Addressing Forest Encroachment And Understory In-Growth In NDT 4 Ecosystems in the Southern Interior Forest Region

Short-term Priorities, Information Gaps and Management Recommendations

Prepared for
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Executive Summary

This report describes the current state and context for management of dry forest and grassland ecosystems in British Columbia's Southern Interior Forest Region. These ecosystems are collectively referred to as 'Natural Disturbance Type 4', based on the expected disturbance regime of relatively frequent low-intensity fire. Management of NDT 4 issues has historically been done on a regional basis. This report identifies current initiatives, gaps and barriers, and suggests ways to move forward to plan and implement NDT 4 restoration across the new larger Southern Interior Forest Region. The new Southern Interior Forest Region of the Ministry of Forests and Range incorporates all of the NDT 4 ecosystems in the province.

Restoration of NDT 4 ecosystems has been identified as a high priority due to the combined effects of fire suppression, urbanization, and agriculture. Open forests and grasslands have dwindled in extent over the past century, affecting forage resources and the species that rely on open habitats. A large number of the province's 'listed' species come from these habitats. While encroachment may rank second to land alienation as an issue on grasslands, it is a major issue to be addressed on Crown grasslands. The dense condition of many Crown forests is also of concern – many closed forests in the NDT 4 pose a risk for high intensity wildfire that can affect timber and biodiversity values as well as communities and infrastructure. The need to address the condition of these forests may be heightened by climatic changes that increase the likelihood of wildfires and ecosystem stress.

Existing information, literature and plans were gathered from government and other sources in December and January 2006. Two workshops were held in January 2006 – one in Williams Lake and one in Kamloops – to solicit existing information and to attempt to determine gaps and barriers and next steps to manage these ecosystems. The resulting description of existing projects and the existing management approach and context for NDT 4 ecosystems is given in this report for the various Ministry of Environment regions of the province. The East Kootenay area of the province is treated somewhat differently, as this area is already actively addressing NDT 4 ecosystems. While not a direct focus of this report, restoration approaches in the East Kootenays were noted, particularly those that could be transferred to other regions.

Restoration techniques to remove encroaching trees and reduce forest densities are described. Preliminary locations for restoration treatments and adaptive management trials are also given, with the strong caveat that these may not be highest priority in the absence of a strategic prioritization framework.

A key finding of this project is the need, and willingness, to re-establish regional committees to deal with strategic planning and prioritization for NDT 4 ecosystems, in both the Cariboo and the Thompson and Okanagan regions. Developing a province-wide NDT 4 committee is another key recommendation, and one that agency staff appear to support. In order for NDT 4 ecosystems to be addressed at an appropriate scale and in the appropriate manner, management direction is required in the form of a strategic prioritization framework, something best devised by these inter-agency regional committees. Based on this framework, the landscape needs to be zoned in order to designate areas to be maintained in or converted to grasslands or open forest conditions. Dedicated funding will be required in order to address NDT 4 ecosystems at the scale required. Forest policy changes to better manage NDT 4 ecosystems through operational forestry practices will also greatly aid in addressing the condition of NDT 4 ecosystems.

1. Introduction

Most land managers agree that it is important to address the condition of dry forests and grasslands to manage for biodiversity and range values, and to mitigate the risk of catastrophic wildfire. This report describes the current state and context for management of dry forest and grassland ecosystems in British Columbia's Southern Interior Forest Region. It highlights information gaps and recommends management actions to develop a more cohesive and focused approach. The report authors did not (and could not) strategically identify areas of formerly open forest and grassland that require restoration or management. Rather, an information/literature review was conducted, with a subsequent consultation with provincial government staff to identify how to move forward in addressing the issues of forest "in-fill" and encroachment.

The results of this project were also used to provide guidance to silviculture and management decisions to recover high priority grasslands and open forests. This guidance is found in a separate short report, entitled "Silviculture and Restoration in NDT 4 Ecosystems: Recommendations to Promote Ecological Integrity" (Jones and Douglas 2006).

2. Project Background and Rationale

Management of NDT 4 issues has historically been done on a regional basis – that is, the former (smaller) Ministry of Forests regions that since 2003 are contained within the Southern Interior Forest Region (see Figure 1). These former regions and the Ministry of Environment Regions associated with them have taken different approaches and are at different stages in the implementation of NDT 4 restoration – with some in the planning stage (with ad hoc or individual projects), and others actively thinning and burning. There is a need to record and transfer knowledge gained, and to move forward to plan and implement NDT 4 restoration across the new Southern Interior Forest Region. The new Southern Interior Forest Region of the Ministry of Forests and Range incorporates all of the NDT 4 ecosystems in the province (see Figure 2).

Over the past century, dry forests in parts of British Columbia have expanded onto formerly open grasslands, and many open forests at the grassland edge have become dense, closed forests. While varying climatic conditions have always affected the location of the grassland-forest interface, the expansion and "in-growth" of forests that has happened this past century is hypothesized to be due to lack of fire disturbance, as a result to fire suppression, domestic grazing and the cessation of aboriginal-induced fires (GCC 2003, Parminter and Daigle 1997, Braumandl 1995). Many studies have shown that even over a relatively short time period of 30-50 years, dramatic episodes of encroachment have occurred and led to the disappearance of thousands of hectares of native grassland (GCC 2003). While the loss of open forests is less easy to document, it is probably at least as dramatic. These changes are of concern because of the resulting impacts on biodiversity, rangeland, wildfire risk, and timber values.

Dry forest and grassland habitats in BC are collectively referred to as "Natural Disturbance Type 4" (NDT 4), based on classification done in the Biodiversity Guidebook (BC of Forests and BC Ministry of Environment, Lands and Parks 1995). The extent of the NDT 4 is shown in Figure 2, and includes the Bunchgrass, Interior Douglas Fir and Ponderosa Pine zones in the BEC (Biogeoclimatic Ecosystem Classification) system. The driest variant of the Interior Cedar Hemlock zone is also included. The total amount of NDT 4 in the province is about

4.5 million hectares (Eng, N.D. in Gayton 2001), or 5.6% of BC's landmass (Lloyd 2001), with the Crown land portion assumed to be roughly 60%, or 2.7 million hectares (Gayton 2001).

Figure 1: The Southern Interior Forest Region is highlighted in green, and contains the entire Natural Disturbance Type 4 zone

Image from the Ministry of Forests and Range, http://www.for.gov.bc.ca/mof/maps/regdis/nrsi.htm viewed December 2005

Restoration of NDT 4 ecosystems was identified as the highest priority (for those regions that contain NDT 4 ecosystems) in Strategic Regional Restoration Assessments done for the province in 2001 (Holt 2001). Rating highest was the Bunchgrass zone due to the combined effects of urbanization, ranching, agriculture, fire suppression (and resulting forest encroachment), and invasive species on this relatively rare ecosystem type. The Ponderosa Pine and Interior Douglas Fir zones ranked closely behind, due mainly to the changes to ecosystems and tree densities brought by fire suppression. According to Holt, the Interior Douglas Fir zone has the highest absolute number of 'listed' species and communities (i.e.,

species/communities considered endangered, threatened or of concern – see BC MSRM 2002) in the Province, and the Ponderosa Pine and Bunchgrass zone have a very high number of listed species per unit area. This is presumably due to dwindling and degraded habitat supply, with open habitats being lost to closed forest or converted to human use.

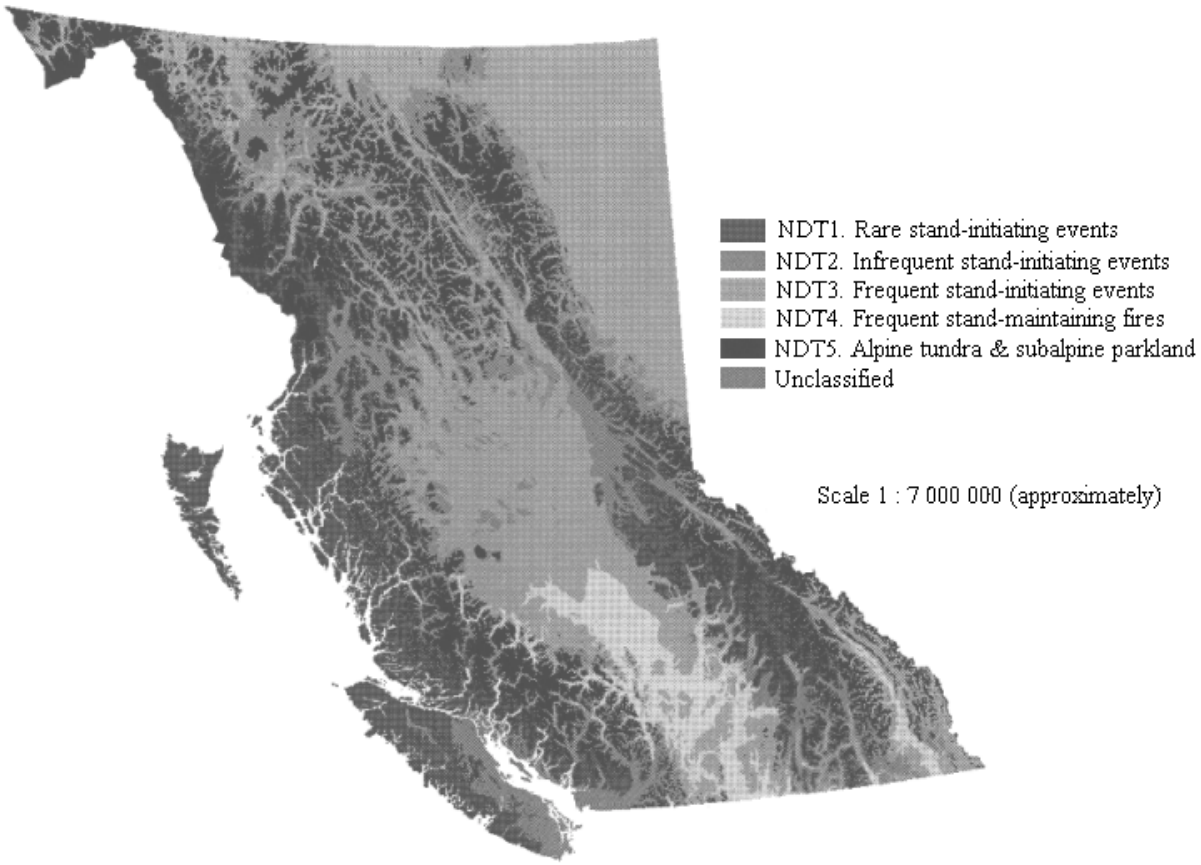

Figure 2: The Extent of NDT 4 and other NDTs in British Columbia
From BC Ministry of Forests and BC Ministry of Environment, Lands and Parks (1995)

Range for domestic livestock is also reduced as a result of forest encroachment and in-fill, affecting the livelihood of ranchers and concentrating domestic and wild ungulate grazing on ever-decreasing areas of land. These remaining open habitats are then prone to degradation from overuse.

The closed, dense condition of many forests in the NDT 4 also affects timber quality, and potentially forest health. Because of the lack of fire disturbance, many of the dry forests contain very high densities of small trees. Because the forests are moisture limited, the large numbers of small trees compete for soil water with large trees, reducing the vigour of the large trees. This has been documented as a causal factor in bark beetle attacks in dry forests elsewhere (Larsson *et al.* 1983, Dolph *et al.* 1995 as cited in Day *et al.* 2003), and is suspected of contributing to outbreaks of Douglas-fir bark beetle in the Cariboo region of the province (Day *et al*. 2003).

After the major fire seasons of 2002 and 2003, the fire risk posed by dry, dense forests is of concern to British Columbians and forest managers alike (see Filmon 2004). Risks to infrastructure and communities are described as “interface” issues and are a major focus of

cities/municipalities and Ministry of Forests and Range staff. Interface issues are not directly addressed in this report, though coordination should occur where other values can be addressed at the same time that fuels around communities are reduced.

Climate change is another factor to consider in NDT 4 management. Warmer conditions are becoming more prevalent – during the 20th Century, BC's central and southern interior regions warmed by 1.1°C, or twice the global average (BC MWLAP 2002). Assuming this warming trend continues, dry ecosystems will likely expand, and will likely experience more fires related to longer periods of dry, warm weather. According to Gedalof (2004) climate change could dramatically alter the natural fire regime for many western forests. Even for a very conservative climate change scenario, it seems likely that area burned by wildfire will at least roughly double by the end of this century in most western states.

With climate change, species will likely migrate northward, and the connectivity and health of dry ecosystems becomes an important consideration.

3. Project Methods

Existing information, literature and plans were gathered from government and other sources in December 2005 and January 2006. The focus of this project was on NDT 4 ecosystems outside of the relatively small area covered by the Rocky Mountain Trench (East Kootenays), though information was gathered from the Trench to inform the project. (See Section 7.2 for a description of activities in the Trench – this area of the province is already actively managing NDT 4 ecosystems and was therefore not seen as a focus of this project.)

Digital mapping information was also gathered, and used to produce several maps defining the NDT 4 area of the province, and features and classifications within it (see Appendix 6). These maps were used in two workshops in January 2006: January 17th in Williams Lake, and January 19th in Kamloops. Agency staff from the Ministry of Environment, Ministry of Forests and Range, and Ministry of Agriculture and Lands, as well as staff from the Grasslands Conservation Council were invited to attend (see Appendix 1 for a list of attendees).

The purpose of the workshops was to engage with staff members currently or formerly active in managing or researching NDT 4 ecosystems in BC. A copy of the meeting agenda is found in Appendix 2. Attendees were asked to identify on the maps any projects they were aware of that had been implemented to manage NDT 4 ecosystems in their area. The intent was to provide a listing of sites and available reports, as currently these are not well tracked. Attendees were also asked, if possible, to identify where on the maps they were aware of encroachment or infill that they believed was a high priority for treatment. It was explained that this exercise was to identify obvious areas for treatment in the near term, and that more rigorous planning would be required to come up with a strategic regional plan. We asked both groups to identify challenges and recommendations for moving forward with NDT 4 management. Both groups were also asked to provide, as possible, specific information on restoration treatment goals and costs.

4. Workshop Outcomes

Please see Appendix 5 for information gathered regarding existing projects, and refer to maps in Appendix 6 for the locations. We acknowledge that these lists will be incomplete, but expect they will capture the majority of work done in recent years. These existing projects may provide insight into techniques to use, or may provide opportunities for monitoring. Appendix 5 also lists other sources for information on past projects.

We were unable to capture many high priority locations for treatment or adaptive management trials. At both workshops, participants stated that they required a priority-setting framework to make those kinds of decisions. However, Kamloops Forest District Range management staff provided a prioritized list of rangeland areas they are interested in treating for encroachment (Appendix 4) – with the caveat that the prioritization scheme was rough. The Williams Lake workshop attendees believe that the entire forested area of the Interior Douglas Fir zone in their region is affected by in-fill. In the Cariboo, many areas of encroachment are already mapped (see Section 7.3, and map 1 Cariboo-Resource Encroachment in appendix 6). At least some Kamloops workshop attendees (Dennis Lloyd personal communication) believe that encroachment is not an issue in the Bunchgrass zone, and that efforts should be focused on the Interior Douglas-fir/Ponderosa Pine zones.

Ideas for moving forward with NDT 4 management were discussed at both workshops, and are reflected in Section 14 of this report. Barriers were also identified and are incorporated into Section 13 of this report. Little data was provided (or available) regarding restoration treatment goals and costs, but the data that was collected is incorporated into section 11 of this report.

Both workshops appeared to spark a renewed willingness to address NDT 4 issues. Little attention had been paid to the issue since the 2002 government restructuring and cutbacks, and workshop attendees were now ready to move forward.

5. Natural Disturbance Regime and Restoration Goals

Any discussion of restoration will refer back to the question: “what is natural”? In NDT 4 ecosystems, “natural” is taken to mean the range of conditions that would result from low intensity surface fire occurring every four to fifty years, as assumed in the Biodiversity Guidebook (BC Ministry of Forests and BC Ministry of Environment, Lands and Parks 1995). This NDT 4 model of fire regime and human impacts on fire is largely based on well-documented changes to dry Ponderosa pine forests in the United States (Covington and Moore 1994 [Arizona], Everett *et al.* 1999 [Washington], Habeck 1990 [Montana], Moore *et al.* 1999, Swetnam *et al.* 1999), which have been extrapolated to other areas. Empirical data for British Columbia is just recently becoming published – with Blackwell *et al.* (submitted) and Wong and Iverson 2004 (as described by Daniels 2004) being recent studies.

Additional unpublished literature (both peer-reviewed and non peer-reviewed) from Gray and others indicate that the mean return interval for low intensity fire in the NDT 4 ecosystems ranges from 4 to approximately 20 years (Gray and Riccius 1999; Riccius 1998; Gray 2000; Blackwell *et al*. 2001; Gray *et al*. 2002a – as cited in Gray *et al.* 2002b). Similar and higher ranges of mean fire intervals are given for other sites and studies in the Interior Douglas Fir and Ponderosa Pine Zones in a literature review by Wong and others (2003). Feller (2004) states that for the IDFdk (the dry cool subzone, which forms the bulk of the western part of the IDF zone), the average fire interval is 20 years. According to Feller, the fire regime in this zone is mixed, meaning it is of variable frequency, severity, and extent. A study from

Arsenault and Klenner (2004) proposes that NDT 4 ecosystems in general are shaped by a mixed severity fire regime (a mosaic of low, moderate, and high severity fires). Daniels (2004) studied the historic fire regime on the Fraser Plateau in the Cariboo Region. She found that the fire regime included mainly low-severity, stand-maintaining fires, but also included some less frequent, stand replacing fires. She also found strong evidence for changes as a result of fire suppression since 1940: the current fire free period was longer than the mean fire interval for all study sites, and was longer than the maximum fire interval for most (6 of 9) sites.

Lastly, Blackwell *et al.* (2003) have proposed a new way of classifying natural disturbance in these ecosystems. Their fire science research team developed models describing the Historic Natural Fire Regimes (HNFR) for the southern interior of B.C. plus the extent of fire regime departure from historic conditions. The HNFR model describes eight fire regimes in a ten million hectare area bounded by the U.S. border to the south, Coast Mountain Range to the west, Alberta border to the east, and the city of 100 Mile House to the north. Because this system takes into account the effects of topography and fire behaviour, as well as extent of fire regime departure from natural, it is described as a higher resolution refinement of the current NDT 4 classification (Gray and Blackwell 2005).

Based on existing evidence, many land managers and scientists hypothesize that the closed forests that have developed in the IDF and PP zones in the past century are outside the range of natural variability, and are at risk of stand replacement fire due to the buildup of fuels (Blackwell *et al*. 2003; Daniels 2004, Agee 1997 & 1998 [mentioned in Gedalof 2004], Covington et al. 1994, United States General Accounting Office 1999, Laverty and Williams 2000). This hypothesis is based both on mostly unpublished local data and the documentation of changes in ecosystem structure and composition from elsewhere in western North America (Morgan *et al*. 1994; Swanson *et al*. 1994; Swetnam *et al*. 1999, as cited in Gray *et al.* 2002b). There have been many examples of catastrophic wildfires occurring in Canada and the United States in areas that were assumed to be previously open, fire-maintained forests. The most recent examples were the high severity fires occurring in and near urban centres in Southern Interior British Columbia in 2002 and 2003. Gedalof and others (2004) point out that these fires have coincided with seasons of unusually severe “fire climate” – meaning drought followed by hot dry summers. Regardless of whether fuel reduction is seen as ‘ecosystem restoration’ or ‘mitigation’, there are social reasons to reduce fuels in these forests (Daniels 2004). There are similarly compelling reasons to address grasslands affected by encroachment, given the large losses of grassland area to urban uses and agriculture, and the need to manage the threatened and endangered species that rely on the remaining grassland habitats.

For any given area considered affected by encroachment or infill, the historical grassland or open forest extent (as provided by older aerial or oblique photos, or early maps), or residual forest structure is often used to help determine restoration goals. Historic conditions are assumed to be more natural, having been influenced less by fire suppression, which became effective starting in 1940 (Daniels 2004), or earlier depending on settlement patterns. Historic conditions can provide a baseline or benchmark towards which restoration efforts can be directed, though data is often incomplete or postdates the influence of European settlement, the banning or cessation of aboriginal burning, and early fire suppression efforts. However it needs to be recognized that no point in time is ecologically “correct”, since the grassland-forest interface has always shifted in response to climatic conditions and the influence of fire. Given the difficulty in deciding upon benchmarks that can be considered “natural”, some land

managers are more comfortable setting management objectives for values of concern, without reference to "restoration" (Arsenault and Klenner 2004).

Other natural disturbance agents aside from fire also influence forest and grassland structure and in the NDT 4 zone. In the Interior Douglas-fir zone, bark beetles, defoliators (e.g., western spruce budworm [*Choristoneura occidentalis*]), Douglas-fir tussock moth (*Orgyia pseudotsugata*), and root rot are important natural agents of disturbance (Wong *et al.* 2003). In the Ponderosa Pine zone, disturbance agents important in influencing stand structure include drought, mountain pine beetle (*Dendroctonus ponderosae)*, western spruce budworm, Douglas-fir beetle (*Dendroctonus pseudotsugae*), Douglas-fir tussock moth, Western pine beetle (*Dendroctonus brevicomis),* root rots (Armillaria, tomentosus [*Inonotus tomentosus*], and laminated root rot [*Phellinus weirii*]), dwarf mistletoe, stem rusts, Elytroderma needle cast (*Elytroderma deformans*), and pine needle blight (*Lophodermella* spp.) (Lundquist and Negron 2000, as cited by Wong *et al.* 2004). The current mountain pine beetle (MPB) outbreak may have major consequences for ponderosa pine forests. In 2005 almost 5,000 hectares of MPB-killed ponderosa pine was mapped in the Okanagan, Kamloops and Merritt Timber Supply Areas (Kevin Buxton, personal communication). It is expected that this number will increase as the mountain pine beetle populations expand on the plateaus in lodgepole pine forests, and eventually drop down into lower elevation ponderosa pine forests. The predictive model used by the Ministry of Forests and Range (Eng *et al.* 2005) predicts that the mountain pine beetle will peak in 2008 for the Kamloops Timber Supply Area, and within the next 15 years most of the lodgepole pine will be dead or salvage logged. Ponderosa pine forests will also be highly affected, though they likely won't be salvaged logged to the same extent.

For NDT 4 ecosystems, Gray (2002b) postulates that the historically lower densities of food sources (trees) would have meant smaller populations of insects and disease than currently. The density of present-day forests is suspected (Day *et al.* 2003) of contributing to outbreaks of Douglas-fir bark beetle in the Cariboo region. Similarly, in the Douglas-fir and ponderosa pine forests of western Montana, changes in stand structure and composition due to reduced fire frequency have increased the duration and intensity of western spruce budworm outbreaks (Anderson *et al.* 1987 in Parminter 1998). In British Columbia's Ponderosa Pine zone, insect defoliators appear to have been increasing since the 1950s (Klenner *et al.* 2001).

Forest harvesting is another major disturbance agent shaping the forests. For instance, most of the dry interior Douglas fir forests around Kamloops and the Okanagan have been selectively logged three or four times prior to 1970. However, the diameter limit logging of the 70's and 80's left a large number of stems behind that were 25 cm dbh and smaller. This has resulted in many areas being overstocked with smaller diameter stems. In the Cariboo Region alone, an estimated 250,000-3000,000 ha would benefit from density reduction treatment strictly from a silvicultural perspective (Ken Day, personal communication).

In ponderosa pine forests, harvesting peaked in the 1960's (Klenner *et al.* 2001). Historically, ponderosa pine was a source of wood for apple boxes, railway ties and small specialty mills. In the 80's some fir stands within the ponderosa pine zone were logged and ponderosa pine was left standing as there were few markets for the wood. Some raw log export did occur in the Okanagan in the late 80's, but even today there is little demand for ponderosa pine.

Forest harvesting creates openings, at least for windows in time, and its current and potential effects need to be taken into account in discussions of the extent of open and closed habitats.

Domestic livestock grazing can be a significant agent of disturbance on many grassland sites and forest openings. If sites are overgrazed, potential negative effects include increased

invasive plants, and changes in species composition to more disturbance-tolerant species. Additionally, grazing is hypothesized to affect the disturbance regime when livestock remove fuels that could carry a fire.

6. Definitions of Open Forest and Grassland

It is helpful to define what is meant by the terms open forest and grassland. We have crafted definitions for this report based on various sources – no one definition exists in British Columbia, particularly for open forests. A standard, agreed-upon definition would greatly assist restoration/ management planning. The definitions offered here are considered to be starting points.

6.1 Open Forest Definition

One definition of open forest is where at least 50% of primary productivity occurs in non-tree species. Based on conditions that will allow at 50% of the site's primary productivity to be produced in the understory, open forest can be defined as:

> 11-20% overstory crown closure, with overstory trees >30 cm diameter at breast height (dbh) arranged in a clumpy distribution and ranging in density from 76 – 150 stems per hectare. Less than 10-20% cover of understory trees, saplings and seedlings.

The maximum crown closure and stems per hectare (sph) numbers above are derived from a modeling exercise (Klenner 2004), and the understory % cover and minimum tree size is derived from the Kamloops NDT4 2001 committee, however some members questioned the % understory component. The minimum overstory crown closure is based on the maximum level of crown closure commonly used in the definition of grasslands (10% crown closure). More work is required to define the upper limit to crown closure for open forest, and this upper limit will depend on the values or conditions to be managed for. The minimum tree density required to constitute open forest was taken from the Kootenay Boundary Land Use Plan (KBLUP). The KBLUP definition of open forest ranges higher than the above definition, from 76 – 400 sph, with a target density of 150 sph and maximum crown closure of 40%. The tree density target of 150 sph is a reduction from the previous target of 250 sph, and a result of ungulate winter range guidelines brought into force in early 2005, as well as a 2003 report that evaluated the relationship between timber volume/forage production and crown closure/tree density (Trench Committee 2006). In the East Kootenays, treatments in both open range and open forest emphasize retention of a percentage of the largest trees on site.

More specific management objectives for open forest will flow from desired conditions of the grass, forb, shrub, sapling and overstory layers, in relation to desired habitat, timber or range values. Many foresters prefer to deal with measurements of basal area in addition to tree densities and diameter classes, as basal area describes the total volume of trees on the site. Crown closure will depend on tree volume as well as density.

Open forests are often expected to provide a balance between timber and forage production. However, the low tree densities that may be required to provide for some understory and habitat values will affect the timber potential of the site. Modeling work done in 2004 suggests that 50% of the timber potential will likely not be achieved at densities below 250 stems per hectare. Low stocking densities increase the likelihood of poorer quality timber in the lower bole due to large knots (Klenner 2004).

6.2 Grassland Definition

Grassland can be defined as:

> Sites where grass species (family Gramineae) are the dominant form of plant life, and where tree cover (crown closure) ranges from absent to a maximum of 10%.

The maximum 10% crown closure in this definition is taken from the Grasslands Conservation Council (2004), who used this number in their grasslands mapping project. This 10% number is also commonly by other jurisdictions as the cut-off point between open habitat and forest. This definition will exclude other kinds of open sites such as wet meadows and rocky terrain.

The cut-off between grassland and open forest is somewhat arbitrary. Ecologist Bob Gray (personal communication) advocates using the site's biological productivity to assess whether it is capable of supporting a forested community (e.g. above a certain biomass threshold) versus a grassland community. This would be a measure of site index or mean annual increment, or net primary productivity.

7. Current Restoration Activities and Research/Mapping in NDT 4 Ecosystems

We collated information related to NDT 4 restoration from all areas of the Ministry of Forests and Range (MOFR) Southern Interior Forest Region, which completely contains the NDT 4 zone. The Southern Interior Forest Region (Figure 1) was newly created in 2003, and encompasses the former Kamloops, Nelson and Cariboo Forest Regions, and the current Kootenay, Cariboo, Thompson, and Okanagan Ministry of Environment Regions (Figure 3). Each Ministry of Environment and former Ministry of Forests region has different management issues and has handled NDT 4 restoration in different ways – therefore the sections below are separated into Kootenay, Cariboo and Thompson-Okanagan Ministry of Environment Regions. Some efforts like those of the Grassland Conservation Council and various researchers apply provincially. Much of the information regarding regional conditions and studies is taken from the Grassland Conservation Council's 2003 document: Changes in the Grassland-Forest Interface: A BC Grasslands Conservation Risk Assessment Communication Tool (GCC 2003).

Figure 3: Ministry of Environment Regions

From Ministry of Environment, http://www.env.gov.bc.ca/main/prgs/regions_map.html, webpage viewed December 2005

7.1 Provincial Restoration Activities and Research/ Management

The Grasslands Conservation Council (GCC) is a non-profit organization highly involved in grasslands management in BC. They have recently completed a four-year project to map the extent and types of British Columbia's private and Crown land grasslands and adjacent communities at a 1:20,000 scale (GCC 2004). Prior to this exercise, grassland areas were not consistently mapped or inventoried. The Council's next step is the Priority Grasslands Initiative, which will use the grassland inventory in conjunction with a variety of provincial inventory data and the expertise of regional agrologists, ecologists, grassland experts, the ranching community and First Nations to identify high value, priority grassland conservation areas in each of the major regions across BC[1].

The Grasslands Conservation Council has also endeavoured to delineate the extent of grassland encroachment in British Columbia. This ambitious goal was not achieved – the state of the data and the scale of the project render encroachment mapping on a province-wide scale very difficult, as discussed in their 2003 report (GCC 2003). A regional approach may be more appropriate, though the difficulty of establishing regional grassland 'benchmarks' will still be an obstacle. However, the GCC is a clearinghouse for the digital

[1] See: http://www.bcgrasslands.org/projects/conservation/priorityinitiative.htm

and other data that is available – including those areas where regional encroachment was mapped or described by others (e.g., Ross' (2000) encroachment mapping onto the Cariboo region grassland benchmark).

As mentioned in Section 5, Blackwell *et al.* (2003) have proposed a new way of classifying the historic natural fire regime and fire regime condition classes, that may form a basis for restoration and fuels mitigation action. Currently, aspects of this approach are being tested in the Okanagan Ministry of Environment Region in order to identify priority areas in need of restoration. If successful this approach may be applied elsewhere.

Academic studies are another source of information for provincial-level NDT 4 restoration. Dr. Lori Daniels from the University of British Columbia (Daniels 2004 and Gray and Daniels 2005) is exploring the effects of climatic variation on fire, in order to help managers forecast areas of the province that will be at risk – both during individual years (related to La Nina events), and on decadal cycles (related to the Pacific Decadal Oscillation). One of her studies found that in the Cariboo, fires burned during droughts that correspond with La Niña conditions. This ongoing work to understand climate effects is complimentary to work done elsewhere, e.g. by Hessl *et al.* (2004).

Dr. M.C. Feller from UBC has investigated the maintenance of plant diversity in mixed severity fire regimes (Feller 2004). To assist the perpetuation of all plant species in an area, it will often be necessary to ensure that the fire regime remains variable across time and space – and not based on regularly prescribed intervals (for example every 20 years), as that would lead to the local extinction of some plant species (Feller 2004).

With respect to the ecological conditions under which encroachment occurs, the Cariboo region has characterized these in some detail. Encroachment in this region tends to affect the middle and upper elevation grasslands more than the lower grasslands, presumably because of heat and moisture availability factors. Encroachment is also more prevalent on north and east facing slopes where cool and moist conditions favour tree establishment. Although a similar suite of ecological conditions are expected to lead to encroachment in other grassland regions, additional research is required (GCC 2003).

7.2 Kootenay NDT 4 Restoration

The East Kootenays has an active open forest and grassland restoration program, though the area involved is relatively small (about 250,000 hectares classified as 'fire maintained' within the Rocky Mountain Trench) compared to the provincial picture. The Rocky Mountain Trench Ecosystem Restoration Steering Committee (2006) estimates that since 1952, an estimated 114,000 hectares of open habitats have been converted to a closed forest condition, despite an average annual forest harvest (since 1980) covering 2,650 hectares. Likewise, major fires such as the Findlay fire of 1950, Ash fire of 1962, Spen fire of 1985 and Brew fire of 1985 have created large areas of open and treed grassland as well as open forest (GCC 2003). However, areas opened up by fire, forest harvesting and thinning are generally considered to be far lesser than the areas converted to more closed conditions.

Ad hoc restoration of open forests and grasslands has been happening in the Trench since the 1970's and 1980's, though not at a large enough scale to reverse the forest encroachment and in-growth. In 1990, the government formed the East Kootenay Trench Agriculture/Wildlife Committee, to address conflict between ranchers and wildlife interests. This marked the beginning of a more coordinated Restoration Program, managed primarily by the provincial government and carried out together with various stakeholders. In the early 1990's the Commission on Resources and Environment (CORE) process was also initiated,

to develop a regional land use plan. CORE identified forest in-growth and encroachment as major resource problems and recommended that a rehabilitation program be established. Using the CORE recommendations as the foundation, the Kootenay Boundary Land Use Plan (KBLUP) was announced in 1995, with an Implementation Strategy released in 1997 (Rocky Mountain Trench Committee 2000). The Implementation Strategy guides restoration efforts today – see Appendix 3 for tree stocking standards that apply to the four categories of land zoned under the KBLUP: shrublands, open range, open forest, and managed forest. Restoration prescriptions for specific sites will fall within the ranges found here. The stocking standards in the KBLUP Implementation Strategy provide a reference point for other regions developing restoration targets, particularly for open forest. The open forest standard ranges from 76 to 400 stems per hectare (sph), with a target stocking of 250 sph. However, this target has been recently changed to 150 sph in response to a 2003 report that evaluated the relationship between timber volume/forage production and crown closure/tree density (Rocky Mountain Trench Committee 2006). Presumably the lower densities are required to allow for understory primary production. The KBLUP Implementation Strategy suggests that the primary productivity coming from open forests will be roughly split between timber and forage production, and that this will be facilitated by clustering crop trees on wetter sites.

The Rocky Mountain Trench Ecosystem Restoration Steering Committee has a vision to restore 135,000 hectares of the Trench to a 'restored ecosystem' by the year 2030. The driving principle behind the restoration plan is to return the Trench to a historic ecosystem in which low intensity ground fires burned every 3 to 25 years (Rocky Mountain Trench Committee 2000). An annual target of 4,500 hectares treated is the goal, in order to mitigate the ongoing losses of open ecosystems and to attempt to restore ecological values. Between 1997 and 2005, over 3 million dollars were spent on restoration and other program activities, and a gross total of 27,822 hectares were treated – though this total is for all treatments (commercial timber harvesting, mechanical and hand slashing, and prescribed burning), and often more than one treatment occurs on the same land base. With approximately 20,000 hectares now considered to be in a restored condition, maintenance re-entries are expected to begin in 2006 (Rocky Mountain Trench Committee 2006).

A five-year plan (2005 – 2010) is currently in place, using potential Habitat Conservation Trust Fund and Columbia Basin Fish and Wildlife Compensation Program funding, to treat various management units for wildlife and other values. Due to mapping limitations at the time the Implementation Strategy was drawn up, some uncertainty remains about the true extent of each ecosystem component. These uncertainties will be resolved with completion of a GIS-based mapping/project tracking database currently being developed. This interactive web-based map and database can be queried online by all interested parties and will be an important strategic planning tool (Rocky Mountain Trench Committee 2006).

The ecosystem restoration program in the Trench has relied on licensees such as BC Timber Sales, Tembec and Galloway to harvest on designated open range and open forest sites within their quota areas. The success of this depends on whether these sites contain merchantable wood worth addressing under the quota system. Many do not and are therefore low or no priority for logging. To address this situation, Chief Forester Jim Snetsinger announced new five-year allowable annual cuts (AAC) for the Cranbrook and Invermere Timber Supply Areas, effective November 2005. The allocation provides 25,000 cubic metres a year directed to ecosystem restoration objectives. Over the next five years, this harvest volume will be targeted at pastures that will benefit from logging and follow-up restoration treatments. This allocation, the first of its kind in the province, presents tremendous opportunities for innovation and leadership and, in itself, could propel the ecosystem restoration program significantly forward in terms of actual hectares treated.

District staff will now commence planning and awarding tenures strategically targeted at harvesting the commercially undesirable stands that have blocked larger-scale ecosystem restoration treatments. The District's success in using the allocation effectively will be reviewed by the Chief Forester in 2010 (Rocky Mountain Trench Committee 2006).

A large degree of public support has been gained through planning processes and outreach in the Trench, as social license and understanding is required for the harvesting and burning that takes place. Bighorn in Our Backyard is an outreach program (see http://www.bighorninourbackyard.org) that has been an important part of gaining support for restoration in the Trench since 1997. In fact support is so strong that resource managers and users are also calling for substantial increases in the level of ecosystem restoration activity. The 2005-09 East Kootenay elk management plan, for instance, says that ecosystem restoration activity must increase by several times the current effort to avoid ongoing social and economic upheaval and significantly worse ecological conditions over the next two to three decades (Rocky Mountain Trench Committee 2006).

Most of the NDT 4 ecosystems in the Kootenay MOE region are contained within the Trench. However parts of the Western Kootenays also have some fire maintained ecosystems. From a management perspective, the West Kootenays (also known as the Boundary Forest District) has more in common with the adjacent Okanagan MOE Region, however it still falls under the KBLUP. In March 2002, an ecosystem restoration plan was prepared for the Gilpen Area of the Boundary Forest District (Swanson 2002). This plan generally follows the KBLUP fire maintained ecosystem management guidelines. The plan identifies treatment units and for many treatment units describes the area, specifies treatment objectives, identifies prescriptions and identifies values at risk.

7.3 Cariboo NDT 4 Restoration

The following description of Cariboo Region grasslands and open forest, and estimated encroachment and in-growth is taken from the Grasslands Conservation Council (2003):

The Cariboo's grasslands and associated dry forests are found primarily in the Fraser and Cariboo Basins as well as on the Chilcotin Plateau. The Fraser Basin supports the vast majority of the Cariboo's grassland environments, while smaller openings are dispersed among Douglas fir, and to a lesser extent, lodgepole pine forests in the adjacent upland regions. The Bunchgrass, Ponderosa Pine and Interior Douglas Fir zones reach their northern limit in the Cariboo-Chilcotin. Forest encroachment is deemed a principal threat to grassland biodiversity and forage production in the Cariboo-Chilcotin (Hooper and Pitt, 1994). Several studies have quantified the extent of encroachment and determined the site conditions associated with this change. Evaluations of fire history have led regional experts to suggest that fire suppression following European settlement is the primary cause of encroachment in the Cariboo-Chilcotin (Strang and Parminter 1980; Cariboo-Chilcotin Grasslands Strategy Working Group 2001; Iverson *et al.* 2002). Based on aerial photo comparisons, it is estimated that the area of open grassland has been reduced by more than 30% since 1962 in some areas (Ross 1997). Across the region, an estimated 20,000 ha (11%) of open grassland has become forested since the early 1960s, with likely a much larger area of grassland lost to forest between the late 1800s and early 1960s (Cariboo-Chilcotin Grasslands Strategy Working Group 2001). Given the present rate of encroachment, the Cariboo's grasslands will cover only 61% of their present area 120 years from now (Cariboo-Chilcotin Grasslands Strategy Working Group 2001). Ross (1997) and the Cariboo-Chilcotin Grasslands Strategy Working Group (2001) concluded that even on the earliest air photos, this infilling had likely already occurred on most sites and was well established. Interpretation of 1950 air photos revealed closed forests with scattered large

trees and a dense layer of much smaller trees of relatively uniform height. Age surveys of these small, understory trees in several sites suggest a major phase of in-growth from 1910 to the early 1920s and possibly as late as 1940 (Cariboo-Chilcotin Grasslands Strategy Working Group 2001, in GCC 2003). (At the meeting held for this project, participants expressed the opinion that almost any area of forest in the IDF zone in the Cariboo Region would be affected by in-growth.)

The Cariboo-Chilcotin Region has developed a Grasslands Strategy in support of the Cariboo-Chilcotin Land Use Plan (CCLUP – see Section 7.2 of this report). The CCLUP identified objectives for sustainability of grassland habitats and species while maintaining grazing targets originally set in the 1960's. However, the CCLUP grazing targets (animal unit months [AUMs]) and grassland biodiversity conservation objectives are currently not possible to maintain because of the concentration of cattle into decreasing areas of grassland (Cariboo-Chilcotin Grasslands Strategy Working Group 2001). Therefore, the first output of the Cariboo-Chilcotin Grasslands Strategy is a report that describes the forest encroachment and in-growth issues and proposes a benchmark area to be permanently managed as grassland (Cariboo-Chilcotin Grasslands Strategy Working Group 2001). However, it is acknowledged in this report that in-filled forests must also be addressed alongside encroached grasslands if AUM targets and range management guidelines are to be met, and risks to biodiversity reduced. The Strategy states that forest in-fill may have had a greater impact on biodiversity than the current reduction in grassland area.

The proposed grassland benchmark is 215,000 hectares in size, and is based on the earliest Ministry of Forests inventory maps, prepared between 1963 and 1975. (See maps 2 & 3 Cariboo Chilcotin Resource Management Zones (East and West) and Wildlife Values in Appendix 6 that depicts the Cariboo benchmark and other NDT 4-relevant information). This benchmark option was chosen because earlier data was incomplete or difficult to utilize; due to its later date, this benchmark is significantly smaller than the area of grassland that was present prior to European settlement and subsequent suppression of aboriginal burning and wildfire. However, Working Group members feel that the risks posed to biodiversity are acceptable as long as tree densities in adjacent forests are also reduced, and point out that in any case risk is lower then if no action is taken. The Working Group recommended that treatments to control recent forest encroachment should be initiated on priority sites as soon as possible. They also recommended that the benchmark and related restoration objectives be incorporated into planning processes and inventory databases (i.e. be removed from the timber harvesting land base), and that the Ministry of Forests should lead grassland restoration on the benchmark, with the designation of an implementation coordinator in each forest district (Cariboo-Chilcotin Grasslands Strategy Working Group 2001).

The next step described in the Grasslands Strategy is to describe and address the forest infill problem; however this has not yet occurred, and little action to address either encroachment or infill has been taken since the 2001 report was released. The January 17th meeting that took place for this project may have rekindled interest in dealing with encroachment and in-fill issues. Additionally, the Integrated Land Management Bureau (Ministry of Agriculture and Lands) has started a project to determine restoration priorities. A MOFR staff member arriving from Australia in a staff exchange will be working on developing an assessment framework for ranking strategic priorities for the Cariboo, beginning in March 2006. This work will synthesize current knowledge and will test the framework in a pilot project to determine its effectiveness and transferability.

Forest habitat conditions for Mule Deer are of concern in the Cariboo Region, as deer winter ranges are affected by forest in-growth. Almost all the forest along the grassland edge is used for mule deer winter range (Harold Armleder personal communication). The CCLUP

Mule Deer Strategy Committee have produced a plan (Dawson *et al.* 2002) that describes the management objectives for specific stand structure classes on these winter ranges. Recommended prescriptions to improve these stands typically involve removing densely overstocked small diameter stems, and thus address many of the concerns in NDT 4 ecosystems. In this plan, habitat for mule deer is identified and categorized. However, while implementing these prescriptions will improve many biodiversity values, crown closure and basal area will typically range higher than the open forest conditions discussed in this report, and may not be compatible with some of the objectives or values to be managed for in open forest. Therefore, management decisions will be required as to which areas are to be managed for the higher crown closure required by mule deer, and which areas are to be brought down to the lower densities expected within the range of natural variability based on the historic fire regime. (As per the biodiversity guidebook, the assumption is that mimicking the natural disturbance regime will provide habitat for the bulk of the species adapted to that regime, but that certain species will require specific attention).

Various projects have been undertaken to promote range values and remove encroaching trees since the 1950's. These are documented to the extent possible by McIntosh (2001), but do not appear to address a large area of the region. More recent projects to address encroachment and in-fill were also documented to the extent possible for this project, and are referenced in Appendix 5 (and located on maps 2 and 3 in Appendix 6). Many of these projects are considered 'pilot' projects as the capacity and knowledge needed to address encroachment/in-fill on a wider scale has not yet been developed.

7.4 Thompson and Okanagan NDT 4 Restoration

The Thompson and Okanagan MOE Regions are located within the former Kamloops Forest Region, for which an NDT 4 Committee was established to develop a strategy for managing dry forests and grasslands. This Committee developed a draft report in 2001 (Klenner *et al.* 2001) and has since been inactive. While all members of the committee did not share the same views regarding the ecology and management of these ecosystems, they did endorse a cautious approach of treating 10% of dry-belt ecosystems belonging to the grassland and dry and very dry forest types, to achieve and maintain open conditions. Limited action has been taken to support this recommendation, however many members of this committee were in attendance at the January 19th meeting for this project, and agreed that action was a priority. There was a willingness to move forward to strategically address the conditions of grasslands and dry forests in these MOE regions. Since the NDT 4 committee disbanded, there has been an increased focus on reducing densities and fuels in 'interface' zones near communities as result of the fires of 2002 and 2003. Additionally, various habitat-related prescriptions and range prescriptions continue to be implemented, but would benefit greatly from a strategic and coordinated interagency plan.

Okanagan Region Conditions

Some experts suggest that grassland encroachment is less of a factor in the Okanagan and Thompson regions due to a combination of heat dryness and soil conditions, though in-fill does occur on the cooler sites in the IDF zone (Dennis Lloyd personal communication). The Okanagan Basin, in particular the southern portion, has some of the hottest and driest conditions in all of Canada (GCC 2003). However, regional estimates of forest encroachment and in-growth in the Okanagan are relatively limited compared to other regions. Despite anecdotal reports and some focused studies, no systematic approach has been undertaken to map the magnitude of tree density changes and to document the ecological conditions associated with that change (Klenner *et al.* 2001). In the southern Okanagan valley and Lower Similkameen valley, Turner and Krannitz (2001) found invasion and in-growth of conifers in Bunchgrass and Ponderosa Pine zones (in unburned sites)

between 1938 and 1996, though the rate of conifer establishment may be slower than at other grassland locales (GCC 2003). Gyug and Martens (2002) compared air photos from 1947 to 1996 to look at changes in forest crown closure. Results showed an increase in crown closure for many sites. While the magnitude of encroachment and in-growth was variable depending upon the site, unburned, open forests at all elevations in the Lower Similkameen experienced in-growth to some degree between 1947 and 1996 and are slowly being converted to closed forests (Gyug and Martins 2002 in GCC 2003). Finally, Taylor and Baxter (1998) compared aerial photographs from 1952 to 1992 for five cover classes at Okanagan Mountain Park. While the treed grassland and open forest classes decreased by 56% and 26%, respectively, the open grassland class showed a decrease of less than 1%. Taylor and Baxter surmised that the decrease in open grassland is less significant at Okanagan Mountain because it is very dry and rocky and the regeneration success is very low (GCC 2003). According to the Grassland Conservation Council (2003), encroachment can be found in many areas of the Okanagan, especially at mid-elevations where conditions are more favourable for tree growth. As encroachment creeps into some grassland areas, fire burns back encroachment in others, such as the Oliver fire of 1969, Garnet fire of 1994 and recent Okanagan Mountain, Vaseaux and Anarchist fires of 2003. Logging in some areas has also created more open conditions. Lastly, in many areas, the interface between grassland and forest has remained unchanged since earlier records (GCC 2003).

Thompson Region Conditions

As is the case in the Okanagan, no systematic study has been undertaken to map the magnitude of tree density changes and to document the ecological conditions associated with that change (Klenner *et al*. 2001). Like the Okanagan, some experts suggest that encroachment is less of a problem or occurring more slowly here than in other regions (Dennis Lloyd personal communication). Some anecdotal accounts of encroachment have been reported at Lac du Bois Grasslands, Tunkwa, Monck and Mount Savona Provincial Parks as well as Upper Hat Creek and the Princeton Basin (GCC 2003). Other areas are unlikely to support trees: conditions in the Thompson Basin are especially difficult for tree establishment as this area frequently endures long periods of drought. For example, after the 1998 drought, anecdotal reports of widespread mortality of ponderosa pine and Douglas-fir saplings near the grassland-forest interface were common (Klenner *et al.* 2001 in GCC 2003). Opposing the forces of encroachment and in-growth, some fires have created more open conditions, such as the 1991 Rayleigh fire (GCC 2003). The fires of 2003 (the Strawberry Hill, Venables and McGillivray fires) may have had similar results, however areas that were salvage logged will be planted to stocking densities optimum for producing timber, rather than managed as open forests at lower stocking densities. There are also plans to reforest other areas that were not salvaged providing funding can be secured. Logging activity in the dry forest in past decades has also created open, grassy habitats on some sites (GCC 2003).

Restoration and Management Activities

Some work has already been done to strategically identify areas for further restoration planning. As part of the 2001 report issued from the NDT 4 Committee, Lloyd (2001) stratified the Natural Disturbance Type Four for the Kamloops Forest Region into broad ecological types for predictive ecosystem mapping (PEM). The primary objective for this classification is for strategic planning for the restoration of lower elevation forests and grasslands. These 13 types are shown below in Table 1, and reflect the diversity within NDT 4 ecosystems. (See also the discussion later this section regarding how this information is being tested in a strategic framework pilot project.)

Table 1: Ecological Site Groupings (Broad Ecological Types) to describe NDT 4 Ecosystems (Lloyd 2001)

Ecological Site Groupings (Broad Ecological Types) to describe NDT 4 Ecosystems	
R/Og	Rock outcrops in the grasslands
R/Of	Rock outcrops in the forested lands
BW	Big Sage-Bluebunch Wheatgrass and Pasture Sage–Bluebunch Wheatgrass
FG	Fescue Grasslands
PyPg	Ponderosa Pine - bunchgrass
FdPg	Douglas Fir Pinegrass – Kinnikinnick
FdPl	Douglas Fir / Lodgepole Pine – pinegrass, twinflower
FdMo	Douglas Fir – moss
Rip-g	Riparian areas in the grasslands
Rip-f	Riparian Spruce – Dogwood in the forested lands
WL	Wetlands, bogs or fens
Agr	Agricultural lands, hayfields, ginseng plantations
Devm't	Developed areas, urban, roads, hydrolines or railways

In a separate initiative, range staff from the Kamloops Forest District have developed a prioritized list of grassland/open forest areas they wish to treat with prescribed fire to manage encroachment. The priority rankings are somewhat arbitrary, and are scored based on:

1. Weeds, based on existing weeds and the potential for invasion after burning;
2. Management, based on ability and commitment to manage areas after burning;
3. Risks, based on developments and improvement, life and property, smoke, natural features, timber and first nations;
4. Benefits, based on improvement to biodiversity, productivity and safety.

These priorities were developed in 2000, and are included in Appendix 4. Sites identified on maps were transferred over to a 1:170,000 Kamloops Resource Management Zones and Wildlife Values map 4 included in appendix 6. There areas have been identified as to their value to wildlife, range and infrastructures. The caution with these priorities is that they require more fieldwork before considering any implementation. Smaller scale (1:30,000) maps reside with the range section in the Kamloops FD and the line work had been reviewed by Ecosystems staff of Ministry of Environment. These mapped priorities are best considered as areas of interest.

Many mapping projects in the Okanagan Basin have been centred on wildlife and critical habitats for rare and endangered species (e.g., Okanagan Habitat Atlas, TEM-like mapping for the South Okanagan, and mapping of IDFdm1, IDFdk2 and IDxh2 for Tree Farm Licenses 15 and 35). As the region's population steadily increases, grassland habitat loss to development has generally been considered before grassland habitat loss to trees (GCC 2003). Much of the restoration activity (thinning and burning) that has occurred has focused on lands within Parks and winter ranges of ungulates such as California big horn sheep and mule deer. Bighorn sheep are a species at risk that live in NDT 4 ecosystems in the South Okanagan, and the bighorn sheep recovery plan (Harper *et al.* 2002) recommends implementing intensive habitat management programs including prescribed burning, forest thinning and weed control. A list of some of the recent restoration projects carried out for the Thompson and Okanagan Regions is found in Appendix 5. Recent projects include prescribed burns in the South Okanagan to improve habitat for California bighorn sheep, and

prescribed burns in the Thompson to improve mule deer and sheep habitat. Burns were also done on a number of sites to improve range values. Recent/known restoration projects are listed in Appendix 5, and were also mapped for Kamloops, Merritt and Lillooet TSA's (see Appendix 6, maps 4, 5 and 6). The Okanagan projects are not identified on a map, as complete information was not available.

Currently, a study is underway on contract to the Okanagan Ministry of Environment office to prepare a strategic plan with a five year operational component, to address the condition of grassland, shrubland and forest ecosystems characterized as NDT 4, and some areas characterized as NDT 3 (e.g. MS and ICH zones), where there is a need for low intensity prescribed burns to manage for ecological values. The plan will describe the goals and objectives of a regional terrestrial ecosystem restoration program for NDT4 ecosystems and support this with a scientific rationale that includes a description of the historic fire regime (including historic range of natural variation (RONV)) and associated stand structures. The Historic Natural Fire Regime and Fire Regime Condition Class Models developed by Blackwell and others (2003) (see Sections 5 and 7) provide coarse-scale spatial direction for this work. Additionally, a coarse-scale approach proposed by Dennis Lloyd (MOFR SI Forest Region Kamloops office) that uses predictive ecosystem mapping (PEM) will be tested in this project. The approach proposed by Dennis Lloyd involves doing PEM using the categories described in Table 1, and overlaying this information with forest cover age class and density data, and information regarding key spring range and areas of high value to wildlife/listed species, to locate areas likely to require restoration attention.

This project for the Okanagan MOE region will use various GIS-based filters and queries to help focus down to operational units once a hierarchical planning approach (agency goals, objectives and prioritization) has been developed. This stage incorporates the necessary environmental, ecological, and social values in a spatial context. Lastly, a field review will be conducted to verify the computer analysis. The final plan due in March 2006 will include program goals, objectives, rationale, methodology, prioritization of treatment units, treatment unit design, maps, schedule, budgets, and a monitoring program. The results of this work and lessons learned can potentially be applied to other MOE Regions.

In the Thompson MOE Region, Ministry of Forests and Range staff have an ongoing study of silvicultural systems at Opax Mountain and another study managing for open forest conditions at the Isobel Lake. The two study areas are located in the IDFxh2 and IDFdk2 variants of the Interior Douglas Fir zone. At Opax Mountain, treatments and data collection is carried out to look at the important management issues of natural disturbance regimes, regeneration, management of vegetation resources, and conservation of biological diversity in managed dry IDF stands (Huggard *et al.* 2005). The Isobel lake project is of particular interest as its main objective was to develop and apply prescriptions to maintain prolonged open forest conditions in dry Douglas fir forest while maintaining future timber values.

The South Okanagan Similkameen Conservation Program[2] is another player in conservation and restoration efforts. It is a partnership between the various agencies and stakeholders involved in biodiversity conservation efforts in the Okanagan. The SOCSCP promote a healthy environment that sustains biodiversity values though land stewardship, community conservation, habitat securement, and sustainable land use.

Mule deer management strategies in the Thompson and Okanagan are guided by Land and Resource Management Plans (LRMPs) that give direction regarding snow interception cover and forage. Addressing deer winter range condition is commonly seen as a way to improve

[2] see: http://www.soscp.org/

open forest values, though conditions on deer winter ranges are by definition more closed than the open forest definition in Section 6.1. In the Okanagan and in Kamloops much of NDT 4 is identified as deer winter range.

In the Thompson and Okanagan, deer winter ranges are arbitrarily broken down into planning cells and within each planning cell, snow interception cover is to be maintained. In the shallow snowpack zone, 15% of the forest area within the planning cell is to be maintained in stands suitable for snow interception, in the moderate 33%, and in the high 40%. Snow interception cover is defined as Douglas-fir stands greater than 140 yrs of age with 46% or greater canopy cover. There will be a need to integrate management of open forest conditions with mule deer winter range requirements. It is difficult to totally understand the implications until the areas planned for open forest management are mapped in some fashion. Obviously open forest conditions can be met in the shallow snowpack zones, but will be more challenging in the deeper snowpack zones.

8. Land Use Plans and Policy Direction

Land use plans and the management objectives contained within drive activities on the land base. Here we highlight the relevant language (objectives, strategies or other wording) that supports NDT 4 management in the land use plans that cover the Southern Interior Forest Region. There are five relevant completed or draft Land Use Plans: Kootenay-Boundary Land Use Plan, Okanagan Shuswap Land and Resources Management Plan (LRMP), Kamloops LRMP, Lillooet LRMP (draft) and the Cariboo-Chilcotin Land Use Plan. The Merritt Timber Supply Area (TSA) does not have a land use plan in place, but there is policy direction guiding some management activities. All plans provide direction for management of the grasslands and drier open forests within NDT 4. Some plans have considerably more details and direction in them than others.

8.1 Kootenay-Boundary Land Use Plan

The Kootenay-Boundary Land Use plan (KBLUP) was described in Section 7.2 – "Kootenay NDT 4 Restoration", because it is the main driver of restoration actions in that part of the province. The KBLUP Implementation Strategy describes a set of management guidelines to specifically address "fire-maintained ecosystem restoration". According to the Implementation Strategy, these guidelines were developed to (Rocky Mountain Trench Committee 2000):

> "Improve the productivity and health of fire-maintained forests and rangelands by restoring stand structure and species composition, through modern methods of timber harvesting, thinning, and prescribed burning"

Restoration was to "improve forest stand vigour, reduce the risk of catastrophic wildfires, and rejuvenate bunchgrass communities". A key section of the Implementation Strategy for the KBLUP is included in this report as Appendix 3, showing guidelines for each of four components (shrublands, open range, open forests and managed forests) that are used to describe the land base or its desired future condition. However one key change has since been made to the numbers in Appendix 3: the open forest target density has recently been reduced to 150 stems per hectare from 250 stems per hectare (see Section 7.2).

Based on the recommendations put forward by the KBLUP Implementation Strategy (and earlier East Kootenay Trench Agriculture/Wildlife Committee), the government formed a Steering Committee in 1998, to direct and coordinate an Ecosystem Restoration Program in the Rocky Mountain Trench (Rocky Mountain Trench Committee 2000). As described in Section 7.2, this committee is active in carrying out the KBLUP Implementation Strategy.

8.2 Cariboo-Chilcotin Land Use Plan

The Cariboo-Chilcotin Land-Use Plan (CCLUP) divides the area into three zones, depending on intensity of use: Enhanced Resource Development Zone, Special Resource Development Zone, and Integrated Resource Management Zone. Each zone consists of a number of separate areas spread throughout the region. Broad management objectives for each of these zones have been defined, and are generally consistent with those in other regions of the province.

The CCLUP was mentioned in Section 7.3 as it is the impetus behind the Cariboo-Chilcotin Grassland Strategy (CCGS). The Strategy was developed so that the grazing and rangeland condition biodiversity targets described in the CCLUP could be met. While open forest condition is not described in the plan, the CCLUP does not preclude managing for open forest conditions to meet grazing, biodiversity and wildlife targets. In fact, the CCGS identifies the need to address forest in-growth adjacent to the grassland bench mark area to meet the CCLUP objectives.

The CCLUP describes a process for managing mule deer winter range values and maintaining access to timber over the short term. Subsequently, management plans have been prepared for the mule deer winter ranges, many of which surround the grassland benchmark. The plans place a heavy emphasis on thinning in small diameter stands to meet the long term habitat conditions on the winter range. These conditions are believed to provide many of the conditions that would be found under open forest conditions, though it may not meet some open forest targets (see Section 7.3).

8.3 Okanagan-Shuswap Land and Resource Management Plan

The Okanagan-Shuswap Land and Resources Management Plan[3] (OSLRMP) identified NDT 4 as a Special Resource Management Zone and divided NDT 4 ecosystems into three components for management purposes. NDT 4a is described as the grassland site series. NDT 4b ecosystems are characterized by frequent, low intensity fires, and are typified by large diameter, well-spaced trees with a well-developed shrub-grass understory, and a mosaic of thickets and openings across the landscape. NDT 4c is the wetter site series, generally higher in elevation, that are considered to have a stand-replacing regime. These three categories are useful at a regional or landscape scale. The ecosystem types used for PEM mapping, as described in section 7.4 (Table 1) are considered a refinement of this categorization, and each is of these types is assigned to either NDT 4 a, b, or c, with riparian and wetland ecosystems occurring throughout.

Some of the key objectives and their supporting strategies are listed here, and numbered as they are in the plan. These objectives and strategies give direction to address encroachment and in-growth within NDT 4 ecosystems. They are found in the section titled, “Ecosystem Natural Disturbance Type 4 (Grasslands and Low Elevation Open Forests).”

1) On at least 85% of permanent range, achieve late seral and/or potential natural community climax plant communities.
3) Maintain or enhance habitat opportunities for rare elements dependent upon NDT 4 ecosystems.

[3] See: http://srmwww.gov.bc.ca/sir/lrmp/okan/index.html for links to the plan.

5) Restore and/or rehabilitate NDT 4 ecosystems.
5.3) A committee will be structured to promote and review enhancement projects. Approved projects will have priority for funding from the Grazing Enhancement Fund (GEF).
10) Maintain the NDT 4a (as defined by the Regional NDT 4 Committee) as grasslands.
10.1) Where practical, return fire to the NDT 4 at historical fire cycle intervals by developing and implementing a burn plan that includes restoration and maintenance burning.
10.6) Mechanically remove encroaching conifers where it is impractical to burn and /or prior to burning on grasslands.
11) Manage the NDT 4b for the stand structure and understory attributes described by the Regional NDT 4 Committee.
11.6) Practice cluster planting to meet stocking standards and allow plant succession to progress naturally in non-planted openings.
11.8) The Regional NDT 4 Committee is to develop stocking standards for the NDT 4 Resource Management Zone (RMZ).
The Special Resource Management Zone (SRMZ) described for NDT 4 in the plan frequently overlaps with other SRMZs of wintering mule deer and California bighorn sheep within the Plan. For example, most mule deer herds spend winters and spring months within NDT 4 but often utilize habitats in other natural disturbance types during the fall and summer months. California bighorn sheep also winter within NDT 4 ecosystems.

Embedded in some of the objectives, strategies and intent statements for the NDT 4 SRMZ is reference to the Kamloops Regional NDT 4 Committee. The LRMP Table had an expectation that the NDT 4 Committee would provide details around these objectives and other tasks identified in the introduction to the NDT 4 section of the plan. The Kamloops Regional NDT 4 Committee was a multidisciplinary committee struck in 1999, which reported to the Regional Management Team of the Kamloops Forest Region. They were tasked with review of issues and technical information pertinent to management of dry-belt ecosystems, and with developing recommendations to improve current planning and management. The team consisted of representatives from the Ministry of Water Land and Air Protection and Ministry of Forests and produced a draft strategy for managing dry belt ecosystems of the Kamloops Forest Region (Klenner *et al.* 2001). The draft was not finalized and as such is not generally available for distribution. The committee is no longer active. However, as mentioned in Section 7.4, many committee members were in attendance at the January 19th meeting for this project and there is a willingness to move forward in implementing the committee recommendations to address the condition of NDT 4 ecosystems.

8.4 Kamloops Land and Resource Management Plan

In the Kamloops LRMP there are a number of objectives that address values within the grasslands and open forests. These objectives and strategies provide less detail than the other plans; nevertheless they do speak to managing biodiversity and long-term productivity on Crown rangelands. Other objectives and strategies speak to disturbance regimes similar to natural processes, managing grasslands to produce a mosaic of grassland habitats, and reducing forest encroachment and density which results from human suppression of natural disturbances.

The following selected objectives and strategies are from the LRMP and guide NDT 4 management. The reader is encouraged to refer to the entire list of objectives and strategies within these sections[4]. The Kamloops LRMP sections relevant to NDT 4 management are:

2.1.3 Ecosystem Management

[4] see: http://srmwww.gov.bc.ca/sir/lrmp/kam/ for links to the entire plan

- Restore species endangered or threatened by human activities
- Maintain natural stand attributes in managed forests
- Maintain and/or enhance a diversity of viable grasslands and alpine ecosystems
- Employ stand level biodiversity practices such as wildlife tree management
- Encourage disturbance regimes that are similar to natural processes
- Manage grasslands to produce a mosaic of grassland habitat

2.1.4 Grasslands Management
- Maintain natural grassland ecosystem processes, including all grassland dependent species
- Manage grasslands for a diversity of habitat for grassland-dependent species
- Reduce forest encroachment and density which results from human suppression of natural disturbances
- Accept natural disturbances as a tool for grassland management.

2.1.10 Range
- Maintain and/or enhance sustainability, biodiversity and long-term productivity on Crown Rangelands.

2.1.12 Wildlife
- Ensure habitat needs of all naturally occurring wildlife species are provided for. Special attention will be paid to those red and blue listed species, as defined by BC Environment, and species designated as regionally important (e.g. Mule Deer).

2.1.12.1 Critical Deer Winter Range
- Maintain or enhance forage production and habitat requirements in critical deer winter range.

The plan also describes two Special Resource Management Zones (SRMZs) for wildlife, namely Skull Mountain and Battle Bluff. These SRMZs occur within NDT 4 ecosystems, and the LRMP contains objectives and strategies for these areas similar to those identified above.

8.5 Lillooet Land and Resource Management Plan

The draft Lillooet LRMP[5] took a slightly different approach and focused on two ecosystem components within NDT 4. The grasslands (NDT 4 a) and the dry open forests (NDT 4 b) were identified for their biodiversity values. The plan also goes on to explain that frequent low-intensity fires have played an important role in maintaining their biodiversity. Both encroachment of conifers into grasslands and in-growth of dry open forests with a dense conifer understory have resulted in greater impacts on species at risk and biodiversity, poorer forage and timber production and greater risk to catastrophic wildfires.

In Section 4.4.2 “Biodiversity in Dry Forests and Grasslands,” objectives and strategies are stated that propose using silviculture and prescribed fire to reduce encroachment and in-growth. In the open forests, stand structure is to be managed by site series to best imitate classical NDT 4 stand structures using recommendations from the Kamloops NDT 4 Committee. There is also general direction to use cluster planting to meet stocking standards and allow natural succession to occur in the non-planted openings.

[5] See: http://srmwww.gov.bc.ca/sir/lrmp/lill/index.html for links to the Draft Lillooet LRMP

8.6 Merritt Policy Direction

The Merritt Timber Supply Area (TSA) does not have a land use plan in place, however there are a number of policies that influence management within NDT 4 ecosystems. The May 18, 1999 Douglas-fir retention policy speaks to maintaining large diameter Douglas-fir and Ponderosa pine stems in lodgepole pine dominated stands, for biodiversity, specific wildlife species and future CWD[6]. It was also recognized that retention would potentially reduce existing and future stand yields, increase initial operating costs and influence pest management issues.

Four objectives were identified in the policy and are as follows.

1) To provide for amounts of Douglas-fir retention that are adequate to meet stand level biodiversity objectives.
2) To provide guidance to persons preparing operational plans
3) To ensure impacts to timber values are limited
4) To resolve conflicts prior to operational plan submission

The policy objectives focus more on harvesting activities within the timber harvesting land base. However the guiding principles identified are also applicable to NDT 4 lands outside the timber harvesting land base. The policy provides direction on retention for all stands that contain large diameter Douglas-fir, and recruitment objectives for stands with fir.

The Ungulate Winter Range Strategy for deer, sheep and elk also provides some recognition of these values within NDT 4 ecosystems, though direction is less clear than those other TSAs covered by a Land Use Plan. There is some expectation by MOE that the approach taken for Ungulate Winter Range Management in the LRMPs recently completed in the Okanagan and Lillooet, will be adopted for the Merritt TSA as an interim measure, if necessary

9. Silviculture Strategies affecting the NDT 4

The majority of the NDT 4 ecosystems in the Province are found in nine Timber Supply Areas within the Southern Interior Forest Region, namely 100 Mile, Williams Lake, Merritt, Kamloops, Okanagan, Cranbrook, Boundary, Invermere and Lillooet.

Silviculture strategies are the primary tool for identifying opportunities to offset negative impacts on timber supply, but they are also used to manage forests for wildlife, water, recreation, range or any combination of these or other forest uses. A Type 1 Silviculture Strategy relies on existing information and results may be qualitative rather than quantitative. Included in each Type 1 Silviculture Strategy are strategies for timber supply, timber quality, stewardship and habitat supply. A Type 2 Silviculture Strategy looks at timber supply and habitat supply issues in more detail and involves modelling. For more information refer to the provincial website for Silviculture Strategies[7].

Six of the nine TSAs will have a Type 1 Silviculture Strategies complete by March 2006, namely: 100 Mile, Williams Lake, Merritt, Kamloops, Okanagan and Cranbrook TSAs. The habitat draft strategies all identified the need for thinning dense fir and ponderosa pine

[6] See: http://www.for.gov.bc.ca/dcs/Planning/Biodiversity/firpolicy2.doc for the Merritt TSA Douglas-fir retention policy

[7] See: http://www.for.gov.bc.ca/hfp/silstrat/provinfo/prov-home.htm for information on Silviculture Strategies

stands where they existed, to concentrate growth in fewer larger stems. They did not differentiate clearly between those stands to be managed as open forests vs managed forests. Type 1 Silviculture Strategies are already completed for Lillooet, Boundary and Invermere TSAs.

The Invermere Type 1 Silviculture Strategy dated Sept 15, 1999, identified three habitat strategies that would be applicable to NDT 4 ecosystems: i) spacing of mixed species and clumpy stands; ii) improving ungulate winter range by spacing to remove pine, leaving clumpyness and creating/enlarging voids; and iii) creating NDT 4 fingers into NDT 3 areas to emulate the ragged boundary.

A Type 1 Silviculture Strategy was completed for the Boundary TSA on December 10, 2000. Though there were no specific strategies identified for NDT 4 ecosystems, two strategies could complement NDT 4 management: i) setting up stands now for commercial thinning so they are available in decades 8 and 11; and ii) setting up stands now to meet old forest requirements. Both strategies could target dense thickets of dry belt fir.

The Lillooet Type 1 Silviculture Strategy (dated March 2000) also identified the need for improved management within NDT 4 ecosystems and dry Douglas-fir forests. The conditions of these dry forests are not well defined and the need for a mapping project was identified, including an interpretive component that stratifies the polygons into known/unknown, and a subsequent field check of the unknowns. A silviculture goal could then be set for limiting encroachment onto grasslands and reducing infill in areas of open forests. Another issue identified was Douglas-fir stands being converted to leading lodgepole pine to meet free-growing standards, and the need to have fir restocking the area over time. To address this issue it was proposed to maximize Douglas-fir stocking on sites where fir is appropriate, particularly on the drier sites in the transition between the Montane Spruce and Interior Douglas Fir BEC zones.

The strategy also recognised that to manage forest health and habitat, lower stocking rates were required, however it failed to address how this was to be accomplished.

Of the nine Type 1 Silviculture Strategies reviewed, all have a component that speaks to the need for improved management of NDT 4 ecosystems and dry-belt Douglas-fir. What appear to be lacking is where and how these stands should be managed, and a ranking system that prioritizes areas for treatment. There is a need to identify where open forest management will occur, with direction for prescriptions to meet the open forest definition as described in section 6.1. In future silviculture strategy development it would be useful to have this information available. The results of a strategic restoration framework that zones the landscape according to desired future condition would be extremely useful for identifying how much and where silviculture work could take place.

10. Current Management Objectives for NDT 4 Ecosystems

Various sections of this report describe management objectives for NDT 4 ecosystems, as they exist in land use plans and related strategies, and in silviculture strategies. With the exception of the Implementation Strategy for the Kootenay-Boundary Land Use Plan (see Appendix 3 and Sections 7.2 and 8.1), most of the management objectives are very general in nature. We include here the most relevant general management objectives gathered:

Management Objectives of the KBLUP Implementation Strategy (see Appendix 3) for fire maintained ecosystem restoration are:

- Improve forest stand vigour
- Reduce the risk of catastrophic wildfires
- Rejuvenate bunchgrass communities
- Improve the productivity and health of fire maintained forests and rangelands by restoring stand structure and species composition.

An ecosystem restoration plan (Swanson 2002) for the Boundary FD (which falls under the KBLUP) also includes the following objectives or intent statements:

- Improve the productivity and health of fire maintained forests and rangelands
- Reduce fire hazards
- Restore wildlife habitat that historically existed in the area.

Key objectives of the Cariboo-Chilcotin Grasslands Strategy are listed as:

- Maintain the area of grasslands
- Maintain domestic range use targets
- Maintain and enhance biodiversity including wildlife
- Provide baseline information for future planning

An example of more site-specific management objectives is given here, from prescriptions for a site near Grand Forks in the Boundary Forest District:

1. Re-establish an early to mid-seral herb and shrub community of native species;
2. Reduce the stocking levels to Open Forest stocking, nearer 75 sph;
3. Fire proof veteran ponderosa pine and Douglas-fir;
4. Maintain brush patches to provide for ungulate cover, as well as large coarse woody debris patches and pieces for habitat;
5. Treat over-mature Saskatoon and Salix bushes so that browse availability and quantity is improved for ungulates;
6. Reduce the amount of weed species to allow the establishment of blue-bunch wheatgrass and other natural species;
7. Maintain visual quality objectives by reducing the fire hazard to prevent the risk of catastrophic fires. The prescribed burn will be scheduled for the year following to allow for the drying of slashed material;
8. Re-establish habitats suitable for red and blue listed species as well as regionally important species, such as mule deer;
9. Maintenance of water quality (there are no riparian areas within this treatment unit);
10. Maintenance of air quality, as much as possible, by burning at an appropriate time.

The Forest and Range Protection Act (FRPA) is the main legislation governing forest management in BC. FRPA was reviewed to determine if it had any language specific to NDT 4 ecosystems, and it does not. It would be possible to capture NDT 4 objectives in the Government Action Regulation or Forest Planning and Practices Regulation. It may be necessary to link the NDT 4 objectives directly to a category of species at risk, regionally important species or specified ungulate species, either by the objective or general wildlife measure. The legislation also states that the Minister must ensure that the action is consistent with other established objectives, would not unduly reduce the timber supply from British Columbia's forests, nor prescribe actions that would be difficult or expensive to implement, and, affected parties must be consulted. Clearly NDT 4 managers must work closely with any agreement holder to ensure the objective or general wildlife measure move forward and are implemented.

The Integrated Land Management Bureau (Ministry of Agriculture and Lands) is currently doing a pilot project for the Okanagan-Shuswap LRMP to see how to move policy LRMP language into Land Use Objectives that would support the FRPA model and reflect the agreement in the approved policy plans. Once the pilot is complete it would be clear how to proceed with other policy type LRMPs.

The Kamloops LRMP is described as a higher-level plan (HLP). The legal interpretation of the Kamloops HLP order is that the objectives and strategies are objectives set by government under FRPA and require results and strategies in a Forest Stewardship Plan. Government has recently undertaken a review and have identified a sub-set of the 300 plus objectives and strategies that are to be continued under the HLP for the purposes of FRPA. As a result of this analysis many of the objectives and strategies were dropped because they were no longer relevant, already covered by legislations, not related to a primary forest activity, related to planning or not practicable or reasonably implementable. After the review process only 26 objectives were identified for continuation with HLP designation under FRPA, one of which has links to NDT 4 management. The objective is, "Ensure habitat needs of all naturally occurring wildlife species are provided for. Special attention will be paid to those red and blue listed species, as defined by BC Environment, and species designated as regionally important (e.g. Mule Deer)." This is particularly relevant to NDT4 management due to the large numbers of species that live within NDT 4 and require open forest stand conditions for part of their life cycle.

The non FRPA objectives and strategies that were identified as providing some direction to NDT 4 management will remain, and the expectation is the spirit and intent of the Kamloops LRMP will be carried on. The remaining plan content continues as Cabinet policy direction, and there is a commitment by forest licensees and regulatory agencies to continue to support the plan. In the event results and strategies fall short of NDT 4 management outcomes it is possible that new objectives and general wildlife measures may need to be developed and implemented.

The CCLUP and KBLUP have established Higher Level Plan Orders which direct some aspects of NDT 4 management. The actual orders can be found at:

http://srmwww.gov.bc.ca/kor/rmd/docs/nov4_2002/KBHLPOrder0925.pdf

http://srmwww.gov.bc.ca/car/planning/cclup/ccluphlpo.pdf

11. Methods to Address Encroachment and Understory In-fill

The main activities used to address forest in-fill and grassland encroachment are harvesting, slashing/non-commercial thinning, knockdown, and prescribed burning. Depending on the site in question, one or all of the above activities may be called for. Current Forest Investment Account standards (under which non-commercial restoration activities can be funded) provide general guidance for terrestrial restoration projects of all kinds[8]. The following is an overview of the kinds of restoration techniques employed; site level considerations will always be unique.

[8] see: http://www.env.gov.bc.ca/wld/fia/terre_treatment_effeval.html for Forest Investment Account standards and related information.

11.1 Prescribed Burning

Prescribed burning is carried out on sites that are open enough to control fire risks. When treating mostly open grassland sites suffering from encroachment, prescribed burns will predictably kill only the small seedlings. Mortality will be based on the heat of the burn and typical spring burning will not remove the larger encroachment accumulated over time (Knezevich 2000) – see Figure 4. Individual larger trees may or may not be harmed by the fire and if their removal is desired, manual (or mechanical - see below) treatments will often be necessary. Cattle may have to be removed for one or two seasons to allow sufficient fuel build-up to carry a fire, and for at least one growing season following treatment to minimize weed establishment and to allow the native vegetation to recover. Once treatments are made to remove encroachment on grasslands or in-fill in open forests, timing between follow-up fires could be 10-15 years (Knezevich 2000). These repeated burns will be necessary to maintain open conditions.

For mostly open grassland sites, the unit cost of burning is generally quite low, e.g., $50/hectare. For sites that have been harvested and/or slashed to attain open forest conditions, prescribed understory burning is considerably more complicated and expensive, and may not always be possible if near communities, private holdings or other infrastructure. The management of fuels to prepare for understory burning will vary by site and may require piling and curing or removal of slashed stems, and removal of accumulated fine litter around trees that are retained. Fire scarred trees and snags may require special attention (e.g. surrounding fuel control, fire retardants) in order to persist.

Generally burns are conducted in the spring. Prescribed burns are lit only when various critical factors come together on the same day. During the six or seven weeks in spring when burning is safest, there may be only three to five suitable weather events, and on particularly poor years there may be none. Understory burning is more complex than grassland burns as it can only be done during a very limited set of parameters: it has to be dry enough to consume the fine fuels but not too dry that fire intensities will cause tree crown scorching. Even when the indices are right, other factors on the day such as wind speed and direction and temperature and relative humidity can affect the decision to burn (Phil Ranson, personal communication). Experience in the northwestern United States shows that burns can be successfully and safely carried out in the autumn (Rocky Mountain Trench Committee 2006), however fall burns are not typically done in BC. Often the drier ground fuel conditions in autumn will cause greater fire intensities and depth of burn, while in spring there is still good moisture at the sub surface level.

Costs associated with the burn will vary greatly depending on site layout, size, the preparation required to provide secure control lines and the degree of mop-up. Burning must be overseen by a ‘burn boss’ (often associated with the MOFR Protection Program) and done according to a burn plan (Phil Ranson, personal communication).

Photo: Fred Knezevich (Knezevich 2000)

Figure 4: After spring burning. Note that only the small trees were killed.

Photos: Rocky Mountain Forest District

Figure 5: Burning in a sloop is a low-impact way to dispose of the small trees cut during slashing. Sloop-burning produces less smoke and less soil damage than pile-burning slash on the ground. Sloops used in the Trench restoration program are made in the East Kootenay from ore cars once used underground in Kimberley's Sullivan Mine (photos and text from Rocky Mountain Trench Committee 2006).

11.2 Knockdown and manual removal of encroachment

Knockdown is a technique recently used to remove encroaching trees from grassland sites in the Cariboo region. Provincial staff have had positive results with this pilot project. The temperature must be –5^{o} C or lower (with night-time temperatures –10^{o} C or lower) for trees greater than 2.5 cm basal diameter to break off using a Caterpillar 966 loader or similar machine with the blade (or replacement tubing) elevated at 15 – 30 cm above ground level

(see Figure 6). Speed is important. Various other logistics and equipment are described by Knezevich (2000). Cost-wise, the preliminary results for knockdown compare very favourably against manual removal, as densities and tree species do not significantly affect the cost per unit area. In treating 0.4 hectares (1 acre), machine costs were $15/acre compared to manual labour costs that varied widely based on density, but averaged between from $16.25 to $360 for the same area. The few big trees scattered among smaller encroachment (i.e., bigger than 30 cm diameter) are removed by chainsaw. A prescribed burn is required afterwards to deal with the ground debris, and properly timed (to generate maximal heat) will kill those trees that were not completely severed from their root system, or kill live branches attached to stumps. Some trees may be too small to be killed by knockdown, and too large to be killed with the first fires (before grass fuels build up – which may take five or more years) and the site may need to be mechanically re-treated (Knezevich 2000).

Photo: Fred Knezevich (Knezevich 2000)

Figure 6: Typical encroachment at the edge of a tree island.

Photo: Fred Knezevich (Knezevich 2000)

Figure 7: Aftermath of trees, post-knockdown. Note how the smaller trees did not break.

Encroaching trees are also removed using chainsaws and brushsaws, and depending on size the trees can be used for Christmas trees. Mechanical control is an effective option for older encroachment. Prescribed fire can prune the lower branches making the trees easier to cut.

11.3 Harvesting/Slashing for Open Forest

Traditional selective harvesting removes stems from across all diameter classes, or removes only the larger, higher quality stems. Thinning from below removes the smaller diameter classes only, to create more open forest conditions, usually with a remnant stand of larger trees. In some cases this activity is commercial (i.e. where the stems are larger than 12.5 or 17.5 cm in diameter and can be sold to a mill), but there is often a mix of stems including sizes that are non-merchantable. Those are handled differently, i.e., they may be 'slashed' or non-commercially thinned instead. Often, little of the volume to be removed is commercially viable. Depending on volume slashed and subsequent fire risk or prescribed burn planning, stems may be left where they fall, may be piled and cured for later burning (typically the following year), or may be removed from the site altogether. Gray and Blackwell (2000) discuss various fuel management options tested for thinned stands near Squamish, B.C. In these operations, choosing which trees to leave behind is the most important activity, and the leave trees should have good form and vigour.

Photo: Tanis Douglas

Figure 8: Slashpile drying before burning in the East Kootenays

Thinning from below is often discussed as a strategy for mule deer winter range, and the commercial logistics for this kind of activity are discussed in detail by Day *et al.* (2000 and 2003). In general, the economics are marginal due to the low volumes per hectare of small logs.

Once the stands are opened up, open forest conditions will need to be maintained over time, typically by utilizing prescribed fires applied at 10-20 year intervals. After harvesting and slashing activity, multiple fires under conditions that gradually remove fuels may be required.

The series of photographs below depict the steps used to open up a closed forest in a demonstration project overseen by the Ministry of Forests, Cariboo Region in 2002, and are taken from Douglas (2003). The commercial harvesting portion of this project was undertaken by Riverside Forest Products.

Photo: Ordell Steen

Figure 9: Dense, closed Douglas-fir stand pre-treatment. Note the lack of understory vegetation and the mosses.

Photo: Ordell Steen

Figure 10: The same stand post timber harvest, all stem diameters down to 12.5 cm dbh were taken and stand openings were purposely created by the harvest of these small stems, by widening skid trails and by intentional damage to many juvenile stems.

Photo: Ordell Steen

Figure 11: The stand post juvenile thinning. The Ministry used the same contractor that Riverside hired to do the mandatory post-harvest stand slashing, thereby realizing cost efficiencies. The thinning treatment removed stems not likely to have a strong growth response or that weren't likely to form a quality crop tree.

Photo: Ordell Steen

Figure 12: Following thinning, an underburn was conducted on a portion of the area. This was the first of a two-stage burn and was conducted primarily to remove fine fuels and reduce fire hazard. A future burn will be needed to remove larger fuels. On unburned area, the thinning slash was left on-site.

11.4 Treatment Costs

As part of this project we attempted to gather unit costs for various treatment types in various regions of the province. We had limited success in this endeavour, as outside of the Trench,

the levels of activity, workforce capacity and techniques are not yet developed enough to have replicable or predictable unit costs. It is expected that once more restoration activity ensues in areas of the province outside the Trench, the unit costs will come down. Additionally, when commercial harvest is done, revenues received are not generally put against the cost of the restoration work - in those situations a true accounting is not done.

Costs vary greatly depending on conditions and the below provides only a very rough estimate. Any burning near to infrastructure or values at risk will be more expensive. Costs don't typically include the cost of government staff time in prescription development and oversight – the costs below are primarily labour costs.

Treatment Type	Estimated Cost Range per hectare		
	Okanagan	Trench	Cariboo
Prescribed grasslands burning	$100-$300	$50 - $100	$50
Prescribed understory burning			$200 - $250
Pile burning		$150 - $225	
Slashing and Thinning (some merchantable volume removed before treatment)	$500-$800		$300
Slashing and thinning without commercial harvest (open forest condition	$2,000-$4,000		
Slashing, and piling (burning)		$150 - $300	$400*
Logging costs			$40 per m3 to truck, logging cost depends on volume per hectare

*estimate for thinning, for a future where a restoration program is underway and various contractors are for hire. Current costs would be much higher

12. Data and Mapping Gaps for Setting Restoration Priorities

As discussed in Section 7, mapping of current conditions and developing restoration needs and priorities across the provincial extent of NDT 4 ecosystems has not been done. The Grasslands Conservation Council is beginning the process of identifying high priority grassland conservation areas in each of the major regions across BC. This will fill a major information gap and address a high priority need. However the extent to which this process will address areas that were formerly grasslands and are now forested is not clear – the new grassland inventory used for this exercise describes the current extent of grasslands only. The encroachment mapping projects that have been done (as described in GCC 2003) will likely be used in describing areas that are a priority for conservation, but the total area of encroachment is much greater than that described in these site-level or sub-regional encroachment assessments.

Areas of in-filled, formerly open forests are not well described. In the Cariboo region, some land managers assume that the entire regional area of the IDF zone suffers from in-fill. If fire has been excluded from IDF and PP forests for significant periods of time (and if harvesting, insects or disease have not significantly opened these stands up) it is safe to assume that the stand structure and composition has changed. There is significant consensus that the state of many of these stands needs to be addressed. To set restoration priorities, the

appropriate data is required to discern the areas or ecological types to treat. Equally important, managers need to describe the restoration goals and desired future conditions.

According to a former mapping expert from the Grasslands Conservation Council, it is theoretically possible to use GIS to locate areas where forests are in-filled or encroaching; the difficulty is choosing which parameters to use for this exercise (Ryan Holmes, personal communication). Currently, one exercise is planned to do just this for the Okanagan MOE Region (as described in Section 7.4) – this project will test two different Geographic Information System (GIS) methodologies to locate priority areas for treatment. The results and lessons learned from this project need to be applied to other areas. Ultimately, each sub-region of the MOFR Southern Interior Forest Region (i.e., the Cariboo, and the Thompson and Okanagan) needs to have its landscapes mapped according to priorities and desired future condition. (The East Kootenays is already zoned and managed in this fashion).

One complicating factor is mountain pine beetle in ponderosa pine stands. The risk to these stands from mountain pine beetle would need to be examined to determine if treating these stands would reduce the risk of tree mortality from beetle. Beetle proofing in lodgepole pine has had some success, it is not clear if it would have similar results in ponderosa pine.

13. Current Barriers to Widespread NDT 4 Restoration

The following barriers to widespread NDT 4 restoration have been identified by various agency personnel, and by our project team:

- Lack of a strategic prioritization framework and associated management direction and focus as to where open forest conditions or grasslands are to be developed or maintained. Lack of targets to be achieved.
- Lack of stable and adequate funding to address highest priorities, at an appropriate scale. Habitat Conservation Trust Fund (HCTF) funding is widely used to address NDT 4 ecosystems, however their funds are not adequate to address the issue on a provincial scale. Additionally, HCTF funds generally need to be directed towards hunted species and hence projects directed at other species at risk are not funding priorities.
- Limited technical expertise, particularly for prescribed burning. Qualified burn bosses outside of the MOFR protection program are in short supply. Technical expertise for other areas of restoration, e.g., creating open forest through both commercial and non-commercial harvesting/thinning, is also limited and can only grow with stable funding.
- Limited staff resources available from MOE and MOFR.
- Limited workforce capacity, e.g., silvicultural contractors, particularly with the current focus on MPB issues (a problem solved with adequate stable funding).
- Lack of central data collection and tracking. Central, long-term storage and collation of reports and data is a need common to various government initiatives. In order for good long term planning and adaptive management to occur in NDT 4 ecosystems, projects undertaken need to be tracked and data recorded in a fashion accessible over the longer term. This need became evident in describing the NDT 4 work carried out to date – poor or no records are available regarding project goals and outcomes for the vast majority of work done to date, and in some cases there is no record of a project's existence. Additionally, to properly address the landscape, the total amount

of open habitat must also be tracked, i.e., open forest or grassland conditions resulting from harvesting, fires or forest heath conditions.
- Current forest policy and appraisals and the quota system present significant institutional barriers to NDT 4 restoration. Areas that are uneconomic to log are low priority for treatment. Fluctuating timber markets also pose a barrier as restoration schedules (where harvest is required) are determined by economic factors. There are very limited markets for the small-diameter logs extracted from restoration treatments.
- Stocking standards and free to grow standards that do not adequately address other forest values.
- Limited public awareness regarding the condition and importance of NDT 4 forests and grasslands, and public concerns regarding smoke.
- Public perception that all forest fires are bad and should be quickly controlled.

Other potential limitations or barriers identified by Phil Ranson (MOFR Protection Program, personal communication) include the shift of MOFR Fire Management resources towards interface projects, which are geographically limited and hence offer only limited benefits to addressing NDT 4 restoration priorities for other (non-infrastructure) values. Additionally, conditions that are conducive to prescribed fire are also conducive to wildfire, leading to a reluctance for MOFR to commit fire management resources (i.e., fire crews and equipment as well as 'overhead') too far, too often. In other words, the Protection Program cannot be looked upon as the sole provider of expertise if there is a shift towards reintroducing fire into ecosystems.

14. Recommendations

1) Revive or re-form interagency committees to address NDT 4 ecosystem concerns. In the Southern Interior (Thompson and Okanagan MOE Regions), the previous Kamloops NDT4 committee needs to be revived or a new committee formed. The same is true for the Grasslands Strategy Working Group in the Cariboo. It is these committees that would be responsible for Recommendations #4 and #5, and partly responsible for #3.
2) Create a Southern Interior Forest Region NDT 4 committee, which interacts with the sub-regional (Cariboo, S. Interior/Kamloops and Trench) committees. This recommendation to set up an overarching committee was widely agreed upon by agency staff participating in this project, so that information can be shared more easily and a more strategic focus applied to the problem. This committee could be responsible for Recommendation #3, and could also be responsible for setting management objectives that span the entire SI Forest Region.
3) Learn from the strategic restoration framework pilot projects currently underway (see Sections 7.3 and 7.4); share this knowledge across the SI Forest Region. Build on these approaches to develop a strategic restoration prioritization framework(s) and management objectives that can be applied to the Cariboo Region, and to the Thompson-Okanagan.
4) Based on a strategic framework, zone the landscape according to desired future condition, i.e., designate areas to be maintained in or converted to grassland or open forest conditions. In addition to areas that are to be permanently maintained as open, some areas could potentially be designated as having a certain percentage of their area in open conditions, with the actual locations shifting over time.
5) It is not clear what timber supply impacts may result from managing for open forest conditions. It may be necessary to undertake some level of analysis so that

managers are better able to articulate implications form both the timber and environmental perspectives.

6) Based on a strategic framework, designate the areas that are highest priority to treat in the short term (within the next five years). Identify geographic areas or subject areas that require further inventory in order to address information gaps within the strategic framework.
7) Inform Land and Resource Management Plan monitoring groups of proposed activities, and incorporate their recommendations.
8) Dedicate funding to addressing restoration priorities – stable funding levels should be applied, sufficient to address enough area that treatment of NDT 4 ecosystems can move beyond pilot projects (outside of the Trench). Stable, substantial funding is required in order to build up technical and workforce (and Ministries') capacity to address encroachment and in-fill at the required scale.
9) Designate areas for long-term adaptive management trials, based on critical information gaps that require addressing, (e.g. optimum densities/basal areas for various open forest/understory values, and the effects of treatments on species at risk). Develop partnerships with academia, industry and First Nations to carry out this work.
10) Designate areas for long term monitoring to track the results of the restoration planning and implementation.
11) Create a data management tracking system to handle and store data and reports related to NDT 4 management and restoration. This tracking system should be accessible to any land manager wanting to learn about the restoration goals and outcomes of previously conducted projects. This data management system should be used to periodically report upon the status of NDT 4 management and restoration in British Columbia. This system should also track other events and treatments on the landscape that affect the quantity of open habitats, i.e., the effects of major fires, interface management, and forest management activities outside of those directly addressing NDT 4 restoration/management. A similar web-based system is now being developed for the Trench and will include GIS mapping as well as a project-tracking database – if successful this can be copied.
12) Once short-term priorities are described, develop longer-term (e.g., 10 to 20 year) plans to address ecosystem condition, and update these plans on a regular basis. This kind of planning will be necessary to schedule re-entries to maintain open conditions, and will rely on good project tracking as described above.
13) Within a strategic prioritization framework, use longer-term climate forecasts to help determine areas of the province at elevated risk to wildfire. Recent and ongoing investigations into the relationship between wildfire and climate cycles should assist in this type of planning (see Daniels 2004, Gray and Daniels 2005 and Hessl *et al.* 2004).
14) Investigate the safe use of summer/fall burning. Burns at this time of year will be hotter than spring burns, and thus more effective at killing encroaching trees. Additionally, burning outside of the spring window provides more opportunities for treatment on an annual basis.
15) Research new markets and uses for small diameter stems.
16) Encourage private landowners and ranchers to recover and maintain grassland values, and develop economic incentives to promote such action.
17) Capitalize on the synergies with those doing interface fire planning and implementation within NDT4. There may be opportunities to address habitat objectives while still meeting fuel management objectives. There may also be opportunities to benefit from knowledge gained from implementing the interface program.

18) In light of government re-organization over the last few years, revisit the existing Memorandum of Understanding (MOU) or develop a new MOU on specific agency responsibilities around prescribed fires. The MOU should address who is responsible for planning, ignition, mop-up, escapes etc.
19) Examine the risks posed to high value ponderosa pine stands from Mountain Pine Beetle, and determine if any 'beetle-proofing' treatments are likely to be effective.
20) Prepare a briefing note for the appropriate Inter-Agency Management Committees, which includes relevant information from the recommendations above. More coordinated management of NDT 4 ecosystems will require management support and direction.
21) Integrate open forest management with ungulate winter range objectives (mule deer, sheep and elk) as much as possible.
22) Increase public education and communication regarding the importance of NDT 4 ecosystems, and regarding restoration initiatives. This will be important, to gain social license for this work and to promote stewardship.

15. Recommendations Regarding Forest Policy and Operational Practices

Forest policy and operational practices are the most efficient way to address the condition of forested NDT 4 ecosystems. At the policy level, a new form of tenure is currently being piloted in the Rocky Mountain Trench. Effective November 2005, the Chief Forester has allotted a volume of 25,000 m^3 annually for restoration purposes. This volume will be targeted at commercially undesirable stands, and will be reviewed in 2010. This addresses the issue of areas that are uneconomic to log under the current quota system, but that need restoration attention. This approach could also be tried in other areas, as it appears to be the most promising way to effect large scale restoration. A potential drawback is the marketability of the small stems that are extracted.

There has been discussion regarding allocating First Nations timber harvesting rights, perhaps some of this new harvest could be directed at small stems, as many Indian Reserves are within NDT 4 and the crown lands adjacent to these areas are often good candidates for management. Non-renewable forest licences targeting specific dense stands provide more options that could be considered. Other potential initiatives that could promote restoration activities include changing the rules for sorting/marking of harvested stems between 12.5 and 17.5 cm diameter (grade 6 logs) – currently the requirement for keeping these stems separate can make it uneconomic to handle them.

At the operational level, NDT 4 restoration/management objectives could be incorporated in the following ways:

- Relieve licensees of stocking obligations in areas designated under the strategic framework(s) as open grassland or open forest;
- Remove from the timber harvesting land base those areas designated in strategic planning frameworks as open grassland, so that they do not falsely contribute to timber supply;
- Before planting trees into areas affected by wildfire, confirm whether this fits into strategic objectives regarding open habitats.

16. Priority Sites for Restoration and Adaptive Management

Part of the original intent of this project was to develop a list of projects that could proceed immediately to address high priority values. Only a very short list was developed, because most participants agreed that a strategic prioritization framework was a necessary first step. The few projects that were identified were acknowledged as not necessarily being of highest priority or addressing all the necessary values, in the absence of this framework. No immediate high priority projects were identified in the Cariboo Region. The following projects were identified in the Thompson MOE region as candidate areas for restoration/ enhancement for their range, wildlife, and/or "interface" interests.

1) Skull Mountain SRMZ: monitor stocking densities consistent with the Skull Plan, to manage for open forest conditions and maintenance of grassland. This area has range and wildlife values.
2) The geographic area south of Lillooet on the west and east side of the Fraser River. Values include range, interface and wildlife.
3) Restoration/management of "recruitment" Old Growth Management Areas (OGMAs) that have been identified and mapped in the ponderosa pine and Douglas fir zones, and that do not have old growth characteristics. Priority should be placed on the Kamloops LRMP area, because OGMA placement was constrained by LRMP direction.
4) South slopes along Kamloops Lake between Carabine and Tranquille Creek. Values include range, interface and wildlife.
5) Hat Creek/Medicine Creek area, for range and wildlife values.
6) Bonaparte River south of Scottie Creek, for range and wildlife values.
7) South of Stump Lake, for range and wildlife values.
8) Southwest of Trapp Lake, for range and wildlife values

Again, we must emphasise that many were reluctant to commit to identifying areas on a map until such time as a strategic prioritization framework was in place.

In addition, we were provided with a prioritized list of locations in the Kamloops Forest District to address range values affected by encroachment, see Appendix 4 and Section 7.4. From this list, only those areas with both range and wildlife values were mapped, and are shown in Appendix 6 on map 4 (Kamloops Resource Management Zones and Wildlife Values).

Two areas that require further discussion with respect to prioritization for treatment are Old Growth Management Areas (OGMAs) and mule deer winter range.

When OGMAs were established in the Kamloops LRMP there was a 4% cap on their impact on timber supply, and consequently many were located within Parks, Protected Areas and deer winter ranges. These OGMAs are shown in Appendix 6 on map 4 (Kamloops Resource Management Zones and Wildlife Values). Many of these OGMAs were established based on forest cover labels and may not provide the necessary attributes normally associated with old growth forests. Some of the OGMAs contain dense Douglas fir and/or ponderosa pine thickets and will not have old growth characteristics in the foreseeable future. Also, high fuel loading and crown closure places these stands at risk in the event of wildfires. Tunkwa Park, Arrowstone Protected Area, Roche Lake Park, Lac Le Jeune and to a lesser extent Lac Du Bois Grasslands Protected Area have a component of NDT 4 within them and believed to

have higher fuel loads. Managing lower elevation stands, particularly those growing on south or south west aspects, in more open forest conditions will reduce the risks of crown fires and permit stands to express old growth characteristics quicker than without intervention. Once these stands have been treated it should be possible to maintain these stand conditions with periodic prescribed burns.

Mule deer are a species whose habitat needs are described by land use plans and their supporting documents. In NDT 4 forests, mule deer winter ranges are an important social priority. As described in Sections 7.2 and 7.3, plans exist that give direction on providing certain canopy closure and forage requirements – these requirements mean that forest densities will need to be reduced. These areas may be a high priority for agencies to address, though as discussed in other sections, canopy closure requirements will typically be higher than the open forest definition in Section 6.1.

A list of proposed adaptive management trials was another expected output. Again, this list is very preliminary in nature due to the lack of strategic information available. No adaptive management trials were identified for the Thompson and Okanagan regions by agency staff, though we expect that the Opax Mountain and Isobel Lake trials carried out by MOFR staff can continue to be a source of information. For the Cariboo Region, adaptive management trials were identified from projects where treatments had already occurred, and continuing data collection and further treatment is required:

1) Farwell canyon. This project near Williams Lake was initiated in 2001 and pictures of work done are included as Figures 9 - 12 in this report. Density reduction and under-burning were conducted in an operational context, to manage for biodiversity, forage and timber. Follow-up monitoring is required to understand treatment effects. Monitoring is needed for understory vegetation (species composition and cover, species richness, grassland/dry forest species and invasive species), forage production (biomass), tree growth rates, tree survival and vigour, and density of tree regeneration. Future burns are also required when sufficient grass has developed to carry the fire.
2) Clumpy spacing for mule deer winter range in the Cariboo. This project was initiated in 1990, and data collection is required on growth and yield and direct measurements of wildlife response.
3) Stein Valley. This area in the Lillooet Forest District is under study by Simon Fraser University Professor Ken Lertzmann and could be used to explore fuel management/fire risk and ecosystem structure restoration. According to Ken Lertzmann, significant data is already available regarding historical fire regimes and stand structure, and First Nations involvement and interest in the area is high. This area also contains ‘interface’ issues. A graduate student working with Ken is potentially available to design adaptive management trials.
4) The Skull Mountain Special Resource Management Zone (SRMZ) is an 8,000 ha area identified in the Kamloops LRMP as an area to be managed for wildlife and biodiversity. A wildlife management plan was completed for the SRMZ and approved by the Kamloops LRMP monitoring table in 1997. Five studies have already been done under the Forest Investment Account to monitor deer and birds, to determine the effectiveness of prescriptions done to mimic low intensity fires. Prescriptions retained the largest diameter Douglas fir trees with all other stems removed to a maximum retention of 10-25 trees per ha. The plan also provided for natural regeneration rather than planting. The plan also identified significant reductions in stocking standards in the IDFxh2 and IDFdk2. It is not certain how closely this part of the plan was followed.

The 2003 McGillvray fire burned over much of the NDT 4 area within the SRMZ. In 2004, salvage harvesting removed much of the standing dead wood across the area. It is not clear what stocking densities were used after salvage harvesting. There are opportunities to implement some adaptive management trails specific to managing for open forest conditions and grasslands in the Skull SRMZ. The focus would be to manage the regeneration coming back on the area post fire. The following is a list of ideas that could be considered and built into the management plan. To a large degree these proposals are still consistent with the intent of the 1997 Skull Wildlife Plan:

- Stratify the landscape within Skull SRMZ into areas to be managed as open forest and grasslands.
- Establish a grassland benchmark within the Skull SRMZ as a first step and develop strategies to manage future encroachment.
- Map areas to be managed as open forest conditions and manage stocking levels to ensure that open forest conditions are maintained over time.
- Within the Skull SRMZ there is an opportunity to monitor the response of wildlife, shrubs grasses and forbs under different stocking regimes.
- Work with the licensees/ other agencies to come up with stocking regimes that manage for both timber and other values across the landscape. Not necessarily on the same piece of ground.
- Manage the regeneration following the fire or salvage harvesting to be consistent with the plan objectives.
- Revise the Skull Management plan to reflect these changes and get support from the LRMP monitoring table.
- Examine data collected to date to determine specifics of adaptive management trials.

17. Effectiveness Monitoring

An effectiveness monitoring plan (including specifics related to proposed trials) was part of the original terms of reference for this project. However, this kind of planning cannot be done in the absence of a prioritization framework and a specific list of projects or types of projects to be completed. We can identify the kinds of effectiveness monitoring likely to be important to conduct - either within adaptive management trials or as part of program-level or individual project monitoring.

Work done in the Trench could be used as a starting point for effectiveness monitoring planning in the Southern Interior Forest Region. The Rocky Mountain Trench Ecosystem Restoration Steering Committee (2006) commissioned an effectiveness monitoring plan in 2002. This report identified 13 restoration objectives and their associated response variables that should be used to track and measure results. The Steering Committee distilled these down to eight objectives, four of which are considered high priority for monitoring ER program results:

- Stand structure and overstory vegetation: crown closure, tree density, diameter, species and decay class.
- Understory structure and composition: grass, herb and shrub percent cover by species, species richness and composition.
- Status of weed species: percent cover by weed species, number of weed species.
- Forage production: kilograms per hectare by species, grazed and ungrazed.

Monitoring for wildlife species response, coarse woody debris, soil conditions and forest health are considered by the Committee to be lower priority due to high costs and have not been included (Rocky Mountain Trench Committee 2006).

These recommendations seem like a good place to start. The objectives chosen for effectiveness monitoring by the SI Forest Region or sub-regions will likely be similar but will depend on the strategic focus. For good effectiveness monitoring to happen, restoration objectives must be clearly stated in advance and must be measurable (quantitative). The regional committee(s) will need to set clear and measurable restoration objectives. Questions that could be answered or further clarified by effectiveness monitoring/adaptive management trials include the following:

1) Which tree densities/basal areas/crown closures or other (e.g.. understory) characteristics are optimal for which specific resource values (e.g. desirable species or habitats, biodiversity or commodity values, reduced fire risk) in open forests?
2) What effect do various treatments have on open habitat-dependant listed species, and other managed species?
3) What effect do various density reduction treatments have on timber values?
4) What effect do various density reduction and burning treatments have on range values (understory response)?
5) What effects do treatments have on the establishment and spread of invasive plants?
6) How can invasive plants be minimized on treatment sites?
7) Which prescribed fire treatments (e.g. timing) or combination of treatments are optimal, under which conditions?
8) What effect do treatments have on fuels and fire risk?
9) What effect do treatments have on forest health (insect/disease presence)?
10) What effect do treatments have on forest stand structure and composition, wildlife trees and coarse woody debris?
11) What effect do treatments have on soils?
12) Which treatment methods are the most ecologically- and cost-effective?
13) Is the restoration program as a whole meeting its goals (e.g. forage, biodiversity and timber targets, area treated annually)?

Effectiveness monitoring is different from implementation monitoring, which involves a mostly qualitative post-treatment assessment to determine if the desired prescription has been achieved. Most treated locations will have only this lower level of monitoring. Effectiveness monitoring is much more resource intensive and will occur only at a small sub-set of treated sites. Good implementation monitoring sets the stage for effectiveness monitoring. Implementation monitoring is particularly critical in correctly evaluating the effects of prescribed burning, as fire and post-fire conditions cannot be predicted based on the prescription.

Monitoring efforts will need to be well documented and communicated to promote adaptive management. Good project tracking (as mentioned in Section 14) will be critical and needs to be done in a centralized manner.

Monitoring should be done across the different biogeoclimatic zones in the NDT 4.

18. Priority Next Steps

While we believe that all the recommendations in sections 14 and 15 are priority, the following is a short list of key steps to be taken in the near term to facilitate a transition to improved management of NDT 4 ecosystems. Some items are also highlighted because of their current management relevance:

- Re-establish the relevant committees in the Thompson/Okanagan and Cariboo MOE Regions, through communications with the regional Inter-Agency Management Committees to obtain the necessary management direction and support.
- Review the recently completed, strategic NDT 4 priorities/mapping project done for the Okanagan MOE region, to determine if it can be transferred to other regions.
- Initiate some form of strategic-level mapping and priority setting to delineate areas to be managed for open forests and open grasslands.
- Specifically map and assess areas where priority work can be undertaken in the short term with minimal timber supply implications, e.g., OGMAs in the IDF and PP zones, and Parks and Protected areas.
- Initiate actions and consultations to understand the timber supply implications of managing for open forest conditions, to facilitate multi-year, landscape-level strategic restoration planning and implementation.
- Explore opportunities for synergies with fuel reduction planning currently happening in wildfire interface zones surrounding communities.
- For areas recently burned by wildfires (or areas burned in future), manage stocking densities to levels consistent with NDT 4 objectives. In some cases this will mean leaving the site unplanted, in order to regenerate to open conditions.
- Explore the forest policy option of developing an AAC for restoration purposes, in areas outside of the Trench.

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Appendix 1 – Persons Consulted

Persons consulted by phone or email only:

Name	Title/Affiliation
Sue Crowley	Ecosystem Biologist, MOE Invermere
Tom Lacey	Contractor Interface Fire, Merritt
Ken Lertzman	SFU Researcher
Murray Henry	Fuel Management Specialist Kamloops

Attendees at the Williams Lake Meeting, January 17th, 2006:

Name	Title/Affiliation
Roger Packham	Senior Ecosystem Biologist, MOE Cariboo
Harold Armleder	Research Wildlife Habitat Ecologist, MOFR, Southern Interior Region (Williams Lake)
Ray Coupe	Research Plant Ecologist, MOFR Southern Interior Region (Williams Lake)
Phil Ranson	Forest Protection Technician, MOFR Cariboo Fire Centre
Becky Bings	Ecosystem Biologist, MOE Cariboo
Chris Easthope	Range Officer, MOFR Central Cariboo Forest District
Chris Armes	District Agrologist, MOFR Central Cariboo Forest District
Ordell Steen	Board Member, Grassland Conservation Council
Ryan Holmes	Spatial Information Analysis, MAL, Cariboo Sub-Region (and former mapper for GCC)
Julie Steciw	Wildlife Biologist, MOE Cariboo
John Youds	Section Head, Ecosystems, MOE Cariboo
Rick Dawson	SRM Officer, MAL Williams Lake
Ken Day	UBC/Alex Fraser Research Forest (Williams Lake)
Glen Davidson	Section Head, Parks and Protected Areas, MOE Williams Lake

Attendees at the Kamloops Meeting, January 19th, 2006

Name	Title/Affiliation
Fred Baxter	Retired, MOE
Glenn Heyes	Retired, Range, Cascades Forest District
Phil Youwe	Range Officer, MOFR Kamloops Forest District
Alex McLean	Range Officer, MOFR Okanagan-Shuswap Forest District
Rick Tucker	Range Agrologist, MOFR SI Forest Region, Kamloops
Dennis Lloyd	Research Plant Ecologist, MOFR Southern Interior Forest Region, Kamloops
Brent Olsen	Stewardship Officer (Silviculture), MOFR Kamloops Forest District
Jim Mottishaw	Zone Manager, MOFR Penticton Fire Zone, Kamloops Fire Centre
Denis Gaudry	Manager, MOFR Kamloops Fire Centre
Bob Beck	Zone Manager, MOFR Kamloops Fire Zone, Kamloops Fire Centre
Steve Newton	Zone Manager, MOFR Lillooet Fire Zone, Kamloops Fire Centre
Doug Lewis	Ecosystem Biologist, MOE Kamloops
Michael Burwash	Senior Ecosystem Biologist, MOE Kamloops
Harry Quesnel	Regional Fire Management Specialist, MOFR SI Forest Region, Kamloops
Walt Klenner	Research Wildlife Habitat Ecologist, MOFR SI Forest Region, Kamloops
Mike Dedels	Range Agrologist, MOFR Kamloops Forest District
Phil Belliveau	Section Head, Ecosystems, MOE Kamloops
Graham MacGregor	Grasslands Conservation Council

Regrets: Judy Millar, Brian Harris, Rob Stewart, Andre Arsenault, Earl Sinclair, and Bruno Delasalle

Appendix 2 – Meeting Agenda

1) Introductions

2) Overview of project

3) Identify known enhancement/restoration projects planned or initiated within the last five years in NDT 4 that have been written up or in progress. To date we have only identified the following:
(list of projects for each the Cariboo/ the Thompson-Okangan)
Identify other restoration/management work and contacts that you are aware of, but likely not to have written reports.

4) Identify where we have known or suspected infill and encroachment in NDT 4

5) Identify mapping and data gaps that would assist in setting future priorities.

6) Identify challenges in moving forward.

7) What recommendations would you make to improve management of NDT 4 in the Cariboo/Thompson-Okangan and across the SIFR?

8) Cost of treatment per ha

9) Stocking Standards for open forests KBLUP example

10) Other

Appendix 3 – Stocking Standards Under the KBLUP

(see next page for table)

- These management systems would not generally apply to retention forest and old growth management areas.
- * Stems/ha=/> 0.5m as per Establishment to Free Growing Guidebook.
- ** Lead Agency responsible for strategic planning and approvals; operations conducted cooperatively by all listed groups, subject to funding and resources.

Note that the open forest target densities have been recently revised downwards from 250 sph to 150 sph.

Ecosystem Component	Primary BGC Variant/Site Series Targeted	General Management System Proposed*	Connectivity Requirement	Target Stocking Standards (Stems/Ha)*	Minimum Stocking Standard (Stems/ha)	Maximum Stocking Standard (Stems/ha)	Free-Growing Window	Crown Closure Threshold Triggering Re-entry	Responsibility for Implementation *(Lead agency italicized**)*
Shrublands	Various IDFdm2/6 IDFxh1/9 PPdh1/6 PPdh2/4	Inventory and periodic burns	none	n/a	n/a	n/a	n/a	n/a	*Ministry of Forests (MOF)* BC Environment (BCE) User Groups Funding Agencies
Open Range	PPdh1/2,3 PPdh2/2a,2b IDFdm1/2 IDFdm2/2 IDFxh1/2 IDFun (s. facing slopes)	Periodic harvesting, prescribed burning and/or thinning to maintain open range condition, enhancing existing or potential bunchgrass sites.	Maintain connectivity of rangelands	20 of the largest 1/3 of existing diameter range	0	75	2-5 yr	10% max	*MOF, Range* BCE, MOAFF, Forest licensees (Where harvesting occurs), Range Tenure holders, User Groups, Funding Agencies
Open Forest	PPdh1/1,4,5 PPdh2/1,3 IDFdm1/3,4,1 IDFdm2/3,1 IDFxh1/3,1,4,5 IDFun (subxeric to mesic)	Periodic entries of burning, thinning and partial cutting to maintain open forest conditions and rangeland values	Provide connectivity between adjacent Open Range areas. Provide ungulate travel corridors between winter range and winter forest cover.	250 (50 of the largest 1/3 of existing diameter range plus 200 well-spaced)	76 (30 of the largest 1/3 of existing diameter range plus 46 well-spaced)	400	2-5 yr	40% max.	*MOF* BCE, MOAFF, Forest licensees (where harvesting occurs), User Groups, Funding Agencies
Managed Forest	IDFdm1/1,4,5,6,7 IDFdm2/1,4,5,6,7 IDFxh1/6,7,8 IDFun (seepage sites)	Rotational harvest entries using clear-cut or light-overstory shelterwood. Manage for timber, ungulate winter range and approximately two decades of interim rangeland values per rotation.	Maintain connectivity of retention forest and OGMAs through managed forest and open forest ecosystems. Provide winter forest cover for ungulates	1000	400-700	5000	12-20 yr	80% max.	*MOF* BCE Forest Licensees Funding Agencies

Appendix 4 – Forest Encroachment Priorities Developed by Range Staff in the Kamloops Forest District

PROPOSED SITES FOR ECOSYSTEM RESTORATION THROUGH BURNING

RANK	AREA #	RANGE UNIT	TENURE HOLDER	TENURE	WEEDS	MGMNT	RISKS	BENEF	COMMENTS
19	16	Hat Airstrip	Schalles	Licence	5	4	5	5	Extensive, Sage, Py and Fd encroachment
19	15	Hat Sep Lake	Manning	Lease	5	5	5	4	Some Fd encroachment and infilling
19	b4	Red Lake; Copper Creek pasture	Bepple	Licence	5	5	4	5	some areas may benefit sheep only, may be protected from cattle grazing without removal of cattle
18	11	Hat Harry	Manning	Lic	5	4	4	5	Priority on 11 a and b, infilling of Py forest and small openings
18	12	Hat Ambusten	Upper Hat	Lic/Lease	5	5	4	4	12a, Fd onto small openings 12b, Fd infilling 12c Fd encroachment onto large openings
17	3	H.V. Barnes	T. DeBoer	Lic.	5	5	3	4	3a,c,d have infilling Py and Fd. 3bis mostly grass control for management away from seedings

17	13	Bedard	McAllist/Pasco	Lic/Lease	5	4	4	4	encroaching Fd adj to proposed blocks
17	34	Stump	Stump Lake	Lic./Lease	5	4	4	4	Many small patches adjacent to recent Tolko logging
16	14	Hat Brand88	Manning	Lic/Lease	5	4	4	3	infilling of small openings
16	25	Durand Camp Lk	Indian Gardens	Lease	4	3	4	5	Infilling of Fd into Py forest
16	b7	dewdrop east	Frolek	Licence	4	4	3	5	Py/Fd encroach/infill
16	b8	dewdrop west	frolek & WMA	Licence	4	4	3	5	Py/Fd encroach/infill
15	5	Mclean Red H.	DeBoer	Lic	4	4	3	4	Py/Fd encroach/infill
15	17	Scottie	Hunter	Lic	4	4	3	4	Py/Fd encroach/infill
15	21	Guichon	Gardens Creek	Lease	4	4	3	4	
15	35	Beresford	Unallocated	Lic/Lease?	3	5	3	4	
15	36	Bleeker	Willow	Lic/priv	4	3	4	4	
15	37	Bestwick	Boshard	Lic/lease	3	4	4	4	
15	b9	mara north	tranquille assoc	Licence	3	4	3	5	
15	b10	wheeler south	tranquille assoc	Licence	3	4	3	5	
14	4	Guichon	Indian gardens	Lease	3	3	3	5	
14	6	McLeanOr Jack	DeBoer	Lic	3	4	3	4	
14	7	McLean Boston	DeBoer	Lic	4	4	2	4	
14	10	McLean Hat	DeBoer	Lic	4	3	3	4	
14	26	Guichon LogLk	Garthwaite	Lic.	4	4	1	5	
14	28	Durand	Hook/King	Leases	4	3	3	4	
14	29	Durand-Beaton	Bowers	Lic.	3	4	3	4	

14	31	Cherry- Beef	Sugarloaf	Lic/Lease	4	4	2	4	
14	32	Morr Mead	Frolek	Lic/Lease	4	4	3	3	
14	33	Minefield	Frolek	Lic./Priv	3	3	4	4	
14	44	Monte Cr. Duck	Flatt	Lic	4	3	3	4	
14	B1	China Mtn West Pasture	Devick Ranch/Corbould	Lic	3	4	3	4	spring range limited, may be difficult to rest for 1 year.
14	b5	Sabiston; Uren Flats	Indian Gardens/Skeetchesn band	Licence	3	3	4	4	may be SK on site; may be difficulties in complete removal of cattle. Tree encroachment problem
14	b11	noble unit	Tom Dey/Terry Inskip	lease	3	4	2	5	
13	B2	Anglessey E SubUnit	Craig/Bonhet	Lic	2	4	4	3	
13	2	H.V. South	Black Canyon	Lic	4	4	1	4	
13	8	McLean Gulch	DeBoer	Lic	2	4	3	4	
13	9	Maiden	Minnabarriett	Lic	4	2	3	4	
13	20	Rattlesnake	Schalles	Lic	4	4	3	2	
13	23	Durand	Kamlands	Lease	1	4	3	5	
13	27	Guich- Chartr.	Drake	Lic.	4	3	3	3	
13	30	Hughes	Sugarloaf	Lease/priv	3	4	1	5	
13	39	Bestwick-Spring	Camp/McLeod	Lic	3	3	3	4	
13	48	Martin Lav3/4	Milne/Harrison	Lic	3	4	2	4	
12	22	Guichon	Indian Gardens	Leases	2	2	3	5	
12	41	Bestwick-Vista	Campbell	Lic	3	3	2	4	

12	43	Monte Cr Holm	Flatt	Lease	3	3	3	3	
12	46	Martin-Front	Johnson	Lic	3	3	2	4	
12	50	Toney/Moult	Larson et al	Lic	3	3	2	4	
12	51	Harper	Harper/KIB	Lic/Le/IR	2	3	3	4	
12	53	Charles Lee	Corb/SevenO	Lic.	3	2	3	4	
11	24	Durand-Brussel	Kam/Bowers	Lic.	2	2	3	4	
11	19	Cache Perry	Perry	Lease	3	1	2	5	
11	18	Cache Bonapar	Bonaparte	Lic/IR	3	1	3	4	
11	40	Bestwic -BuseH	Campbell	Lease/priv	2	2	3	4	
11	42	Monte Cr-Robb	BarDBar	Lease	2	2	3	4	
11	45	Rio Vista	Hamming	Lic/priv	2	2	2	5	
11	47	Martin-Holding	Camp/Murray	Lic/priv	2	3	2	4	
11	52	Strawberry	Seven O	Lease	2	2	3	4	
11	b3	Fishtrap	Mitchell/Mcdougall	Licence	2	2	4	3	would be for benefit of wildlife
10	1	Pimainus	Curnow	Lic	3	2	3	2	
10	49	Pinant-Niskon	Shaw/Unallocated	Lic/IR	2	2	2	4	
10	b6	Rockpile Unit	Indian Gardens	Lease	2	2	3	3	would be for benefit of wildlife, may have large impacts on lease holder
9	38	Bestwick-Eagle	Campbell	Lic./lease	1	2	1	5	

WEEDS BASED ON EXISTING WEEDS AND POTENTIAL FOR INVASION AFTER BURNING
MGMNT BASED ON ABILITY AND COMMITMENT TO MANAGE AREAS AFTER BURNING
RISKS BASED ON DEVELOPMENTS AND IMPROVEMENT, LIFE AND PROPERTY, SMOKE, NATURAL FEATURES, TIMBER AND FIRST NATIONS
BENEFITS BASED ON IMPROVEMENT TO BIODIVERSITY, PRODUCTIVITY, AND SAFETY

Appendix 5 – Existing Projects Identified by Agency Staff

Existing projects are not described for the East Kootenays (Trench) – we assume that these projects are tracked by the Rocky Mountain Trench Restoration Committee, to support the implementation of the KBLUP. For the other areas of the Southern Interior Forest Region, existing projects were collated from the agency staff that attended one of the two meetings, and referenced to the maps found in Appendix 6. The intent was to identify report information that may assist the development of new projects, or treated areas that could contribute to adaptive management trials or effectiveness monitoring. Additionally, in the Cariboo Region, encroachment projects from 1950 to 2000 are described to the extent possible by McIntosh (2001). The accompanying box of archived files and reports should be available through Chris Easthope, MOFR (Terry McIntosh, personal communication).

The below is not an exhaustive list, but rather the information that was readily available from staff. Ideally, information regarding treatments should be collected in a central database handled by the Ministry of Forests and Range, so that valuable management information can be captured and adaptive management practiced.

Table A: Cariboo Region Known NDT 4 Enhancement/Restoration/Management Activity

LOCATION DOT #	**PROJECT NAME/ACTIVITY** prescribed burn, weed management, pre commercial thinning, commercial thinning, etc	**REPORT Y / N**	**CONTACT NAME/AGENCY AND COMMENTS**	**ADAPTIVE Management trial Y/N year(s)**
1 Big Creek	Spring turn-out/knockdown TERP	N	Chris Armes (MOFR)	
2 Cotton Rd	Cotton Road	Y	Chris Armes (MOFR)	
3 Churn Cr	Sheep migration corridor ecosystem restoration plan – due March 2006		MOE – Becky Bings	
4 Tstlayoko Lake	Tstlayoko Lake Ranch – Nature Conservancy of Canada	?	ILMB – Ryan Homes	
5 Alex Fraser Research Forest	Commercial thinning for MDWR values	Y	Ken Day UBC	
6 Alex Fraser Research Forest	Fuel Reduction Interface Fire after C.T.	Not Yet	Ken Day UBC	
7 Alex Fraser	Prescribed burning after juvenile	N	Ken Day UBC	

Research Forest	spacing			
8 Farwell Canyon	Managing ingrown Douglas-fir for biodiversity, forage & timber: The Farwell Canyon Project	Y	Harold Armleder, SIFR	Initiated 2001
9 Becher's Prairie Area	Grassland restoration Beecher's Prairie	N	Shaw Meisner, Tolko	
10 South Williams Lake	Interface fuel reduction	N	Shawn Meisner, Tolko	
11 Churn Creek	Churn Cr Farm restoration	N	Glen Davidson	
12 Churn Creek	Coal pit basin sagebrush burn	N	Glen Davidson	
13 Churn Creek	Churn Flats burns	N	Glen Davidson	
14 Junction Sheep Range	Junction Sheep grassland burn	?	Glen Davidson	
15 Junction Sheep Range	Junction Sheep encroachment/ingrowth	N	Glen Davidson	
16 Knife Creek	Clumpy spacing for Mule Deer winter range	Y	Ken Day UBC Harold Armleder SIFR	Initiated 1990
17 Williams Lk and Area	Interface Fire Plan	Y	Ken Day UBC Research Forest	

Table B: Thompson and Okanagan Regions

Okanagan TSA

LOCATION DOT #	**PROJECT NAME/ACTIVITY** prescribed burn, weed management, pre commercial thinning, commercial thinning, etc	**REPORT Y / N**	**CONTACT NAME/AGENCY AND COMMENTS**
1 Mahoney Lk	WLGPA (Mahoney Lake) weed management, pre commercial thinning, commercial thiinign, etc	Y	MOE P&PA Rose Gunoff/Ecosystems Judy Millar
2 West Vaseux	CWS – West Vaseux 22 Ha – 03 30/07	Y	Pam Kranitz Dave Smith Canadian Wildlife Service
3 Dutton Cr	Vaseux PA (Dutton Cr)	Y	Parks – Judi Millar

	03 – 60Ha Ecosystem Restoration: thinning, pruning, piling, burning, weed management, prescribed fire		Rob Stewart
4 Shorts Cr	Shorts Cr Sheep 02	Y	MOE Okanagan Rob Stewart/Brian Harris
5 South Slopes	Snowy Protected Area South Slopes Sheep Various	Y	MOE Okanagan Rob Stewart
6 Casorso/Emery Property	Casorso/Emery Property Sheep recovery	Y	Nature Trust Brian Harris Carl McNaughton
7 Red Bridge Cr	Red Bridge Cr/ Horseshoe Canyon	Y	MOE Brian Harris
8 Horseshoe Canyon	Horseshoe Canyon Sheep	Y	MOE
9 Kalamalka LK Park	Kalamalka Lake Ecosystem Restoration and Interface Fuel Reduction Ecosystem Restoration; (thinning, pruning, piling, burning, chipping, weed management and prescribed fire.)	Y	MOE P&PA John Trewhitt, Ecosystems Judy Millar
10 Wolfcub Cr	Wolfcub Cr – Burn thin	Y	Jim Mottishaw/Denis Goudry
11 Arawana	Arawana – Elk – thin – burn	N	MOE Brian Harris
12 Turnbull Cr Greyback	Turnbull Cr Greyback Elk habitat burn/10's	N	MOE
13 Antleres Saddle	Antlers Saddle 83	?	MOE Deer range
14 Faulder	Faulder – Habitat – late 80's	?	MOE Deer range
15 K Mt	K Mountain Goat 2001/02	Y	MOE Brian Harris Rob Stewart
16 Fairview Blind Creek	Fairview/Blind Creek – Range burn	?	F.S. Range
17 West White Lake	West White Lake – Range	?	F.S. Range

Okanagan Projects listed, but not mapped:

- Wildlife-specific habitat restoration projects in Fintry and Snowy Protected Areas
- Kalmalka Lake Park – multiple-year project with thinning, burning, and thinning and burning
- SAR-specific projects done at White Lake Grasslands PA for Whiteheaded woodpecker, multi-year project at Vaseux Lake for Big Horn Sheep and Whiteheaded woodpecker (federal funding for the woodpecker)
- In Kekuli Bay, parks did an experimental burn on 20 ha to see effects on invasives; the outcome was very negative (good for invasives!)

Merritt TSA

LOCATION DOT #	PROJECT NAME/ACTIVITY prescribed burn, weed management, pre commercial thinning, commercial thinning, etc	REPORT Y / N	CONTACT NAME/AGENCY AND COMMENTS
1 M-1	Periodic Spring burns by Prot. Coutlee	N	Tom Lacey/Harry Spahan
2 M-2	Periodic Spring burns above bench	N	Tom Lacey/Harry Spahan
3 M-3	Hamilton Mtn spring burns	?	Tom Lacey/Harry Spahan
4 M-4	Burn SE of Glimpse Lk – rate of Spread	Y/?	Judy Beck, Harry Spahan
5 M-5	Pitney Lake F&W burn	?	Penticton F & W
6 M-6	Pothole Commercial thinning Project	Y	Bill Nash (or perhaps E Nedokus)
7 M-7	Coultee exclosure burn	Y	Rick Tucker
8 Cooke Cr Connely Cr	Prescribe burn following small business logging for elk and deer	N	Tom Lacey/Brian Harris

Kamloops TSA

LOCATION DOT #	PROJECT NAME/ACTIVITY prescribed burn, weed management, pre commercial thinning, commercial thinning, etc	REPORT Y / N	CONTACT NAME/AGENCY AND COMMENTS	ADAPTIVE Management Trials Y/N year
1 Duck Range	Thinned area – Mule Deer Thinning & slashing in the Dry Interior Forest IWS. 1994	Y	D. Ketter	
2 Benton Lk	Thinned area – Mule Deer Thinning & slashing in the Dry Interior Forest IWS. 1994	Y	D. Ketter	
3 Dewdney Heifer Pasture	Monitoring sites ester Heifer Prescribed Burn – Dewdney Pasture	Y	Phil Youwe/Protection DKA	
4 Rouseau Cr	Roy Strang's prescribed burn	Y	Brian Nyberg	
5 Medicine Cr	Prescribed Burn small 04/05 monitoring sites estab	Y	Phil Youwe/DKA Protection	

6 Hat Creek	GEF. Mechanical R pile & burn 98 encroachment S. Medicine Cr 99	N	KDA Mike Dedels	
7 Dewdrop Flats	Tranquille Eco Reserve Plot in Parks 1999	Ag. Canada Y	Parks Bob Shear	
8	Watson Levsen thinning interface	Y	Terry Green	
9 Rosseau Cr	Prescribed Burn 2004	Y (HCTF)	Phil Belliveau MOE	
10 Westwold	Py thinning Westwold Thinned area – Mule Deer Thinning & slashing in the Dry Interior Forest IWS. 1994	Y	D. Ketter, Dave Low MOE	
11 Inks Lake	Thinned area – Mule Deer Thinning & slashing in the Dry Interior Forest L. WS. 1994	Y	D. Ketter, Dave Low MOE	
12	Py planting trial multiple spacing	Y	Rick Tucker	
13 China Mtn	Prescribed burn 1982 – 4 Py burn	Y	Kamloops DWT Phil Youwe	
14 Dry Corner	Spacing Prescribed burn mid 80's		Kamloops Dist – Brent Olson Dave Low MOE	
15	Commercial Thinning Logging/spacing	Y	Kamloops Dist - Brent Olson	
16 Sutto Lake	Thinning	Y	Kamloops Dist – Brent Olson	
17 Skull Mtn	Planting & harvesting/mule deer prescriptions	Y	MOE /Kamloops Forest Dist Mike Burwash	Y 1999?
18 Isobel Lk	Logging to maintain open forest conditions and timber vlaues	Y	Walt Klennar	Y 2001
19 Opax Mountain	Examines different silviculture systems	Y	David Huggard, Andre Arsenault, Walt Klennar	Y 1993

Lillooett TSA

LOCATION DOT #	**PROJECT NAME/ACTIVITY** prescribed burn, weed management, pre commercial thinning, commercial thinning, etc	**REPORT Y / N**	**CONTACT NAME/AGENCY AND COMMENTS**
1 Carpenter Lk	Carpenter Lake Mule Deer Range Enhancement burn	Y	Steve Newton (250 256-1400) - BC Hydro funded (ongoing)
2 Seaton Lk	Retasket sheep range enhancement	N	Steve Newton (250 256-1400)

	Burn 2001		
3 Spences Bridge	Big horn sheep range	N	Steve Newton (250 256-1400)
4 Stein River	Stein Park LET burn 1996	Fire reports only Y	Steve Newton (250 256-1400)
5 Whitecap Cr	Whitecap Fire – limited Action 2004	Y	Steve Newton (250 256-1400)
6 Seaton Lk	Seton Fire 2002 Limited Action	Y	Steve Newton (250 256-1400)
7 Seaton Lk	Seton Fire 2004 Limited Action	Y	Steve Newton (250 256-1400)
8 Carpenter Lk	Terzaghi Fire 2004 Limited Action	Y	Steve Newton (250 256-1400)
9 Carpenter Lk	Range Enhancement Burn No Action – 1986	N	Steve Newton (250 256-1400)
10 Fountain	Town Creek Fire Limited Action – 2004	Y	Steve Newton (250 256-1400)
11 Fountain	Fountain Fire Limited Action 1998	Y	Steve Newton (250 256-1400)
12 Liza Lk	Liza Lake Fire Limited Action – 2004	Y	Steve Newton (250 256-1400)
13 Stein River	Earl Creek Fire No Action – 2004	Y	Steve Newton (250 256-1400)
14 Kwoiek Cr	Kwoiek Lake No Action – 2004	Y	Steve Newton (250 256-1400)
15 Kwoiek Cr	Hanging Valley – 2003 Limited Action	Y	Steve Newton (250 256-1400)
16 Kwoiek Cr	Kwoiek Fire No Action – 1998	Y	Steve Newton (250 256-1400)
17 Lytton	Lytton Fire Limited Action – 1993	Y	Steve Newton (250 256-1400)

Appendix 6 – Maps

Map 1 Cariboo Resource Encroachment
Map 2 Cariboo Chilcotin Resource Management Zones (west) and Wildlife Values
Map 3 Cariboo Chilcotin Resource Management Zones (east) and Wildlife Values
Map 4 Kamloops Resources Management Zones and Wildlife Values
Map 5 Merritt Resource Management Zones and Wildlife Values
Map 6 Lillooet Resource Management Zones and Wildlife Values