Environmental Screening for the Mount Nestor Interagency Prescribed Fire

Banff National Park and Spray Valley Provincial Park

Revised: October 2006

Alberta Community Development

Alberta Sustainable Resource Development

Parks Canada

EXECUTIVE SUMMARY

This environmental screening is for a prescribed fire that is planned for an area around Mount Nestor situated on the boundary of Banff National Park and Spray Valley Provincial Park (Figure 1). Three agencies are involved in the planning and implementation of this prescribed fire including Alberta Parks and Protected Areas, Alberta Forest Protection and Parks Canada.

This is the next of a series of planned burns along the Spray River and one of several trans-boundary fires in the Central Canadian Rockies that will help meet shared ecological and land management goals on a regional scale; goals that would likely not be met without an interagency approach.

The primary goal of this prescribed burn is to restore fire to subalpine forests in order to maintain diversity and abundance of fire dependent species. This goal is part of a larger goal to maintain ecological integrity. Several specific ecological objectives are tied to this goal as well as strategic land management objectives.

The fire is planned for the spring of 2007. The total area of the proposed fire is 1423 Ha. Of this, 560 Ha is in Spray Valley Provincial Park and 863 Ha in Banff National Park. In comparison, the last major wildfire in the area was in 1894 which burned over 10,000 Ha.

The planned fire is rated low complexity according to the Parks Canada Complexity Rating Process (Appendix I). There are excellent containment boundaries, few values at risk, and impacts to park users and nearby communities will be minimal and of short duration. This fire will be ecologically beneficial and mitigate the impacts of nearly seven decades of fires exclusion on the landscape.

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ACKNOLEDGEMENTS

This environmental screening was formulated with contributions from many individuals and agencies. Parks Canada, Alberta Community Development and Alberta Sustainable Resource Development are the main contributors to this assessment. Individuals include Ian Pengelly, Brian Low, Steve Donelon, Scott Jevons and Rick Arthur as well as many others. The assistance of Judy Thomas and the staff of the Alberta Government Library are greatly appreciated.

This environmental assessment is an update of an earlier screening that served for several prescribe fires and fuel treatments in the Spray Valley conducted between 1998 and 2001. The authors wish to acknowledge the contributors of that document:

Parks Canada. 1998. Cumulative environmental effects screening for fire management in FMU 20 & 21, (the Middle and Upper Spray Valley, Bryant and Turbulent Creeks) for the period April 1998 – November 2000. Parks Canada, Banff, AB. 47 pp. + appendix.

Suggested Citation

Alberta Community Development, Alberta Sustainable Resource Development and Parks Canada. 2006. Environmental screening for the Mount Nestor interagency prescribed fire: Banff National Park and Spray Valley Provincial Park. Canmore, AB. 89 pp. + appendix.

INTRODUCTION

This environmental screening is for a prescribed fire that is planned for an area around Mount Nestor on the boundary of Banff National Park and Spray Valley Provincial Park (Figure 1). Three agencies are involved in the planning and implementation of this prescribed fire including Alberta Parks and Protected Areas, Alberta Forest Protection and Parks Canada.

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The fire is planned for the spring of 2007. The total area of the proposed fire is 1423 Ha. Of this, 560 Ha is in Spray Valley Provincial Park and 863 Ha in Banff National Park. In comparison, the last major wildfire in the area was a 10,000 Ha fire that burned in 1894.

The planned fire is rated low complexity according to the Parks Canada Complexity Rating Process (Appendix I). There are excellent containment boundaries, few values at risk, and impacts to park users and nearby communities will be minimal and of short duration. Due to natural barriers (rock, water bodies and tundra), wind patterns, and previous modification of fuels in strategic areas, there are many barriers that can be used to contain most planned and randomly ignited fires within these landscape management units (LMU[1]).

Objectives of Review

This environmental screening is done in accordance with the draft environmental review policy of Alberta Community Development, Parks and Protected Areas Division (PPAD) (2006). PPAD recognizes that environmental review for new projects and activities within the Parks and Protected Areas system is essential in order to meet the following objectives:

1. To identify potential impacts in order minimize, mitigate or avoid negative impacts before they occur

2. To formally incorporate environmental factors into decision making and approval process

The environmental review policy states that all new projects and activities will be evaluated if projects or activities introduce a new disturbance into an otherwise natural setting:

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[1] Landscape Management Units (LMU) are now used by Banff National Park in place of Fire Management Units (FMU).

PPAD Environmental Review Policy Statement

PPAD recognizes environmental review as a necessary tool for anticipating, evaluating, mitigating and reducing negative impacts in Alberta's Parks and Protected Areas System. Environmental review will be required for all new projects and activities which have the potential to impact people, landscapes, biodiversity, natural processes or natural, historic and cultural features.

For Parks Canada, the environmental review will ensure the planning and implementation of the prescribed burn complies with the *Canadian Environmental Assessment Act* (CEAA), Directive 2.4.4 of the federal *Species at Risk Act* (SARA), *Banff National Park Management Plan* (Parks Canada 1997) and *Banff Field Unit Fire Management Plan* (Parks Canada 2001a) as well as other applicable legislation and policy.

Review Components

This review identifies and evaluates:

a) Ecological impacts
b) Cultural impacts
c) Cumulative impacts
d) Knowledge deficiencies
e) Mitigation measures
f) Residual impacts[2]

Mitigation measures for impacts include:

- Modifications to the project or activity design or location
- Alternative construction techniques or timing
- Staff supervision requirements during the lifetime or selected phases to ensure environmental compliance
- Alternative operational practices once a project or activity is completed
- Follow-up monitoring requirements once a project or activity is completed

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[2] Residual impacts are impacts that will endure for the long term after mitigation is completed.

Scope

This review considers cumulative effects from fire suppression, fuel modification, guard construction, planned and random fires and human activities before, during and after the prescribed fire, including research and monitoring.

Limitations

Fire is a beneficial ecosystem process that has shaped vegetation and animal communities for millennia. Plant and animal communities around Mount Nestor not only survive the regular occurrence of fire, many species need fire to exist or thrive. Planned burning, if done in a way that closely emulates the ecological role of fire, should be beneficial. Fire restoration mitigates the impact of fire exclusion.

We need to recognize however, that some forest conditions are now far outside the historical range of variation and that there are significant other human impacts to consider. Fire restoration activities may not closely mimic historical fire patterns and the impacts of fire may be greater on some species than in historical times.

For these reasons, we need to be cautious about our assumptions about the benefits of fire. Overall, we can expect that fire will have a net benefit, but fire may have significant impacts on some species. Impacts on rare or endangered species in particular need to be carefully assessed and monitored.

PROJECT EVALUATION

Policy and Legislation

All new projects and activities on lands managed by Alberta Parks and Protected Areas are evaluated to determine appropriateness by determining how projects relate to:

a) Legislation
b) Divisional policy
c) Site classification
d) Management direction for the site

The prescribed burn must comply with the *Provincial Parks Act* of Alberta and the *Peter Lougheed & Spray Valley Provincial Parks Management Plan* (Alberta Community Development, Parks and Protected Areas 2006a) as well as other applicable legislation and policy.

Peter Lougheed and Spray Valley Provincial Parks Management Plan

The Mount Nestor prescribed fire plan is consistent with the direction of the *Peter Lougheed and Spray Valley Provincial Parks Management Plan*. The plan states:

> *Where feasible, natural processes of vegetative change will be permitted including wildfire, flooding, avalanche, and insect and disease infestations. Techniques such as prescribed fire or non-commercial selective logging may also be used to accomplish vegetation management objectives.*

(Alberta Community Development, Parks and Protected Areas 2006a)

Alberta Parks and Protected Areas, Strategic Direction

The burn plan is aimed at meeting the vision, mission, goals and guiding principles for the Parks and Protected Areas program. Specifically, the vision statement includes a statement about preserving natural processes. Fire is one such natural process:

> *Alberta's parks and protected areas preserve in perpetuity landscapes, natural features and processes representative of the environmental diversity of the province.*

(Alberta Community Development, Parks and Protected Areas 2006b)

For Parks Canada, planning and implementation of the prescribed burn must comply with the *Canadian Environmental Assessment Act* (CEAA), Directive 2.4.4 of the federal *Species at Risk Act* (SARA), *Banff National Park Management Plan* (Parks Canada 1997) and *Banff Field Unit Fire Management Plan* (Parks Canada 2001a) as well as other applicable legislation and policy.

Banff National Park Management Plan
The prescribed fire plan is aimed at partially meeting the following goals of the BNP management plan:

- Restore the role of fire in modifying vegetation communities
- Maintain and restore key structural components of the park's vegetation
- Achieve 50% of the long-term fire cycle by means of prescribed burns and non-suppression of lighting-cause fires

A policy context was prepared for fire management in the mountain national parks (Lopoukhine 1996). Readers are also directed to the *National Fire Management Strategy – Parks Canada Agency* (Parks Canada Agency 2005).

PROJECT DESCRIPTION

Project Goal

The primary goal of this prescribed burn is to restore fire in subalpine forests to maintain diversity and abundance of fire dependent species. This goal is part of a larger goal to maintain ecological integrity. Several specific ecological objectives are tied to this goal as well as strategic land management and research objectives.

Ecological Objectives

Several specific ecological objectives will be addressed by this prescribed fire:

1. Restore diversity of vegetation ages, structure and composition that is more representative of the historical fire regime in subalpine forests.

2. Re-establish a wider array of habitats and improve wildlife habitat quality with the aim of promoting overall increased species richness and diversity.

3. Improve grizzly bear (*Ursus arctos*) habitat in areas with low human use.

4. Restore open-grassland, bighorn sheep (*Ovis Canadensis*) habitat at upper elevations that are being lost through forest succession.

5. Provide suitable habitat for regeneration of whitebark pine (*Pinus albicaulis*).

Land Management Objectives

1. Reduce the short and long term susceptibility of forest stands to attack and spread of mountain pine beetle (*Dendroctonus ponderosae*) and other forest insects and pathogens.

2. Reduce the build-up and continuity of forest fuels to reduce the threat of catastrophic fire to communities within the lower Bow Valley and surrounding area.

Research Objectives

1. Document the effects of prescribed fire on whitebark pine regeneration and blister rust.

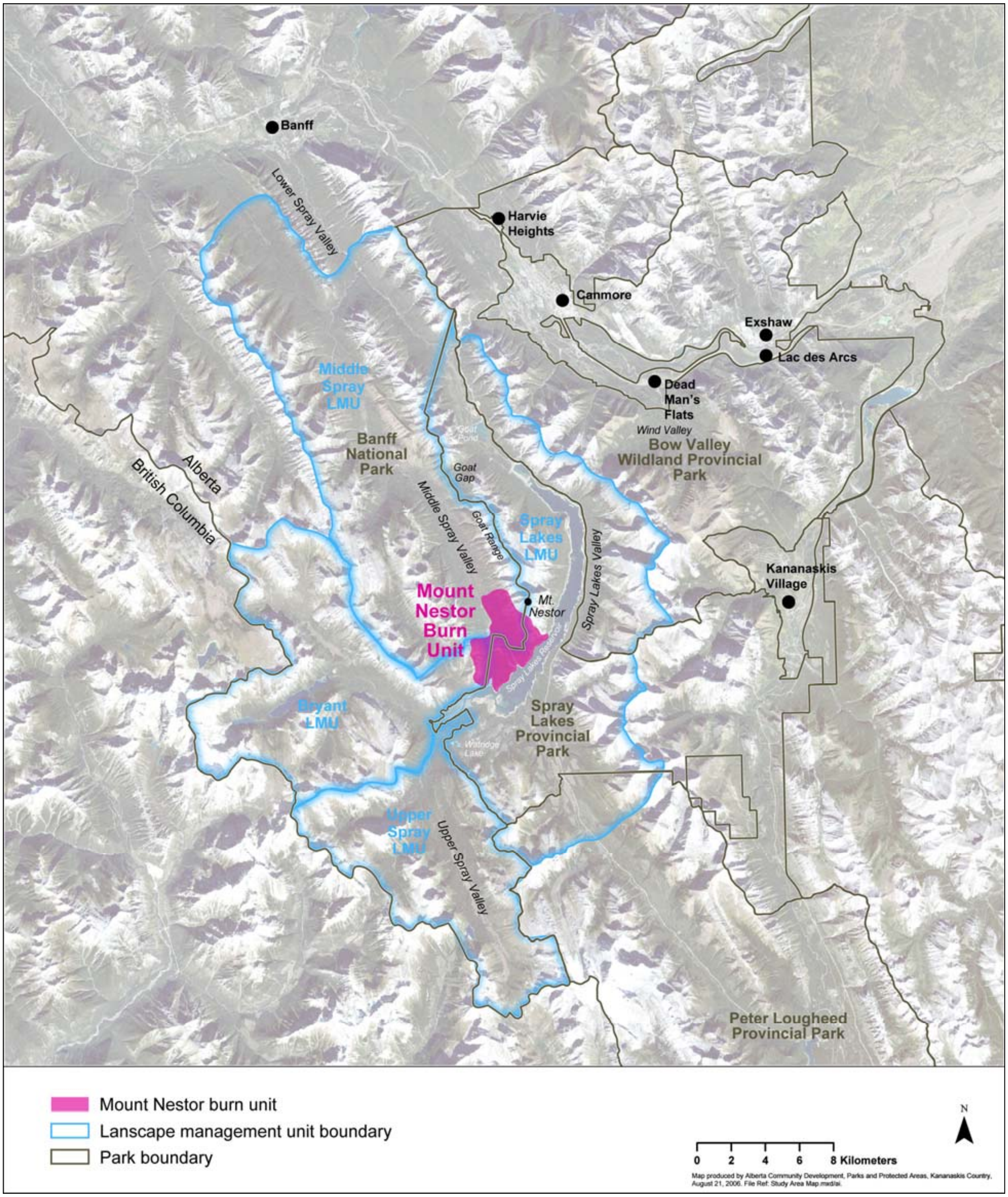
2. Correlate fire intensity and severity with post-fire succession patterns.

3. Document the relationship between fuel loadings, fire intensity and mountain pine beetle brood mortality in known green attack locations.

4. Assess the overall effectiveness of prescribed burning in reducing the susceptibility of pine forests to mountain pine beetle attack.

5. Assess the effectiveness of this prescribed burn in improving habitat quality for grizzly bears, bighorn sheep and other ungulates.

6. Evaluate the utility of infra-red satellite imagery as a means of assessing fire severity.



Map produced by Alberta Community Development, Parks and Protected Areas, Kananaskis Country, August 21, 2006. File Ref: Study Area Map.mxd/ai.

Figure 1: Area of the prescribed fire planned for the Mount Nestor burn unit.

Background

It is well recognized that fire is an essential ecosystem process that shapes the structure and function of many ecosystems. Fire was largely excluded from most landscapes over the last century due to a combination of fire suppression and the elimination of traditional burning practiced by Canada's aboriginal peoples. The decline in fire activity has caused the following ecological problems in the Canadian Rocky Mountains:

- Decline in species biodiversity
- Decline in the quality and quantity of animal habitats as a result of altered succession patterns
- Decline in aspen, open conifer, and young pine stands
- Disappearance of certain grasslands at an unnatural rate
- More older vegetation than would naturally be expected
- Overgrowth of some forested areas, with a significant degree of canopy cover
- More continuous vegetation and a decline in the amount of open space
- Unnatural buildup of vegetation to fuel wildfires
- Fires of higher intensity and severity due to biomass accumulations (White 1985a)
- Unnatural susceptibility of forest stands to large scale forest insect outbreaks
- Change in the spatial age mosaic of forests
- Decline in suitable sites for the regeneration of whitebark pine

Planned fire or wildfire can be used to mitigate the impacts of fire exclusion. This may include planned ignition (prescribed) fires or allowing lightning or human caused fires to burn within constraints of public safety and facility protection (White 1985a).

SITE DESCRIPTION

The following site description is taken from the *Mount Nestor Interagency Prescribed Fire Plan* (Alberta Community Development *et al.* 2006).

The Mount Nestor burn unit is situated at the south end of the Goat Range on the boundary between Banff National Park (BNP) and Spray Valley Provincial Park (SVPP) near the towns of Canmore and Banff in Alberta (Figure 1).

The unit is 1423 Ha in size, 862 Ha in BNP and 560 in SVPP. Most of the unit lies along 4 km of south and southwest facing slopes where Mount Nestor meets the Spray Reservoir. This reservoir separates the upper and middle sections of the Spray River Valley. The unit ranges in elevation from 1690m in the valley bottom to 2200m. The summit of Mount Nestor is 2975m.

Five major valleys come together at this location making this area important for wildlife, allowing animals to travel between high quality habitats. Large mammal species that use the area include grizzly bear, black bear, cougar, lynx, wolf, bighorn sheep, elk, moose, and deer. Elk use the area to migrate between winter and summer range.

Vehicle access to the area is via the Spray Lakes Road and the West Side Road which is closed to vehicle traffic. An established heliport is located at Mount Shark, 3km away.

Natural Region and Subregion

The unit lies within the subalpine natural subregion within the Rocky Mountain natural region. The subalpine can be divided into lower and upper subalpine. The lower subalpine is roughly between 1650 metres above sea level to 1950 meters. The upper subalpine is between 1950 and 2500 meters. The lower subalpine is mainly covered with closed forests. The upper subalpine is a transitional zone between forested lower subalpine and the treeless alpine subregion (White 1985a).

The subalpine covers 3.8% of Alberta. Half of this is protected within national parks (31%) and Alberta provincial parks and protected areas (22%). The remainder is under consumptive forest management such as forestry. Over 2/3 of Kananaskis Country is subalpine, accounting for 9% of the subalpine natural subregion in Alberta. Fifty three percent of the sub-alpine in Kananaskis Country is found within provincial parks and protected areas. Approximately 25% of BNP is lower subalpine, mainly covered with closed forests and 25% of BNP is within the upper subalpine (White 1985a).

Fire suppression is having a major impact on subalpine forests altering the age composition, structure, and diversity of species. Almost all of the subalpine in Alberta is not representative of forests under historical fire regimes. Few stands exist that have the same age class distribution and structure of 100 years ago.

Geology

The Nestor prescribed burn unit is located in the Front Ranges of the Canadian Rockies. The Upper Spray and Bryant Creek are a major fault separating the valleys of the Front Ranges from the Main Ranges of the southern Canadian Rocky Mountains. The Front Ranges are thrust-faulted mountains often with paleozoic limestone forming the peaks and mesozoic shale forming the bedrock material in the valley bottoms and lower slopes. The trend of these mountains and valleys is northwest to southeast, roughly perpendicular to the prevailing southwest and westerly winds. The Main Ranges to the west of this fault form the Continental Divide (Holland and Coen 1982).

Vegetation and Fuel Loading

The forest is mostly lodgepole pine (*Pinus contorta*) (FBP[3] C3, 80% of unit) established after a large fire in 1894, with bands of white spruce (*Picea glauca*) at lower elevations (FBP C2) and Engelmann spruce (*Picea engelmanni*) and subalpine fir (*Abies lasiocarpa*) at upper elevations (FBP C1) (Figure 2). Vegetated areas within the unit are dominated by BNP Fire (Fuel) Groups 2, 5, and 6, based on the biophysical inventory (Holland and Coen 1982) and the description of closed forest types in BNP (White 1985a).

A summary of vegetation types, ecosite communities (Figure 3) and fuel types (Figure 4) is shown in Table 1. The fuel loading typical of each fire group is listed in Table 2. The classification of ecosite communities is only available for the area in BNP.

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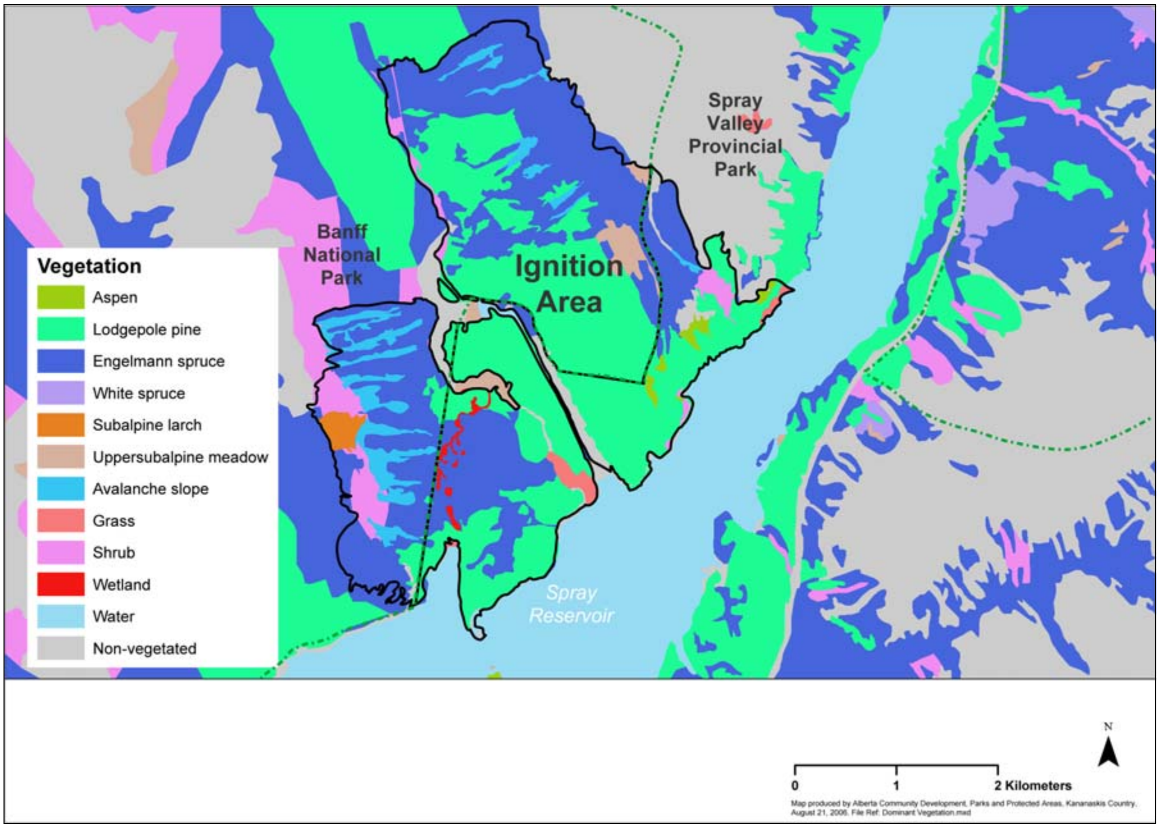
[3] The Canadian Forest Fire Behaviour Prediction (FBP) System

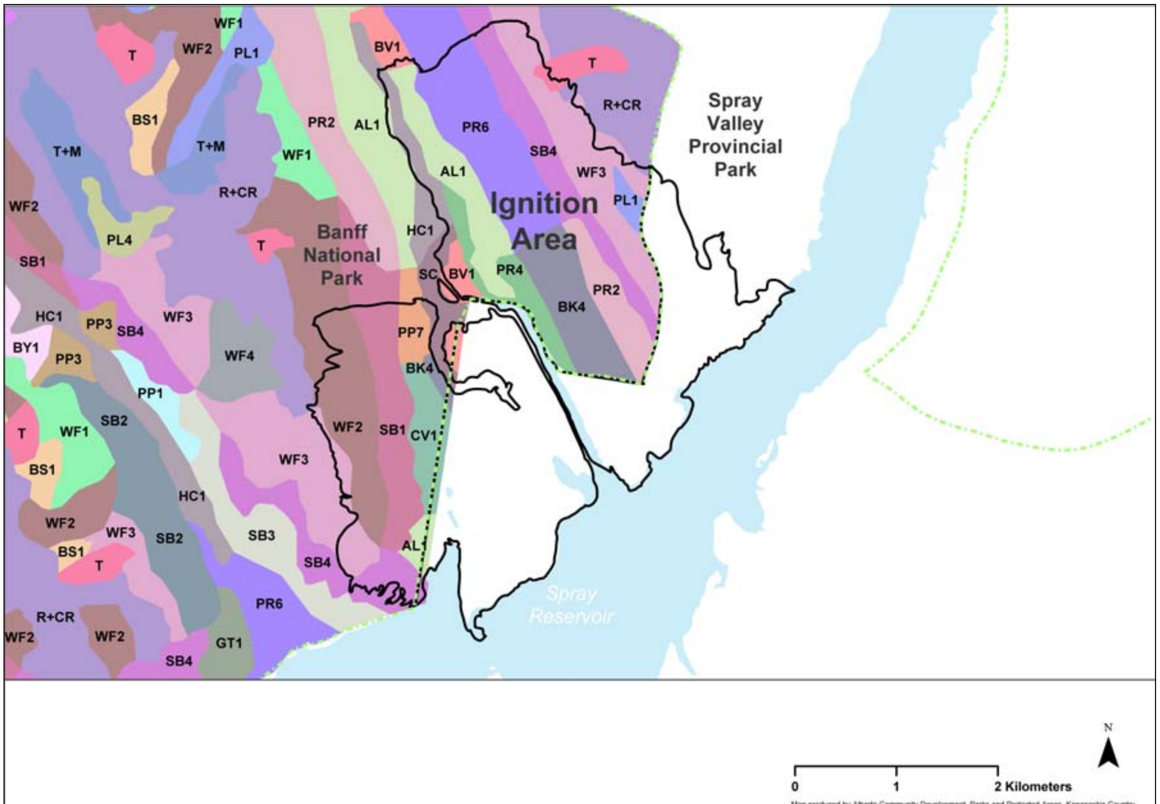
Table 1: Vegetation summary, including corresponding FBP fuel types.

Ecosite	Dominant Vegetation Type	FBP Fuel Type	Fire Group
AL1	C19	C3	2
BK4	C18, C19	C2	5
PL1	C15, C21, O1	C2	8
PR2	C6, C18, C19	C3	6
PR4	C13, C14, C30, C31	C3	6
PR6	C11, C18, C19	C3	5
SB4	O4, O17	C1	5
WF3	O4, O10, O12	C2	5



Map produced by Alberta Community Development, Parks and Protected Areas, Kananaskis Country, August 21, 2006. File Ref: Dominant Vegetation.mxd

Figure 2: Dominant forest vegetation of the Mount Nestor burn unit.

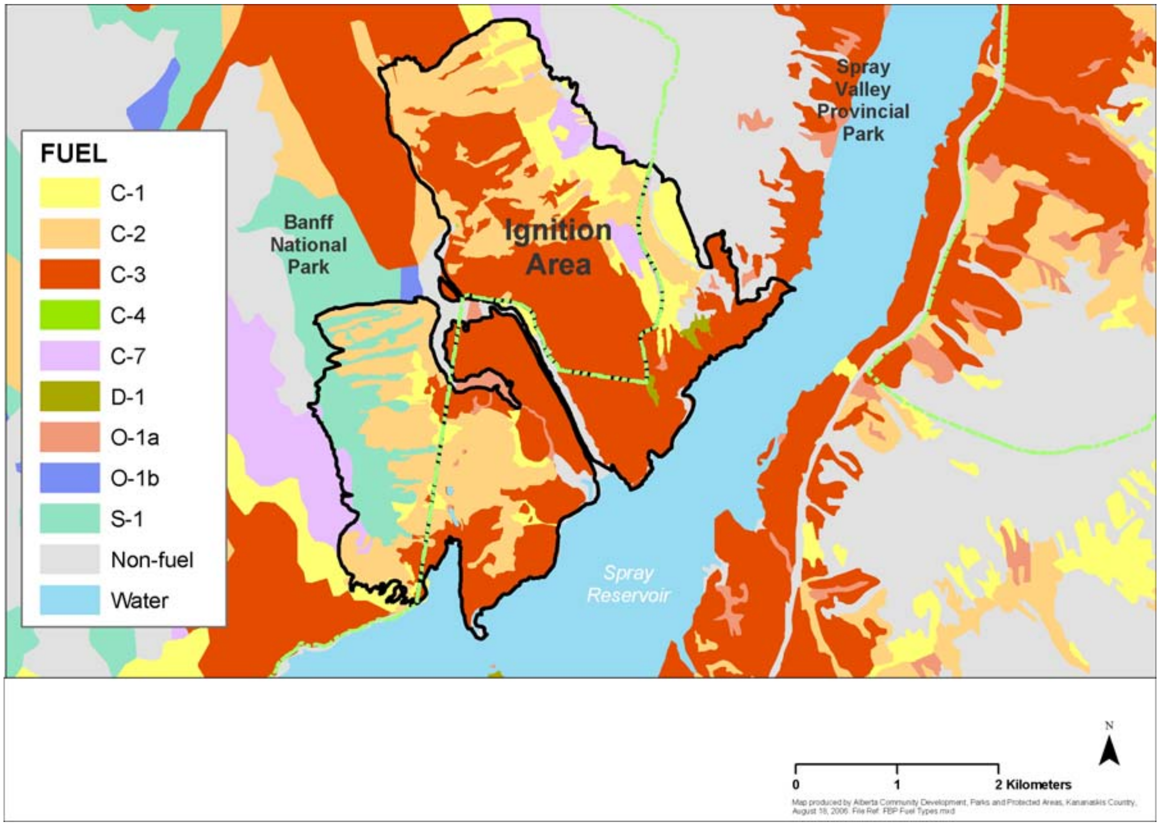


Map produced by Alberta Community Development, Parks and Protected Areas, Kananaskis Country. August 21, 2006. File Ref: Ecosites.mxd

Figure 3: Ecosite classification for the Mount Nestor burn unit.

Table 2: Fuel Loading by BNP Fire (Fuel) Group.

	Fuel Group		
	2	**5**	**6**
Ground Fuels			
Total ground fuel loading (t/ha)	57.6	111	152.5
Duff depth (cm)	4.4	8.8	12.3
Litter cover (%)	58	29	15
Surface Fuels			
Herb & dwarf shrub biomass (t/ha)	0.5	0.3	0.2
Shrub (t/ha)	1.3	2.3	2.7
Total downed wood (t/ha)	36.5	39.8	52.1
Fine downed wood (t/ha)	1.9	1.68	2.3
Crown Fuels			
Total crown biomass (t/ha)	25.6	38.2	63.9
Foliage loading (t/ha)	8.9	15.8	25.1
Foliage density (kg/m^3)	0.1	0.2	0.3
Height to live crown (m)	6.1	6.4	5.2



Map produced by Alberta Community Development, Parks and Protected Areas, Kananaskis Country, August 18, 2006. File Ref: FBP Fuel Types.mxd

Figure 4: FBP fuel type of the Mount Nestor burn unit.

The southerly aspect slopes in this short section of west-east trending valley tends to be warmer and drier than the remainder of the area in which the narrow valleys lie between the northwest-southeast trending mountains. There are many reasons for these microclimates such as differences in precipitation (localized rain shadow effects), wind patterns, and differences in the angle of incidence of sunlight.

Valley orientation, elevation, distance from the continental divide and slope aspect all effect drying of forest fuels and direction of fire spread. Over time, these differences have resulted in different levels of fire activity or probability of burning on the landscape.

Fire History

The following description of fire history is taken from *Spray II: Planned Ignition Prescribed Fire, Banff National Park* (Parks Canada 2001b):

The Spray Valley from the Spray Reservoir north through Goat Gap (Charlie Horse Pass) has seen an interesting and active period of fire since the turn of the century. Fires contributed largely to raising the awareness of wardens regarding the threat of wildfire to the town of Banff and spurred the development of several fire protection initiatives in the park.

Stand origin data is obtained from the BNP biophysical inventory (Holland and Coen 1982) and more detailed fire history studies conducted by White (1985a), Rogeau (1994), and Rogeau and Gilbride (1994). Stand origin boundaries within the unit based on their findings are presented in [Figure 5].

White (1985a) provides a detailed summary of fire activity in the Spray Valley based on his study, archived reports, and historical accounts extracted from the Crag and Canyon newspaper:

> *In 1894 a 3000 hectare fire of unknown origin burned north from Palliser Pass and moved north affecting what is today the Spray reservoir & Canyon Dam area affecting approximately 1500 hectares in the vicinity of Canyon Dam. This fire occurred despite precipitation amounts leading up to this fire being at or above mean precipitation values.*
>
> *On July 23, 1908 another 3000 hectare fire of unknown cause moved north from the Goat Gap area burning out the Eau Claire logging camp and a large portion of its timber berth in the Lower Spray Valley. This fire burned on both sides of the river and triggered the construction of a fire guard on the Spray River 6.0 kilometres south of Banff townsite. A Crag and Canyon article (Crag and Canyon August 15, 1908) sums up the concern of town residents as follows:*
>
> "*A number of guest at the CPR hotel got into a panic last Sunday when dense clouds of smoke rose from Goat Mountain, due to the fire running up the slope of the mountain facing town. Several residents of Banff were also on edge, and have had to stand a good deal of joshing since, on account of their unreasoning fears."*

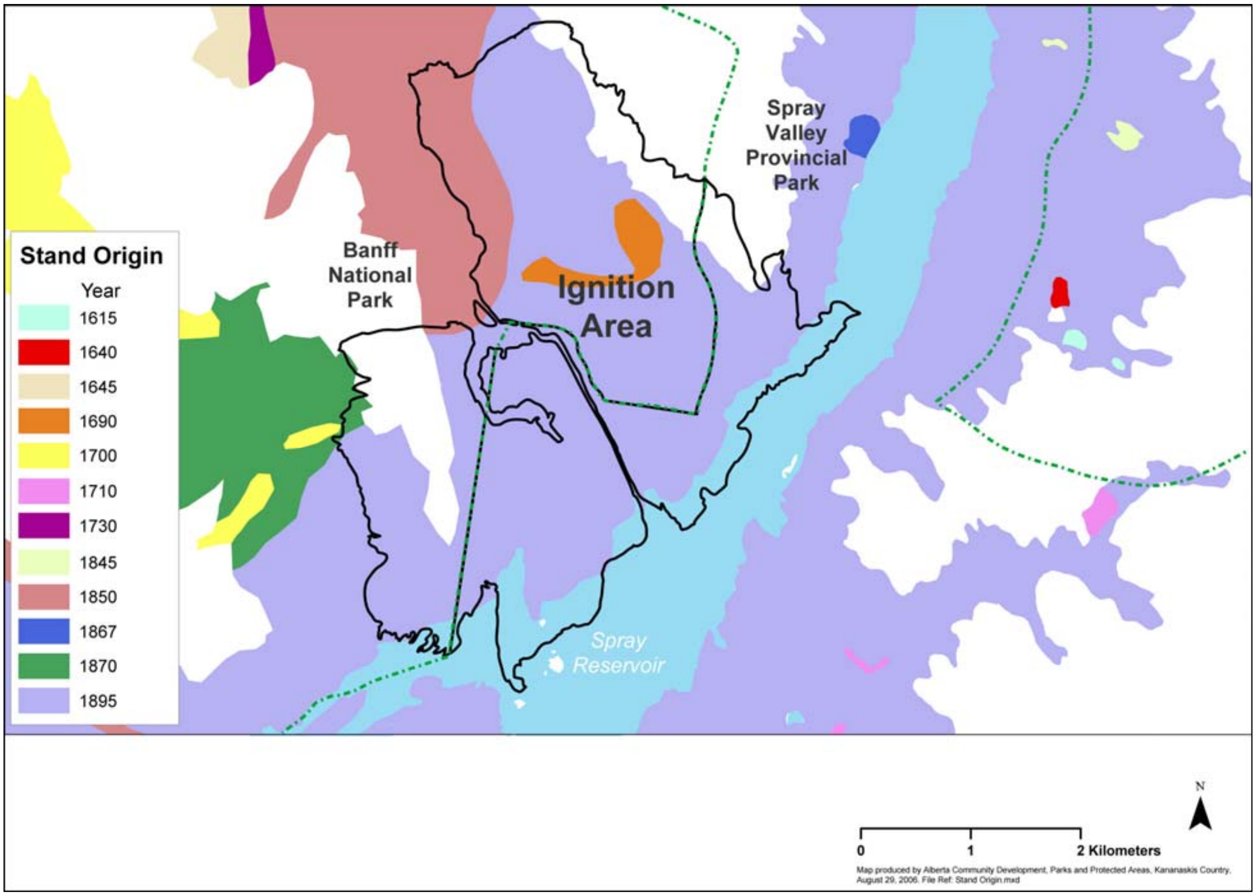
In a study of climatological patterns associated with large fire occurrence in Banff National Park, Baker (1984) notes that:

> *… worried guests and Banff residents had justified fears. Had winds continued from the south / southwest and the fire continued down the Spray Valley those doing the joshing might have changed their tune.*

Baker's observation is well taken in light of fire behaviour observed on the Castle Junction fire burning at the same time which took a 12.8 kilometre run in 1.5 hours. Had the high pressure system persisted and winds had continued out of the south, Banff townsite would surely have been threatened. White's summary continues:

> *On August 15th, 1920 Canyon Dam saw fire activity again which amounted to 400 hectares in size. The next three years saw the introduction of aircraft patrols for fire detection, improvements to fire pump technology, the construction of wooden water reservoirs on Sulphur Mountain and a more formalized training program for fire fighters.*
>
> *Eight years later a large fire started in the vicinity of Goat Gap and once again moved north towards Banff consuming 1700 hectares. The origin of the fire was suspected to be a campfire used by a fishing party.*

On August 9th, 1940 a lightning strike in Goat Gap started a small wildfire that once again spread from south to north, consuming a total of 200 hectares. This was the most recent fire to impact the area within the proposed Spray I unit. Around this time, construction of a network of fire roads and fire towers was initiated in order to improve detection and access to fires throughout the park.



Map produced by Alberta Community Development, Parks and Protected Areas, Kananaskis Country, August 29, 2006. File Ref: Stand Origin.mxd

Figure 5: Stand origin of forest in the Mount Nestor area.

Recent Fire Activity

All recent fire activity is due to prescribed burning done by Parks Canada within BNP (Table 3, Figure 6).

Table 3: Summary of prescribed burns in the Spray Valley

Year	**Season**	**Location**	**Area (**Ha)
1998		Charlie Horse Pass	53
1999		Lower Spray Nestor Guard	316
2000	Spring	Spray I	803
		A. 642 Ha	
		B. 86 Ha	
		C. 5 Ha	
		D. 71 Ha	
2001		Spray II	1090
	Spring	Guard construction (blacklining) on Mt. Fortune	
		Burn lower Turbulent Creek	
		Guard construction near Charliehorse Pass	
		Guard construction (blacklining) in upper Turbulent Creek	
		Burn upper slopes of Mt. Nestor to Charliehorse Pass	
	Summer	Unit burn of lower slopes of Mt. Nestor to Charliehorse Pass	
	Fall	Guard construction (blacklining in Upper Turbulent Creek	
		Guard construction (burning slashed line) on east facing, north guard of Spray 1 unit.	
		Total	**2261**

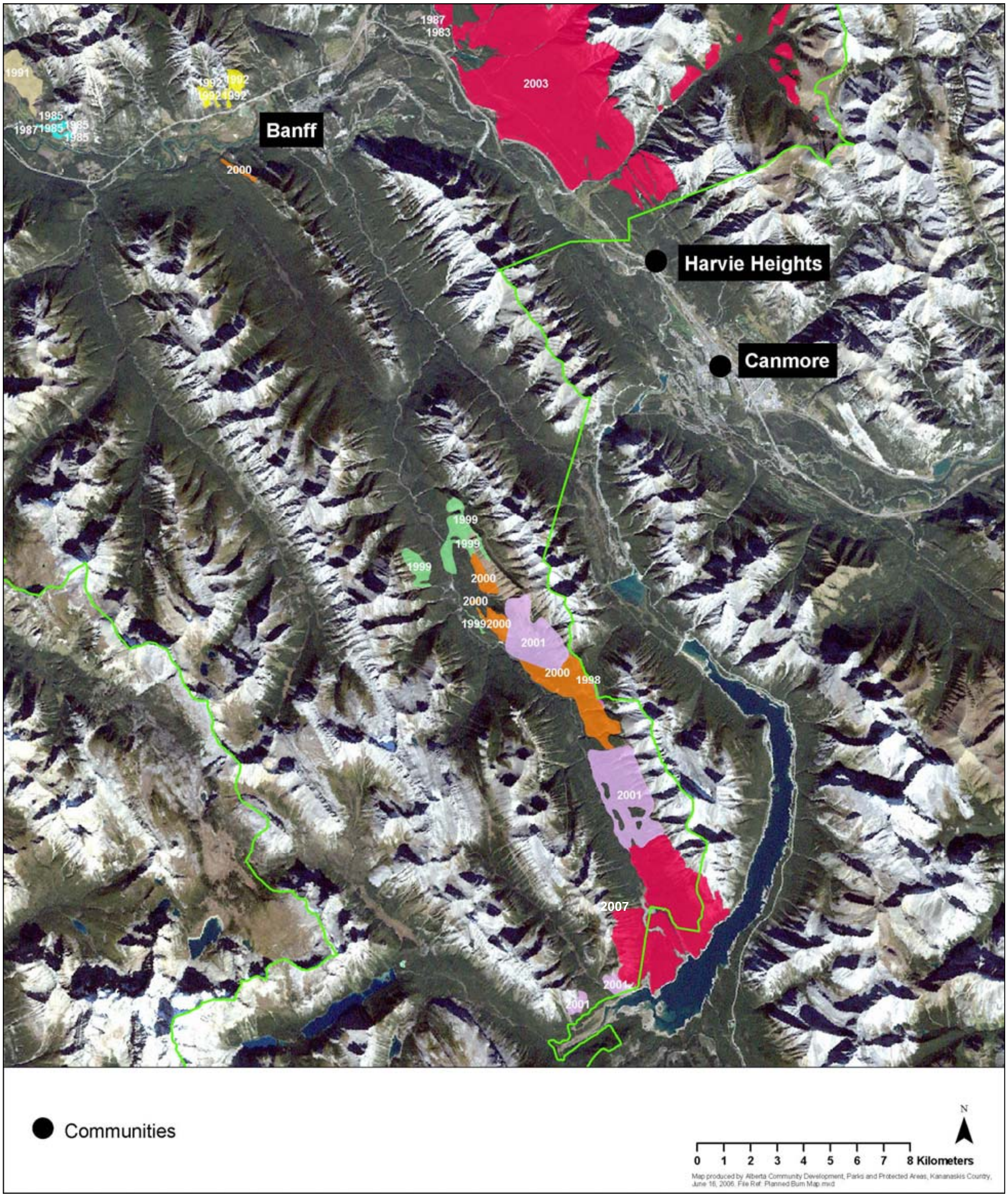


Figure 6: Recent prescribed fires in the Mount Nestor area.

FIRE REGIME

A fire regime is the spatial and temporal patterns of fire described by the cause, season, frequency, intensity, severity, and patch characteristics of fire. Fire regimes can be broadly defined into four types: stand-replacement, understory, mixed and no-fire. Each type can further be divided into more homogeneous regime components. The no-fire regime is where fires rarely or never occur. High elevation vegetation communities, particularly those isolated by topography, may never burn.

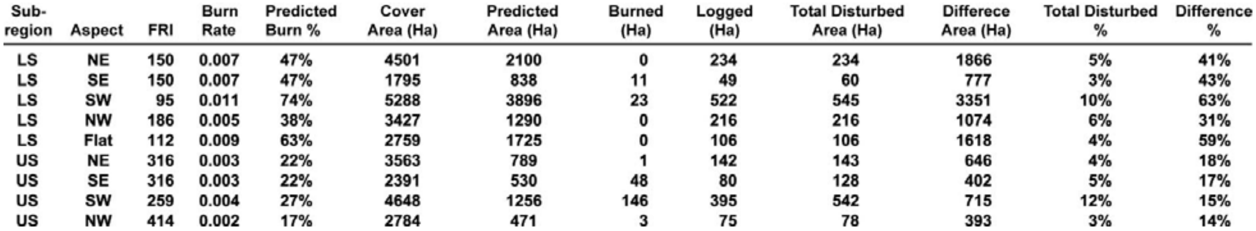
Most of Kananaskis Country has a stand-replacement fire regime, including most of the subalpine. This regime is characterized by fires of high severity and intensity that kill most trees. The montane natural subregion has a mixed fire regime with both understory and stand-replacement fires.

Variations in topography, climate (atmospheric processes) and patterns of ignition (lightening and human caused) make each of these regimes spatially heterogeneous (Rogeau *et al*. 1998). Within each regime, stands will have different fire frequency, severity, intensity, sources and probability of ignition and patch characteristics. To fully understand fire regimes we need to divide the landscape into homogenous components. For instance, north-facing slopes in the subalpine are cooler and wetter and are less likely to burn than dry, warm, south-facing slopes. Most studies recognize this spatial variability and attempt to delineate these different areas.

Several studies have examined fire history and fire regimes in BNP and Kananaskis Country (Johnson 1987, Hawkes 1979, White 1985a, Rogeau 1994, Rogeau and Gilbride 1994, Rogeau 2004). Study is continuing to better understand historical fire regimes in Kananaskis Country and BNP. This assessment presents some of the preliminary work on calculating fire frequency and burn deficit.

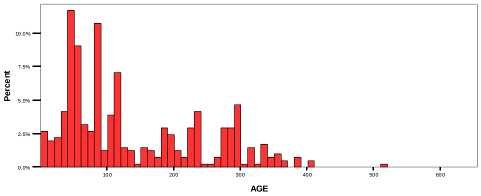
The most recent study done to understand fire frequency in Kananaskis Country shows significant differences in fire frequency between the lower and upper subalpine and between different slope aspects (Jevons and Donelon, in progress). Table 4 shows the estimated fire return intervals (FRI) and the differences between observed and expected burning for the years 1940 to 2009. FRI were derived from maximum likelihood estimates based on the negative exponential distribution for stands in portions of Kananaskis Country and BNP for the period before 1940. Difference between observed and expected landscape disturbance are only for Peter Lougheed Provincial Park (PLPP) and Spray Valley Provincial Park (SVPP). Figure 7 shows the stand-age distribution for each aspect category in the lower and upper subalpine natural subregions in BNP, SVPP and PLPP (Jevons and Donelon, in progress). This study demonstrated the large difference that aspect and elevation have on fire frequency. It also shows that stands on south facing slopes such as those around Mount Nestor have survived far beyond the mean fire return interval and are well outside the normal range of variation. For example, southwest slopes in the lower subalpine have an estimated fire return interval of 95 years. Most of the Spray Lakes Valley has stands that are 112 years or older (as of 2006). Typically, 2/3 of the area would burn within the fire return interval. Stands in the Middle Spray Valley would be well outside the fire return interval if not for prescribe burning done by Park Canada over the last several years. The amount of area that will be burned by prescribed fires around Mount Nestor is small compared to the amount of area that would normally burn under historical fire regimes.

Table 4: Difference between observed and expected landscape disturbance, 1940 to 2009.

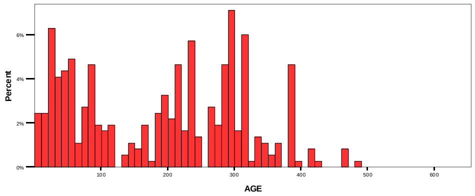


Sub-region	Aspect	FRI	Burn Rate	Predicted Burn %	Cover Area (Ha)	Predicted Area (Ha)	Burned (Ha)	Logged (Ha)	Total Disturbed Area (Ha)	Differece Area (Ha)	Total Disturbed %	Difference %
LS	NE	150	0.007	47%	4501	2100	0	234	234	1866	5%	41%
LS	SE	150	0.007	47%	1795	838	11	49	60	777	3%	43%
LS	SW	95	0.011	74%	5288	3896	23	522	545	3351	10%	63%
LS	NW	186	0.005	38%	3427	1290	0	216	216	1074	6%	31%
LS	Flat	112	0.009	63%	2759	1725	0	106	106	1618	4%	59%
US	NE	316	0.003	22%	3563	789	1	142	143	646	4%	18%
US	SE	316	0.003	22%	2391	530	48	80	128	402	5%	17%
US	SW	259	0.004	27%	4648	1256	146	395	542	715	12%	15%
US	NW	414	0.002	17%	2784	471	3	75	78	393	3%	14%

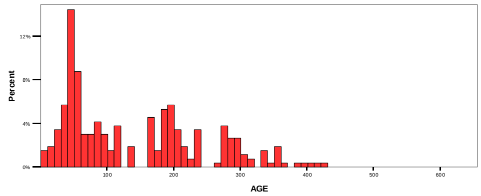
LSA, northeast aspect



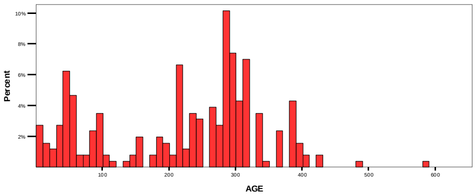
USA, northeast aspect



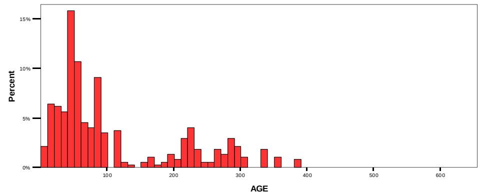
LSA, northwest aspect



USA, northwest aspect



LSA, southeast aspect



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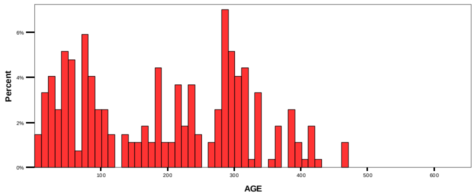
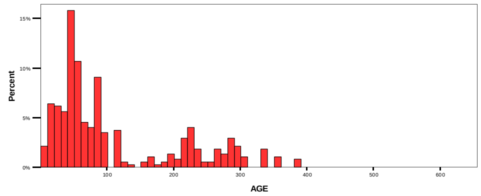
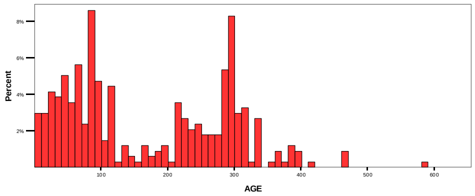


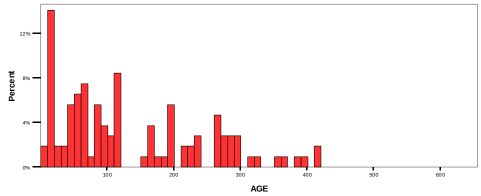
LSA, southwest aspect



USA, southwest aspect



LSA, flat aspect



USA, flat aspect

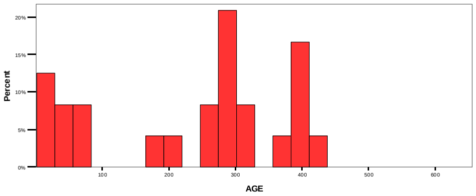


Figure 7: Stand age distribution for aspect categories in the lower and upper subalpine, Banff National Park and Peter Lougheed and Spray Valley Provincial Parks.

The *Banff National Park Management Plan* (Parks Canada 1997) requires maintenance of 50% of the long-term fire interval, or approximately 14 km^2 burned annually through prescribed burns or unsuppressed lightening-caused fires. The *Banff Field Unit Fire Management Plan* sets out the range and average fire return intervals for twelve vegetation groups in BNP (Table 5) (Parks Canada 2001a). These average fire return intervals are based on field studies in BNP and other regions in the Rocky Mountains (Table 6). The average annual burned area and burned area objectives for the Middle and Upper Spray LMU are based on the lower end of these acceptable fire intervals (most frequent rate of burning) as these LMU is one of the areas of the park with the fewest constraints for fire use. The mean annual area burned calculations for the Bryant LMU are based on the highest end of desired range as there are considerable constraints on fire use in this unit.

Table 5: Vegetation groups in Banff National Park and acceptable range of fire intervals.

Veg. Group	**Vegetation Description**	**Acceptable Range of Fire Cycle**	**Area (km^2 in BNP)**
1	Dry Montane Lodgepole Pine and Douglas Fir	40-80 years	103
2	Dry Lower Subalpine Lodgepole Pine	80-140 years	454
3	Aspen Forests	30-70 years	10
4	Mesic Montane White Spruce and Douglas Fir	120-200 years	56
5	Cool/Moist Lower Sub-alpine Lodgepole Pine	120-200 years	460
6	Lower Subalpine Engelmann Spruce and Subalpine Fir	150-250 years	805
7	Floodplain Spruce Forest	150-250 years	66
8	Upper Subalpine Spruce, Subalpine Fir and Larch	200-300 years	1233
9	Engelmann Spruce and Sub-alpine Fir on Permafrost Sites	300-400 years	84
10	Montane Grasslands	10-30 years	2
11	Dry Shrub Meadows	20-60 years	105
12	Subalpine Grasslands	40-80 years	171
15	Tundra, fens and wet shrub meadows	----------------	682

Table 6: Mean historic fire intervals (years) for various Rocky Mountain forest types.

	Montane		**Lower Subalpine**		**Upper Subalpine**	
Area	Aspen	Grassland/ Savannah	Douglas fir	Lodgepole pine	Subalpine fir	Reference
Yellowstone NP, WY	20-25		20-25[1]	150-250[2]	300-400[3]	1. Houston 1973 2. Barrett 1994 3. Romme 1982
Selway Idaho Bitterroot MT			119	47-112	166	Brown *et al*. 1995
W. Montana			35-40			Arno & Gruell 1983
Glacier NP, Montana	42* (25-100)		36	50-200 96-187*	202	Barrett *et al*. 1991 *Barrett 1993
Bob Marshal, Montana				40		Gabriel 1976
Waterton Lakes NP, AB	36	5	36	71	200	Barrett 1996
Kananaskis, AB				101	304	Hawkes 1980
Banff NP, AB	20		42	94-130	181	White 1985a
Jasper NP AB		20	18-27	74		Tande 1979

In dense coniferous forests, the fire return interval is equal to the mean age of forest stands where the stands have an equal probability of burning. This permits monitoring of the effects of fire suppression and prescribed burning by comparing current mean stand age with the desired upper and lower means. In LMU where the vegetation group covers less than 1000 ha, the mean stand age may vary widely, and should be averaged with adjacent LMU. In addition to achieving a certain range of mean stand age, it is desirable that approximately two thirds of the area is younger and one third of the area be older than the mean stand age to provide diversity in each vegetation type.

Fire activity in grasslands, shrub and open coniferous forests cannot be monitored through measuring mean stand age. In these vegetation groups, fire activity is measured through studies of fire intervals at a point (fire scarred trees within or adjacent to the area) and historic records. Historically, fires used to be common in these vegetation groups.

Table 7 and Table 8 show the areas of vegetation groups, the acceptable fire intervals and the management objectives for fire use within the Middle, Upper Spray and Bryant LMU. These LMU boundaries changed since these calculations were made so values are only approximate. There are currently no burn objectives for the Bryant LMU.

Table 7: Fire use objectives for the Middle and Upper Spray LMU.

Vegetation Group	Area (hectares)	Range & Preferred Fire Cycle (years)	Mean Annual Area Burned	Objective for Area Burned by Period
1	----	40-80, 40	----	----
2	1929	80-140, 80	24 ha/year	723 ha/30 years
3	----	30-70, 30	----	----
4	----	120-200, 120	----	----
5	2161	120-200, 120	18 ha/year	720 ha/40 years
6	4881	150-250, 150	33 ha/year	1627 ha/50 years
7	743	150-250, 150	5 ha/year	250 ha/50 years
8	5336	200-300, 200	27 ha/year	1868 ha/70 years
9	----	300-400, 300	----	---
10	----	10-30, 20	----	----
11	82	20-60, 20	4 ha/year	40 ha/10 years
12	8	40-80, 60	----	----

Table 8: Fire use objectives for the Bryant LMU.

Vegetation Group	Area (hectares)	Range and Mean Fire Cycle (years)	Mean Annual Area Burned	Objective for Area Burned by Period
1		40-80, 80	-----	-----
2		80-140, 140	ha/year	ha/40 years
3		30-70, 70	----	----
4		120-200, 200	----	----
5		120-200, 200	ha/year	ha/50 years
6		150-250, 250	ha/year	ha/70 years
7		150-250, 250	ha/year	ha/70 years
8		200-300, 300	ha/year	ha/80 years
9		300-400, 400	ha/year	nil
10		10-30, 30	----	----
11		20-60, 60	ha/year	ha/15 years
12		40-80, 80	ha/year	ha/20 years

The preferred fire intervals and mean stand ages for closed forest types (with an area > 1000 ha) are similar to the mean stand age in 1940, indicating that the preferred fire cycles are appropriate. During the past 50-70 years, forest fire activity in the southern Canadian Rockies has been much lower than at any other time in the past five hundred years or more (Van Wagner 1995, Barrett 1996). The effect of this period of fire exclusion is indicated by the mean stand age prior to prescribed burning. The effect of recent prescribed burns is indicated by comparing the age in 1940 to the mean stand age in 1998 (Table 9).

Further prescribed burning is required to reach the preferred mean stand age conditions in vegetation groups 2, 5, 6, and 7. Also, burning is required in grassland, shrub and aspen habitats to maintain desired structure and range conditions.

The incidence of lightning fires within these LMU is very low. Therefore objectives will be attained primarily through use of planned (management ignited) prescribed fires. However, a prescription has also been prepared which will allow some lightning or accidental human fires (random ignitions) to burn under certain conditions after the mid point of the fire season.

Table 9: Effect of fire exclusion and prescribed burning on selected forested vegetation groups within the Middle and Upper Spray LMU.

Veg. Group	Area (Ha)	Preferred Fire Intervals & Mean Stand Age	Mean Stand Age (1998)	Mean Stand Age (1940 – before suppression)
2	1929	80	113	55
5	2161	120	136	78
6	4881	150	211	153
7	743	150	174	116
8	5336	200	194	136

ECOLOGICAL

Knowledge Deficiencies

In management of wildland ecosystems, precise knowledge of wildlife, vegetation and the interactions of these and human use is often lacking. Parks Canada recently reviewed the appropriateness of past fire management actions and the future of the program. Three reports were prepared:

1. *The Policy Context for Fire Management in the Mountain National Parks* (Lopoukhine 1996)

2. *Scientific Issues in Fire Management* (Achuff 1996)

3. *Risk Assessment of Fire Management Alternatives* (LaMorte 1996).

The conclusions of these reports are that:

1. Restoration of fire is appropriate, in fact, essential to the maintenance of ecological integrity.

2. Ecosystems are complex and management (whether fire use or exclusion) should be applied though an adaptive experimental design to maximize feedback and information in the decision making process.

3. Given the lack of fire during the past 60-80 years, continued fire exclusion in the mountain parks poses a greater risk to the ecosystems than restoration of fire.

Therefore, forest and vegetation ecologists within Parks Canada recommended that prescribed fire programs should be continued.

Monitoring of vegetation change after burning is required to develop greater understanding of successional pathways following fires of various intensities and severities, and grazing and browsing by ungulates at various intensities. The species of vegetation selected by ungulates and the severity of the browsing and grazing will be studied at permanent vegetation plots and exclosures.

VEGETATION

A significant amount of vegetation and fire regime research has been completed, analysed and developed into operational programs in Banff National park within the Rocky Mountain subregion of Alberta. Much of this work can be extrapolated to the same Natural regions and subregions found in Kananaskis Country which shares common boundaries with Banff National Park. In addition, recent fire regime analysis in the Kananaskis region demonstrates similar vegetation and fire regime patterns to those in Banff National Park (Hawkes 1979; Johnson 1987; Jevons and Donelon, in progress; Rogeau 1994; Rogeau 2004;).

Historical Overview

Historical ecology uses information from many sources such as dendrochronology, early historical accounts of vegetation and wildlife, ethnography, palynology, glaciology, and archaeology to develop a picture of past climate, vegetation, fire activity, wildlife and human use. Evidence from these fields of study suggests that over the past 4000 years the biota (plants and animals) have been relatively stable (Vance *et al*. 1995; Hallet 1996). It is also apparent that the biota have evolved and been influenced by aboriginal peoples who have been in the Banff Bow Valley for more than 10,000 years. Vegetation reflects the deliberate or accidental use of fire and the response of wildlife to hunting (Kay *et al.* 1994).

During the past century, humans have altered vegetation structure and processes in BNP. The predominant change was greatly reduced fire activity in the past 70 or more years in BNP and other Rocky Mountain parks and reserves. Except for recent management-ignited burns, fire has been virtually absent from the park since 1940. This has resulted in increased amounts of older, closed forest vegetation particularly spruce and spruce-fir forest. The amount of younger communities including herb and low shrub communities and young conifer forests has declined.

After elk were reintroduced in about 1920, the population increased quickly. Numbers have varied due to culls (1940-1969), highway and railway collisions, predation by large carnivores, and winter severity. However, levels of browsing by elk, and to a lesser extent by other ungulates, has suppressed the regeneration of aspen, willow and other highly palatable plants during most of the past 50 years or more. As a result changes in the extent, vigour, and structure of vegetation continue. These impacts affect other species of wildlife whose habitat quality is declining under high levels of herbivory.

An Example of Vegetation Change from the Banff Bow Valley Watershed

The primary indicators of vegetation change are stand age and the amount and spatial distribution of various vegetation types, *e.g.* aspen, lodgepole pine, white spruce, Douglas fir, Engelmann spruce, subalpine fir, larch, shrub or grass.

These indicators were used to monitor rates of stand-replacing disturbances, such as forest fires and, based on the average life span and competitive ability of various plant species, to predict vegetation change.

The analysis of vegetation patterns was based largely on information from the BNP Ecological Land Classification (ELC) (Holland & Coen 1982). The ELC map units (ecosites) were grouped into 30 broad vegetation types using the vegetation type classification from the ELC (Achuff & Corns 1982). Using a Geographic Information System (GIS), a map of these broad vegetation types was developed and 1995 ages were assigned to each vegetation map polygon using current stand age information for BNP (Rogeau and Gilbride 1994). A vegetation change scheme was developed to account for the current vegetation of each ecosite and changes through time using 30 broad vegetation types and seven age classes (Table 10).

Starting with the 1995 condition of each ecosite polygon, the vegetation composition of the Banff Bow Valley was backcast to 1950 by reducing the stand age of each polygon by 45 years and determining the vegetation type for that age from the vegetation change scheme. Similarly, the vegetation types for 2020 and 2045 were forecast, assuming no further fire disturbance from 1995 to 2045. Patterns of change vary depending on fire intensity and size, and adjacent vegetation as well as weather following the fire. However, in this analysis, only one vegetation change rate and pathway for each ecosite is used; those which are believed to be the most likely. Using 30 broad vegetation types and seven age classes sets a certain level of coarseness to the analysis. However given current information, a more detailed analysis was not possible.

Comparing the backcast 1950 conditions with current ones, the largest differences are in the greater amounts of non-forest vegetation, especially herb+low shrub; pine, spruce and mixed conifer saplings; and young pine, spruce, open conifer, Douglas fir-pine and aspen forest (Table 11).

The 1995 conditions show a virtual absence of herb+low shrub vegetation as it develops since 1950 into shrub, sapling and young forest types. The amount of sapling and young forest also declines as older both open conifer and closed pine, spruce-fir, white spruce, Douglas fir-pine, spruce-pine and Douglas fir-white spruce forests develop from the younger stages. Aspen forest also declines sharply and becomes mostly aspen-spruce forest as shade-tolerant conifers develop beneath the aspen canopy.

Changes over the next 25 years (1995-2020) include the loss of aspen forest along with the pine, spruce and mixed conifer sapling stages, young spruce, and young Douglas fir-pine. There is also a marked reduction of aspen-spruce forest, young open conifer and young pine forest. Vegetation types that increase include spruce-fir, pine, white spruce, spruce-pine and Douglas fir-white spruce.

By 2045, there is a further reduction in young forest types and in aspen-spruce and pine types as stand age exceeds the life expectancy of both aspen and lodgepole pine in the absence of rejuvenating disturbance. Types that increase include spruce-fir, white spruce, spruce-pine and Douglas fir-white spruce.

Summarising vegetation change over this 95 year period, the vegetation of the landscape has become much older, much more forested, and nearly entirely coniferous. Species which have increased most are Engelmann and white spruce, and subalpine fir, while aspen, and eventually lodgepole pine have decreased most. Also notable is the decrease in the number of vegetation types from 29 in 1950 to 19 in 2045. This loss of biodiversity at the community level affects numerous species and is unfavourable for the maintenance of ecological integrity.

Table 10: An example of vegetation types and successional sequences for BNP ecosites.

Ecosite	AGE CLASS (years)						
	0-20	**21-40**	**41-80**	**81-120**	**121-200**	**201-300**	**>300**
AL1	herb + l.shrub	pine sapling	young pine	pine	pine	spruce-pine	spruce-fir
AL2	herb + l.shrub	pine sapling	young pine	pine	spruce-pine	spruce-fir	spruce-fir
AT1	herb + l.shrub	pine sapling	young pine	pine	pine	spruce-pine	spruce-fir
AT3	grassland	grassland	pine-grassland	pine-grassland	pine-grassland	open pine	open pine
AZ1	herb + l.shrub	spruce sapling	young spruce	open conifer	open conifer	open conifer	open conifer
BK1	herb + l.shrub	pine sapling	young pine	pine	pine	spruce-pine	spruce-fir
BP1	herb + l.shrub	conifer sapling	young o. conifer	open conifer	open conifer	open conifer	open conifer
CN1	herb + l.shrub	shrub	shrub	shrub	shrub	open conifer	open conifer
CV1	herb + l.shrub	wet shrub	wet shrub	wet open conifer	wet open conifer	wet open conifer	wet open conifer
EG1	herb + l.shrub	spruce sapling	young spruce	spruce-fir	spruce-fir	spruce-fir	spruce-fir
EG2	herb + l.shrub	larch sapling	young larch	larch	larch	larch	larch
EN2	AvC2	AvC2	AvC2	AvC2	AvC2	AvC2	AvC2
FV1	AvC1	AvC1	AvC1	AvC1	AvC1	AvC1	AvC1
HC2	fen	fen	fen	fen	fen	fen	fen
HD4	grassland	grassland	grassland	young o. conifer	open conifer	open conifer	open conifer

AvC1 = Lower Subalpine avalanche communities
AvC2 = Upper Subalpine avalanche communities

Table 11: Areas (km^2) of broad vegetation types for the years 1950, 1995, 2020 and 2045.

Vegetation type	**1950**	**1995**	**2020**	**2045**
Herb + low shrub	57	0	0	0
Wet shrub	54	37	37	32.3
Shrub	9	34.7	33.3	33.3
Fen	3.4	3.4	3.4	3.4
Tundra	203.6	201.5	201.5	201.5
AVC1	24.3	24.3	24.3	24.3
AVC2	146.2	146.2	146.2	146.2
Grassland	46.1	44.1	43.9	43.9
Pine saplings	70.9	4.8	0	0
Spruce saplings	43.4	0.7	0	0
Conifer saplings	19.5	0.2	0	0
Larch saplings	0	0	0	0
Young pine	323.7	62	4.8	0
Young spruce	71.2	20.9	0	0
Young open conifer	96	34.2	6.1	1.6
Young larch	8	0	0.2	0
Young wet spruce	12.9	0.2	0	0
Young Douglas fir / pine	12.6	1.4	0	0
Aspen	7.9	0.2	0	0
Pine	285.1	580.5	586	481.2
Open conifer	234.8	355.4	385.4	385.8
Wet open conifer	91.4	119.9	121.7	121.7
Spruce-fir	341.3	451.4	484.2	521.8
Larch	36.4	45	45	45.2
Aspen-spruce	1.7	8	2.4	0.2
White spruce	9.7	25.5	31.4	34
Douglas fir / pine	7.7	20.9	14.6	11.7
Spruce-pine	82.5	109.3	152.3	228
Douglas fir / white spruce	0.6	3.1	10.8	13.7
Herb mat	0.7	0.7	0.7	0.7
Not classified	1202	1169	1169	1169
Total	3504	3504	3504	3504

AvC1 = Lower Subalpine avalanche communities
AvC2 = Upper Subalpine avalanche communities

Impacts of Fire Exclusion and Other Human Activities on Vegetation

Fire is a key ecosystem process. Vegetation composition, diversity and structure are shaped by fire as well the other species that depend on these communities. This fact was well known to indigenous people in the Americas and even early settlers. In the last century, the importance of fire was buried under an ethic that fire is bad. Wildfire suppression was very successful and essentially eliminated fire in most ecosystems.

After seventy or more years of effective fire suppression, the impacts of removing this vital process are obvious and becoming more pronounced. In BNP and Kananaskis Country, fire suppression is leading to ecosystem degradation, disease and insect infestation, loss of biodiversity and species abundance, loss of recreation opportunities, and economic loss to tourism and industry. Increased forest fuel loads and contiguous fuels increase the treat of catastrophic wildfire that could destroy facilities and communities. Ecologist and land managers have come to understand the contribution of fire as an essential ecosystem process. It is well established that this process must be allowed to occur. Yet, the perception persists in the public mind that fire is bad.

The following information is extracted and adapted from the *Banff Bow Valley Study, Cumulative Effects and Ecological Outlook Model* (Achuff *et al*. 1996). Although it was written for the Bow Valley watershed which covers the southern two thirds of BNP, it is also applicable to the park as a whole.

In BNP, vegetation structure is influenced primarily by fire, avalanche and flood disturbances and herbivory by large mammals. Fire and flooding have been manipulated by humans - by igniting and suppressing fires, and by damming and diverting water flows - as has herbivory - by culling herbivores, predator control or altering animal use patterns. Thus, humans directly and indirectly are a *keystone* species which has affected both vegetation and wildlife.

Changes in Forest Biomass with Increasing Time-Since-Fire

White (1985a) developed a forest biomass accumulation model based on 220 plots in twenty six closed forest vegetation types described in the Banff/Jasper Ecological Land Classification. Following discriminant analysis, these forest types were reduced to 9 fire [fuel] groups. Sample size permitted temporal analysis of changes in six of the nine groups. These six groups were analysed as four climate/ecoregion types:

1). Warm/dry montane forests (Fire Group 1) - stands of Douglas-fir and lodgepole pine on warm/dry montane ecosites dominated by C1, C3, and C6 vegetation types.

2). Warm/dry lower subalpine forests (Fire Groups 2 and 6) - lodgepole pine stands (C3, C6, C9, C11, C18, C19 vegetation types) and Engelmann spruce-subalpine fir stands (C13, C31 vegetation types) that are successionally related (in Holland and Coen 1982) on warm/dry lower subalpine ecosites.

3). Cool/moist lower subalpine forests (Fire Groups 5 and 6) - lodgepole pine stands (C20, C29 vegetation types) and Engelmann spruce/subalpine fir stands (C14, C21, C30 vegetation types) that are successionally related (in Holland and Coen, 1982) on cool/moist lower subalpine ecosites.

4). Upper subalpine forests (Fire Groups 8 and 9) - stands of Engelmann spruce, subalpine fir, and alpine larch (C15, C23, C24, C33, C34 vegetation types) on upper subalpine ecosites.

Temporal variation biomass was described for the crown layer, surface layer, and ground layer for four time since fire/stand origin classes: young (<50 years), mature (50-149 years), transitional (150-299 years), and old (>300 years). Total biomass accumulation rates are generally high in young and mature stands (< 150 years), and then decrease in older forests. For all stand ages, total biomass is highest in cool/moist lower subalpine stands and lowest in upper subalpine forests.

White (1985a) described changes in fire behaviour potential associated with these in forest biomass. With time, deeper duff depths and higher quantities of downed wood increase the amount of effort to contain and extinguish a fire. The potential rate of spread may decrease as forests age, due to decreases in dwarf shrub/herb cover, although the quantity of fine woody fuels (<3 cm) may offset this trend. Surface fire intensity is often high in young stands with abundant dead wood material, decreases to a low in mid-aged stands, and then begins to rise again in old forests. Forests with short fires return intervals (<50 years) often experience sub-lethal fires while fires occurring after a fire-free period of more than 100 years are usually intense and leave little of the crown layer alive. This indicates that fire behaviour in warm/dry montane forests may be substantially different in the future because of forest fuel accumulation that has occurred during a nearly fire-free period of 60-90 years.

Impacts of Fuel Management on Vegetation

The effects of fuel management will be evident in certain areas where fuels will be reduced primarily through repeated prescribed burning. These areas are the southerly aspect slopes of Mt Fortune and Mt Nestor, and the westerly aspect slopes of the Spray-Sixteen Mile ungulate winter range. The effect of repeated burning in these areas will result in some forested habitats becoming open forest, shrub fields, aspen and grasslands.

Some fuel reduction has been carried out on the lower slopes of Mt. Nestor on provincial lands to create a fuel break between the planned burns in BNP and the continuous forests along the Spray Reservoir. Some piling and burning of fuels will also be required to create a fuel break near the north end of the Spray-Sixteen Mile ungulate winter range. As well, some hand falling, piling and burning may be needed in the South Goat Gap to prevent fires from crossing this forested divide between BNP and SVPP.

Impacts of Fire on Vegetation

The primary environmental impacts on vegetation within this unit will be due to restoration of fire. Van Wagner and Methvan (1980) note that the primary effects of fire on live and dead vegetation:

(a) Partial or complete removal of the overhead canopy resulting in increased radiation at the ground surface. This in turn results in release of dormant vegetative buds (stump, root-collar, roots); stimulation of roots, rhizomes, and buried seeds through increased soil temperatures; and optimum light intensity for growth and energy accumulation.

(b) Consumption of duff and humus which results in an increase in soil reaction (pH), an increased supply of bases, increased soil temperature and improved seedbed characteristics.

(c) Control of competing or successional vegetation that would exclude fire adapted communities.

(d) Prevention of fuel accumulations (living and/or dead) to levels that endanger the survival of particular communities.

(e) Maintenance of a stable mix of communities and age-classes by differential recycling that prevents large build-up of pathogenic organisms, and that provides a mosaic of habitats for a thriving and varied wildlife population.

The pattern and effects of fire on vegetation are dependant upon the fire behaviour which is affected by many factors such as (1) fuel moisture conditions, weather and ignition pattern at the onset of burning, (2) weather conditions between ignition and extinguishment, (3) vegetation type, accumulations, continuity, and arrangement, and (4) terrain. The vegetation that establishes after a fire also depends on many factors. However, some generalizations usually apply: (1) low severity burns tend to be recolonized by the same vegetation that was on site prior to the burn, due to seeds, root stocks and rhizomes which survive in the unburned soil; (2) high severity burns may have a different assemblage of species as revegetation is more dependant upon wind blown, water carried, and animal dispersed seeding mechanisms (Wright and Bailey 1982).

Planned prescribed fires will primarily be low severity burns.

Impacts of Prescribed Fire on Vegetation

With the exception of a few locations, high mountain ridges and the Spray Reservoir provide a substantial barrier to fire spread on the eastside of the Spray and Bryant LMU. However, under extreme conditions, fires could spread east near Watridge Lake, over the top of Goat Gap, or north beyond the Sixteen Mile Range. Fire spreading through these areas would be burning on east and north aspect slopes which require a substantial period of drying. Although values at risk downwind of these areas are low, they are provincial forests with few natural fuel breaks. Therefore, the prescriptions for lightning and accidental human caused fires within these units are restricted to moderate fuel moisture conditions during the mid summer (August), gradually increasing as the fire season draws to a close in September and October. The likelihood of a wildfire occurring within prescription is quite low.

If fire suppression is necessary, impacts (dozer trails, hand built fireguards, helicopter landing pads, use of long and short term fire retardant drops, and fire camps) will be minimized where possible, and rehabilitated as much as possible prior to demobilizing the fire crews.

The impacts of maintaining fuel breaks in strategic areas through repeated burning are similar to the restoration of fire within the historic range of fire intervals. The impacts of fire on forests and other vegetation will closely duplicate the natural process of wildfire. Fire has been associated with many, if not most plant communities, and particularly forest communities throughout their evolution. Fire is a normal and pervasive component of the environment. Fire stabilizes forest ecosystems by interrupting succession before the plant community is radically altered.

It is not known whether browsing and grazing of post burn regenerating vegetation will result in normal succession changes. The impacts of fire and herbivory will be monitored at wildlife exclosures. If monitoring of grazing and browsing of recently burned habitats is determined to be excessive and undesirable, burning in these areas will be discontinued until the elk population is low enough to permit successful regeneration.

Impacts of Fire on Riparian Systems

Impacts on riparian systems are mitigated by choosing ignition patterns and fire intervals which limit the amount of burning in riparian areas. A small amount of riparian forest may be reburned (primarily on the Middle Spray River Valley) to maintain the fuel break between the upper parts of the watershed and the Bow Valley.

Although planned fires may occasionally spread into riparian areas as wildfires do, the impacts of planned fires will be less extensive and less severe because riparian fuels are often too wet to burn under prescribed conditions.

Riparian areas have longer fire return intervals than surrounding forests due to moist fuels and topographic differences. As a result, riparian areas may add greater stand-age structure and habitat and species diversity.

Within the burn unit there is a stand of old spruce originating around the year 1690 in riparian habitat. This 1690 stand likely survived the 1894 fire because of moist fuels. It adds complexity to the stand-age mosaic and greater habitat and species diversity.

While we can expect that this stand will eventually burn, it will not likely burn during the prescribed fire due to fuel moisture. In order to maintain habitat and species diversity, our recommendation is to not specifically target this older stand for burning.

Rare Vegetation Communities

ELC[4] vegetation type C16 is found within the subalpine in this area and is considered rare and in decline in the region due to forest succession. Types C9 and C23 have range boundaries within southern BNP. These vegetation types have limited distribution within these LMU and occur in tracts too small to be mapped as ecosites.

C16 is defined by aspen (*Populus tremuloides*) in the overstorey, with a shrub layer of buffaloberry, prickly rose (*Rosa acicularis*) and juniper (*Juniperus communis*). The herb-dwarf shrub layer is dominated by hairy wild rye (*Elymus innovatus*) and pine grass (*Calamagrostis rubescens*).

C9 is dominated by lodgepole pine (*Pinus contorta)* in the overstorey and dwarf bilberry (*Vaccinium caespitosum*) in the herb-dwarf shrub layer. It occurs along the Spray River on subalpine tracts of AL1, FR1 and SP1 ecosites.

C23 is dominated by subalpine larch (*Larix lyallii*) and grouseberry (*Vaccinium scoparium*) and everlasting (*Antennaria lanata*) in the shrub and herb-dwarf shrub layers. It occurs in scattered stands near treeline.

Rare Plants

A rare plant survey was conducted in July, 2006 as part of this assessment for the portion of the burn area in Spray Valley Provincial Park. No rare plants were found. However, *Pedicularis contorta* was found. This plant is not currently on the rare plant list but needs to be reviewed and perhaps listed as there are few occurrences in Alberta (Gould, pers. comm. 2006).

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[4] Ecological Land Classification for Banff National Park

Known locations of rare vascular plants are listed below. These records are from tracking lists compiled by Alberta Natural Heritage Information Centre (ANHIC) (compiled by Wallis 1998). The criteria for species considered sufficiently rare to be tracked by the ANHIC are presented in Table 12.

Table 12: ANHIC criteria for species considered

S1	≤ 5 occurrences in the province or only a few remaining individuals, or may be imperilled because some factor of its biology makes it especially vulnerable to extirpation.
S2	6-20 occurrences or with many individuals in fewer occurrences: or may be susceptible to extirpation because of some factor of its biology.
S3	21- 100 occurrences may be rare and local throughout its provincial range or in a restricted provincial range (may be abundant in some locations or may be vulnerable to extirpation because of some factor of its biology).

Epilobium lactiflorum
A willow herb listed on the S2 tracking list. It has been found at the end of Spray Lakes near the outlet of Bryant Creek.

Pedicularis racemosa
This herb is commonly known as leafy lousewort. It has been found in subalpine meadows near Marvel Lake and near Lake Louise in BNP. It is listed on the ANHIC S1 tracking list.

Runuculus verecundus
An alpine buttercup listed on the ANHIC S2 tracking list for rare plants in Alberta. It has been found near Bryant Creek Warden Cabin.

Castilleja pallida
A species of paintbrush listed on the ANHIC SU tracking list. It was reported in 1946 from the Middle Spray River Valley between Mt Turbulent and the Goat Range.

The principal known threats to rare plant species in BNP and SVPP are surface disturbances associated with construction activities and modification of the natural disturbance regime such as fire and grazing.

The potential impact of fire on the four species of rare plant species is unknown. It is likely that *Castilleja pallida* and *Runuculus verecundus* occur in habitats that have been burned in the past. It is not known whether the reported populations are adapted to survive fire or whether they depend on other populations to seed into burned areas.

It is unlikely that the habitat where the willow herb (*Epilobium lactiflorum*) would be affected by low severity prescribed burning as these moist sites are not usually burned. It could be affected by fire suppression activities such as line building with hand tools or machinery.

The leafy lousewort (*Pedicularis racemosa*) occurs in an upper subalpine meadow. It is unlikely to be affected by any fire management activities.

Whitebark Pine (*Pinus albicaulis*)

Whitebark pine is known to occur on Mount Nestor. Five trees were found during a survey on July 31, 2006. It is likely that many more are dispersed through the site. Two of these trees were infected with blister rust fungus (*Cronartium ribicola*).

Animal Habitat

Since vegetation is a major habitat component for animals, vegetation change information is used to analyse changes in habitat quality for elk. Using information on seasonal habitat quality for each ELC ecosite (Holroyd & Van Tighem 1983), as well as broad vegetation types and stand ages, the vegetation change scheme was used to backcast winter and summer habitat quality to 1950 and to forecast it 2020 and 2045 for the Bow Valley within BNP. The polygons were rated as very high, high, medium, low, present or nil.

The decline is most notable in winter habitat (Table 14) where very high quality winter habitat is forecast to disappear by 2020 while the high and medium quality classes decline sharply though 2045. Concurrently, the three lowest quality classes (nil, present and low) increase from 1950 to 2045.

Table 13: Areas (km^2) of summer elk habitat in the Banff Bow Valley for the years 1950, 1995, 2020 and 2045.

Quality Class						
	0	1	2	3	4	5
1950	22.5	238.5	477.2	491.4	528.2	165.7
1995	29.9	301.8	588.8	581.5	354.2	74.4
2020	32.4	353.7	693.1	597.9	211.6	41.9
2045	37.6	430.4	757.9	521.2	163.2	20.3

Quality classes: 0=nil, 1=present, 2= low, 3=medium, 4=high, 5=very high.

Table 14: Areas (km^2) of winter elk habitat in the Banff Bow Valley for the years 1950, 1995, 2020 and 2045.

Quality Class						
	0	1	2	3	4	5
1950	216.5	523.3	670.6	407.6	85.5	27.1
1995	268.7	521.4	838.5	247.7	47.7	6.6
2020	311.9	501.3	877.6	208.4	31.4	0
2045	382.7	524.1	811.9	197.9	14	0

Similar trends occur in elk summer habitat quality (Table 13) with the amount of the high and very high quality habitat decreasing from 1950 to 2045 while the amount of inferior quality habitat increases. It should be noted that this is a model of habitat quality, not habitat use. Habitat use, while partly influenced by habitat quality, is also affected by other factors, such as predators, human disturbance and travel corridors.

As an example of change in grizzly bear (*Ursus arctos*) habitat quality, the change in production of buffaloberry (*Shepherdia canadensis*) with vegetation change was assessed (Hamer 1996). It was found that a dense forest canopy resulted in a rapid decrease in berry production once the forest canopy exceeded 45% closure. This degree of canopy closure occurred in forests as young as 23 years. Buffaloberry feeding habitat in forests older than 100 years primarily occurs in microsites where forest in growth is slowed by various environmental factors.

Yellow hedysarum (*Hedysarum spp.*) is an important grizzly bear food in the spring season and the fall if buffaloberry fruit production is low. In a 1986 burn it was found that yellow hedysarum roots were heavier, more easily dug, and occurred at higher density than in the adjacent forest. Hedysarum roots in this burn were dug extensively between 1995 and1997, but no diggings were found in the adjacent forest which last burned in 1914 and 1889. This study demonstrates the importance of recent burns for grizzly bear habitats.

WILDLIFE

Impact of Fire on Wildlife

Fire has been a major form of disturbance that results in higher diversity in vegetation and larger populations of mammals. Food and space are the most important habitat variables for mammals and food is most diverse in a range of successional stages after fire or other disturbance. Cover for predator avoidance, thermal stability, and security is also of high importance to small species. Different species have adapted to exploit various successional stages after fire. Special habitat needs may be the limiting factor for some populations in marginal habitats.

Large mobile animals can flee faster than most fires advance. Small burrowing mammals can survive underground. Loss of life appears to be quite rare among mammals. Excepting areas which are repeatedly burned to maintain fuel breaks, in these LMU it is possible to use line fire rather than progressive strip head fire as the firing technique. This will minimize the chance of animals being trapped and burned by the fire.

Impacts of Fire Suppression on Wildlife

In the future, the impacts of fire suppression on wildlife within the Spray and Bryant LMU should be greatly reduced. Where fire suppression is necessary, access will be with aircraft rather than by road. Use of large machinery within these units is now unlikely as most roads are now closed and becoming impassable to motor vehicles.

Impacts of Fuel Management on Wildlife

Fuel reduction through cutting live and dead vegetation, piling and burning may disrupt wildlife movements and use of habitat while the activity is being carried out. The impacts of fuel modification through repeated burning in strategic area are similar to restoring fire within the historic range of fire return intervals.

Table 15: Residents and potential residents of special significance in the Spray, Bryant and Turbulent Creek drainages.

Species	**Scientific Name**	**Status (COSEWIC)**	**Status (SARA)**
Large Mammals			
Grizzly bear	*Ursus arctos*	Special concern	Special conc.
Cougar	*Felis concolor*		
Grey wolf	*Canis lupus*	Special concern	Special conc.
Wolverine	*Gulo gulo*	Special concern	None
Fisher	*Martes pennanti*		
Rodents			
Water shrew	*Sorex palustris*		
Richardson's water vole	*Arvicola richardsoni*		
Birds			
Great gray owl	*Strix nebulosa*		
Calliope hummingbird	*Stellula calliope*		
Black-backed woodpecker	*Picoides arcticus*		
Western flycatcher	*Empidonax difficilis*		
Steller's jay	*Cyanocitta stelleri*		
Magnolia warbler	*Dendroica magnolia*		
Golden eagle	*Aquila chrysaetos*		
Lewis' woodpecker	*Asyndesmus lewis*		
Goshawk	*Accipiter gentilis*		
Coopers hawk	*Accipiter cooperi*		
Merlin	*Falco columbarius*		
Hawk owl	*Surnia ulula*		
Fish			
Cutthroat trout	*Salvelinus clarki lewisi*		
Bull trout	*Salvelinus confluentis*		
Amphibians			
Spotted frog	*Rana pretiosa*	Endangered	Endangered
Long-toed salamander	*Ambystoma macrodactyLUM*		
Boreal toad	*Bufo boreas boreas*	Special concern	Special conc.

UNGULATES

Most ungulates will likely benefit from the Mount Nestor burn. Some disturbance of species will occur during the spring burning period which coincides with the time that ungulates give birth. If the burn is done in September, there would be less potential for impacts on ungulates in the sensitive birthing period.

Some older forests should be left to increase forest biodiversity and specifically provide hiding cover and thermal cover. This is not expected to be an issue since it is likely that only 50 to 80% of any area will be burned.

Bighorn Sheep (*Ovis canadensis*)

Bighorn sheep are the ungulate species most likely to be impacted by burning operations in the spring. Sheep will be foraging on the lower slopes on Mount Nestor when burning begins in April. Lambs are born between the last week of May and early June. Lambing is finished by June 21. Impacts may be due to fire or human disturbance including helicopter activities.

Burning is expected to have a net ecological benefit for bighorn sheep by restoring native grassland lost due to forest succession resulting from fire exclusion. One of the ecological objectives of the fire is to increase the amount of open grassland habitat at upper elevation to provide forage for bighorn sheep.

A department biologist should monitor bighorn sheep activity during the burning operation to reduce the potential for impacts. Sheep must be given the opportunity to escape fire and human activities. Certain areas may have to be avoided at certain times. This should be at the discretion of the department biologist.

The potential to disturb bighorn sheep during spring lambing can be avoided by doing site inspections and other preparation activities in the autumn of 2006 rather than in the spring.

Moose (*Alces alces*)

Moose will likely benefit from the Mount Nestor burn as it will provide both early succession forests for food and older stands for cover. The burn will likely leave some older forests intact, increasing forest biodiversity, and provide cover for moose. Moose tend to prefer edges of burns and islands of forest within small burns (Thomas 1995). Moose density appears to peak when large areas of young, post-fire habitat are available (Thomas 1995).

Elk (*Cervus elaphus*)
The following summary of elk use of the Spray Lakes area is from Thomas (1995) as it appears in the original cumulative effects screening for the Spray Valley (Parks Canada 1998, pp. 23-24).

Elk prefer grassland, recently burned shrub land and early succession vegetation interspersed with forest cover. These watersheds are primarily used during the spring, summer and fall. Elk use upper subalpine areas during much of the summer, perhaps to avoid biting insects and possibly as a predator avoidance strategy. Most elk that summer in these watersheds migrate to the Bow Valley for winter range. However, some stay on the Spray-Sixteen Mile Range all winter (Skjonsberg 1993). Prescribed burns may affect the distribution and seasonal movements of elk within the park. Whether populations may increase due to improved habitat is unknown, as several other factors also affect elk numbers.

Impacts to elk may occur during the fire and include disturbance from the fire as well as human activities. Elk will likely be displaced from the area during the operational phase and may have some difficulty migrating through the area. However, operations will only be during the day. This may give elk the opportunity to travel through at night.

Overall, the fire should have a net beneficial impact for elk by improving elk habitat. Burning will increase the area of early succession forests and grassland as well as increase the quality of grassland forage.

Deer (*Odocoileus virginianus, Odocoileus hemionus*)
The following summary of elk use of the Spray Lakes area is from Thomas (1995). It appears in the original cumulative effects screening for the Spray Valley (Parks Canada 1998, p. 24):

Deer prefer grasslands, and recently burned shrub lands and forest. Mature forest is needed for thermal cover in the winter, and perhaps for shade in hot summer weather. Deer also use upper subalpine and alpine areas for relief from heat and biting insects.

Regenerating forests provide deer with better forage. Deer may benefit from increased grazing opportunities after the fire.

Caribou (*Rangifer tarandus)*
The Mount Nestor area is not within caribou range so no benefits or impacts are anticipated.

Mountain Goat (*Oreamnos americanus*)

Mountain goats are known to use the upper elevations of the Goat Range, primarily at or above tree line. There are not anticipated to be any significant impacts to mountain goats by the prescribed burn.

LARGE CARNIVORES

Grizzly Bear (*Ursus arctos*)

Grizzly bears were once widely distributed throughout western North America but their range is now greatly reduced. They are listed as vulnerable to extinction (COSEWIC 1997). The population in BNP and adjacent areas is believed to be stressed due to a high level of mortality from various human causes and fragmentation of habitat (Gibeau pers. com. 1998).

Many grizzly bears foods and prey occur in early succession vegetation such as avalanche paths and recent burns. The Front Ranges of Banff National Park and Kananaskis Country may be more heavily used than the Main Ranges.

One of the ecological objectives of the Mount Nestor plan is to improve grizzly bear habitat in areas with low human use. A recent long-term study of grizzly bear in the Canadian Central Rockies Ecosystem (CRE) recognized the importance of maintaining ecological processes such as fire for grizzly bears. Management recommendations from the final report of the Easter Slopes Grizzly Bear Project included the following goals:

> 1. Maintain, restore or mimic ecological processes in order to recreate plant and animal communities that are more similar to those grizzly bears experienced in the CRE when First Nation peoples where the only humans.
>
> 2. Begin to systematically restore grizzly bear habitat in the CRE.
>
> (Herrero 2005, p XVI - XVIII)

The study showed that the Spray Lakes area is used by grizzly bears though no known grizzly bear den sites are in the area. However, relatively fewer telemetry locations are found around Mount Nestor compared to other locations. This may reflect the lower habitat quality of large, contiguous stands of mature pine and spruce forests.

Bears appear to frequent areas along the Spray Lakes Road, West Side Road and Spray West Campground, areas where there is potential for conflicts with humans and greater chance of grizzly bear mortality. Grizzly bears are attracted to these areas because the forest canopy is more open, offering favourable conditions for buffaloberry (*Shepherdia canadensis*) growth. Buffaloberry is a main source of nutrition for grizzly bear on the East Slopes of CRE.

By improving grizzly bear habitat around Mount Nestor, an area with low human use, park managers hope that grizzly bears will use the Mount Nestor area more frequently than areas with higher levels of human use.

The following summary by Thomas (1995) provides information on grizzly bear habitat associations:

Generally, both black bears and grizzly bears prefer early succession vegetation for feeding during much of the year particularly during the spring and fall. Black bears and grizzly bears occur in the Middle Spray River Valley. Elsewhere in these units, black bears appear to be displaced by grizzly bears.

During the spring grizzly bears primarily feed on *Hedysarum spp.* roots and prey on elk or other ungulate calves. During the early summer, grizzly bears feed on *Eequisetum spp.* which is found in riparian areas and some parts of mature forests. In the fall, grizzly bears will feed almost exclusively on buffaloberries (*Shepherdia canadensis)* where these are abundant. Buffaloberry habitat does not become productive until more than five years after the fire. Buffaloberry feeding habitat usually declines after thirty to one hundred years after fire (Hamer 1996).

When berries are scarce, bears switch to alternative foods, primarily feeding on *Hedysarum* roots until they den (Hamer and Herrero 1983). *Hedysarum* abundance is much greater in burned rather than unburned habitat six years after burning on the nearby Panther River. The biomass of roots was much greater within the burn site 10 years after burning in one area, but about equal in burned and unburned forest 6 years after the fire in another area (Hamer 1997).

Black Bear (*Ursus americanus*)
Black bears do not dig for roots, and are much more dependent on berries, ants, carrion and other foods (Thomas 1995). It is anticipated that the fire will temporarily displace black bears from the site but they will return to use the area following the burn.

Bobcat (*Lynx rufus*)
Bobcat is not known to use the area around Mount Nestor but can be found further east.

Lynx (*Lynx canadensis*)
Lynx have been reported in the area and can be expected to be temporarily displaced from the burn area following the fire.

Cougar (*Felis concolor*)
In Alberta, cougars are largely confined to the mountains and foothills. They are common south of the Bow River. In BNP observations are primarily from the montane and lower subalpine ecoregions in the Front Ranges. In many areas their distribution corresponds to that of mule deer, however, in BNP they also prey on elk, sheep and mountain goats.

Grey Wolf (*Canis lupus*)
In the Canadian Rockies wolf control began by 1859 and numbers were greatly reduced by the 1930s. The wolf population in BNP increased to about 48 animals during the late 1940s coincident with an increase in the elk population. Wolf control intensified during the early 1950s following a rabies outbreak in Alberta, and the BNP population was fewer than 10 wolves until about 1970. During the 1970s and 1980s numbers increased with wolves denning in a number of watersheds in the Front Ranges of the park. It appears that wolves are important in limiting the population size and habitat use of ungulates in BNP. Thus, they are a keystone species influencing various aspects of the ecosystem. The continued existence of a viable population of wolves in BNP is important for the maintenance of ecological integrity within the park (Kay *et al*. 1994).

The density of wolves is related to the type and biomass of prey. Wolves may spend more time in the Spray Valley if prey foraging increased due to more early successional vegetation created the burn (Thomas 1995).

A wolf den exists along the Spray River in Banff National Park. This den is within the fire containment area but 11 km from the planned burn. Wardens will assess if this den is occupied before burning. All necessary mitigations will be implemented to minimize impacts if the den site is occupied.

These mitigations include:

- Minimizing disturbance from human use and aircraft
- Ensuring the fire does not escape into the area around the den

If the den is occupied when burning occurs, an assessment will be done after the fire to evaluate if there are any impacts.

Wolverine (*Gulo gulo*)
Wolverines are listed as endangered in eastern Canada, and vulnerable to extinction within western Canada (COSEWIC 1997). This is the rarest carnivore in Alberta. The most stable populations occur within the cordillera of Alberta, British Columbia and the Yukon. They are locally common within BNP and the park may be important for their continued survival. Of the recent report sightings in BNP, approximately two thirds were from the Main Ranges and one third from the Front Ranges. Important watersheds for wolverine based on winter tracking are Johnson Creek, Baker Creek, Healy Creek, Bryant Creek, Clearwater River and the middle Bow River.

Distribution of wolverine within the park is similar to the distribution of porcupines which are a major prey species. The porcupine is most common in Main Range valleys with extensive Engelmann spruce and subalpine fir forests.

Wolverines prey heavily on porcupines during the winter, particularly in upper subalpine areas (Holroyd and van Tighem 1983). Wolverines tend to prey on species that favour mature Engelmann spruce/subalpine fir forest and would be negatively affected if large fires were to occur in this habitat type (Thomas 1995). Forest in the Mount Nestor area is mostly pine and spruce originating around 1895 so there should be no little or no impact on wolverine habitat.

Fisher (*Martes pennanti*)
Fishers occur mainly in mature, closed coniferous forest of the lower subalpine ecoregion. This habitat is extensive in the Main Ranges near the Continental Divide, yet the population size remains small, apparently due to natural factors.

The Mount Nestor prescribed fire with burn mostly younger forests that originated after 1895 and there is no anticipated impact on fisher.

Marten (*Martes americana*)
Marten are generalist feeders and use all stages of forest. They will eat berries, mice, hares and voles in recently burned areas, or voles, and squirrels in mature forest. They have been associated with old growth forest because they prefer mature and old forests for resting and den sites (Thomas 1995).

Forest in the Mount Nestor area is mostly pine and spruce originating around 1895 except for a small area of older spruce forest as old as the year 1690. This older forest may provide good habitat and connectivity for marten.

Martes americana atrata, the Newfoundland Population is listed as endangered by both COSEWIC and SARA.

SMALL MAMMALS

Beaver (*Castor Canadensis*)
Beaver prefer early successional vegetation along slow moving streams such as the Upper Spray River Valley. In the wetlands of the lower Bow Valley the beaver population appears to have declined due to sympatric competition, primarily from elk (Nietveld 1996). The beaver population in the burn unit is unknown and interactions with other species such as elk and wolves has not been studied (Thomas, 1995).

Hares (*Lepus americanus*)
Hares prefer feeding in shrub lands and early successional mixed wood forests. Cover is also very important for avoidance of predators. Thick regenerating shrubs, and conifers, with abundant deadfalls and windthrown trees vegetation, provide suitable escape terrain (Thomas 1995).

Red Squirrels (*Tamiasciurus hudsonicus*)
The red squirrel feeds primarily on seeds of conifers. Populations are low in burned areas until the regenerating trees develop cones which take from 10-15 years. As well, escape terrain is limited until the crowns of trees are close enough for tree squirrels to travel above the ground. Ground squirrels are more abundant after a burn due to increased food supply (Thomas, 1995).

Microtines
Deer mice (*Peromyscus maniculatus*) recolonize burns in 1-3 years. The optimum habitat is about 7 years post fire. As forests age, deer mice populations decline and voles *Microtus spp.* and chipmunk *Eutamias spp.* populations increase (Thomas, 1995).

Water Shrew (*Sorex palustris*)
The water shrew is very rare but widespread in BNP. They occur from the montane to the upper subalpine in habitats that include mossy spruce-fir forests, shrubby open forests and shrub communities near fast cold streams.

Richardson's Water Vole (*Arvicola richardsoni*)
Richardson's water vole is rare to uncommon in BNP. Typical habitat for this species includes upper subalpine herb and shrub meadows close to water and snow patches. A Richardson's water vole was observed along the small riparian complex at the south east base of Mount Fortune on July 29, 2006 during an amphibian survey of the proposed burn site.

AMPHIBIANS

Effects of Fire on Amphibians

Banff National Park is currently conducting a long-term study on the effects of fire on amphibians. Results of that study are not yet available.

Amphibians will not likely be directly affected by the fire. Impacts could occur from changes to ground water and runoff that may adversely impact amphibian habitat. Changes will likely be temporary and not last for more than a few years.

Amphibians in the Mount Nestor Burn Unit

A survey was done of potential amphibian habitat on July 29 and 30, 2006 within the study area. Twelve wetlands were surveyed and amphibians were found at 8 sites. All 12 sites are just east of the national park boundary at the base of Mount Fortune. Amphibians observed include boreal or western toads (*Bufo boreas boreas*) at 4 sites (3 adult single occurrences, one young of year), adult Columbia spotted frogs (*Rana pretiosa*) at 2 sites (single occurrences), and unidentified adult frogs at 2 sites (three occurrences at each). No tadpoles were observed. Several wet riparian areas were also surveyed but no amphibians were found at those locations. There is potential that the wood frog (*Rana sylvatica*) and long-toed salamander (*Ambystoma macrodactylum*) exist within the burn unit but these were not observed.

Two species of significance are found in the proposed burn area. The spotted frog is now listed as Endangered by both the Species at Risk Act (SARA) and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). The boreal toad is listed as a species of Special Concern under both SARA and COSEWIC.

Spotted Frog (*Rana pretiosa*)
This species is uncommon in Alberta. It is also on the Status of Alberta Wildlife Blue List, which indicates that the species is believed to be vulnerable to population declines (Bryson 1995). The Rocky Mountains form the eastern part of its range. The species has been reported in the Spray River Valley. It spawns in small ponds and river terraces up to about 2000 metres elevation.

Table 16: Life stages of the spotted frog.

Life Stage	April	May	June	July	August	Sept.
Breeding	🟩	🟩	🟩			
Eggs Hatch	🟦	🟦	🟦			
Transformation					▬	▬

(Alberta Sustainable Resource Development 2006)

Boreal or Western Toad (*Bufo boreas boreas*)
Boreal toads are both common and widespread in Alberta. Although listed as a species of special concern in by COSEWIC Alberta's populations are currently considered to be healthy and are listed as green by the Status of Alberta Wildlife. This species was observed in the proposed burn area on July 29th, 2006.

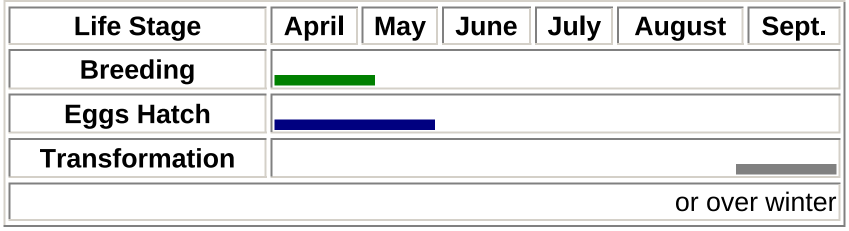
Table 17: Life stages of the boreal toad.

Life Stage	April	May	June	July	August	Sept.
Breeding	🟩	🟩	🟩			
Eggs Hatch	🟦	🟦	🟦			
Transformation	▬	▬	▬			
						or over winter

(Alberta Sustainable Resource Development 2006)

Long-toed Salamander (*Ambystoma macrodactylum*)
This species has been reported in the Bow Valley between the East Park Gate and near Herbert Lake (McIvor and McIvor 1996) and at Buller Pond, across the reservoir from the Mount Nestor burn unit (Booth, pers. comm. 2001). As yet there are no records of it occurring in the Spray and Bryant LMU. It is a Red List species in Alberta, indicating that the population is no longer viable or at immediate risk of declining to nonviable levels (Bryson 1995).

Table 18: Life stages of the long-toed salamander.

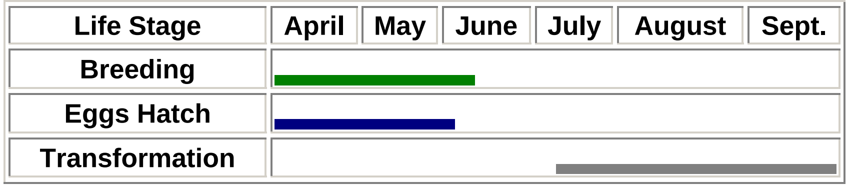


Life Stage	April	May	June	July	August	Sept.
Breeding	🟩	🟩				
Eggs Hatch	🟦	🟦				
Transformation						▬
						or over winter

(Alberta Sustainable Resource Development 2006)

Wood Frog (*Rana sylvatica*)
The wood frog is common in Alberta and is currently listed as green by the Status of Alberta Wildlife.

Table 19: Life stages of the wood frog.



Life Stage	April	May	June	July	August	Sept.
Breeding	🟩	🟩	🟩			
Eggs Hatch	🟦	🟦	🟦			
Transformation				▬	▬	▬

(Alberta Sustainable Resource Development 2006)

REPTILES

There is potential that the western terrestrial (wandering) garter snake (*Thamnophis elegans*) may exist within the burn unit. This species has been observed in other subalpine habitats in the region.

BIRDS

Forest Birds and Fire

The section below is a summary of information presented by Telfer (1995).

As a consequence of the historical development of bird species and their habitats in the boreal forest, there are species capable of using any combination of age class and tree species composition that may occur. Thus changes due to wildfire incidence or human management can be expected to impact negatively on some bird species but benefit others.

The 146 species of forest-nesting birds are widely distributed among the major habitat types. The broad distribution of use shows that every category of upland habitat is used by some species in the regional avifauna. The average number of categories used per bird species was between 3 and 4, indicating a substantial level of habitat generalization.

Spring is the preferred season for burning to limit fire intensity, severity, amount of area burned, smoke emissions, and atmospheric inversions. However, burning in this season will result in the death of some birds. Migratory songbirds generally arrive in the northern Rocky Mountain forests in late April to early May. Breeding birds establish territories, mate and begin egg laying by late May. Hatching begins in mid June. There is a two to three week period where the young are helpless before they leave the nest.

This chronology indicates that fires burning between mid May and early July probably destroy nests with eggs and young of the years. Because of the strong bond of the adults to their young and breeding territory, crown fires at that time may also kill adult birds. If burning occurs early in the nesting season, most species will renest and may produce some young.

While fires during the nesting season undoubtedly kill some birds, this is not a significant effect on the regional population. Other natural disasters such as periods of cold, wet weather accompanied by snow in the late spring can cause nesting failure over much larger areas. At a population level, direct mortality from forest fire has probably not been a limiting factor for birds.

Outside of the May-July period, little direct bird mortality is caused by fire. Burning renders an area unsuitable for birds requiring forest habitat for varying periods of time (Telfer 1995).

Table 20: Number and percentage of 146 bird species using various habitats during the breeding season in the boreal forests of Canada's prairie provinces.

Age Class	Deciduous	Mixed Wood	Coniferous	Totals
Young (0-25 years)	48 (9%)	61 (11%)	54 (10%)	163 (30%)
Immature (26-50 years)	30 (6%)	38 (7%)	33 (6%)	101 (19%)
Mature (51-150 years)	52 (8%)	82 (15%)	77 (14%)	211 (39%)
Old (150+ years)	13 (3%)	27 (5%)	21 (4%)	61 (11%)
Totals	143 (27%)	208 (39%)	185 (35%)	536 (100%)

*Species were listed in all categories that they were reported to use.

The following descriptions are of residents or potential residents of special significance in the Spray, Bryant and Turbulent Creek drainages.

Goshawk (*Accipiter gentilis*)
This species occurs primarily in montane and Lower subalpine ecoregions in dry, spruce-pine open forest. The species is most common in the Front Ranges which includes the Spray and Bryant LMU.

Coopers Hawk (*Accipiter cooperi*)
This is a blue list species in Alberta (Bryson 1995). Typically it is found in aspen forests and forested areas in the Lower subalpine ecoregion, especially near fluvial fans.

Merlin (*Falco columbarius*)
The merlin is a rare summer resident. It also migrates through BNP in the spring and fall. Sightings are widely distributed in the park.

Hawk Owl (*Surnia ulula*)
The hawk owl breeds locally in the mountains and northern half of Alberta. It has nested in unburned forest inside the Vermilion Pass burn, and been seen in montane wetland forest and subalpine spruce-fir forest.

Great Gray Owl (*Strix nebulosa*)
The great gray owl is a rare resident of BNP, and a blue list species in Alberta (Bryson 1995). It prefers coniferous and mixed coniferous-deciduous forests near wetlands and meadows in the montane and lower subalpine ecoregions.

Calliope Hummingbird (*Stellula calliope*)
The calliope hummingbird occurs mostly in open areas (avalanche slopes, burns, meadows, open forests) where flowers are abundant from the montane to the upper subalpine.

Lewis' Woodpecker (*Asyndesmus lewis*)
The Lewis' woodpecker is a rare summer resident in BNP. It nests in dead snags and seems to prefer dry, open forests in the montane ecoregion and old burns.

Black-backed Woodpecker (*Picoides arcticus*)
The black-backed woodpecker is a rare resident in BNP. It prefers open forests and burns with dead trees, mainly in the montane ecoregion.

Western Flycatcher (*Empidonax difficilis*)
The western flycatcher is a rare summer resident of BNP. It is primarily found in open coniferous forests near streams and seepages in the montane and lower subalpine ecoregions.

Steller's Jay (*Cyanocitta stelleri*)
The Steller's jay is a rare year round resident. There are many observations of the species in the Bryant Creek area. It usually occurs in mixed or coniferous forests and avalanche slopes of the montane and lower subalpine ecoregions.

Magnolia Warbler (*Dendroica magnolia*)
The magnolia warbler is a rare summer resident of BNP. It occurs in open coniferous and mixed forests in the montane and Lower subalpine ecoregions.

Golden Eagle (*Aquila chrysaetos*)
The golden eagle is an uncommon summer, and rare winter resident. It has been known to nest in the Bryant Creek area. It migrates in large numbers through the Front Ranges of the Rockies spring and fall.

FISH

The prescribed fire is not likely to adversely impact fish habitat or populations in the watershed. Fire is considered a beneficial natural process necessary for the structure and function of aquatic communities. In some ecosystems, fire can have damaging local and regional impacts, particularly in areas where humans have altered vegetation structures or damaged soils. However, no damaging impacts are anticipated from the prescribed fire. Potential impacts could occur due to operational activities associated with the prescribed fire but no damaging impacts are anticipated. Withdrawal of water from Goat Pond or Spray Reservoir by hose or buckets would only have a minor impact on fish populations.

Brook trout (*Salvelinus fontinalis*) were found in a stream on the west side of the burn unit during an amphibian survey in July, 2006. This is an introduced population that is likely isolated. (Lajeunesse, pers. com. 2006). It is desirable to remove this introduced species from stream. Therefore, there are no concerns about impacts on this brook trout population.

Bull Trout *(Salvelinus confluentis)*

Bull trout are a species of char native to the watersheds in the eastern slopes of the Rocky Mountains. Over the past few decades, populations of this species have declined in the mountain parks and provincial waters, to the extent that the species is now considered threatened. Competition due to the widespread stocking of non-native trout and char and overfishing are factors that appear to have caused the species to decline. Bull trout are not found in the Spray Lakes Reservoir due to the introduction of Lake Trout (*Salvelinus Namaycush)*, (Lajeunesse pers. com. 2006).

Westslope Cutthroat Trout *(Salvelinus clarki lewisi)*

This species is native to the Spray watershed but is rare is Spray Lakes Reservoir due to competition with Lake Trout (*Salvelinus Namaycush)*. Pure strains of cutthroat trout are found in Smuts and Bryant Creeks (Lajeunesse pers. com. 2006).

A more detailed review of damaging impacts of forest fire on fish habitat and populations is provided below:

Effects of Forest Fires on Fish

Potential impacts of forest fire on fish habitat and populations spans a continuum from severe to negligible. However, within these LMU, most of the smaller creeks where sediment loads are likely to be greatest, have too steep a gradient to provide suitable habitat for rearing, spawning, foraging or resting. The effects of erosion and sediment loads are primarily off-site, downstream impacts. These impacts are mitigated by increased stream flows, and the availability of pools, eddies, backwater channels, springs and other sources of ground and surface waters.

In general, the effects of fires on fish are dependant upon the size of the stream, the severity of the fire, the steepness of slopes, stability of soils and climate of the area (Rieman and Clayton 1997). In watersheds where small creeks (first order streams, mean summer discharge < 2 cu m/s) have dissected terrain with steep slopes and unstable soils, the loss of vegetation and ground cover may result in soil slumping and surface erosion which greatly increases sediment loads. As well, the loss of riparian vegetation can increase water temperatures and sediment loads in streams. These factors would negatively affect the availability of spawning beds, the survival of eggs, and possibly the use of the stream by fingerlings and mature fish.

Conversely, large streams bordered by relatively flat terrain would be not be noticeably affected by a low severity burn which would leave much of the ground cover and riparian vegetation intact. Typical of many streams in BNP, the Spray River has many small tributaries including Bryant Creek, Turbulent Creek, Smith Dorian Creek which join to form a small river (third or fourth order stream with mean summer discharge of 8-20 cu m/s) by the time it joins the Bow River below the town of Banff.

INSECTS

Effects of Fire Exclusion on Insects

Fire exclusion may create large, contiguous stands of mature trees. Such forest can be prone to attack and spread of forest insects. The current mountain pine beetle (*Dendroctonus ponderosae*) outbreak is a direct result of fire exclusion and warm winters as well as other factors.

Mount Pine Beetle in the Spray Lakes Valley

The current mountain pine beetle (MPB) outbreak has reached the Spray Lakes Valley, spreading into Alberta from the national parks and British Columbia. Large, contiguous stands of mature lodgepole pine (*Pinus contorta*) have likely facilitated the spread of MPB in the Spray Valley. MPB is infecting mature lodgepole pine and may also attack whitebark pine (*Pinus albicaulis*). In epidemic situation, MPB may also attack other conifer species and different age classes.

Control of MPB in the Spray Valley

Over the winter of 2005/2006, attacked trees were treated to kill beetles and larvae prior to dispersal of beetles in the late spring or summer.

An attempt is currently being made to control the spread of MPB in the Mount Nestor area using baited traps.

One of the land management objectives of the Mount Nestor Plan is to reduce the short and long term susceptibility of forest stands to attack and spread of mountain pine beetle and other forest insects and pathogens. Research tied to this objective includes:

1. Documenting the relationship between fuel loadings, fire intensity and mountain pine beetle brood mortality in known green attack locations

2. Assessing the overall effectiveness of prescribed burning in reducing the susceptibility of pine forests to mountain pine beetle attack

Effects of Forest Fire on Insects

Burning will remove mature lodgepole pine stands that are most susceptible to attack by MPB. Fire will also create a greater mosaic of different age forests less susceptible to attack and the spread of insects. However, forest fire may also weaken trees making them more susceptible to attack by MPB. Under normal conditions this is not an issue but in this large outbreak this could defeat the objectives of reducing the spread of pine beetle. Stands must be inspected and treated if necessary after burning.

SOIL

Impacts of Fire Suppression on Soil

During the 1940s the Spray River road was constructed from Banff to Trail Centre, primarily for fire suppression. The road, covering a distance of approximately 45 km was closed to all vehicle traffic in the late 1980s and is slowly revegetating by forest ingrowth and invasion of some exotic plants. In some road cuts and creek crossings, soil erosion and slumping are evident.

In the future there is little reason for new impacts of fire suppression on the soils within the LMU under most conditions.

Effects of Fuel Modification on Soil

Fuel modification within these units will primarily be through prescribed burning of forest fuels on the southerly aspect slopes of Mount Nestor and Mount Fortune. An area of approximately 25 ha will require some hand falling of small trees, piling of downed wood and burning. The impacts of fuel management are addressed under the impacts of fire on soils.

Impacts of Fire on Soil

The immediate impact of fire on a site is a reduction of organic material covering the mineral soil. There will be volatization and leaching of ashed minerals. There are many studies documenting the changes in various forms of nitrogen, phosphorous, bicarbonate and cation responses after fire. Much of the losses occur during the loss of sediment. However, the losses are low (0.7-8%) relative to the total nutrient capital of the preburn site for N, P, K, Mg, Ca, and Na. Loss of cations from soil in cool burns (<300 degrees C soil temperature) are lower than in “hot” burns.

This loss is rarely significant in terms of site nutrients, and is usually replenished by the time the next fire occurs. Prior to a fire, nutrient dynamics are largely closed and possibly limiting. After fire, the nutrient dynamics are open, and accumulative. Where fire is a prevalent feature of the environment, ecosystems are adapted to take advantage of the altered nutrient status after fire through rapid revegetation and growth (Van Wagner and Methvan 1980).

The impacts of fire on soil are described in a publication by Boyer and Dell (1980):

> The principle physical components of soil affected by fire include the alteration of the forest floor (reduction in organic matter content), loss of soil structure and porosity, and changes in soil moisture and temperature regimes. Consumption of the forest floor and soil organic matter has the most significant effect of fire on soil productivity. Organic matter consists of the following

components: surface litter layer, duff layer, humus layer, coarse woody debris, and organic matter fully incorporated with mineral soil.

The forest floor and incorporated organic matter act as a primary reservoir for plant nutrients. The soil organic material provides physical protection to the soil from erosion processes, moderate diurnal temperature fluctuations and acts as a moisture reservoir. It provides suitable habitat for soil microbes and carbon compounds that serve as an energy source for microbial metabolism. Loss of the organic component during a burn may result in reduced porosity and soil structure. This leads to surface crusting of soil, a reduction in soil aggregation and less desirable plant soil air and moisture regimes.

Removal of the vegetative cover and reduction of the forest floor depth will increase soil temperature while loss of precipitation interception and vegetation transpiration rates will enhance soil moisture conditions. Dormant soil microorganisms in dry soils are less sensitive than more active organisms in moist soils.

Plant communities accumulate and cycle substantial quantities of nutrients in their role as the biological continuum linking soil, water, and atmosphere. Part of the plant and litter incorporated N, P, K, Ca, Mg, Cu, Ge, Mn, and Zn are volatilized. Metallic nutrient elements such as Ca, Mg, and K are converted to oxides and deposited as ash on the soil surface. The oxides are low in solubility until they react with CO_2 and H_20 in the atmosphere and are converted to bicarbonate salts. In this form, they are much more soluble and vulnerable to loss via surface runoff and leaching. Several soil-plant cycling mechanisms may reduce the uptake of nutrients by plants and increase loss by leaching. Above normal leaching and surface erosion could impair quality of water for domestic consumption and possibly result in eutrophication of aquatic habitats.

“Fire severity” is the term used to describe the degree of fire effects. Severity is closely related to the dryness of the duff layer. Effects of fire on soil are low when the moisture level of the duff is high, limiting the degree of organic soil consumption. To date, fire severity on prescribed burns has been lower than on wildfires. In 100 days of weather when wildfires were burning in BNP, (between 1890 and 1990) the DMC was above one hundred on 25 days, but none above this level on prescribed fires (Banff Warden service files 1997).

The lack of organic soil consumption on prescribed fires has been identified as a “problem” in that inadequate seed bed preparation may result in some areas if too little duff is removed by the fire (Wierzchowski 1995). However, burning when the DMC is greater than 100 also increases smoke emissions. Typically these conditions occur in mid to late summer when smoke dispersal is less than optimal. These two factors would increase the impacts of smoke on recreational use both inside and adjacent to the park.

The prescription for randomly ignited fires will permit some fires with a DMC >100. However, planned ignition fires will primarily occur with a DMC < 100.

Mitigating Measures

In the future, the impacts of fire suppression on soils should be negligible as suppression activities will be limited to initial attack on wildfires which exceed the prescription for random fires. The likelihood of such a fire(s) occurring is very low.

HYDROLOGY AND LANDFORMS

Impacts of Fire Suppression

In the future, fire suppression within the Spray and Bryant LMU will rely primarily on indirect or delayed attack. Active suppression may be necessary near Watridge Lake if a fire appears likely to spread onto provincial lands east of this location, or near the Spray-Sixteen Mile Range if a fire is spreading north toward the Bow Valley.

Impacts of Fuel Management

The general impacts of managing forest fuels through repeated prescribed burning are similar to those of restoring fire within the historic range of fire cycles and described below.

Impacts of Fire Restoration on Hydrology and Landforms

The information summarizes *Effects of Fire on Water*, USDA Forest Service, General Technical Report WO-10, 1979:

(A) Fire and hydrologic processes, onsite effects:
Hydrologic processes that may be affected by fire include: interception, infiltration, soil moisture storage, snow accumulation, snow melt, overland flow, surface erosion, and mass erosion.

Removal of vegetation by fire decreases the amount of interception thereby increasing the potential for runoff. Infiltration is the amount of water that can be absorbed by soil in a given time period. Generally, fire results in reduced infiltration and increased overland flow.

In most of the United States [and Canada], soil moisture is recharged to capacity or near capacity during the springtime. Soil moisture is gradually depleted through the growing season by evapotranspiration. Generally, removal of vegetation by fire results in more soil moisture remaining at the end of the growing season due to reduced evapotranspiration.

Snow accumulation is primarily affected by total snowfall, interception and evaporation by vegetation, and the deposition or erosion by wind. In sheltered areas, accumulation following fire will be increased due to the lack of interception and evaporation by vegetation. In large areas with few live trees, accumulations following fire may decrease due to increased erosion by wind.

Spring snow melt is more rapid in large natural forest opening than under the forest canopy. Snow melt is probably also more rapid following forest fire, due to increased longwave radiation to the snowpack.

Overland flow occurs when the infiltration rate of a soil has been exceeded by the amount of incoming precipitation or by the rate of snow melt. Independent variables include all the soil and plant factors that influence infiltration rate, intensity and duration of precipitation, steepness of slope, and whether or not the soil is frozen. On flat ground, overland flow may be similar to rates prior to burning. However, on steep slopes, overland flow may be many times greater following fire.

Surface erosion is the movement of individual soil particles by water or wind, and is a function of forces available, protection afforded the soil surface, and the inherent erodibility of the soil. Fire increases the forces available by increasing effective precipitation, wind movement, and overland flow. Fire also reduces protection at the soil surface by reducing the surface litter. Soil erodibility is increased because of the volatilization of soil organic matter and destruction of soil aggregates. The net effect of burning is to increase surface erosion.

Mass erosion is the down slope movement of part of a landscape under the direct application of gravitational forces. This type of erosion occurs after some fires in mountainous terrain. Causes and processes of mass erosion are complex and not well understood. However, the principle elements responsible are elimination of stability provided by roots of vegetation and high soil pore water pressures resulting from loss of transpiration. However, sometimes landslide volumes are higher on unburned areas, apparently because of water repellent layers that formed in burned areas.

(B) Downstream effects of fire on stream flows:
The responses of stream flow to the integrated effects discussed above are: increased peak spring discharge, increased total annual discharge, greater storm flows, and increased base flow. These result in changes in water quality and aquatic habitat. Sediment and turbidity are the most dramatic and important water quality responses associated with fire. These result from: overland flow and erosion, channel scouring because of increased discharge and greater stream exploration area, and mass erosion. On flat ground changes may be small and insignificant; however on steep slopes changes are much greater.

Stream temperature may increase due to the loss of shade from stream side vegetation. Increased flow rate resulting from reduced evapotranspiration offsets some effects of shade reduction.

The effects of fire on nutrients and stream water chemistry are reasonably well known but the attendant responses on aquatic habitat and macro invertebrates have not been studied thoroughly. Most studies to date have been unable to show significant changes in species diversity of numbers of aquatic macro invertebrates when streams were exposed to clear cutting and slash burning.

Special Hydrologic and Geologic Features

Fortune Springs

This is a cold sulphur spring near the Fortune Warden Cabin on the Middle Spray River Valley. Wildlife uses the marshy area below the springs.

There is one significant ecosite Azure 1 (AZ1) within these LMU. AZ1 is characterized by ridged and hummocky landforms of non-calcareous, ice contact stratified drift which usually result in a dry-wet landscape pattern. The dry, upland portion contains dystric brunisols and spruce-fir closed or open forest (C15, O10), and the wet, depressional portions contain gleysolic and organic soils with wet shrub and herb meadow vegetation (S8, H9). AZ1 occupies a total of 245 ha in BNP, one of which occurs at Palliser Pass, the headwaters of the Spray River. The upland vegetation in this tract is young and open due to an intense fire in the late 1800s (White 1985a).

Mitigating Measures

The removal of vegetation and organic matter covering the soil will lead to erosion. However, in the Rocky Mountains and much of BNP, it is likely that the forests have burned about 50-100 times since the last glaciation. Most of the potential fire-associated erosion has likely taken place and the landscape is now reasonably stable (Van Wagner and Methvan 1980).

Riparian habitats such as floodplain spruce forests have moderate to long fire cycles (150-250 years). Few prescribed fires are planned for these areas. Typically, the indices of planned prescribed burns will limit the spread of fire through riparian areas from adjacent upland habitats. However, in some areas such as the Spray-Sixteen Mile Range it is necessary to burn these habitats to create and maintain fuel breaks.

A large culvert connects a stream under the old Spray Fire Road within Spray Valley Provincial Park. This culvert no longer serves a useful purpose since the fire road is no longer used by vehicles. The culvert may have impact on stream hydrology if it is not maintained. The culvert was inspected in the summer of 2006 and found to be partially blocked by debris which should to be removed to restore stream flow. It may be desirable to remove the culvert however, it should be done before the prescribed fire as there will be limited opportunity to remove the culvert after the fire. It will be difficult to move heavy equipment to the site as burned trees will block the old fire road. Likely, only a trail will be maintained through the area after the fire. If the culvert remains, it will require ongoing maintenance but because of its remote location it may be neglected.

SOCIAL AND ECONOMIC IMPACTS

Smoke

Smoke is the main potential social and economic impact from prescribed burning. Smoke can result in poor air quality causing heath impacts, inconvenience and loss of business due to reduction in recreation and tourism. People with respiratory ailments are more susceptible to impacts from smoke. Cumulative impact on individuals, businesses or communities may occur because of prescribed fire, wildfire or other burning.

Smoke from wildfire or planned burning will occur regardless of management approach. Impacts from smoke can be mitigated but not entirely eliminated as forest will eventually burn. Impacts should be considered in comparison to those impacts that occur due to fire exclusion. These include loss of species diversity, poor ecosystem health, increased potential for catastrophic wildfires, and outbreaks of insects and forest diseases. The emerging epidemic of mountain pine beetle, for example, is a direct result of fire exclusion. This has impacts on forestry, recreation and tourism. Planned fires may be done in ways that minimize impacts. Burning under controlled conditions may reduce the impacts of smoke compared to wildfires which have impacts that are extensive and cannot be controlled.

Smoke Dispersal Prediction

Due to the small scale and seasonal timing of the Mount Nestor burn, the potential for impacts from smoke is low. Good air mixing through convective column development is expected and concentrations of smoke should not pose a significant compromise in air quality.

Smoke is most likely to adversely impact air quality and visibility only on a local scale, less than 10 km from the fire. Smoke could impact Mount Engadine Lodge and the Spray Lakes Road. Smoke will not impact park visitors to the Middle Spray area since a seasonal closure for wildlife protection is in effect in the Middle Spray Valley during the spring.

The most likely smoke dispersal pattern during peak burning period under the influence of high atmospheric pressure will be influenced by winds from the southwest. Winds during a high pressure system will tend to come from a southerly direction. Under good convective conditions it is anticipated that smoke will cross directly over the Kananaskis Range and Kananaskis Village area. There is potential for some light ash deposits over Kananaskis Village.

In portions of the unit where topography is gentle and fuels moist, combustion will be less than optimal, particularly near the end of each burning day. This will result in accumulation of smoke at night at lower elevations in the valley bottoms.

Communities in the lower Bow Valley from Banff to Seebe and Kananaskis Village may experience minor deterioration of air quality due to night-time inversions and cold air drainage (Figure 8). Campgrounds and outlying visitor accommodation may also experience some deterioration in air quality.

Atmospheric inversions, while less common during spring, occur when clear skies occur at night and the earth radiates heat into the atmosphere. This can result in air near the ground being cooler than the air aloft and poor air mixing conditions prevail. Establishment of inversion layers will compromise air quality locally if they occur. Once daytime heating breaks down the inversion, venting conditions will improve and concentrations of valley bottom smoke will dissipate.

Precipitation in May and June generally extinguishes spring fires. In 2000, about 1 ha of the Spray I burn continued to smoulder until mid July when it was mopped up (Parks Canada 2001).

There are five other projects involving burning operations within a 30 km radius of this proposed project that are scheduled for the spring of 2007. These include:

- Burning of slash debris related to a fire guard at Spray 16 KM
- Burning of slash debris related to wildfire protection measures on the outskirts of the town of Banff
- A small scale (<100 hectares) prescribed fire at Carrot Creek fire break east of Harvie Heights
- Burning of slash debris at a fire guard on the east park boundary between the Trans-Canada Highway and the Bow River
- Slash burning on provincial lands in the vicinity of the Canmore Nordic Centre

While smoke from each of these project should only have impacts on a scale of 1-3 km, the potential for smoke to become trapped in the valley bottom under inversion conditions does exist.

Air Quality and Health

The impact on air quality and heath from smoke is covered in the Heath and Safety section.

Impact of Smoke on Communities

Smoke in the lower Bow Valley and Kananaskis Valley is not expected to be significant. Communities may experience minor deterioration of air quality due to night-time inversions and cold air drainage. These communities include Banff, Harvie Heights, Canmore, Exshaw, Lac des Arcs, Dead Man’s Flats, and Kananaskis Village (Figure 8).

Small amounts of ash may be transported by wind and deposited around Kananaskis Village.

Impact of Smoke on Roadways

If smoke occurs on roadways it is likely to be minimal and of short duration. Highway 742 is the only pubic roadway that smoke is likely to affect. Any traffic delays, if they occur, should be minor.

Impact on Facilities and Recreation

Due to the seasonal timing of the unit and low recreational use of the area in the spring, there is low potential for impacts on local facilities and recreation.

Localized smoke from burning and the establishment of inversion layers will compromise air quality locally if they occur. Once daytime heating breaks down inversions, venting conditions will improve and concentrations of valley bottom smoke will dissipate.

Campgrounds may experience some deterioration in air quality. Use of campgrounds in the spring is low. The nearest campground, Spray Lake West, opens mid May. Other campgrounds in the Kananaskis Valley open as early as the beginning of May. There are some year-round campgrounds near the towns of Canmore and Banff.

A seasonal closure for wildlife protection is in effect in the Middle Spray Valley during the spring months. This may impact horse outfitters that have restricted access. These outfitters will be consulted and informed of closures that may affect them.

West Side Road is permanently closed to vehicle traffic. This road and the trail that leads beyond the road to Bryant Creek will be closed during burning operations. Due to low use in the spring, it is not likely that many users will be inconvenienced. Cyclists likely make up the largest proportion of uses of West Side Road. Notices will be posted and information distributed to inform people when the road and trail are closed. If fires persist into the summer months, temporary closure of trails may be extended. An increased number of dead trees across trails through burned areas may inconvenience travellers. Trees will be cleared from West Side Road and other official trails.

Spray Lakes Reservoir will remain open during burning except for the south end which will be closed to ensure public safety. The reservoir may still be frozen when burning begins in April.

Day use areas in the Spray Valley receive low use in the spring. If smoke affects these areas, few if any visitors will be affected. Day use areas in the vicinity that may be affected include Mount Shark, Buller Mountain, Spray Lakes, Sparrowhawk, and Driftwood. Mount Shark will be used as the incident command centre and helicopters may use the site. This may inconvenience some users.

Trans- Alta Utilities

Trans-Alta Utilities manages a water development licence in the Spray Valley which includes the Spray Lakes reservoir, two dams, the Three Sisters hydroelectric plant and the spray canal.

The Spray Lakes Reservoir and Canyon Dam are located within and adjacent to the prescribed burn location. Canyon Dam includes a small monitoring and control building and several flow monitoring stations on the outlet to the Spray River. The West Side Road is also located on the water development licence and provides access for Trans-Alta employees and equipment to Canyon Dam.

Potential impacts to Trans-Alta operations could include direct damage to the small building and monitoring equipment from the fire, slope instability and silt accumulations in water bodies post fire, disruption to access during the burn, and disruption to access following the burn from potential downed trees across the West Side Road.

Alberta Parks and Protected Areas will work closely with Trans-Alta and Alberta Environment to mitigate any potential impacts from the prescribed burn.

Helicopter operations

Helicopters use the Mount Shark helipad for scenic tours and trips to Mount Assiniboine Lodge. Assiniboine Lodge will be closed during the period of the prescribed fire. Smoke potentially could impact helicopter tours. Potential impacts will be identified and minimized through planning and consultation.

Mount Assiniboine Lodge

The lodge is not in operation between April 9 and June 15, approximately. Any potential impacts will be identified and minimized through planning and consultation.

Mount Engadine Lodge

Impacts to the lodge guest and operations may occur due local smoke dispersal during burning or smoke during inversion events after unit ignition. Once daytime heating breaks down the inversion, venting conditions will improve and concentrations of valley bottom smoke will dissipate. Burning in the shoulder season will help mitigate impacts. Potential impacts will be identified and minimized through planning and consultation.

Dog Sled Operators

Dog sled operation in the Spray Lakes Valley will be finished for the season before burning begins. However the dog sledding overnight camp location near Canyon Dam is within the burn area. Potential impacts to this site will be minimized through consultation with dog sled operators.

Smoke Mitigation

In a broader regional context, prescribed burns are only conducted in an area in alternating years to further minimize impacts.

The Mount Nestor burn may coincide with other prescribed fires, fuel treatments or natural fires in other jurisdictions. Fire management activities in other jurisdictions will be coordinated with this plan.

The burn plan is very specific in how burning will be conducted to reduce the potential for impacts. This information from the plan is summarized below.

Effective smoke management from prescribed burning in mountainous terrain requires careful assessment of weather forecasts, fuel moisture, atmospheric venting, diurnal cold air drainage patterns and inversion conditions. Smoke management is comprised of several key elements. All elements form integral components of daily operational planning and implementation.

1. Ignition practices
2. Accurate smoke dispersal prediction and monitoring
3. Precise meteorological forecasting
4. Fire behaviour forecasting
5. Effective communication
6. Public awareness

Ignition will only be conducted when atmospheric venting and smoke dispersal conditions are optimal. All possible measures will be taken to minimize potential for such an occurrence. In the event that poor venting conditions prevail, ignition will cease.

The majority of lighting will be conducted under the influence of a high pressure system. This should give acceptable venting conditions for the peak of each burning period. Low spring drought and duff moisture values will result in less fuel available for combustion and less smouldering.

The pattern of ignition will be determined by the daily wind direction. A convective column will be established on the upwind side of the unit by using aerial ignition high on the slope. This convection column may be visible for a considerable distance up to 100 km. Ignition will then progressively precede downhill taking advantage of the in-draft of the convective column. Good air mixing through convective column development is expected and concentrations of smoke should not pose a significant compromise to air quality.

Ignition will be halted on the downhill perimeter when the break in slopes demonstrates a low potential to maintain vigorous surface fire. This approach will further minimize smouldering combustion and holdover problems. Ignition activities will cease well before the end of each burning period in order to minimize smouldering combustion and poor venting.

Smoke Dispersal Monitoring

Smoke dispersal monitoring is covered in the Public Safety section of the prescribed fire plan.

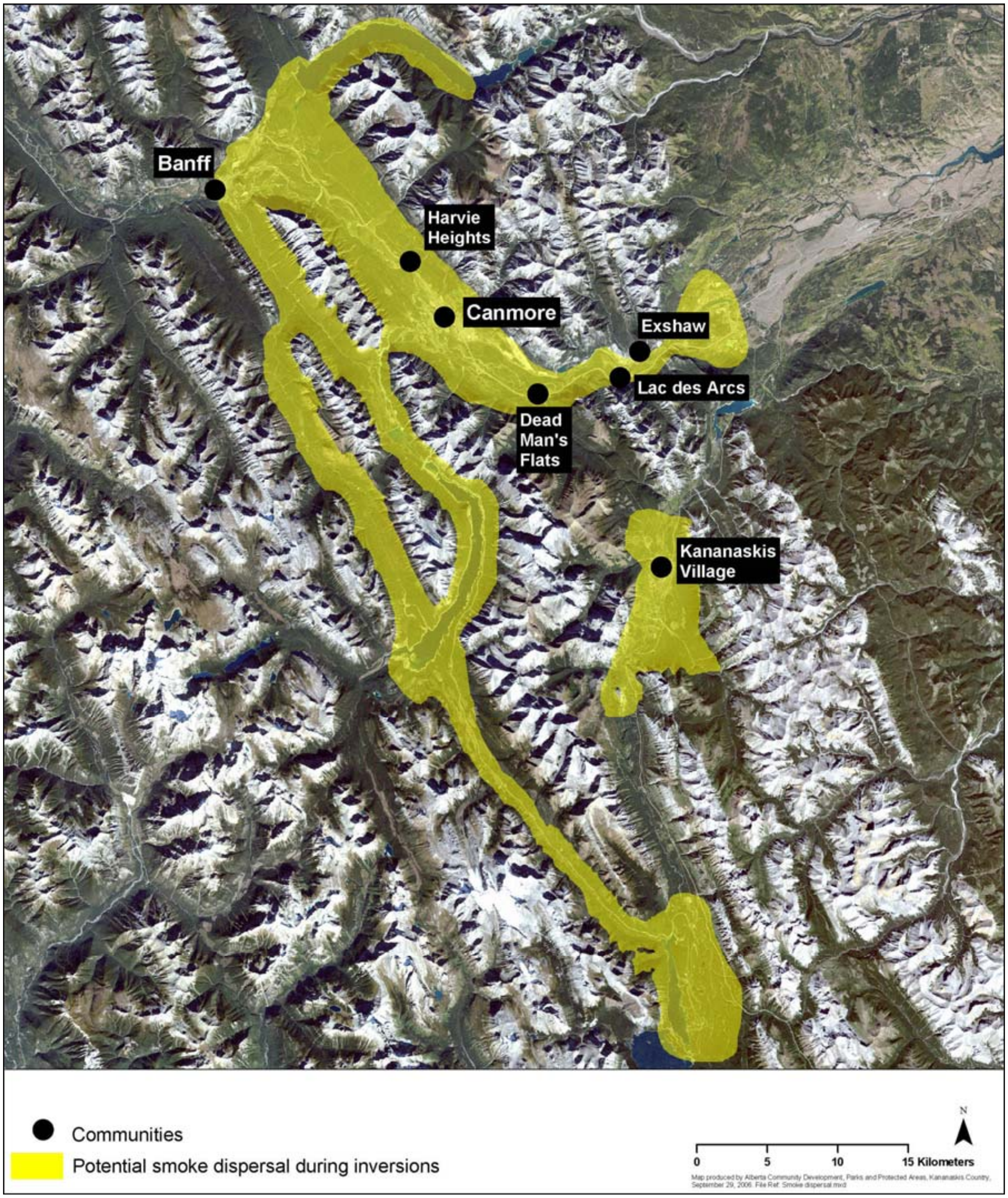
Meteorological and Fire Behaviour Forecasting

Meteorological and fire behaviour forecasting are covered in the Implementation section of the prescribed fire plan.

Daily smoke dispersal prediction will be done prior to ignition each day. The Venting Index will be consulted and temperature sounding by helicopter (to 10,000 ft ASL) will be conducted prior to ignition.

Communication and Public Awareness

Communication and public awareness strategies specific to smoke management are summarized in the Communication section of the prescribed fire plan.



Map produced by Alberta Community Development, Parks and Protected Areas, Kananaskis Country, September 29, 2006. File Ref: Smoke dispersal.mxd

Figure 8: Predicted smoke dispersal during inversion conditions.

HEALTH and SAFETY

Applicable Legislation and Policy

Health and safety is covered under the Public Safety section of the prescribed fire plan. All operations must follow all applicable legislation, policy and protocol. Fireline safety is covered under protocols and hazard assessments prepared by the Forest Protection Division.

Public Safety

Public safety may be compromised due to burning operations, smoke dispersal, or from hazards created from burning. The following procedures should be adequate to ensure public safety.

The burn is being done in a location and season with very low public use. The area in the vicinity of the burn will be closed during operations as well as the south end of Spray Lakes Reservoir. Helicopter sweeps will be conducted prior to and during burning to ensure no members of the public are in the area.

Use of fire for fuel modification or habitat restoration may create a temporary hazard from trees being burned out at the roots adjacent to trails. While fires are ongoing, there is a slight risk of travellers stepping onto ash layers covering deep beds of hot coals if they venture off trail. Other hazards such as rolling rock occur at the toe of steep burned slopes. Where forests are partially burned, crown fire runs may occur suddenly during hot, windy conditions. These hazards warrant closing the area to the public during the burn and shortly after a prescribed fire. These hazards also dictate that the amount of “mop-up” in the burned stand be minimized where possible for the safety of fire fighters.

Backcountry travellers will be informed of the special hazards that exist in recently burned forests through signage and information at kiosks. Burned landscapes can pose dangers that are not always visible. Burned trees fall, particularly during windy periods. Roots and ground surfaces smoulder and shift, creating unstable pockets under the soil surface that may not be visible.

Transportation Safety

Smoke may obscure visibility on the Spray Lakes Road (also known as the Smith-Dorrien Road or Highway 742). The probability is low that smoke will reduce visibility on the Trans-Canada Highway and Highway 40.

The methods and timing of burning as outlined in the Mount Nestor burn plan should minimized the amount of smoke that may obscure visibility. Ignition will only be conducted when atmospheric venting and smoke dispersal conditions are optimal. The plan calls for other road safety measures that should be adequate to ensure road safety. These measures include:

- Prior to unit ignition and whenever inversion conditions are forecast, air quality advisories will be issued and disseminated as required. This will include a NOTAM[5] to airports and pilots.
- Visibility on roads, railways, and in local airspace will be monitored 24 hours per day when required.
- A road safety team will be tasked with monitoring visibility and controlling traffic as required. This function will be provided by a certified road safety contractor.
- Measures will include appropriate signage, flagging crews, road report updates, and pilot vehicles to escort traffic if required.
- All actions will be coordinated with the Banff Warden Service, Alberta Parks and Protected Areas, Alberta Sustainable Resource Development, Parks Canada Highways Department, the RCMP, and Alberta Transportation.

Additional information on smoke management is found in the Mount Nestor burn plan.

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[5] NOTAM - Notification Of Temporary Access Modifications

Air Quality

The lack of fire activity in BNP and other protected areas in the Rocky Mountains has resulted in accumulation of biomass (White 1985a). The increased forest biomass could increase smoke emissions if burned during extreme drought conditions. By burning during less severe drought conditions, prescribed fires can reduce the total amount of smoke. By burning during the spring and early summer, maximum dispersal of smoke emissions can be achieved. Never-the-less, prescribed burns will result in temporary reductions of air quality within these LMU and areas downwind.

The air quality during the burn is unlikely to affect human health. Fire fighter exposure to smoke on prescribed fires is usually very low. However, acute or chronic exposure to smoke can affect respiratory functions. Care will be taken to limit the exposure of fire fighters. Fire fighters with symptoms of respiratory distress will be removed from the burn and examined by a physician as soon as possible.

There is no net contribution to global greenhouse gases. The primary by-products of burning (water, carbon dioxide, particulate matter and ash) are eventually taken up as young trees and other plants grow on the site.

The following section summarizes information contained in Reinhardt and Ottmar (1997) and was taken directly from Parks Canada (1998):

A number of studies addressed the effects of smoke from prescribed and wildland fires on the health of fire fighters between 1973 and 1995. Overall, the data indicate that smoke exposure at wildfires and prescribed fires is usually no more than an inconvenience, but on occasion it approaches or exceeds [American] legal and recommended occupational exposure limits. The hazards in smoke seem to be limited to respiratory irritants and carbon monoxide.

Overexposure to carbon monoxide and respiratory irritants (such as aldehydes) is likely among fire fighters when direct control of fire is required and smoke production is intense. Such overexposures are mostly brief events, but sometimes poor atmospheric dispersion or rigorous work schedules cause hours or even days of unhealthful working conditions. Small but statistically significant declines in lung function have been observed in a number of wildland fire fighters, across both work shifts and seasons. More data are needed to determine whether these losses are reversible.

Acute smoke exposure is a more prevalent problem than average exposure. High exposure may be associated defending a fire line or working around the head of a fire, particularly one burning in heavy ground fuels or pushed by strong winds. The effects of carbon monoxide exposure are greater among fire fighters who smoke and therefore have impaired blood oxygen transport.

There has been some concern about other potential health hazards including crystalline silica, which is a potential hazard during fires in dusty conditions, and polynuclear aromatic hydrocarbons (PAH). Wood smoke contains at least five carcinogenic PAH. These are absorbed by particulate matter in smoke and can be inhaled into the lung. A recent publication of the USDA Forest Service (1995) summarized the risks to fire fighters from exposure to of PAH in smoke on prescribed burns. The hazard analysis was based on the toxicities of combustion products, and exposure analysis that estimates the exposure to the smoke, and a risk analysis that estimated quantifiable risks to workers. The estimated cancer risk from working 400 days (6 hours per day, 40 days per year, for 10 years) is estimated to be 9.4 in one million. By comparison, the cancer risk from a single x-ray is 7 in one million.

On prescribed burns, smoke exposure may be limited by avoiding prescriptions with strong winds and fuel moisture at either end of the possible range of conditions. In the United States, it has been found that a 1% decrease in 1,000 hour fuel moisture can result in a 3% decrease in particulate emissions. Burning when duff moisture is high can greatly reduce particulate emissions. For some field conditions, more than 50% of particulate emissions result from smouldering combustion of duff. On the other hand, burning when duff moisture is too high can result in high concentrations of smoke due to poor venting and dispersal.

The studies of fire fighter exposure to smoke suggest that the health risk to the public is very low, except for individuals with other respiratory diseases or allergies to smoke.

Impacts of Fire Suppression

The impacts of fire suppression on air quality would be products of internal combustion engines in aircraft and machinery being used in the suppression effort (Parks Canada 1998).

Impacts of Fuel Modification

Fuel reduction through piling and burning live and dead vegetation might result in reduced visibility and some smoke in valley bottom areas if the burns are conducted in the fall or winter when the atmosphere is stable and temperature inversions are common (Parks Canada 1998). The impacts of fuel modification on air quality by using fire are similar to the impacts of restoring fire throughout the LMU.

CULTURAL and HISTORIC RESOURCES

There is one known prehistoric archaeological site in the area, located at Palliser Pass. Other archaeological sites likely exist. Archaeological sites in forested areas have undoubtedly been burned many times over time and new impacts to sites due to planned fire or wildfire are not expected. However, following the 1994 planned fire in the Red Deer Valley in BNP, elk damaged a site by trampling and mixing the soil layers. This type of impact may be new as there is no historic or prehistoric evidence that the elk population was ever as great as now (Parks Canada 1998).

A total of nine historic sites have been identified within burn area or the containment area. Table 21 provides a description of each site and each site is shown in Figure 9. Only the Charles McKee (1912) site is rated has highly significant. All others are rated as low significance. There are two warden cabins with historic value in the area, Fortune cabin in the containment area in the Lower Spray Valley and the Bryant Creek cabin. There are some artefacts of logging camps in the Lower Spray Valley, particularly near the present Spray River warden cabin.

If the prescribed fire should move outside the ignition perimeter into the containment area and threaten these resources, mitigations to protect them will include mechanical removal of flammable vegetation and blacklining. In addition, sprinkler kits will be deployed as required to further protect the grave site.

A Historical Resources Inventory (HRI) was conducted in the fall of 2006 for those lands in Spray Valley Provincial Park covered by the proposed burn plan. The results of the HRI will be incorporated into this assessment when complete. Any identified sites of historic or archaeological significance will be protected prior to the prescribed burn.

Fire suppression activities should have little or no impact on archaeological sites unless heavy equipment is used during fire suppression.

Fuel management through the repeated burning of strategic areas and the restoration of fire throughout the LMU will have similar impacts.

Table 21: Cultural resources within the burn plan area and containment area.

ID[6]	Site	DISTURBANCE	COND.	THEME	AREA	AGENCY
1	Grave (Charles McKee)	Natural-vegetation encroachment, general decay, animal disturbance, cultural-vandalism, and area use	Partially disturbed	Sacred or spiritually significant sites; Early industrial-logging	Containment	Parks Canada
2	Log feature (logging ramp)	Natural-water erosion, natural decay, cultural-visitor impact, pot hunting, and cultural-area use	Partially disturbed	Early industrial-logging	Containment	Parks Canada
3	Log feature (bridge remains)	Natural-water erosion, vegetation encroachment, natural decay, cultural-area use	Largely disturbed	Early industrial-logging	Containment	Parks Canada
4	Log features (road)	Natural-vegetation encroachment and natural decay, cultural-area use.	Partially disturbed	Early industrial-logging	Containment	Parks Canada
5	Logging camp	Natural-water erosion and general decay, cultural-area use	Partially disturbed	Early industrial-logging	Containment	Parks Canada
6	Logging camp	Natural-water erosion and general decay, cultural-area use	Partially disturbed	Early industrial-logging	Containment	Parks Canada
7	Fortune Warden cabin	Natural decay			Containment	Parks Canada
8	Logging camp	Natural decay		Early industrial-logging	Burn area	Parks Canada
9	Dam	Natural decay		Early industrial-logging	Burn area	Alberta Parks

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[6] See Figure 9 for locations of historic sites.

VALUES AT RISK

There are few values at risk within the perimeter of the unit or located in the vicinity (Figure 9). Values located near the burn unit are summarized below and in Table 22 and Table 22.

Ecological Values

The following information is a summary of significant ecological values:

- There is relatively high use of the Middle Spray Valley by grizzly bears.
- Periodically wolves use the Spray River Valley. A wolf den exists along the Spray River within the Banff National Park portion of the containment area. This den was not used in the last several years and there is little chance it will be used when the burning occurs. All necessary mitigations will be implemented to minimize impacts if the den site is occupied. The Parks Canada wildlife specialist in Banff will be consulted if fire threatens this den location.
- The area is the only area of sheep and elk winter range south of the Bow Valley in BNP.
- Several rare plants are known to exist in the area. These species are likely to benefit from fire rather than be adversely affected.
- Boreal toads and spotted frogs are known to live in and around the wetlands on the western portions of the site. These populations are not likely to be adversely impacted by planned fire activities.

Historic Values

See Cultural and Historic Resources in this report.

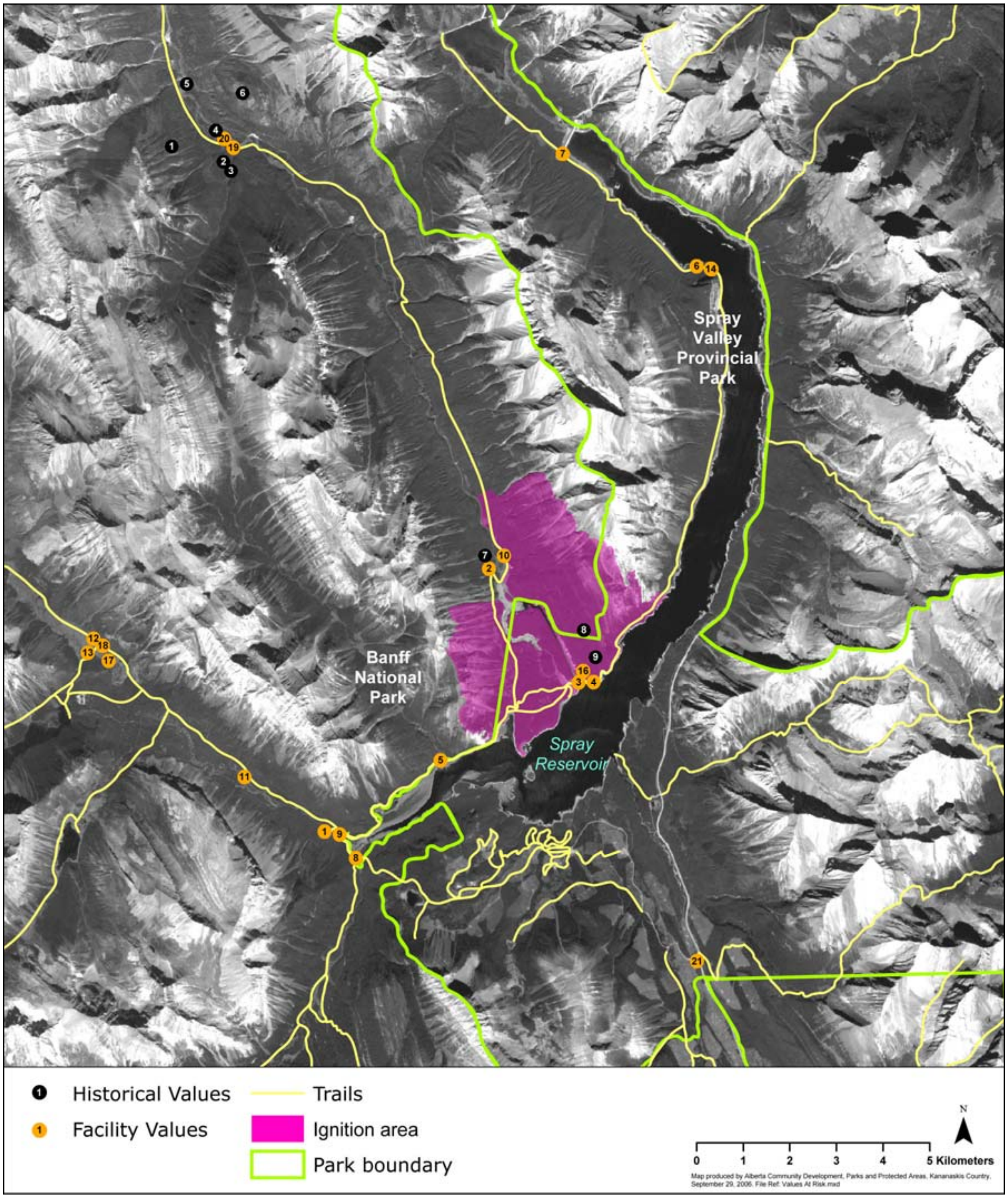
Facility Values

There are few facilities in and adjacent to the burn unit (Figure 9). In the event of an escaped fire or slop-over, some facilities could potentially require protection. These facilities are listed below:

- Trails
- Boundary signs along Spray reservoir
- Spray-Canyon Dam trailhead signs
- Spray West Campground
- Gate on West Side Road
- Parks Canada information kiosk along West Side Road
- Warden Cabins: Spray, Fortune, Bryant and Trail Centre
- Backcountry campgrounds: Fortune Flats (SP35), Eau Claire (SP23), Big Springs (BR9), Marvel Lake (BR 13), McBrides (BR14)
- Foot Bridges: Spray, Bryant, Fortune Flats, Turbulent Creek
- Canyon Dam
- Water gauge below Canyon Dam

Table 22: Key to facility values in Figure 9.

ID	Value	Agency
1	Trail Centre Warden Cabin	Parks Canada
2	Fortune Warden Cabin	Parks Canada
3	Canyon Dam	Trans-Alta
4	Corrals	Alberta Parks
5	Turbulent Creek Bridge	Alberta Parks
6	Spray West Campground	Alberta Parks
7	Firewood Shed	Alberta Parks
8	Spray River Bridge	Alberta Parks
9	Fortune Bridge	Parks Canada
10	Fortune Flats Campground (SP35)	Parks Canada
11	Big Springs Campground (BR 9)	Parks Canada
12	Bryant Creek Warden Cabin	Parks Canada
13	Bryant Creek Bridge	Parks Canada
14	Kiosk	Parks Canada
15	Gate	Alberta Parks
16	Monitoring Station	Trans-Alta
17	Bryant Creek Shelter	Parks Canada
18	McBrides Campsite (BR14)	Parks Canada
19	Spray Warden Cabin	Parks Canada
20	Eau Claire Campground (SP23)	Parks Canada
21	Mount Engadine Lodge	Alberta Parks



Map produced by Alberta Community Development, Parks and Protected Areas, Kananaskis Country, September 29, 2006. File Ref: Values At Risk.mxd

Figure 9: Values at risk near the Mount Nestor burn unit.

RESIDUAL IMPACTS

Residual impacts include:

(1) Visual impacts of burned landscapes
(2) Reduced visibility and air quality due to smoke emissions
(3) Altered and possibly unsuitable habitat conditions for wildlife

VISUAL IMPACTS

A landscape burned by wildfire can look desolate immediately after a fire. But that same landscape can quickly turn into lush verdure with the growth of diverse, new vegetation supported by a flush of nutrients released by the fire. Some park users object to the appearance of burned forest, however, other users will enjoy enhanced wildlife viewing, increased vistas of distant mountains formerly obscured by heavy timber, and the diversity of flora and greater abundance of wildflowers.

Visual impacts from wildfire may be real or perceived. Over the last several decades, people learned from the immensely successful Smokey the Bear campaign that fire is bad and perceptions were shaped by this message. In discussions of the visual impacts of wildfire and fuel modification, both perceptions and tangible visual impacts need to be addressed. Perceptions are important to consider. If people view fire as bad, public support for allowing fires to burn on the landscape will be reduced. Every effort must be made to minimize potential visual impacts and educate visitors.

The Mount Nestor fire will cover a relatively small area and is not in a location that is overly visible in the Spray Valley. The location is mostly visible to lake users and visitors on helicopter tours or flying to Mount Assiniboine Lodge from the Mount Shark helipad.

The most significant visual impact will be immediately after the fire when the forest is blackened. Flat areas will generally not be visible. Steeper slope are more visible. Approximately 50 to 70% of the forest will be burned on southwest facing slopes. This will create a pattern that will have less of visual impact than would a larger fire. Scorched trees at the edge of the burn will appear brown due to scorched needles. Areas burned early in spring will soon support ground cover which will lessen the visual impact. Spring burns on grasslands are visible for a week or two before new growth occurs.

After the first season, the forest will gain a more forest coloured tone. Ground cover will be more visible and will generally make the site attractive, green in the spring and more golden later in the season. Burned shrub lands are evident for a two or three years before regrowth reaches the same height as unburned shrubs.

A return to historic fire intervals on areas exposed to sun and wind will eventually restore grass and shrub meadows. The impacts of fuel modification through repeated prescribed burning will result in greater extent of open forests, grass and shrub.

Burned trees still sanding after the fire will eventually fall but some may stand for several decades. A few burned trees are still standing from the fire that burned the valley in 1894.

Five years after the fire, the burn should not be obvious to most visitors. Two small prescribed fires that burn the southeast slopes of Mount Fortune in 2001 are not apparent to most visitors five years after the fire.

Mitigation

Perceived impacts can be mitigated by public awareness and information. Parks Canada has actively promoted the ecological role and benefit of fire for many years. A public awareness and information strategy is being developed as part of the Mount Nestor burn plan. This will include a process to work with stakeholders to identify and mitigate impacts. Opportunities exist for interpretive signage to inform people of the reasons for the Mount Nestor fire and the ecological role of fire. Efforts need to be concentrated in educating visitors and changing the negative perceptions of fire.

Treed areas between the West Side Road and the reservoir will not be burned and will serve to control erosion and lessen perceived visual impacts.

CUMMULATIVE EFFECTS

The assessment of cumulative effects includes the impacts of this and other projects (past, present and future) that, when combined, may have implications that require mitigation. There are five other projects involving burning operations within a 30 km radius of this proposed project that are scheduled for the spring of 2007. These include:

- Burning of slash debris related to a fire guard at Spray 16 KM
- Burning of slash debris related to wildfire protection measures on the outskirts of the town of Banff
- A small scale (<100 hectares) prescribed fire at Carrot Creek fire break east of Harvie Heights
- Burning of slash debris at a fire guard on the east park boundary between the Trans-Canada Highway and the Bow River
- Slash burning on provincial lands in the vicinity of the Canmore Nordic Centre

While smoke from each of these project should only have impacts on a scale of 1-3 km, the potential for smoke to become trapped in the valley bottom under inversion conditions does exist. Burning activities at these project areas will require coordination and careful evaluation of atmospheric venting conditions in order to ensure that air quality in the lower Bow Valley remains within acceptable levels. Parks Canada will be responsible for ensuring that these measures are taken during implementation of the Mt. Nestor prescribed fire.

SURVEILLANCE REQUIREMENTS

Activities related to the Mount Nestor prescribed fire will be monitored. The primary objectives of surveillance are to:

- Ensure the safety of the public, fire fighters and park staff during all activities

- Ensure that implementation of fire management goals and objectives are ecologically sound

- Ensure the protection of public and private property within the park and adjacent lands

- Ensure that wildfires are done according to the Escaped Fire Situation Analysis if necessary

- If fire suppression actions are necessary, ensure that the impacts of these activities are minimized where possible, and ensure disturbed lands are rehabilitated as much as possible

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APPENDIX I: PARKS CANADA FIRE COMPLEXITY RATING

The Parks Canada Fire Complexity Rating Process provides a method to assess the complexity of both random and planned ignition fires. The analysis incorporates an assigned numeric rating complexity value for specific complexity elements that are weighted in their contribution to overall complexity. The weighted value is multiplied times the numeric rating value to provide a value for that item. Then all values are added to generate the total complexity value. Breakpoint values are provided for low, moderate, high complexity values. The complexity is worksheet is accompanied by a guide to numeric values for 6 each complexity element shown, provided on the following pages.

Complexity element	*Weighting factor*	*Complexity value*	*Total Points*
Safety	5	2	10
Threats to Boundaries	5	0	0
Fuels and Fire Behavior	5	2	10
Objectives	4	2	8
Management Organization	4	2	8
Improvements	3	1	3
Ecological, Cultural, Social Values	3	1	3
Air Quality Values	3	1	3
Logistics	3	1	3
Political Concerns	2	1	2
Tactical Operations	2	2	4
Interagency Coordination	1	1	1
Total complexity points			55
Complexity Rating (circle)	[✓ L]	M	H
Complexity Value Breakpoints:	*Low*	*40 - 90*	
	Moderate	*91 - 140*	
	High	*141 - 200*	

Parks Canada Fire Complexity Rating Worksheet Numeric Rating Guide

COMPLEXITY ELEMENT	GUIDE TO NUMERIC RATING		
	1	3	5
Safety	• Safety issues are easily identifiable & mitigated	• Number of significant issues have been identified • Safety hazards identified on LCES worksheet & mitigated	• Dedicated Safety Officer required • Complex safety issues exist
Threats to Boundaries	• Low threat to boundary • Boundaries naturally defensible • shared fire management policies on both sides of boundary	• Moderate threat to boundary • Moderate risk of slopover or spot fires • Boundaries need mitigation actions for support to strengthen fuel breaks, lines • no shared policy, but boundary fire management agreements in place	• High threat to boundary • High risk of slopover or spot fires • Mitigation actions necessary to compensate for continuous fuels • no boundary fire management agreements in place
Fuels/Fire Behaviour	• Low variability in slope & aspect • Weather uniform & predictable • Surface fuels (grass, needles) only • Grass/shrub, or early seral forest communities • Short duration fire • No drought indicated	• Moderate variability in slope & aspect • Weather variable but predictable • Ladder fuels & torching • Fuel types/loads variable • Dense, tall shrub or mid-seral forest communities • Drought index indicates normal conditions to mod. drought; expected to worsen	• High variability in slope & aspect • Weather variability & difficult to predict • Extreme fire behaviour • Fuel types/loads highly variable • Late seral forest communities or long-return interval fire regimes • Altered fire regime, hazardous fuel/stand density conditions • Potentially long duration fire • Drought index indicates severe drought; expected to continue
Objectives	• Maintenance objectives • Prescriptions broad • Easily achieved objectives	• Restoration objectives • Reduction of both live & dead fuels • Moderate to substantial changes in two or more strata of vegetation • Objectives judged to be moderate hard to achieve • Objectives may require moderate intense fire behaviour	• Restoration objectives in altered fuel situations • Precise treatment of fuels & multiple ecological objectives • Major change in structure of 2 or more vegetative strata • Conflicts between objectives & constraints • Requires a high intensity fire or a combination of fire intensities difficult to achieve

COMPLEXITY ELEMENT	GUIDE TO NUMERIC RATING		
	1	**3**	**5**
Management Organization	• Span of control held to 3 • Single fire • no external personnel required	• Span of control held to 4 • Multiple fires managed together • Short-term commitment of specialized resources • external Parks Canada Fire Management personnel required	• Span of control greater > 4 • Multiple fires, multiple management teams • Specialized resources needed to accomplish objectives • external personnel required, including interagency personnel
Improvements to be Protected	• No risk to people or property within or adjacent to fire	• Several values to be protected • Mitigation through planning &/or preparations is adequate • Require some commitment of specialized resources	• Numerous values &/or high values to be protected • Severe damage likely without significant commitment of specialized resources with appropriate skill levels
Ecological, Cultural, & Social Values to be Protected	• No risk to ecological, cultural &/or social resources within or adjacent to fire	• Several values to be protected • Mitigation through planning &/or preparations is adequate • Require some commitment of specialized resources	• Numerous values &/or high values to be protected • Severe damage likely without significant commitment of specialized resources with appropriate skill level
Air Quality Values to be Protected	• Few smoke sensitive areas near fire • Smoke produced < 1 burning period • Air quality agencies generally require only initial notification &/or permitting • No potential for scheduling conflicts with cooperators	• Multiple smoke sensitive areas, but smoke impact mitigated in plan • Smoke produced 2-4 burning periods • Daily burning bans are sometimes enacted during the burn season • Infrequent consultation with air quality agencies is needed • Low potential for scheduling conflicts with cooperators	• Multiple smoke sensitive areas with complex mitigation actions required • Health or visibility complaints likely • Smoke produced > 4 burning periods • Multi-day burning bans often enacted during season • Smoke sensitive class 1 airsheds • Violation of provincial or federal health standards possible • Frequent consultation with air quality agencies is needed • High potential for scheduling conflicts with cooperators

COMPLEXITY ELEMENT	**GUIDE TO NUMERIC RATING**		
	1	**3**	**5**
• **Logistics**	• Easy access • Duration of fire support < 4 days	• Difficult access • Duration of fire support 4-10 days • Logistical position assigned • Anticipated difficulty in obtaining resources	• No vehicle access • Duration of support > 10 days • Multiple logistical positions assigned • Remote camps & support necessary
Political Concerns	• No impact on neighbours or visitors • no controversy • no media interest	• Some impact on neighbours or visitors • Some controversy, but mitigated • Press release issued, but no media activity during operations	• High impact on neighbours or visitors • High internal or external interest & concern • Media present during operations
Tactical Operations	• No ignition or simple ignition patterns • Single ignition method used • Holding requirements minimal	• Multiple firing methods &/or sequences • Use of specialized ignition methods (terra-torch, AID) • Resources required for up to one week • Holding actions to check, direct, or delay fire spread	• Complex firing patterns highly dependent upon local conditions • Simultaneous use of multiple firing methods &/or sequences • Simultaneous ground & aerial ignition • use of heli-torch • Resources required for > 1 week • Multiple mitigation actions at variable temporal & spatial points identified. Success of actions critical to accomplishment of objectives • Aerial support for mitigation actions desirable/necessary
Interagency Consultation	• Cooperators not involved in operations • No concerns	• Simple joint-jurisdiction fires • Some resource competition for resources • Some concerns	• Complex multi-jurisdictional fires • High competition for resources • High concerns