phase:

Manipulation of establishment densities and species choices will provide for the larger piece sizes and species that form a key component of CWD requirements. In addition to planning retention, establishing new plantations which contain some areas with lower stocking at a greater than target inter tree distance (3-5 m) will aid in the development of larger piece sizes in a shorter period of time (future CWD recruitment). These areas often occur naturally across landscapes in the more extreme moisture regimes (hygric to subhygric sites). However, care should be taken during future crop planning to encourage their existence. Some sites with higher planting densities can also recruit CWD by increasing competition mortality between stems with subsequent breakage and input of CWD throughout the rotation.

Free Growing (Age 5-20 Years) Phase:

Existing establishment to free growing standards will not prohibit the achievement of desired stand conditions for CWD recruitment. However, several opportunities to augment CWD requirements exist

through this period of stand development, e.g., targeting retention of a minor deciduous component during brushing; juvenile spacing small dispersed areas to minimum free growing densities thereby recruiting future large wildlife trees and subsequent CWD.

Juvenile (Age 20-60 Years) Phase:

Existing stands within this age class may be managed to create the desired CWD composition through late juvenile spacing, e.g., space portions of treatment areas to 400-500 stems per ha for the recruitment of larger CWD, or commercial harvesting through thinning and retention strategies.

Mature (Age 60+ Years) Phase:

Subsequent harvesting strategies should be implemented that are consistent with the recommended recruitment strategies outlined.

Figure 8: Coniferous CWD decays more slowly than deciduous CWD, and provides habitat for a longer period. *Photo*: Alex Inselberg.

Selected References:

B.C. Ministry of Forests. 1997. Stand level biodiversity for forest managers course workbook, 3rd ed. B.C. Ministry Forests., B.C. Ministry of Environment, Lands and Parks, Victoria, B.C. 97pp.

B.C. Ministry of Forests. 2002. Provincial coarse woody debris policy. B.C. Ministry of Forests, Forest Practices Branch, Victoria, B.C. URL: http://www.for.gov.bc.ca/hfp/wlt/cwd-policy-01.htm.

B.C. Ministry of Forests and B.C. Ministry of Environment, Lands and Parks. 2000. Provincial wildlife tree policy and management recommendations. B.C. Ministry of Forests, Research Branch, B.C. Ministry of Environment, Lands and Parks, Habitat Branch, Victoria, BC. 14pp. URL: http://www.for.gov.bc.ca/hfp/wlt/ .

Darling, L.M. 1995. Monitoring changes in wildlife diversity during operational hardwood harvesting - aspen clearcutting in the Dawson Creek Forest District. Working plan 1995/96. B.C. Ministry of Environment, Lands and Parks, Wildlife Branch, Victoria, B.C.

Gayton, D.V. 2001. Ground work: basic concepts of ecological restoration in British Columbia. Southern Interior Forest Extension and Research Partnership (SIFERP), Kamloops, B.C. 25pp.

Greenough, J.A. and W.A. Kurz. 1996. Stand tending impacts on environmental indicators. B.C. Ministry of Forests, Silviculture Practices Branch, Victoria, B.C.

Hamilton, D. and D. English. 2000. A summary of habitat guidelines for enhanced silviculture. B.C. Ministry of Environment, Lands and Parks, Invermere, B.C. 43pp.

Hayes, J.P., S.S. Chan, W.H. Emmingham, J.C. Tappeiner, L.D. Kellogg and J.D. Bailey. 1997. Wildlife response to thinning young forests in the Pacific Northwest. Journal of Forestry 95(8):28-33.

Manning, T., P. Chytyk and L. Darling. 2001. Woody debris and wildlife trees in aspen and mixed-wood forests of northeastern British Columbia. B.C. Ministry of Environment, Lands and Parks, Wildlife Working Rep. No. WR-103, Victoria, B.C.

Stevens, V. 1997. The ecological role of coarse woody debris - an overview of the ecological importance of CWD in BC forests. B.C. Ministry of Forests, Research Program, working pap. 30, Victoria, B.C. 26pp.

Wildlife Tree Committee of B.C. 2001. Wildlife/danger tree assessor's course workbook - forest harvesting and silviculture module, June 2001. B.C. Ministry of Forests, B.C. Ministry of Water, Land and Air Prot., and B.C. Workers' Compensation Board, Victoria, B.C.

Wood, C. 1998. Habitat/ecosystem objectives and monitoring procedures for incremental and backlog silviculture treatments, ver. 2.0. B.C. Ministry of Environment, Lands and Parks, Resource Stewardship Branch, Victoria, B.C. 70pp.

5.2 Wildlife Tree Patches (WTPs)

Habitat Objectives

Retain and/or recruit trees with valuable wildlife tree attributes.

Wildlife tree retention objectives and percent of cutblock area requirements for wildlife tree retention in harvest blocks are described under section 9.1 and section 66 of the *Forest Planning and Practices Regulation* (http://www.for.gov.bc.ca/tasb/legsregs/frpa/frparegs/forplanprac/fppr.htm). **Note**: text that is shown as bold in this section will specifically provide **habitat attributes beneficial to bat species**.

General Measures

1. Integrate wildlife tree retention into higher level planning processes such as Landscape Unit Plans, as well as operational plans (e.g., Forest Stewardship Plans). In general, the amount and distribution of wildlife trees will be determined by biogeoclimatic subzone and will be based on: i) the proportion of the Timber Harvesting Landbase (THLB) in the subzone and the amount of THLB that has already been harvested in the THLB without wildlife tree retention, i.e., this will usually be a target set for a particular Landscape Unit (BC Ministry of Forests and BC Environment. 1999); **OR** ii) the default wildlife tree retention target which is calculated as a percentage of the cutblock area, i.e., net area to be reforested as per FPPR regulation sec. 66.

   Note: Site-specific factors such as the presence of ecological features of high habitat value (see MWLAP. 2004) or Identified Wildlife Management objectives (IWMS version 2004), may influence the size and location of WTPs beyond those recommended for that subzone in Landscape Unit Plans or by FPPR regulation sec. 66.

2. **Where possible, locate wildlife tree retention in association with valuable habitat features, e.g., mature or old forest patches, mixed-wood forest patches, upland hardwood patches, riparian areas, rocky outcrops, treed wetlands, gullies, and in areas of known occupied habitat features of species at risk or regionally important wildlife (e.g., dens, maternity roosts, hibernacula).**

3. **The size of WTPs should be at least large enough to buffer key wildlife trees (e.g., snags containing nest cavities; trees with broken tops, stem scars, hollows or cracks) from adjacent work areas, AND provide some undisturbed habitat and "interior-forest-like conditions".** As a general rule of thumb in order to meet these safety and ecological considerations, and where operationally possible, (i.e., consider topography, harvesting methods, etc**.), WTPs should have a minimum size of two tree lengths in radius (approximately 1 ha+), but can be larger.** Where possible, WTPs should be roughly centered on a focal biological anchor, such as a nest tree. A roughly circular patch shape, where topographically and operationally feasible, and ecologically appropriate (i.e., the patch contains the desired habitat attributes), will optimize forest interior habitat.

4. Locate WTPs in areas where there are high amounts of naturally occurring, quality wildlife trees and coarse woody debris (CWD). Retain some areas of root rot centres, which are usually in a concentrated location of snags, within WTPs.

5. Design wildlife tree retention to have a mix of management schemes, including patches and dispersed trees. Emphasize wildlife tree retention in patches rather than as single trees.

6. **Where present, retain a variety of tree species, including deciduous (particularly, trembling aspen (*Populus tremuloides*) paper birch (*Betula papyrifera*), and black cottonwood (*Populus balsamifera* ssp. trichocarpa), and uncommon coniferous species (such as Douglas-fir**

(*Pseudotsuga menziesii)* in the SBS zone), within WTPs.

7. Leave blowdown that occurs in WTPs as downed material for CWD.

Management Guidelines

1. Retain a range of tree diameters (starting at 20 cm dbh and greater) and decay classes (subject to worker safety requirements) within WTPs, (coniferous tree decay classes 2-6, and deciduous tree decay classes 2-4 are preferred for retention).

2. **Retain larger coniferous trees (in the upper 10% of the diameter range distribution) that have one or more of the following characteristics:**

    - show evidence of wildlife use;
    - minimum preferable diameter of > 50 cm for interior areas;
    - presence of heart rot decay (fungal conks may be visible);
    - **large diameter (>100 cm dbh) hollow stems (particularly cedars or black cottonwood which can function as bear dens or bat roosts);**
    - **stem scars or cracks;**
    - dead or broken tops;
    - **loose sloughing bark or thick fissured bark; and/or**
    - **trees which extend above the main forest canopy layer.**

3. **Retain larger deciduous trees (in the upper 10% of the diameter range distribution, with an emphasis on trees >30 cm dbh in interior areas) that have one or more of the following characteristics:**

    - **presence of large cavities, stem hollows or dens;**
    - presence of heart rot decay, fungal conks; and/or
    - **stem scars, scars from large broken limbs, large stem cracks or bark crevices.**

Figure 9: Bat roosts in large stem cracks in trembling aspen (left and right photos), and under loose sloughing bark in pine (below photo). *Photos*: J. Psyllakis.

4. Where available, use standing dead (especially decay classes 3-4) or live defective coniferous trees (decay class 2) with characteristics as described in #2 above, as "biological anchors" around which WTPs can be designed. Where possible, having a green tree buffer around the anchor tree(s) will enhance the habitat value of these trees.

5. Where operationally feasible, retain some large declining (decay class 2) and recently dead trees (decay class 3) along the edges of green WTPs.

6. **Maintain some WTPs beyond typical rotation periods (at least 60-100 years or greater) to allow mature and old forest attributes to develop.**

7. When conducting juvenile spacing or thinning activities, space some sites to lower than target densities in order to create a more open stand. This will recruit larger, "wolfy" trees.

8. Where necessary, use the danger tree assessment procedures found in the provincial "Wildlife/Danger Tree Assessor's Course" (WTC. 2001) to evaluate potential tree hazards and risks to workers in areas where there are standing dead or defective trees. Use these techniques to retain standing dead or defective tree structure in a safe manner during both harvesting and silviculture operations. See http://www.Forestsgov.bc.ca/hfp/wlt/ for more information on dangerous tree assessment procedures in B.C.

9. Where operationally feasible and ecologically appropriate, the following activities can enhance wildlife tree densities in areas deficient of naturally occurring wildlife trees by:

   - Planting upright snags with an excavator. This technique uses cull logs and is usually only recommended for activities such as road deactivation or other areas where no standing dead tree structure exists.
   - Creating stubs (stems cut at 4-6 m high with a mechanical harvester). Stubs should be retained in small clusters; leave advance regeneration or deciduous trees around some of the stubs to provide additional cover. Trees selected as candidates for stubbing should have some evidence of existing damage or decay (e.g., cavities, scars, cracks, conks).
   - Inoculating live coniferous trees with endemic heart rot fungi. This is an ecosystem-specific technique best suited to second growth stands and is currently being operationally tested in British Columbia, see Manning (2003).

10. Trees considered for fungal inoculation should be reserved as "full cycle trees" (i.e., until they have decayed as CWD). Selected trees should typically be healthy, class 1, second growth trees, such as, dispersed trees or seed trees found in partial cutting silvicultural systems (recommended species for inoculation include Douglas-fir (*Pseudotsuga menziesii*) and spruce (*Picea* spp.).

Silviculture Regimes

Development of specific silviculture regimes to achieve wildlife tree patch objectives is not possible on a broad scale. Management for the WTP conditions described above must first be considered and incorporated into landscape level planning. Specific stand level management practices that create the desired WTP conditions throughout rotation lengths are extremely varied. In general, existing stand level stocking standards as described in the *Establishment to Free Growing Guidebooks* will not prohibit forest managers from achieving suitable WTP conditions. Stand level management strategies and practices that work towards providing the conditions described in the General Measures and Management Guidelines sections should be implemented across the landscape as applicable.

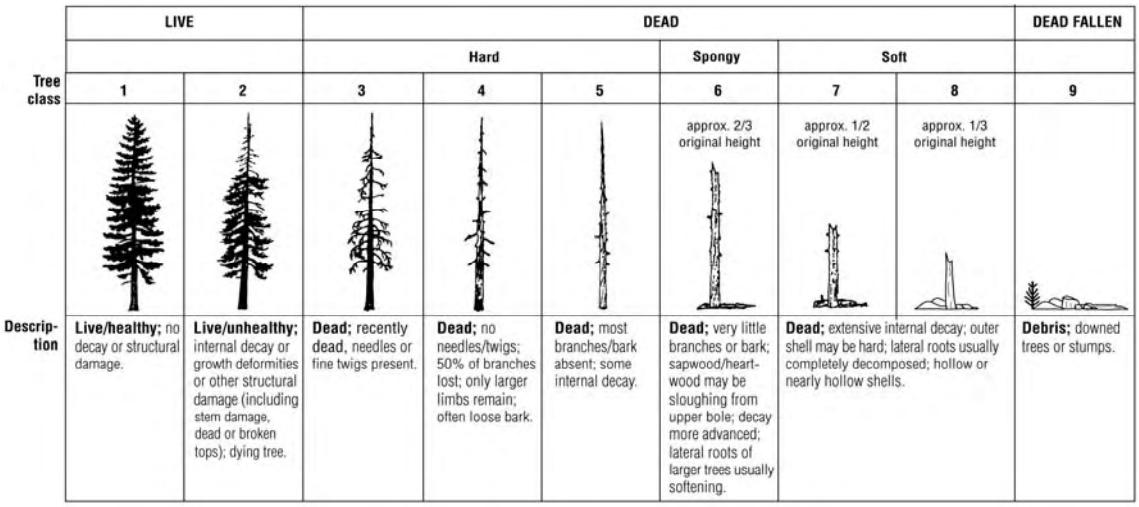

Figure 10: Coniferous wildlife tree decay classes. *Source*: Wildlife Tree Committee (2001).

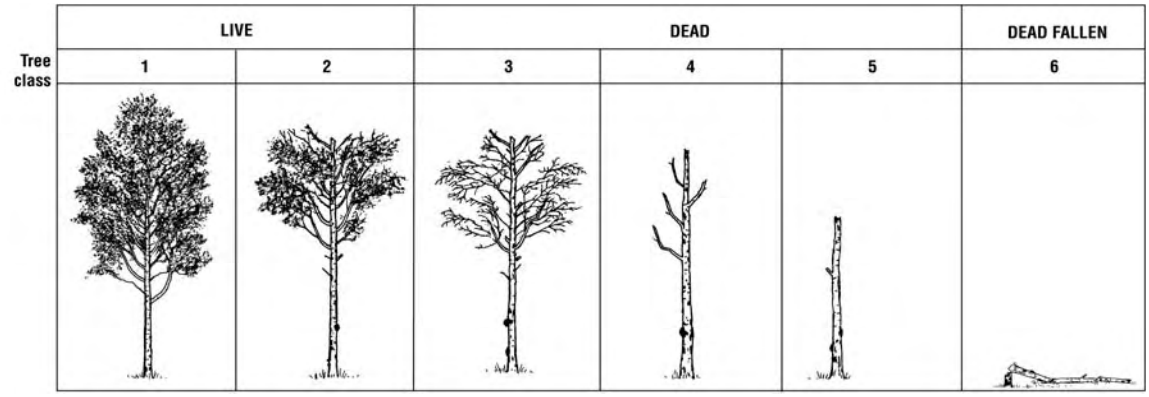

Figure 11: Deciduous wildlife tree decay classes. *Source*: Wildlife Tree Committee (2001).

Figure 12: Wildlife trees provide important habitat for various bird species, including Great Horned Owls. *Photo*: Alex Inselberg.

Figure 9: Diverse stand structure provides CWD, varied shrub understory and a range of tree classes, sizes and species. *Photo*: Alex Inselberg.

Selected References:

Aubry, K.B. and C.M. Raley. 2002. The pileated woodpecker as a keystone habitat modifier in the Pacific Northwest. USDA Forest Service, Gen. Tech. Rep. PSW-GTR-181.

Barclay, R.M.R. and R.M. Brigham (editors). 1996. Bats and Forests Symposium, October 19-21, 1995, Victoria, British Columbia, Canada. Research Branch, BC Ministry of Forests, Victoria, B.C. Working Paper 23/1996. 292pp.

B.C. Ministry of Forests. 1997. Stand level biodiversity for forest managers course workbook, 3rd ed. B.C. Ministry of Forests, B.C. Environment, Lands and Parks, Victoria, B.C. 97pp.

B.C. Ministry of Forests and B.C. Ministry of Environment, Lands and Parks. 1999. Landscape unit planning guide. Victoria, BC.

B.C. Ministry of Forests and B.C. Ministry of Environment, Lands and Parks. 2000. Provincial wildlife tree policy and management recommendations. Victoria, B.C. 14pp. URL: http://www.for.gov.bc.ca/hfp/wlt/.

Bunnell, F.L., L.L. Kremsater, and E. Wind. 1999. Managing to sustain vertebrate richness in forests of the Pacific Northwest: relationships within stands. Environmental Review 7:97-146.

Craig, V. J., and S.L. Holroyd Rasheed. 2004. Bat Conservation Strategy for B.C. and Alberta. Draft report. B.C. Ministry of Water Land and Air Protection.

Darling, L.M. 1995. Monitoring changes in wildlife diversity during operational hardwood harvesting - aspen clearcutting in the Dawson Creek Forest District. Working plan 1995/96. B.C. Ministry of Environment, Lands and Parks, Wildlife Branch, Victoria, B.C.

Gayton, D.V. 2001. Ground work: basic concepts of ecological restoration in British Columbia. Southern Interior Forest Extension and Research Partnership (SIFERP), Kamloops, B.C. 25pp.

Greenough, J.A. and W.A. Kurz. 1996. Stand tending impacts on environmental indicators. B.C. Ministry of Forests, Silviculture Practices Branch, Victoria, B.C.

Hamilton, D. and D. English. 2000. A summary of habitat guidelines for enhanced silviculture. B.C. Ministry of Environment, Lands and Parks, Invermere, B.C. 43pp.

Hayes, J.P., S.S. Chan, W.H. Emmingham, J.C. Tappeiner, L.D. Kellogg and J.D. Bailey. 1997. Wildlife response to thinning young forests in the Pacific Northwest. J. of Forestry. 95(8):28-33.

Lacki, M. J; and J. H. Schwierjohann. 2001. Day-roost characteristics of northern bats in mixed mesophytic forest. Journal of Wildlife Management 65: 482-488.

Laudenslayer Jr., W.F., P. J. Shea, B. E. Valentine, C. P. Weatherspoon, and T. E. Lisle (technical editors). 2002. Proceedings of the Symposium on The Ecology and Management of Dead Wood in Western Forests, 2-4 November 1999, Reno, Nevada. USDA Forest Service General Technical Report PSW-GTR-181.

Machmer, M. M. and C. Steeger. 1995. The ecological roles of wildlife tree users in forest ecosystems. B.C. Ministry of Forests, Research Branch, Land Management Handbook No. 35, Victoria, B.C. 54pp.

Manning, T. 2003. Fungal inoculation to create wildlife trees. *In* Integrating ecosystem restoration into forest management: Practical examples for foresters. Society for Ecological Restoration BC, Victoria, B.C. pp. 17-18.

Manning, T., P. Chytyk and L. Darling. 2001. Woody debris and wildlife trees in aspen and mixed-wood forests of northeastern British Columbia. B.C. Ministry of Environment, Lands and Parks, Wildlife Working Rep. No. WR-103, Victoria, B.C.

Ministry of Water, Land and Air Protection (MWLAP). 2004. Identified Wildlife Management Strategy (IWMS) version 2004. Victoria, BC. URL: http://www.env.gov.bc.ca/wld/identified/strategy_info.htm.

Ministry of Water, Land and Air Protection (MWLAP). 2004. Wildlife Habitat Features (WHF) – Summary of management guidelines for the Northern Interior Forest Region. Victoria, B.C. DRAFT. Nov. 2004.

Parsons, S., K. J, Lewis, and J. M. Psyllakis. 2003. Relationships between roosting habitat of bats and decay of aspen in the sub-boreal forests of British Columbia. Forest Ecology and Management 177:559-570.

Stevens, V. 1997. The ecological role of coarse woody debris - an overview of the ecological importance of CWD in B.C. forests. B.C. Ministry of Forests, Research. Program, working pap. 30, Victoria, B.C. 26pp.

Stone, J.N. and J.L. Porter. 1998. What is forest stand structure and how to measure it? Pp. 25-26 *in* J.A. Trofymow and A. MacKinnon, (eds.). Workshop proc., Structure, process, and diversity in successional forests of coastal British Columbia, Feb. 17-19, 1998, Victoria, B.C. Northwest Science, vol. 72 (Spec. Issue No. 2).

Vonhof, M.J., and R.M.R. Barclay. 1997. Use of tree stumps as roosts by the western long-eared bat. Journal of Wildlife Management 61:674-684.

Waldien, D.L., J.P. Hayes, and E.B. Arnett. 2000. Day-roosts of female long-eared myotis in western Oregon. Journal of Wildlife Management 64:785-796.

Wildlife Tree Committee of B.C. (WTC). 2001. Wildlife/danger tree assessor's course workbook - forest harvesting and silviculture module, June 2001. B.C.Ministry of Forests, B.C. Ministry of Water, Land and Air Protection, and B.C. Workers' Compensation Board, Victoria, BC. URL: http://www.for.gov.bc.ca/hfp/wlt/.

Wood, C. 1998. Habitat/ecosystem objectives and monitoring procedures for incremental and backlog silviculture treatments, ver. 2.0. B.C. Ministry of Environment, Lands and Parks, Resource Stewardship Branch, Victoria, B.C. 70pp.

5.3 Primary Cavity Excavators

Habitat Objectives

Maintain and/or recruit habitat elements for primary cavity excavators (includes 19 species of native birds) – for reproduction, roosting, and foraging.

Two species of Woodpeckers are known to use lodgepole pine forests preferentially, but are not restricted to it. These are the Black-backed Woodpecker (*Picoides arcticus*) and Three-toed Woodpecker (*Picoides tridactylus*). These birds feed and nest in beetle-infected pine stands.

By providing habitat for primary cavity excavating birds, a variety of secondary cavity users benefit (i.e., they use abandoned Woodpecker cavities and excavations for nesting, denning and roosting). (See WTC 2001 for additional information on wildlife tree-dependent species).

A discussion of landscape level considerations relevant to the management of wildlife trees is found in section 5.2 of this report.

Forest Types or BEC Zones

SBPS dc, mk, SBS dk, dw, mc, mh, mk

While primary cavity excavators occur in all BEC units that have suitable trees, the above zones or subzones are those that generally have "high" habitat suitability for a range of primary cavity excavating bird species where lodgepole pine occurs.

Management Guidelines

Harvesting:

1. Retain standing dead trees (snags) and live defective trees (decay class 2 trees) where safe to do so. Include trees with dead tops, broken tops, thick fissured bark, lightning scars or stem cracks, fire scars, mechanical injury stem scars, or evidence of internal decay (i.e., presence of fungal conks, woodpecker cavities and excavations). See WTC (2001) for further information on danger tree assessment procedures in harvesting operations and along roads.

2. Where possible, retain standing dead or defective trees located within green tree patches [i.e., Wildlife Tree Patches (WTPs), also see sec. 5.2]. Using dead or defective trees as "biological anchors" around which WTPs are built, will increase the habitat value of these trees.

3. Where possible, retain some larger diameter healthy live trees (known as decay class 1 trees) across rotation lengths into the next rotation (at least 60-100 years, or greater) for recruitment of future wildlife trees. For operational efficiency and biological reasons, clumpy or patchy distribution is preferred to single tree, dispersed distribution. The latter can also significantly add to meeting retention objectives.

4. In general, larger diameter and taller wildlife trees provide better habitat quality:
   - > 50 cm dbh conifers are preferable in interior areas of B.C.; and
   - > 15 m in height preferable.

5. Retain large (> 40 cm dbh) trembling aspen (*Populus tremuloides*) and a range of sizes and decay

classes of paper birch (*Betula papyrifera*) where they occur throughout interior B.C. Mixed wood stands containing these species are especially valuable.

6. Retain large diameter (> 50 cm dbh) black cottonwood (*Populus balsamifera trichocarpa*), especially in riparian areas.

7. 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.

8. Where non-pine tree species are not available for retention, create feller-buncher-cut stubs from beetle-killed pine stems. Trees selected for stubbing should be cut at approximately 4-6 m high. Look for trees that already have existing stem damage or decay, e.g., scars, cracks, cavities, conks, as candidates for stubbing.

9. Consider recruiting future wildlife trees by inoculation with native heart rot fungi (see Restoration section below).

Pileated Woodpecker (*Dryocopus pileatus*)

Because of their important role as a keystone species in forest ecosystems (i.e., their nest and feeding excavations provide habitat for other species of wildlife), specific strategies should be implemented to provide habitat for the Pileated Woodpecker, as follows:

1. 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 that are food for Pileated Woodpeckers.

2. Because of the large home range sizes of Pileated Woodpeckers, provide at least one large diameter conifer per ha across the landscape for roosting, nesting or feeding habitat (spruce or Douglas-fir > 70 cm dbh, tree decay classes 2-5 recommended).

3. Retain large diameter (>40 cm dbh) trembling aspen as nesting habitat.

Management Guidelines

Restoration:

1. When harvesting in second growth conifer stands, consider fungal inoculation of some larger diameter (> 70 cm dbh in coastal areas and > 50 cm dbh in interior areas) live individual leave trees [spruce (*Picea* spp.) recommended] with native heart rot fungi (*Phellinus pini* or *Fomitopsis pinicola* recommended) to create heart rot decay. Selected trees should be inoculated at least 10 m above ground. These trees should be retained at least for the length of the rotation (60-100 years or more) and should accelerate recruitment of wildlife trees over natural decay dynamics, thereby increasing habitat supply for Woodpeckers and other cavity users. See Manning (2003) for additional information on fungal inoculation.

Regeneration:

1. Manage for inclusion or natural acceptance of some Douglas-fir sites where they are preferred or acceptable, even when otherwise managing for single species crops of other species such as

lodgepole pine (*P. contorta*). Consider multiple species plantations for biodiversity and forest health.

2. When selecting free growing stocking standards for most sites, allow for some variances in density to below minimums for the development of large wildlife trees, and variances in species composition (e.g., a hardwood component such as trembling aspen, paper birch or black cottonwood) so a variety of wildlife are attracted.

3. Try to avoid damage to the root systems and boles of retained wildlife trees during mechanical site preparation activities.

Brushing:

1. When brushing, maintain some black cottonwood, paper birch or trembling aspen on suitable microsites, bench sites and flood plains, as potential habitat.

Spacing/Thinning/Pruning:

1. Spacing or thinning of stands allows manipulation of species composition in order to retain a variety of tree species for forest health. In general, stand tending (pruning, spacing or thinning) tends to have the following beneficial effects on Woodpecker habitat quality by affecting the volume and diameter of snags and CWD recruited into the stand:

   - Stand tending decreases the future volume of CWD but increases its average future size;
   - Spacing or thinning increases tree incremental growth, thus recruiting trees to become larger snags at an earlier age; and
   - Variable density thinning to minimum densities on some areas of a stand provides opportunities to recruit larger diameter wildlife trees of preferred tree species.

Consider retaining dead and defective trees as wildlife trees in all of the above silviculture activities. Consult the "Wildlife/Danger Tree Assessor's Course" (WTC 2001) for information on tree assessment criteria and procedures. Also consult the Wildlife Tree Committee of B.C. website (URL: http://www.for.gov.bc.ca/hfp/wlt/) to download a copy of the course and for information on registration requirements.

Protection (fire, insects, disease, damage):

1. Piling and burning of CWD should be avoided where possible, as feeding opportunities for various Woodpeckers are greatly reduced. However, escaped fringe burns can dramatically increase both Woodpecker feeding and nesting opportunities in some areas. Do not salvage burned trees that will provide habitat in escaped fringe burns unless they pose an unacceptable forest health or worker safety risk.

2. Where slash is piled for burning, large CWD should either be excluded from the piles, or piles should be left unburned, which will also benefit small mammals.

3. Root rot pockets (both *Phellinus* spp. and *Armillaria* spp.) will provide temporary feeding opportunities for primary cavity excavators. However, most immature or thrifty mature standing dead trees with sap rot provide poor quality nesting habitat for primary cavity excavators, but can be good foraging sites. Large diameter and veteran Douglas-fir which have root rot infections and which are dying from the crown down, are, on the other hand, suitable wildlife trees. Infected trees in this condition should be retained singly or in wildlife tree patches. Therefore, plant disease-resistant species around root rot patches to minimize spread into adjacent plantations. Root rot-killed trees are also important for weak primary cavity excavators such as Nuthatches and Chickadees.

4. Conifers infected by bark beetles are used by various Woodpeckers for feeding and in some cases for nesting. When salvage harvesting such stands, some beetle-killed, large diameter pine, spruce or Douglas-fir should be left in wildlife tree patches and preferably surrounded by other non-infected and/or non-susceptible green trees (conifers and hardwoods).

Silvicultural Regimes

Management of habitat conditions for cavity nesters and other species must first be considered at the landscape level. Silviculture regimes should be planned and applied, based on management objectives for the species in question and according to the habitat capability and suitability of sites. In general, existing stand level stocking standards as described in the *Establishment to Free Growing Guidebooks* can achieve suitable habitat conditions for primary cavity excavators on a site specific basis.

Monitoring Standards

Establishment (Age 0-4 Years) Phase:

In general, manipulation of establishment densities and species choices will provide for the larger piece sizes and species that form a key component of habitat requirements. In addition to retention strategies for harvested areas, establishing new plantations that contain some areas with lower stocking at a greater than target inter tree distance (3-5 m) will aid in the development of larger piece sizes in a shorter period of time. These areas generally occur across a landscape naturally in the more extreme ecosystems (hygric to subhygric sites); however, care should be taken during future crop planning to ensure their existence.

Free Growing (Age 5-20 Years) Phase:

Several opportunities to augment habitat requirements exist through this period of stand development, e.g., targeting retention of a minor deciduous component during brushing or juvenile spacing small dispersed areas to minimum free growing densities will allow for future recruitment of large wildlife trees.

Juvenile (Age 20-60 Years) Phase:

Existing stands within this age class may be managed to create the desired larger stem sizes and species composition through late juvenile spacing (space portions of treatment areas to 400-500 stems per ha) or commercial harvesting through variable thinning and variable retention strategies.

Mature (Age 60+ Years) Phase:

In general, subsequent harvesting strategies should be implemented that are consistent with the retention strategies outlined. Consider periodic monitoring to determine whether wildlife trees of suitable condition are being retained and managed for primary cavity excavators.

Figure 10: Wildlife trees provide forage habitat for Pileated Woodpeckers and other primary cavity excavators. *Photo*: Alex Inselberg.

Figure 11: Mixed-wood stands provide good nesting and foraging habitat for primary cavity excavators. *Photo*: Alex Inselberg.

Selected References:

Aubry, K.B. and C.M. Raley. 2002. The Pileated Woodpecker as a keystone habitat modifier in the Pacific Northwest. USDA Forest Service, General Technical Report. PSW-GTR-181, Olympia, WA.

Bull, E.L. and R.S. Holthausen. 1993. Habitat use and management of Pileated Woodpeckers in northeastern Oregon. Journal of Wildlife Management 57:335-345.

Campbell, R.W., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser, and M.C.E. McNall. 1990. The birds of British Columbia, vol. 2, nonpasserines, diurnal birds of prey through woodpeckers. Royal British Columbia Museum, Victoria, BC and Canadian Wildlife Service, Delta, B.C. 662pp.

Cannings, R.J. 1992. Status report on the White-headed Woodpecker *Picoides albolarvatus* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON. 13pp.

Cooper, J.M. 1995. Status of the Williamson's Sapsucker in British Columbia. B.C. Ministry of Environment, Lands and Parks, Wildlife Working Report No. WR-69, Victoria, B.C. 24pp.

Cooper, J.M. and S. Beauchesne. 2000. Inventory of Lewis's Woodpecker population and habitat in the east Kootenay. B.C. Ministry of Environment, Lands and Parks, Wildlife Working Report. No. WR-100, Victoria, B.C. 30pp.

Cooper, J.M. and C. Gillies. 2000. Breeding distribution of Lewis's Woodpecker in the East Kootenay Trench in relation to fire history. Pp. 423-428 *in* L.M. Darling (ed.). At risk: proceedings of a conference on the biology and management of species and habitats at risk. B.C. Ministry of Environment, Lands and Parks, Habitat Branch, Victoria, B.C.

Cooper, J.M., C. Siddle, and G. Davidson. 1998. Status of the Lewis's Woodpecker in British Columbia. B.C. Ministry of Environment, Lands and Parks, Wildlife Working Report No. WR-91, Victoria, B.C. 34pp.

Daily, G.C. 1993. Heartwood decay and vertical distribution of red-naped sapsucker nest cavities. Wilson Bull. 105:674-679.

Erskine, A.J. and W.D. McLaren. 1972. Sapsucker nest holes and their use by other species. Canadian Field Naturalist. 86:357-361.

Keisker, D.G. 1987. Nest tree selection by primary cavity-nesting birds in south-central British Columbia. B.C. Ministry of Environment, Wildlife Branch, Wildlife Report No. R-13, Victoria, B.C. 67pp.

Machmer, M. M. and C. Steeger. 1995. The ecological roles of wildlife tree users in forest ecosystems. B.C. Ministry of Forests, Research Branch, Land Management Handbook No. 35, Victoria, B.C. 54pp.

Manning, T. 2003. Fungal inoculation to create wildlife trees. *In* Integrating ecosystem restoration into forest management: Practical examples for foresters. Society for Ecological Restoration BC, Victoria, B.C. pp. 17-18.

Steeger, C. and C.L. Hitchcock. 1998. Influence of forest structure and diseases on nest-site selection by red-breasted nuthatches. Journal of Wildlife Management 62:1349-1358.

Stevens, V. 1995. Database for wildlife diversity in British Columbia: distribution and habitat use of amphibians, reptiles, birds and mammals in biogeoclimatic zones. Working Paper, B.C. Ministry of Environment, Lands and Parks, Victoria, B.C.

Wood, C. 1998. Habitat/ecosystem objectives and monitoring procedures for incremental and backlog silviculture treatments, ver. 2.0. B.C. Ministry of Environment, Lands and Parks, Resource Stewardship Branch, Victoria, B.C. 70pp.

Wildlife Tree Committee of B.C (WTC). 2001. Wildlife/danger tree assessor's course workbook - forest harvesting and silviculture module, June 2001. B.C. Ministry Forests, B.C. Ministry of Water, Land and Air Protection, and B.C. Workers' Compensation Board, Victoria, B.C. URL: http://www.for.gov.bc.ca/hfp/wlt/ .

5.4 Northern Goshawk (*Accipiter gentilis atricapillus*) Reproduction and Foraging

Habitat Objectives

Maintain and/or recruit reproduction and foraging habitat elements for Northern Goshawk (interior subspecies).

Landscape level management objectives such as connectivity, patch size distribution and seral stage targets should be described in higher-level plans and sustainable forest management plans. It is important to provide a mosaic of mature or old forest reserves and forested corridors to maintain habitat and habitat connectivity across the landscape. Objectives should link to higher level plan objectives such as mature/old forest targets and old growth management areas (OGMAs) for a landscape unit or other planning area, with specific practices implemented at the stand level is also very.

Refer to the *Identified Wildlife Management Strategy Version 2004* (http://www.env.gov.bc.ca/wld/identified/iwms2004.html) for additional detailed management guidelines for Northern Goshawk.

Forest Types or BEC Zones

Interior: SBS wk2

Management Guidelines

Harvesting:

1. Maintain and/or recruit forest structure [e.g., snags, wildlife tree patches (WTPs) and coarse woody debris (CWD)] in harvested areas that will provide foraging habitat after regenerated stands begin to self-thin.

2. Maintain and/or recruit forest buffers around and travel corridors in between: riparian areas (including streams and wetlands); areas of significant forest structure (e.g., old forest patches); and topographical features such as gullies and rock outcroppings.

3. Maintain and/or recruit mature and old forest canopy characteristics [e.g., a single-storied main canopy with a high overall canopy closure (60-90%)]; canopy gaps; areas with multi-layered canopies; some dispersed single or imbedded patches of hardwood components [e.g., trembling aspen (*Populus tremuloides*)] with an average main canopy tree height > 20 m.

4. If a suitable variety of tree species exists, implement partial cutting and retention strategies that create a mosaic of accessible, semi-open foraging habitats as well as some areas with higher canopy closure (>60%) containing some large diameter trees that could provide suitable nest sites.

5. On slopes, give priority to habitat enhancements located at low, mid-slope positions and on slope benches. Benches appear to be preferred locations for nest sites.

6. Retain old roads, trails and railway grades as their more open canopy structures are often used by Goshawks as flight paths and for foraging.

7. Retain and recruit large diameter trembling aspen (> 40 cm dbh) where present, as these are often used as nest trees by both Goshawks and some of their prey species (e.g., Woodpeckers).

Management Guidelines

Restoration:

1. In second growth conifer stands where snags can be recruited, consider fungal inoculation of some larger diameter (> 30 cm dbh in the interior), live individual leave trees [Douglas-fir (*Pseudotsuga menziesii*), and white spruce (*Picea glauca*) recommended] with endemic heart rot fungi (*Phellinus pini* or *Fomitopsis pinicola* recommended) to create heart rot decay. These trees should be retained for the length of the rotation or several rotations (≥ 60 years), to accelerate wildlife tree recruitment (i.e., to create trees which can accommodate cavity excavators/dwellers) as well as tree decay/breakage and formation of small canopy gaps, which promote open foraging areas for Goshawks and increase habitat supply for the Goshawk prey base.

Regeneration:

1. Regenerate with the preferred and acceptable species for the indicated microsites with the overall aim to achieve closed, raised canopies as soon as possible in order to reduce dense understory and achieve self-pruning of the low to mid boles. Allow for some species mixes by planting or natural ingress singly, in dispersed groups or patches, as well as scattered brushy openings and hardwood components for diversity of prey species (e.g., small mammals, songbirds and grouse).

Brushing:

1. Early plantation brush treatments will release and manage distribution, future stem density and tree species composition. Early brush treatments per se will have little direct influence on actual understory brush densities at the time of Goshawk use (later in the rotation). However, these treatments will create or maintain some brushy openings in a stand as habitat for passerine bird prey species and grouse habitat.

2. Maintain low to moderate levels of ground vegetation cover (< 40%), and relatively open understories.

3. Maintain some over-grown brush areas, hardwood components or other prey species (e.g., passerine birds and grouse) habitat for future maintenance within an otherwise densely managed coniferous stand.

Spacing/Thinning/Pruning:

1. Thin and space early seral stands to reduce successional time for a stand to exhibit mature and old forest characteristics.

2. Maintain and/or recruit low to moderate levels of ground vegetation cover (< 40%), and relatively open understories.

3. Target an overall stand matrix with raised coniferous canopies (with crown closures >60%), low to moderate understory vegetation, and fairly high stem densities. Within these stands, create or maintain some diverse openings for shrubs and single trees, or scattered patches of hardwoods to create and/or maintain Goshawk prey habitat.

Fertilization:

1. Forest fertilization can be expected to accelerate overall stand development by increasing bole diameters, canopy closure and accelerating understory brush die-back and self-pruning below the canopy. Fertilize at an early seral stage (usually at the time of, or soon after juvenile spacing) to reduce successional time for a stand to achieve crown closure, self-pruning and understory brush suppression.

Protection (fire, insects, disease, damage):

1. Maintain some unburned slash piles to create Goshawk prey habitat (e.g., small mammals and birds) within the future stand.

2. Maintain large CWD and slash accumulations, non-catastrophic blowdown to achieve similar results.

3. Insect and disease pockets of dead standing and downed CWD trees will maintain scattered prey habitat niches in a stand.

Silvicultural Regimes

BEC Zones ***SBSwk2***	**Submesic to Subhygric sites**: Management of these sites should focus on the enhancement and/or recruitment of stand structure and habitat elements for Goshawk. The associated standards reflect this goal, primarily the desire to move to closed canopies with little understory vegetation as rapidly as possible. Silvicultural systems that may be applicable for this objective include clearcut with reserves, variable retention cut, seed tree, and shelterwood systems. Where safe to do so, all site preparation treatments should protect wildlife trees retained during harvesting and should maintain some slash piles unburned when machine piling. Establish plantations on a uniform pattern to encourage earlier crown closure. The intent is to have the wetter and drier ecosystems across a landscape naturally provide the canopy gaps that Goshawks require. Therefore, management of submesic to subhygric ecosystems is intended to develop closed canopy stands containing some gaps as rapidly as possible, with little understory vegetation (except in the gaps). Maintain low levels of competing vegetation through the establishment phase by manual, or possibly chemical, treatments (ensure adequate buffers adjacent to nesting areas). Other opportunities that may be available through the establishment phase that can coincide with brushing treatments include girdling of retained green wildlife trees to initiate stem decay for snag recruitment and future CWD. Implement juvenile spacing programs as required (max density 4000 stems per ha) to ensure an even distribution of crop trees and even, rapid crown closure occurs. Post spacing standards should equal the target stocking standard for single entry spacing. Opportunities to initiate stem decay for snag recruitment and CWD requirements should be considered during spacing operations (e.g., girdling or fungal inoculation of existing green trees, see Restoration section).

Monitoring Standards

Establishment to Free Growing Stocking Standard Guidelines

Applicable Ecosystem (BEC)			Stocking Standard Modifiers							
Zone	**Subzone**	**Moisture Nutrient Regime**	**Species Selection**	**Stocking Standard Modifier**	**Regen Delay**	**Assess-ment Time Frame**	**Min. Tree Ht.**	**% Tree Over Brush**	**Min Inter Tree Distance**	
SBS	wk2	3-5/B-E	Same	Same	Same	Same	Same	Same	2.0	

1. Broadleaf species management for mixed coniferous/deciduous stands should be seriously considered where applicable for this management objective. Utilize the appropriate broadleaf species as a primary or secondary species as indicated in the Establishment to Free Growing Guidebooks.
2. Maximum density is 4000 stems per ha for these ecosystems. Post spacing densities should equal target stocking standard densities. The relatively narrow range from MSS to max density is intended to provide for a rapid move to old forest canopy characteristics, e.g., a single-storied main canopy with a high overall canopy closure (60-90%) and relatively open understories.

Monitoring Standards

Juvenile (Age 20-60 Years) Phase:

No specific standards are developed for this point in stand development. Management of younger age classes (e.g., establishment to free growing 0-20 years) is intended to develop suitable stand conditions through this age class. Existing stands within this age class may be managed to create the desired closed, even canopy conditions through late juvenile spacing or commercial thinning.

Mature (Age 60+ Years) Phase:

No specific standards are applicable for this age class. In general, subsequent harvesting strategies should be implemented that are consistent with the guidelines outlined. Consider monitoring as appropriate to determine if desired structural characteristics have been achieved.

Selected References:

Campbell, R.W., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser, and M.C.E. McNall. 1990. The birds of British Columbia, vol. 2, nonpasserines, diurnal birds of prey through woodpeckers. Royal British Columbia Museum, Victoria, BC and Canadian Wildlife Service, Delta, B.C. 662pp.

Chytyk, P., J.M. Cooper and S. Bennett. 2001. 2001 Northern Goshawk inventory of block 4, Canfor TFL 48, Chetwynd, BC. Unpubl. rep. for Canadian Forest. Products Ltd., Chetwynd Operation, Chetwynd, B.C. 38pp.

Chytyk, P., J.M. Cooper, and K. Dhanwant. 1997. 1997 Northern Goshawk population inventory of the Queen Charlotte Islands/Haida Gwaii. Unpubl. rep. for B.C. Ministry of Environment, Lands and Parks, Smithers, B.C. 28pp.

Cooper, J.M. and V. Stevens. 2000. A review of the ecology, management and conservation of the Northern Goshawk in British Columbia. B.C. Ministry of Environment, Lands and Parks, Wildland Bulletin. B-101, Victoria, B.C.

Doyle, F. and T. Mahon. 2000. Inventory of the Northern Goshawk (*Accipiter gentilis*) in the Kispiox Forest District. Unpubl. rep. for Skeena Cellulose Inc., Smithers, BC.

Graham, R.T., R.L. Rodriguez, K.M. Paulin, R.L. Player, A.P. Heap and R. Williams. 1999. The Northern Goshawk in Utah: habitat assessment and management recommendations. USDA Forest Service, Rocky Mountain. Research Station, GTR RMRS-GTR-22.

Machmer, M.M. 1999. Development of Northern Goshawk forest management guidelines for the Arrow Forest District. B.C. Ministry of Forest, Arrow District, Castlegar, B.C. 38pp.

Machmer, M.M. and J. Dulisse. 2000. Northern Goshawk inventory and breeding habitat assessment in the Invermere Enhanced Forest Management Pilot Project Area: final report (1998-1999). B.C. Ministry of Forests, Invermere, B.C.

Mahon, T. and F. Doyle. 2003. Northern Goshawks in the Morice and Lakes Forest Districts, 5-year project summary. Wildfor Consultants Ltd., Telkwa, B.C. IFPA Project No. 431.02.

Mahon, T. and F. Doyle. 2000. Inventory of the northern Goshawk in the Lakes Forest District. Unpubl. rep. for Babine Forest Products, Burns Lake, B.C.

McClaren, E. 2001. Queen Charlotte Goshawk (*Accipiter gentilis laingi*) population inventory summary for Vancouver Island, B.C. (2000/2001). Unpubl. rep. for B.C. Ministry of Environment, Lands and Parks, Nanaimo, B.C. 34pp.

McClaren, E. 2001. Factors influencing Northern Goshawk detectability and reproduction on Vancouver Island, British Columbia. MSc. thesis., Col. State Univ., Dep. Fish. and Wildlife Biology, Ft. Collins, CO. 54pp.

McClaren, E.L., P.L Kennedy and S.R. Dewey. 2002. Do some Northern Goshawk nest areas consistently fledge more young than others? Condor 104: 343-352.

Stevens, V. 1995. Database for wildlife diversity in British Columbia: distribution and habitat use of amphibians, reptiles, birds and mammals in biogeoclimatic zones. Working Paper, B.C. Ministry of Environment, Lands and Parks, Victoria, B.C.

5.5 Mule Deer (*Odocoileus hemionus hemionus*) Winter Range

Habitat Objectives

Maintain and/or recruit habitat elements for Mule Deer winter range [i.e., winter forage, thermal protection (snow interception) and security cover]**.**

Landscape level management objectives such as connectivity, patch size distribution and seral stage targets should be described in higher level plans and sustainable forest management plans. It is important to link higher level plan objectives such as mature/old forest targets for a landscape unit or other planning area, with specific practices implemented at the stand level.

Forest Types or BEC Zones

SBS dh, dw, mh

There are some variations in the harvesting and silviculture strategies recommended below, based on site-specific ecosystem variation. Site variables such as soil moisture regime will influence the growth characteristics of stands on those sites, thereby affecting stand structural features such as canopy height and crown closure.

Management Guidelines

Harvesting and Access Development:

1. Retain and/or recruit critical winter habitat [i.e., mature and old forests, predominantly Douglas-fir (*Pseudotsuga menziesii*) leading in the southern and central interior] with closed, multi-layered canopies (generally > 60% canopy closure), on moderate to steep slopes (approximately > 40%), on warm, southerly aspects in low and moderate snowpack areas). This stand structure provides a balance of snow interception and browse/litterfall availability. Other slopes and aspects in association with the warmer aspect stands are often important components of winter ranges.

2. Retain and/or recruit winter forage in mature and old forest stands on valley bottoms and slopes that receive winter sun and are <1000 m in elevation.

3. Minimize the width (< 120 m) of clearcuts to provide accessible security cover for foraging.

4. Security cover patches should be a minimum of 100-300 m wide for Mule Deer.

5. Maintain and/or recruit forage areas through alternative silvicultural practices (e.g., sequential harvesting).

6. Minimize the amount and size of roads, skid trails and landings in important forage habitat.

7. Harvest (in general) according to topographic profile, e.g., Mule Deer tend to use ridges and topographic breaks frequently and these areas should be avoided where possible.

8. Retain and/or recruit vegetation or incorporate topographical relief into cutblock layout that visually screens ungulates from roads and access points.

9. Maintain and/or recruit forage areas by creating openings with small group selection or clumpy

single-tree selection (i.e., maximum opening width of 1 tree length for clumpy single tree selection, or 2 tree lengths with sizes ranging from 0.2-0.6 ha for group selection).

10. Maintain and/or recruit openings adjacent to rock outcroppings, particularly downslope and/or southerly to maximize solar exposure.

11. Retain and/or recruit ungulate forage species such as Saskatoon berry (*Amelanchier alnifolia*), big sagebrush (*Artemisia tridentata*), Douglas maple (*Acer glabrum*), red-oiser dogwood (*Cornus stolonifera*), *Vaccinium* spp., wild rose (*Rosa* spp.), willow (*Salix* spp.), arboreal lichens, grasses (*Poaceae* spp.) and forbs.

12. Retain and/or recruit 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.

13. Reduce slash to a depth of < 20 cm on 75% of treatment areas in important foraging habitat.

14. Minimize harvest or damage to residual Douglas-fir stems to ≤ 5% (including skid road development) of the pre-harvest basal area of stems > 12.5 cm diameter at breast height (dbh).

15. Regenerate Douglas-fir as much as ecologically possible, and protect and promote established Douglas-fir regeneration.

16. In shallow and moderate snowpack zones, where possible:

    - On warm aspects (135-270^{o} aspect), use small group harvest (0.1- 0.3 ha in size) on flat slopes (0-10% slope) and single tree harvest on steeper slopes (> 10% slope);
    - On moderate aspects (270-315^{o} and 90-135^{o} aspect), use small group harvest (0.2-0.4 ha in size) on flat to moderate slopes (0-30% slope), small group harvest (0.1-0.3 ha in size) on steep slopes (31-60% slope), and single tree harvest on very steep slopes (> 60% slope); and
    - On cool aspects (315-90^{o} aspect), use small group harvest (0.2-0.4 ha in size) on flat to moderate slopes (0-30% slope), and small group harvest (0.3-0.5 ha in size) on steeper slopes (> 30% slope).

17. In deep and very deep snowpack zones, where possible:

    - On warm aspects (135-270^{o} aspect), use small group harvest (0.2-0.4 ha in size) on flat and moderate slopes (0-30% slope) and single tree harvest on steeper slopes (> 30% slope);
    - On moderate aspects (270-315^{o} and 90-135^{o} aspect), use small group harvest (0.3-0.5 ha in size) on all slopes; and
    - On cool aspects (315-90^{o} aspect), use small group harvest (0.3-0.5 ha in size) on flat to moderate slopes (0-30% slope), and small group harvest (0.4-0.6 ha in size) on steeper slopes (> 30% slope).

Restoration:

1. In shallow snowpack zones (< 100 cm/year) maintain 40% of the habitat as low crown closure (<35% canopy closure) habitat, 40% as moderate crown closure (36-65% canopy closure) habitat, and 20% as high canopy closure (> 65% canopy closure) habitat. Increasing crown closure results in increased snow interception.

2. In moderate snowpack zones (100-150 cm/year), maintain 1/3 each of low, moderate and high crown closure habitats.

3. In deep snowpack zones (150-200 cm/year), maintain 1/3 of the habitat as low crown closure

habitat and 2/3 as high crown closure habitat.

Regeneration:

1. On subhygric to hygric sites utilizing even-aged management to target desirable forage conditions, consider establishing new plantations through cluster planting or retention of natural advance regeneration in a cluster pattern.

2. On subxeric to submesic sites utilizing even-aged management to target desirable thermal and security conditions, establish plantations in a uniform pattern to encourage earlier crown closure. The intent is to have the mesic and drier ecosystems across a landscape provide the canopy cover required for effective thermal protection (snow interception) and security cover. Management of these ecosystems (subxeric to submesic) should focus on developing closed canopies as rapidly as possible.

3. Regenerate to Douglas-fir on all sites where Douglas-fir is ecologically appropriate and/or viable.

Brushing:

1. On subhygric to hygric sites utilizing even-aged management to target desirable forage conditions, do not employ broadcast brushing techniques such as herbicides. In addition, during brushing and/or spacing treatments, ensure that forage production between clusters can be sustained or enhanced for a longer period.

2. On subxeric to submesic sites utilizing even-aged management to target desirable security conditions, maintain low levels of competing vegetation through the establishment phase by manual, or possibly chemical, treatments to promote the rapid development of closed canopy conditions.

Spacing/Thinning/Pruning:

1. Maintain and/or recruit forage areas through stand tending practices, e.g., single heavy thinning, or repeated lighter thinnings.

2. Maintain and/or recruit long-term forest structure by thinning pole layer (trees 12.5-37.5 cm dbh) in ungulate management areas.

Protection (fire, insects, disease, damage):

1. Where possible, use single tree harvesting of stems currently infested with Douglas-fir bark beetles (*Dendroclonus pseudotsugae*). Avoid damage or removal of non-affected stems.

2. In mixed Douglas-fir/lodgepole pine (*Pinus contorta*) stands currently infested with mountain pine beetle (*D. ponderosae*), minimize harvest and damage of Douglas-fir by:

   a) harvesting pine only in areas where there is a reasonable expectation of beetle control; and
   b) carefully designing block layout and skid trails.

Silvicultural Regimes

BEC Zones	**Subhygric to Hygric sites**:
SBSdh, dw, mh	Management of these sites should focus on the enhancement and/or recruitment of areas for ungulate woody forage species. The following regimes reflect only those possible regimes associated with even-aged silvicultural systems.

	Silvicultural systems that may be applicable for this objective include clearcut, patch cut or small group selection, shelterwood, retention and seed tree systems. The season of harvest should be limited to conditions that will limit soil and root disturbance. Consider establishing new plantations through cluster planting or retention of natural advance regeneration in a cluster pattern. Do not employ broadcast brushing techniques such as aerial herbicide application. In addition, during brushing and/or spacing treatments, ensure that forage production between clusters can be sustained or enhanced for a longer period. Implement juvenile spacing programs as required (max density 5000 stems per ha) to ensure canopy gaps linked to forage production will be present later into stand development (20-60 years). **Subxeric to Submesic sites:** Management of these sites should focus on the enhancement and/or recruitment of areas for thermal protection (snow interception). The following regimes reflect only those possible regimes associated with even-age silvicultural systems. Uneven-aged management targeting variable residual post harvest densities should be practiced where possible. Silvicultural systems that may be applicable for this objective include: clearcut, patch cut or small group selection, shelterwood, retention and seed tree systems Establish plantations in a uniform pattern to encourage earlier crown closure. The intent is to have the mesic and drier ecosystems across a landscape provide the canopy cover required for effective thermal protection (snow interception). Management of these ecosystems (subxeric to submesic) is intended to develop closed canopies as rapidly as possible. Maintain low levels of competing vegetation through the establishment phase by manual, or possibly chemical, treatments to promote the rapid development of closed canopy conditions. Implement juvenile spacing programs (max density 5000 stems per ha) to ensure an even distribution of crop trees and rapid crown closure is occurring. Post spacing standards should equal the target stocking standard for single entry spacing; however, a more desirable option would be to plan for a two entry spacing regime. For example, the first entry could target 3000 stems per ha with a second spacing entry (approximately at age 25 years) reducing the density to target levels.

Monitoring Standards – Establishment to Free Growing Seral Stage

Stocking Standard Guidelines

Applicable Ecosystem (BEC)				Stocking Standard Modifiers					
Zone	**Subzone**	**Moisture Nutrient Regime**	**Species Selection**	**Stocking Standard Modifier[1]**	**Regen Delay**	**Assess-ment Time Frame**	**Min. Tree Ht.**	**% Tree Over Brush**	**MITD**
SBS	dh, dw	2-3/A-E	Broadleaf[2]	1.2	Same	Same	Same	Same	2.0
SBS	dh, dw	5-6/C-E	Broadleaf[2]	0.8	Same	Same	Same	Same	1.5

1. The term Stocking Standard Modifier refers to the factor applied to existing stocking standards contained within Establishment to Free Growing Guidebooks. For example: the stocking standards (well-spaced/ha) for SBSdw3 - 06 site as found in the Establishment to Free Growing Guidebook, Prince George Forest Region equals = TSSpa **1200**, MSSpa **700**, MSSp **600**. The equivalent stocking standards (well-spaced/ha) for areas with maintenance and/or recruitment of forage supply, stand structure and habitat elements for Mule Deer winter range objectives would be TSSpa **960**, MSSpa **560**, MSSp **480**. TSS - target stocking standard, MSS – minimum stocking standard, pa – preferred and acceptable, and p - preferred.

2. Broadleaf species management should be seriously considered where applicable for this management objective. Utilize the appropriate broadleaf species as a primary or secondary species as indicated in the Establishment to Free Growing Guidebooks.
3. Maximum density is 5000 stems per ha for these ecosystems. Densities exceeding this threshold at the free growing stage will severely limit the suitability of forage (moisture regime 5-6 sites) and/or security (moisture regime 2-3 sites) habitat requirements through subsequent stand development.
4. The Free Growing survey methodologies used to assess the success of meeting these standards should reflect the clumpy nature of the forest being designed. However, do not stratify areas into contiguous units smaller than one ha, or use dispersed stratum survey methodologies. In general, more plots may be required to prove obligations are met due directly to the desired variable post-free growing density distribution targeted. The maximum number of plots required will be 1.5 per ha.

	Monitoring Standards – Establishment to Free Growing Seral Stage - Cluster Distribution							
Desired Stocking (tpha)	**Clusters per Hectare**							
	Triangular Inter-Cluster Spacing (m)							
	8	**7**	**6**	**5**	**4**	**3**	**2**	**1**
200	21.5	20.1	18.6	17.0	15.2	13.2	10.7	7.6
250	19.2	18.0	16.6	15.2	13.6	11.8	9.6	6.8
300	17.5	16.4	15.2	13.9	12.4	10.7	8.8	6.2
350	16.2	15.2	14.1	12.8	11.5	9.9	8.1	5.7
400	15.2	14.2	13.2	12.0	10.7	9.3	7.6	5.4
450	14.3	13.4	12.4	11.3	10.1	8.8	7.2	5.1
500	13.6	12.7	11.8	10.7	9.6	8.3	6.8	4.8
550	13.0	12.1	11.2	10.2	9.2	7.9	6.5	4.6
600	12.4	11.6	10.7	9.8	8.8	7.6	6.2	4.4
650	11.9	11.2	10.3	9.4	8.4	7.3	6.0	4.2
700	11.5	10.7	9.9	9.1	8.1	7.0	5.7	4.1
750	11.1	10.4	9.6	8.8	7.8	6.8	5.5	3.9
800	10.7	10.1	9.3	8.5	7.6	6.6	5.4	3.8
850	10.4	9.8	9.0	8.2	7.4	6.4	5.2	3.7
900	10.2	9.5	8.8	8.0	7.2	6.2	5.1	3.6
950	9.9	9.2	8.5	7.8	7.0	6.0	4.9	3.5
1000	9.6	9.0	8.3	7.6	6.8	5.9	4.8	3.4

Monitoring Standards – Establishment to Free Growing Seral Stage – Cluster Distribution								
Desired Stocking (tpha)	**Clusters per ha**							
	Trees per cluster							
	8	**7**	**6**	**5**	**4**	**3**	**2**	**1**
200	25	29	33	40	50	67	100	200
250	31	36	42	50	63	83	125	250
300	38	43	50	60	75	100	150	300
350	44	50	58	70	88	117	175	350
400	50	57	67	80	100	133	200	400
450	56	64	75	90	113	150	225	450
500	63	71	83	100	125	167	250	500
550	69	79	92	110	138	183	275	550
600	75	86	100	120	150	200	300	600
650	81	93	108	130	163	217	325	650
700	88	100	117	140	175	233	350	700
750	94	107	125	150	188	250	375	750
800	100	114	133	160	200	267	400	800
850	106	121	142	170	212	283	425	850
900	112	129	150	180	225	300	450	900
950	119	136	158	190	238	317	475	950
1000	125	143	167	200	250	333	500	1000

Monitoring Standards

Juvenile (Age 20-60 Years) Phase:

Management of younger age classes (e.g., establishment to free growing 0-20 years) is intended to develop suitable stand conditions through this age class. Existing stands within this age class may be managed to encourage forage production by creating gaps through late juvenile spacing or commercial harvesting.

Mature (Age 60+ Years) Phase:

In general, subsequent harvesting strategies should be implemented that are consistent with the Management Guidelines outlined. In addition, review of Cariboo Forest Region Extension Note 25A (Dawson and Armleder 2000) is recommended.

Figure 12: Forested cover provides bedding, shelter and security habitat for Mule Deer. *Photo*: Alex Inselberg.

Selected References:

Dawson, R.J. and H.M Armleder. 2000. Structural definitions for management of Mule Deer winter range in the interior Douglas-fir zone. B.C. Ministry of Forests, Research Section, Extension Note 25A., Williams Lake, B.C. 8pp. URL: http://www.for.gov.bc.ca/cariboo/research/research.htm.

Resources Inventory Committee. 1998. British Columbia wildlife habitat rating standards. B.C. Ministry of Environment, Lands and Parks, Resource Inventory Committee, Wildlife Interpretations Subcommittee, Victoria, B.C. 108pp.

Stevens, V. 1995. Database for wildlife diversity in British Columbia: distribution and habitat use of amphibians, reptiles, birds and mammals in biogeoclimatic zones. Working Paper, B.C. Ministry of Environment, Lands and Parks, Victoria, B.C.

Wood, C. 1998. Habitat/ecosystem objectives and monitoring procedures for incremental and backlog silviculture treatments, ver. 2.0. B.C. Ministry of Environment, Lands and Parks, Resource Stewardship Branch, Victoria, B.C. 70pp.

5.6 Caribou – Northern Ecotype (*Rangifer tarandus*) Winter Range

Habitat Objectives

Maintain and/or recruit habitat elements for Northern Caribou – for the creation of conditions suitable for terrestrial lichen production.

Landscape level management objectives such as connectivity and habitat fragmentation, patch size distribution and seral stage targets, as well as access management, should be described in higher level plans and forest stewardship plans. It is important to link these higher-level plan objectives with specific practices implemented at the stand level.

Forest Types/ BEC Zones

SBPS mc, mk, xc SBS dk, mc, mk, wk (minor)

Management Guidelines

Harvesting and Access Development:

The following guidelines are intended to apply to areas where harvesting is managed through a Higher Level Plan.

1. Maintain or recruit 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.

2. Limit access to exposed, windblown alpine slopes with abundant terrestrial lichen.

3. Protect Caribou from access-related impacts by developing a road/access management plan. Try to minimize road access to and habitat fragmentation of winter ranges.

4. Access management plans should include road deactivation recommendations to minimize vehicle access to, and isolation of winter ranges or Wildlife Habitat Areas for Caribou.

5. 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.

6. Maintain approximate pre-harvest tree species composition.

7. On sites with significant terrestrial lichen cover, care should be taken to minimize surficial disturbance. In these stands, winter logging when snow cover is present may be appropriate.

8. Avoid excessive physical obstructions (such as windrowed slash or many downed trees).

Restoration:

1. Maintain low crown closure (25-55% canopy closure).

2. Light scarification or prescribed burning (post-harvest) may be considered in order to enhance suitable ground conditions for lichen colonization.

Regeneration:

1. On subhygric to hygric sites, no changes to normal management regimes. Conditions suitable for the production of terrestrial lichens (especially *Cladina* spp.) cannot be achieved.

2. On subxeric to mesic sites, utilize even-aged management to target conditions suitable for the production of terrestrial lichens (especially *Cladina* spp.)

Brushing:

1. On subhygric to hygric sites, no changes to normal management regimes. Conditions suitable for the production of terrestrial lichens (especially *Cladina* spp.) cannot be achieved.

2. On subxeric to submesic sites, utilize even-aged management to target desirable conditions suitable for the production/maintenance of terrestrial lichens. Target lower post-spacing densities (700-1000 stems/ha).

3. Limit use of broadcast-brushing techniques such as herbicides in areas that contain significant amounts of terrestrial lichens, unless this technique is being used to control moose-browse shrub species (e.g., willows) near Caribou winter ranges or WHAs.

Spacing/Thinning/Pruning:

1. On subhygric to hygric sites, no changes to normal management regimes are prescribed. Conditions suitable for the production of terrestrial lichens (especially *Cladina* spp.) cannot be achieved.

2. Maintain and/or recruit long-term forest structure by thinning pole layer (trees 12.5-37.5 cm dbh) in Caribou habitat areas.

Protection (fire, insects, disease, damage):

1. In mixed Douglas-fir/lodgepole pine stands (i.e., SBS dh, dw, mw; SBPS mk) currently infested with mountain pine beetle (*D. ponderosae*), minimize harvest and damage of Douglas-fir by:

   a) Harvesting pine only in areas where there is a reasonable expectation of beetle control; and

   b) Implementing careful harvest block and skid trail design and layout.

Silvicultural Regimes

BEC – Zones	
SBS dk, mc,mk,wk *SBPS mc, mk, xc*	**Subhygric to Hygric sites**: Management of these sites should sites should conform to normal management regimes. Conditions suitable for the production of terrestrial lichens (especially *Cladina* spp.) cannot be achieved. Subxeric to Submesic sites: Management of these sites should focus on the enhancement and/or recruitment of areas of terrestrial lichen production. The following regimes reflect only those possible regimes associated with even-age silvicultural systems. Silvicultural systems that may be applicable for this objective include clearcut, patch cut

	systems. Establish plantations at lower than normal densities to encourage open canopy conditions favourable for the production of terrestrial lichens. The intent is to have the mesic and drier ecosystems across a landscape at crown closures between 25% and 55%. Implement juvenile spacing programs as required (max density 4000 stems per ha) ensuring open canopy conditions. Post spacing standards should equal the 80% of the target stocking standard.

Monitoring Standards – Establishment to Free Growing Seral Stage

Stocking Standard Guidelines

Applicable Ecosystem (BEC)			Stocking Standard Modifiers							
Zone	**Subzone**	**Moisture Nutrient Regime**	**Species Selection**	**Stocking Standard Modifier[1]**	**Regen Delay**	**Assess-ment Time Frame**	**Min. Tree Ht.**	**% Tree Over Brush**	**Min Inter Tree Distance**	**Max Density**
SBPS	dc, mc, xc	2-4/A-E	Same	0.8	Same	Same	Same	Same	2.0	4000[2]
SBPS	dc, mc, xc	5-6/C-E	Same	Same	Same	Same	Same	Same	2.0	10 000
SBS	dk, mc	2-4/A-E	Same	0.8	Same	Same	Same	Same	2.0	4000[2]
SBS	dh, dw	5-6/C-E	Same	Same	Same	Same	Same	Same	2.0	10 000

1. The term Stocking Standard Modifier refers to the factor applied to existing stocking standards contained within Establishment to Free Growing Guidebooks. For example: the stocking standards (well-spaced/ha) for SBSmc2 – 08 site as found in the Establishment to Free Growing Guidebook, Cariboo Forest Region equals = TSSpa **1200**, MSSpa **700**, MSSp **600**. The equivalent stocking standards (well spaced / ha) for areas with maintenance and/or recruitment of forage supply, stand structure and habitat elements for Caribou winter range objectives would be TSSpa **960**, MSSpa **560**, MSSp **480**. TSS - target stocking standard, MSS – minimum stocking standard, pa – preferred and acceptable, and p - preferred.
2. Maximum density is 4000 stems per ha for these ecosystems. Densities exceeding this threshold at the free growing stage will severely limit the production of terrestrial lichens.

Monitoring Standards

Juvenile (Age 20-60 Years) Phase:

Management of younger age classes, e.g., establishment to free growing 0-20 years, is intended to develop suitable stand conditions for the production of terrestrial lichens. Existing stands within this age class may be managed to encourage terrestrial lichen production through late juvenile spacing or commercial harvesting.

Mature (Age 60+ Years) Phase:

In general, subsequent harvesting strategies should be implemented that are consistent with the guidelines outlined above.

Figure 13. Terrestrial lichen (*Cladina* spp.) – a preferred winter food source for Northern Caribou. *Photos*: Susan Stevenson.

Selected References:

B.C. Ministry of Forests. 1996. Silvicultural systems for lodgepole pine and northern Caribou. B.C. Ministry of Forests, Research Section, Extension Note 19., Williams Lake, B.C. 6pp. URL: http://www.for.gov.bc.ca/cariboo/research/research.htm.

Manning, T. and J.M. Cooper. 2004. Stand-level management guidelines for selected forest-dwelling species in the Fort St. John Timber Supply Area. Report prep. for Canadian Forest Products Ltd., Peace Region, Fort St. John, B.C. Nov. 2004.

Resources Inventory Committee. 1998. British Columbia wildlife habitat rating standards. B.C. Ministry of Environment, Lands and Parks, Resource Inventory Committee, Wildlife Interpretations Subcommittee, Victoria, B.C. 108pp.

Stevens, V. 1995. Database for wildlife diversity in British Columbia: distribution and habitat use of amphibians, reptiles, birds and mammals in biogeoclimatic zones. Working Paper, B.C. Ministry of Environment, Lands and Parks, Victoria, B.C.

Waters, L. and R. DeLong. 2001. Recruiting Caribou habitat using silviculture treatments. Unpubl. rep. prepared for B.C. Ministry of Environment, Lands and Parks. 35pp. URL: http://srmwww.gov.bc.ca/frco/programs/efp/reports.html.

Wood, C. 1998. Habitat/ecosystem objectives and monitoring procedures for incremental and backlog silviculture treatments, ver. 2.0. B.C. Ministry of Environment, Lands and Parks, Resource Stewardship Branch, Victoria, B.C. 70pp.

5.7 Grizzly Bear (*Ursus arctos horribilis*)

Habitat Objectives

Maintain and/or recruit forage and security cover habitat elements for Grizzly Bears.

Landscape level management objectives such as patch size distribution and seral stage targets should be described in higher-level plans and sustainable forest management plans. It is important to link higher level plan objectives such as seral stage targets for a landscape unit or other planning area, with specific operational plans and practices implemented at the stand level.

Also refer to Extension Note 54 (MOF 2001) for additional information on landscape planning and stand-level forest management practices (silviculture treatments) in Grizzly Bear habitat.

Forest Types or BEC Zones

SBS mc, mk, mm, wk

Management Guidelines

Harvesting and Access Development:

1. Retain and/or establish forested travel corridors between riparian habitats, using subhygric and wetter site series where possible. These areas should provide security and escape cover for bears as they travel.
2. Where available, leave buffer strips of forested habitat to provide security cover and bedding areas adjacent to important foraging areas (e.g., avalanche chutes, wet meadows, estuaries, riparian habitats, swamps, seeps and alder swales) and existing den sites. Avoid planting of these forage sites. These areas will often provide additional habitat elements such as mark and rub trees, as well as connectivity and escape habitat.
3. Minimize new road placement near important bear foraging areas. Use access management plans to minimize potential human grizzly interactions.
4. If roads have been previously located near areas important for bear foraging, permanently deactivate these roads when they are no longer required for access. Restrict grass seeding to > 500 m away from active roads.
5. Blowdown patches, large root wads, large diameter black cottonwood (*Populus balsamifera*), caves, or overhanging banks that can be dug out, all make potential den sites. Where possible, include these habitat elements in wildlife tree patches or riparian reserves to provide a buffer around them.
6. In areas where fish are an important part of the diet, retention of security cover and escape terrain along streams, rivers and estuaries are critical. This applies to any watersheds that drain to the Pacific Ocean (i.e., coastal watersheds including the Skeena and Fraser river systems).
7. Schedule stand entry activities outside of expected times of Grizzly Bear use of that area.
8. Maintain and/or recruit canopy gaps, in a variety of shapes and sizes, to create a range of light and growing conditions for forage species production. Newly created gaps should range in size between 0.1-2.0 ha and be grouped (i.e., within 500 m of one another). Gaps of this nature should be considered regardless of the silvicultural system and harvest opening size. Total area retained in gaps should be similar to pre-harvest natural gap levels, which can be identified at the cutting permit scale.

Restoration:

1. Maintain and or recruit berry production through controlled, light impact broadcast burns in dense berry forage areas.

2. Maintain and/or recruit areas of important grazing species, e.g., grass (*Poaceae* spp.), sedge (*Carex* spp.) or clover (*Trifolium* spp.), through scarification in areas > 500 m from access roads. This should be practiced on < 20% of prescription sites in a planning area.

3. Remove clover from the grass seed mixtures when close to active roads (< 500 m), so that these areas are less preferred by Grizzlies for foraging.

4. Maintain and/or recruit habitat for ants, e.g., carpenter ants (*Camponotus pennsylvanicus*), particularly on drier site series, by not disturbing large naturally occurring pieces of coarse woody debris (CWD), by enhancing levels of CWD across a prescription area, and by leaving high cut stumps (minimum of 0.5 m tall).

5. Forage quality depends, to a large extent, on herb and shrub cover, which in turn is influenced by seral stage, stand density and canopy closure. Higher forage value is usually associated with wetter site series and higher shrub cover (> 50% cover between clusters). This relationship is most valid in the wet subzones of the SBS, but is also applicable to other subzones where berry forage is found. In areas where there are important forage species for bears, at the landscape level, manage the seral stage distribution and at the stand level manage for stand structure that has gaps of sufficient size to promote forage production. Three strategies to provide gaps at the stand level are: protecting existing natural gaps; cluster planting; and patchy spacing treatments (see below).

Regeneration:

1. Planting a mix of tree species should be considered when the number of trees per cluster is high. For cluster planting, a range of 10-30 conifer seedlings per cluster is recommended.

2. Plant a mixture of tree species and retain a deciduous component in the stand. Do not plant through existing alder swales, non-commercial cover, shrub fields, etc., that have been identified as forage habitat.

3. Target tree stocking in clumps or patches so that berry forage production between clumps can be sustained for a longer period. A range of 10-30 conifer seedlings per cluster is recommended.

4. For clumpy planting (i.e., cluster planting), a reduced minimum inter-tree spacing and a lower maximum density are prescribed.

5. Shade-tolerant or species subject to epicormic branching, e.g., spruce (*Picea* spp.) should be planted in the centre of a cluster, with less shade-tolerant species planted around the cluster perimeter.

6. The recommended inter-crop tree distance within clusters is 1-2 m, closer to 1 m for small clusters, and closer to 2 m for large clusters where more tree growing space is required.

7. Use the existing distribution of forage, crop trees and available microsites to determine roughly the target number of clusters per hectare. Fewer clusters may be more suitable on uneven, wet, brushy or hummocky sites.

8. Manage seral stage distribution and stand structure to create gaps of sufficient size to promote forage production through cluster planting.

9. Avoid planting in important foraging areas, e.g., avalanche chutes, wet meadows, estuaries, riparian habitats, skunk cabbage swamps, seeps and alder swales.

10. Minimize soil and tree root disturbance between clusters to reduce damage to forage species root systems.

11. Spacing between clusters should be adjusted to reflect site conditions and microsite location. Uniform distribution of clusters over the block is appropriate where site conditions are relatively uniform. However, clusters should be located on appropriate planting sites, taking advantage of natural site features such as elevated hummocks or stumps.

12. Inter-cluster spacing is measured from the centre of one cluster to the centre of the adjacent ones on a square grid. However, where sites are undulating, clusters should be located on appropriate planting sites to take advantage of natural features such as elevated hummocks or stumps. Inter-cluster distances should be varied in order to optimize microsite selection.

13. Inter-cluster spacing is recommended to be a minimum of 80% and a maximum of 120% of that required to achieve the desired planting target. This range should result in achieving the overall desired stocking density, within acceptable statistics limits, when a stocking survey is applied across the area.

14. "Dispersed or non-uniform cluster" uses a mix of cluster densities across the block, and is appropriate for some blocks where microsites suitable for clusters (e.g., elevated hummocks) are not evenly distributed. For dispersed cluster planting, the minimum inter-tree distance within a cluster is 1 m on suitable microsites. The number of suitable clusters per ha should be estimated from a reliable survey that covers the entire area. The minimum/maximum inter-cluster distances may vary substantially, as long as the overall target density is met.

Brushing:

1. Use crop-tree centered brush treatments. Avoid herbicide application or simply spot treat in areas containing important forage species, e.g., huckleberries and blueberries, (*Vaccinium* spp.), cow parsnip (*Heracleum lanatum*), fireweed (*Epilobium angustifolium*), devil's club (*Oplopanax horridus*), salmonberry (*Rubus spectabilis*), red elderberry (*Sambucus racemosa*), gooseberries and currants (*Ribes* spp.), red-osier dogwood (*Cornus stolonifera*), soopolallie (*Shepherdia canadensis*), black twinberry (*Lonicera involucrata*), horsetail (*Equisetum* spp.) and sedges (*Carex* spp.).

2. Brush treatments should be limited to within and immediately adjacent to clusters, using backpack chemical applications or manual brushing methods.

Spacing/Thinning/Pruning:

1. As stands mature, use thinning to create partially open canopies (40-60% crown closure) to promote shrub forage production. A combination of cluster planting and patchy spacing treatments can be used to achieve this stand structure.

2. Manage seral stage distribution and stand structure to create gaps of sufficient size to promote forage production through patchy spacing treatments.

3. Spacing can be used to open the canopy, or enlarge or create gaps; determine which method is most appropriate for the specific stand. Maintain a deciduous tree component after spacing or brushing treatments. Prescribe a range of spacing densities across a site, higher densities should be maintained along roads and adjacent to special habitats for security cover.

Protection (fire, insects, disease, damage):

Management of catastrophic and endemic stand damaging events should be planned in the context of a well thought out access management strategy.

Silvicultural Regimes

Interior BEC – Zones	**Subhygric to Hygric sites**: Management should focus on the enhancement and/or recruitment of areas for berry and forb forage at the stand level. Where these areas are a part of a riparian system, they can be important travel corridors and grizzly feeding areas of fish.
SBS	All silvicultural systems may be applicable for this objective. The season of harvest should be limited to conditions that will limit soil and root disturbance. Site preparation treatments should consider light controlled broadcast burns to promote maintenance and recruitment of berry forage. Establish new plantations through cluster planting or retention of natural advance regeneration in a cluster pattern as per the Additional Planting Information section. Establish a target percent area of gap retention that will be maintained so this objective can be measured at the free-growing survey. Use brush treatments that center around crop trees. Do not use broadcast brushing techniques such as herbicide treatment. During brushing and/or spacing treatments, ensure that berry forage production between clusters can be sustained or enhanced for a longer period by pruning shrub species to increase forage quality, or pruning crop trees on the edge of clusters to allow light to enter gaps. Use spacing to reduce crown cover or actually create canopy gaps that will persist later into stand development (20-60 years).
BEC Zones ***SBS***	**Submesic to Mesic sites:** Management of these sites should focus on the enhancement and/or recruitment of areas for berry and herbaceous forage at the stand level. This is especially important in areas with south aspects that can produce spring forage. All silvicultural systems may be applicable for this objective. The season of harvest should be limited to conditions that will limit soil and root disturbance. Site preparation treatments could include light controlled broadcast burns to promote maintenance and recruitment of berry forage and/or mechanical scarification methods followed by grass seeding to promote forage opportunities. This treatment should not be conducted near roads and on < 20% of a cutblock area. Establish new plantations through cluster planting or retention of natural advance regeneration in a cluster pattern as per the Additional Planting Information section. Do not employ broadcast-brushing techniques such as herbicides. In addition, during brushing and/or spacing treatments ensure that berry forage production between clusters can be sustained or enhanced for a longer period. Implement juvenile spacing programs as required to ensure canopy gaps will be present later into stand development (20-60 years).

	Very Xeric to Submesic sites: Management of these sites should focus on the enhancement and/or recruitment of areas for insects (ants) and shrubby forage species, e.g., Soopolallie/dry *Vaccinium* spp., production at the stand level. This is especially important in non-Pacific drainages and when berry crops are low. All silviculture systems may be applicable for this objective. Harvesting should be conducted to a lower utilization standard to provide high stumps (> 0.5 m) and larger pieces of CWD to provide a substrate for ants and small mammal forage. The interim CWD strategy (MOF 2002) is 4m^3/ha dry belt, 10m^3/ha transitional, and 20m^3/ha in the interior wet belt and coastal areas. Where possible, minimum CWD piece sizes dispersed throughout the harvest area are recommended at > 10 cm dbh and > 6 m long (NSC 2002). Site preparation treatments should be avoided, as the disturbance of existing CWD will reduce piece size and increasing decay rates. Establish new plantations through planting or retention of natural advance regeneration in a uniform fashion so that subsequent crown closure will provide screening and security habitat, in particular, along roads, travel corridors and identified bear habitat features.

Monitoring Standards – Establishment to Free Growing Seral Stage

Stocking Standard Guidelines

Applicable Ecosystem (BEC)			Stocking Standard Modifiers						
Zone	**Subzone**	**Moisture Nutrient Regime**	**Species Selection**	**Stocking Standard Modifier[1]**	**Regen Delay**	**Assess-ment Time Frame**	**Min. Tree Ht.**	**% Tree Over Brush**	**MITD**
SBS	mm, mk mc, wk	4-6/A-E	Broadleaf[2]	0.67	Same	Same	Same	Same	1.0

1. The term Stocking Standard Modifier refers to the factor applied to existing stocking standards contained within Establishment to Free Growing Guidebooks. For example: the stocking standards (well-spaced/ha) for SBSmc2 - 08 site as found in the Establishment to Free Growing Guidebook, Prince Rupert Forest Region equals = TSSpa **1200**, MSSpa **700**, MSSp **600**. The equivalent stocking standards (well spaced / ha) for areas with maintenance and/or recruitment of Grizzly Bear foraging and security habitat objectives would be TSSpa **804**, MSSpa **469**, MSSp **402**. TSS - target stocking standard, MSS – minimum stocking standard, pa – preferred and acceptable, and p - preferred.

2. Broadleaf species management for mixed coniferous/deciduous stands should be seriously considered where possible for this management objective. Utilize the appropriate broadleaf species as a primary or secondary species as indicated in the Establishment to Free Growing Guidebooks.

3. Maximum density is 4000 stems per ha for these ecosystems, this max density standard is inclusive of deciduous species. Deciduous stems will contribute to maximum density calculations in the same fashion as coniferous stems. In addition, stands will not be considered free growing unless they are demonstrated to contain a minimum of 20% canopy gaps. This is to be assessed through the establishment of random systematic free growing survey plots as discussed in point 4 below. If inadequate gap creation exists, then a juvenile spacing entry must be completed to provide the required gaps. Spacing is to target leaving gaps in areas with abundant forage present.

4. Do not stratify areas to units smaller than one ha, or use dispersed stratum survey methodologies. In general, more plots will be required to prove obligations are met due to the desired patchy nature

of the target stocking. The maximum number of plots required will be 1.5 per ha. The statistical requirements for these areas should be consistent with existing survey methodologies. In addition to meeting the stocking requirement for these stands it is imperative that gap creation has occurred by the free growing determination stage. To test if adequate gap creation exists, a minimum of 20% (per stratum) of the randomly systematic established plots ($50m^2$) should contain less than or equal to one conifer (> 50 cm height), or the equivalent of 200 stems per ha.

	Monitoring Standards– Establishment to Free Growing Seral Stage – Cluster Distribution							
Desired Stocking (tpha)	**Clusters per Hectare**							
	Triangular Inter-Cluster Spacing (m)							
	8	**7**	**6**	**5**	**4**	**3**	**2**	**1**
200	21.5	20.1	18.6	17.0	15.2	13.2	10.7	7.6
250	19.2	18.0	16.6	15.2	13.6	11.8	9.6	6.8
300	17.5	16.4	15.2	13.9	12.4	10.7	8.8	6.2
350	16.2	15.2	14.1	12.8	11.5	9.9	8.1	5.7
400	15.2	14.2	13.2	12.0	10.7	9.3	7.6	5.4
450	14.3	13.4	12.4	11.3	10.1	8.8	7.2	5.1
500	13.6	12.7	11.8	10.7	9.6	8.3	6.8	4.8
550	13.0	12.1	11.2	10.2	9.2	7.9	6.5	4.6
600	12.4	11.6	10.7	9.8	8.8	7.6	6.2	4.4
650	11.9	11.2	10.3	9.4	8.4	7.3	6.0	4.2
700	11.5	10.7	9.9	9.1	8.1	7.0	5.7	4.1
750	11.1	10.4	9.6	8.8	7.8	6.8	5.5	3.9
800	10.7	10.1	9.3	8.5	7.6	6.6	5.4	3.8
850	10.4	9.8	9.0	8.2	7.4	6.4	5.2	3.7
900	10.2	9.5	8.8	8.0	7.2	6.2	5.1	3.6
950	9.9	9.2	8.5	7.8	7.0	6.0	4.9	3.5
1000	9.6	9.0	8.3	7.6	6.8	5.9	4.8	3.4

Monitoring Standards– Establishment to Free Growing Seral Stage – Cluster Distribution								
Desired Stocking (tpha)	**Clusters per Hectare**							
	Trees per cluster							
	8	**7**	**6**	**5**	**4**	**3**	**2**	**1**
200	25	29	33	40	50	67	100	200
250	31	36	42	50	63	83	125	250
300	38	43	50	60	75	100	150	300
350	44	50	58	70	88	117	175	350
400	50	57	67	80	100	133	200	400
450	56	64	75	90	113	150	225	450
500	63	71	83	100	125	167	250	500
550	69	79	92	110	138	183	275	550
600	75	86	100	120	150	200	300	600
650	81	93	108	130	163	217	325	650
700	88	100	117	140	175	233	350	700
750	94	107	125	150	188	250	375	750
800	100	114	133	160	200	267	400	800
850	106	121	142	170	212	283	425	850
900	112	129	150	180	225	300	450	900
950	119	136	158	190	238	317	475	950
1000	125	143	167	200	250	333	500	1000

Monitoring Standards

Establishment (Age 0-4 Years) Phase:

No more than 10% of individual opening sizes created for areas with this objective are to be > 2 ha in size. In addition, no individual opening should exceed 5 ha in size, e.g., a 10 ha block created with a patch cut system may contain the following gap sizes – 5, 2, 1, 0.5, 0.25, 0.4, 0.6 hectares. These openings reflect the natural gap sizes found in wet SBS ecosystems.

Juvenile (Age 20-60 Years) Phase:

Management of younger age classes (e.g., establishment to free growing 0-20 years) is intended to develop suitable stand conditions through this age class. Opening up existing stands by creating gaps through late juvenile spacing or commercial thinning may be strategies that could be implemented to encourage forage species.

Mature (Age 60+ Years) Phase:

At stand maturity, partial cutting silvicultural systems can be used to create a patchy network of new seral openings (i.e., which simulate canopy gaps and open areas for forage production) and nearby forested security cover. In general, subsequent harvesting strategies (regardless of the silvicultural system) will have to be implemented that are consistent with the gap creation strategies discussed.

Figure 14: Planting and spacing regimes can mimic naturally occurring patchy, foraging habitat. *Photo*: Alex Inselberg.

Figure 15: Patchy and clumpy forest mosaic with shrubby openings provides forage and security habitat. *Photo*: Alex Inselberg.

Figure 20: Patchy and clumpy forest mosaic with heavy understory provides good security habitat. *Photo*: Alex Inselberg.

Figure 21: Patchy and clumpy forest mosaic with varied shrub and regeneration understory provides foraging and security habitat. *Photo*: Alex Inselberg.

Selected References:

B.C. Ministry of Forests. 2002. Provincial coarse woody debris policy. B.C. Ministry of Forests, Forest Practices Branch, Victoria, B.C. URL: http://www.for.gov.bc.ca/hfp/wlt/cwd-policy-01.htm.

B.C. Ministry of Forests. 2001. Grizzly Bear habitat in managed forests: silviculture treatments to meet habitat and timber objectives. B.C. Ministry of Forests, Res. Sect., Extension Note 54., Victoria, B.C. 7pp. URL: http://www.for.gov.bc.ca/hfd/pubs/Docs/En/En54.htm

B.C. Ministry of Forests. 2000. Kalum land and resource management plan – consensus recommendations package December 2000. B.C. Ministry of Forests, Land-Use Coordination Office. URL: http://www.luco.gov.bc.ca/lrmp/kalum/recom/2.htm#2.2.11.

B.C. Ministry of Forests and B.C. Ministry of Environment, Lands and Parks. 1998. Field manual for describing terrestrial ecosystems. B.C. Ministry of Forests, Research Branch, B.C. Ministry of Environment, Lands and Parks, Inventory Branch, Land Management Handbook No. 25, Victoria, B.C.

Beaudry, L., M. Martin and J. Paczkowski. 2001. Using silviculture to maintain and enhance Grizzly Bear habitat in six variants of the Prince George Forest Region. B.C. Ministry of Environment, Lands and Parks, Habitat Branch, Victoria, B.C. 58pp.

Fuhr, B. and D.A. Demarchi. 1990. A methodology for Grizzly Bear habitat assessment in British Columbia. B.C. Ministry of Environment, Victoria, B.C. Wildlife Bulletin. B-67.

Manning, T. and J.M. Cooper. 2004. Stand-level management guidelines for selected forest-dwelling species in the Fort St. John Timber Supply Area. Report prep. for Canadian Forest Products Ltd., Peace Region, Fort St. John, B.C. Nov. 2004.

Northern Silviculture Committee. 2002. Northern Silviculture Committee workshop. Unpubl. proc., Feb. 2002 meeting, Prince George, B.C.

Resources Inventory Committee. 1998. British Columbia wildlife habitat rating standards. B.C. Ministry of Environment, Lands and Parks, Resource Inventory Committee, Wildlife Interpretations Subcommittee., Victoria, B.C. 108pp.

Stevens, V. 1995. Database for wildlife diversity in British Columbia: distribution and habitat use of amphibians, reptiles, birds and mammals in biogeoclimatic zones. Working Paper, B.C. Ministry of Environment, Lands and Parks, Victoria, B.C.

Wood, C. 1998. Habitat/ecosystem objectives and monitoring procedures for incremental and backlog silviculture treatments, ver. 2.0. B.C. Ministry of Environment, Lands and Parks, Resource Stewardship Branch, Victoria, B.C. 70pp.

6.0 Selected References

Bancroft, B. and K. Zielke. 2002. Guidelines for riparian restoration in British Columbia -- Recommended riparian zone silviculture treatments. Prep. for B.C. Ministry of Forests, Watershed Restoration Program, Victoria, B.C. March 2002. URL: http://www.for.gov.bc.ca/hfp/publications/00077/riparian_guidelines.pdf

Beaudry, L., M. Martin and J. Paczkowski. 2001. Using silviculture to maintain and enhance Grizzly Bear habitat in six variants of the Prince George Forest Region. Report prep. for B.C. Ministry of Environment, Lands and Parks, Habitat Branch, Victoria, BC. March 2001.

B.C. Ministry of Environment, Lands and Parks. 1998. British Columbia wildlife habitat rating standards. B.C. Ministry of Environment, Lands and Parks, Resources Inventory Comm., Victoria, B.C. April 1998.

B.C. Ministry of Environment, Lands and Parks. 2002. Identified wildlife management strategy. B.C. Ministry of Environment, Lands and Parks, Wildlife Branch, Victoria, B.C. URL: http://wlapwww.gov.bc/wld/identified/.

B.C. Ministry of Forests. 2000. Establishment to free growing guidebook - Vancouver and Prince Rupert Forest Regions. Forest Practices Code of British Columbia, Victoria, B.C.

B.C. Ministry of Forests and B.C. Ministry of Environment, Lands and Parks. 1995a. Forest practices code of British Columbia – riparian management area guidebook. Victoria, B.C. Dec. 1995.

B.C. Ministry of Forests and B.C. Ministry of Environment, Lands and Parks. 1995b. Forest practices code of British Columbia – biodiversity guidebook. Victoria, B.C. Sept. 1995.

B.C. Ministry of Forests and B.C. Ministry of Environment, Lands and Parks. 1999. Landscape unit planning guide. B.C. Ministry Forests, Forest Practices Branch., Victoria, B.C. March 1999.

Greenough, J. and W. Kurz. 1996. Stand tending impacts on environmental indicators. FRBC/FRDA rep. prep. for B.C. Ministry of Forests, Silviculture Practices Branch, Victoria, B.C. Oct. 1996.

Hamilton, D. 1998. Habitat/ecosystem objectives and monitoring procedures for incremental and backlog silviculture treatments. Rep. prep. for B.C. Ministry of Environment, Lands and Parks, Resource Stewardship Branch, Victoria, B.C. June 1998.

Hamilton, D. and D. English. 2000. A summary of habitat guidelines for enhanced silviculture. Rep. prep. for B.C. Ministry of Environment, Lands and Parks, Invermere, B.C. March 2000.

Meidinger, D. and J. Pojar. 1991. Ecosystems of British Columbia. B.C. Ministry of Forests, Special Report Ser. 6, Victoria, B.C. Feb. 1991.

Stevens, V. 1995. Database for wildlife diversity in British Columbia: distribution and habitat use of amphibians, reptiles, birds and mammals in biogeoclimatic zones. Working Paper, B.C. Ministry of Environment, Lands and Parks, Victoria, B.C. April 1995.

7.0 Ecological Principles for Large-scale Salvage of Mountain Pine Beetle Affected Landscapes

In response to the unprecedented magnitude of the current mountain pine beetle (*Dendroctonus ponderosae*) outbreak in British Columbia, the need to adequately address ecosystem recovery and restoration in the context of managing large-scale salvage operations has been acknowledged (Stadt 2002; Eng 2004). Significant volume increases in the allowable annual cuts (AAC) of three Timber Supply Areas (TSAs) in British Columbia: Lakes, Prince George and Quesnel; raise concern for the potential long-term and landscape level impacts of large-scale salvage logging on economic, ecosystem and social values (Drever and Hughes 2001; Stadt 2001; Eng 2004, Lidenmayer *et al.* 2004).

Many planning processes have already been expedited to meet the accelerated rate of logging already occurring in beetle-damaged lodgepole pine (*Pinus contorta*) stands. However, this should not compromise the quality and potential for forest stewardship and adaptive, results-based forest practices (Lindenmayer *et al.* 2004). Effective land stewardship is possible in large-scale salvage operations if management approaches encompass an ecosystem-based perspective and are directed at identified feasible goals and results.

7.1 Ecosystem-based Practices

Management practices that meet the objectives and goals defined for maintaining ecosystem values such as land, water and air qualities, as well as associated habitats and biological communities, include an emphasis on landscape level perspectives and ecologically sound science based management applications (Noss 1983; Franklin 1993; Peters *et al.* 1997; Perry 1998; Landres *et al.* 1999; Simberloff 1999; Dale *et al.* 2000). Large, infrequent disturbances like the recent mountain pine beetle (MPB) outbreak are considered integral to lodgepole pine ecosystems (Amman 1977; Dale *et al*. 1998). Therefore, it is possible to adapt and develop land use management practices to direct and promote desired ecosystem recovery processes (Landres *et al.* 1999; Dale *et al.* 2000).

Management practices that maintain areas of residual stand composition and structure similar to those that characterize the landscape prior to management can provide a means of maintaining biodiversity and the essential functions of forest ecosystems (Franklin 1993; Haila *et al.* 1994; Gauthier *et al.* 1996; Franklin *et al.* 1997; Landres *et al.* 1999; Patel-Weynand 2002). Maintaining wildlife habitat within salvage and treated areas is clearly an important stewardship objective and utilizes the benefits of existing biological legacies with particular emphasis on riparian areas that harbor the greatest proportion of vertebrate species in beetle-damaged areas (Hansen *et al.* 1991; Franklin *et al.* 1997; Bunnell *et al.* 2004; MCA 2004).

Lodgepole pine is a tree species commonly found in pure and even-aged stands originating after fire disturbance (Farrar 1995). Lodgepole pine ecosystems with MPB attack reveals the justification, at least in many situations, for mainly conventional, even-aged silvicultural systems and logging methods for areas undergoing large-scale salvage operations. Silvicultural practices inspired by the natural stand dynamics of fire-initiated even-aged forests typically use clear cutting systems of logging. This permits maximum extraction of merchantable timber while still providing opportunities for habitat retention. Successional forests originating from clearcutting

differ from fire-originated stands both in terms of the spatial arrangement of seral stages, and retention of many stand level attributes (Kimmins 1997). These differences are of special concern for wildlife species in beetle salvage operations, where increased rate and scale of conventional even-aged systems of logging are being prescribed (Eng 2004). However, even slight modifications to salvage harvesting plans and prescriptions, such as retention of tree species other than pine during logging, can benefit about 60% of the vertebrate species present as well as many invertebrates, bryophytes and lichens, in post-salvaged pine landscapes (Sullivan *et al.* 2001; Bunnell *et al.* 2004).

Large areas of non-salvaged pine forest will inevitably remain after salvage operations due to the shear volume of beetle-affected pine (Eng 2004). The opportunity to plan strategically the locations of forest retention areas and guide salvage management practices with respect to ecosystem structures, allows forest stewardship objectives to be adequately addressed, to the extent possible, while minimizing timber losses. Additionally, implementing the use of adaptive management principles will facilitate the development of effectiveness monitoring indicators of stand- and landscape-scale management activities in beetle-salvaged areas (Niemelä 2000; Bunnell *et al.* 2004).

7.2 Recommended Guiding Principles for Management

The following is a summary of recommended guiding principles for maintaining habitats, wildlife species and general biodiversity in areas affected by the large-scale salvage of lodgepole pine. Most of the information presented below is summarized from two recent papers by Bunnell et al. (2004) and Eng (2004).

1. The total area harvested caused by the combined green tree and salvage harvesting should not significantly exceed that which would have occurred in the absence of the beetle outbreak – the “total will be reached sooner.

2. At the very least, leave what was originally planned under existing landscape-level plans and legislation.

3. Removal of large quantities of certain habitat, e.g., standing dead trees, large diameter live trees (especially non-pine species), riparian areas, hardwood trees, can have negative impacts on species that require or benefit from those habitats. The extent and effects of these negative impacts at this scale are not known.

4. There should be no changes to the management of Wildlife Habitat Areas, Wildlife Habitat Features, and other fine-filter mechanisms for managing species at risk, regionally important wildlife and significant wildlife habitats.

5. Only three vertebrate species found in central British Columbia are known to preferentially use lodgepole pine forests, but none is restricted to it. These include Black-backed Woodpeckers (*Picoides arcticus*), Three-toed Woodpeckers (*Picoides tridactylus*) and Caribou (northern ecotype *Rangifer tarandus*). The woodpecker species feed and nest in beetle-infected pine (Steeger and Dulisse 1997), but are mobile and can more easily move between fire- or beetle-killed areas (Hutto 1995). However, Caribou appear unable to roam as widely and therefore are more threatened by large-scale salvage logging or treatment.

Northern ecotype Caribou use mature and old pine/spruce stands that contain abundant terrestrial lichen as winter forage.

6. Forest harvesting in Caribou habitat areas should be prohibited in those areas not included in the Timber Harvesting Land Base (THLB), primarily in the Itcha-Ilgachuz area, and allowed in the "modified" zones only to the limits already agreed to for management of Caribou.

7. Areas for priority salvage should be based on a sliding scale determined by the percentage of the stand volume that is pine, and the percentage of that pine volume killed. For example, areas with >70% composition of pine and where >50% of this volume has been beetle-killed, should be considered a High priority for salvage.

8. Salvage logging should also be focused on areas where rapid stand regeneration and subsequent growth is likely.

9. The creation of large openings (>1000 ha) are within the range of natural disturbance levels for lodgepole pine ecosystems, provided they are designed to respect existing land use planning objectives, and that the legacies that are left increase in proportion to the increasing size of the opening (up to 25% by area in the case of 1000 ha harvest openings).

7.2.1 Stand Level

1. Retain species other than lodgepole pine during logging.

2. Provide small buffers of dead lodgepole pine around retained inclusions of other tree species. This mix of live and dead trees will increase the structural diversity of these remnant patches, providing feeding, shelter and dispersal ("stepping stone") habitat, and some intact forest floor.

3. In pure pine stands, retention of small (>0.2 ha) groups of standing dead pine will provide some habitat function (feeding, cavity nesting, perching sites) for wildlife, as well as intact forest floor.

4. Lodgepole pine does not usually provide large diameter coarse woody debris (CWD). However, where present, retain CWD (slash) that is >15 cm diameter, using a combination of small, loosely layered piles (<1 m height) and scattered distribution, that is, leave it where it lies.

5. Follow riparian management area guidelines when harvesting near streams and rivers (see Forest Planning and Practices Regulation 47(4); http://www.for.gov.bc.ca/tasb/legsregs/frpa/frparegs/forplanprac/fppr.htm).

6. Avoid mechanical or other disturbances in or within 20 m of S3 and S4 streams.

7. Reserve hardwood tree species from harvest, including those in riparian areas and upland areas.

8. Where non-pine tree species are not available for retention, create feller-buncher-cut stubs from beetle-killed pine stems. 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.

7.2.2 Landscape Level

1. Plan areas to be reserved from harvest (e.g., retention) as well as areas to be harvested as large blocks.

2. Avoid salvage in selected areas where intermixed pine represents <30% of the species composition mix. Herbers et al. (2004) found that bird species richness (i.e., number of species) and bird densities (i.e., number of birds/10 ha) declined with increasing stand-level composition of lodgepole pine.

3. Get in and out of salvage areas quickly, and deactivate new roads wherever possible.

4. Where salvage in lodgepole pine ungulate winter range (UWR) is considered, reserve ½ of the UWR from salvage.

5. Leave areas should include areas where there are high densities of fish species that are sensitive to salvage logging, and for which the province has a high stewardship responsibility (e.g., Bull Trout, Dolly Varden).

6. Retain unharvested riparian buffers around wetlands and lakes.

7. Avoid log storage within lakes.

7.3 References

Amman, G.D 1977. The role of the mountain pine beetle in lodgepole pine ecosystems: impacts on succession. *In* The role of arthropods in forest ecosystems. Mattson, W.J. (ed.) p.3-18. Springer-Verlag, New York.

Attiwill, P.M. 1994. The disturgance of forest ecosystems: the ecological basis for conservation management. *Forest Ecology Management.* 63: 247-300.

Bergeron, Y. and Harvey, B. 1997. Basing silviculture on natural ecosystem dynamics: an approach applied to the southern boreal mixedwood forest of Quebec. *Forest Ecology and Management* 92: 235-242.

Bergeron, Y., Harvey, B, Leduc, A. and Gauthier, S. 1999. Forest management guidelines based on natural disturbance dynamics: stand- and forest-level considerations. *Forestry Chronicle* 75: 49-54.

Bunnell, F.L., Squires, K.A., and Houde, I. 2004. Evaluating effects of large-scale salvage logging for mountain pine beetle on terrestrial and aquatic vertebrates. Mountain Pine Beetle Initiative Working Paper 2004-2

Dale, V.H., Lugo, A.E., MacMahon, J.A., Pickett, S.T.A. 1998. Ecosystem management in the context of large infrequent disturbances. *Ecosystems* 1: 546-557.

Dale, V.H., Brown, S., Haeuber, R.A., Hobbs, N.T., Huntly, N. Naiman, R.J. Riesame, W.E., Turner, M.G., and Valone, T.J. 2000. Ecological principles and guideline for managing the use of land. *Ecological Applications* 10(3): 639-670.

Duinker, P.N. 1996. Managing Biodiversity in Canada.s Public Forests. In: Biodiversity, Science and Development: Towards a New Partnership (F. di Castri and T. Younes, eds). Wallingford, UK.

Eng, M. 2004. Forest stewardship in the context of large-scale salvage operations: an interpretation paper. B.C. Ministry of Forests, Research Branch, Victoria, B.C. Tech. Rep. 019.

Franklin, J. 1993. Preserving Biodiversity: Species, Ecosystems, or Landscapes? *Ecological Applications* 3(2): 202-205.

Franklin, J.F., D.R. Berg, D.A. Thornburgh, J.C. Tappeiner. 1997. Alternative silvicultural approaches to timber harvesting: Variable Retention Harvest Systems. In: Creating a Forestry for the 21st Century (Komb, K and J.A. Franklin, eds.). Island Press, Washington, DC).

Gauthier, S., Leduc, A. and Bergeron, Y. 1996. Forest dynamics modeling under a natural fire cycle: A tool to define natural mosaic diversity in forest management. *Environment Monitoring Assessment.* 39: 417-434.

Haila, Y, Hanski, I.K. Niemelä, J., Punttila, P., Raivio, S. and Tukia, H. 1994. Forestry and the boreal fauna: matching management with natural forest dynamics. *Annu. Zool. Fennici* 31: 187-202.

Hansen, A.J., S.L. Garman, F.J. Swanson, J.L. Ohmann. 1991. Conserving Biodiversity in Managed Forests. *BioScience* 4:6:382-392.

Herbers, J.R., R. Serrouya and K.A. Maxcy. 2004. Effects of elevation and forest cover on winter birds in mature forest ecosystems of southern British Columbia. *Canadian Journal Zoology*. 82: 1720-1730.

Hutto, R.L. 1995. Composition of bird communities following stand-replacement fires in northern Rocky Mountain (USA) conifer forests. *Conservation Biology* 9: 1041-1058.

Keisker, D. G. 2000. Types of wildlife trees and coarse woody debris required by wildlife of north-central British Columbia. Research Branch, Ministry of Forests, Victoria, B.C. Work. Pap. Available at: http://www.for.gov.bc.ca/hfd/pubs/Docs/Wp/Wp50.htm.

Landres, P.B., J. Verner, and J.W. Thomas. 1988. Ecological uses of vertebrate indicator species: A critique. *Conservation Biology* 2: 316-328.

Landres, P.B., Morgan, P. and Swanson, F.J. 1999. Overview of the use of natural variability concepts in managing ecological systems. *Ecological Applications* 9(4): 1179-1188.

Manning, Cooper and Associates. 2004. Silvicultural guidelines and practices for maintaining or recruiting key habitat objectives. BC Ministry of Water, Land and Air Protection, Biodiversity Branch, Victoria, B.C.

McLennan, D.S., Ronalds, I, and Cichowski, D. 2001. Best management practices and ecosystem restoration recommendation in areas affected by major salvage operations. Review Draft, BC Ministry of Water, Land and Air Protection, Terrestrial Ecosystem Restoration Program.

McCullough, D.G., Werner, R.A. and Neumann, D. 1998. Fire and insects in northern and boreal forest ecosystems of North America. *Annu. Rev. Entomol.* 43: 107-127.

Niemelä, J. 2000. Biodiversity monitoring for decision-making. *Annu. Zool.Fennici* 37: 307-317.

Norton, T.W. 1996. Conservation of biological diversity in temperate and boreal forest ecosystems. *Forest Ecology and Management.* 85: 1-7.

Noss, R.F. 1983. A Regional Landscape Approach to Maintain Biodiversity. *Bioscience.* 33(11): 700-706.

Noss, R.F. 1993. Wildlife corridors. *In* Smith, D.S. and Hellmund, P.C. (Eds.) Ecology of greenways pp.43-68. University of Minnesota Press, Minneapolis.

Patel-Waynand, T. 2002. Biodiversity and Sustainable Forestry: State of Science Review. The National Commission on Science for Sustainable Forestry. Washington, DC. 54pp.

Perry, D. 1998. The Scientific Basis of Forestry. *Annu. Rev. Ecol. Syst.* 29: 435-466.

Peters, R.S., Waller, D.M., Noon, B., Pickett, S.T.A. Murphy, D., Cracraft, J., Kiester, R., Kuhlmann, W., Houck, O. and Snape, W.J. 1997. Standard scientific procedures for implementing ecosystem management on public lands. *In* Pickett, S.T.A., Ostfeld, R.S., Shachak, M. and Likens, G.E., (Eds.) The Ecological Basis for Conservation. Chapman and Hall, New York, NY. p. 320-336.

Probst, J.R. and T.R. Crow. 1991. Integrating Biological Diversity and Resource Management. *Journal of Forestry* 89:2:12-17.

Simberloff, D. 1999. The role of science in the preservation of forest biodiversity. *Forest Ecology and Management* 115: 101-111.

Stadt, J.J. 2002. Landscape unit planning principles in the Lakes Forest District: does the mountain pine beetle change things? Summary of contributions from an expert panel comprising Burton, P.J., deLong, C., Pojar, J. Stadt, J.J. and Stevenson, J.D. BC Ministry Sustainable Resource Management, Skeena Region.

Steeger, C. and J. Dulisse. 1997. Ecological interrelationships of Three-toed Woodpeckers with bark beetles and pine trees. Ministry of Forests, Extension Note 035. URL: http://www.for.gov.bc.ca/rsi/research/nextnotes/Rs035.htm.

Stockdale, C.; Taylor, S.W.; Hawkes, B.C. 2004. Incorporating mountain pine beetle impacts on stand dynamics in stand and landscape models: a problem analysis. Pages 200-209 *in* T.L. Shore, J.E. Brooks, and J.E. Stone, editors. Mountain Pine Beetle Symposium: Challenges and Solutions, Proceedings: Challenges and Solutions. October 30-31, 2003, Kelowna, British Columbia, Canada. Natural Resources Canada, Canadian Forest Service, Pacific

Forestry Centre, Victoria, British Columbia, Information Report BC-X-399. 298 p. Abstract available at: http://bookstore.pfc.cfs.nrcan.gc.ca/FMPro?-db=PUB_Publication_.fp5&-format=detail.html&-token=12705702&-lay=ForWeb&CatalogNumber=25049&-script=Web_English&-find.

Sullivan, T.P, Sullivan, D.S., and Lingren, P.M.F. 2001. Stand structure and small mammals in young lodgepole pine forest: 10-year results after thinning. *Ecol. Applications.* 11(4): 1151-1173.

8.0 Glossary of Terms

Arboreal Lichen – A lichen species that tends to grow above ground, typically from the branches of standing trees.

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

Blowdown – A tree or trees uprooting by the wind. Often referred to as windthrow.

Blue list – List of ecological communities and indigenous species and subspecies of special concern (formerly vulnerable) in British Columbia.

Bole – The trunk of a tree.

Broadcast Burning – A controlled burn, where the fire is intentionally ignited and allowed to proceed over a designated area within well-defined boundaries, to reduce fuel hazard after logging or to prepare the site before planting.

Brushing – A silviculture activity done by chemical, manual, grazing, or mechanical means to control competing forest vegetation and reduce competition for space, light, moisture, and nutrients with crop trees or seedlings.

Buffer – A strip of land (often including undisturbed vegetation) where disturbance is not allowed or is closely monitored to preserve or enhance aesthetic and other qualities along or adjacent to roads, trails, watercourses and recreation sites.

Canopy – The forest cover of branches and foliage formed by tree crowns.

Canopy Closure – The percentage of the ground surface covered when the canopy crown is projected vertically.

Canopy Gap – A distinct air space or hole between the foliage of the canopy crown.

Capability – The ability of the habitat, under optimal natural (seral) conditions to provide the life requisites of a species, irrespective of its current habitat condition.

Closed Canopy – The condition when the crowns of trees touch and effectively block sunlight from reaching the forest floor.

Clumpy – Refers to the pattern of distribution of vegetation in an area such as a harvest opening, and can include the distribution of trees, regeneration, or shrub cover. A clumpy distribution is characterized by groups or clusters of vegetation, as opposed to uniformly or randomly distributed vegetation. “Clumpy” is often used in the context of planting and juvenile spacing treatments, and is also referred to as “patchy”.

Commercial Thinning – A silviculture treatment that removes or cuts stems that can be used commercially (e.g., fence posts) from an immature stand to help accelerate the growth and diameter size of the remaining stems.

Conk – A hard, fruiting body that typically grows on the trunk of a tree, which contains spores of a wood-decaying fungus

Connectivity – To have forest stands or habitat areas attached or linked to one another across the landscape.

Critical Winter Range – Forested habitat, usually stands of mature or old growth conifers, which provides ungulates with resources critical to survival during severe winters.

CWD (Coarse Woody Debris) – Above ground, dead woody material in various stages of decomposition that is not self-supporting and provides habitat for plants, animals, and insects and is a source of nutrients for soil development.

CWD Decay Classes – A five-category system that describes the amount of decay that is present on a downed piece of wood >7.5 cm in diameter (i.e., class 1 is intact, hard and elevated above ground; class 5 is decayed into many small pieces with soft portions that is partly sunken into the ground).

Danger Tree (Hazard Tree) – A live or dead tree whose trunk, root system or branches have deteriorated or have been damaged to such an extent as to be a potential danger to human safety.

DBH (Diameter at Breast Height) – The stem diameter of a tree measured at breast height, 1.3 metres above the ground.

Deactivation – Measures taken to stabilize roads and logging trails during periods of inactivity, including the control of drainage, the removal of sidecast where necessary, and the re-establishment of vegetation for permanent deactivation.

Disturbance – A discrete event, either natural or human-induced, that causes a change in the existing condition of an ecological system.

Edge Habitat – Habitat conditions that exist along the outer band of a forested patch that are significantly different (e.g., differences in humidity, vegetation heights, plant associations, and exposure to light or wind) from the interior of the patch.

Exotic Species – A species introduced accidentally or intentionally to a region beyond its natural range. "Exotic" is a preferred synonym for "alien", "foreign", and "non-native".

Forest Floor – The layers of fresh leaf and needle litter, moderately decomposed organic matter, humus or well-decomposed organic residue found on the ground within a forest stand.

Fragmentation – The process of transforming large continuous forested areas into one or more smaller patches surrounded by human-made or naturally occurring disturbed areas.

Fungal Inoculation – An artificial means of introducing wood-decaying fungal spores into a live tree to increase decay and wildlife value.

Girdling – To kill a tree by severing or damaging the cambium layer and interrupting the flow of food between the leaves and the rest of the tree.

Habitat – The place where an organism lives and/or the conditions of that environment, including the soil, vegetation, water, and food.

Habitat Feature (elements) – An element of a forest stand that is used by a wildlife species for sustaining its ecological role, i.e., a snag, hollow log, mossy covered branch, forked limb crotch, rocky outcropping, etc.

Habitat Matrix – A series of linked habitat areas that maintain large-scale ecological processes at the landscape level.

Hard Forest Edge – An immediate, well-defined boundary between two or more distinctly different seral stages (i.e., the edge between an early seral stage and a late seral stage).

Herb Layer – All herbaceous plants (regardless of height) and low woody plants <15 cm tall.

Interior Forest Habitat – Microclimate conditions, e.g., light intensity, temperature, wind, relative humidity and moisture levels, found deep within forests usually away from the effects of open areas.

Juvenile Spacing – A silvicultural treatment to reduce the number of trees in young stands, often carried out before the stems removed are large enough to be used or sold as a forest product. Also called precommercial thinning.

Landscape Level – The level of forest management at which ecosystem processes, habitat types and seral stage distribution are managed for large, geographically separate areas.

Landscape Unit – A planning area, up to 100 000 ha in size, based on topographic or geographic features such as a watershed or series of watersheds.

Landing – An area modified by equipment that is designed for accumulating logs before they are transported.

Leave Trees – All trees, regardless of species, age, or size, remaining on a harvested area as a result of a predetermined silviculture prescription to address a possible range of silviculture or resource needs.

Maintain – To stay at, or approximate, current natural levels of forage or other habitat attributes.

Management Guideline - Generally accepted non-legislated guidance and management recommendations based on the best available data and expert opinion.

Mature Forest – The stage at which trees in a narrowly even-aged stand attain full development, particularly in height and seed production.

Natural Disturbance Regime – The historic patterns (frequency and extent) of fire, insects, wind, landslides and other natural processes and disturbances in an area.

Old Forest – Over-mature, structurally complex stands consisting of live and dead trees of various sizes, species, composition, and age class structure.

Overstory – Foliage within the shrub and canopy layers of a forest stand that obstruct sunlight from reaching the forest floor.

Partial Harvesting – A general term referring to silvicultural systems other than clearcutting, in which only selected trees are harvested.

Patch Cutting – A silvicultural system that creates openings less than 1 hectare in size and is designed to manage each opening as a distinct even-aged opening.

Patchy – Refer to definition of Clumpy.

Prescribed Burning – The knowledgeable application of fire to a specific unit of land to meet predetermined resource management objectives.

Pruning – The manual removal, close to or flush with the stem, of side branches, live or dead, and of multiple leaders from standing, generally plantation-grown trees.

Recruit – To restore forage or other habitat attributes to previous natural equilibrium levels. Recruit can also be used in the context of enhancement, which means to increase forage or other habitat attributes above previous natural equilibrium levels.

Red List – Includes any indigenous species or subspecies (taxa) considered to be extirpated, endangered, or threatened in British Columbia. Extirpated taxa no longer exist in the wild in British Columbia, but do occur elsewhere. Endangered taxa are facing imminent extirpation

or extinction. Threatened taxa are likely to become endangered if limiting factors are not reversed.

Retention – To retain or save a portion of the original stand in a cluster or clump.

Riparian – an area adjacent to a stream, lake, pond or wetland where water influences the vegetation.

Riparian Management Area (RMA) – An area, the width as determined in accordance with standards described in the Forest Practices Code *Operational Planning Regulations*, which is adjacent to a stream, wetland or lake. The RMA consists of a riparian management zone **(RMZ)** and, depending on the riparian class of the stream, wetland or lake, a riparian reserve zone **(RRZ)**. The riparian class is determined by the attributes of the stream, wetland or lake, as well as the adjacent terrestrial ecosystems. Attributes include channel width, size (area) of the wetland, presence of fish, domestic water use, and gully status (stream gradient and sidewall slope).

Riparian Reserve Zone (RRZ) – The portion of a riparian management area that borders the stream channel. RRZs are determined by the stream class and associated attributes (see RMA). Forest management activities are restricted in RRZs.

Rotation Period – The planned number of years between the formation or regeneration of a tree crop or stand and its final cutting at a specified stage of maturity.

Scarification – A method of seedbed preparation that consists of exposing patches of mineral soil through mechanical action.

Second Growth – A forest or stand that has grown up naturally after removal of a previous stand by fire, harvesting, insect attack or other cause.

Security Cover – Vegetation structure or topographical features, or both, that provide an animal with security or a means of escape from the threat of predators or harassment.

Selective Harvesting – The removal of certain trees in a stand as defined by specific criteria (species, diameter at breast height, height or form).

Seral Stage – Any stage of development of an ecosystem, from a disturbed, unvegetated state to a climax plant community.

Shrub Layer – All woody plants <10 m and >15 cm tall.

Silviculture – The theory and science of controlling the establishment, growth, composition, health and quality of forests and woodlands.

Silviculture Prescription – A site-specific, integrated operational plan to carry out one or a series of silviculture treatments.

Single Tree Selection – A silvicultural system that removes mature timber either as single scattered individuals or in small groups at relatively short intervals.

Slash – The residue left on the ground as a result of forest and other vegetation being altered by forest practices or other land use activities.

Small Group Selection – A silvicultural system that removes mature timber in a small area or grouping, typically $\leq$0.5 ha in size.

Snag – A standing dead tree.

Snag Classes – A nine-category system that describes the amount of decay that is present on a standing tree (i.e., class 1 is a live tree with no rot or decay present; class 9 is a fully decayed stump partially incorporated into the forest floor).

Soft Forest Edge – A gradual, transitional boundary between two or more seral stages, i.e., the edge between a middle seral stage and a late seral stage.

Soil Moisture Regime – The available moisture supply for a soil relative to other sites and soil types.

Soil Nutrient Regime – The available nutrient supply for a soil relative to other sites and soil types.

Spacing – The removal of undesirable trees within a young stand to control stocking, to maintain or improve growth, to increase wood quality and value, or to achieve other resource management objectives. Also see Thinning.

Stand Attribute – A measurable component of a forest stand, i.e., canopy closure, basal area, stem distribution, or seedlings/ha, etc.

Stand Level – The level of forest management at which a relatively homogeneous land unit can be managed under a single prescription, or set of treatments, to meet well-defined objectives.

Stand Structure – The distribution of trees in a stand, which can be described by species, vertical or horizontal spatial patterns, size of trees or tree parts, age, or a combination of these.

Stocking – A measure of the area occupied by trees, usually measured in terms of well-spaced trees per hectare, or basal area per hectare, relative to an optimum or desired level.

Stub Tree – An artificially created wildlife tree, mechanically cut from a class 1, 2 or 3 tree.

Succession – The gradual supplanting of one community of plants by another.

Suitability – Ability of the habitat in its <u>current</u> condition to provide life requisites of an animal.

Thermal Cover – Vegetation structure and/or topographical features that provide an animal a means to thermoregulate.

Thinning – A silviculture treatment that removes or cuts stems in an immature forest primarily to accelerate diameter increment but also, by suitable selection, to improve the average form of the trees that remain.

Treatment Area – Productive forest land designated in a prescription for a specific silviculture activity or series of treatments.

Tree Layer – All woody plants >10 m tall.

Understory – Any plants growing under the main tree canopy, particularly those found in the herbaceous and shrub layers.

Veteran Tree (Vet) – A tree that is significantly older (usually <u>≥</u>150 years of age) than the trees of the main forest canopy. Veteran trees may have survived one or more fires as evidenced by fire scars, and are usually isolated in distribution and often extend well above the main tree canopy. Because of their large size, they usually provide valuable wildlife tree habitat for many decades.

Wildlife Corridor – A strip or band of habitat that wildlife use to travel from one habitat area to another.

Wildlife Tree – A standing dead or live tree with special characteristics that provide valuable habitat for the conservation or enhancement of wildlife.

Wildlife Tree Patch (WTP) – An area specifically identified for the retention and recruitment of suitable wildlife trees that is reserved from harvest for at least 1 rotation length.

Winter Range – A range, usually at lower elevation, used by ungulates during the winter months that is typically better defined and smaller than summer range.

Yellow List – A list of ecological communities and indigenous species that are not at risk in British Columbia.

Young Forest – A loose term applied to all stages of forest after it is established and before it becomes mature.

Appendix 1. Biogeoclimatic Subzones of British Columbia.

Zonal Group	Biogeoclimatic Zone	Subzone	Subzone Code
Coastal	Coastal Douglas-fir	Moist Maritime	CDFmm
	Coastal Western Hemlock	Wet Hypermaritime	CWHwh
		Very Wet Hypermaritime	CWHvh
		Very Dry Maritime	CWHxm
		Dry Maritime	CWHdm
		Moist Maritime	CWHmm
		Wet Maritime	CWHwm
		Very Wet Maritime	CWHvm
		Dry Submaritime	CWHds
		Moist Submaritime	CWHms
		Wet Submaritime	CWHws
Mountain Hemlock	Mountain Hemlock	Wet Hypermaritime Parkland	MHwhp
		Wet Hypermaritime	MHwh
		Moist Maritime Parkland	MHmmp
		Moist Maritime	MHmm
Dry Interior	Bunchgrass	Very Dry Hot	BGxh
		Very Dry Warm	BGxw
	Ponderosa Pine	Very Dry Hot	PPxh
		Dry Hot	PPdh
	Interior Douglas-fir	Very Dry Hot	IDFxh
		Very Dry Warm	IDFxw
		Very Dry Mild	IDFxm
		Dry Mild	IDFdm
		Dry Cool	IDFdk
		Moist Warm	IDFmw
		Wet Warm	IDFww
	Montane Spruce	Very Dry Very Cold	MSxv
		Very Dry Cool	MSxk
		Dry Cold	MSdc
		Dry Cool	MSdk
		Dry Mild	MSdm
Interior Cedar-Hemlock	Interior Cedar-Hemlock	Very Dry Warm	ICHxw
		Dry Warm	ICHdw
		Moist Warm	ICHmw
		Moist Mild	ICHmm
		Wet Cool	ICHwk
		Very Wet Cool	ICHxk
		Dry Cool	ICHdk
		Moist Cool	ICHmk
		Moist Cold	ICHmc
		Very Wet Cold	ICHvc

Zonal Group	Biogeoclimatic Zone	Subzone	Subzone Code
Central Plateau	Sub-boreal Pine-Spruce	Very Dry Cold	SBPSxc
		Dry Cold	SBPSdc
		Moist Cool	SBPSmk
		Moist Cold	SBPSmc
	Sub-boreal Spruce	Dry Hot	SBSdh
		Dry Warm	SBSdw
		Dry Cool	SBSdk
		Moist Hot	SBSmh
		Moist Warm	SBSmw
		Moist Mild	SBSmm
		Moist Cool	SBSmk
		Moist Cold	SBSmc
		Wet Cool	SBSwk
		Very Wet Cool	SBSvk
Engelmann Spruce-Subalpine Fir	Engelmann Spruce-Subalpine Fir	Very Dry Cold	ESSFxc
		Dry Cool	ESSFdk
		Dry Cold	ESSFdc
		Dry Very Cold	ESSFdv
		Moist Warm	ESSFmw
		Moist Mild	ESSFmm
		Moist Cool	ESSFmk
		Moist Cold	ESSFwc
		Moist Very Cold	ESSFmv
		Wet Mild	ESSFwm
		Wet Cool	ESSFwk
		Wet Cold	ESSFwc
		Wet Very Cold	ESSFwv
		Very Wet Cold	ESSFvc
		Very Wet Very Cold	ESSFvv
Boreal	Boreal White and Black Spruce	Dry Cool	BWBSdk
		Moist Warm	BWBSmw
		Wet Cool	BWBSwk
	Spruce-Willow-Birch	Dry Cool	SWBdk
		Moist Cool	SWBmk
		Dry Cool Scrub	SWBdks
		Moist Cool Scrub	SWBmks
Alpine Tundra	Alpine Tundra		AT

Source: Meidinger, D. and J. Pojar. 1991. Ecosystems of British Columbia. B.C. Ministry of Forests. Special Report, Series 6, Victoria, B.C.