Cariboo-Chilcotin Land Use Plan

Regional Mule Deer Winter Range Strategy

INFORMATION NOTE #1

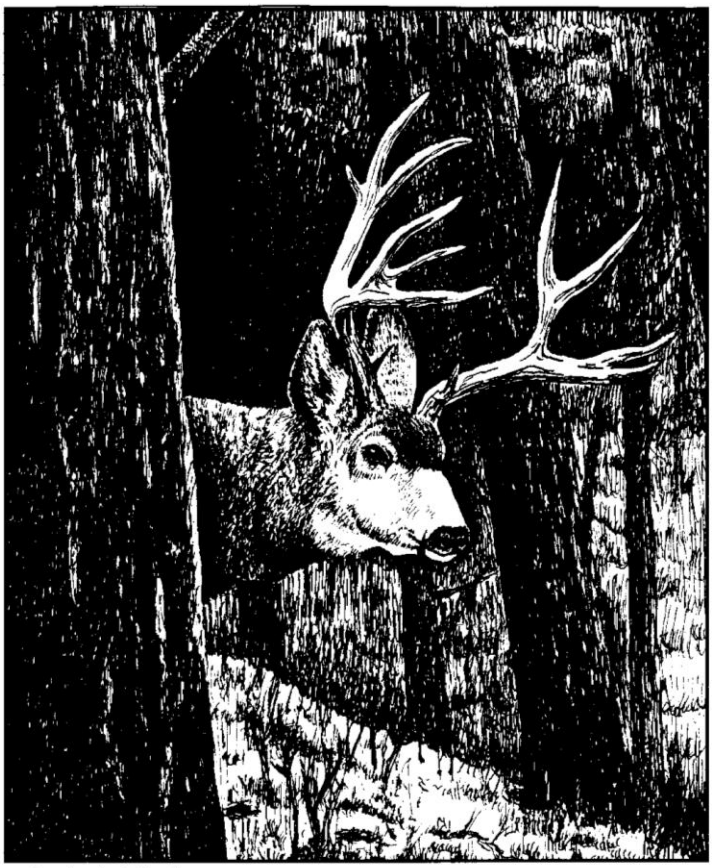
Guidance for Fire-damaged Stands

Prepared by: Mule Deer Winter Range Strategy Committee

Prepared for:

The Regional Management Team

June 2014



Drawing by J. Youds

Mule Deer Winter Range Strategy Information Notes are prepared by the Cariboo-Chilcotin Mule Deer Winter Range Strategy Committee for purposes of technical clarification of the General Wildlife Measures, established under the Government Action Regulations of FRPA. These notes are prepared in response to issues and questions presented to the MDWR Committee or recognized by the members of the Committee.

Members of the Mule Deer Winter Range Committee include: Becky Bings – chair (FLNRO), Michaela Waterhouse (FLNRO), Chris Nowotny (FLNRO).

Information Note #1 Guide for Fire-damaged Stands has been prepared collaboratively with:

David Rusch (Forest Pathologist), Nola Daintith (Silviculture Specialist), Teresa Newsome (Silviculture Research), Kerri Howse (Stewardship Officer), Jodi Axelson (Forest Entomologist) – all from FLNRO.

Information Note #1 Guide for Fire-damaged Stands

Draft Guidance for Fire-damaged Stands in Mule Deer Winter Range within the CCLUP Area

1. Introduction

1.1 Mule Deer Winter Range Background

Winter survival of mule deer in the Cariboo is dependent on sufficient habitat that provides adequate food, shelter and low snow depths to help counter balance the energetic outputs required during winter. Functional mule deer winter range contains multi-layered uneven-aged stands dominated by mature Douglas-fir. Large diameter mature Douglas-fir with large wide crowns provide snow interception, which results in lower snow depths and less energy expended for movement. Multi-layered Douglas-fir stands also provide security and thermal cover. Douglas-fir foliage, primarily from large, old trees is a valuable forage species for mule deer and is the most common species in the mule deer winter diet, averaging about 65% of the diet over the winter and reaching 89% in some months (Waterhouse *et al*. 1994).

Research, establishment and management planning for mule deer winter range (MDWR) has spanned several decades, starting in the 1970s and 1980s. Development of management plans and achievement of MDWR objectives were directed by the Cariboo-Chilcotin Land Use Plan (CCLUP, 1996) and has been further described in detail in Land Management Handbooks 59 (Dawson *et al*. 2006) and 60 (Dawson *et al*. 2007). This direction was also established in 2007 as General Wildlife Measures in two separate Orders under the Government Actions Regulation (GAR) of the *Forests and Range Practices Act* (*FRPA*).

Large scale fires can have a significant impact on the quality and suitability of mule deer winter range habitat. The impact of fires on MDWR is often made worse by Douglas-fir beetle outbreaks that are associated with fires and windthrow events, and can result in even greater habitat loss. Post-fire treatments must have the objective of restoration of MDWR habitat. Timber salvage in MDWR following a fire or other large scale natural disturbance event generally requires an exemption from the General Wildlife Measures. The forest health and other benefits of fire salvage in MDWR must be carefully weighed against the potential negative impacts posed by salvage operations especially as they relate to MDWR stand and long-term objectives. Guidance in this document is intended to apply to MDWR in the Shallow and Moderate Snowpack Zones. It is expected that proposed salvage in Transition and Deep Snowpack Zone MDWRs can be addressed within General Wildlife Measures for group selection.

This document outlines some of the factors that should be considered before applying post-fire treatments in MDWR and is intended to:

- provide guidance to licensees applying for salvage exemptions from the General Wildlife Measures on MDWR in the Shallow and Moderate Snowpack Zones,
- guide forest health activities aimed at preventing further damage to MDWR in the Cariboo Region from Douglas-fir beetle post-fire, and
- guide future investments on mule deer winter range aimed at restoring MDWR habitat after large-scale wildfires.

1.2 Impact of 2009 and 2010 Wildfires on MDWR

There are approximately 450,000 ha within the productive forest land base managed as MDWR in the CCLUP area. The majority of this habitat is situated within the Interior Douglas-fir (68%) and Sub-boreal Spruce (24%) biogeoclimatic zones, along the Chilcotin and Fraser River valleys as well as other smaller features. Twenty-five percent of the productive forest land base within MDWR is also designated and managed as Old-Growth Management Area (OGMA).

In 2009 and 2010, the Cariboo Chilcotin experienced a number of large fires associated with MDWR in the IDF. These fires had a significant impact on several winter ranges, mainly in the Chilcotin area (see Table 1). The highest impacted MDWR was North Taseko with 93% of the winter range within a fire boundary. The burn intensity can vary considerably within the fire boundary. For example, an analysis of burn intensity for some of the 2010 fires indicated that roughly half of the burned area was classified as moderate. Severely burned and unburned areas each accounted for 14% of the burned area and the rest was classified as low severity.

Table 1. Area and percentage of MDWR impacted in 2009 and 2010 fires including and excluding OGMAs. Areas and percentages within the productive forest land base.

Winter Range	**MDWR area and percent of MDWR within fire boundaries**		**MDWR area and percent of MDWR within fire boundaries excluding OGMAs**	
	(ha)	**(%)**	**(ha)**	**(%)**
Alkali-Dog Creek	4149	16.4	2953	11.7
Edge Hills	760	18.5	430	10.5
General Tingley	272	7	235	6
Kostering Creek	781	45.5	781	45.5
Meldrum	226	1.7	146	1.1
North Taseko	8863	92.6	5851	61.1
Porcupine Creek	960	37.6	953	37.3
River Ranch	1057	23.5	931	20.7
South Chilcotin	1536	22.2	1302	18.8
West Chilcotin	2906	31.7	2305	25.1
West Chilko	2353	53.8	1501	34.3
Total	23863		17388	

1.3 Post-fire Douglas-fir Beetle

Fire damaged stands are very attractive to the Douglas-fir bark beetle because fire killed trees often have viable phloem for up to a year, making them susceptible to Douglas-fir beetle attack. This can result in local build-ups of beetle populations that can then attack fire stressed trees in subsequent years.

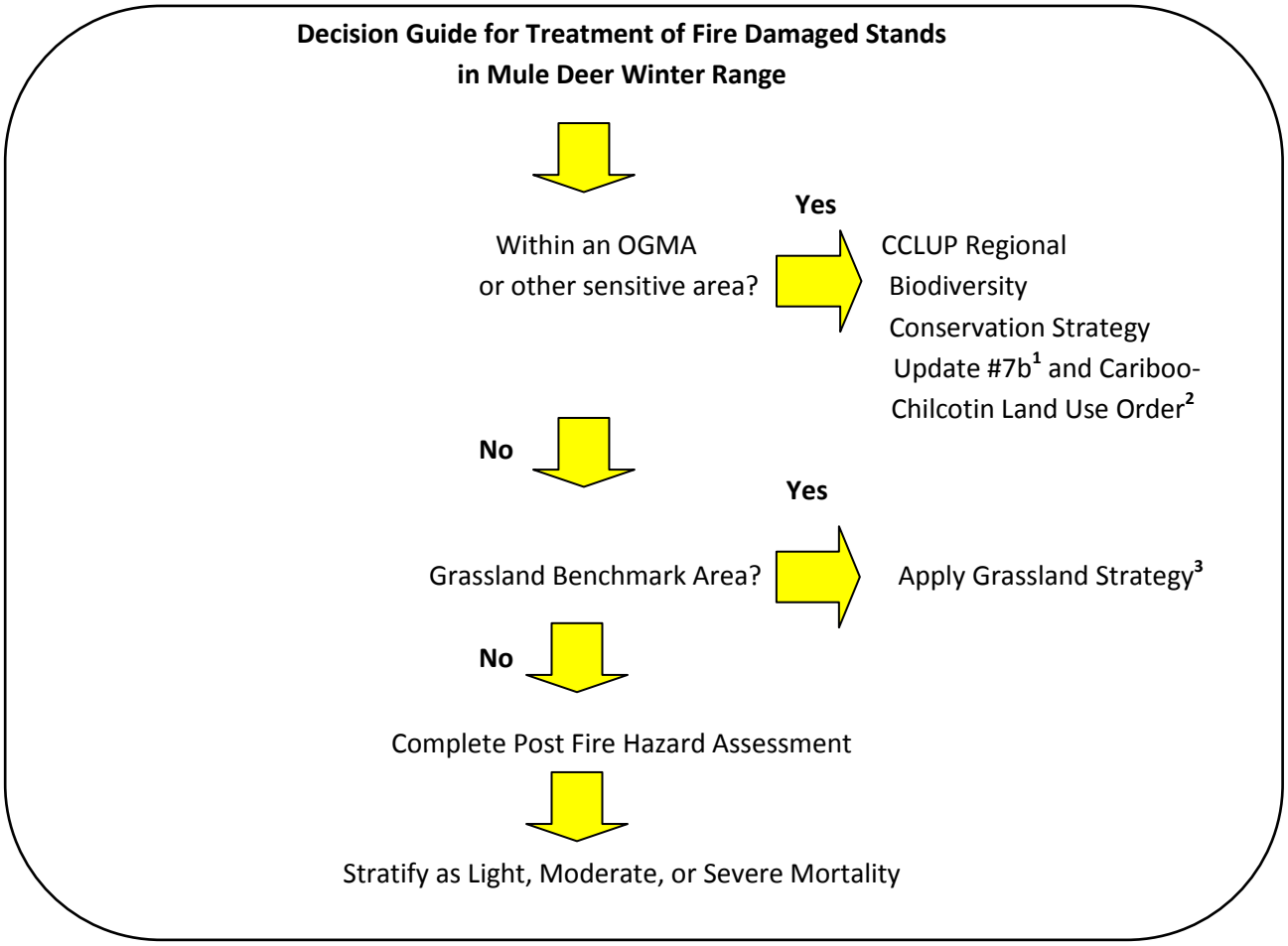
Detailed probing of a small 2009 fire near Alexis Creek indicated that two years after the fire most trees over 37.5 cm dbh in the moderate and low severity burned areas were killed by Douglas-fir beetle. A similar pattern of mortality has been observed in portions of the much larger Siwash fire south of the Chilcotin River. Increased mortality from Douglas-fir beetle after fire has also been documented in other jurisdictions (Amman 1990, Jeans-Williams *et al*. 2001, Bulaon 2003, Fowler and Sieg 2004, Parker *et al*. 2006, Hood and Bentz 2007).

2 Management Considerations and Treatment Options

2.1 Considerations for Management

Douglas-fir trees killed or damaged by fire can have a wide range of impacts on MDWR habitat, and the level of impact depends on factors such as fire severity, size or extent of fire, location within the winter range, residual winter range condition and potential for subsequent forest health risks. For example, the impact to MDWR function of a smaller fire in a low stand structure objective area, within a winter range in good current condition would be significantly less than a large fire within a high stand structure area of a winter range that does not currently have adequate high stand structure habitat. Restoration treatments may also differ within and between different MDWRs, but the objective of restoring MDWR habitat (*i.e*. Douglas-fir) remains constant.

MDWR habitat includes other values and designations that may need to be addressed during post-fire treatment considerations. The following decision guide will help to focus assessments in areas of MDWR that are not managed under other directives.



[1] http://archive.ilmb.gov.bc.ca/slrp/lrmp/williamslake/cariboo_chilcotin/plan/biodiv/biodiv_update7b_dec_11_2006.pdf

[2] ftp://ftp.geobc.gov.bc.ca/publish/Regional/WilliamsLake/Cariboo-Chilcotin_LUOR_Order/legal_order_document/CaribooChilcotinLUO_May2011.pdf

[3] http://archive.ilmb.gov.bc.ca/slrp/lrmp/williamslake/cariboo_chilcotin/news/files/reports/grasslands_strat/grassland_bmps_aug_2007.pdf

Before planning treatment activities it is recommended that a post-fire assessment be conducted and that the burned area is stratified by burn severity.

Post-fire assessments should be completed to determine what, if any, treatments should be considered to restore MDWR habitat in a feasible time period. This will include consideration of the factors mentioned previously and should also include the potential for natural regeneration, a bark beetle risk assessment, access, and other risk factors (such as soil sensitivity or the likelihood of slope failures).

A light severity burn is defined as an area where less than 10% of the trees 17.5 cm dbh or greater are killed immediately post-fire. Moderate severity areas are those areas with 10-80% of the merchantable trees are killed immediately post fire, and high severity burned areas are areas where more than 80% of the merchantable trees are killed immediately post-fire. Some examples of low, moderate, and high severity burns are shown in Figure 1. Salvage harvesting should only be considered in areas with moderate to high tree mortality (≥10% mortality).

Fig. 1a Light severity (note the unburned juniper)

Fig. 1b Light severity

Fig. 1c Moderate severity (note the scorch on lower boles and presence of killed trees)

Fig. 1d Moderate severity

Fig. 1e High severity (note the lack of any forest floor)

Fig. 1f High severity

2.2 Treatment Options

The post-fire assessment and severity stratification can help determine treatment and activity options, in short and long term. Combinations include:

- no treatment
- no salvage, reforestation with Douglas-fir
- no salvage, addressing Douglas-fir beetle through trap trees, MCH, GWMs for sanitation
- monitoring in all cases, may lead to future restoration activities (Douglas-fir underplanting, initial planting with pine then conversion to Douglas-fir)
- salvage, with Douglas-fir reforestation

Salvage

The decision to salvage should be based on whether the potential benefits outweigh the potential risks. Such a determination should consider the following factors:

- salvage within 1 or 2 years of a fire may reduce subsequent loss of live trees from Douglas-fir bark beetle.
- reforestation of sites (required after harvesting) may return the stands to a forested condition more quickly than through the process of natural regeneration.
- salvage activities may kill surviving natural regeneration and remove vertical structure. Also, this may remove frost protection necessary for the establishment, survival and growth of Douglas-fir natural regeneration.
- salvage activities have the potential of causing increased soil compaction and erosion associated with salvage activities and road construction, especially on steep slopes. Soil stability assessments for most large fires in the Cariboo Region can be found in the Post-Wildfire Natural Hazard Risk Analyses that are carried out as part of the Provincial Emergency Program (PEP).
- regeneration of drybelt Douglas-fir is more difficult without an existing overstory.
- regeneration of salvaged stands back to high densities of lodgepole pine could result in full site occupancy and prevent the natural ingress of Douglas-fir.

Salvage harvesting coupled with Douglas-fir bark beetle treatments within two years of a fire is recommended to reduce the risk of continual mortality in MDWR where stands have been killed by moderate to high severity fires. These strategies will have the highest chance of success if they are employed within the first year following a fire before beetle populations build to unmanageable levels. Proceeding with a salvage proposal should be considered, for the purposes of salvaging dead or severely damaged trees in areas of moderate to high fire severity, where the following conditions are met:

- The exemption request is for the removal only of dead trees or trees with more than 80% crown scorch. (Hood and Benz (2007) found that only 9% of trees with more than 80% crown scorch were alive four years after fire regardless of diameter, cambium damage, or beetle attack level.),
- The risk of Douglas-fir bark beetle is high (consult Regional Entomologist)
- Evidence can be provided that there is a low potential for natural regeneration.
- Post-wildfire hazard assessment has been completed, and proceeding with salvage will not cause site damage or increase risk of damage to roads or structures.
- Douglas-fir regeneration strategies will be employed to expedite the recovery of the winter range.

3. Recommended Best Management Practices

3.1 Salvage Techniques

Retain all live trees with less than 80% crown scorch and a height to diameter ratio <100 in order to provide shade and frost protection as well as a seed source for subsequent regeneration. Large woody debris and slash that does not pose a risk for increased Douglas-fir beetle activity should be left throughout the block to reduce the risk of frost, maintain biodiversity, and soil moisture holding capacity. Large woody debris is dead woody material, in various stages of decomposition, located above the soil, larger than 7.5 cm in diameter which is not self-supporting (Densmore *et al*. 2009). Consider retaining some patches of fire killed trees. Leave tree patches should not contain trees that could support Douglas-fir beetle attack (i.e. live or fire killed trees that still have viable cambium). Stubbing is another technique that could be used as a method of preserving some additional vertical structure.

Harvesting practices must be prescribed in a manner that minimizes forest floor erosion, soil compaction, and damage to surviving natural regeneration. Post wildfire risk analyses prepared by MFLNRO may identify areas with an increased risk of erosion post fire. Copies of the post-fire risk analyses can be obtained from FLNRO staff by request. There may be areas of increased soil erosion that are not identified in the post-wildfire risk analyses because these analyses often focus on areas where property or structures are at risk.

3.2 Douglas-fir beetle Management Strategies

There are a number of other Douglas-fir bark beetle management strategies that can be used either in conjunction with salvage or in places where salvage harvesting may not be appropriate. Requests for exemptions should include a description of Douglas-fir beetle management strategies that will be employed.

3.2.1 Funnel Traps

Funnel traps are a way to concentrate Douglas-fir beetles and keep them out of areas that are at risk of beetle attack. They should only be used in areas where live Douglas-fir over 20 cm dbh are absent within 100 m of the trap sites (such as severely burned areas or lodgepole pine areas). Funnel traps should be placed in groups of three in a triangular pattern roughly 10 m apart. The distance between trap sites should be between 300-500 m. Traps are hung at least 2 m above the ground prior to May 1. Traps need to be relatively accessible so they can be easily monitored on a regular basis throughout the summer.

3.2.2 Anti-aggregation pheromones

Anti-aggregation pheromones can be used before or after salvage to disperse beetles and help prevent mass attack. They can be used to help protect valuable seed trees or as part of a push pull strategy in conjunction with trap trees. They can also be used in areas where salvage and trap trees may be difficult

to use (eg. steep or inaccessible areas) or to minimize beetle attack in fresh tree fall (Douglas-fir blowdown that has been down less than one year). They are best used over small areas or lightly attacked areas and are generally employed in a 10-12 m grid pattern.

3.2.3 Salvage techniques for minimizing subsequent beetle spread

There are a number of methods that can be used to reduce the spread of Douglas-fir beetle after salvage. These include keeping the height of green Douglas-fir stumps below 30 cm, removing bark from stumps, and removing any green slash over 20 cm dbh prior to burning bans coming into effect. Any decked wood must be removed before April 1st.

3.2.4 Trap Trees

Trap trees are recommended as a follow-up to sanitation harvesting or in areas where sanitation harvesting is not possible. Refer to the Bark Beetle Management guidebook for recommended trap tree procedures.

3.3 Silviculture

The overarching objective for reforesting in MDWR is the restoration of a Douglas-fir canopy that provides winter habitat (forage and cover) for mule deer.

An application for an exemption from GWM 1, which is related to re-establishing Douglas-fir after primary forest activities, must include a regeneration plan for the entire exemption application area. The regeneration plan will outline strategies for the regeneration of Douglas-fir and other species, and it is strongly recommended that the plan specifies planting at least 50% Douglas-fir stems over the entire exemption area. Stocking standards must be reflective of these regeneration objectives.

The regeneration plan should consider the site limiting factors (e.g. frost, drought, diurnal temperature extremes, vegetation competition, livestock grazing, wildlife damage, forest health) that may affect the successful establishment of Douglas-fir. Treatment options for addressing the site limiting factors may include, but are not limited to, the following:

- Retain live and small diameter stems during salvage that do not pose a forest health risk. This residual structure can potentially reduce the risk of radiation frost, ameliorate diurnal temperature extremes, and provide a seed supply.
- Plant Douglas-fir in the best microsites. Planting adjacent to heat radiating obstacles such as stumps, large woody debris and boulders will reduce the skyview factor and reduce frost hazard. Obstacle planting can also reduce the risk of livestock and wildlife damage.
- Plant a higher percentage of Douglas-fir in the fire areas on sites where the risk of drought and growing season frost is minimal. Steen *et al*. (1990) provides frost sensitivity ratings for common species and frost ratings by biogeoclimatic subzone and mesoslope position in the Cariboo Region. Delong *et al*. (Ecora Resource Group Ltd.) (2012) also provide drought risk and frost hazard ratings for the Williams Lake TSA (http://www.for.gov.bc.ca/ftp/DCC/external/!publish/Stewardship/Drought%20Risk%20and%20Frost%20Hazard/), however this is a mapping/modelling product. Assessments of frost/drought

risks used for exemption requests must be based on a site-specific field evaluation rather than a mapping exercise.
- Plant Douglas-fir in a species mixture where it may potentially establish in the shelter of other species, especially if minimum inter-tree distances are reduced,
- Select a Douglas-fir stock type that has potential to withstand site conditions (e.g. use of plug-bareroot Douglas-fir stock that is better adapted to field conditions than nursery stock),
- Use mechanical site preparation, that creates a decrease in frost and high daytime surface soil temperatures while increasing moisture availability as well as discouraging cattle activity directly around seedlings (a winged ripper tooth is a good option).
- Apply wildlife deterrents.

The regeneration plan should promote a stand having a clumpy distribution of Douglas-fir and, possibly, other species. A clumpy distribution of Douglas-fir stems will, over time, increase snow interception cover and forage production for deer (Armleder *et al*. 1999); a clumpy distribution of other species can increase microsites where Douglas-fir can fill in naturally, or be planted in the longer term.

In consideration of the above, the following are examples of variances to the *Reference Guide* stocking standards that may be considered in the Forest Stewardship Plan (FSP) for application on MDWR fire salvage regeneration areas.

- The minimum inter-tree distance (MITD) may be varied to help increase clumpiness of the stand, encourage obstacle planting, and promote maximum use of microsites for Douglas-fir. Stocking standards must include measurable stand level objectives of the cluster treatment such as the number of trees per cluster and total clusters per hectare. Refer to the Silviculture Survey Procedures Manual (2012, Section 9.3.1) which describes survey methods to assess clustered stand structures (http://www.for.gov.bc.ca/hfp/silviculture/Surveys/SilvicultureSurveyProceduresManual-2012.pdf).
- Aspen may be considered non-deleterious when assessing the free growing status of Douglas-fir.
- Ponderosa pine may be added as an acceptable species where it is ecologically suitable and within the Chief Forester's Standard for Seed Use in order to provide a wider range of species options, especially in the IDFxm.
- Lodgepole pine may be added as a preferred species in the IDFxm due to the uncertainty of establishing Douglas-fir on salvage areas with little residual stand structure.

4. Long-term Monitoring and Restoration

Re-establishment of sufficient Douglas-fir to provide winter range habitat over large areas that have been severely burned is a long-term goal. A post-fire assessment and fire severity mapping will be helpful in identifying where active restoration of MDWR stand structure is needed and to help guide future investment funding of planned treatments.

Monitoring of applied treatments is required to evaluate effectiveness. In areas that have been planted after salvage, licensees should complete a regeneration survey in year 3. This will allow both licensees and government to jointly evaluate success of establishing Douglas-fir. Based on the evaluation, it may be necessary to forward plan in RESULTs beyond free-growing (year 20) to 'flag' openings where habitat suitability should be assessed by the Crown and Douglas-fir restoration plans developed if required. Monitoring of natural Douglas-fir infilling in untreated areas is also important.

5. Exemption Process for Salvage of Fire-killed Stands in MDWR

Authority to consider an exemption from the requirement to comply with the General Wildlife Measures is provided in Section 92(1) of the Forest Planning and Practices Regulation.

Salvage of dead (non-infectious) timber resulting from severe natural disturbance may be proposed as an exemption if the proposal results in a net benefit to the Ungulate Winter Range species being managed for, as opposed to taking no action.

The content of exemption requests should include:

- *Reason and rationale for exemption*. Describe circumstances to explain why complying with GWM is non-practicable. List which GWM(s) exemption is requested from and explain how alternative treatment will benefit MDWR and what strategies will be to enhance MDWR. Also include a summary of the post-fire assessment, fire severity stratification and how the conditions from page 6 have been met (removal of dead trees only, high fir-beetle risk, low potential for natural regeneration).
- *Proposed activity*. Describe activities/treatments proposed, by block and by winter range, including:
  - area (size) to be salvaged, and summary of trees to be removed, by diameter class, species, basal area
  - forest health strategy and plans (refer to 3.0 Recommended Best Management Practices)
  - placement and deactivation of roads
  - allocation of wildlife trees or patches (as per the Land Use Order “Land Use Objectives for the CCLUP Area”
  - timber harvesting plan (refer to 3.0 Recommended Best Management Practices)
  - silviculture strategies/plans for Douglas-fir regeneration and re-establishment, proposed changes to stocking standards (for approval by DM) (refer to 3.0 Recommended Best Management Practices)
  - long-term monitoring plan
- *Detailed Map*. - The map may show preliminary block boundaries as long as a final map showing actual block boundaries is submitted prior to the final exemption being granted. Map layers should include BEC boundaries, OGMA, grassland benchmark, orthophoto (with current fire severity if available), block boundaries, leave areas, access, and any other information considered necessary for evaluation.
- *Proposal for monitoring and reporting*. In order to monitor the effectiveness of an exemption from GWM 1 resulting in a net benefit to MDWR, a regeneration survey should be proposed to be completed by the licensee in year 3 and submitted to the Director of Resource Management, Cariboo Region.

Requests for exemptions are to be submitted to the Director of Resource Management, FLNRO. Exemptions that are granted usually include conditions, such as the submission of site plans prior to harvest. Conditions imposed under exemptions are legal requirements and must be complied with (FRPA sec 112(3)).

6. FRPA Legislation

Forest Planning and Practices Regulation
General wildlife measures

69 *An authorized person who carries out primary forest activities on an area must comply with each general wildlife measure that applies to the area.*

***Exemptions by minister responsible for* Wildlife Act**

92 *(1) The minister responsible for the Wildlife Act may exempt a person from section 69 of this regulation in relation to a general wildlife measure, if satisfied that*

(a) the intent of the general wildlife measure will be achieved, or

(b) compliance with that provision is not practicable, given the circumstances or conditions applicable to a particular area.

Forests and Range Practices Act
Power to impose conditions

112 (1) Except in prescribed circumstances a person with a discretion under this Act to make an order, grant an exemption, give a consent, grant an approval, or grant an authorization under this Act or the regulations may

(a) impose conditions that the person considers necessary or desirable in respect of the order, exemption, consent or approval, and

(b) remove or vary the conditions by own motion or on the application of a person who is the subject of the order, exemption, consent or approval.

(2) A condition imposed under subsection (1) is conclusively deemed to be part of the order, exemption, consent or approval in respect of which it is imposed, whether contained in or attached to it or contained in a separate document.

7. References

Amman, G.D. 1990. Bark beetle-fire associations in the Greater Yellowstone Area. Fire and the Environment. Ecological and Cultural Perspectives. USDA General Technical Report SE-69.

Armleder, H., B. Penny, B. Bings, and K. Day. 1999. Clumpy spacing: juvenile spacing Douglas-fir into clumps to imitate natural stand structure. Ministry of Forests Research Program, Victoria, B.C. Extension Note 32. http://www.for.gov.bc.ca/hfd/pubs/Docs/En/En32.htm

Bulaon, B.M. 2003. Douglas-fir Beetle surveys of the fires of 2000 in the Northern Region Forest Health protection Spring 2003. Forest Health Protection Report 03-2. USDA.

Cariboo-Chilcotin Grasslands Strategy Working Group. 2007. Best management practice guidelines for harvesting treatments on CCLUP grassland benchmark sites. Prepared for Cariboo Managers Committee.

Dawson, R.J., H.M. Armleder, B.A. Bings and D.E. Peel. 2006. Management strategy for mule deer winter ranges in the Cariboo-Chilcotin – part 1b: Management Plan for transition and deep snowpack zones. B.C. Min. For. Range, Res. Br., Victoria, B.C. Land Manage. Handb. 59. http://www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh59.pdf

Dawson, R.J., H.M. Armleder, B.A. Bings and D.E. Peel. 2007. Management strategy for mule deer winter ranges in the Cariboo-Chilcotin – part 1a: Management Plan for shallow and moderate snowpack zones. B.C. Min. For. Range, Res. Br., Victoria, B.C. Land Manage. Handb. 60 . http://www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh60.pdf

Densmore, N. R. Thompson, D. McGeough, K. Kilpatrick. 2009. Protocol for stand-level biodiversity monitoring Version 5.0 Ministry of Forests & Range, Victoria BC. 47pp. http://www.for.gov.bc.ca/ftp/hfp/external/!publish/frep/indicators/Indicators-SLBD-Protocol-2009.pdf

Fowler, J.F. and Sieg C.F. 2004. Postfire mortality of Ponderosa Pine and Douglas-fir: A review of methods to predict tree death. General Technical Report RMRS-GTR-132

Hood, S.M. and Bentz, B., 2007. Predicting postfire Douglas-fir beetle attacks and tree mortality in the northern Rocky Mountains. Can J. For. Res. 37:1058-1069.

Jeans, Williams N. 1998. Bark Beetle Management Actions on the 1998 Silver Creek Fire. BC Ministry of Forests. (not widely available)

Parker, T.J., Clancy, K.M. and Mathiasen, R.L. 2006. Agricultural and Forest Entomology 8: 167-189.

Steen, O.A., Stathers, R.J., and Coupe, R.A. 1990. Identification and Management of summer frost-prone sites in the Cariboo Forest Region B.C. Ministry of Forests Victoria, B.C. FRDA Report 157. http://www.for.gov.bc.ca/hfd/pubs/Docs/Frr/Frr157.htm

Waterhouse, M.J., H.M. Armleder, and R.J. Dawson 1994. Winter food habits of mule deer in the central interior of British Columbia. B.C. Min. For., Res. Br., Victoria, B.C. Res. Note 113. http://www.for.gov.bc.ca/hfd/pubs/docs/Mr/Rn113.htm