WORKING DRAFT

Ministry of Environment
Ecological Restoration Priorities

Priorities compiled through consultation with MOE staff in regions affected by Mountain Pine Beetle and Catastrophic Wildfire

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Prepared for Ecosystems Branch,
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The information in this report is based on the expert local opinion of staff and supported by best available information. Assessment of watersheds, landscape and their current and future condition in relation to natural variability were inferred but not subject to any analysis using a consistent quantitative approach

Thanks to MOE staff who provided their knowledge and time. Appendix 4 contains the list of staff consulted.

This draft report has been developed by Mike Fenger, Tanis Douglas, Rachel Holt, Dave Jones and Bob Gray.

Purpose

This report captures consultations with Ministry of Environment staff, whose wisdom and practical ability we admire and with whom we developed these ecological restoration priorities.

This report will form background to further consultations with stakeholders and First Nations and the subsequent development of Strategic Regional Restoration Plans.

This Working Draft is *not* a description of the Ecological Restoration Program. Nor is it meant to serve as any kind of definitive or complete document on Ecological Restoration. It is not meant to be a fully polished business report or rigorous "technical paper".

Mike Fenger and Associates accepts all responsibility for any errors or omissions that may have occurred as we collated MOE knowledge. This document is a working draft, and as such, MOE staff will be able to provide additional comment to this report during the wider stakeholder consultation period (January 25th – March 6th, 2006).

Summary

The province's interior forested ecosystems are experiencing unprecedented levels of environmental impact from widespread and continuing death of pine trees (primarily lodgepole pine), as a result of catastrophic Mountain Pine Beetle infestations. To a lesser extent, the after-effects of wildfires of 2002 and 2003 are also having an impact on timber supply, habitat supply and biodiversity, and are likely affecting other environmental values such as water quality.

In response, the Ministry of Environment (MOE) is determining strategic restoration priorities for six of their regions affected by these disturbances. These six MOE regions are grouped into three strategic plan areas: the northern group (Omineca and Skeena MOE regions), interior group (primarily the MOE Cariboo Region), and the southern group (portions of the Thompson, Okanagan and Kootenay MOE regions). Regional strategic restoration plans that also include the input of stakeholders and First Nations will be developed in a separate project concluding in March 2006.

The restoration priorities for Mountain Pine Beetle (MPB) affected areas will not become completely clear until the epidemic has peaked and the areas where salvage harvesting will be done are known. Only at this time can the location and magnitude of environmental impacts be appreciated, and restoration needs known more precisely. Also affecting environmental impacts and restoration priorities are the cumulative effects of past forest harvesting and road development, and other disturbances caused naturally or by humans.

Despite these uncertainties, MOE staff were able to identify values and priorities at a regional level. MOE staff applied their knowledge and local understanding of ecological values and threats in order to identify potential values most in need of restoration activities. The process used is described in Section 4. Staff were asked to provide their priorities within the ecological framework provided, and their thoughts were recorded and sent back to the interviewees for confirmation.

The ecological framework used in this report is based on the approach taken and information gathered for previously completed "Strategic Ecological Restoration Assessments" (Holt 2001a-e). The strategic restoration priorities identified in 2001 noted evidence of ecosystem degradation (loss of resilience) before MPB became epidemic and before the fire seasons of 2002 and 2003. This previous restoration overview was narrowed to those ecosystems classified as Natural Disturbance Types 3 and 4. Mountain Pine Beetle impacts are closely correlated to those ecosystems that experience frequent stand-replacing disturbances, i.e., Natural Disturbance Type 3 (NDT 3). Recent catastrophic wildfires experienced in 2003 and 2004 are generally found within Natural Disturbance Type 4 (NDT4) – the areas of the province that historically experienced frequent stand maintaining natural disturbance in the form of low-intensity fire. The relevant ecological issues and priorities assembled in 2001 appear in Appendix 3. Areas that are already highly affected by (mostly) human disturbances as described here will often appear as high restoration priorities when other stressors like MPB and fire are added.

To assist understanding of what happens when a major disturbance occurs, Appendix 1 was developed as a brief overview of the ecological consequences of Mountain Pine Beetle. Considered alone, MPB directly affects several environmental values. When considered with salvage harvest and previous forest development, indirect and cumulative impacts are added. Appendix 2 provides a similar ecological overview for catastrophic wildfires. These Appendices are summarized in Table 4 into landscape changes, watershed changes, invasive plant concerns, changes in stand structures and potential restoration activities – an ecological framework.

Restoration guiding principles were developed. A central tenant in determining degradation is to seek watersheds and landscapes that are furthest outside their range of natural variability, as these are at greatest risk and most in need of restoration. Another tenant is that where impacts or risk is high, it is most prudent and cost effective to avoid the need for restoration. A third tenant used is to focus on environmental values most sensitive to impacts and those likely to respond to treatment. Table 2 provides the full list of guiding principles. Threat and risk assessment is also applied to set priorities for the highest values, as per Table 5.

Areas identified in land use plans and legislation, such as Parks and Protected Areas, Riparian Reserves and Management Areas, Ungulate Winter Ranges, and Old Growth Management Areas, are collectively called "conservation emphasis areas" in this report (the full list appears in Table 3). These administrative zones may not be at highest risk, but are given restoration consideration due to security of investment in these areas.

Provincially, MOE staff identified the following environmental values and concerns to be at highest risk and most in need of restoration in NDT3 and NDT4 ecosystems:

- community watersheds (drinking and domestic water);
- high-value fish streams;
- temperature sensitive streams;
- older forest structures, stands, and connectivity at the landscape level;
- lodgepole pine-dominated winter ranges for terrestrial lichen-adapted caribou herds;
- winter ranges for other regionally important species;
- widespread increase of human and livestock access;
- historic decline in deciduous species;
- spread of invasive species;
- blockage of fish passage;
- loss of riparian stand structures for shade, nutrients, and stream bank stability;
- Flooding and related effects on drinking water intakes and infrastructure; and,
- in-filled formerly open forests (forest health, risk to biodiversity and wildfire risk);

The distribution of these values varies within and between regions as does the risk to them depending on cumulative and anticipated impacts. This variation in value and anticipated impacts is reflected in the regional priorities in Section 5.

According to MOE staff, restoration activities to address problems created by MPB and fire should be directed at:

- maintaining riparian ecosystem function;
- speeding hydrologic recovery;
- reducing surface runoff and sediment;
- recruiting older forest stand structures in younger stands;
- increasing structural and compositional diversity with deciduous and other suitable tree species;
- maintaining natural barriers to livestock/humans;
- re-introduction of fire;

The types of activities associated with a restoration program to achieve the above aims are:

- underplanting ecosystem-appropriate vegetation under MPB-killed stands (with or without some form of site preparation), particularly in areas with a conservation focus (riparian/wildlife habitat), or watersheds prone to erosion and water quality/stream temperature concerns;
- thinning from below to speed older forest conditions or prepare for prescribed fire;
- mechanical or bio-chemical control of invasive species;
- vegetation seeding for erosion control;
- planting deciduous or appropriate non-pine species into riparian ecosystems;
- recontouring, planting, seeding, and dispersing drainage on roads;
- re-introduction of fire through controlled burns;
- removing or replacing culverts to ensure fish passage;
- managing debris and beaver dams for flood control/fish passage;
- snag falling or fencing areas to replace lost natural barriers in areas sensitive to livestock use;
- managing access to areas used by species sensitive to disturbance, e.g., winter ranges and calving areas; and,
- working with species at risk recovery teams to address specific needs of impacted species/ecosystems.

Key data gaps and questions were also identified, that if answered, would help set restoration priorities (see Section 5.3).

Priority setting was done with the key assumption that salvage harvesting will be done in a fashion that does not create a need for significant restoration.

Key concerns are changes in old growth forest amount and distribution, changes in hydrology associated with extensive young forests, and access management. There is uncertainty regarding the future of Mountain Caribou dependent on terrestrial lichen in mature pine forests. NDT 3 and NDT 4 are also experiencing changes in climate at a greater rate than coastal areas and there is uncertainty for both forestry and environmental values.

The priority values and concerns identified by MOE staff will be fed into a Challenge Dialogue process that includes other experts, stakeholders and First Nations. This process will result in three regional strategic restoration plans to guide restoration efforts.

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1. Introduction

The province's interior forested ecosystems are experiencing unprecedented levels of environmental impact from widespread and continuing death of pine trees (primarily lodgepole pine), as a result of Mountain Pine Beetle (MPB) infestations. To a lesser extent, the loss of mature forests from the wildfires of 2002 and 2003 is also having an impact. Vast areas of mature and older forest are being reset to early successional young forest. These massive and sudden changes affect aquatic and terrestrial ecosystems by changing water quality and quantity, timing of flows, water temperatures, and sediment delivery to streams, loss of mature and old forest habitat and the connectivity of older forest structures across landscapes.

Though the MPB epidemic is a natural disturbance, this may be the largest epidemic in recorded history. In addition to the direct impacts from MPB on ecosystems, there are indirect and incremental impacts associated with past harvesting and current major salvage.

Some impacts are immediate, while other will progress during the next 20 to 40 years and persist into the long term (70 to 100 years). Also adding to the uncertainty is the degree to which climate change will affect the future forests and future assemblages of species. A brief review of the likely ecological consequences of Mountain Pine Beetle and wildfires has been included in Appendices 1 and 2.

The Ministry of Environment (MOE) needed to determine restoration priorities that address its values and concerns related to the effects of MPB and fire. This restoration opportunity is linked to the provincial Mountain Pine Beetle Emergency Response Strategy announced September 19, 2005, which identifies 7 million dollars in federal funding for ecological restoration purposes. More details about the MPB strategy are at http://www2.news.gov.bc.ca/news_releases_2005-2009/2005OTP0108-000832.htm and at http://www.for.gov.bc.ca/hfp/mountain_pine_beetle/. Further funding is also available from the provincial Forests for Tomorrow Program to address the effects of the 2002 and 2003 fires, see http://www.for.gov.bc.ca/hfp/fft/index.htm.

This report summarizes priorities identified by MOE staff, which will be incorporated into a wider consultation process (a "Challenge Dialogue") occurring January to March 2006 as part of a separate project involving a number of stakeholders and First Nations. The Challenge Dialogue will produce three strategic level regional restoration plans. MOE input was collected in advance of the of the wider stakeholder consultation in order to define the restoration needs, communicate the MOE's efforts to develop a restoration program, and minimize overall demands on MOE staff time. MOE staff's local knowledge and understanding of values, concerns and threats will help direct restoration funds to their best use.

The six MOE regions consulted for this project are grouped into the three Strategic Restoration Plan areas based on Ministry of Forests and Range (MOFR) Timber Supply Area (TSA) and Tree Farm Licence (TFL) management units as well as MOE regional boundaries. MOFR selected the areas in Table 1 based on extent of the MPB outbreak

and potential impacts to timber supply. Many of these management units are being reviewed for timber supply, and increases in Allowable Annual Cut (AAC) are being applied where this is needed to capture economic value. See Section 3 for discussion on assessing threats or risks.

Table 1: Strategic Restoration Plans and their relationship to MOFR Management Units/MOE Regions

Geographic Areas for Strategic Restoration Plans
Northern Strategic Restoration Plan area (Skeena and Omineca MOE Regions) 1. Morice TSA 2. Lakes TSA 3. Prince George TSA 4. Mackenzie TSA
Cariboo Strategic Restoration Plan area (Cariboo Region) 1. Quesnel TSA 2. Williams Lake TSA 3. 100 Mile TSA 4. TFLs, 5, 52, 53
Southern Interior Strategic Restoration Area (Thompson, Okanagan, Kootenay MOE regions) 5. Kamloops TSA 6. Merritt TSA 7. Okanagan TSA 8. Cranbrook TSA

2. Restoration definition and potential restoration activities to address forests affected by MPB and fire

2.1 What is Restoration?

The International Society for Ecosystem Restoration 2004[1], in their Ecological Restoration Primer, defines Ecological Restoration as:

> ***"a process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed."***

This definition is further clarified:

> ***Ecological restoration is an intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability. Frequently, the ecosystem that requires restoration has been degraded, damaged, transformed or entirely destroyed as the direct or indirect result of human activities. In some cases, these impacts to ecosystems have been caused or aggravated by natural agencies such as wildfire, floods, storms, or volcanic eruption, to the point at which the ecosystem cannot recover its predisturbance state or its historic developmental trajectory.***"

[1] http://www.ser.org/content/ecological_restoration_primer.asp#3

Ecological restoration in this report refers to the restoration of both terrestrial and aquatic ecosystems. The term aquatic ecosystem restoration refers to restoration of habitat for many aquatic species including fish.

From these definitions, three elements are relevant to determining the need for restoration:

1. Whether the ecosystem has been 'degraded' to some extent. This can be examined by looking at whether a disturbance is 'natural' or not. Natural events may cause significant changes to an ecosystem but are not usually considered to 'degrade' the ecosystem.
2. Whether permanent, irreversible trends have been caused. For example, a fire may be 'natural' but if it destroys critical remaining habitat for an endangered species then restoration may be ecologically appropriate.
3. Whether restoration is likely to be effective in a timely manner.

In all restoration discussions it is noted that it is considerably cheaper and more effective to avoid the need for restoration in the first instance – and that this is particularly relevant when restoration activities are considered to have a low probability of success.

2.2 Restoration Approach, Summary of Impacts and Potential Restoration Activities

Guiding Principles were developed to help staff set restoration priorities, and are listed in Table 2.

Table 2: Ecosystem Restoration Guiding Principles

Within an ecological framework, restoration priority is based on:

1. Addressing watersheds and landscapes furthest outside their range of natural variability (these are at greatest risk for degradation).
2. Preventing further impacts to areas at highest risk, as avoiding the need for restoration is considered the most cost effective and beneficial approach.
3. Maintaining a focus on values most sensitive to impacts.
4. Maintaining a focus on values and areas where treatments will have the highest probability of success in the short and medium term.
5. Reducing threats to human health and safety (e.g., from flooding, water quality, fire). This requires linkage to other initiatives described in the Mountain Pine Beetle Action Plan, as these are not directly the focus of ecological restoration.
6. Focusing on areas with environmental objectives, which have been identified in land use plans and forest and range regulations. (See Conservation Emphasis Area summary in Table 3: all other factors being equal, these are the preferred locations for restoration)
7. Selecting activities that benefit the greatest number of environmental values.

A further discussion on risk or threats to values is provided in Section 3.

As described in Table 2, the best approach for ecological restoration is to avoid the need for restoration. To reduce the need for restoration and to manage for environmental values in areas where the Allowable Annual Cut (AAC) has been elevated, there is policy direction to enhance the retention of forest above the minimum legal requirements of the *Forest and Range Practices Act*. This policy direction is posted at: http://www.for.gov.bc.ca/hfp/mountain_pine_beetle/stewardship/. These guidelines address:

- increased protection for riparian areas;
- maintenance of non-pine species for biodiversity, seed source and future harvest opportunities;
- protection of sensitive soils;
- increased maintenance of stand structure from either live or dead trees - with intact forest floor;
- allowing for cutblock design that more closely mimics natural disturbance; and
- hydrological considerations.

How well this retention guidance is incorporated into harvest plans may determine the extent to which future restoration will be required. A discussion of salvage logging guidelines designed to prevent environmental degradation is beyond the scope of this report. Douglas (2003) provides some suggestions for these kinds of practices as well as other forest restoration case studies. This document can be found at http://www.serbc.info/resources/file_repository/Ecosystem_Restoration.pdf.

Before restoration can proceed, the objective for the restoration needs to be clear and the desired future condition of the ecosystem needs to be defined. Once the restoration investment has been made, safeguards need to be put in place against subsequent environmental damage (Gray and Blackwell 2005). Focusing restoration on areas managed for their conservation value can mitigate this risk. There are numerous zones in land use plans and in regulations that define areas that have higher conservation values; in this report these are collectively referred as Conservation Emphasis Areas. Table 3 lists potentially high priority areas for restoration that are likely to be managed for environmental objectives into the future.

Table 3: Conservation Emphasis Areas (CEAs)

The following list of CEAs is not presented in any order of priority.

1. Parks, Protected Areas, Ecological Reserves, Wildlife Management Areas. and area and Nature Trust Lands managed by MOE
2. Parks, Protected Areas and Ecological Reserves.
3. Higher Level Plan conservation emphasis zones; areas designated in LRMPs that are zoned for specific ecological objectives. Management objectives in each zone will guide the type of restoration. For instance, restoration is identified as an objective in some land use plans.
4. Spatially and non-spatially[2] established Old Growth Management Areas.

[2] Assuming that areas not spatial under legislation will be spatially recognized as operational plans are developed.

5. Seral stage distribution (mature and old components) in Landscape Units/BEC subzones.
6. Community Watersheds.
7. Drinking water watersheds.
8. High value fish streams.
9. Temperature Sensitive Streams.
10. Important/Critical habitats identified by Species and Ecosystems at Risk recovery plans.
11. Wildlife Habitat Areas.
12. Ungulate Winter Ranges.
13. Habitat for regionally important species.
14. Riparian Areas (both Reserve and Management Zones).
15. Wildlife Tree Retention Areas (also called Wildlife Tree Patches).

A synopsis of the ecological consequences of Mountain Pine Beetle is found in Appendix 1 and a synopsis of ecological consequences of wildfire is found in Appendix 2. The information in these appendices forms the basis for the information found in Table 4 below, which describes the ecological values affected and possible restoration treatments. The possible treatments to restore ecological attributes described here form the current 'toolkit' for restoration. However, it is important to note that for some impacts, the restoration potential (i.e., our ability to speed up recovery) is low.

Table 4: Summary of ecological attributes affected, and restoration activities that could be implemented.

Attribute Affected/ Threat	**Possible Restoration/Forest Management Activities and Restoration Potential**
Changes in Landscape Characteristics	
Loss of large mature and older patches	• Once large older forest patches have been fragmented or lost, restoration takes many decades (low restoration potential). Restoration techniques as below.
Loss of mature and old forest structures and diversity Loss of older well distributed habitat structures across landscapes. Loss of connectivity of old forest ecosystems Loss of suitable habitat for movement corridors.	• Select the best available stands for silvicultural treatments (e.g., thinning from below) to speed the attainment of old forest attributes such as larger diameters, crown and limbs. (e.g., treat OGMAs in poor condition/recruitment OGMAs.) • Create some larger-diameter standing dead wood and coarse woody debris, where scarce, through girdling or other means. • Create specific habitat features missing in younger forests (e.g., cavities, nest boxes, dens), including use of fungal inoculation. • Reduce stems and understory fuels to establish strategic fuel breaks in areas where human safety may be at high risk. • Plant late successional tree species into understories, i.e., shade tolerant species. • Pre-commercial or commercial thin to reduce stand densities

Attribute Affected/ Threat	Possible Restoration/Forest Management Activities and Restoration Potential
	and establish or enhance understory growth and old stand structure. • Thin from below and where appropriate pile and burn to reduce stocking densities and fuel loading in formerly open forests. • Conduct understory prescribed burns to create open stands/understory growth. Tie in with tree removal and understory treatment to protect infra structures. • Passive restoration: Identify areas for natural succession and lengthen duration of earlier seral stages and increase species diversity i.e., shrub-forb communities and deciduous tree species, • Use silviculture (see activities above) to develop stands with older forest attributes in key locations, including riparian.
Changes in Watershed hydrology	
Changes to snowpack, earlier snowmelt and run-off. Reduced evapo-transpiration, higher water tables in lower slopes.	• Reforest to improve and speed hydrologic recovery in areas where significant loss of live trees impacts an entire basin. Focus on basins with high equivalent clearcut area and sediment potential (erodable soils and unstable terrain). • Plant fast growing deciduous species, • Seed with native grasses, • Site prep and plant/seed to break up hydrophobic soils. • Reduce road densities and impact by rehabilitating skid trails, roads, fire breaks, and landings to natural contours and drainage. • Reforest with species likely to survive higher water tables, and plant on drier microsites. • Monitor to determine ecological effects of changes in water levels on drinking water and wetlands and riparian zones.
Changes Riparian function, stream flow, temperature and water quality	
Increased sedimentation. Increased bank erosion and sediment transport due to increased runoff. Effects on drinking water quality. Increases in stream temperature and loss of riparian vegetation providing shade and nutrient sources.	• Reforest entire basin to speed hydrologic recovery, as above. • Plant fast growing, ecologically appropriate species into riparian ecosystems to provide shade, nutrients and bank stability. • Reduce runoff by minimizing log salvage in riparian areas, and managing road densities and preventing harvest of live trees.

Attribute Affected/ Threat	Possible Restoration/Forest Management Activities and Restoration Potential
Blockage of fish passage	• Remove or replace (or clear) culverts blocking fish passage, where government has accepted responsibility for the structure. • Restore areas surrounding failed road crossings, or restore culvert fish passage through pool creation,
Invasive species	
Invasive alien species colonization (as a result of disturbance and access, and due to direct seeding of roads or burned areas). Invasive plants effects erosion, local hydrology, and plant communities.	• Prioritize alien invasive plant removal based on local needs, and prevent their spread in sensitive ecosystems. Requires prioritization process. • Seeding of landings and roadsides (where government has responsibility) with native seed mixes or appropriate approved seeds, to minimize disturbed areas available for colonization. (Policies to ensure appropriate seeding are required.). Invasive plants reduce forage, increase erosion and increase threats to endangered native plants. • Monitor invasive alien plant species to identify potential problems.
Soil disturbance	
Reduce opportunity for invasive species and sediment sources	• Seeding disturbed areas with native grass seed mixes or appropriate approved seeds. • Restoring roads, landings and firebreaks to natural contours and drainage.
Changes in Access	
Increased active road density leading to sediment effects on streams, changed predator-prey relationships, introduce invasive plant species, increased hunting, fishing and poaching. Increased cattle access to sensitive ecosystems due to loss of barriers.	• Reducing sediment sources by seeding native grass species mixes. • Developing access management plans to identify restoration opportunities. Where appropriate, close or gate roads, and deactivate roads. • Deactivating and revegetating roads and landings (restoring natural contours and drainage; seeding, planning trees, adding CWD). • Removing or replacing culverts. • Excluding cattle from sensitive areas by creating 'natural' barriers, and fencing.
Stand structure attributes	
Loss of large live and dead wildlife trees Loss of CWD Changed stand structural	• Post salvage restoration of large trees/snags and CWD is cost prohibitive, and pre-harvest planning is critical. Once large older structures are absent they can only be replaced effectively after many decades of natural succession. Restoration activities (see below) focus on areas with live

Attribute Affected/ Threat	Possible Restoration/Forest Management Activities and Restoration Potential
diversity and composition and densities relative to range of natural variability	trees, particularly areas with a conservation emphasis like wildlife tree patches, OGMAs, ungulate winter ranges, etc. • Thin and in some cases plant to increasing species diversity, and introduce structure, CWD and encourage larger trees (i.e. creating old forest structures and diversity through techniques mentioned above under "loss of mature and old forests structures and diversity"). • Reduce fuels loading in NDT4 zones by slashing, thinning, directed harvest, prescribed fire, reducing stocking densities, planned zones for no fire suppression, to return stands to Range of Natural Variability (RONV)*, reduce future fire risks, provide species-specific habitats and improve forest health. • Create species-specific habitat features (e.g., cavities by fungal inoculation).
Severe fire impacts forest soils reducing site productivity.	• CWD additions, seeding, planting trees.
Habitat loss/degradation for rare and endangered species/ecosystems	
Potential loss of rare ecosystems	• Limit access by cattle. • Identify and map locations where salvage logging should not occur.
Loss of habitat features needed by listed species and ecosystems	• Implement habitat restoration recommendations in Species Recovery Plans or as recommended by Recovery Teams.
Loss of suitable habitat for regionally important species e.g., Ungulate winter ranges	• Thin from below in deer winter range - manage for stand composition and density and forage production. • Develop old growth stand structures (see activities above).

* We use 'range of natural variability' interchangeably with similar terms such as historic range of variability (HRV) to mean the natural range of a process or value over ecologically appropriate spatial and temporal scales.

3. Assessing Threat or Risk Levels

The level of threat to a particular value is central to determining whether the value should be at high priority for restoration (or improved planning to avoid restoration). This concept is central to the Ecosystem Restoration Guiding Principles described in Table 2.

Risk assessment is outlined in the report entitled "*Environmental Risk Assessment (ERA): An Approach for Assessing and Reporting on Environmental Conditions"* (BC Ministry of Environment, Lands and Parks 2000). The basic premise in this report is that risk is

based on the level of threat and the importance of the environmental value threatened. The highest risk and therefore highest restoration priority is based on high environmental values faced with a high level of threat. The risk framework is provided in Table 5.

Table 5: Environmental Risk Assessment framework

Threat to value	**Restoration Priority ➔**	
High	**Moderate**	**High**
Low	**Low**	**Moderate**
	Low value	High Value
	Environmental Value ➔	

Value can refer to highly productive ecosystems, rare ecosystems and habitat attributes. This concept allows a relative ranking of ecosystems and does not imply any one value (e.g., fish, wildlife, biodiversity, water quality, etc.) more valuable than another.

The extent of the threat posed by MPB or wildfire to any given environmental value is location-specific, but the following information sources can aid in the process of understanding broad levels of threat.

3.1 Threat levels from Mountain Pine Beetle

At a management unit level, condition of watersheds, landscape units and conservation areas such as community watersheds will provide the best measure of the threat to environmental values.

To provide some overall context, provincial MPB maps are helpful as a strategic overview to where MPB impacts are occurring. These maps can be viewed at: http://www.for.gov.bc.ca/hre/bcmpb/. This site shows Timber Supply Area boundaries and the distribution of lodgepole pine in 4 classes: < 40% pine, 41 –70% pine, 71-99% pine, and 100% pine. The maps also depict the timber harvesting land base and the percentage of pine killed to 2004, and the percentage project to be killed by 2011. Animated maps showing pine kill projected over time and into the future are also available on this site.

These maps indicate the magnitude, location of the impacts and temporal aspects of the MPB outbreak, and therefore indicate where the environmental impacts will likely occur. A more detailed time sequence of mortality and defoliation has been compiled for the Lillooet, Kamloops, Merritt and Okanagan TSAs, and includes other forest pests as well as MPB. This is found at the following site: http://www.for.gov.bc.ca/rsi/ForestHealth/overview_reports/Overview_2004.html

In understanding the environmental impacts of MPB, it is also helpful to refer to the percentage of the timber harvesting land base (THLB) affected. Table 6 shows the anticipated impacts on the THLB to the year 2010, in terms of percentage of forests that are expected to contain dead pine. The ratio of dead trees as a ratio of the entire THLB provides a relative indicator of which Timber Supply Areas (TSAs) might sustain the greatest impacts to environmental values. Additionally, in response to the MPB outbreak, many of the TSAs listed here have shifted harvest to lodgepole pine and away

from other species, and others have increased the overall harvest to capture the economic value of the pine while it lasts. Table 7 show which TSAs have increased the harvest. The areas with highest AACs are also expected to have the highest environmental impacts.

Table 6: Anticipated impacts to timber harvest land base *(MOF Forest Analysis Branch April 2004.)*

TSA List based on May 2004 projections	Equivalent Area Dead 2010 ratio of dead to THLB
Quesnel TSA*	0.49
Lakes TSA*	0.39
Williams Lake TSA	0.37
100 Mile House TSA	0.28
Merritt TSA	0.26
Prince George TSA*	0.24
Cranbrook TSA	0.16
Morice TSA	0.16
Kamloops TSA	0.13
Lillooet TSA	0.12
Arrow TSA	0.11
Invermere TSA	0.11

Calculated on basis of the ratio of projected equivalent area dead to current THLB.
Note: PG TSA is still recognized in "top 4" as this approach does not adequately reflect the impacts in FSJ and Vanderhoof Districts
* see Table 7 for increases in AAC.

Table 7: ***Management Units where Allowable Annual Cut has been raised for salvage logging (2004).***

Management Unit	AAC (million cubic metres)	Salvage AAC (million cubic metres)	% increase
Prince George TSA	2.7	14.9	551
Quesnel TSA	2	5.3	265
Lakes TSA	.2	3.2	1600
Kamloops TSA	2.7	1.7	62

In tracking the MPB epidemic, the province has been divided into Beetle Management Units (BMUs) that show which units are using: 1) holding actions, 2) salvage and 3) suppression. These maps are available at http://www.for.gov.bc.ca/hfp/forsite/fhdata/bmu.htm.

The Interior Emergency Bark Beetle Management Area and the Strategic Planning maps also show similar strategies. This information can be found at http://www.for.gov.bc.ca/hfp/mountain_pine_beetle/maps/ebbma/March31_04_EBBMA_Final.doc.

3.2 Threat levels from Catastrophic Wildfire

Predicting wildfires is less reliable than forecasting expansion of MPB. Some of the wildfires of 2002 and 2003 occurred in dry southern interior ecosystems that have been classified as frequent fire maintained, Natural Disturbance Type 4 (NDT4) (Ministry of Forests and Ministry of Environment, Lands and Parks, 1995). The most destructive fires occurred in Interior Douglas-fir (IDF) and Ponderosa Pine (PP) biogeoclimatic zones in the Wildland-Urban Interface (WUI). The intensity of some portions of these fires is considered outside the range of natural variability and was, in part, due to high fuel volumes. The high levels of fuel are the result of successful fire exclusion over many decades.

The fire that began in Okanagan Mountain Park and moved into Kelowna has prompted a review of fuel loading in parks and a ranking of parks in need of restoration that are in close proximity to residential areas. Blackwell and Associates (2005) ranked risk and focused on WUI parks, fire intensity and probability of ignition. Parks were also selected due to the need for ecosystem restoration associated with interrupted natural fire cycles.

The areas of the province in the NDT4 are generally considered to be outside of their range of natural variability due to fire suppression (and sometimes historic logging practices), and are at a greater risk of catastrophic wildfire.

4. Approach and Method for Capturing MOE Restoration Priorities

Collecting MOE input and expertise was an important first step in determining the highest and best use of funds for restoration projects starting in fiscal year 2006/2007. The ecological framework used in this report is based on the approach taken and information gathered for previously completed "Strategic Ecological Restoration Assessments" (Holt 2001a-e). The strategic restoration priorities identified in 2001 noted evidence of ecosystem degradation (loss of resilience) before MPB became epidemic and before the fire seasons of 2002 and 2003. This previous restoration overview was narrowed to those ecosystems classified as Natural Disturbance Types 3 and 4. Mountain Pine Beetle impacts are closely correlated to those ecosystems that experience frequent stand-replacing disturbances, i.e., Natural Disturbance Type 3 (NDT 3). Recent catastrophic wildfires experienced in 2003 and 2004 are generally found within Natural Disturbance Type 4 (NDT4) – the areas of the province that historically experienced frequent stand maintaining natural disturbance in the form of low-intensity fire. The relevant ecological issues and priorities assembled in 2001 appear in Appendix 3. The Natural Disturbance Types and Biogeoclimatic zones provided a strategic framework for collecting information on restoration priorities. Areas that are already highly affected by (mostly) human disturbances as described here will often appear as high restoration priorities when other stressors like MPB and fire are added.

The method developed to capture current MOE priorities is described below in Table 8. However, due to limited MOE staff time and uncertainty around which ecosystems have

been or will be most affected (and how they will be affected), this consultation process evolved into a less formal approach than that described in Table 8. Input was received by phone and e-mail, and some face-to-face meetings. This input was recorded and sent back to the interviewees for confirmation.

Results are summarized in Section 5 of this report. Most of these priorities are not related to specific geographic areas. More detailed priorities at the Management Unit/site level will likely be developed as part of the separate "Challenge Dialogue" process referenced in Section 1.

Table 8: Summary of intended consultation process.

MOE staff were given the following summary and the information described within it, and were asked to review the information if their time permitted. Subsequent staff interviews captured information on regional and management unit level priorities for MPB and fire-affected areas.

Background Information

STEP 1. Understand the ecosystem and ecosystem attributes affected by the catastrophic events. Understand the environmental values impacted by MPB and wildfire, (and fire suppression) in particular the values that MOE manages. If the MOE staff person to be interviewed has an understanding of the location and magnitude of impacts of MPB in the region, proceed. Otherwise, we suggest a review of MPB impacts using regional overview maps available on the web. (Refer to working report for web links and summaries (Table 6 and 7).

STEP 2. Understand Natural Disturbance Types and their distribution as these are linked to lodgepole pine forests and MPB distribution and ecosystems at high risk of wildfire. If the MOE staff person to be interviewed has an understanding of Natural Disturbance Types, proceed. Otherwise, we suggest a review of the distribution of Natural Disturbance Types[3] (NDTs) in their region. MPB impacts correlate more closely with NDT 3 (frequent stand replacing disturbances), and higher probability of wildfire correlates more closely with NDT 4 (frequent stand maintaining natural disturbance.)

Regional Priorities

Three broad geographic areas are being used to set restoration priorities. Appendix 3 provides a Biogeoclimatic Ecosystem zone framework to set regional priorities. Where values are aquatic ecosystem (watershed/stream) and species related, provide names of the watersheds/sites that have a restoration priority.

STEP 3. Review previously identified priority ecological issues (Holt 2001a-e) in Appendix 3.

Do these factors make sense to you?

What would you change and/or add to these? Revise or confirm the ecological issues and restoration priorities.

[3] http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/biodiv/biotoc.htm

STEP 4. Review the Ecosystem Components affected in Appendix 3.
Do these factors make sense to you?
What would you change and/or add to these?
Review, add or amend evidence of degradation.

STEP 5. Set regional restoration priorities. Consider all the environmental values in the ecological (BEC) unit. If you could direct funds to a single restoration activity in a BEC zone, what would that be? What would be your second priority? After considering all ecological units, which would be your highest regional priority? Use Tables 2, 3, 4 and 5 (see below) to assist in setting your priorities.

- Table 2 Ecosystem Restoration Guiding Principles.
- Table 3 Conservation Emphasis Areas (CEAs)
- Table 4 Summary of Environmental Attributes Affected, and Restoration Activities That Could be Implemented
- Table 5 Environmental Risk Assessment

Management Unit Level Priorities (if Known)

STEP 6. Use Ministry of Forests and Range Timber Supply Areas (TSAs – and including Tree Farm Licenses) in your region to set Regional/TSA level priorities and identify existing restoration projects would address your priorities.

- **What types of restoration projects are you aware of that address your priorities?**
- **What past projects were funded under FRBC or HCTF or other sources**?

5. Summary of restoration priorities by MOE region

5.1 Assumptions and Limitations

The restoration priorities for MPB-affected areas will not become completely clear until a monitoring phase (post-beetle attack) has been completed and levels/locations of MPB-related mortality understood. Only at this time will we be fully able to understand which ecosystems have been affected and how they have been affected. Restoration priorities will also be affected by forest management decisions (i.e., where and how salvage logging occurs).

For these and other reasons (e.g., MOE staff time, lack of data about current MPB effects), the priorities listed here are preliminary. The restoration priorities are based on expert opinion and local knowledge. The regional lists are in relative priorities, and in some cases the ordering of these priorities is tentative, and is more definitive in some regions than others. The emphasis of restoration projects will change depending on the severity of the MPB (and subsequent salvage logging) impact and the location.

Assumptions used by MOE staff when developing the priorities were:

- Best Management Practices and salvage logging plans are being followed. Further Best Management Practices are under development or will be developed, in order to reduce the need for restoration.
- Access management is a high priority for Best Management Practices and salvage logging planning. Concerns are: increased recreational use, increased hunting, wildlife disturbance and poaching, increased cattle use of sensitive intact ecosystems, spread of invasive alien species, stream crossings and increased runoff and siltation. Some regions listed access management as a restoration priority and others assumed it would be handled mostly outside a restoration program (Road rehabilitation is an eligible restoration activity only in backlog areas where the Crown has assumed responsibility for roads).
- Designated Ungulate Winter Ranges (UWR) and their general wildlife measure (GWM) are being followed.
- Ecological Restoration activities are incremental to legal obligations carried out by the forest industry when salvage logging, road building and harvesting.
- Without restoration, impacts in these areas for these values would not be mitigated, or it would take an unacceptable length of time to mitigate the impacts.

5.2 Brief summary of results

MOE staff identified the following environmental values and issues to be of highest concern and at highest risk:

- community watersheds (drinking and domestic water);
- high-value fish streams;
- temperature sensitive streams;
- older forest structures, stands, and connectivity at the landscape level;
- lodgepole pine-dominated winter ranges for terrestrial lichen-adapted caribou herds;
- winter ranges for other regionally important species;
- widespread increase of human and livestock access;
- historic decline in broad leaf species;
- spread of invasive species;
- blockage of fish passage;
- loss of riparian stand structures for shade, nutrients, and stream bank stability;
- Flooding and related effects on drinking water intakes and infrastructure; and,
- in-filled formerly open forests (forest health, risk to biodiversity and wildfire risk) (Grasslands in need of restoration were not considered.);

MOE staff indicated that restoration activities to address problems created by MPB and fire should be directed at:

- maintaining riparian ecosystem function;
- speeding hydrologic recovery;

- reducing surface runoff and sediment;
- recruiting older forest stand structures in younger stands;
- increasing structural and compositional diversity with broad leaf and other suitable tree species;
- maintaining natural barriers to livestock/humans; and,
- re-introduction of fire.

The types of activities associated with a restoration program to address the above values are:

- underplanting ecosystem-appropriate vegetation under MPB-killed stands (with or without some form of site preparation), particularly in areas with a conservation focus (riparian/wildlife habitat), or watersheds prone to erosion and water quality/stream temperature concerns;
- thinning from below to speed older forest conditions or prepare for prescribed fire;
- mechanical or bio-chemical control of invasive species;
- vegetation seeding for erosion control;
- planting broad leaf or appropriate non-pine species into riparian ecosystems;
- recontouring, planting, seeding, and dispersing drainage on roads;
- re-introduction of fire through controlled burns;
- removing or replacing culverts to ensure fish passage;
- managing debris and beaver dams for flood control/fish passage;
- snag falling or fencing areas to replace lost natural barriers in areas sensitive to livestock use;
- managing access to areas used by species sensitive to disturbance, e.g., winter ranges and calving areas; and,
- working with species at risk recovery teams to address specific needs of impacted species/ecosystems.

The specific priorities and potential projects are identified below in Sections 5.4 to 5.6.

5.3 Inventory, knowledge and data gaps identified

Determining restoration priorities involved some expert opinion, as many data gaps and questions exist. MOE staff were asked to list the information or knowledge required to determine effective restoration priorities/projects. MOE staff raised the following questions:

1) Where the water table is significantly elevated due to pine mortality and salvage logging in the uplands, can planting be effective in riparian zones without major site disturbance such as ditching and mounding?
2) What methods could be used to restore Mule Deer Winter Range where snow interception is provided by lodgepole pine?
3) What tools and techniques are available to build old growth structure into Old Growth Management Areas?

4) Within some riparian areas, the impacts of heavy slash loading on animal movement are unknown.

5) What is the extent of the area affected by MPB, and what are the mortality levels? This applies particularly to the MS and ESSR BEC units (Cariboo-Chilcotin).

6) To what extent (in what areas) will the licensees undertake salvage harvesting? (In some areas, restoration may be speeded by salvage harvesting and associated planting.)

7) Are any of the areas that were skipped in the fires in need of treatments - specifically thinning from below to improve stand structure? Is the patchiness created by the fires and log salvage best left as is? (The answer would depend on species-specific needs.)

8) Are standing dead trees comparable to harvested trees with respect to Equivalent Clearcut Area - or what is the relationship?

9) How much shade do dead pine trees contribute around temperature sensitive streams?

10) What is the lodgepole pine component in the riparian zones around streams? What proportion of riparian zones would contain significant dead pine?

11) How do we proceed with prescribed fire without promoting the spread of existing weed populations?

12) There is a need to initiate and augment native seed nursery production.

5.4 Northern MOE Regions – Skeena and Omineca

Table 9: Summary of Skeena MOE Regional Restoration Priorities (particularly within Morice and Lakes TSAs)

Priority*	Factors that will mitigate impacts	Restoration activity
NDT 3 **SBS and SBPS zones** Even-aged lodgepole pine and mixed pine stands affected by Mountain Pine Beetle		
1) Hydrological issues associated with high value fish streams. Increased water temperatures (leading to potential species shifts), timing of flows, peak flows, and sediment delivery.	Maintain Riparian integrity Speed hydrologic recovery Reduce sediment delivery to streams by managing surface runoff. Reduce amount of area in roads	**Underplant riparian** to increase shade in those areas that are pure lodgepole pine with no understory. Use ecologically appropriate species i.e., plant broad leaf (cottonwood). **Note** concern expressed with high water tables from salvage harvesting/ MPB and survival of plantings. **Under plant key upland areas** outside the timber harvest land base in drainage where these contribute a significant portion of ECA and natural regeneration rate will be slow.
2) Caribou habitat in Tweedsmuir Entiako parks and protected areas and in Chelaslie and Telkwa area.	Allow natural processes (fire and succession) on some sites	**Monitor the effects of MPB on caribou** habitat use by tracking radio-collared animals and conducting winter site assessments. Funding has been secured for collar purchase and placement, but no funding is in place for the actual monitoring **Inventory and map the dry lodgepole pine stands with terrestrial lichen** and identify which ones have been hit by MPB. **Develop research** to address gaps in our knowledge on how terrestrial lichen responds to MPB and/or fire in caribou habitat. There is currently a multi year study in the Entiako Park and Protected Area examining the impacts of MPB on terrestrial lichen abundance. Continuing with this study is a high priority - a pressing issue in Tweedsmuir-Entiako caribou habitat. This study is a high priority needed to determine what restoration strategies could be implemented at this time to restore caribou habitat. A project has

		been scoped out to address this gap, but funding is currently lacking. It is unclear what could be done to restore terrestrial lichen in caribou habitat impacted by MPB. The various options need to be scoped out and implemented or adaptive management trials established. **Control burn** some sites to speed up natural processes **Spacing, thin, or plant** to speed up achieving caribou habitat
3) Manage for and restore natural processes in Parks	Allow natural processes (fire) where feasible	**Apply prescribed fire** in Tweedsmuir and Entiako Parks, where large MPB disturbances exist Complete Vegetation Resource Inventory (VRI) and Tkematic Ecosystem Mapping (TEM) in Tweedsmuir, in order to facilitate restoration/management planning
4) Non status roads	Ensure fish passage Manage access	**Remove barriers to fish passage.** Address backlog fish passage issues, i.e., culverts or and areas that are potential high risk from debris jams or increased peak flows where tenure holders no longer have responsibility **Rehabilitate secondary and tertiary roads** through culvert removal, cross ditching and reforestation secondary and spur roads where tenure holders no longer have responsibility particularly when adjacent to goat, grizzly bear and other priority species.
4) Grizzly bear habitat	Produce forage (berry production)	**Thin to release understory** shrubs with berries. **Control burn** to produce understory with berries.
5) Old growth Management Areas (OGMAs) and Wildlife Tree Patches (WTPs)	Retention of suitable replacement areas	**Develop old growth stand structure** where this in deficit, utilize silvicultural prescriptions to mimic or speed up the attainment of these attributes within OGMAs, WTPs etc
6) Mule Deer Winter Range	Improve canopy structure for snow interception	**Space young lodgepole pine** or non-pine species to provide increased crown closure to improve snow interception.
7) Mountain Goat habitat adjacent to lodgepole pine forests.	Improve mountain goat habitat and reduce access.	**Apply prescribed fire** to develop forage **Reduce access** through road rehabilitation or access management adjacent to goat habitat.

NDT 4 Frequent stand maintaining fire systems		
Area within boundaries of recent fires – none identified		
Areas outside boundaries of recent fires:		
Francois Lake grasslands	Restore grasslands	Remove fir infill and aspen encroachment.

* priority is given to areas that have a conservation emphasis, where benefits from investment will be long term i.e., Ungulate Winter Ranges, Old growth Management Areas (recruitment OGMAs), Wildlife Habitat Areas, Parks

Questions

The following questions were raised, and answering these questions would help determine restoration priorities:

1) How effective will planting be in riparian zones, without major ditching and mounding, if the water table is significantly elevated due to salvage logging in the uplands?
2) What methods could be used to restore Mule Deer Winter Ranges where snow interception is provided by lodgepole pine?
3) What tools are available to build old growth structure into Old Growth Management Areas (OGMAs)?
4) Impacts of heavy slash loading within some riparian areas on animal movement are unknown?

Table 10: Summary of Omineca MOE Regional Restoration Priorities (particularly within Prince George and Mackenzie TSAs)

Priority Restoration*	Factors that will mitigate impacts	Restoration activity
NDT 3 Ecosystems with frequent stand-initiating events Even-aged lodgepole pine and mixed pine stands affected by MPB SBPS and SBS zones		
1) Hydrological issues associated with high value fish streams. Timing of flows, peak flows, sediment delivery.	Maintain Riparian integrity /function. Reduce road area and ground disturbance	**Hydrologic recovery** Underplant key upland areas outside the timber harvest land base and non-recoverable losses areas in drainages where these contribute a significant portion of ECA and hydrologic green up will be slow.
2) Temperature sensitive streams (concerns with species shifts; impacts on bull trout)	Maintain Riparian integrity /function.	**Riparian Function.** Underplant riparian to increase shade in those areas that are pure lodgepole pine with no understory. Use ecologically appropriate species e.g., plant broad leaf (cottonwood)/non-pine species. **Note** concern expressed with high water tables from salvage harvesting/ MPB and survival of plantings.
3) Caribou habitat.		Terrestrial lichen habitat maintenance within caribou UWR There is currently a multi year study in the Entiako Park and Protected Area examining the impacts of MPB on terrestrial lichen abundance. Continuing with this study is a high priority. It is a high priority to determine what restoration strategies could be implemented at this time to restore caribou habitat.
4) Non-status roads and related fish passage.	Ensure fish passage Access management	**Fish Passage** Address backlog fish passage issues, i.e., culverts and/or areas that are potential high risk from debris jams or increased peak flows where tenure holders no longer have responsibility. **Road rehabilitation**. For secondary and tertiary/spur roads, remove culverts, cross ditch and reforest where tenure holders no longer have responsibility particularly when adjacent to caribou, goat, grizzly bear and other priority species. **Reduce access.** Protect caribou, grizzly bear, moose and other sensitive species from the disturbance and predation brought by increased access brings**.**

5) Grizzly bear habitat (berry production)	Allow natural processes	**Broad cast burning.** To create post fire understory conditions, berry production and conditions to develop terrestrial ground lichen.
6) Old Growth Management Area's and Wild Tree Patches	Speed old growth structure development	**Stand structure enhancement**. Where old growth is in deficit, utilize silvicultural prescriptions to mimic or speed up the attainment of these attributes e.g., within OGMAs, WTPs etc
NDT 4 Frequent stand-maintaining fire (not prevalent in region)		
Restoration for areas burned in 2002 and 2003 are specifically identified as a priority for the Forests for Tomorrow Program. Staff did not know the extent of fires and hence priorities for burned areas were not identified.		
Restoration of areas outside of 2002 and 2003 burns.		
7) Mule Deer Winter Ranges (snow interception	Speed old growth structure development	**Thin from below** and controlled burning to speed up creation of older forest stand structure (shrub herb layer and overstory canopy).

* priority is given to areas that have a conservation emphasis, where benefits from investment will be long term i.e., Ungulate Winter Ranges, Old growth Management Areas (recruitment OGMAs), Wildlife Habitat Areas, Parks and Protected Areas.

Questions
The following questions were raised, and answering these questions would help determine restoration priorities:

1) How effective will planting be in riparian zones, without major ditching and mounding, if the water table is significantly elevated due to salvage logging in the uplands?
2) What methods could be used to restore MDWR where snow interception is provided by lodgepole pine?
3) What tools are available to build old growth structure into OGMAs?
4) Impacts of heavy slash loading within some riparian areas and winter range areas (e.g., Terrestrial lichen sites) on animal movement are unknown?

Note: There is a Lichen Adaptive Management Project in the Mackenzie and Vanderhoof to address forestry disturbance on lichen, two key items being considered are mechanical damage reduces lichen cover, and harvesting debris smothers/covers up lichens.

5.5 Cariboo-Chilcotin MOE Region

Table 11: Summary of Cariboo-Chilcotin MOE Regional Restoration Priorities

Priority	Factors that will mitigate impacts	Restoration activity
NDT 3 Frequent Stand Replacing disturbances has created area with even-aged lodgepole Pine **SBPS, SBS, MS*, ESSF*** *MS and ESSF zones lower priority for restoration since harvesting history is recent. Data required to understand MPB extent/effects in these zones		
1. Address fish passage issues on pre-FPC stream crossing structures	Restore Fish Passage	**Restore fish passage** at logging and highways stream crossings (and mining crossings as appropriate) mitigate some short-term MPB impacts **Plan restoration** by using a risk rating based on fish species (red or blue-listed and endangered runs to focus restoration activity. Many fish passage problems occur at culverts,), fish habitat values at risk, fish populations, economic benefit to tourism operators, degree of fish passage restriction (full or partial) and most importantly total estimated cost of establishing fish passage
2. Restore natural small grasslands	Allow natural processes	**Conduct fall and burn or simply burn** to restore small natural grasslands present amongst the forests (address conifer encroachment), to restore habitat for many species including red and blue listed, mule deer spring range.
3. Monitor, address/restore caribou habitat needs	Access management Fire hazard risk reduction Licensee decisions on where to salvage	**Monitor MPB spread to identified caribou** WHA's and other important habitats (winter range) **Monitor caribou mobility** and assess the effects of dead/dying lodgepole pine on lichen sources **Apply prescribed fire** to reduce risk of catastrophic fire (and the subsequent negative effects on caribou) – i.e., create 'fire guards' through managed burns in strategic locations. This would require completion and implementation of fire management plans with emphasis on the no harvest and modified harvest portions of the Caribou winter range. **Assess lichen availability** through altered harvesting techniques/planning/CWD management **Restore pine lichen ecosystems** as quickly as possible in areas not salvage logged
4. Assessment of	Watershed	**Continue a project that monitors hydrologic impacts** due to MPB and associated

Priority	Factors that will mitigate impacts	Restoration activity
hydrological impacts due to MPB and associated logging/road construction	Assessments on selected drainages	logging/roads on two stream systems that present different physical attributes, varying amounts of harvest (past, present and proposed), and have current MPB attack and history of previous attacks. **Expand monitoring** to two further drainages in the Quesnel District.
5. Monitoring of angling presence on formerly less accessible lakes	Limit access	**Monitor recreational use** on formerly inaccessible/less accessible lakes, to avoid boom and bust fisheries. Many of these lakes are designated as Wilderness Quality Lakes under the CCLUP. Monitoring will lead to proactive fish regulation changes and to access management as required.
6. Restoration Planning/data collection within Protected Areas	Improve Protected Areas data management	**Complete of air photo coverage** of Tsylos Park **Support Inventory** VRI mapping for Tweedsmuir and Bowron Lake parks (data required for restoration, fire management planning). Lack of data has implications for CCLUP as well, as old growth within the parks are to contribute to old growth requirements but no inventory data exists on actual forest conditions within the parks)
7. Ecosystem/ Wildlife habitat burns, fuel management in PA, and around PA infrastructure	Restore natural processes in PAs	**Develop plan controlled burning,** i.e., ignitions to improve habitat suitability for specific species of wildlife and to manage the risk of wildfire (where large amounts of dead lodgepole pine are found, and where infill is occurring). Fire management planning/fuel assessments in Tweedsmuir, Ts'yl-os, Big Creek, Itcha Ilgatchuz, Kluskoil and Bowron Parks, to protect integrity of parks ecosystems and infrastructure
8. Restore heron rookeries affected by MPB	Provide nesting habitat	**Monitor Heron nesting in dead pine.** The few blue heron rookeries we have in the Cariboo are generally located in lodgepole pine trees (some of which are or were alive). As these trees die we may want to look at the possibility of replacing the dead pine before they fall over with artificial "trees" (i.e. treated posts with limbs.
9. Monitor species affected by MPB	Improve species knowledge	**Support research** on Fisher DNA hair sampling **Support inventory/monitoring** of Marten and Lynx: populations and promote/research silviculture practices that can ensure their presence **Monitor Sharp-tail grouse lek sites**
Un-prioritized items previously provided, for further feedback from Cariboo Region:		
Fire-proofing front-country zones in Protected Areas	Fuel management to within Range of Natural	**Prescribe burn** to reduce flammable materials around the perimeter of Protected Areas/in high use areas, to reduce risk of wildfire and damage/destruction of ecosystems in backcountry (as well as risk to infrastructure - carry out in conjunction with danger

Priority	Factors that will mitigate impacts	Restoration activity
	Variability	tree falling. Parks projects related to safety have a different funding source)
Rehabilitation and reforestation of roads affecting wildlife and hydrology	Access management	**Restrict or reduce access** to specifically address road access to Cariboo WHA's, Mule Deer Winter Range, Wilderness Quality Lakes, Grizzly Bear WHA and high value areas, all Protected Areas **Reduce access** to Protected Areas and create a 2KM no access "buffer" around the larger PA's **Reduce access** by rehabilitation of secondary and tertiary road rehabilitation: remove culverts, cross ditch and reforest secondary and spur roads where tenure holders no longer have responsibility
Monitor effects of increased logging and associated access on moose populations	Access management	**Inventory/monitor moose populations** (to enable management to ensure sustenance for First Nations) and estimate changes to moose habitat and hunting and poaching pressure related to access
Monitor condition of spatially delineated Old Growth Management Areas	Develop alternate OGMAs	**Monitor loss of old growth trees** due to: firewood cutting, possible trespass logging, forest pests, in order to determine management actions (potential underplanting?)
Address invasive species	Maintain natural species and rare ecosystem diversity	**Seed using native grass species to rehabilitation disturbed areas**, to reduce opportunities for invasive plant establishment. Summer '05 showed an unprecedented increase in knapweed. **Monitor invasive species** locations and spread, and effectiveness of treatments
Restore cattle movement barriers	Decrease cattle impacts to sensitive ecosystems	**Create cattle movement barriers** (natural and fenced as appropriate – fencing affects ungulates) for OGMAs, WTP, riparian areas, grasslands, caribou and mule deer winter range, various WHA's and numerous habitats for red and blue-listed species. Fell and place dead pine as appropriate, to create barriers and protect seedlings.
Restore open forest	Increase areas in open forest	**Understory thin and burn**, with priority on Mule Deer winter range, OGMAs and PAs
Restore hydrologic stability/fish habitat	Recovery hydrologic function	**Under plant in community watersheds**, modified harvest Caribou WHA, no-harvest Caribou habitat, Protected Areas and other areas designated as no harvest or modified harvest in the CCLUP, that have significant areas of dead pine trees
Underplant in grizzly bear WHAs and to address cattle access impacts	Manage vegetation to reduce cattle bear	**Underplant to provide cover** where fire/MPB will result in significant cover loss for grizzly

Priority	Factors that will mitigate impacts	Restoration activity
	interactions	**Underplant to create cattle access barriers**
Remove beaver dams on and to fish spawning areas to restore fish passage	Maintain fish passage	**Restore fish passage** where blocked by beaver dams (remove dam or provide access through). This will also reduce risk to infrastructure/loss of grazing area by removing beaver dams
CWD management for marten habitat	Place CWD	**Deposit large CWD into patches of immature forest** Scatter patches of CWD throughout cutblocks, incremental to harvesting efforts (licensee effort)
Restore riparian areas and streams affected by MPB	Maintain riparian integrity (wide leave zones)	**Understory plant (spruce) to address fish habitat and shade**, and local hydrologic impacts of dead overstory lodgepole pine **Remove large in-stream debris** accumulations/dams threatening streambank integrity and/or fish passage
Replanting Whitebark pine (NDT2)	Maintain rare pine species.	**Monitor Whitebark pine loss due to MPB**. Replant Whitebark pine as many species are dependant on it and it has a limited range
NDT 4. Frequent Stand Maintaining Natural Disturbances Interior Douglas Fir Zone, (Bunch Grass zone) No restoration projects identified within bounds of recent fires. Along with MPB, FFT addresses 2002 and 2003 fires occurring primarily in the Southern Interior. The degree to which restoration will be done in other forested parts of the NDT4 zone not yet affected by major fire is under discussion. The NDT4 is a restoration priority for any funding source and is included here for completeness.		
1. Address fish passage issues on pre-FPC stream crossing structures	Increase fish access to natural habitat	**Restoring fish passage** at mining, logging and highways stream crossings to mitigate loss in other areas from short-term MPB impacts
2. Restore grassland values	Increase area in natural grassland	**Fall and broadcast burn or simply burn** to restore grasslands present amongst the forests (address conifer encroachment), to restore habitat for many species including red and blue listed, deer spring range. Projects within and outside of PAs.
3. Restore open IDF forests (address forest ingrowth)	Develop open stand structures	**Understory thin and burn,** with priority on OGMAs and PAs, WHAs, and high priority to mule deer winter range especially where these intersect with other values Assess range of natural variability and address where high degree of variance that is causing severe stress from forest pests (Spruce/Fir Beetle, Spruce Bud Worm) **Manage fuels and thin and burn** to address high fire hazard, especially in urban interface
Un-prioritized items previously provided, for further feedback from Cariboo Region:		
Rehabilitation and reforestation of roads	Access management and wilderness values	**Rehabilitate fire guards/roads** within the PA as well as roads that provide access close to PA's (potentially create a 2KM no access "buffer" around the larger PA's) to specifically address access affecting Cariboo WHA's, Mule Deer Winter Range,

Priority	Factors that will mitigate impacts	Restoration activity
		Wilderness Quality Lakes, Grizzly Bear WHA and high value areas, all Protected Areas
Address invasive species		**Seed native grasses and rehabilitate of disturbed areas**, to reduce opportunities for invasive plant establishment. (Summer '05 showed an unprecedented increase in knapweed.) -identify priority areas affected by invasives and environmental values at highest risk and implement treatments **Monitor invasive species** locations and spread, and effectiveness of treatments
CWD management for marten habitat	Manage CWD	**Deposit large CWD** into patches of immature forest. Also scatter patches of CWD throughout cutblocks, incremental to harvesting efforts (licensee effort)
Ecosystem/Wildlife habitat burns, fuel management around PA infrastructure	Restore natural fire disturbance	**Plan prescribed burns** i.e., ignitions (inside and outside PAs) to improve habitat suitability for specific species of wildlife and to manage the risk of wildfire (where infill is occurring). Fire management planning/fuel assessments in Tweedsmuir, Ts'yl-os, Big Creek, Itcha Ilgatchuz, Kluskoil and Bowron Parks, to protect integrity of parks ecosystems and infrastructure

Questions
The following questions were raised, and answering these questions would help determine restoration priorities:

1. What is the extent of the area affected by MPB, and what are the mortality levels. This applies particularly to the MS and ESSR BEC units.

2. To what extent (in what areas) will the Licensees undertake salvage harvesting? (In some areas, restoration would be speeded by salvage harvesting and associated planting.)

5.6 Southern MOE Regions (Kamloops, Okanagan and Kootenays)

Table 12: Summary of Kamloops MOE Regional Restoration Priorities (particularly within Merritt and Kamloops TSAs)

Priority*	Factors that will mitigate impacts	Restoration activity
NDT 3 Even-aged lodgepole pine and mixed pine stands affected by MPB MS and ICH zones		
1) Temperature Sensitive Streams or reaches	Maintain Riparian integrity	**Underplant riparian** to increase shade in those areas that are pure lodgepole pine with no understory. Use ecologically appropriate species e.g., plant broad leaf/non-pine species.
2) High value fish bearing streams	Ensure fish passage Reduce sediment delivery to streams	**Address backlog fish passage issues**, i.e., culverts and/or areas that are potential high-risk debris jams where tenure holders no longer have responsibility. **Restore natural barriers** that will restrict cattle access to treated, riparian and high value wetland habitats e.g., fell and place dead pine to protect plantings and existing understory vegetation.
3) Community watersheds with high ECA's** in tributaries with sensitive soils above the intake	Speed hydrologic recovery Reduce road area and road access and runoff	Underplant key upland areas outside the timber harvest land base in drainages where these contribute a significant portion of the ECA and where natural regeneration rate will be slow. **Rehabilitate secondary and tertiary roads** by removing culverts, cross ditching and reforesting secondary and spur roads where tenure holders no longer have responsibility
4) Rare upland grassland habitats	Maintain rare grasslands	**Reclaim upper elevation grassland** by felling and burning dead lodgepole pine and new regeneration
5) Caribou habitat	Speed recovery of pine terrestrial lichen sites	**Replant areas in caribou habitat** that have not been salvage logged as quickly as possible.
6) Natural processes in parks	Allow natural processes (fire) in appropriate areas	**Apply controlled burns** in identified areas, treat MPB-affected stands with fire. Tunkwa Park has prescriptions done already. Lac Le Jeune is having a plan developed to remove affected MPB stems **Treat areas** with invasive weed species

NDT 4 **Frequent stand maintaining fire** Even and uneven aged Douglas fir, Ponderosa Pine and mixed species stands		
Area within boundaries of recent fires***		
1) High value fish bearing streams	Maintain riparian integrity	**Plant riparian areas to** increase shade. Use ecologically appropriate species e.g., plant broad leaf/non-pine
2) Land Resource Management Plan designated winter ranges. Initial priority Skull Mountain.	Develop old growth canopy and understories. Control spread of weeds.	**Thin from below** where appropriate in forested patches that were left within the fires or in adjacent unburned stands. (consider species diversity) **Control weeds by pulling and spraying** in the Skull Mountain SRMZ requires implementation of the weed management plan with other partners.
3) Invasive species	Control spread of weeds	**Monitor and control** invasive species in the N. Thompson burned areas
Areas outside of recent fires:		
1) Old growth Ponderosa Pine stands		**Thin from below** to remove IDF in growth pile and burn. Thin Ponderosa pine to appropriate stocking densities to meet objectives.
2) Old growth IDF	Manage for structural diversity	**Thin from below** to remove IDF in growth pile and burn. Rosseau Creek area suggested as priority area. **Broadcast under burn where possible**
3) Invasive species management	Minimize disturbed areas	**Identify priority areas** where invasive species threaten environmental values.
4) Recruitment OGMAs	Develop older stand structures.	**Thin from below recruit old forest attributes** sooner to develop OGMAs

* priority is given to areas that have a conservation emphasis, where benefits from investment will be long term i.e., Ungulate Winter Ranges, Old growth Management Areas (recruitment OGMAs), Wildlife Habitat Areas, Parks
**ECA stands for Equivalent Clear-cut Area
*** this priority is linked directly to the assumption that FFT is restricted to areas within previous catastrophic burns.

Questions
The following questions were raised, and answering these questions would help determine restoration priorities:

1. Are any of the areas that were skipped in the fires in need of treatments - specifically thinning from below to improve stand structure? Is the patchiness created by the fires and salvage best left as is? (The answer would depend on species-specific needs.)
2. Are standing dead trees comparable to harvested trees with respect to ECA - or what is the relationship?
3. How much shade do dead pine trees contribute to shading in temperature sensitive streams?
4. How many streams and how much of the riparian zones have a significant component of dead pine?

NOTE: restoration priorities relating to safety in parks have been removed (i.e. removal of danger trees in high use park areas). These activities are not considered ecological restoration and have a separate funding source.

Table 13: Summary of Okanagan MOE Regional Restoration Priorities (particularly within Okanagan TSA).

Priority*	**Factors that will mitigate impacts**	**Restoration activity**
NDT 3 Frequent Stand Replacing Disturbance Even-aged lodgepole pine and mixed pine stands MS and ICH zones		
1) Community watersheds and tributaries with high ECA's**	Speed hydrologic recovery Maintain Riparian integrity Access management/road rehabilitation (reduce road area)	**Underplant lodgepole pine** in areas not salvaged, where it is possible to improve hydrological recovery and where natural regeneration rate will be gradual. Address areas such as community watersheds and systems critical to the fish culture program, Pennask and Echo Creeks. Also address systems sensitive to changes in temperature. Use broad leaf/non-pine tree species as appropriate
2) High value fish streams, shading	Speed hydrologic recovery Maintain Riparian integrity Access management/Road rehabilitation (reduce sediment delivery) Ensure fish passage	**Underplant riparian reserve and management zones** to increase shade in those areas that are pure lodgepole pine with no understory. Use ecologically appropriate species e.g., plant deciduous and non-pine species **Restore natural barriers** that will restrict cattle access to treated, riparian and high value wetland habitats i.e., fell and place dead lodgepole pine to protect plantings and existing understory vegetation. **Address backlog fish passage issues**, i.e., culverts where tenure holders no longer have

		responsibility and streams with beaver dams or unusual debris jams block historically used stream reaches.
3) Areas with greatest loss of older stand structures		**Space younger stands to** develop old forest structures where these are severely limited
4) Natural processes in parks	Allow natural processes (fire) in appropriate areas	**Apply controlled burns** to identified areas, treat MPB-affected stands with fire. Treat invasive weed areas
5) Non status roads	Access management/road rehabilitation (reduce road area) Ensure fish passage	**Rehabilitate roads to control runoff and access**. Focus on non-status roads, in watersheds with high ECA's and high environmental values. Develop prescriptions that take into account current use and where possible, remove culverts, cross ditch and reforest secondary and spur roads.
NDT 4 Frequent stand maintaining fire Even and uneven aged Douglas fir, Ponderosa Pine and mixed species stands IDF, PP, ICH, (BG) zones		
Area within boundaries of recent fires* ** (FFT addresses 2002, and 2003 fires.)		
1) Invasive Species	Minimize disturbed area	**Monitor and control invasive** species in the Okanagan Mountain and Vaseaux Lake fires.
2) Erosion		**Planting grass species** with best outcome to reduce erosion **Manage off road use** and other uses that contribute to the spread of invasive weeds and site degradation
3) At risk species/plant communities (specific projects)		**Thin and burn** to maintain and manage open forest habitat **Fencing** to manage adjacent livestock **Specific recovery plans** i.e., Antelope bush communities, Vaseaux Lake fire and LRMP designated winter ranges with priority to California bighorn sheep ranges.
NDT 4 Frequent stand maintaining fire Even and uneven aged Douglas fir, Ponderosa Pine and mixed species stands IDF, PP, ICH, (BG) zones **Outside of recent fire-impacted areas.**		
1) Old growth Ponderosa Pine	Restore natural processes	**Thin, pile and burn** to remove IDF in growth. Thin Ponderosa pine to appropriate stocking densities to meet objectives.

stands		
2) Invasive species management	Minimize disturbed area	**Monitor and control invasive** species with priority to environmental values at highest risk
3) IDF affected by in-fill/ encroachment	Restore natural processes	**Thinning from below, pile and burn** to remove IDF in-growth, and restore structural diversity and open habitats South Okanagan priority based on numbers of red and blue listed wildlife. **Prescribed burns** where possible
4) Recruitment OGMAs	Develop old forest stand structures.	**Silvicultural treatments** to 'recruitment OGMAs' to attain old forest attributes sooner, e.g., thinning from below, pile and burn**.**

* priority is given to areas that have a conservation emphasis, where benefits from investment will be long term i.e., Parks and Protected Areas, Wild Management Areas, Ungulate Winter Ranges, Old growth Management Areas (recruitment OGMAs), Wildlife Habitat Areas, Parks

** ECA stands for Equivalent Clear-cut Area

*** This priority is linked directly to the assumption that FFT is first focused to areas within previous catastrophic burns.

Questions

The following questions were raised, and answering these questions would help determine restoration priorities:

1. Are any of the areas that were skipped in the fires in need of treatments - specifically thinning from below to improve stand structure? Is the patchiness created by the fires and salvage best left as is? (The answer would depend on species-specific needs.)
2. Are standing dead trees comparable to harvested trees with respect to ECA - or what is the relationship?
3. How much shade do dead pine trees contribute to shading in temperature sensitive streams?
4. How many streams and how much of the riparian zones have a significant component of dead pine?
5. How to proceed with prescribed fire without promoting the spread of existing weed populations?
6. Need to augment native seed nursery production.

NOTE: restoration priorities relating to safety in parks have been removed (i.e. removal of danger trees in high use park areas, fuel loading around infrastructure). These activities are not considered ecological restoration and have a separate funding source.

Table 14: Summary of East Kootenay MOE Regional Restoration Priorities (particularly within Cranbrook TSA)

Priority*	Factors that will mitigate impacts	Restoration activity
NDT 3 Frequent Stand Replacing disturbances Lodgepole pine and mixed pine stands affected by MPB MS and ESSF Zones		
1) Mitigate stream temperature on specific streams or reaches, drainages with high ECAs**	Maintain riparian integrity Speed hydrologic recovery	**Riparian underplanting** to increase shade in those areas that are pure lodgepole pine with no understory. Use ecologically appropriate species i.e., plant deciduous/non-pine species as appropriate. Leave all functional wildlife trees. Tailed Frog project underway.
2) Mitigate Community Watersheds with high ECA's in tributaries with sensitive soils above the intakes	Speed hydrologic recovery Minimize soil disturbance Access management/road rehabilitation (minimize road area/sediment delivery)	**Speed hydrologic recovery** and minimize erosion by underplanting key upland areas outside the timber harvest land base or in areas where there will be non recoverable losses in drainage where these contribute a significant portion of the ECA and natural regeneration rate will be slow. **Road rehabilitation -** Secondary and tertiary road rehabilitation, remove culverts, cross ditch and reforest secondary and spur roads where tenure holders no longer have responsibility
3) Mitigating changes in hydrology for high value fish bearing streams e.g., Bull trout.	Maintain riparian integrity Access management/road rehabilitation (minimize road area/sediment delivery) Ensure fish passage	**Speed hydrologic Recovery** (see above) by focusing underplanting to drainages of importance to Bull trout or other managed fish species Riparian underplanting and road rehabilitation (see above) Removal of excessive debris jams where necessary. **Restore natural barriers** that will restrict cattle access to treated, riparian and high value wetland habitats i.e., fell and place dead pine to protect plantings and existing understory vegetation. Restore natural barriers to restrict/limit people's access to areas sensitive to disturbance.
4) Mitigating loss of older forests	Develop old forest stand structures.	**Space younger stands to** develop old forest structures where these are severely limited.

5) Caribou habitat	Develop Caribou habitat	**Reforest caribou habitat** that has not been salvage logged as quickly as possible and reduce access through road rehabilitation. Dewar Creek
6) Spread of invasive species	Minimize soil disturbance	**Monitor and remove invasives** spread
7) Natural processes in parks	Allow natural processes	**Apply broadcast burns** to speed up natural process on some sites by re-introducing fire.
NDT 4. Frequent Stand Maintaining Natural Disturbances **Interior Douglas Fir and Ponderosa Pine Zones.**		
Area within boundaries of recent fires*** (FFT addresses 2002, and 2003 fires.)		
1) Community Watershed and Fish bearing streams	Maintain riparian integrity	**Plant riparian areas to increase shade.** Use ecologically appropriate species i.e., plant deciduous.
2) Designated winter ranges		**Thin from below, pile and burn** to restore snow interception cover and forage, and develop and open stand with well-developed understory where appropriate.
3) Invasive species	Minimize disturbed area	**Seed** disturbed sites **Monitor and control invasive species** in burned areas Identify priority areas and environmental values at highest risk and implement.
Restoration priorities in areas outside of recent wildfires. The Trench Restoration plan is undertaking prescribed burns and slashing/piling activities in the NDT4 to enhance ungulate winter range characteristics and restore overall ecosystem function. See list of projects for 2006 2007, below.		
1) Old growth Ponderosa Pine stands	Restore natural processes	Restore old growth Ponderosa Pine stand structure and composition. **Thin from below** to remove IDF in-growth pile and burn. Thin Ponderosa pine to appropriate stocking densities to meet objectives.
2) Open IDF forests, Old growth IDF, and recruitment OGMAs from younger stands	Restore natural processes	**Thin from below** to restore older forest structural diversity: **Thin from below** to remove IDF in growth **Pile and burn as appropriate,** to recruit old forest attributes **Broadcast under burn** where possible **Restore natural barriers** to control/limit access for cattle and people to areas sensitive to disturbance.
3) Ungulate Winter Ranges	Maintain winter range functions	**Apply variety of treatments** under KBLUP restoration of Trench with a focus on ungulate winter ranges, native grasslands and open forest condition.
4) Invasive species management	Minimize disturbed area	**Monitor and control invasive species** Identify priority areas and environmental values at highest risk and implement.

* priority is given to areas that have a conservation emphasis, where benefits from investment will be long term i.e., Ungulate Winter Ranges, Old growth Management Areas (recruitment OGMAs), Wildlife Habitat Areas, Parks
**ECA stands for Equivalent Clearcut area
** this priority is linked directly to the assumption that FFT is restricted to areas within previous catastrophic burns.

Trench restoration plan projects.
Crown Land:

- St. Mary's-North Cherry = MU 4-20; 50 ha; north of Kimberley; slashing and piling;
- Cherry-TaTa-Lost Springs = MU 4-20; 200 ha; north of Kimberley; prescribed burn.
- Sunflower Hill = MU 4-20; 35 ha; west of Kimberley; slashing, piling & sloop burn
- Wapiti Lake = MU 4-22; 100 ha; west of Jaffary; slashing & piling
- Gina Lake= MU 4-21; 50 ha; southeast of Skookumchuck; slashing/piling

Provincial Parks / Conservation Properties (Crown/MOE):

- Kikomun Creek Park = MU 4-22; 75 ha; southwest of Elko; slashing & burning
- Premier Lake = MU 4-21; 100 ha; east of Skookumchuck; slashing & burning
- Wycliffe Corridor = MU 4-20; 100 ha; northwest of Cranbrook; slashing, piling & pile burning

Bighorn sheep winter ranges: (Crown)

- Wigwam Flats/Rocky Ridge = MU 4-02; 80 ha; S.E. of Elko; slashing/piling/burning slash piles;
- Columbia Lake East = MU 4-25; 80 ha; north of Canal Flats; slashing/piling/pile burning/plan;
- Premier Ridge area = MU 4-21; 50 ha; southeast of Skookumchuck; slashing/piling/pile burning
- Dry Gulch Provincial Park = MU 4-25; south of Radium; 15 ha; slashing and piling
- Andy Good Creek = MU 4-23; southeast of Sparwood; pile burning
- Radium Mile Hill = 4-25; south of Radium; pile burning

It was noted that there is a shortage of available native shrub/forge species nursery able to provide stock for restoration projects.

Questions
The following questions were raised, and answering these questions would help determine restoration priorities:

1. Are any of the areas that were skipped in the fires in need of treatments - specifically thinning from below to improve stand structure? Is the patchiness created by the fires and salvage best left as is? (The answer would depend on species-specific needs.)
2. Are standing dead trees comparable to harvested trees with respect to ECA - or what is the relationship?
3. How much shade do dead pine trees contribute to shading in temperature sensitive streams?
4. How many streams and how much of the riparian zones have a significant component of dead pine?

NOTE: restoration priorities relating to safety in parks have been removed (i.e. removal of danger trees in high use park areas, fuel loading around infrastructure). These activities are not considered ecological restoration and have a separate funding source.

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Appendix 1 - Ecological Consequences of the Mountain Pine Beetle Epidemic

The current Mountain Pine Beetle epidemic has caused significant changes to large areas of forest in interior British Columbia. This epidemic is forecast to create significant changes to forested ecosystems until 2020 (Eng *et al.* 2005). The ecological significance of these changes is immediate and will continue far into the future.

Mountain Pine Beetle (MPB) is a natural disturbance agent that has shaped and will continue to shape the forests of British Columbia. However, the current epidemic is beyond what is known to have been previously experienced - Gawalko (2004) notes this is the largest recorded natural disturbance event to occur in BC. The current, unprecedented condition of the lodgepole pine forests is considered to be one factor behind the epidemic. Effective fire prevention has removed large-scale fires from much of the pine forest, creating a landscape with a higher percentage of the older lodgepole pine forests that are preferred habitat for MPB. Climate change is the other unprecedented factor that favours MPB, as it removes the likelihood of severe cold conditions that cause MPB mortality.

Regarding climate change, The Ministry of Water, Land and Air Protection 2002 report on Climate Change indicators (BC MWLAP 2002a) notes:
"Temperature limits the range and size of MPB populations. Warmer temperatures may allow the beetles to more northwards into new regions and upwards into new ecosystems"

The report further concludes,
"Because minimum temperatures delineate the northern range of the MPB, this increase in minimum temperatures provides forest managers with reasons for concern."

The State of Environment Report 2002 (BC MWLAP 2002b) notes:
"The central and southern interior regions warmed by 1.1°C, or twice the global average. In northern British Columbia, the warming trend of 1.7°C is nearly three times the global average. Climate models predict further warming in British Columbia at the rate of 1-4°C in this century, with the interior warming faster than the coast. Potential impacts of increasing atmospheric temperatures include: change in river temperatures and flow patterns resulting in disruption of salmon migration and spawning, spread of pests, such as mountain pine beetle, and reduced soil moisture in some areas"

It appears that the outbreak itself is a natural phenomenon, likely outside the range of natural variability due to fire suppression and climate change. Restoration of direct impacts is therefore appropriate. In addition, the indirect impacts of harvesting and salvage are relevant to restoration where damage to ecological values is caused.

A summary of the potential direct and indirect ecological consequences of MPB is presented below to provide context for this project. This summary is compiled from existing publications, specifically Stadt (2001), Bunnell *et al*. (2004), Eng (2004), Wong *et al.* (2003), BC MWLAP 2005, Douglas 2003, and communications with MOE and MOFR staff, as well the knowledge of the Mike Fenger and Associates project team.

The Direct Impacts of Mountain Pine Beetle

1. A shift to a high percentage of forest landscapes in early seral stages. Older-forest dependent species will be very restricted in their distribution, and may not be able to persist in much of the landscape. The distribution of important stand-level attributes associated with older seral stages – i.e., larger diameter live and dead trees and dead and down wood (coarse woody debris) will affect species distribution. Timeframe: immediate and impacts will continue far into the future.
2. Changes in snow pack, snowmelt and runoff. (Dave Wilford, personal communication 2005). The likely increases in peak flows and loss of riparian trees will lead to increased sediment mobilization and siltation, erosion of stream channels and banks, destabilization of channel beds and large woody debris, loss of undercut/overhanging banks (loss of fish habitat), and general degradation of fish habitat (Peter Tschaplinski, personal communication, 2005). These changes may also affect drinking water quality. Timeframe: immediate and impacts will continue into the mid term.
3. Significantly reduced evapotranspiration, causing increased spring runoff and lower summer flows. Lower slopes and lower ground is expected to be wetter, affecting the understory and changing the suitability for tree species. This creates uncertainty over appropriate tree species selection for regeneration, linked to changes in site conditions (drier sites are expected to be drier and wetter lower slopes wetter). There is a potential for beetle-killed stands to be converted to shrub communities (Dave Coates personal communication 2005). Increased spring runoff will also affect wetlands, which are expected to fill with more water in spring, and retain more water longer into the summer season. Timeframe: short-term to mid-term for effects on riparian areas and wetland ecology (Will Mackenzie, personal communication, 2005.)
4. Death of riparian trees, causing reduced local litter input and increased large woody debris (LWD) to streams in the short to mid-term (Peter Tschaplinski, personal communication, 2005), and then presumably loss of large woody debris input over the longer term until the next stand is developed. With tree death, reduced leaf litter results in reduced organic litter available to support aquatic insect species depending on this food source. Direct insect inputs (i.e., fish food from riparian areas) are also potentially reduced. LWD performs many important stream functions, and increased LWD can be beneficial to those streams that, due to past streamside harvesting, have LWD deficits. However, excessive LWD in streams can change channel morphology, create logjams, impede fish movement and access to habitats, and destabilize stream banks. The above can affect fish survival at all life stages from eggs to smolts. Timeframe: immediate to mid-term increase in LWD and decrease in litter, and a longer-term loss of LWD.

5. Loss of shade, with increases in stream temperatures (or more accurately, greater temperature fluctuations), with implications for temperature-sensitive aquatic species. Potential impacts of increased temperatures include mortality, reduced habitat availability, and change in species composition for fish and other sensitive aquatic species. Increased light favours algae production and aquatic insects that depend on algae, and these species shifts are not necessarily favourable for fish. (Peter Tschaplinski, personal communication 2005). However, increased temperatures in more northern areas (i.e., North of Quesnel) can increase streams' productivity for fish (Phil Burton personal communication, 2005.). Fish productivity increases related to increased temperatures after the removal of streamside trees are well documented for Carnation Creek on the west coast of Vancouver Island (though fish numbers later declined due to increased sediment and reduced habitat complexity). Timeframe: short to mid-term impacts of increased stream temperature.
6. A significant increase in wildlife trees and coarse woody debris (CWD) in the short-term, with mid- to longer-term loss of such structures over extensive areas. The short-term increase in structures can be beneficial for species that depend on these features for some part of their life cycle, particularly as their distribution is restricted in some harvested areas. Episodic events like beetle outbreaks are very important to the long-term supply of these elements. However, in the mid-term when dead lodgepole pine trees lose their root strength and fall, the mobility of large ungulates (caribou, deer, and moose) is expected to be restricted in those stands where fallen stems are suspended and form a barrier to movement. Over the longer term the loss of large structures throughout extensive stands is likely to have a significant negative effect on species requiring larger live or dead standing or down trees. Timeframe: immediate to long term complex responses.
7. Increased understorey light once needle drop is complete. There will be positive and negative responses of understory plants to changes in light and microclimate, e.g., increases in kinnick kinnick and decreases in terrestrial lichen (D. Cichowski personal communication 2005). Timeframe: immediate.
8. Loss of critical or core habitat for a variety of species: responses will vary depending on species, but extensive impact will remove critical habitat for some species (e.g., ungulate winter range/ caribou habitat/ listed species habitat). Timeframe: short to long term.

Indirect Impacts of Mountain Pine Beetle (Harvest and Salvage)

Species in interior forests evolved with MPB-related disturbance. There may have been equally extensive MPB disturbances in the past, with related impacts on various species. However, there are now additional impacts associated with large-scale harvest and salvage of lodgepole pine. The term "salvage" is used to describe the recovery of economic value before a certain commodity loses that value (Ice *et al*. 2004). It implies that there is a limited economic window of opportunity, which for MPB-killed trees is understood to be 5-10 years after tree death. Impacts related to harvest and salvage are generally understood to be:

1. Exacerbated timelines for most of the direct impacts listed above.

2. Increased road access, which results in less landscape as refuge. This affects disturbance intolerant species such as grizzly bear, moose and caribou and enables changes in predation and hunting patterns. Timeframe: immediate to short-term as roads are built and accessed.
3. Increased road density, which results in increased numbers of stream crossings, and increased sediment load and runoff due to channelling of flow, associated with access. Timeframe: immediate to mid-term.
4. Reduce stand structure due to loss of large live residual trees from both harvest and salvage. This impacts both pine and other species where they occur. Timeframe: immediate to long-term.
5. Reduced stand structure, i.e., less coarse woody debris in salvaged areas and a high level of coarse woody debris in unsalvaged areas as dead trees fall. Timeframe: mid-term.
6. Increased landscape-level homogeneity, i.e., a high percentage of the landscape originating from similar management prescriptions, resulting in loss of natural landscape complexity. Timeframe: short to long-term.
7. Loss or impacts to critical habitats due to rapid planning and variances that expedite harvest and salvage. Timeframe: immediate to long-term.
8. Loss of natural barriers allowing cattle access to sensitive habitats. Timeframe: immediate to long term.

Other factors influencing non-timber forest values related to the effects of MPB are:
1. A significant reduction in timber supply within the next two decades. This is expected to create pressure to harvest remaining older stands that have been identified for conservation purposes. This pressure will reach a peak at end of the next decade, and remain constant when timber supplies are at their lowest. Extensive infrastructure will be in place for harvesting at the same time that there will be very low levels of available mature wood. Species such as aspen will likely be recognized as commercially viable.
2. Land Use Plans have identified areas to be managed for conservation emphasis, that are to remain unharvested (and that were erroneously assumed to be unaffected by natural disturbance). Many of these areas will likely be affected by MPB and thus converted to earlier seral conditions. Old growth management areas and landscape level objectives also require a set percentage of landscape units and biogeoclimatic subzones be left in older seral stages – a requirement that may be difficult to meet.
3. There will be continued review of the Land Use Plans and questions on what is best within conservation areas especially those that we expected to remain with a high older forest component.
4. Widespread use of herbicides is a strategy that may be selected to get brush-prone sites into conifer forest production. This places stream values at risk during spraying operations and reduces the duration of biodiverse early seral stages.

Widespread use of fertilizers is another strategy that may be selected as a means to improve wood supply in the next one to two decades. Increases in nutrients can have a negative affect on wetlands and streams in combination with fluctuations in runoff and temperatures.

Appendix 2 – Ecological Consequences of Major Wildfire

The influence of wildfires on ecosystems can be either "natural" or "unnatural" depending on the ecosystem's fire regime and the context of fire within the range of natural variation. A fire occurring within the range of natural variability (RONV) for frequency in a dry forest ecosystem would exhibit ecological effects that the ecosystem has evolved with. Fires occurring too frequently or following an unnatural absence could lead to disruptions in patterns and processes that have no historic precedence for that ecosystem. The primary gauge of natural or unnatural "effects" is fire severity and burn severity.

Fire severity refers to the direct effects from the combustion process. The combustion process results in the direct killing of trees, heating of soils, smoke production, and the consumption of the forest floor. Each of these can be within or outside the RONV for an ecosystem's fire regime. Likewise, burn severity can be used to gauge the ecological context of fire effects. Burn severity is a term that qualitatively describes classes of fire-caused changes to soil hydrologic function, as evidenced by soil characteristics and surface fuel and duff consumption. Given the same area is burned, burn severity is the more critical measure when assessing ecological consequence, as it has a much longer-term impact on site productivity than fire severity. These two measures – fire severity and burn severity – have different implications to ecological processes, with fire severity typically having landscape-level implications, and burn severity having longer-term site productivity impacts.

Measuring departure from RONV for these different effects involves assessing overstory, understory, soil and coarse woody debris impacts due to wildfire. Unnaturally high overstory mortality, an invasion of noxious weeds into the understory, complete consumption of all coarse woody debris (CWD), or deleterious soil/hydrologic impacts are all examples of "departed" (from RONV) fire effects.

Direct Impacts of Catastrophic Wildfire

The following are potential primary effects of catastrophic wildfire, at the landscape and forest stand scales:

1. Landscape level: loss of significant areas of standing trees, including riparian, critical habitats etc. Timeframe: immediate.
2. Landscape level: impacts to riparian / wetland ecosystems. Timeframe: immediate, but potentially short-term.
3. Landscape and Stand level: consumption of forest floor, including potentially complex and significant impact to ecological processes, hydrological impacts, productivity etc. Timeframe: immediate to long-term.

4. Stand level: increased availability (in the short-term) of dead or injured standing trees, causing changes in communities for insects and disease, plus cascading community impacts. Timeframe: immediate.
5. Stand level: heating of soils, including potential significant impact to ecological processes. Timeframe: immediate.
6. Stand level: loss of downed woody debris within the stand, resulting in lower habitat values in the short-term, and a change in local species composition. Timeframe: immediate to mid-term.
7. Stand level: loss of understory vegetation, resulting in changed habitat values and impacts on hydrology. Timeframe: immediate.
8. Stand level: increased probability of colonization by invasive plant species. Timeframe: immediate to mid-term.

Indirect Impacts of Wildfires

The indirect impacts of fighting wildfires are fire-specific and complex, but generally include:

1. Increased road access, which results in less landscape as refuge. This affects disturbance-intolerant species such as grizzly bear, moose and caribou and enables changes in predation and hunting patterns. Timeframe: immediate to short-term as roads are built and accessed.
2. Local impacts of helicopter landings, roads/skid trails and firebreaks. Local impacts can include sedimentation/ local habitat loss etc. Timeframe: immediate to mid-term.
3. Increased road or fire break density, which results in increased numbers of stream crossings, and increased sediment load and runoff due to channeling of flow associated with access. This can be excessive where roads or fire breaks are built under emergency situations. Timeframe: immediate to mid-term.
4. Reduced stand structure due to loss of large live residual trees from salvage. This impacts both lodgepole pine and other species where they occur. Timeframe: immediate to long-term.
5. Reduced stand structure, i.e., less coarse woody debris in salvaged areas and a high level of coarse woody debris in unsalvaged areas as dead trees fall. Timeframe: short to mid-term.
6. Increased landscape level homogeneity, i.e., a high percentage of the landscape originating from similar management prescriptions resulting in loss of natural landscape complexity. Timeframe: short to long-term.
7. Loss or impacts to critical habitats due to rapid planning and variances that allow expedited harvest and salvage. Timeframe: immediate to long-term.
8. Increased potential for invasive species colonization along roads / trails into otherwise inaccessible areas. Timeframe: short to long-term.
9. Loss of natural barriers allowing cattle access to sensitive habitats. Timeframe: immediate to long-term.

Salvage harvesting impacts are another example of indirect impacts of wildfire. Yet, salvage harvesting may contribute to post-fire ecosystem recovery in some cases, though there are potential issues related to road access (hydrologic concerns), invasive species

and aesthetics, as well as the appropriateness of creating another disturbance on the heels of the first (Beschta *et al*. 2003). Nevertheless, removal of fire-killed or damaged trees may be appropriate at part of the long-term recovery of an ecosystem (Ice *et al.* 2004). An assessment of attributes that are outside the RONV for that particular fire regime may conclude that tree density is still outside the RONV - this condition may be true whether the trees are green or black. Leaving dead trees is no less deleterious to the ecosystem than leaving them standing green. In fact, once dead they constitute a greater threat. An emerging issue within the entire fire regime/RONV debate is the concern over "reburn" conditions. A "reburn" occurs when the trees killed in a wildfire fall to the forest floor and are burned in a subsequent wildfire. The issue is the fuel loading and burn severity departure from RONV (Brown *et al*. 2003). This is primarily an issue in short-interval fire regimes. In a few documented cases from the recent severe fire years in the western US, the ecological consequences of the reburn far outweigh the consequences of the initial wildfire. In these ecosystems a significant amount of dead material should be removed as sensitively as possible while leaving structures that are appropriate for the recovering ecosystem (e.g., large diameter trees, some large diameter dead downed material). In longer-interval fire regimes the fire-killed attributes may not be outside the RONV and would therefore not constitute a reburn threat.

Post-wildfire recovery efforts should be guided by the following principles: (a) assess what remaining attributes are within the RONV and retain them; (b) assess what remaining attributes are outside the RONV and remove them; (c) develop an inventory of invasive species; and, (d) re-establish elements of the ecosystem that have been extirpated by the disturbance. This ecosystem recovery/restoration process should be segregated from a purely economics-driven salvage process.

Appendix 3 - Strategic Ecological Restoration Assessments (2001)

A preliminary (and incomplete) list of priority ecological issues was developed based on restoration issues/priorities developed for the former Terrestrial Ecosystem Restoration Program (Holt 2001a-e). These ecological issues are presented in a Biogeoclimatic Ecosystem Classification (BEC) zone framework, by region. These preliminary "restoration assessments" were adapted from work done prior to MPB reaching epidemic proportions, and previous to the wildfires of 2002 and 2003. The versions circulated to MOE staff contained blank columns for entering restoration priorities beside the ecological issues/ecosystem components affected columns (see below). As the process evolved, MOE input was instead incorporated into the simpler tables found in Section 5. Nevertheless the information is included here as it still provides valuable context.

Cariboo Region Restoration Assessment

MPB outbreaks are most extensive in the Sub Boreal Spruce (SBS) and Montane Spruce (MS) zones. Lodgepole pine also occurs in large portions of the Interior Douglas Fir (IDF) zone.

The term Cariboo Region here refers to the former MOF Cariboo region (as described in Holt 2001a). This previous Forest Region reasonably reflects today's MOE Cariboo region. The BEC zones given priority in 2001 were Bunchgrass (BG), IDF, Interior Cedar Hemlock (ICH), and Sub Boreal Pine Spruce (SBPS). The SBS was considered a lower priority but has been elevated in light of mortality of lodgepole pine.

Cariboo Region Sub Boreal Pine Spruce zone. SBPS

Context for zone

Size of zone ha	Approximate Number of red and Blue listed Species	Approximate number of Listed Communities	Percent protected	
			Provincially	Regionally
2,139,692	28	4	9	3

Priority Ecological Issues	Ecosystem Components Affected
Landscape level: - low representation of ecosystems in PAS - high road densities -extent of change from natural disturbance patterns - fire exclusion	➢ Forest management fails to mimic natural disturbance by applying same rotation to entire landscape. ➢ Significant changes in remaining forest patch sizes on the landscape from natural conditions. ➢ Few large mature /old patches remaining and loss of rare types of old such as 'old' lodgepole pine stands. Exacerbated by single approach to management across landscape, ➢ Fire exclusion: ingrowth causing 'doghair' stands ➢ Species composition in non-forested ecosystems also changing due to suppression of fire
Stand level impacts: simplification of forest structure	➢ Wildlife tree patches fail to maintain appropriate long rotation large sized trees due to combination of policy and approach problems (e.g., concern over forest health impacts). ➢ Lichen species lost due to short rotations and clearcut with mechanical site preparation. ➢ Mechanical site prep removing shrub cover stage following harvest - implications for many species (unsure of the extent). ➢ Narrow range in density of young stands (insufficient variation in stocking standards).
Forest Health management MPB killed stands	➢ Extensive MPB salvages leading to lower volume of dead wood on landscape. ➢ MPB salvage does not account for microsite differences ➢ Mistletoe sanitation potential negative biodiversity impacts of sanitizing stands for mistletoe – loss of stand structure; reluctance to retain in WTR areas
Access	➢ High road density. Exotic weed species being spread intentionally with seeding, and non-intentionally by movement. ➢ Wildlife movement patterns changed – historical patterns along riparian changed to movement along or limited by road corridors.
Range	➢ Extensive cattle grazing causing decrease in above ground biomass and changes in species composition ➢ Focused impacts on riparian systems due to trampling (riparian edges/ shrub carrs/ streamside) ➢ In the xc there are particularly high impacts. Cows in dry non-forested areas are causing high grazing pressure.
Specific species habitat	➢ Terrestrial lichen is important for woodland caribou. Ground lichen is being lost from the landscape. This is a particularly important issue in the SBPSmc.

Cariboo Sub Boreal Spruce zone

Context for zone

Size of zone ha	Number of red and Blue listed Species	Listed Communities	Percent protected	
			Provincially	Regionally
1,139,681	25	5	6	3

Priority Ecological Issues*	**Ecosystem Components Affected**
Landscape level: - extent of harvest - planning - representation of ecosystems in PAS -extent of change from natural disturbance patterns	➢ Extensive change from natural disturbance patterns due to rate and type of cut – resulting in extensive loss of old and mature forest, plus considerable changes in patch sizes. Very few large sized mature/ old patches remain on the landscape. Highly fragmented landscape. ➢ Highest impacts are in wetter areas (particularly SBSwk1 and SBSmw – which currently have more old forest remaining, however concern that current expansion of harvesting here will have high impacts). ➢ Fire exclusion/harvesting combination: stand conversion from deciduous to coniferous stands. ➢ Windthrow issues, (particularly in wetter variants) resulting in inadequate riparian management and loss of riparian reserve zones. ➢ Stand conversion throughout zone resulting in significant loss of Fd. ➢ Fire exclusion impacts (see IDF) are significant on edge of this zone, on steep W facing slopes. ➢ Highest priority area: SBSmw and SBSwk1: rate of cut/ loss of old forest and riparian management are worst in this variant.
Stand level impacts: - simplification of forest structure	➢ Partial cutting in this zone is resulting in stand conversion from Fd/ Pl stands to Pl stands – losing the Fd component. ➢ No management for CWD, or for maintaining stand structure (standing and down wood) into the future. Particularly important for large sized pieces.
Forest Health	➢ Extensive fir bark beetle and Mountain Pine Beetle salvage; also Armillaria. ➢ Inappropriate management for ensuring retention of adequate stand structure through time – extensive loss of old forest attributes throughout the landscape.
Riparian impacts - including wetlands	➢ High levels of cattle grazing and trampling impact vegetation here more so than other areas due to particular vegetation types in this zone (forbe dominated). Results in a shift in the structure of forbe communities in younger stands. ➢ Wetter variants: concern about windthrow resulting in poor management to maintain riparian reserve zones – tendency to

Priority Ecological Issues*	Ecosystem Components Affected
	avoid leaving any structure (i.e. inappropriate use of riparian management zones). Impact is quite extensive in this zone.
Access	➢ Extensive access impacts: entire area is fully roaded (no unroaded valleys; all operable). High accessibility. ➢ Suspected to change patterns of habitat use by many animals. ➢ Increases hunting /poaching pressures throughout landscape – there are no areas without roads. ➢ Wetter variants: extensive roading is providing access to important higher elevation areas, particularly caribou areas for summer and winter traffic. Potential high impact here. Due to historic harvesting patterns, impact is higher in western areas.

Cariboo Region Interior Douglas Fir zone IDF

Context for zone

Size of zone ha	Number of red and Blue listed Species	Listed Communities	Percent protected	
			Provincially	Regionally
1,646,743	40	26	4	5

Priority Ecological Issues*	Ecosystem Components Affected
Landscape level: - planning - representation of ecosystems in PAS -extent of change from natural disturbance patterns	➢ Fire exclusion resulting in a) considerable ingrowth and overly dense stands; b) forest encroachment on grasslands; c) loss of forage particularly for ungulates; d) exacerbates fir bark beetle; e) loss of habitat for large number of listed species. Overall: have a highly stressed system which has been pushed to another category of disturbance types – i.e., fuel loading and high forest health problems result in high potential for catastrophic stand-replacing fires
Stand level impacts: - simplification of forest structure - silviculture	➢ Majority of the changes in natural disturbance patterns are exhibited at a stand level: extensive loss of large stand structure, without planning for replacement (i.e. not systematically managing for long rotation stand structure throughout the zone). Although deer winter range guidelines reduce this problem in some areas, it is still extensive throughout this zone. Historic and current logging results in loss of large trees throughout. ➢ Primary issue exacerbated by WCB guidelines –extensive impact especially in areas where selective silviculture systems are being used – results in total loss of dead and dying. ➢ Lack of coarse woody debris management: ability to utilize small sized wood pieces in many areas resulting in thorough

	removal of coarse woody debris impacting a) habitat for many species and b) concern over long-term productivity losses on these sites. ➢ Fire suppression results in significant changes in understory characteristics: shrub/ herb to moss dominated. Has local habitat impacts, and also potentially results in lower growth rates for timber.
Forest Health management	➢ Extensive fir bark beetle and spruce budworm are exacerbating the loss of remaining large-sized Fd due to increased stress.
Invasive species Linked to access	➢ Relatively low concern for invasive plants, but important changes in species composition and frequency are occurring - though not necessarily due to invasive plant species. Spreading of non-native species on roads and due to grazing throughout the zone is a serious problem. ➢ dk3 – tragopogon ➢ dk4 – tragopogon ➢ xm – Hounds-tongue ➢ xw – knapweed
Access	➢ Extensive road network in this relatively accessible area. ➢ Particular concern regarding increased hunting and poaching throughout the entire zone (few areas are inaccessible). This is particularly important due to high value ungulate areas.
Non-forest impacts - range	➢ Extensive cattle grazing/ trampling causing wetland, streamside riparian and grasslands damage.

Cariboo Region - Montane Spruce Zone MS

This zone was not considered high priority but has been elevated due to the high pine content. Holt 2001 notes that MS is similar to SBPS in terms of impacts and ecology, with more significant areas of Pl stands due to less frequent natural disturbances. Not a restoration priority in Holt 2001 since harvesting history is relatively recent.

Context for zone

Size of zone ha	Number of red and Blue listed Species	Listed Communities	Percent protected	
			Provincially	Regionally
1,646,743	40	26	4	5

Priority Ecological Issues*	**Ecosystem Components Affected**

Landscape level: - planning	➢ Relatively recent harvesting history – so landscape pattern issues currently small ➢ Concern that current policy is inadequate to prevent this landscape from becoming fragmented with little old-growth and little stand structure. ➢ Generally, thought to be heading towards the patterns and problems in the SBPS
Stand level impacts: simplification of forest structure	➢ Loss of large sized structures in areas where harvesting has occurred ➢ Clearcutting with short rotations is causing negative impacts on lichen populations – future impacts on caribou populations, especially as development increases in future
Access	➢ Currently relatively minor roading, however, it is starting to increase and there is concern that this will be a future problem. Increase in poaching and increase in invasive species from roads.

Generic Concern all Zones

Access: throughout all zones, increasing road density was considered a major agent of degradation. Highlighted in areas where road-sensitive or hunted species were present. However, the general impacts of roads on habitat quality and use by many species was a concern throughout. Access management in the dry / flat zones is a particular issue since roads are not necessary to allow mechanized access.

Bunchgrass zone

Noted as a high priority restoration zone Holt 2001a with forest encroachment issues related to fire suppression. Restoration in the Bunchgrass zone is a high priority, and ecological issues relate to managing the ecological effects of ranching, agriculture, access and non-native plant species, as well as fire suppression.

Interior Cedar Hemlock zone

Noted as a high priority restoration zone Holt 2001a for issues unrelated to MPB or fire. However one issue mentioned is species conversion from Cw/Hw to Pl/Fd, raising potential for MPB impacts. MPB may be in issue in the drier variants. Local knowledge is needed.

Engelmann Spruce-Subalpine Fir zone

Not a priority in Holt 2001a, since harvesting history is relatively recent. Restoration priorities linked to fire suppression and in-growth and concern for stand conversion through planting of lodgepole pine.

Omineca and Skeena Regions Restoration Assessment

MPB outbreaks are most extensive in the Sub Boreal Spruce (SBS) and Montane Spruce (MS) zones. Lodgepole pine also occurs in large portions of the Interior Douglas Fir (IDF) zone.

The terms Omineca and Skeena Regions have been applied to the 2001 Prince Rupert and Prince George MOF Regions described in Holt 2001d and 2001e. These older Forest Regions reasonably reflect today's MOE regions.

Sub Boreal Pine Spruce and Sub-boreal Spruce (SBPS and SBS)

The Sub Boreal Spruce Zone has the highest lodgepole pine components in the Skeena and Omineca MOE Regions, a long harvest history, and occurs in a landscape highly accessible for harvesting. In areas affected by MPB, only the SBSdh in the Omineca and the Sub Boreal Spruce dk in Skeena were ranked as high for restoration Holt 2001d and 2001e - these variants were treated separately as they represent the urban-rural interface with the longest growing season, highest biodiversity and highest restoration needs separate and additional to impacts from forestry. Other restoration priorities separate from MPB were identified for the Queen Charlotte Islands, Coastal Western Hemlock zone, Interior Cedar Hemlock zone, Boreal White and Black Spruce zone, and the dh variant of the Sub Boreal Spruce zone. See Holt 2001 for more details. Invasion by marsh plume thistle in the Interior Cedar Hemlock, Engelmann Spruce-Subalpine Fir, and Sub Boreal Spruce zones was mentioned as an urgent ecological restoration issue.

The Sub Boreal Pine Spruce (SBPS) zone has a relatively short development history in the Skeena/Omineca, and covers a relatively small area in the southern part of the regions. A large portion of this zone is in a protected area. Therefore it was not a high restoration priority in Holt 2001. However it is contiguous with the SBPS in the Cariboo Region, and Entiako Park is affected by MPB, and affected by MPB salvage outside its borders. Local knowledge is needed to determine if there are restoration priorities in this zone in the Skeena/Omineca regions. Salvage harvesting in this zone should follow ecological best management practices for major salvage

Omineca Sub Boreal Spruce and Sub Boreal Pine Spruce

Size of zone ha		Number of red and Blue listed Species	Listed Communities	Percent protected	
				Provincially	Regionally
SBPS	73,397	5	11	0	39
SBS	5,859,821	13	33	15	4

Skeena Sub Boreal Spruce and Sub Boreal Pine Spruce

Size of zone	Number of red and	Listed	Percent protected

				Percent protected	
				Provincially	Regionally
SBPS	55,067	12			100
SBS Except dk	2,467,219	28	5		8

Omineca Sub Boreal Spruce and Sub Boreal Pine Spruce

Priority Ecological Issues	**Ecosystem Components Affected**
Landscape level:	➢ Reduction of old forest through harvest. Exacerbated as a result of approach to managing beetle outbreaks -. Approximately 30% old forest expected under natural age class distribution and current policy will result in a reduction to approximately 8% of the landbase. ➢ Salvage harvest concentration. All stand structure removed if sanitation cut. Salvage can leave standing dead. No AAC up-lift yet – but concern that there will be an uplift – which will decrease the quality of stand management, and increase the rate of harvest. ➢ No young natural forests because of fire suppression in combination with intensive forestry reforestation. Naturally young seral would have consisted about 20% of the landscape?? Any burns that occur are salvage logged – so structure is lost anyway. ➢ Land alienation due to agriculture, 5 to 19 percent estimated agriculture clearing. Williston Reservoir major loss of lower elevation wetlands.
Stand level impacts:	➢ Insufficient retention of larger structures after harvesting - - concern for species reliant on cavity nests, and coarse woody debris (e.g., black-backed woodpeckers and furbearers) ➢ Normal harvesting practice involves 'pile and burn' – no broadcast burning even in clearcuts –so the natural disturbance processes are not mimicked. ➢ Aspen near populations at unnaturally high levels due to clearings
Direct habitat loss	➢ Dam building has resulted in extensive loss of lower elevation areas – including previously high biodiverse wetland areas ➢ Agriculture/ private land has also resulted in clearing and habitat alienation **SBSdh** ➢ Very high impact in this zone – is 80% developed/ agriculture/ cleared – especially loss of wetland areas which are under private land management and are often drained or highly impacted by cattle.
Riparian impacts	➢ Livestock particularly impact the finer texture riparian areas through trampling and changes in understory through grazing **SBSdh** ➢ Very high impact on riparian ecosystems – private land management – logging and cattle ranching – (almost) unregulated impact on

Priority Ecological Issues	Ecosystem Components Affected
	riparian systems.
Access	➢ Extensive roading: impacts numerous species, particularly grizzly bear populations which are impacted by general access leading to increased hunting/ poaching plus increased human bear conflicts (which increase bear mortality rates). ➢ Roading (and general access) has a high impact on wolf populations – due to targeted hunting and general wolf kill.
Range	➢ Loss of grassland community (e.g., around Francois lake - though perhaps more relevant to this ecosystem in the Prince Rupert Region) being encroached by aspen, especially on south facing slopes – concern that native plant communities are at risk from a combination of grazing and fire suppression.
Invasive species	➢ Numerous invasive species – in particular: Canada thistle, spotted knapweed, Dalmation toad flax - increasing in number and distribution.

Skeena Sub-Boreal Pine-Spruce

Priority Ecological Issues	Ecosystem components impacted:
Landscape	➢ Loss of valley bottom habitat due to flooding. ➢ Extensive harvest in landscape surrounding the park – following beetle outbreaks, so unregulated, and uplift in AAC responding to beetle outbreak. Extensive and rapid roading associated with this approach to harvesting. ➢ Extensive access and habitat changes due to harvesting is increasing moose and wolf populations outside the Park, resulting in negative impacts on caribou populations.

Skeena Sub-Boreal Spruce (except dk)

Priority Ecological Issues	Ecosystem components impacted:
Landscape Level	➢ Fire suppression: Forest health impacts due to extensive fire suppression. Response is to salvage wood impacted by mountain pine and spruce bark beetle. Uplift in harvest to allow this resulting in rate of cut too high. Particularly impact on spruce forests in riparian areas, (which historically would have burned less frequently). There are no remaining 'natural' young or old seral forests in this landscape – highly managed, with unknown impacts on biodiversity in long term. However, a) loss of old growth large spruce, b) loss of old lodgepole pine forests (management is not at right scale to identify these rare ecosystems), c) significant changes in understory composition, with unknown impacts on stand level biodiversity values. ➢ Largely zoned as intensive forestry areas: concern the biodiversity provisions (core reserves and corridors) will need restoration since they

Priority Ecological Issues	Ecosystem components impacted:
	have already been impacted by previous harvesting ➢ Mountain pine beetle present in all pine stands – concern that approach to management will further exacerbate beetle activity in future. ➢ SBSmc: low % in protected area. ➢ No natural young forests: loss of early seral natural succession benchmarks. ➢ Ineffective coarse filter so reliance on fine filter approaches to biodiversity management. However, current policy considered ineffective. E.g., Morice district will do minimum LU (no LRMP).
Stand Level	➢ Short rotation, even-aged forestry removing within-stand heterogeneity, likely will impact species requiring large-sized structures (e.g., cavity associated species) ➢ Reduction in deciduous component of landscape: will impact beaver populations and may significantly change the nature of the landscape (with knock-on effects to passerines and small mammals).
Access	➢ Extensive roading for harvest: impacts wildlife use.

Engelmann Spruce Subalpine Fir zone was not considered a priority zone. While there is lodgepole pine in this zone, when compared to other zones it does not warrant restoration consideration.

Generic Comments for all zones in the Skeena Region:

- lack of planning resulting in continued degradation of ecosystems
- access throughout ecosystems results in numerous cumulative impacts – will continue to increase, and is not managed by any agencies in a comprehensive manner
- implementation of biodiversity policy based on timber impacts, not original intent – therefore failing to protect the values originally identified as important
- policy implementation results in 'suggestion' that there is a large area of old growth remaining – however, it is ignoring biological realities that low elevation old growth is rapidly disappearing
- lack of inventory is particularly a problem in the north and in the complex coastal forests – difficult to obtain money for biological inventory here
- rate of harvest – throughout the zone – aims to sustain timber, not ecological values. Is set 'top down' due to rules of maintaining flow etc, not based on biology of the system. This is exacerbated in areas with beetle salvage – and will continue into future as second growth stands are also susceptible to beetles.

Southern Interior Restoration Assessment (Thompson, Okanagan and Kootenay Regions)

Three MOE regions will be combined into a single reporting area for regional restoration planning. This initial information on degradation and priorities is based on the "Strategic Ecological Restoration Assessment" from Holt (2001b&c), which used MOF 2001 regional boundaries - hence the term Nelson and Kamloops appear when defining BEC zones.

The priority zones identified for restoration in Holt 2001b&c were those most affected by fire exclusion combined with harvesting practices leading to:

- extensive in-growth of historically open forest stands, resulting in low biodiversity and economic value;
- loss of open forest stand attributes (large snags and live trees);
- changes in plant communities; and,
- increase in forest health issues.

The zones that were most in need of restoration were those affected by a combination of cattle ranching, fire exclusion, settlement and increases in road density and recreation resulting in:

- rapid increase in the abundance and geographic extent of non-native plant species
- heavy pressure on any remaining native grassland plant communities;
- cumulative impacts of high urban and agricultural development increasing direct habitat loss.

In 2001, the MPB epidemic had not yet fully developed and the catastrophic fires for 2002 and 2003 had not occurred - though the high fuel accumulations and the high probability for severe burns existed. The need to restore large areas in Natural Disturbance Type 4 (frequent low severity fire) was present. Zones where frequent low severity fire was the dominant disturbance type are the Ponderosa Pine, Interior Douglas Fir, and southerly aspects in the Montane Spruce and Interior Cedar Hemlock zones. Not all zones ranked in 2001 are listed, as only the BEC zones prone to disturbance from MPB and fire are brought forward in this report.

Kamloops portion of the Interior Cedar Hemlock (ICH)

Size of zone ha	Number of red and Blue listed Species	Listed Communities	Percent protected	
			Provincially	Regionally
1,115,618	59	/	9	15

Nelson portion of the Interior Cedar Hemlock (ICH)

Size of zone ha	Number of red and Blue listed Species	Listed Communities	Percent protected	
			Provincially	Regionally

ICH 2,057,411	75	/	9	7
ICH dry 376,484	/	/	/	5

Dry Interior Cedar Hemlock (ICH) Nelson and Kamloops combined

Priority Ecological Issues	**Ecosystem components impacted:**
Landscape level - insufficient consideration of natural disturbance patterns - Fire suppression - rate of harvest and landscape pattern - extensive and continued logging of remaining old growth	➢ Fires and residual structure legacy are not matched by logging ➢ Large fires provided bear habitat (huckleberries.). Absent in clearcuts due to stand tending. ➢ Dry ICH sites exhibit wide range of natural disturbances types (1-4) on a local scale almost complete removal of NDT 1 and 2 ➢ Fire suppression particularly on south facing drier sites has caused a) ingrowth, exacerbating forest health issues (e.g., Armillaria and Douglas-fir bark beetle)., and has reduced high value ungulate winter range in localized areas ➢ Extensive changes in species abundance (from white pine and ponderosa pine to Douglas fir). ➢ Loss of early seral stages due to brushing/herbicide. . ➢ Loss of CWD and snags in plantations. In the 1980s/1990s site prep practices were too "clean" and removed excessive CWD. ➢ Fundamental change in landscape pattern 'slicing' landscape into increasingly small blocks. Lack of reference data on fire patterns (though known to be fire maintained patterns of 10-15yr FRI in some areas ➢ hydrological impacts – suggested large changes in hydrology flow due to changes in landscape pattern ➢ Rate of forest turnover – based on BGB an approximation to natural would be <0.5% turnover per year. However, harvesting results in 0.75-1%/ year turnover in the timber harvesting landbase. ➢ Loss of old growth stands and old growth stand structure in majority of landscape.

Priority Ecological Issues	Ecosystem components impacted:
Landscape (continued)	➢ Losing Cw, Fd, and Hw (all in different areas) in favour of timber (Pl and Sx are preferentially planted). ➢ Concern over establishing enough Cw Hw on sites of concern. ➢ planting Pl in wet areas ➢ Concern that brush mgmt is changing the conifer / deciduous balance and that loss of deciduous will impact root disease. ➢ A rotation of trembling aspen may be beneficial in "cleaning up" root rot.
Stand Level - loss of snags and CWD - management approaches - management of forest health issues - intensive silviculture	➢ Loss of CWD and snags in plantations. In the 1980s/1990s site prep practices were too "clean" and removed excessive CWD. ➢ Systematic removal of large sized stand structure throughout landscape historic logging exacerbated by current policy – impacting standing live and dead structures, plus coarse woody debris ➢ salvage logging considered a large negative impact on standing structures, ➢ firewood cutting along roadways ➢ Heavily exacerbated by WCB regulations. Concern over systematic decrease in large snags and CWD available into the future given current low retention levels. ➢ Inappropriate management approaches: removal of large veteran tree species, historically maintained by fire (large Fd; Lw; Py) resulting in no large structures retained through time ➢ Mistletoe eradication is removing important habitat – nesting and food supply; ➢ free to grow standards are eliminating brush stage ➢ Loss of bear forage is a landscape level problem caused by lack of stand level gappiness and is related to changes in NDT from moderate to large disturbances.
Stand level (continued)	➢ The mid-seral stage is truncated b/c it is harvested in short rotation forestry ➢ Systematic loss of CWD resulting in changes in long term nutrient cycling, soil structure and ground habitat. Unknown extent, but likely large in riparian habitats within drier ecosystems

Priority Ecological Issues	Ecosystem components impacted:
Access	➢ Extensive road infrastructure numerous negative impacts: (a) loss of productivity due to permanent road network (b) increased potential for landslides across landscape and general hydrology changes (c) vectors for non-native species. (d) human access and poaching and other disturbance (e.g., grizzly bear impacts in previously remote valleys) ;

Interior Douglas Fir (IDF)

Kamloops IDF

Size of zone ha	Number of red and Blue listed Species	Listed Communities	Percent protected	
			Provincially	Regionally
2,005,512	162	12	4	3

Nelson IDF

Size of zone ha	Number of red and Blue listed Species	Listed Communities	Percent protected	
			Provincially	Regionally
484,945	130	/	4	1

Kamloops and Nelson - Interior Douglas Fir

Priority Ecological Issues	Ecosystem components impacted:
Landscape Level - fire suppression / lack of disturbance - fragmented thinking – inadequate planning processes - dams - Ecosystem classification problems	➢ Loss of fire disturbance – extensive ingrowth throughout the zone. . . ➢ Silviculture is not replicating fire as the primary natural disturbance and the origin of Fd stands. Fire would have removed Pl and left Fd vets.
Stand Level - stand simplification - harvest systems - AAC - soils	➢ There is resistance to apply the AAC to small wood (rather than stands with large trees) in the Trench.

Montane Spruce (MS) Nelson and Kamloops

Kamloops MS

Size of zone ha	Number of red and Blue listed Species	Listed Communities	Percent protected	
			Provincially	Regionally
1,024,400	50	3	7	3

Nelson MS

Size of zone ha	Number of red and Blue listed Species	Listed Communities	Percent protected	
			Provincially	Regionally
584,201	63	/	7	9

Nelson and Kamloops Montane Spruce

Priority Ecological Issues	**Ecosystem components impacted:**
Landscape Level 1) fragmentation and patch size (most of this is general) 2) loss of shoulder seasonal habitat 3) loss of old seral stages 4) harvest pattern is opposite of natural disturbance regimes 5) species conversion 6) lack of protected old	➢ Fragmentation of forest landscape patterns differs from historic patterns. For example, average fire size in Arrow has gone from 50ha to <1ha. ➢ Ungulates go from summer to winter range, but skip shoulder ranges due to ingrowth in NDT4/mixed severity fire ecosystems. ➢ There are watershed-level problems from heavy logging in the MS, particularly in Merritt. ➢ If large-scale harvest is to replace large fires, we need to improve planning and increase structural retention. ➢ Harvesting in Sx stands remove the best interior forest habitat. These stands are relatively rare.

Priority Ecological Issues	Ecosystem components impacted:
Stand Level 1) ingrowth 2) fire suppression / 3) loss of old structure	➢ In NDT4 stand types, fire starts at low elevation and moves up. Mixed fire regimes, with low FRI and low intensity fires as well as stand replacing fires were experienced in the MS. ➢ loss of stand level structures ➢ Stands have been homogenized due to logging and planting. Spacing patterns (pre-commercial thinning) could increase horizontal heterogeneity as a means of increasing stand structure. ➢ Succession is truncated at both ends: there is no brush stage (due to Free to Grow) and no old forest (due to short rotations). ➢ The development of old structures in mature stands could be accelerated through retention patterns in current harvesting

Ponderosa Pine and Interior Douglas Fir– very dry

Kamloops PP

Size of zone ha	Number of red and Blue listed Species	Listed Communities	Percent protected	
			Provincially	Regionally
236,467	83	8	2.4	3

Nelson - Ponderosa Pine (PP)

Size of zone ha	Number of red and Blue listed Species	Listed Communities	Percent protected	
			Provincially	Regionally
84,205	64	/	2.4	0

Nelson and Kamloops PP and very dry IDF

Priority Ecological Issues	Ecosystem components impacted:
Landscape level	➢ a) The PP zone has been reduced in size due to mgmt. The defining characteristics (plant communities) of the zone are not found at the same extent now as historically. There is a reduction in Ponderosa pine in the PP zone. Now, there is more Fd than Ponderosa pine in areas.
Stand Level - loss of stand	➢ High density stands are leading to much reduced regeneration of shade intolerant species.

Priority Ecological Issues	Ecosystem components impacted:
structure - forest health - species changes	➢ These ecosystems display slow responses to past disturbances. Logging was heavy and extensive until the 1960s. This has set up a very different stand structure environment than would be expected. Stands are no longer self-maintaining. Livestock has also compounded the problem. ➢ Dense stands and past harvesting have increased forest health issues, but forest health is a timber problem, not an ecological problem. Insects, like bark beetles, lead to species conversion and stand structural complexity. ➢ Bats and other species are impacted by loss of stand structure, especially the loss of large diameter trees and snags with no recruitment. ➢ Ponderosa pine is suppressed in wetter areas by management for Fd.
Riparian	➢ Issues are similar to the BG. ➢ Mesic, hygric and riparian areas are a low % of the area, but have high value for wildlife. These sites are being harvested. ➢ Livestock cause problems due to trampling, pollution and grazing. ➢ Communities in wet areas are single age class with no regeneration. There are deciduous regeneration problems. ➢ Species with elevational migration patterns use these zones. They need the structure and patterns found in features such as wet areas. E.g., Clarks nutcracker, woodpeckers, passerine birds, ungulates, etc.
Access - roads - recreation	➢ Roads are abundant at these low elevations. Roads spread invasive species and facilitate impacts from firewood cutting (loss of snags) ➢ Off-roading is large problem because the zones are highly accessible. This causes trampling of native species.

Other restoration priorities

The Bunchgrass and Interior Cedar Hemlock zones (wetter variants) also have high restoration priorities unrelated to Mountain Pine Beetle and wildfire. See Holt 2001b&c for more details.

Appendix 4 - Contact list

The following Ministry of Environment Staff were contacted by e-mail, phone or in person, to solicit their priorities for restoration in areas affected by MPB and fire.

Northern MOE Regions

Name	title	phone	e-mail
Chris Ritchie	Ecosystems Section Head Omineca	614-9910	Chris.Ritchie@gov.bc.ca
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Andy Macdonald	Skeena Protected Areas	847 7658	Andy.M.Macdonald@gov.bc.ca
Karen Diemert	Ecosystems Specialist Skeena	847-7800	Karen.Diemert@gov.bc.ca

Cariboo MOE Region

Name	title	phone	e-mail
John Youds	Ecosystems Section Head	398-4563	John.Youds@gov.bc.ca
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Charlotte Kurta	Ecosystem Officer Quesnel	992-4480	Charlotte.Kurta@gov.bc.ca
Glen Davidson	SH P&PA	398 4888	Glen.8.Davidson@gov.bc.ca
Chris Schmidt	Ecosystem Biologist	394-4745	Chris.Schmid@gov.bc.ca

Southern MOE Regions

Name	title	phone	e-mail
Kootenay			
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Pinnell			
Thompson			
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Martin Carver	Watershed Hydrologist	387-1923	Martin.Carver@gov.bc.ca