Strategic Environmental Assessment of the Fire and Fuel Management Program in the Contiguous Mountain National Parks
FINAL REPORT

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Executive Summary

A strategic environmental assessment (SEA) is the assessment of a policy, plan or program. The basic framework of a SEA is a preliminary scan, analysis of environmental effects, and public consultation. The purpose of this SEA is to provide decision-makers and stakeholders with information on the environmental implications of the fire and fuels management program in Banff, Kootenay, Yoho and Jasper National Parks. While Canadian Environmental Assessment Agency (CEAA) requirements form the key legal and administrative framework for fire management activities within the National Parks, as of 2007 no cohesive strategic assessment had been completed at a regional scale to effectively link fire and fuel management program objectives and knowledge within the mountain park field units. Extensive stakeholder consultation and a regional cumulative effect analysis were identified as key elements needed in a strategic assessment of fire and fuel management in the mountain parks.

This SEA of the Fire and Fuels Management Program in the contiguous mountain parks identifies, describes, evaluates and seeks a degree of resolution to the ecological, social, cultural, and economic issues associated with fire and fuels management in the mountain parks. This process was guided by two levels of concern:

- strategic issues with considerable public interest and/or ecological implications, and
- smaller-scale issues with potential impacts that are generally repetitive, predictable, and spatially and temporally limited.

Section 1.0 provides a context for the SEA of fire and fuels management in the contiguous mountain parks and outlines the purpose, objectives and scope of the assessment.

Section 2.0 discusses the various guiding principles, legislative frameworks and the management strategies and practices that have shaped the fire and fuel management program in the contiguous mountain parks as well as the fire management practices and strategies that are employed to achieve fire management goals and objectives. As part of this discussion the current Fire Management Plans (FMPs) for the mountain parks were reviewed. FMPs contain information on fire management policy and strategies; planned responses for managing wildfires and prescribed burns; and fire personnel organization and deployment plans. In addition the Banff, Jasper and LLYK (Lake Louise, Yoho, Kootenay) fire management plans outline ecological management objectives for prescribed fire in their respective field units; as well as ecological and social issues related to the use of fire in the parks and strategies to communicate the objectives and desired outcomes of the fire and fuel management program to all stakeholders in the parks.

Section 3.0 outlines the process for issues scoping and identification of valued ecological and social components in the fire management plans as those that may be impacted by fire and fuel management programs in the mountain national parks. The scoping revealed that the major effects and concerns of fire and fuel management are linked to broad, regional scale valued ecosystem components (VECs) including ecological, social, cultural and economic values.

Section 4.0 identifies the potential impacts of prescribed fire and fuel management to natural and social, cultural and economic resources at the project-level (repetitive, small-scale impact) and outlines mitigation measures. Since a wide range of environmental factors including vegetation types, wildlife habitat, soil conditions, and water quality may be affected by prescribed burning and fuel management projects, each prescribed burn and fuel treatment within the mountain parks an ESR is required by Parks Canada under the Canadian Environmental Assessment Act (CEAA). An ESR outlines the potential project level impacts on wildlife, vegetation, landforms, aesthetics, public safety, cultural resources and socio-economic parameters and details mitigation measures to avoid, reduce or eliminate potential negative environmental effects. This section follows the same format as outlined for CEAA Environmental Screening reports and serves as a template that can be copied from the SEA directly into project level environmental assessments, such as environmental screening reports (ESR). This will help to streamline the project level environmental assessment process for fire and fuel management activities by eliminating the need to address some issues repeatedly at the project stage thereby saving time and effort.

Section 5.0 is the cumulative effects assessment (CEA), which includes an overview of conducting cumulative effects assessment at a strategic level and a discussion of the need to address the cumulative effects of fire and fuels management at a strategic level. The main part of this section is an analysis of cumulative effects of past and present fire and fuel management programs on VECs representative of the broad ecological, social, cultural and economic values within the mountain parks. Recommendations for monitoring and mitigating these impacts are also included. The broad VECs that served as the basis for the CEA were Biodiversity, Terrestrial Ecosystem Health, Aquatic Ecosystem Health, Atmosphere, Human Health and Safety, Infrastructure and Built Assets, Social and Cultural Values and Economic Vitality.

The cumulative effects of fire exclusion and fire suppression as fire management practices over the last 100 years (late 1890s to mid-1980s) and the current fire management program including prescribed burning and fuel management beginning in the 1980s and forecasting 10 years into the future are analyzed in section 5.0. The cumulative effects assessment revealed that past fire management programs, which consisted primarily of intensive fire suppression in the mountain national parks and surrounding provincial lands in British Columbia and Alberta have negatively impacted vegetation biodiversity and terrestrial ecosystem health over time. The CEA identified that prescribed fire conducted as part of the current fire management programs are having a positive cumulative effect on biodiversity (including many species at risk), and terrestrial and aquatic ecosystem health. Fire is the main source of habitat diversity on park landscapes and is therefore necessary to maintain ecological integrity. However, these activities can have negative impacts on social and cultural and economic values in the parks. Mitigation measures related to all aspects of the current fire and fuels management program are outlined in this section.

Section 6.0 contains the methods and results of the internal Parks Canada consultation and public consultation process conducted as part of the SEA. The Parks Canada consultation was part of the Phase I SEA and has been on-going in the Phase II of this project. Parks Canada consultation included contacting Parks Canada experts in fire, wildlife, vegetation, cultural resources, Species at Risk, and CEAA as well as provincial Sustainable Resource Development personnel and other experts in the field of fire and fuels management in mountain parks ecosystems. A questionnaire was sent to applicable specialists within the organization; and there were meetings, phone conversations, information requests and emails to several Parks Canada personnel to obtain available literature and up-to-date information on fire and fuel management in the mountain national parks. The result was input from knowledgeable sources, including recently available documents to contribute to the SEA.

The public consultation component involved providing several different options for the public to provide input into the SEA and FMP process. There was an ad run in the local newspapers of all the communities within the mountain parks offering the public to complete a survey, comment on the draft SEA and FMPs or have a one on one meeting with their local Parks Canada Fire Specialist. A comprehensive list of non-government organizations, tour operators, businesses, smoke sensitive individuals, local governments and First Nations was compiled and each organization or individual contacted. The list was separated into high interest and moderate interest groups. The people, businesses and organizations on the high interest group were invited to attend a workshop in Banff or Radium, complete a survey, review and comment on the FMP and SEA and/or have a one on one meeting with Parks Canada. The moderate interest group was invited to partake in all of those options except the workshops. The result of the public consultation was a list of key issues that the public have with fire and fuel management, as well as mitigation measures to work with the public and reduce or eliminate the issues discussed. A summary of the surveys and workshops are provided in Appendix I and there are separate Workshop Summaries for each workshop (under separate cover).

Section 7.0 covers the monitoring required to determine if the objectives of fire and fuel management activities carried out under the mountain park FMPs are achieved. Monitoring adds to the body of knowledge of fire effects on ecosystems in the mountain national parks. Currently a Parks Canada National Fire Monitoring Guide is being produced by fire ecologists in the Parks Canada Western and Northern Service Center. In addition, techniques to monitor fire attributes using normalised burn ratio (NBR) derived from Landsat satellite imagery have been developed for the mountain national parks. NBR is a measure of change between pre and post fire landscape conditions and can be used to determine the range of burn severities within fires and to delineate unburned interior polygons within a fire. It also has some value in delineating the perimeter of a fire although sometimes the convoluted outer boundaries of a fire are hard to discern using this technique. Fire severity is a key parameter to monitor as it is a major determinant of post-fire ecosystem changes and vegetation succession pathways.

To date there has been very little monitoring done on the ecological effects of large high severity stand-replacing fires in the mountain parks which typically occur as midsummer lightning-ignited wildfires. Parks Canada is implementing a national Ecological Monitoring program in all national parks across Canada in the next 5 years (Parks Canada 2006). This program will monitor various indicators of biodiversity; terrestrial ecosystem health; aquatic ecosystem health; landscapes and geology; and climate and atmosphere in the mountain national parks.

Section 8.0 addresses knowledge gaps on fire and fuel management. These knowledge gaps span a range of topical areas and have been organized by the following categories: baseline knowledge of fire ecology within the mountain parks, effects of fire and fuel management on valued ecological ecosystem components and social, cultural and economic ecosystem components, and technological and communication capacity.

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Acronyms Table

ASRD	Alberta Sustainable Resource Development
BFU	Banff Field Unit
BNP	Banff National Park
CEAA	Canadian Environmental Assessment Act
CFFDRS	Canadian Forest Fire Danger Rating System
ESR	Environmental Screening Report
FDO	Fire Duty Officer
FMP	Fire Management Plan
FOW	Fire Operations Warden
IAC	Initial Attack Crew
ICS	Incident Command System
ICT	Incident Command Team
IFA	Initial Fire Assessment
JNP	Jasper National Park
KNP	Kootenay National Park
LLYK	Lake Louise, Yoho, Kootenay National Park
MPB	Mountain Pine Beetle
NBR	Normalized Burn Ration
NGO	Non-government Organizations
PB	Prescribed Burn
PFIS	Park Fire Information System
PMP	Park Management Plan
SAC	Sustained Action Crews
SARA	Species at Risk Act
SEA	Strategic Environmental Assessment
VEC	Valued Ecosystem Component
WUI	Wildland/urban interface

Table of Contents

List of Tables

List of Figures

Appendices

1 INTRODUCTION

1.1 Background

The three mountain parks field units (Banff, Lake Louise Kootenay Yoho (LLYK) and Jasper) are currently engaged in common fire management initiatives related to ecosystem restoration and protection from wildfire. These activities include wildfire response, prescribed burning, and forest fuel reduction.

Directive 2.4.4 specifies that fire management in National Parks will be carried out in accordance with the Canadian Environmental Assessment Act (CEAA) and the Parks Canada Agency Management Directive 2.4.2 on Environmental Impact Assessment.

While CEAA requirements form the key legal and administrative framework for fire management activities with the National Parks, as of 2007, no cohesive strategic assessment had been completed at a regional scale to effectively link fire and fuel management program objectives and knowledge within the mountain park field units. Extensive stakeholder consultation and a regional cumulative effect analysis were identified as key elements of a strategic assessment of fire and fuel management in the mountain parks.

In January 2007 Parks Canada retained the services of Avens Consulting to develop a scoping document for the first phase of a Strategic Environmental Assessment (SEA) of the fire and fuel management program in the contiguous mountain National Parks. The scoping document outlined a process for strategically reviewing the fire and fuel management program.

In October 2007 Avens Consulting was retained by Parks Canada to complete the second phase of the strategic review. This document is the final complete report of the Strategic Environmental Assessment of the Fire and Fuel Management Program in the Contiguous Mountain National Parks.

1.2 Strategic Environmental Assessment

Strategic environmental assessment (SEA) is the assessment of a policy, plan or program (Figure 1.1). While there is no single process for a conducting a SEA, there are recommended elements that should be included in a SEA such as a preliminary scan, analysis of environmental effects, and public consultation.

This SEA followed the process outlined below:

Setting the Context
Conduct a review of policy to identify relevant plans
Identify environmental protection objectives
Propose SEA objectives
Decides on the scope of the SEA

Assess the Effects of the Plan
Identify and evaluate effects at project level and strategic level
Propose mitigation measures
Propose monitoring options
Consult with authorities with environmental expertise

Public Consultation
Provide public with a copy of the SEA
Take findings of the consultation into account
Integrate considerations to amend SEA

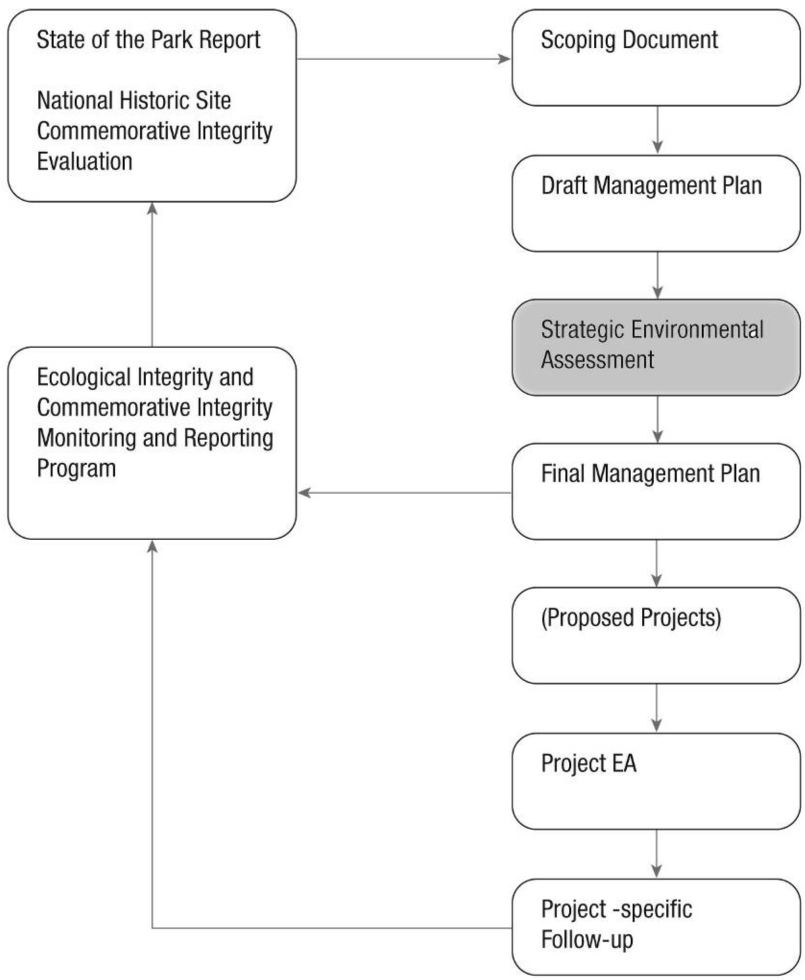


Figure 1.1 Links between management planning and environmental assessment process.
Source: Parks Canada Guide to Compliance with the Canadian Environmental Assessment Act, January 2007.

This document is the second phase of a Strategic Environmental Assessment (SEA) of the fire and fuel management program in the contiguous mountain National Parks. In this phase of the SEA, a cumulative effects assessment of past and present fire management practices in the mountain parks was completed (section 5.0) as well as an analysis of the results of comprehensive public consultation process (section 6.0).

1.3 Purpose and Objectives of the SEA

1.3.1 Purpose

The purpose of the Strategic Environmental Assessment (SEA) is to provide decision-makers and stakeholders with information on the environmental implications of the fire and fuels management plans in Banff, Kootenay, Yoho and Jasper National Parks.

1.3.2 Objectives

The SEA of the fire and fuels management plans will assist decision-makers in:

1. optimizing positive environmental effects and minimize or mitigate negative environmental effects from the plans;
2. considering potential cumulative environmental effects of the plans;
3. streamlining project-level environmental assessment by eliminating the need to address some issues at the project stage;
4. promoting accountability and credibility among the general public and stakeholders; and
5. Contributing to broader Parks Canada policy commitments and obligations.

The SEA was completed in accordance with the Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals (Cabinet Directive 2004) under Canadian Environmental Assessment Act (CEAA).

1.4 Scope of the Assessment

The scope of the SEA was to identify, describe, evaluate and seek a degree of resolution of the ecological and socio-cultural issues associated with fire and fuels management in the mountain parks. This process was guided by two levels of concern:

- strategic issues with considerable public interest and/or ecological implications, and
- smaller-scale issues with potential impacts that are generally repetitive, predictable, and spatially and temporally limited.

These issues were addressed by:

- Completing an assessment of the overarching policies and frameworks within which fire and fuels management program operates and the fire management strategies and practices within existing fire management plans of individual fire management units within the mountain national parks.

- Conducting a cumulative effects assessment (CEA) to determine the positive and negative effects of past, present and future fire and fuels management activities in combination with other major land use changes within the mountain national parks and surrounding landscapes.

- Completing a public consultation process to solicit expert opinion on ecological and socio-cultural strategic and project-level issues associated with fire and fuels management in the contiguous mountain parks.

- Developing a comprehensive resource for streamlining the environmental assessment process for project level fire and fuels management within the mountain national parks.

2 FIRE MANAGEMENT PLANS IN THE MOUNTAIN PARKS

2.1 Purpose of fire management plans

National parks with fire-dependent vegetation and an implied fire history are required to prepare a fire management plan that details all fire management activities within the park under Parks Canada's *Management Directive 2.4.4* (Parks Canada 2005). The fire management plans in the mountain national parks serve to direct both the prevention and control of fire to protect people, property and landscapes and the use of fire to meet park ecosystem management goals (Shepherd and McDonald 2007, Parks Canada 2008, DeLong et al. 2008).

Fire management plans contain information on fire management policy and strategies; planned responses for managing wildfires and prescribed burns; and fire personnel organization and deployment plans. In addition the Banff, Jasper and LLYK fire management plans outline ecological management objectives for prescribed fire in their respective field units. These plans also detail ecological and social issues related to the use of fire in the parks and strategies to communicate the objectives and desired outcomes of the fire and fuel management program to all stakeholders in the parks. These fire management plans are in effect for 10 years.

2.2 Alternatives to fire management plans

Alternatives to the current approach to fire management do exist. These include full suppression and "let it burn" scenarios. Each alternative is detailed below and an overview of the advantages and disadvantage is provided.

2.2.1 Full Suppression Alternative

This alternative entails suppressing all fires in the park and not lighting any prescribed fires. This alternative represents the past fire exclusion policy in the national parks until the mid-1980's when the current fire management program was implemented. Advantages of this alternative are that people and built assets are well protected from wildfire.

Disadvantages of this alternative are decreased ecological integrity and biodiversity in the parks as a result of excluding fire which is the dominant disturbance agent and source of variability in mountain park ecosystems.

2.2.2 Let it Burn Alternative

A 'let it burn' scenario entails allowing all fires (wildfire and human ignited) to burn their natural course. Advantages of this alternative include ecological benefits of returning fire to landscapes that support species that benefit from the changes fire produces and decreasing the potential for an extreme fire event within the burned area in the future. Disadvantages of this alternative include the potential for extreme uncontrollable fire and the associated risks to human health and safety and built assets.

Like full suppression, let it burn policies are not ecologically or politically desirable and are not considered to be a viable option for fire management in the mountain parks.

2.2.3 Mechanical Fuel Reduction Alternative

This alternative involves using only mechanical fuel reduction techniques to manage fire within the mountain parks. The advantages of this approach include the high level of control over forest stand management and the potential economic gains of logging trees. The disadvantages include the time consuming nature of the work, the inability to replicate the ecological benefits of fire, and the ecological costs associated with machinery and disturbance of soils and non-target vegetation. This alternative also contravenes the *National Parks Act* which states that: "*Maintenance or restoration of ecological integrity, through the protection of natural resources and natural processes, shall be the first priority….when considering all aspects of the management of parks*".

Although mechanical fuel reduction provides a protection outcome, it does not confer any of the ecological benefits of fire and has significant ecological costs. Therefore, mechanical fuel reduction alone is not considered an appropriate method for fire management within the mountain parks.

2.2.4 Combination Alternative (Current Fire and Fuels Management Program)

This alternative refers to the current fire and fuels management program which utilizes a combination of suppression and let it burn tactics as well as prescribed burning and fuel treatment to manage fire within the mountain national parks in a manner that strives to meet Parks Canada's land management objectives under each Park Management Plan. The advantages of suppression and let it burn are combined within this approach to achieve ecological goals as well as reduce human health and safety risks. Prescribed burning is used to reduce fuel loads that have accumulated as a result of decades of full fire suppression management and to restore the ecological role of fire to landscapes. The current fire and fuels management program is considered to be the most appropriate fire management approach at the present time.

2.3 Fire management policy framework and guiding principles

In the national parks, fire and fuel management programs operate within a framework of legislation, policies, and management directives at the national level. In Banff, Kootenay, Yoho and Jasper national parks fire management goals and objectives are outlined in park management plans, vegetation management plans and strategies, and community plans specific to each field unit and/or park community.

2.3.1 Federal Acts

2.3.1.1 The National Parks Act

The main principles underlying fire management in national parks are derived primarily from the *Canada National Parks Act*, which states that:

The National parks are dedicated to the people of Canada for their benefit, education and enjoyment. Subject to this Act and the regulations, all the parks shall be maintained and made use of so as to leave them unimpaired for the enjoyment of future generations.

Maintenance or restoration of ecological integrity, through the protection of natural resources and natural processes, shall be the first priority of the Minister when considering all aspects of the management of parks.

In this context fire management can be considered a resource tool to aid in the maintenance or restoration of ecological integrity.

2.3.1.2 Species at Risk Act

The *Species at Risk Act (SARA)* was designed as a legislative tool for the conservation and protection of Canada's biological diversity. It fulfills a key commitment under the United Nations Convention on Biological Diversity and provides protection to species at risk in Canada. Prohibitions under SARA came into force June 1, 2004, and these apply to all federal lands, including national parks. All Parks Canada management activities, including fire and fuel management, are subject to these prohibitions. Species at risk considerations are therefore to be integrated into all aspects of fire planning, management, and monitoring. This should normally occur as part of the Strategic EA (SEA) process for policies and plans, the formal project EA process as prescribed by CEAA, or as part of a separate SARA permit.

Under SARA the following criteria has been established for any activity that will affect a listed species at risk:

1. All reasonable alternatives to the activity must be considered and the best solution must be adopted;
2. All feasible measures to mitigate the impact of the activity on the species, critical habitat or residences must be identified;
3. It must be demonstrated that the activity will not threaten the survival or recovery of the species.

Protection requirements for all SARA-listed species in the mountain national Parks are included in each fire management plan.

2.3.1.3 Canadian Environmental Assessment Act

The *Canadian Environmental Assessment Act (CEAA)* requires the assessment of the potential environmental impacts of projects when the government is the proponent, or is providing funding, land, or a permit for a project. Activities which do not fall within the 'project' description but could have an adverse effect on ecosystems or cultural resources in national parks are subject to the provisions of the Canadian Environmental Assessment act (CEAA) under Inclusion List Regulations Section 1.1(a).

> *Physical activities carried out in a national park, … for management or scientific purposes, that involve an intent to*
>
> *(a) manipulate an ecosystem function*;

Fire management operations such as suppression and prescribed fire projects fall into this category and as such require an environmental screening report under CEAA. These reports entail a comprehensive and systematic process designed to identify, analyze, and evaluate the environmental impacts of proposals and identify measures to mitigate those impacts.

2.3.2 Guiding Principles and Operational Policies

Parks Canada's *Guiding Principles and Operational Policies* (1994) outlines policies for protecting and managing park ecosystems:

> 3.2.3
> National park ecosystems will be managed with minimal interference to natural processes. However, active management may be allowed when the structure or function of an ecosystem has been seriously altered and manipulation is the only possible alternative available to restore ecological integrity.
>
> 3.2.4
> Provided that park ecosystems will not be impaired, the manipulation of naturally occurring processes such as fire, insects and disease may take place when no reasonable alternative exists and when monitoring has demonstrated, that without limited intervention:
>
> i) there will be serious adverse effects on neighbouring lands; or
> ii) major park facilities, public health or safety will be threatened; or

iii) the objectives of a park management plan prescribing how certain natural features or cultural resources are to be maintained cannot be achieved.

These policies allow for the use of fire as an ecosystem management tool in the mountain national parks to maintain fire-adapted ecosystems where fire exclusion has negatively affected ecosystem structure and function. It also allows for fire control to protect people, park facilities and park resources from unwanted fire.

2.3.3 National Fire Management Strategy

The revised *National Fire Management Strategy* (Parks Canada 2005) sets the strategic direction for fire management for the next 15 years in the national parks and national historic sites. This strategy sets out a number of principles that provide a foundation for the fire management program within Parks Canada:

1. Public and fire fighter safety is the first concern of all fire management actions.

2. National parks with fire dependent ecosystems will recognize the role of fire in restoring or maintaining ecological integrity and biodiversity.

3. Management decisions will support the role of fire in the ecosystem, while mitigating social and ecological risks.

4. Public communication strategies focusing on building awareness and support for fire management decisions are an integral part of the fire management program.

5. Fire is managed using the best available scientific knowledge and the principle of adaptive management.

6. Fire management is based on approved fire management plans and vegetation management objectives that flow from the park management plan.

7. Fire is managed on a landscape basis having regard to the goals and objectives of neighbours.

8. The fire management program is sustainable and based on business planning principles.

9. Parks Canada operates an integrated fire organization that utilizes people who have a range of duties rather than employees solely dedicated to fire management.

10. Fire management planning is integrated with other Parks Canada Agency functions.

2.3.3.1 Park management plans

Each mountain national park has an approved management plan that provides strategic goals, objectives and key actions that direct park management actions to maintain or restore ecological integrity while providing for visitor enjoyment in the parks. The fire management plans for each field unit are nested under these park management plans (PMP). Each PMP contains specific objectives and actions relating to the use of fire to maintain or restore native vegetation communities within the park.

The strategic goal in relation to fire is essentially the same in all the management plans for Banff, Kootenay, Yoho, and Jasper:

> *To maintain and, where feasible, restore native vegetation communities to reflect the long-term ecosystem states and processes.* (Banff Park Management Plan, 1997)
>
> *Natural processes maintain the long-term composition and structure of vegetation communities.* (Kootenay, Jasper, Yoho National Park Management Plans, 2000)

The objectives and key actions for fire are consistent between the PMPs for the four mountain parks although the wording and level of detail varies. These plans are updated every 5 years.

2.3.3.2 Banff National Park

Objectives

- To restore the role of fire in modifying vegetation communities, except where limited by public safety, public health, major park facilities and neighbouring lands;
- To maintain and restore key structural components of the park's vegetation including aspen, willow and grassland communities;
- To determine suitable vegetation patterns, including age-class structures and distributions that will ensure viable populations and natural biodiversity;
- To improve public awareness of natural disturbances, such as fire, and the management implications of these disturbances;
- Through prescribed burns and not suppressing fires caused by lightning, achieve a target of 50% of the long-term fire cycle or approximately 14 sq. km burned annually.

Key Actions

- Consult with stakeholders, municipal and provincial governments, and interested parties in the development of a Vegetation Management Plan.
- Conduct prescribed burns after consultation with affected parties.

- Work with a variety of stakeholders to encourage understanding of and support for the prescribed burn program.
- Complete a Bow Corridor Fire Protection Plan with the Town of Banff, Hamlet of Lake Louise, Harvie Heights, Canmore and operators of other facilities. The plan will include:
  - the use of prescribed burns to reduce fuel in forested areas;
  - controlling the supply of fuel for a fire around facilities; and
  - interagency planning, including joint emergency response, communications, training, use of volunteers, and building standards.
- Increase efforts to reduce non-native plant populations, particularly noxious species that have the potential to invade recently burned areas, native wetlands, and grasslands.
- Use communication and education programs about fire management and specific burns to promote a greater public understanding of the ecological role of fire.

2.3.3.3 Kootenay and Yoho National Parks

These parks are administered within one field unit and have the same goals, objectives and key actions relating to fire.

Objectives

- To maintain and restore the role of fire and other ecological processes, except where limited by safety considerations and the protection of park facilities and neighbouring land.

Key actions

- Consider the objectives of adjacent land managers when planning prescribed fires. With adjacent land managers and the province of British Columbia, develop a strategy to reduce the probability of wildfires spreading beyond the park boundary.
- Determine, through scientific research and traditional knowledge, the effect of First Nations' traditional activities on vegetation and biodiversity.
- Restore, through prescribed fires and fires caused by lightning, 50% of the estimated long term fire cycle (e.g., approximately 3.5 square kilometres annually).
- Promote a greater understanding of the ecological role of fire.

2.3.3.4 Jasper National Park

Objectives

- To maintain or restore the role of fire and other ecological processes, except where limited by safety considerations and the protection of park facilities and neighbouring lands

Key actions

- Define appropriate fire regimes that reflect desired cycles for various vegetation groups, ecoregions, and site moisture classes.
- Restore at least 50% of the long term fire cycle through prescribed fires, and, where appropriate, limited suppression of fires caused by lightning or accident; monitor the effects.
- Identify scenarios and locations where randomly ignited fires can contribute to the fire regime.
- Work with other agencies and stakeholders to encourage understanding and support for the prescribed fire program; consult with affected parties.
- Protect facilities, communities and adjacent lands from unwanted fires through suppression and fuel management.

2.3.3.5 Field unit-specific plans

There are other management plans within the mountain national parks that have been prepared by Parks Canada and/or local community officials that deal with emergency response to fire and fire risk reduction within developed areas and communities in the parks. A management strategy was also developed in conjunction with Alberta government officials (Sustainable Resource Development and Community Development) that addresses the timing and sequencing of burns in BNP and neighbouring provincial lands to deal with the current mountain pine beetle outbreak (Parks Canada 2002). All of these plans are integrated with the fire management plan in each park. These plans are as follows:

Banff field unit

Banff National Park disaster plan
Banff National Park Wildland Fire Emergency Procedures Manual
Banff field unit developed area forest management plan
Regional Forest Management Strategy: Banff National Park
Town of Banff Tactical Response Plan (currently being developed with Parks Canada)

LLYK field unit

Lake Louise Community Plan
Field Community Plan

Jasper field unit

Jasper community land use plan
Town of Jasper tactical wildfire response plan

Municipality of Jasper Emergency Response Plan

2.4 Fire Management strategies and practices

2.4.1 Calculating fire cycles

In order to achieve the stated objective of 50% of the long term fire cycle, the historical fire cycles in the mountain parks (prior to effective fire suppression) had to be determined for each park. There have been several fire history studies conducted in each park and the results have been used to calculate historical fire cycles in each region or vegetation type in the mountain parks. These numbers are used to plan the size and location of prescribed burns and determine areas in the parks that lightning-ignited fire could be allowed to burn if there is no threat to people, built assets or cultural resources.

In Banff National Park, research indicates that the fire cycles vary across the park according to 4 topographic features: elevation, aspect, distance to the Continental Divide and valley orientation (White et al. 2003). Initially ecosite and vegetation types (Holland and Coen 1982) were used to create “fire groups” with similar fire regimes (White 1985). Fire cycles were then calculated for each of these fire groups using mean forest stand origin year. The fire cycles of the fire groups increase with elevation and are longer on cool moist terrain types compared to warm, dry slopes at the same elevation. In Banff National Park lightning-ignited fire is rare compared to parks to the west of the Continental Divide (Wierzchowski et al. 2002). There is historical evidence of frequent human-caused fires ignited in the spring and fall, likely set by Aboriginal people burning meadows and montane habitat to encourage grass growth and draw ungulates to the burned areas (White 1985).

In Kootenay National park (KNP), the fire cycles were determined using time-since-fire distribution analysis (Masters 1990) and paleoecological pollen studies (Hallett and Walker 2000). In this park the research suggests that climate is the overriding factor that has influenced fire cycles on a millennial scale. The cooler climate over the last several centuries has created reduced fire frequency and older more closed forests that exist in the park today. Most fires in the park are ignited by lightning. From 1980-2000 lightning caused 95% of all fires in the park while the remaining 5% were caused by humans or unknown sources. There is also evidence that burning by First Nations in Kootenay Valley may have occurred in patterns similar to those seen in Banff National Park.

In Yoho National park, Tymstra (1991) identified two different fire regimes, one for low to moderate intensity fires and the other for high intensity stand-replacing fires. Fires in this park occur more frequently in the western portion of the park than in the eastern portion of the park next to the Continental Divide. There is some evidence of human-caused fires in this park during the construction of the railway, and mining and logging in the park from 1883-1915. Otherwise human-caused fires appear to be uncommon in this park.

In Jasper National Park, fire cycles were originally calculated using stand origin maps created by Tande (1979) and others within Parks Canada. Recently, the fire cycles have been recalculated using vegetation and landforms data from Jasper National Park's Ecological Land Classification (Holland and Coen 1982) to determine specific fire cycles for each vegetation type in the park (Achuff et al. 2001). These cycles range from 15 years in montane meadows to more than 600 years in the upper sub-alpine. Lightning is not a common ignition source for fires in Jasper National Park. Not including prescribed fire, 16% of all fires were lightning-caused from 1929 to the present and 84% were human-caused (along roads, railway, adjacent to Jasper townsite etc.).

In surrounding provincial lands in Alberta there have also been several fire history studies conducted (Rogeau 1994a, Rogeau 1994b, Rogeau 2007). These studies mirror results from within the mountain parks indicating that the fire regime in these adjacent lands is generally under the same environmental influences as those in the parks (i.e. elevation, aspect, distance to Continental Divide and valley orientation).

2.4.2 Fire Control

2.4.2.1 Fire Zones

All of the mountain parks are divided into fire management zones based on values-at-risk (ecological, cultural and social), difficulty of fire control, and acceptable tactics for fire control. The purpose of fire management zoning is to allow natural processes like fire to occur without intervention where possible, limit expenditure of suppression funds, and minimize wildfire risks to fire-fighters. These zones identify which areas within each park are a priority for fire detection and suppression. There are three fire management zones: intensive, intermediate and extensive. All of these zones have been mapped in each of the three mountain park field units.

2.4.2.2 Intensive fire zone

The ***intensive*** fire management zone primarily follows transportation corridors and surrounds communities and other infrastructure. This zone covers areas of high visitor use and lands adjacent to provincial boundaries with downwind values at risk. All available means of fire suppression are acceptable within this zone including the use of long and short term fire retardant and heavy equipment such as bulldozers and tracked excavators for building fire line. There is an emphasis on rapid detection and suppression of fires through initial attack.

Large scale, landscape-level proactive measures are required in the intensive zone as part of the preparation for response to wildfire. This will include construction of fireguards, control lines, prescribed burns, fuel modification and reduction, and other vegetation management alterations to control or limit wildfire spread during extreme burning conditions.

The overall goal is to reduce the amount of area in the Intensive fire management zone over time in each park (i.e. the area requiring a full suppression option). This will be achieved by implementing a long term and multi-scaled approach to reduce the threat of wildfires. At the landscape level, this strategy includes fuel reduction, the creation of fireguards, and limited prescribed burning.

2.4.2.3 Intermediate fire zone

Areas zoned ***intermediate*** in the mountain national parks have limited infrastructure and human use. The primary park users are hikers or backcountry campers. This zone has only tertiary roads and trails and includes lands that are managed under joint agreements with the province of Alberta or British Columbia. The ***intermediate*** zone serves as a buffer between the ***intensive*** and the ***extensive*** zones.

In this zone there is less emphasis on early detection, but most fires will be subjected to initial attack as soon as possible. Suppression tools include aircraft with retardant, but use of heavy equipment is not acceptable.

Values-at-risk located within this zone are Warden and outfitter cabins, alpine huts, and cultural and heritage resources. Site-specific fire mitigations will be employed for these resources including fuel removals and temporary sprinkler deployments, to the extent necessary to provide reasonable protection for the resource. For non-cultural/heritage resources, protection efforts should not exceed the cost of facility replacement.

Habitat that has been identified as core range for woodland caribou in Banff and Jasper National Parks is zoned intermediate (Parks Canada 2007a).

2.4.2.4 Extensive fire zone

In the ***extensive*** fire management zone, wildfires will be managed with minimal intervention. Management actions will focus on fire monitoring and containing fire growth within the extensive zone. The use of heavy machinery and fire retardants is not acceptable in this zone except in circumstances where there is an immediate wildfire threat to people or significant values-at-risk.

Extensive fire zones are located in the regions of the parks that have no significant permanent infrastructure or high use trails, have few visitors, and are not located adjacent to forested border areas. Most fires occurring in this zone will be managed for their ecological benefits after evaluation through the Fire Analysis process.

2.4.2.5 Wildfire Risk Analysis

In Jasper National Park a wildfire risk assessment was carried out for the entire park resulting in one risk value being assigned to each fuel type polygon for each of the spring, summer and fall seasons. Risk in this case is defined in broad terms as a measure of a future, non-intentional event possibly leading to a loss.

Wildfire risk is calculated by considering three factors: potential fire intensity, ignition probability and probable consequences. A numerical value is assigned to each of the three factors on a scale of 1 to 12 and then added together to give an indicator of fire risk (range of 3-36). Fire risk categories have been created that were used to produce fire risk maps for Jasper National Park as follows:

Negligible risk	3 to 12 points (value of “1”)
Low risk	13 to 18 points (value of “2”)
Significant risk	19 to 24 points (value of “3”)
Critical risk	25 to 36 points (value of “4”)

The fire risk maps, in conjunction with the related fire management zone map, identify areas that will receive the greatest focus for wildfire detection and fire prevention activities. Emphasis will be on areas of greatest risk that are zoned as “Intensive” with a reduction of suppression resources dedicated to lower risk “Extensive” zoned landscapes.

2.4.3 Response to fire

2.4.3.1 Initial Attack

All fires, regardless of intensity, in the Banff, LLYK and Jasper field units will have an Initial Attack Crew (IAC) dispatched to the site of the fire. In extreme hazard, this dispatch may involve multiple resources. Once on site, the IAC will assess the fire and an appropriate response will be formulated based on an evaluation of public and firefighter safety, fire behaviour, values-at-risk, fire management zoning, potential suppression impacts, and the availability of fire management resources.

If the fire is in the intensive zone, the IAC will take steps to control the fire as soon as they arrive on scene. In the intermediate and extensive zones, the IAC response will depend on the prescription for the zone (i.e. is the fire threatening identified values-at-risk or can the fire be allowed to burn within a prescribed area to meet ecological management objectives?). If a fire is out of prescription, the IAC will take steps to control the fire upon arrival. If the fire is in prescription, the IAC will report back to the fire duty officer with an Initial Fire Assessment (IFA).

All specific tactics and procedures employed in the Banff, LLYK and Jasper field units for fire suppression are contained in Parks Canada’s Fire Management Standard Operating Procedures Manual for each field unit.

2.4.3.2 Fire Analysis

All fires that are not controlled, or expected to be controlled (i.e. a wildfire that escapes initial attack), by the next day's burning period will be subjected to a Fire Analysis. The Fire Analysis examines options for the response to a wildfire in the context of fire management objectives including human safety, ecological integrity, economic costs, facility protection, and predicted fire behaviour (determined through analysis of weather forecasts, fuel types, topography, etc.). Less than full suppression methods may be used. However, emphasis must be placed on wildfire control within a reasonable time and according to available human and fiscal resources (Parks Canada 2005).

The Fire Analysis is a decision-making process in which the Field Unit Superintendent or their delegate coordinates a collaborative approach to:

- Describe the fire situation;
- Establish objectives and constraints for the management of the fire;
- Compare multiple strategic fire management alternatives;
- Evaluate the expected effects of the alternatives;
- Select the preferred alternative; and
- Document the decision.

2.4.3.3 Incident Command System

All fires in the mountain national parks are managed using the Incident Command System (ICS). The ICS framework is becoming broadly used by many agencies around the world for emergency and incident management. The Fireline Handbook (National Wildfire Coordinating Group 2004) provides an extensive description of the use of ICS in Fire Management. This approach is integrated into Parks Canada's Fire Management program.

For fires, the ICS has five levels depending on the size and severity of the fire and the resources required to control it. The ICS specifies a command and personnel structure for fighting fires that are rated as Type 1 to 5 Incidents as follows:

Type 1 Incident: 76+ fireline personnel responsible for incident management.

Type 2 Incident: 26–75 fireline personnel responsible for incident management

Type 3 Incident: 9–25 fireline personnel responsible for incident management

Type 4 Incident: 1- 8 fireline personnel responsible for incident management

2.4.3.4 Fire Danger Levels

Fire danger in the mountain National Parks is rated according to the Canadian Forest Fire Danger Rating System (CFFDRS). This system provides information as to the risk of wildfire during fire season. There are four categories of fire danger: low, moderate, high and extreme. For each level of fire danger Parks Canada has associated preparedness levels for fire suppression personnel in all of the field units (Table 2.1).

There is also a communications strategy associated with the fire danger levels to inform the public of fire bans and restricted activities when the fire danger is high to extreme. Fire danger signs are located in all of the field units on major highways and at warden stations. Municipal fire departments in Jasper, Banff, and Lake Louise also have fire danger signs.

Table 2.1 Parks Canada fire alert levels.

Fire Danger LEVEL	ACTION GUIDELINES
I ***LOW***	**Green Alert Status.** Initial Attack Crew (IAC) on normal shift (08:00-16:30) All wardens on normal shifts. PFIS (Park Fire Information System) reporting weekly by Fire Operations Warden (FOW) or designate. Fire Duty Officer (FDO) shift established. Shifts (08:00-16:00)
II ***MODERATE***	**Blue Alert Status *.** IAC on normal shift (08:00-16:30) or on days off. All wardens on normal shifts, If lightning is forecasted, crews put on standby and IAC may be required to work through days off. *Alert Status bumped to Yellow PFIS reporting weekly by FDO or designate. Fire Duty Officer shifts (08:00-16:00)
III ***HIGH***	**Yellow Alert Status*.** IAC on adjusted shift (10:00-18:30). IAC on standby when off shift including days off. A command spotter may be pre-positioned if multiple fires are forecasted. Fire trained resource conservation staff may be required for fire operations. Fire Duty Officer shifts (08:00-16:00). FDO on standby after 16:00. Radio/phone contact to be maintained with IA crews. Shift hours may be extended. If there is a probability of "intense lightning" forecasted with less than 2 mm of precipitation, a rappel capable intermediate helicopter may be pre-positioned at the compound location determined by conference calls. Loaded patrols may be flown by IAC. ***Alert Status bumped to Red**. DW's may be required to provide detection during lightning activity.
IV ***EXTREME***	**Red Alert Status**. IAC on adjusted shift (12:00-20:30). IAC required to work through days off. IAC on standby. For rappel crews, the command spotter may be pre-positioned. Fire trained trail crews may be required for fire operations. Resource Conservation Staff may be required to work through days off. PFIS reporting daily by FDO or designate. Daily Conference call initiated by NFC. Fire Duty Officer shifts extended. See III. Helicopters will be pre-positioned at strategic locations. "Loaded" patrols may be flown after lightning storms. DW will assist with detection. See III. Sustained Action Crews (SAC) (may include other qualified Parks Staff) mobilized if there is probability of "intense lightning" forecasted with less than 2 mm. of precipitation. Crews will be pre-positioned in strategic areas within the Field Unit. Additional 3 person fire crews mobilized from resource Conservation or other "functions" within the park or from other parks may be required to assist in multiple fires if necessary (this crew may have a helicopter at their disposal). National Incident Command Team (ICT) on Standby.

2.4.3.5 Rehabilitation of sites post-fire

Ideally, planning for post-fire rehabilitation will be initiated during early fire operations planning when significant disturbance due to heavy machinery is anticipated in the course of suppression activities. Most impacts will be mitigated following the Minimum Impact Suppression Guidelines as outlined in the National Fire Management Standard Operating Procedures manual.

Fire suppression crews, after achieving control of a fire, will be employed in rehabilitating sites as necessary. Each fire will be evaluated and a rehabilitation plan will be created that will identify what level of rehabilitation will occur including objectives and methods of the rehabilitation strategy. Rehabilitation plans are subject to CEAA guidelines and as such may require an Environmental Assessment when there are significant impacts which require mitigation. Generally, rehabilitation will be restricted to areas of heavy disturbance caused by control activities and rarely within the burned zone of natural fire.

Post-burn rehabilitation should be undertaken with the final objective of restoring the native vegetative cover according to the following priorities (Section 5.2.8; Axys 1998):

- Adequate erosion under all but the most severe weather conditions,
- Establishment of a plant cover composed of plants adapted to the environment and suitable for erosion control and soil reconstruction, and
- Re-establishment of native plant species by invasion or replanting.

Recently burned areas provide ideal sites for the establishment of non-native invasive plant species as there is little competition and high light and nutrient availability. The rehabilitation plan for a fire should include ways to prevent and reduce the spread of non-native species into burned areas. Sites within burns that are most susceptible to invasion by non-native plants are heavily disturbed areas (e.g. catline) and areas adjacent to large existing populations of exotic plants. Areas that are successfully invaded by non-native species can displace native species and potentially alter the area's fire regime by changing the flammable characteristics of fuels in the area (Brooks et al. 2004).

2.4.4 Fuel Management

2.4.4.1 Fuel modification around communities and outlying facilities

Of the three factors governing fire behaviour (fuel, weather and topography) only fuel can be managed. The National Fire Management Directive (Parks Canada 2005) recognizes that fuel management is appropriate where fuel build-up poses risk of intense fire behaviour that would threaten the public, property and adjacent lands.

Two main strategies exist for reducing fuels: prescribed burning and mechanical fuel reduction. Although prescribed burning in preferred where possible, reducing fuels through burning in the immediate vicinity of a facility often presents substantial fire control challenges, particularly where fuel loads are heavy. In these cases the only practical and safe method for reducing hazardous fuels is through mechanical fuel reduction.

Mechanical treatment can also be used in combination with prescribed burning to treat areas around facilities. For example, mechanical treatment can be used to thin stands, reducing the likelihood that a fire will be able to move from crown to crown, which can then be followed by prescribed burning to remove surface fuels, such as downed wood and litter.

In general, fuel management projects are carried out in three areas in the mountain National Parks (1) around isolated facilities that are surrounded by forests or other combustible vegetation (e.g. backcountry lodges, warden cabins, backcountry huts); (2) at the wildland/urban interface (WUI) around the perimeter of communities, and; (3) in wildland areas where fuel management is used to reduce the risk of fire spreading into urban areas or adjacent provincial lands.

To date fuel modification projects have been carried out or are in progress around the communities of Banff, Jasper, Radium Hot Springs, Lake Louise and Field.

2.4.4.2 FireSmart program

In the 1990s, a number of national, provincial and municipal associations and government departments responsible for emergency services, land-use planning, and forest and resource research and management recognized the need to establish a set of guidelines aimed at reducing the risk wildfires pose to communities in the WUI. The coalition, known as *Partners in Protection* developed and published a manual titled *FireSmart: Protecting Your Community from Wildfire*. The manual describes vegetation management and structural options for buildings within the WUI to mitigate wildfire risks. This manual also suggests community infrastructure configurations (roads, water supply, green space and utility locations) to facilitate quick response by firefighters and increase public and firefighter safety (Partners in Protection 1999).

FireSmart programs have been initiated in all of the field units. This program is used to reduce wildfire risk to outlying commercial facilities as well as the WUI around communities within the parks. In general facility operators are responsible for taking steps to reduce the risk on their lease including vegetation thinning, removal of ladder fuels, and any appropriate structural changes to their buildings. Any changes must be consistent with park management plans, community plans, outlying commercial accommodation guidelines and ecological management objectives within the park. Some risk reduction measures can be implemented by leaseholders without an environmental assessment (EA) or development review but more complex projects may require an EA.

In some cases the work may be done in conjunction with risk reduction measures planned by Parks Canada in adjacent land off the lease.

In Jasper National Park the *FireSmart* program involves selective thinning, pruning and burning around the Town of Jasper. This *FireSmart* project is also a component of the Foothills Model Forest *FireSmart Communities Project*. The goal of the project is to develop, implement and assess innovative, ecologically-based methods for managing forest fuels in ways that reduce wildfire risk but also maintains or enhances ecological conditions, wildlife habitat, and aesthetic qualities in the forest lands located immediately adjacent to the Town of Jasper and other major developments. In addition to reducing wildfire risk the secondary objective of the *FireSmart* fuel modifications is to restore Douglas-fir stands to a more open stand condition. These treatments reduce forest density and also decrease fuel accumulations on the forest floor.

2.4.4.3 Protection of cultural resources

Many significant cultural resources such as historic backcountry cabins have protection plans in place to decrease the risk of a loss of these resources from wildfire. The protection plans may include fuel treatments to reduce fuel loads in the areas immediately surrounding around identified cultural resources. In many cases there is a plan to protect these resources with sprinklers in the event that a wildfire threatens these structures.

2.4.5 Fire use

Over the last few decades Parks Canada has recognized the importance of fire in maintaining ecological integrity within national parks. This is reflected in national legislation, directives, policy, and practice (see section 2.3). Prescribed burning is an accepted practice in the Banff, LLYK, and Jasper field units and is used to meet specific ecosystem management goals and to reduce the risk of wildfire. There are four broad objectives for prescribed fire in the mountain national parks: (1) to reduce the threat of a major stand-replacing fire that could threaten people, facilities and neighbouring lands; (2) to restore and maintain fire-dependant vegetation communities; (3) to meet specific ecosystem management goals; and (4) to restore 50% of the long term fire cycle through prescribed fires, and, where appropriate, limited suppression of fires caused by lightning or accident.

2.4.5.1 Protection of people, facilities and other values-at-risk

Prescribed burns within the mountain National Parks help to reduce the risk of unplanned wildfire that can cause damage or loss of important values-at-risk including human life and property, species-at-risk and cultural resources both within park boundaries and on neighbouring lands. Prescribed burns can provide barriers to wildfire spread by reducing available fuel for a wildfire and altering vegetation composition, structure, and forest age. Prescribed burning allows managers to remove fuel at strategic locations, so that the spread of a wildfire is slowed or prevented from becoming a high intensity crown fire.

The advantage of prescribed burning over wildfire to meet targets for restoring natural fire cycles is that it allows for advance planning for protection of built assets, cultural resources and rare habitats which may not be possible with an uncontrolled wildfire. In addition prescribed burns can be located strategically to create firebreaks on the boundaries of the parks to protect neighbouring lands from wildfire that originates inside the park. Also prescribed burns may be used to “cap” a valley so that a wildfire will not spread beyond the valley.

2.4.5.2 Restoration and maintenance of fire-dependant plant communities

The management-ignited prescribed burning program in the mountain National Parks aims to restore and maintain fire-dependant vegetation communities that have been altered through fire suppression. In general, fire suppression has resulted in older, more homogeneous forests with more closed canopies than occurred a century ago (Rhemtulla et al. 2002). The effects of fire suppression are most acute in vegetation communities with shorter fire cycles such as grasslands, montane meadows, aspen, and Douglas fir forests. Research indicates that many of these communities were maintained historically by frequent low intensity surface fires, and the absence of fire over the last 40 to 80 years has led to a reduction in the area occupied by these vegetation community types (Amiro et al. 2002, Rhemtulla et al. 2002, White et al. 2003). The fire management program in the mountain national parks focuses on restoring grasslands, meadows and open forests in the montane and sub alpine ecoregions of the field units. Recently prescribed burning has also been focused on closed pine and spruce forests in the lower subalpine in the 100-200 year age class. These forest types have been targeted to reduce the amount of mountain pine beetle susceptible pine stands on park landscapes.

Meadows and grassland

A study in the LLYK field unit revealed that the area occupied by montane meadows in Kootenay National Park has been steadily decreasing over the last number of decades with the ingress of trees into these sites (Van Egmond 1990). Regular burning of many of these meadows in several LMUs has been initiated to reduce the ingress of conifers and expand the current range of montane meadows. Grassland areas have also declined in size in Jasper National Park over the past century and are a priority for prescribed burning (Rhemtulla et al. 2002). At present, subalpine grasslands and dry subalpine shrub meadows are a priority for prescribed burning in the Banff Field Unit both of which show satisfactory post-fire regeneration to date.

Aspen

Aspen stands are in decline in both Banff and Jasper National Parks due to high herbivore rates by elk as well as attack by insects and disease. Fire is a useful tool to regenerate aspen stands as the trees will re-sprout from their root systems following fire. However, research has shown that post-fire regeneration of aspen in the mountain national parks has been hindered by browsing by ungulates (White et al. 2003). Therefore, for aspen stand restoration, prescribed burning must occur in conjunction with attempts to normalize elk and wolf distributions (White et al. 2003, Parks Canada 2005). Aspen restoration is likely to be successful only in areas where wolves help to control elk populations which would result in reduced browsing pressure by elk on new aspen seedlings (Amiro et al. 2002, White et al. 2003).

Douglas-fir

Fire history studies indicate that low elevation open Douglas-fir stands depend on periodic, low-intensity surface fires to maintain their open structure. Decades of fire suppression have resulted in the loss of open Douglas-fir forest and grassland ecosystems due to the encroachment of other species such as spruce and sup-alpine fir, which would normally be eliminated by fire. In the LLYK field unit there is an open Douglas-fir/grassland restoration project underway east of Radium Hot Springs on the slopes above the town. The first phase of this project involved thinning the forest and removing other conifer species as well as shrub species. The next phase of the project will involve a series of small prescribed burns that will reduce fuel loads and maintain the open stands of larger Douglas-fir created by the thinning phase. In Jasper National Park fuel thinning projects have been used to attempt to mimic fire-maintained open Douglas-fir stands adjacent to Jasper. In more remote areas careful application of prescribed burning will be used to restore and maintain open forests with a large mature Douglas-fir overstory.

Whitebark pine

Banff, Yoho, Kootenay, Jasper and Waterton National Parks have adopted a regional ecosystem restoration strategy for whitebark pine (Wilson 2005). Populations of whitebark pine are in decline across its northern range due to fire suppression, white pine blister rust, and mountain pine beetle infestations (Arno and Hoff 1989, Kendall and Arno 1990, Keane and Arno 1993). This pine species has a mutually beneficial obligate relationship with a bird species, the Clark’s nutcracker, which feeds on and caches whitebark pine seeds, some of which sprout providing the only source of new seedling recruitment for this pine (Tomback et al. 1990). Active management of whitebark pine through prescribed burning of key habitat is required to create openings that will be conducive to nutcracker caching and reduce competition from other conifer species (Keane 2000).

The following specific measures will be part of the strategy for whitebark pine restoration (as per Wilson 2005):

1. Fuel reduction to reduce competition with existing whitebark pine will try to focus on the Lodgepole pine/Whitebark pine interface occurring in the lower sub alpine ecoregion.
2. Older whitebark pine (approx. 200+ years old) will be preferentially targeted for additional protection from prescribed burns (prescribed burns listing Whitebark restoration as a primary objective) using fuel reduction, pre-burning of nearby flashy fuels, and altered ignition patterns to protect some seed-source trees.
3. Forests that have older whitebark pine with other species encroaching that are younger will be prioritized for whitebark pine restoration burning.

4. Sample plots will be set up prior to burn treatment to allow post burn assessment of seedling success, and to provide input into an adaptive management restoration approach.
5. Prescribed burns, and prescribed burn preparation will prioritize attempts to accommodate whitebark pine research efforts.

2.4.5.3 Meeting specific ecosystem management goals

Grizzly bear habitat

The maintenance of viable, stable grizzly bear populations in the mountain parks is challenging, due to fragmentation of the landscape and widespread human use. Research in Banff National Park indicates that periodic fire is important to maintain high quality grizzly bear habitat (Gibeau et al. 1996). Fire opens the stands and stimulates growth of important bear foods in the understory including Hedysarum and buffaloberry. Strategically located prescribed burns can contribute to overall goals for grizzly bear conservation by restoring or improving habitat. Prescribed burns to improve grizzly bear habitat are planned and carried out in all of the field units in the mountain National Parks.

A 2001 workshop with grizzly bear experts from across North America identified five major priorities that should form the basis of a comprehensive research and monitoring program for grizzly bears in Banff National Park. One of these priorities was the investigation of habitat relationships, which would include:

- New research into the relationships between fire, key grizzly bear foods and habitat enhancement
- The documentation of changes in bear use patterns in response to prescribed fire.

Mountain pine beetle control

The mountain pine beetle (*Dendroctonus ponderosae* Hopkins)(MPB) is a significant mortality agent of pine in western North America. MPB is a native insect, attacking lodgepole pine, ponderosa pine, whitebark pine, and limber pine. Historically there have been several outbreaks of mountain pine beetle in the mountain national parks, including an outbreak from 1929 to 1943 in Kootenay National Park which affected approximately 65,000 hectares of pine forest. Epidemic MPB populations are presently affecting a significant proportion of pine forests in British Columbia and consequently the forestry industry in that province.

Fire suppression, lack of aboriginal ignition, global warming, and land management practices have resulted in an abundance of older pine stands in the mountain National Parks that are highly susceptible to MPB colonization. Presently, beetle populations are increasing exponentially in the Banff and LLYK field units. Populations of MPB are also increasing rapidly in Jasper National Park although it is not considered a serious outbreak to date. To address this situation a co-operative MPB management strategy was proposed in conjunction with Alberta government agencies to address the current beetle populations and to work to reduce the threat of future beetle outbreaks in Alberta.

The overall objective for MPB management in the mountain National Parks is to maintain the natural disturbance regime within historic ranges of variation, which means ensuring that forested land is subject to a fire-dominated disturbance regime. Prescribed burning can assist in halting the spread of pine beetle in the short term, by removing susceptible trees or trees that have been attacked, and in the long term, by reducing the mean age of pine stands and increasing the distance between older, more susceptible stands, so that beetles have to travel farther to attack new hosts. The benefits of restoring fire to the landscape include a reduction in mountain pine beetle populations and habitat, a more diverse forest that is more resilient to insect and disease attacks, improved habitat conditions for wildlife, reduced threat of wildfire and potentially increased biodiversity.

The long-term landscape level management plan includes prescribed burns that create a mosaic of different stand ages and species across the landscape that are unfavourable for future large outbreaks of bark beetles (Hughes 2002). These forest mosaics will coincide with ecological burn objectives and capping unit features for fire management objectives.

A management area along the eastern portion of Banff National Park has been identified for active management and control of the expanding MPB populations. In this area, Parks Canada is undertaking direct actions to manage the mountain pine beetle, including pheromone baiting; intensive monitoring, cutting and removal or burning of green attack trees; development of fire guards to safely implement prescribed fires and the use of prescribed fires to reduce beetle populations and habitat.

In Jasper National Park MPB populations are being controlled by cutting and removal of trees in lightly infested stands. If populations of MPB reach epidemic proportions then the strategy will be to shift to prevention and long-term habitat reduction strategies through the use of prescribed fire.

2.4.5.4 Restoration of natural fire cycles

The National Parks Act specifies the need for Parks Canada to protect natural processes as one of the first priorities of the agency. Management-ignited prescribed burning will contribute to park management plan objectives of achieving 50% of the long-term fire cycle in the mountain National Parks in order to maintain or restore fire as a natural process. In intensive fire management zones, management-ignited prescribed burning is the only way management plan targets will be achieved. In other zones, management-ignited burning may be employed in conjunction with modified suppression or monitoring of unplanned wildfires.

Fire cycle values calculated for each field unit provide a coarse target for prescribed burn extent within a ten-year planning cycle for fire management. In reality total-area burnt will be a combination of wildfires and prescribed burns.

2.5 Communications

Communications programming aims to foster public understanding of Parks Canada's approach to fire and build support for the fire management program in the mountain National Parks. The following five communication objectives were developed as part of a national fire information strategy:

1. Build and maintain public understanding and support for Parks Canada's fire management program – create broad public understanding and stakeholder awareness of the ecological role of fire and the public safety benefits of a fire management program.
2. Provide up-to-date information and opportunities for stakeholder and community input and involvement in Parks Canada's fire management program and communications activities.
3. Integrate fire management communications into national, regional and field unit communication strategies.
4. Create mechanisms for effective, efficient and consistent communication of fire ecology and ongoing fire management programs as well as fire-related emergencies and events across the system.
5. Create a cross-functional team approach to implementing fire management goals through communication.

2.5.1 Public Consultation

As per the Fire Management Directive 2.4.4 the development of the fire management plans in the mountain National Parks will engage communities, neighbouring jurisdictions, and the public during the creation of objectives and techniques for wildfire control and fire use, including such issues as smoke management (Parks Canada 2005). A public consultation on the objectives and perceptions of the fire management plans in the mountain parks will be conducted as part of this SEA process (see section 7.2).

During project planning and development public consultation is important for identifying overarching concerns and issues and sharing knowledge. Of particular importance is the public consultation process with First Nations stakeholders. First Nations people were the original "fire managers" in the mountain parks and have a wealth of knowledge of historical fire cycling and the ecological importance of fire. Traditional knowledge of resource harvesting practices, conditions optimal for medicinal plants, maintenance of fire dependent plants, and location of sacred sites is a valuable resource for improving current fire management practices.

At the project implementation stage, options for public involvement range from notification, to dialogue and even consultation. The type and breadth of involvement (e.g. local vs. regional stakeholders) will depend on the scale of the project and its potential impacts. Small projects like meadow burns will involve only notification of local stakeholders. Larger projects will require notification on a much broader scale. Fire management staff may also be required to engage the public in dialogue about these projects. Feedback might be sought through meetings with key stakeholders, or presentations to community councils, in order to ensure that key issues have been identified.

2.5.2 Public Education and Visitor Experience Opportunities

Public interest in fire-related issues tends to peak during a busy fire season, however there are many other opportunities during the year to deliver fire-related messages. The following activities help to foster support for the fire management program by providing information about the ecological role of fire, and the role of fire management in protecting public safety:

- **Non-personal media** incorporate fire management messages.
- **Interpretive programs** incorporate information about fire.
- Solicitation of **media coverage** for specific initiatives or projects (e.g. fire research, ecological restoration projects) allows Parks Canada to reach a broader audience.
- **Scientific publications** (e.g. journal papers, conference proceedings) inform the scientific community about ongoing fire-related research
- **Field trips** or **presentations** to community groups, schools, and other organizations, provide in-depth information to key local and regional audiences.
- **Staff orientations** at the beginning of each summer season provide frontline staff with accurate information about fire management.
- Other products, such as national fire management fact sheets, display components, field unit fact sheets, and web-based information help to deliver messages in a consistent manner.

2.5.3 Public Awareness

As stated in the Fire Management Directive 2.4.4 (Parks Canada 2005) under the 'General Principles' guidelines for Fire Prevention, Section I - Fire Occurrence Control: *"The occurrence of fires caused by humans may be reduced through education. Each park/site to which the present directive applies will, in concert with national, provincial, territorial, and private organizations, make their users aware of the fire danger and implement preventative measures aiming to reduce the likelihood of accidental fires. This must be done in a manner that explains the ecological role of fire."*

Public awareness refers to the prevention of human-caused non-prescribed fires through public awareness campaigns using appropriate media. It is accomplished through dissemination of information to the general public, businesses and concessions, media contacts, and through partnerships with other agencies. The media used may include television and radio spots, newspaper advertisements, posters, signs, public forums, interpretive tours, and personal contact. Media is used to convey information to the public regarding fire management programs in the Banff, Jasper and LLYK field units and to provide daily information about current and expected fire conditions during the fire season. When fire danger is high, regulations and visitor activity restrictions or guidelines along with the latest weather forecasts and fire danger information are communicated on a daily basis.

Awareness and education efforts will be focused on increasing park visitors and local residents' awareness and knowledge of fire danger and how to implement preventative measures aimed at reducing the likelihood of accidental fires.

3 ISSUES SCOPING AND IDENTIFICATION OF VALUED COMPONENTS

There are many issues with respect to the effects of fire and fuel management on natural resources, social and cultural resources, local economies and park users in the mountain National Parks at multiple scales. As part of the SEA a scoping exercise was completed to identify issues that need to be addressed at a strategic level.

3.1 Issues Scoping

There are many issues with respect to fire and fuel management and its effect on natural resources, cultural resources and park users in the mountain National Parks. For the purposes of this Strategic EA document, the following sources were used for issues scoping:

- Banff Fire Management Plan
- Jasper Fire Management Plan
- LLYK Fire Management Plan
- Parks Canada Questionnaire for Fire and Fuels Management SEA (see section 6.1)
- communications with Parks Canada fire management personnel
- internal survey of Parks Canada personnel
- public survey and workshops
- project level CEAA screening reports for prescribed burns and fuel reduction projects in the Banff Field Unit (as examples of project level issues and mitigations)

3.2 Valued Ecosystem Components

The scoping exercise revealed that the major effects and concerns of fire and fuel management are linked to broad, regional scale valued ecosystem components (VECs). There was a public consultation process conducted as part of the second phase of the SEA for fire and fuel management (see section 6.2). The information obtained through a public survey and workshops provided more information with respect to the social and economic issues surrounding the fire management program in the mountain National Parks.

3.3 Identification of Valued Ecosystem Components

The valued ecosystem components (VECs) which could be impacted by the fire and fuel management programs in Banff, LLYK, and Jasper Field Units have been identified using the following sources:

- project level CEAA screening reports for prescribed burns and fuel reduction projects in the Banff Field Unit (as examples of project level VECs)
- public and internal Parks Canada surveys on fire and fuel management conducted in the Banff and LLYK field units
- Parks Canada Questionnaire for Fire and Fuels Management SEA (see section 7.1)

The following list of Valued Components (VCs), both ecosystem and social, and are included in the discussion of project-level impacts and mitigation measures (section 4.0):

Ecological VECs

Wildlife – populations of species, wildlife habitat and rare species

Vegetation – population and communities of species, rare plants, old-growth

Landforms and soils – soil and soil properties, landscape heterogeneity

Aquatic systems and hydrological resources – populations of fish and invertebrates, wetlands, water quality and quantity

Invasive species – mountain pine beetle, bark beetle, non-native plants

Pollution – air quality, fuels, persistent organic pollutants

Social, Cultural and Economic VECs

Aesthetics- viewscapes, clean air, wildlife viewing

Public Facilities and Services- communities, built assets, utilities, pipelines etc

Public safety – safety of fire fighters, residents, and visitors

Cultural and heritage sites – identified significant cultural resources including First Nations traditional sites, world heritage sites

Socio-economic factors – livelihoods of people working in parks, commercial operations, provincial forest resources, neighbouring communities.

3.4 Climate Change

In addition to the VECs the scoping exercise also revealed that there are external factors that contribute to fire regimes in the mountain parks. Perhaps the most concerning external factor identified was climate change.

In 2000 Parks Canada gained an understanding of climate change and its probable impacts on each national park by commissioning a comprehensive literature review. In 2003 Parks Canada commissioned the generation of a database of probable climate changes according to several models and emission scenarios endorsed by the Intergovernmental Panel on Climate Change (IPCC). These studies are reinforced by climate change reports from the IPCC, the World Wildlife Fund, the Nature Conservancy, the World Commission on Protected Areas, international conferences and numerous scientific journals. From this literature, Parks Canada accepts that climate change has serious implications for the resources under its stewardship and for the conduct of its business (Welch 2006).

However, climate change is a global phenomenon and beyond the capacity of Parks Canada to mitigate directly. Nevertheless, Parks Canada is committed to taking action within various departments whenever possible to mitigate contributions to climate change and, perhaps more directly related to fire management, becoming aware of potential ecosystem changes that may result from climate change and consider options to mitigate negative impacts.

Climate change impacts can affect all aspects of fire management. As such climate change is addressed in various sections throughout the SEA. In general, it is accepted that climate change will contribute to a consistent annual warming trend with greater seasonal climate variability within the mountain parks (Welch 2006). The Government of Canada report From Impacts to Adaptation: Canada in a Changing Climate 2007 summarizes the spectrum of climate change impacts that relate to fire management.

Climate change is projected to increase the frequency, extent and severity of forest fires, (Macias Fauria and Johnson 2007) thereby reducing mean fire return intervals, shifting age class distributions towards younger forests (Johnson and Fryer 1989, Johnson 1992), triggering more frequent shifts from conifer to deciduous-dominated successional trajectories, and decreasing the amount of terrestrial carbon stored in the boreal forest (Lemmen et al. 2008).

Associated impacts are likely to include increased area burned, longer fire seasons related to the spring northward advance (and the progressive penetration of warm Pacific air into the continent) and the autumn southward advance of the polar front (Johnson 1992), increased intensity due to increased drying capacity of the air (Street 1989, Johnson 1993) and increased forest fire hazard - more and longer area closures and fire bans.

Climate change and associated impacts are considered throughout the SEA including the identification and evaluation of cumulative impacts of fire and fuel management.

4 IMPACTS TO NATURAL AND CULTURAL RESOURCES AND MITIGATION MEASURES

This section provides a strategic overview of the project-level impacts and mitigation measures for prescribed burning and fuel management as outlined for CEAA Environmental Screening reports (CEAA 2007).

Prior to the initiation of phase two of this project, one of the objectives of the SEA was to streamline the project level environmental assessment process for fire and fuel management activities by eliminating the need to address some issues repeatedly at the project stage. As such fire and fuel management staff in the three field units collectively determined the desired outcome of this analysis of impacts and mitigation measures. It was decided that the preparation of a comprehensive list of project level potential impacts (repetitive, small-scale impacts) and current mitigations would be a valuable asset to the fire management program in addition to the analysis of strategic environmental impacts discussed under the cumulative effects section (section 5.0). The individual project level EA process for prescribed burning and fuel treatment has proven to be time consuming and somewhat redundant within the mountain parks field units. A comprehensive reference list of potential effects impacts and mitigations for prescribed burns and fuel treatments below will assist in streamlining the process and reduce duplication across the field units.

A wide range of environmental factors including vegetation types, wildlife habitat, soil conditions, and water quality may be affected by prescribed burning and fuel management projects. For each prescribed burn and fuel treatment within the mountain parks an environmental screening report (ESR) is required by Parks Canada under the Canadian Environmental Assessment Act (CEAA). An ESR outlines the potential project level impacts on wildlife, vegetation, landforms, aesthetics, public safety, cultural resources and socio-economic parameters and details mitigation measures to avoid, reduce or eliminate potential negative environmental effects.

The comprehensive list that appears in this section is a preliminary assemblage of the common project level impacts and mitigations that have been continuously referred to in prescribed burn and fuel treatment ESRs from the three field units is outlined below. The effects impacts and mitigations have been pulled directly from ESRs for prescribed burning and fuel management in the Banff, Jasper and LLYK field units and inserted verbatim, organized under standard ESR headings. Examples of useful ESRs are listed at the beginning of each section.

It is critical to note that this is not an exhaustive list of all potential effects impacts and associated mitigations related to fire and fuels management; rather it is a “first attempt” at developing working a reference tool for improving project level ESRs. Additional research will be required in any ESR to ensure that all potential impacts and mitigations are covered for each specific project as site specific impacts and mitigations may differ from site to site. It is recommended that this list be periodically re-evaluated to ensure the impacts and mitigations are up-to-date and accurate.

For wildlife, the list will not cover site specific impacts and mitigations that may differ from site to site. If this reference list is to serve as the guiding document for ESR development, critical site specific effects and mitigations may be overlooked.

An alternative approach could be to develop an ESR framework for project level fire and fuels management that serves as a comprehensive guideline or check list. This document could be developed as a template that includes all of the appropriate headings for an ESR, includes the common effects and mitigations related to prescribed fire and fuels treatment, and also include instructions under each heading for ensuring that other site specific effects and mitigations are included. This would not only assist in streamlining of the ESR process, but would also provide a failsafe method for writing ESRs that ensures consistency, saves time, and allows for site specific issues to be dealt with properly.

4.1 Wildlife

4.1.1 Prescribed Fire Impacts

Short-term effects to wildlife include habitat disturbance on the site in the form of people, equipment, and helicopter operations as well as the immediate loss of habitat from burning. These activities have the potential to induce avoidance behaviour and displace species from preferred forage or travel routes.

Prescribed burning may also result in direct wildlife mortality due to potential conflict through surprise encounters with people, or attraction to staging area food and waste, although research suggests that more mobile species are often able to avoid the effects of fire. Larger mammals have a better ability to avoid burning operations. Small mammals may be more directly affected and not be able to move out of the burn area.

Long term effects include meeting the primary burn objectives and altering habitat. Habitat changes over time should mimic historic habitat fluctuations and favour wildlife species adapted to these historic fire regimes. In the long term wildlife species assemblages should respond positively to the historic fire regime habitat types.

Grizzly Bears

Increased high quality habitat for the existing grizzly bear population, fire is a key factor in creating open habitats rich in food sources for grizzly bears.

Large Carnivores

Wolves that rely on prey species such as ungulates and other browsers will benefit indirectly from increased post-fire forb, grass, and shrub production.

Active wolf dens sites within the project area could be impacted.

Wolverines may be displaced for a short period as a result of disturbance associated with burning activities. However, the long-term effect of fire on the wolverine population may be positive because burned areas can increase the food supply for wolverines.

Habitat suitability for lynx is improved by post-fire changes in landscapes including the increased presence of young stands of pine and a scarcity of old-growth forest communities.

Birds

There are potential negative effects of prescribed fire to nesting birds including loss of nesting grounds and wintering habitat.

4.1.2 Fuel Management Impacts

Guard building operations will create a new short-term disturbance on the site in the form of people, equipment, and possibly helicopter operations.

The potential short-term effects are local displacement of species from preferred forage or travel routes, shade loss of breeding habitat in standing water areas, loss of food to fire, and potential conflict through surprise encounters with people.

For birds and amphibians, tree removal has the potential to remove nests or nesting cavities, and reduce shading of standing water areas where amphibians would be breeding.

Increased palatable forage for ungulates.

Fragmentation of largely contiguous forest and disruption of wildlife corridors.

Logging has little overall effect on the number of bird species in a forest (species richness) but may lead to a reduction in species that inhabit habitats in mature conifer forests in favour of those bird species that are generalists.

Logging and thinning for fuel management may cause a decline in cover of mature conifer forests on the landscape which provide important winter habitat for many species of birds.

Fish species may be negatively impacted by silting and slumping of creeks and streambeds from the use of heavy machinery.

4.1.3 Mitigations

Helicopter traffic will be minimized by avoiding, when possible, any areas where wildlife is observed. Where air traffic is unavoidable, pilots will be instructed to minimize impact by maintaining as much distance as possible from wildlife by altering flight lines. Flights will be of two types: low elevation and high elevation. The low level flights will include any crew/equipment moves, fire behaviour monitoring, and ignition and suppression operations. High-level flights will be for Incident command and observation platforms. Direct low-level operations will be minimized through a thorough team briefing of objectives and 'Stop and Go' triggers prior to the operation. Ignition strategies are focused on patterns that should not trap the large mammals.

Burning parameters have been designed to reduce fire severity which should allow small mammals a better survival rate within underground homes.

No food or garbage will be left unattended on site outside of wildlife proof containers.
The residual effects should be minimal (very low probability of direct or induced mortality and no permanent alienation of individuals from established territories of identified species). The long-term effect of carnivores at the individual and population level should be favourable as a result of fire-induced changes to vegetation favouring bear foods and improved habitat quality.

Plan activities in early spring to reduce impacts to breeding and nesting birds.

Work duties will be maintained during a regular 10-hour day shift to avoid the crepuscular movements of many mammals of the region.

Plan project outside expected breeding and nesting season of birds.

Identified wildlife trees (those containing nests or tree cavities) will be buffered in terms of tree removal and burning. Only conifer trees of greater than 5cm diameter at breast height (DBH ~ 1.3m) will be removed, and only limbing of larger conifers (>5cm DBH) will occur within 25m of any identified wildlife trees.

Mature Poplars and Aspen (>5cm DBH) will not be removed aside from standard right of way and boundary width clearing maintaining future wildlife habitat potential.

Trees on southeast, south, southwest, and west sides of standing water that provide shade for standing water will not be removed to protect amphibian breeding sites.

An unthinned buffer will be left along park boundary where hunting activity takes place to ensure that preferred grazing and browsing habitat is not created close to the boundary and the ease of detection is not increased.

Pattern of thinning has been designed to maintain a vertical and horizontal vegetation cover and greater diversity in seral communities.

Bears

Bear food habitat attributes will be monitored to assess the impact of the prescribed burn on bear foods.

Standard Bear Management protocol regarding temporary area warnings and closures related to seasonal use will be followed. Should Grizzly Bear use increase to the point that potential bear-human conflicts become a concern.

Wolves

The fall burn window is considered to be a mitigation to reduce possible short- term impacts to wildlife such as wolves that are more sensitive to disturbance during denning season.

The prescribed burn will not take place during the critical spring kidding season (Mountain Goats), lambing season (Big Horn Sheep).

Helicopter pilots will be made aware of potential Mountain Goat locations and flight paths will be adjusted. Any sightings will be noted and made available to all helicopter pilots to ensure minimum disturbance.

Birds

Work that involves any clearing and burning within 250m of active owl nests will occur during December and January.

Retention of residual patches in cutblocks to help maintain and possibly enhance songbird populations.

See:

Ferguson, C., I. Adams, B. Low, and I. Pengelly. 2001. Environmental Assessment of Fire Management in the Cascade/Bow Ecological Management Area, Banff National Park. Parks Canada, Banff, AB.

Golder Associates. 2005. Screen Report for the Lake Louise Community Wildfire Protection Project, Banff National Park, Lake Louise Field Unit. Golder Associates, Calgary, AB.

Parks Canada. (200-). Environmental Screening for the Redstreak Ecological Restoration in Kootenay National Park. Parks Canada.

Parks Canada. 2006. Environmental Screen for the Mt. King Prescribed Burn, Lake Louise, Yoho, Kootenay Fire and Vegetation. Parks Canada.

Sharp, B. 2007. Environmental Assessment Screening Report for Henry House II Prescribed Burn, Jasper National Park. Parks Canada, Jasper, AB.

Westhaver, A. 2003. Environmental Screening Report, FireSmart - Forestwise Community Protection and Forest Restoration Project, Foothills Model Forest, Jasper National Park. Parks Canada, Jasper, AB.

4.2 Vegetation

4.2.1 Prescribed Fire Impacts

Altered vegetation structure due to fireguard construction and prescribed burn. This is considered to be a positive ecological change as the dominant forest disturbance process in the project area is fire and the subsequent re-generation will be highly productive. The regeneration of many of the plant species found in the project site is dependent on periodic fire. The prescribed burn component is expected to initiate ecological renewal by renewing the successional process of the forest.

Until the canopy closes, there will be an expected increase in growth of grasses, forbs and shrubs. As the canopy closes these will decrease and the coniferous trees will be the dominant vegetation on the landscape.

Reduction in fuel loadings and an increase in understory herbage production resulting from microsite changes in light and temperature on the forest floor.

Species compositions will change as will the age class of the forest. Given the type of burning and season of work, many species on the open grassy slopes will survive via protected underground growing points (grasses and shrubs). Rapid regrowth of these life forms is predicted.

There is potential for non-native and noxious weeds to establish in disturbed areas.

There are potential impacts to rare vegetation species.

Planned ignition patterns should provide neutral to positive effects on existing whitebark pine populations.

Burning at higher intensities in riparian or upper sub-alpine areas could create a negative situation for associated vegetation communities.

The most visible impacts of the guard will be a reduction in fuel loadings and an increase in under story herbage production resulting from microsite changes in light and temperature on the forest floor.

Deciduous species will flourish from the crown canopy being removed, and with more light reaching the forest floor.

Many species of deciduous trees and shrubs, grasses and sedges will survive via protected underground growing points such as roots, rhizomes, layering and root collar or stump buds.

Revegetation by species that favour exposed soils may be slower in areas where slash material has been chipped and left on site and where decomposition rates are slower due to lack of moisture.

The propagation of non-native weed species is more likely when mineral soil is disturbed.

Windrow after thinning due to increased penetration of winds within the stands.

4.2.2 Fuel management Impacts

Stand thinning will reduce tree densities. The residual trees may be more susceptible to blow-down due to the opening of the canopy.

Altered ground layer species composition and structure in favour of shade intolerant herbs and forbs.

Increased light to the ground surface with subsequent propagation of shade intolerant species.

Increased biomass of berry species and native grasses.

4.2.3 Mitigations

Identify fire behaviour parameters to reduce undesirable effects to vegetation.

Ensure that outlined prescriptions are met and not exceeded.

If observed fire behaviour or weather conditions deviate from the prescribed effects, unit treatment will be altered or halted until the correct conditions prevail.

If whitebark pine is located within the affected area it will be documented and this information will be passed along to the Park Ecologist.

Ignition around whitebark pine will be done to ensure a surface burn, where possible, which would prepare a viable seedbed surface. No whitebark pine will be mechanically damaged or removed. Whitebark pine monitoring plots will be placed to determine the impacts of fire on the existing whitebark pine population and on whitebark pine regeneration.

The area will be monitored to manage the potential incursion of non-native species and noxious weeds.

Weed control will be carried out, and propagation of non-native weed species will be avoided by the washing of heavy equipment prior to the commencement of work.

Trees will be individually selected for elimination, to facilitate identification of clumps with high loads of surface fuels, or "jackpots", which have high potential to initiate crown fire.

Small areas of thermal and hiding cover will be retained within the forest in addition to the larger wildlife movement corridors.

Felling tree operations will be conducted so as to maintain existing distributions and patterns of understory vegetation.

Information on post-thinning successional patterns will be collected during the monitoring phase of the project.

No areas containing rare or endangered plant species will be impacted.

Thinning patterns will be modified in exposed ridges and shallow soil horizons to prevent windthrow. Clearings will be kept as small as possible. Minor windthrow will be tolerated in the fuel break area, but a major event will be cleared.

If observed fire behaviour deviates from the desired fire behaviour and fire effects, unit treatment will be halted until the correct conditions prevail.

Burning conditions are planned for reduced severity fire thereby protecting root zones of herbaceous and shrub layers.

Fuel removal projects will occur while the ground is frozen to reduce vegetation and soil damage.

Poplar and other deciduous trees and large shrubs will not be removed except along the designated widths previously approved for the right-of-way and for park boundary delineation.

Mechanical thinning will not be used in steeper areas, which will be hand thinned.

Maintenance of fuel breaks through repeated burning should limit the need for fire suppressions within the fire management unit. If fire suppression is necessary, the effects (dozer trails, hand built fireguards, helicopter landing pads, retardant drops, and fire camps) will be minimized where possible, and rehabilitated as much as possible prior to demobilising the fire crews.

Effects of fire on herbivory will be monitored at wildlife exclosures, and if grazing and browsing of recently burned habitats is determined to be excessive and undesirable, burning in these areas will be discontinued until browsing and grazing pressures are low enough to permit successful regeneration.

Implement pre-treatment vegetation plots in the proposed treatment area if possible to gather detailed information on post-thinning vegetation succession patterns. This should include rare plant surveys.

See:

AXYS Environmental. 2007. Environmental Screening of the Upper Saskatchewan Prescribed ***Burn, Kootenay/Yoho/Lake Louise Field Unit, Banff National Park. Jacques Whitford AXYS Ltd., Calgary, AB.***

Ferguson, C., I. Adams, B. Low, and I. Pengelly. 2001. Environmental Assessment of Fire Management in the Cascade/Bow Ecological Management Area, Banff National Park. Parks Canada, Banff, AB.

Parks Canada. 2006. Environmental Screen for the Mt. King Prescribed Burn, Lake Louise, Yoho, Kootenay Fire and Vegetation. Parks Canada.

4.3 Landforms and Soil

4.3.1 Prescribed Fire Impacts

Scope of the changes occurs outside of the historic disturbance regime for this area.

Certain fire behaviour can lead to high severity impacts to local soils essentially creating a less than optimal growth medium.

Fire disturbances remove trees, exposing soil to sunshine and allowing sun-tolerant species to re-establish themselves and potentially the invasion of weed species.

Impacts on soil processes may be significant due to increased fuel involvement, intensities and fire residence times. Soils can be sterilized by intense heat. Fire can also reduce soil structure and porosity, which changes soil moisture and temperature regimes.

On slopes where protective vegetation or debris have been consumed or killed by fire, soil can erode even without heavy rains, due to the sheer force of gravity.

Reduction in organic matter content of soil.

Loss of soil structure and porosity.

Changes in soil moisture and temperature regimes.

4.3.2 Fuel Management Impacts

During fireguard construction soil disturbance will be negligible. Mineral soil may be exposed in places where slash is burned at higher intensities, maximizing organic layer involvement due to smouldering.

Removal of vegetative cover can cause landforms to erode on steep slopes. Soils can be lost to erosion.

Heavy machinery can compact soils reducing permeability, restricting water filtration, aeration, and root growth.

Removable of trees exposes soils to sunshine allowing for sun-tolerant species to re-establish themselves, and may potentially expose soil to invasion by weed species.

4.3.3 Mitigations

Reducing compaction by restricting machinery to predetermined skid trails or protecting soil with a layer of slash or snow.

Burning conditions are planned for reduced severity thereby protecting soils, root zones of herbaceous and shrub layers which stabilize soils.

Downed medium and large woody debris, which will be left in place, will act as erosion bars in steeper terrain, provide habitat and a long term source of soil nutrients.

Enforcing prescription parameters to result in a range of fire intensities over the burn area will mitigate the potential for this issue. This will be monitored utilizing Fire Severity monitoring protocol.

Fuel supply and removal equipment will only be employed while the ground is frozen

The use of landings will reduce the need for road cuts. Short sections of sidehills (<50m) may require modification by cut and fill to provide a level surface for log trucker or skidders. However, extensive (>50m) cut and fill will be avoided.

Where mineral soil is exposed or rutted, the contractor will be responsible for re-contouring, scarifying, rehabilitation and re-seeding the areas with approved native grass seed.

If necessary, small trees will be transplanted where adequate screening or understory cover does not exist.

Methods of mechanical removal will vary depending on steepness of terrain. On slopes greater than 35 degrees winter burning procedures will be implemented and no heavy equipment will be permitted to access these areas.

Schedule logging for winder, when the ground is frozen, to reduce compaction of soils and damage to coarse woody material.

The use of machinery on steep slopes will be avoided to minimize disturbance to soils and to reduce the chance of slumping.

Cutting and hauling of tress will be scheduled for winter months when the ground is frozen, to minimize Impacts of heavy machinery on soils.

Layout and thinning pattern requires no crossing of permanent streams and leaves a minimum undisturbed buffer of 75 metres around all sensitive areas.

See:

AXYS Environmental. 2007. Environmental Screening of the Upper Saskatchewan Prescribed Burn, Kootenay/Yoho/Lake Louise Field Unit, Banff National Park. Jacques Whitford AXYS Ltd., Calgary, AB.

Ferguson, C., I. Adams, B. Low, and I. Pengelly. 2001. Environmental Assessment of Fire Management in the Cascade/Bow Ecological Management Area, Banff National Park. Parks Canada, Banff, AB.

4.4 Aquatics and Hydrological resources

4.4.1 Prescribed Fire Impacts

The potential exists for hydrocarbons used for ignition operations and for power equipment to enter and impact aquatic resources within the project area and downstream.

Possible effects of the prescribed burn on streams include: increased peak spring discharge; increased total annual discharge; greater storm flows, increased base flow caused by vegetation removal. Increased surface flow along with ground ash and debris can cause increased sedimentation, turbidity, and water temperatures which could affect fish.

Fire and its hydrological effects can contribute wood and course sediment that is necessary to create and preserve productive fish habitat

Potential for increased mercury levels in post fire fish populations. The larger, predatory bull trout are more likely to bioaccumulate mercury due to their position in the food web.

Amphibian breeding habitat could be affected by the removal of shade cover over standing water areas.

4.4.2 Fuel Management Impacts

Stream or river crossing activities (built structures, temporary structures) may interfere locally with fall spawning fish.

Snow accumulation is primarily affected by total snowfall, interception and evaporation by vegetation, and deposition or erosion by wind. In sheltered areas, snow accumulation will increase. In wind-exposed areas accumulation due to decreased interception by vegetation may be lost by wind erosion and/or sublimation back in to the atmosphere.

Spring snow melt is more rapid in large natural forest opening than under that forest canopy. Therefore, snow melt will probably be more rapid in clearings but may be slower in thinned areas where snow has accumulated due to decrease in interception by tree canopies.

Reduction of vegetation will result in a general decrease in interception and evapotranspiration which will result in increases in soil moisture, however, increased exposure to sun and wind will exert an increased drying effect. Overall it is anticipated that south and west facing slopes will be drier, while north facing slopes will be wetter after fuel reduction.

4.4.3 Mitigations

During the ignition phase of the prescribed burn ignition pattern will be adjusted to apply lower intensity fire to riparian areas and forested vegetation immediately adjacent to creeks. Backing fire may creep into these areas, but high intensity, stand-replacing fire will be minimized. This should reduce riverbank soil erosion and cover and shade loss along reproductive stream and riverbeds and provide for sediment recovery.

During the burn process use of foam, fuel for ignition devices and power equipment in close proximity to water resources (surface and groundwater) will be avoided to reduce the risk of contamination. Any use of foams or ignition fuels in other areas will be minimized.

No work will occur in any areas where soils are saturated or have standing water except during the frozen period of late November to January.

No mechanical activities will be used that would disturb the soil, and create siltation concerns.

During the burn process, use of foam and torches in close proximity to ground water sources will be avoided to reduce the risk of contamination. Any use of foams or ignition fuels will be minimized.

No guard burning activities or mulch material will be located on or within 25m of any standing or running water; burn piles will not be located over frozen open water.

Trees on southeast, south, southwest, and west sides of standing water that provide shade for standing water will not be removed to protect amphibian breeding sites.

Enforcing prescription parameters so as to result in a range of fire intensities will mitigate sedimentation effects from steeper high elevation run-off sources. This will be monitored utilizing Fire Severity monitoring protocol.

Fish bearing pools will be assessed immediately pre-burn to determine the presence/absence of breeding bull trout. If located, pools with breeding bull trout will be mapped and avoided for fire operations.

If required, helicopter bucket operations may be facilitated through the use of portable water reservoirs (donuts) instead of directly bucketing from the deep pools in the stream.

The helicopter staging/refuelling area will be located away from direct or runoff contact with any water bodies. Helicopter fuelling will be completed at the Parks Canada compound heli-base whenever possible.

A heli-torch testing site will be identified where any unburned gel can be easily contained and collected for proper disposal.

Wherever fuel is used or stored, it will be contained in fuel berms with the appropriate spill kits onsite. Where fuel spills do occur, appropriate measures will be taken to promptly remove the contaminant.

It is not necessary to cross permanent streambeds. Intermittent stream crossings will be made only when the water is frozen.
A spill kit of sufficient size to contain and clean up 110% of the site's largest possible fuel/chemical spill must be retained on site at all times. All personnel on site must be aware of the kit, its location and proper use.

Portable privies will be used at the staging areas. As a result, there should be no issues with sewage management, given that the sewage will be self contained and disposed of at a sewage treatment plant.

See:

Golder Associates. 2005. Screen Report for the Lake Louise Community Wildfire Protection Project, Banff National Park, Lake Louise Field Unit. Golder Associates, Calgary, AB.

Parks Canada. 2006. Environmental Screening for the Baker Creek Prescribed Burn, Lake Louise, Yoho, Kootenay Fire and Vegetation. Parks Canada, Banff National Park.

Parks Canada. 2006. Environmental Screen for the Mt. King Prescribed Burn, Lake Louise, Yoho, Kootenay Fire and Vegetation. Parks Canada.

4.5 Pollution

4.5.1 Prescribed Fire Impacts

Local air quality may be temporarily compromised due to the production of smoke and airborne particulate matter resulting from combustion of fuels within the unit.

Smoke produced from burning operations in the form of a moderate to heavy column. Smoke distribution is expected to affect a distance of up to _____km based on the size and type of burn. The largest concerns are with particulate matter, which stay suspended in the atmosphere and can cause respiratory problems especially to those who are sensitive. The particles can also act as nuclei and enhance the formation of fog which is a primary concern along major highway corridors

Local air quality will be temporarily compromised due to the production of smoke and airborne particulate matter resulting from combustion of fuels within the unit and exacerbated by the influence of temperature inversions.

Hydrocarbons in the form of fuel for mechanical hand tools, hand torches and helicopters could potentially be another pollutant.

Aerial and hand-held ignition devices will be used during this operation. All hydrocarbons leaving these devices are burned off by design.

4.5.2 Fuel Management Impacts

Fuel reduction through piling and burning live and dead vegetation might result in reduced visibility and smoke in the valley bottom areas during fall and winter as smoke is often trapped near the ground due to temperature inversions in the atmosphere.

4.5.3 Mitigations

If weather conditions change and indicate that there may be a potential for an inversion, then ignition will be continued to allow sufficient time for the majority of ignited fuels to burn out.

Atmospheric conditions will be monitored to ensure the prescribed fire takes place when dispersal of smoke and airborne particulate matter are optimal.

Fuel load will be reduced by burning outside the active growing season.

Residual smoke impact will be minimized by: isolating fuel concentrations that have the potential to burn for long periods using natural and manmade barriers, or by spreading fuels; rapidly extinguishing fires reducing smouldering emissions; and burning with lower drought code values.

Any burning will be adequate to allow for good venting and to reduce the amount of burning material continuing into the evenings. Surrounding roads will be monitored during ignition operations and appropriate authorities will be notified if there are any expected concerns. Signs stating Prescribed Fire in Area will be posted during the project.

An electronic sign stating “Smoke in Area, Drive with Caution” will be posted on the westbound lanes of Highway 16, and sandwich board signs will be placed on the eastbound lanes. A second electronic sign will be placed on the eastbound lanes if it is required

Monitoring equipment will be available for monitoring smoke locally, with information also being collected at affected sites downwind as applicable, in order to determine smoke distribution.

Environment Canada will measure chemical composition of smoke close to the source and in a site representative of downwind affected communities.

Atmospheric conditions prescribed for unit treatment should provide for effective dispersal of smoke and airborne particulate matter.

Temporary compromises in air quality resulting from the influence of temperature inversions are possible and are deemed tolerable due to their short period of existence.

Any burning operations will be adequate to allow for good venting and to reduce the amount of burning material continuing into the evenings. Highway 16 will be monitored during ignition operations and the Highways supervisor will be notified if there are any expected concerns.

If smoke production from burning operations is sufficient the Regional Transport Canada air traffic control authority.

As much as possible, park managers will try to restrict burning to periods when the conditions for smoke dispersal are most favourable, primarily during the spring and early summer when the atmosphere is unstable thereby allowing smoke to rise above the valley bottom.

Portable privies will be used at the staging areas. As a result, there should be no issues with sewage management, given that the sewage will be self contained and disposed of at a sewage treatment plant.

Power tools, hand drip torches and helicopter torches will be in good working order. Equipment will be inspected daily for fluid/fuel leaks and kept in good working order. In the event of any fuel/lubricant leaks, absorbent material will be provided for clean up.

A spill kit of sufficient size to contain and clean up 110% of the site's largest possible fuel/chemical spill must be retained on site at all times. All personnel on site must be aware of the kit, its location and proper use.

See:

Parks Canada. (200-). Environmental Screening for the Redstreak Ecolgoical Restoration in Kootenay National Park. Parks Canada.

Sharp, B. 2007. Environmental Assessment Screening Report for Henry House II Prescribed Burn, Jasper National Park. Parks Canada, Jasper, AB.

Shepherd, L. 2006. Environmental Assessment Screening Report, Hawk Mountain Prescribed Burn, Jasper National Park. Parks Canada, Jasper, AB.

Westhaver, A. 2003. Environmental Screening Report, FireSmart - Forestwise Community Protection and Forest Restoration Project, Foothills Model Forest, Jasper National Park. Parks Canada, Jasper, AB.

4.6 **Aesthetics**

4.6.1 Prescribed Fire Impacts

Local aesthetics will change as a result of prescribed fire. Blackened area interspersed with a mosaic of green islands and fingers of mature vegetation.

To some visitors the burnt area may be seen as a negative visual effect representing loss of trees to fire; to others concerned about fire safety, mountain pine beetle or ecological renewal it may be seen as a positive visual effect and still to others it may not even be noticed. Visual effects will diminish over time as the burn area greens up.

Noise disturbance to visitors and residents due to helicopter use.

Short-term sensory impacts for some local residents and visitors to the area.

4.6.2 Fuel Management Impacts

Logging activities will inevitably generate noise and industrial activity, neither of which is compatible with park visitor’s desire for a natural and relaxed experience.

Forest thinning opens up vistas previously concealed by dense timber.

On the valley floor, fuel reduction will create a park-like woodland with more open meadows and more variety of plant species. Wildlife viewing should also improve.

4.6.3 Mitigations

Communication and education program will be implemented to help residents and visitors understand the role of natural disturbances on the landscape and clearly outline how the fire meets Parks Canada management objectives.

The communication program will provide information to the local media outlets to communicate these points.

A communications strategy has been developed to educate park visitors about the ecological importance of fire to habitat renewal.

In areas where felling and bucking operations will be concentrated, efforts will be made to reduce the visual impact with strategic falling practices including cutting stumps as low to the ground as feasible.

Signs stating Prescribed Fire in Area will be posted during the project. Informational signage will also be posted prior to and after the burn.

To mitigate helicopter disturbance to visitors helicopter staging areas and have been strategically pre-planned to minimize disturbance to motorists and other users of the Park.

Schedule activities for fuel treatment (logging) for the low season, in areas not visible from roads, and areas that receive infrequent visitation.

Depending on proximity to human use areas, downed material from steep slopes may be more effectively removed by helicopter than piling and burning or hauling it with skidders.

See:

Golder Associates. 2005. Screen Report for the Lake Louise Community Wildfire Protection Project, Banff National Park, Lake Louise Field Unit. Golder Associates, Calgary, AB.

Parks Canada. (200-). Environmental Screening for the Redstreak Ecolgoical Restoration in Kootenay National Park. Parks Canada.

Shepherd, L. 2006. Environmental Assessment Screening Report, Hawk Mountain Prescribed Burn, Jasper National Park. Parks Canada, Jasper, AB.

4.7 Public Facilities and Services

4.7.1 Prescribed Fire Impacts

While no public facilities are directly affected in any prescribed fire, there is always the risk of an escaped fire. The operation would then switch over to a wildfire suppression operation and the tactics and strategies in place would be implemented.

Temporary closures or access limitations to surrounding airports, trails and huts may result.

Positive long-term effect on public facilities and services by protecting facilities from wildfire through the enhancement of natural fire barriers

Some disruptions to public services such as temporary area closures during the prescribed burn phases.

Major highways may be affected periodically by smoke from burn piles or from the prescribed burn.

Area closures will be well documented in the Communications Plan for the burn and posted throughout public areas and information centres as per standard operating procedure. Area and trail closures will be lifted at the earliest possible time as per the discretion of the Incident Commander's threat assessment in order to limit the time frame of the closure and impact to Park visitors.

Flagging crews will be hired to mitigate smoke related traffic issues on major highways.

4.7.2 Fuel Management Impacts

Enhance wildlife viewing by creating habitat, previous obscured scenic vistas and woodland will be opened up, and ecological health will be restored to a portion of the mountain parks.

4.7.3 Mitigations

Signs stating Prescribed Fire in Area will be posted during the project. Informational signage will also be posted prior to and after the burn.

Duration of area closures will be limited to the duration of fire activities and will be reopened as soon as possible and safe to do so.

All line leaseholders will be contacted prior to any fire ignition that may affect their holdings. The companies may wish to have a liaison officer on site during burning operations.

See:

Golder Associates. 2005. Screen Report for the Lake Louise Community Wildfire Protection Project, Banff National Park, Lake Louise Field Unit. Golder Associates, Calgary, AB.

Ferguson, C., I. Adams, B. Low, and I. Pengelly. 2001. Environmental Assessment of Fire Management in the Cascade/Bow Ecological Management Area, Banff National Park. Parks Canada, Banff, AB.

Westhaver, A. 2003. Environmental Screening Report, FireSmart - Forestwise Community Protection and Forest Restoration Project, Foothills Model Forest, Jasper National Park. Parks Canada, Jasper, AB.

4.8 Public safety

4.8.1 Prescribed Fire Impacts

Smoke will likely affect driving visibility on surrounding highways. This impact is most likely to occur in the evenings, overnight and in the early morning with inversions causing smoke to pool and remain on the valley floor.

Conducting the prescribed burn poses risk to public safety if the fire escapes beyond its perimeters or exposes major highways to excessive smoke.

It is possible that highway motorists may become distracted or create traffic congestion by stopping on the highway to view or take pictures.

Smoke exposure can cause health impacts varying with exposure time and personal sensitivity to smoke. Smoke exposure for sensitive individuals could have negative impacts. Smoke generated from small projects, like this, is of relatively short duration and manageable compared to wildfires.

4.8.2 Fuel Management Impacts

Increased risk to vehicular traffic from logging truck entering, exiting and traveling on the roads and highways.

There is potential risk of injury to the public during thinning operation and from heavy equipment.

There will likely be an increased risk of blow down in the area due to thinning that will expose remaining trees to more wind.

Over the long-term, public safety should be enhanced for residents and visitors by reducing the threat of wildfire to communities.

4.8.3 Mitigations

Slowdowns or temporary closures will be implemented based on smoke conditions and highway traffic volumes at the discretion of the Incident Commander.

CP Rail will be advised of any visibility issues.

Ignition will be carried out when smoke venting conditions are favourable to smoke dispersal. Wind direction will be closely monitored to minimize impacts to traffic and communities/facilities downwind of the project.

Fall scheduling of the prescribed burn will limit undesired fire spread potential due to decreasing length of burn periods, regional susceptibility to precipitation and cooler weather with higher humidity, and lack of long-term holdover potential due to encroaching winter.

Ignition patterns used during burning will be designed to contain fire within pre-defined parameters through convective involvement and intensity manipulation. Although unlikely, if fire escapes the containment area, standard operational wildland fire fighting protocol will be applied.

Communications and public awareness, detailed in the Communications Plan for the burn, will be an important tool to ensure public safety.

Smoke will be monitored and every effort will be made to advise smoke sensitive individuals of the project.

Close the area to the general public to avoid risk of heavy equipment operations or tree-felling operations during fuel reduction operations.

Any skid trails that have the potential to attract hiker traffic in the future will be screened by planted trees to discourage use, and care will be taken to minimize the intersection of skid trails with existing hiking trails.

Signs at trailheads and access points will advise any trail users of fuel reduction activities and the need for caution in the vicinity of machinery.

Fuel reduction crews will be briefed on appropriate safety precautions, and the contractor will restrict access where tree-felling is in progress, or machinery is in use.

See:

Golder Associates. 2005. Screen Report for the Lake Louise Community Wildfire Protection Project, Banff National Park, Lake Louise Field Unit. Golder Associates, Calgary, AB.

Parks Canada. 2006. Environmental Screening for the Baker Creek Prescribed Burn, Lake Louise, Yoho, Kootenay Fire and Vegetation. Parks Canada, Banff National Park.

Westhaver, A. 2003. Environmental Screening Report, FireSmart - Forestwise Community Protection and Forest Restoration Project, Foothills Model Forest, Jasper National Park. Parks Canada, Jasper, AB.

4.9 Cultural Heritage

4.9.1 Prescribed Fire Impacts

There may be fire effects to vegetation and soils in a region with historical and/or cultural significance for First Nations communities.

Historical sites including heritage sites or sites with archaeological significance may be impacted by fire.

4.9.2 Fuel Management Impacts

Unidentified sites could be impacted by fuel treatment activities.

4.9.3 Mitigations

Parks Canada cultural resource managers will be consulted prior to guard or main unit ignition.

Consultation with the appropriate First Nations groups to identify the span of the cultural site of interest and to ensure any additional sites were located and marked. This consultation included a site visit to the area. The area that contains the valued cultural resource will have protection measures established around it through the use of sprinklers, black-lining, and altered ignition patterns will be employed to reduce the risk of fire spread into cultural sites. Such protection measures will be implemented prior to the guard or main unit ignition.

If any additional archaeological site locations are identified by Parks Canada cultural resource managers, groups representing First Nations, or are found during burn operations, they will be identified and protected.

All operational fire personnel will be made aware of cultural site locations and all reasonable precautions will be taken to protect cultural sites. They will be protected primarily with rotary- wing bucket support followed up by ground crews.

Any potential archaeological site locations found during the project will be identified and Cultural Resource Managers will be brought in for consultation. All fire personnel will be made aware of the location and every effort will be made to protect the site, both during felling operations and in the event of potential fire damage.

No grubbing or ground disturbance will be permitted within at least several meters of the sites.

Should any cultural resources be unearthed during site preparation, or discovered at any other stage of the project, work will be halted until the find is evaluated and a federal regulatory officer evaluates the site and issues clearance for the project to resume.

See:

AXYS Environmental. 2007. Environmental Screening of the Upper Saskatchewan Prescribed Burn, Kootenay/Yoho/Lake Louise Field Unit, Banff National Park. Jacques Whitford AXYS Ltd., Calgary, AB.

Shepherd, L. 2006. Environmental Assessment Screening Report, Hawk Mountain Prescribed Burn, Jasper National Park. Parks Canada, Jasper, AB.

Westhaver, A. 2003. Environmental Screening Report, FireSmart - Forestwise Community Protection and Forest Restoration Project, Foothills Model Forest, Jasper National

Park. Parks Canada, Jasper, AB.

4.10 Socio-economic impacts

4.10.1 Prescribed Fire Impacts

Short-term effect would be decreased numbers of smoke-sensitive visitors during the burn.

Long-term positive visitor experiences will result from a varied landscape with a potential increase in wildlife numbers and wildlife viewing potential as a result of prescribed burns.

There may be some small effect on hunting opportunities that exist just outside the park boundary.

4.10.2 Fuel Management Impacts

Fuel reduction will contribute in a small way to the local economy through hiring or labour, biologists, various sub-contractors, the purchase of materials and services, and the sale of firewood and merchantable timber.

There may be short term economic impacts to local businesses that result from the effects of prescribed fire and fuel treatment including smoke, restricted access, and reduced visibility.

4.10.3 Mitigations

Communications and public awareness will be an important tool to ensure visitors understand and value the overall objectives.

Time ignition and fuel treatment work taking into consideration stakeholder concerns to minimize impact.

See:

Parks Canada. 2006. Environmental Screen for the Mt. King Prescribed Burn, Lake Louise, Yoho, Kootenay Fire and Vegetation. Parks Canada.

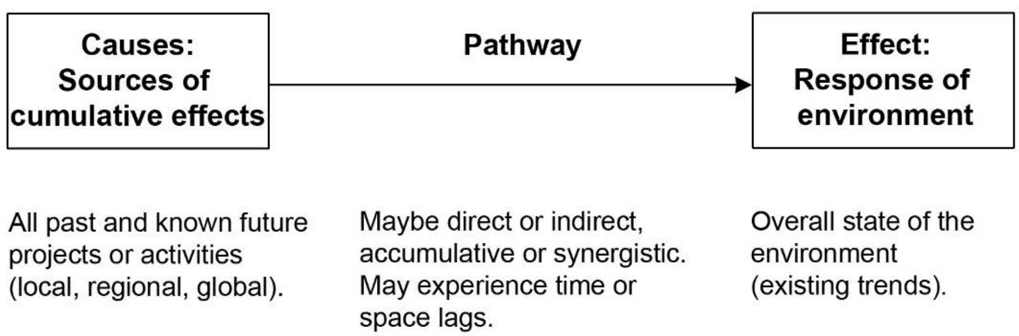
Shepherd, L., and R. Fingland. 2007. Environmental Assessment Screening Report for Fiddle River Prescribed Burn Complex, Phase I: Fireguard, Jasper National Park. Parks Canada, Jasper, AB.

5 CUMULATIVE EFFECTS ASSESSMENT

5.1 Introduction

Cumulative effects are changes to the environment that are caused by an action in combination with other past, present and future human actions (Hegmann et al. 1999).[1] Characterized as impacts on natural and social environments, cumulative effects occur so frequently in time or so densely in space that they cannot be "assimilated" and/or combine with effects of other activities in a synergistic and compounding manner (Sonntag et al. 1987). Cumulative impact assessments are most often undertaken to analyse cumulative negative effects on environmental parameters but cumulative effects can also be positive.

The cause, or source of stress, is the combination of all past, present and known future projects or activities which affect a given environment. These various stressors act upon the environment in different ways, sometimes through indirect or complex pathways. The environment will also respond in different ways, depending on its sensitivity and resilience. This process is illustrated in Figure 5.1.



Source: Kingsley, 1997.

Figure 5.1 A conceptual model illustrating cumulative effects.

Ultimately, the overall consequences (impacts) resulting from the combination of stressors, will determine the current state of the environment. Usually, this state will be somewhere on a scale between absolute integrity and total disaster (Kingsley 1997) Types of cumulative effects are shown in Table 5.1.

[1] Numerous definitions of cumulative effects exist in the literature. Many of these are quite complicated and refer to technical aspects of cumulative effect's interactions. This definition is intended specifically for single-project assessments as opposed to regional planning (in which case there is not necessarily a single project that serves as the starting point and focus of the assessment), and borrows the broad definition of "environment" as used in the Canadian Environmental Assessment Act. In this definition, "actions" include projects and activities. A Cumulative Effects Assessment (CEA) is an assessment of those effects. (Hegmann et al. 1999)

Table 5.1 A typology of cumulative effects.

Type	Main Characteristics
Time crowding	Frequent, repetitive and simultaneous impacts on an environmental resource
Time lag	Long delays between cause and effect
Space crowding	High spatial density of impacts on an environmental system
Cross-boundary movement	Impacts occur some distance away from source
Fragmentation	Change in landscape pattern
Compounding/synergistic effects	Effects resulting from multiple sources or impacts which may be different in nature from the individual impacts
Indirect effects	Secondary impacts resulting from a primary activity
Triggers and thresholds	Fundamental changes in system behaviour or structure
Nibbling	Incremental or decreasing effects

Source: adapted from Cooper 2004 (modified from Spaling 1994).

5.1.1 Cumulative Effects Assessment at a Strategic Level

Cumulative effects assessment (CEA) is a systematic procedure for identifying and evaluating the significance of effects from multiple activities. Cumulative effects assessment can be undertaken at different levels: the management plan/policy level and the project level. However, project-level environmental assessments (EAs) do not necessarily consider broad environmental degradation over many years, such as the impacts of cumulative effects over larger spatial and temporal scales. Addressing cumulative effects at a strategic level provides an opportunity to assess the implications of projects and/or activities and to fully evaluate alternatives and tradeoffs, including the need for subsequent alternatives, at a broader scale. Table 5.2 summarizes some characteristics of strategic CEA.

Table 5.2 CEA at a strategic level.

Aspects	**CEA at strategic level**
Focus	Impacts of plan options, policies and proposals combined with impacts from other plans
Purpose	Improve planning and assist environmental management
Context	SEA and planning process
Strengths	Proactive, early in planning process Can address actions not covered in EA regulations Can facilitate project EAs
Limitations	Analysis mainly qualitative Large number of variables Greater uncertainty

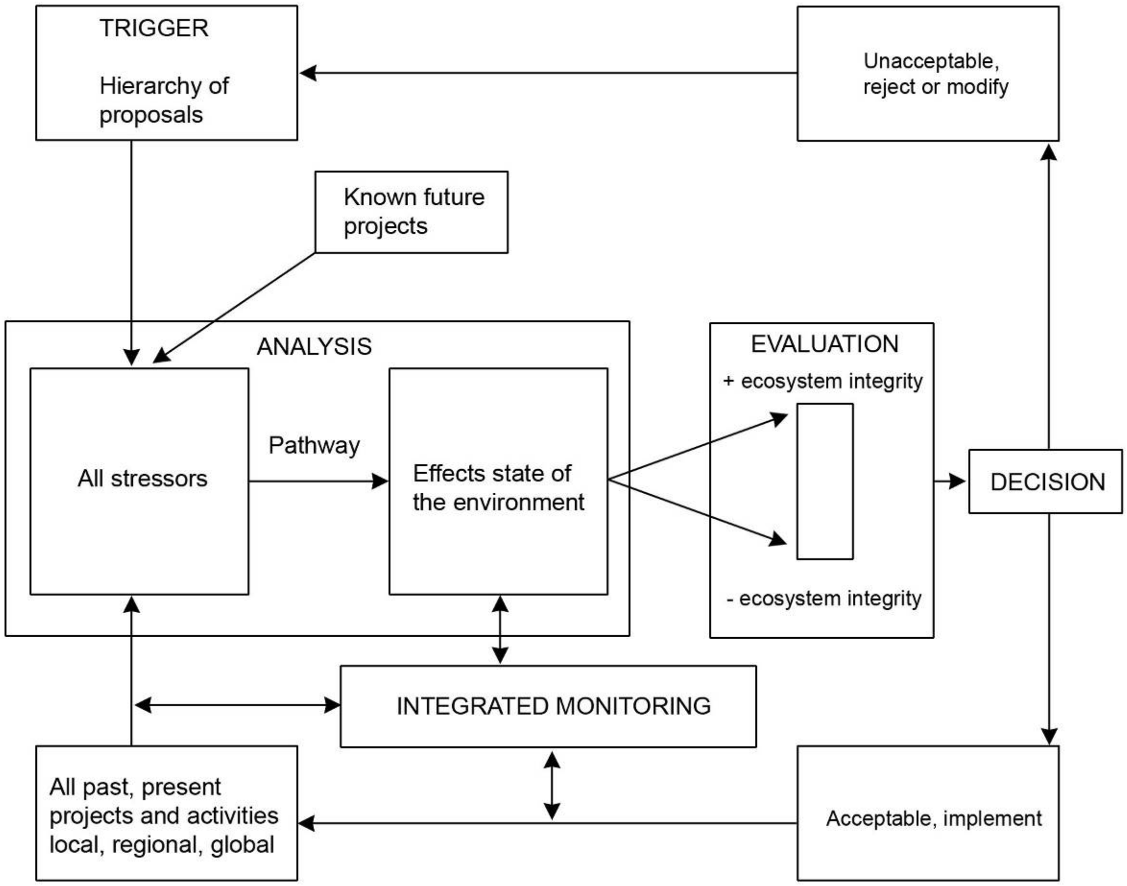
Source: Cooper 2004.

The process for conducting a CEA at a strategic EA level involves identifying, analyzing, and evaluating cumulative effects at a strategic level (Table 5.3). The decision making process for managing cumulative effects is iterative (Figure 5.2).

Table 5.3 CEA process at a strategic level.

Steps in CEA	**Tasks**
Scoping	Identify regional issues of concern Select appropriate regional valued ecosystem components (VECs) Identify spatial and temporal boundaries Identify other actions that may affect the same VECs Identify potential impacts due to actions and possible effects
Analysis of Effects	Complete the collection of regional baseline data Assess effects of proposed action on selected VECs Assess effects of all selected actions on selected VECs
Evaluation of Significance	Evaluate the significance of residual effects Compare results against thresholds or land use objectives and trends
Identification of Mitigation	Recommend mitigation measures
Develop Monitoring Program	Incorporate findings of cumulative effects into monitoring program
Propose Management Program	Report findings for development of an overarching management program

Source: Hegmann et al. 1999.



Source: Kingsley 1997.

Figure 5.2 A conceptual framework of a strategic CEA.

5.1.2 Cumulative Effects Assessment of Fire and Fuels Management

The incremental and compounding effects of historical fire management practices (exclusion) and current fire management practices (suppression, prescribed burning, fuel management) throughout the contiguous mountain parks is largely unknown. Project level EAs for fire and fuels management do not adequately deal with cumulative effects. There is a need for a CEA of fire and fuels management at a strategic level.

Fire can produce a spectrum of effects on environmental and cultural resources. Immediate and long-term responses occur. The effects can produce both positive and negative results. Assessing the cumulative impacts of past, present, and future fire management can assist in making fire and fuels management decisions within broad spatial and temporal boundaries in order to minimize the negative impacts of cumulative effects.

5.2 Purpose and Objectives of the CEA

5.2.1 Purpose

The cumulative effects of past, present and future fire and fuel management activities present a suite of regional ecological, social, economic and cultural concerns within the contiguous mountain parks. Identifying cumulative effects and the valued resources being affected is an important component of strategic environmental assessment.

The purpose of this CEA is to use the process outlined above to identify, analyze and evaluate the cumulative effects of past, present and future fire management regimes in order to determine the potential cumulative effects of fire management on selected valued ecological parameters within the contiguous mountain parks ecosystem at a strategic level and offer recommendations for monitoring and mitigating these impacts.

The cumulative effects of fire management activities, combined with other major land use changes such as loss of forest cover, increased development and increased human use should were also considered within this CEA.

5.2.2 Objectives

Specific objectives of the cumulative effects assessment include:

Objective 1

To identify, analyze and evaluate the cumulative effects of fire exclusion and fire suppression as fire management practices over the last 100 years (late 1890s to mid-1980s).

Objective 2

To identify, analyze and evaluate the cumulative effects of the current fire management program including prescribed burning and fuel management beginning in the 1980s and forecasting 10 years into the future.

5.3 Valued Ecosystem Components

The cumulative effects issues associated with fire and fuels management activities on the ecological, social, cultural and economic integrity of the contiguous mountain parks are complex and inherently interconnected. The CEA required the use of a detailed approach for examining the cause-effect linkages and the cumulative impacts of fire and fuels management on broad regional scale, valued components and processes.

Table 5.4 outlines VECs that were identified as broad regional scale valued environmental resources or components that may be affected by the cumulative effects of past, present and future fire management efforts in the contiguous mountain parks.

Table 5.4 Selected VECs

VEC	Descriptors
Biodiversity	wildlife and vegetation species diversity, landscape heterogeneity, habitat diversity
Terrestrial Ecosystem Health	tree stand health, soil dynamics, invasive species
Aquatic Ecosystem Health	watershed regimes, water quality, water quantity
Atmosphere	climate, air quality
Human Health and Safety	public health concerns, public safety, firefighter safety
Infrastructure and Built Assets	private and public buildings, campgrounds, park facilities, roads
Social and Cultural Values	traditional land uses, First Nations, heritage buildings
Economic Vitality	commercial operations, local business, economic development and stability

There are several benefits of using these VECs as a framework the CEA. These VECs are considered important by the public for environmental, social, cultural, scientific, aesthetic and economic reasons. These VECs also form the basis of the Ecosystem Integrity Monitoring Program being developed by Parks Canada (Parks Canada, Fire Ecology Unit in Calgary, in progress). By using these VECs as a framework for evaluating the cumulative effects of fire and fuels management, the broad scale issues identified by the public as potential concerns can be systematically addressed. In addition, using these VECs will allow for some level of integration with the Parks Canada Ecosystem Integrity Monitoring Program once the program is implemented in the mountain parks.

5.4 Boundaries of the CEA

5.4.1 Geographical Boundaries

The geographical scale of the analysis includes the four contiguous mountain national parks as well as adjacent provincial lands (Figure 5.3). The geographical boundaries of the CEA are based on relevant ecological units that correspond to the selected VECs. The boundaries were delineated as the approximate point at which the cumulative effects of fire and fuels management activities used within the mountain parks become insignificant or are too difficult to separate from the cumulative effects of other major land use activities or disturbances in the area. In the absence of definitive ecologically-based boundaries, anthropogenic boundaries were used. Anthropogenic boundaries were necessary for delineating the eastern boundary of the CEA study area because a definitive ecological boundary could not be identified which would match the scope of the work being undertaken.

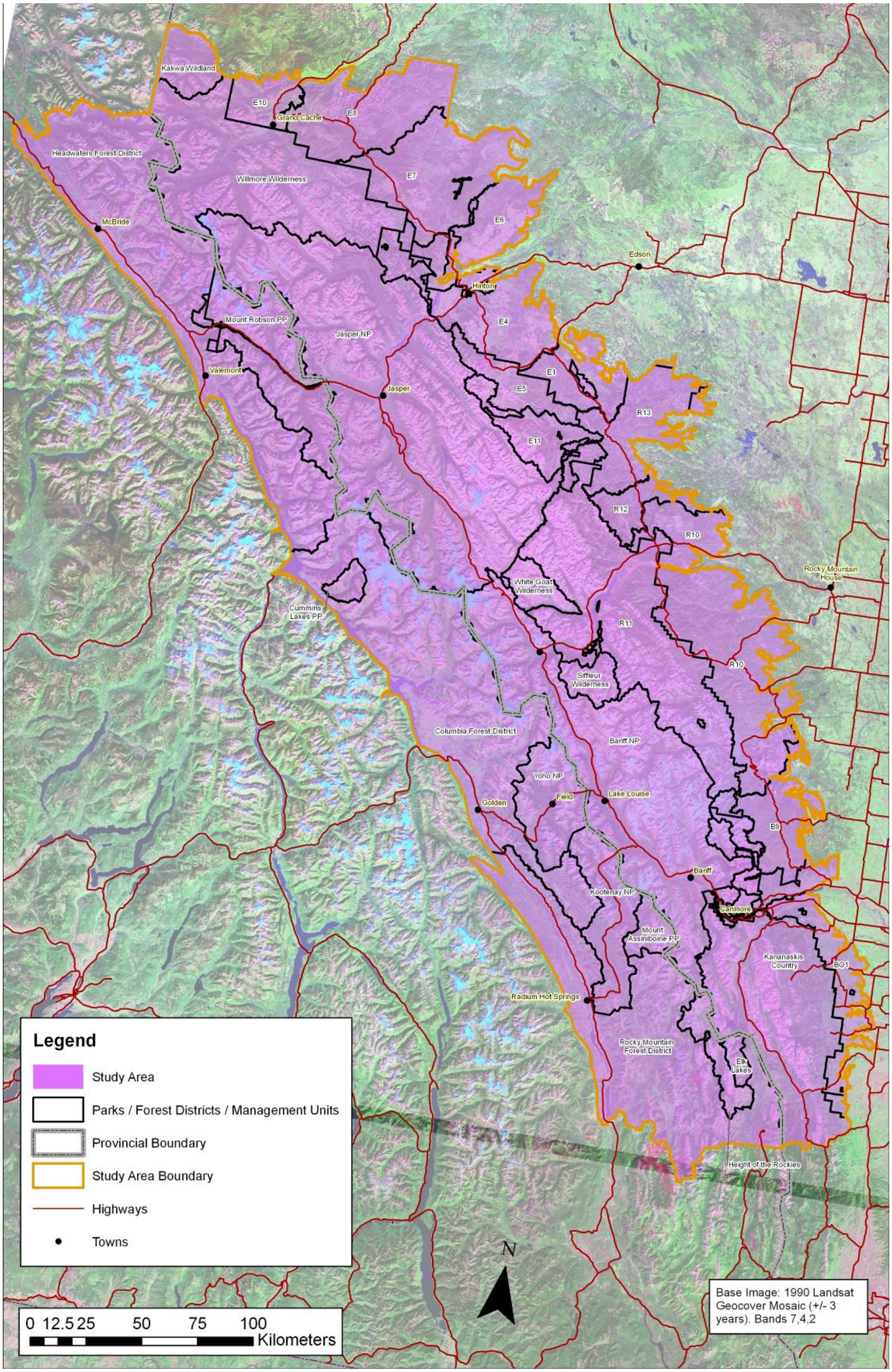


Figure 5.3. Geographical boundaries delineated for the CEA.

5.4.2 Temporal Boundaries

The cumulative impacts of fire and fuels management have various temporal scales. Historically, fire management consisted mainly of excluding fire from the landscape. This management tactic began in the late 1980s in the mountain parks and continued until the mid-1980s with the introduction of prescribed burning and fuel management programs. The current fire management program consisted of a combination of suppression, prescribed burning and fuel management.

The temporal boundaries of the CEA extend 100 years into the past and 10 years into the future. This allows for the analysis of the cumulative effects of almost 100 years of fire exclusion and an analysis of recent cumulative effects of the current fire management program and potential impacts of this program over the next 10 years. While 10 years may not be long enough into the future to determine all effects of prescribed fire and fuel management projects, much of the research used as a basis for the analyses and recommended mitigations are based on data that backcasts more than 400 years (fire history studies) and forecasts out to 2045 (modeling data from Banff Bow Valley study). The challenge in using a temporal boundary further out than 10 years into the future lies in synchronizing proposed management actions with those that that will actually occur beyond a 10 year planning horizon given changes in funding priorities, available resources, and the unpredictability of a management action like planned prescribed fire.

Two temporal scales were selected: an historical scale (1890s – 1980s) and a more recent time scale including the last 3 decades and a 10 year projection into the future (1978-2017). Since prescribed burning practices in the mountain national parks began in the late 1980s, the period between the 1890s and the 1980s represents a time when fire exclusion was the dominant fire management technique. The period between the 1980s up until the present (2008) represents a period in which fire management practices evolved within the mountain parks. This included a reduction in fire suppression activities and the use of prescribed fires for ecological purposes. As it is likely that the current fire management program will continue, the temporal scale was adjusted to the next decade. This 10-year period coincides with the 10-year timelines outlined within the JNP, BFU and LLYK Fire Management Plans.

5.5 Cumulative Effects Assessment of Fire Exclusion and Suppression

5.5.1 Background

This section discusses the cumulative effects of the past fire and fuel management programs which consisted primarily of intensive fire suppression in Banff, Jasper, Yoho and Kootenay National Parks and surrounding provincial lands in B.C. and Alberta on the ecological and social VECs.

5.5.2 Historical Fire Management Context

Over the past 100 years there has been a shift in the fire regime of many areas in the Rocky Mountain region (Tande 1977, Van Wagner 1995). Fire-history studies suggest that fire frequency and extent have decreased markedly, especially in the montane ecoregion, over the past century (Tande 1977). Fire history records for Jasper National Park indicate widespread fire events in the summer of 1889, less extensive fires in 1905, and little fire thereafter (Tande 1979). It is generally accepted that fire has been negligible within Canadian Rocky Mountain parks over the past 70 years (Hawkes 1979, Tande 1979, White 1985, Masters 1990, Van Wagner 1995, Barrett 1996).

The major factors contributing to the lack of fire activity during the past century are the implementation of fire exclusion policy, the widespread use of suppression activities, and the expulsion of First Nations people from the mountain parks at the turn of the century and, consequently, their use of fire as a management tool (Lewis 1980, Pyne 1997, MacLaren 1999, Barrett 1981, Johnson and Larsen 1991, Kay and White 1995).

Fire exclusion is the policy of trying to eliminate fires from the landscape using fire suppression techniques. Fire suppression is human intervention to extinguish fires. Before there can be a suppression effect at a particular location in the landscape an ignition must occur. The only part of the landscape that is directly affected by suppression is the area that would have burned if the fire had not been suppressed. The remainder of the landscape and the actual area burned are not directly affected by suppression. Historically, suppression was the primary tool used to control both wildfire and human ignited fires. Currently, suppression is used as a management tool in conjunction with other fire management techniques to control fires.

During the 1880s many high intensity fires swept through North America, a period that has been dubbed “The Great Barbeque” (Pyne 1997). The fires were not part of a natural regime, but were the result of human ignition sources and shifting land practices. As a result, the U.S. Forest Service formalized a national approach to wildland protection, which was heavily weighted towards aggressive fire suppression policy (Cohen and Miller 1978). That led to a national perspective of fire eradication and was underpinned by a lack of understanding of managing in concert with natural forces (e.g., predators, fires, floods). Thus, early fire management was based on "dominion over" the forces of nature as it was considered a more desirable land management policy (Mutch 1995). By the late 1930s, fire suppression had become effective in reducing the annual extent of fires, even in large wilderness areas in the northern Rocky Mountains (Barrett et al. 1991, Brown and Bradshaw 1994).

As other land resource management agencies came into being, they followed the U.S. Forest Service's lead. Similar fire suppression policy emerged after 1945 in the Canadian Rocky Mountains; however, suppression activities had been taking place throughout the mountain national parks and surrounding landscapes since the early 1900s, as frontier settlers did not embrace fire as a natural process (Woodley 1995). While not completely suppressed, there was a great reduction in wildland fire. Fire suppression policy effectively put a stop to most traditional landscape burning.

For several decades fire exclusion seemed beneficial to society (for example, preservation of timber resources and watershed protection), but on closer scrutiny, there seems little doubt this policy has created many unhealthy features on Rocky Mountain landscapes. The structures of forests have shifted from early to late successional species, habitat diversity has declined, and hazardous fuels have accumulated (Keane et al. 2002). The health of many Rocky Mountain ecosystems is in decline because of fire exclusion. Furthermore, fire exclusion has actually made it more difficult to fight fires, and this poses greater risks to the people who fight fires and for those who live in and around Rocky Mountain forests and rangelands (Keane et al. 2002).

The following sections detail the diverse cumulative effects of fire exclusion and suppression with respect to VECs in the mountain national parks. It is important to note that the impacts of exclusion occur gradually and are manifest in nearly every portion of the landscape. It is difficult to comprehensively describe and quantify these effects across large regions because exclusion effects are extremely variable in time and space. This discussion provides an overview of the known major consequences of fire exclusion on VECs in the mountain parks and surrounding landscapes.

5.5.3 Cumulative Effects on Ecological VECs

5.5.4 Biodiversity

Cumulative effect of fire exclusion on biodiversity: Decreased fire frequency, severity, and intensity due to long periods of fire exclusion has resulted in a reduction in diversity of vegetation and wildlife at multiple scales in the mountain national parks ecosystems.	
Direction: negative	**Magnitude:** major
Geographic extent: Rocky Mountain ecosystem	**Duration:** long-term

Fire exclusion and suppression dominated fire management policy in the mountain national parks between 1945 and the mid-1980s. This resulted in decades of decreased fire frequency and longer fire cycles throughout the mountain national parks and surrounding provincial lands compared to historical fire regimes (White 1985, Johnson and Larsen 1991). The cumulative effects of these changes have impacted the diversity of vegetation and wildlife. These effects are primarily negative and have compounded over time as a result of decades of suppression.

5.5.4.1 Vegetation diversity

Perhaps the most documented and studied cumulative effect of fire exclusion is the change in stand structure (spatial distribution of ‘patches’ or relatively homogeneous areas) and composition (the variety of patch types and their relative abundance) of vegetation in fire prone landscapes. In general, forest composition shifts from early seral, shade-intolerant tree species to late seral, shade-tolerant species, while stand structure moves from single-layer canopies to multiple-layer canopies with prolonged fire exclusion (Mutch et al. 1993, Quigley and Arbelbilde 1997, Steele 1994, Veblen and Lorenz 1991). Shifts from early to late seral species in the absence of fire are consistent with successional theory that characterizes how vegetation will change without major disturbances (Table 5.5) (Arno et al. 1985, Drury and Nisbet 1973, Horn 1974).

Table 5.5 Characteristics of early seral versus late seral species.

Early seral species	Late seral species
Higher photosynthetic rates Lower tolerance for shade Rapid height and diameter growth Frequent cone tops Shorter life spans Short crown lengths	Lower photosynthetic rates High shade tolerance Slow height and diameter growth Infrequent cone tops Long life spans Longer crown lengths, more dense Commonly have higher plant densities Multi-layered stand structures with sparse undergrowth

Source: Bazzaz 1990, Oliver and Larson 1990, Grime 1979, Frost 1998, Horn 1974, Brown 1978, Van Hulst 1978.

After decades of fire suppression plant species adapted to disturbance (those that best survive or regenerate after fire) are replaced by species better able to compete for resources in the absence of fire (Bazzaz 1979, Noble and Slatyer 1980). The density, cover, height, and vigour of undergrowth species tend to decrease as the overstory becomes dense and tree leaf area increases because of dominance by shade-tolerant species (Gruell 1986, Stickney 1985). In turn, undergrowth vascular plant species richness and density tend to decline on fire-excluded landscapes. Therefore, at a stand level, the diversity of vegetation in forest ecosystems decreases in fire suppressed landscapes.

There is concern that the past fire suppression practices of Parks Canada may have altered the natural successional processes and may be contributing to a decline in stand diversity. Wilson and Stuart-Smith (2002) indicate that whitebark pine populations in the Canadian Rockies are threatened by anthropogenic factors including fire suppression, and associated seral replacement by more shade tolerant tree species. In Banff National Park, Achuff et al. (1996) modeled future vegetation succession for 50 years in the absence of fire and concluded that continued fire suppression would lead to an overall loss of biodiversity caused by a loss of 19 of 29 vegetation types. Aspen stands, in particular, are at high risk, as are open Douglas-fir stands and grasslands (Achuff et al. 1996).

At the ecosystem scale, prolonged lack of fire in a landscape leads to a reduction in landscape diversity across fire prone landscapes. This has been identified in ecosystems that historically experienced surface fire regimes in southeastern British Columbia and are now experiencing a reduction of grassland and open forests and an increase in shade-tolerant species and dense forests (Taylor et al. 1998). Extensive conifer invasion into montane grasslands has been documented in the Southern Rocky Mountains (Allen et al. 1998, Bogan et al. 1999).

The longer fire is excluded from fire prone landscapes the more homogeneous (less diversity of tree species and forbs) landscapes become because succession will eventually advance all stands to similar communities dominated by shade-tolerant species (Keane et al. 1996 and 1997, Marsden 1983, Turner et al. 1994). Even though late seral species may differ across a landscape depending on the site, the multilayer structures of these late seral stands are nearly identical across most biophysical settings (Oliver and Larson 1990). However, there are situations where the exclusion of fire has not significantly impacted landscape diversity. Ecosystems historically characterized by infrequent stand-replacing fires may not have been greatly altered by decades of fire suppression, partially because it is often not possible to suppress high-intensity fires (Agee 1993, Johnson and Larsen 1991, Romme and Despain 1989). High-elevation subalpine forests in the Rocky Mountains typify ecosystems that experience infrequent, high-severity crown fires (Peet 2000, Veblen 2000). Fire free periods in the subalpine can persist as long as, or longer than, the fire exclusion period during the 20th century (Romme 1982, Romme and Despain 1989, Kipfmueller and Baker 2000, Veblen 2000, Schoennagel et al. 2003). Therefore, it is unlikely that the short period of fire exclusion in the mountain parks has significantly altered the naturally long fire intervals in subalpine forests and, in turn, the vegetation diversity (Romme and Despain 1989, Johnson et al. 2001, Veblen 2003). It is generally accepted that large, infrequent stand-replacing fires are "business as usual" in the subalpine, not an artefact of fire suppression (Schoennagel et al. 2004).

Fire suppression was not effective enough to reduce subalpine burned area in Banff National Park in Canada (White 1985). Decreased vegetation diversity as a result of fire exclusion is therefore more likely to be prevalent in lower elevation forests, especially montane ecosystems, that more commonly experience mixed-severity burns. This phenomenon has been well illustrated through comparative analysis of historical and current photographs taken in the same location within the mountain parks (White and Hart 2007, Rhemtulla et al. 2002) (Figures 5.4-5.9).

Source: M.P. Bridge land 1915

Figure 5.4a Jasper National Park, Power House Cliff, (1915).

Athabasca River Valley bottom across a flood plain. The landscape consisted of patchy vegetation – open coniferous stands, large grasslands, juvenile forest and the occasional stand dominated by deciduous species.

Source: J. Rhemtulla and E. Higgs 1998

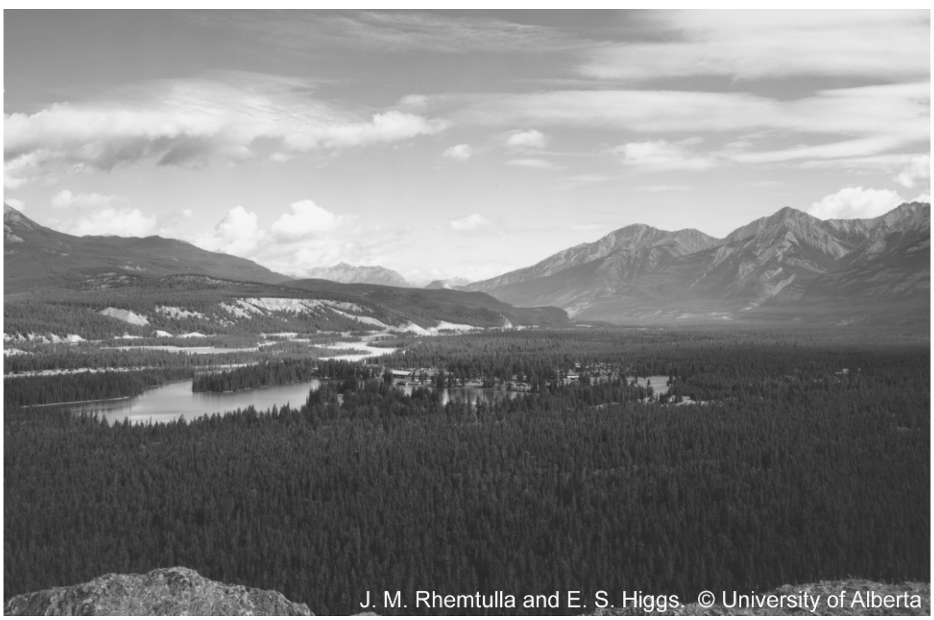
Figure 5.4b Jasper National Park, Power House Cliff, Athabasca River Valley (1997).

Over time the landscape has transited to a more homogenous vegetation cover dominated by closed canopy coniferous forests. Deciduous stands have declined and grassland, shrubland, and juvenile forest have been replaced by forest. New forest growth up the valley flanks is evident.

Source: M.P. Bridgeland 1915

Figure 5.5a Jasper National Park, Old Fort Pointe (1915).

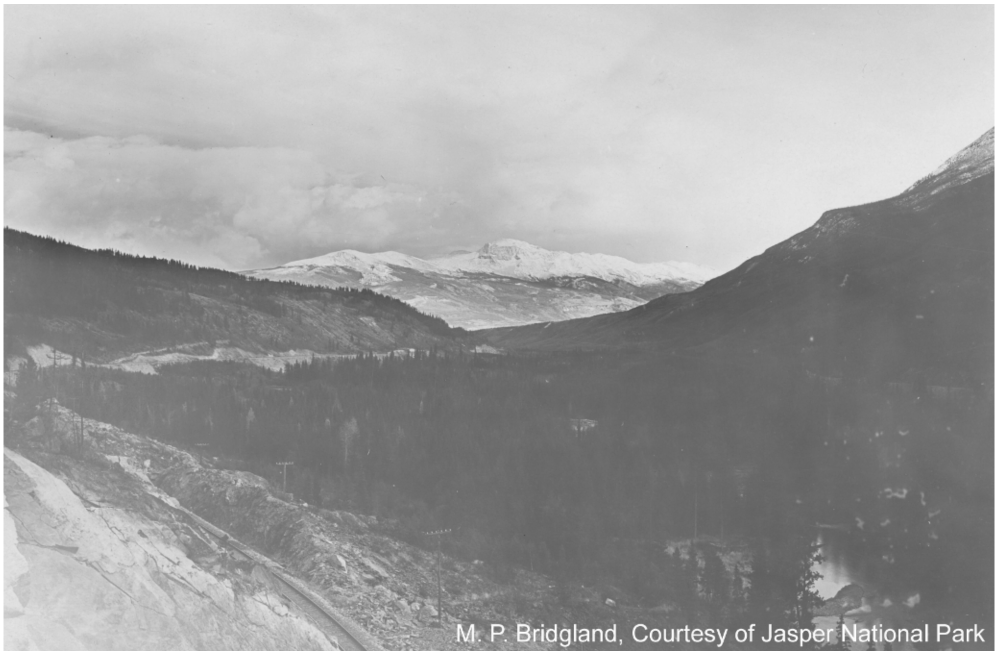
East of Jasper townsite shows valley bottom near Twin Lakes. The landscape consisted of patchy open grassland/shrubland, possibly the result of fire or other disturbances.



Source: J. Rhemtulla and E. Higgs 1998

Figure 5.5b. Jasper National Park, Old Fort Pointe (1997).

Dense, closed canopy coniferous stands have replaced the open patchy mosaic of grassland/shrubland and sporadic juvenile forest.



Source: M.P. Bridgeland 1915

Figure 5.6a Jasper National Park, Railway Photograph (1915).
Portion of the CPR along the Miette River. Landscape consisted of mixed forest stands.

Source: J. Rhemtulla and E. Higgs 1998

Figure 5.6b Jasper National Park, Railway Photograph (1997).
Encroachment of forest up valley sides is evident as well as crown closure.

Source: White and Hart 2007

Figure 5.7a Mount Rundle and Echo Creek, Banff National Park, Bow River Valley (1918) (Byron Harmon, Whyte NA 71-6244).

Riparian areas along creek are dominated by aspen and willow species.

Source: White and Hart 2007

Figure 5.7b Forty Mile Creek, Banff National Park, Bow River Valley (2005) (CW 2005-09B-05).

Riparian areas have succeeded to more homogeneous conifer dominated stands.

Source: White and Hart 2007

Figure 5.8a Popes Peak from the railroad above Hector Station, August 1901 (Vaux family, Whyte NG-4-820).

Photo taken following a stand replacing fire.

Source: White and Hart 2007

Figure 5.8b Sink Lake and Popes Peak from the railroad near Kicking Horse Pass, September 2006 (CW 2006-09C-23).

Post-fire succession has resulted in a closed conifer forest.

Source: White and Hart 2007

Figure 5.9a Crowfoot Glacier, 1902 (Vaux family, Whyte NA 80-1108).
Upper sub-alpine closed conifer stand.

Source: White and Hart 2007

Figure 5.9b Crowfoot Glacier, July 2003 (CW 2003-07L-11).
The upper sub-alpine stands have changed relatively little as a result of fire exclusion.

5.5.4.2 Habitat and wildlife diversity

Fire exclusion not only decreases the diversity of vegetation, but also decreases the variability in ecosystems states and processes at the landscape scale. This can lead to decreased diversity in landscape structure and composition in the long-term, which affects the diversity of organisms at all trophic levels.

The cumulative effects of decades of fire exclusion on habitat and wildlife diversity tend to be more prominent in landscapes that experience mixed-severity fire regimes. In these landscapes fires either cause selective mortality of fire-susceptible species in the overstory or alternate between understory and stand-replacement, with overlapping burn boundaries, which creates a complex mosaic of ages and structures. This pattern is accentuated in areas where variable topography and microclimate influence fire spread, such as the montane ecoregions within the mountain parks ecosystem. Prolonged fire exclusion in these landscapes generally results in landscapes becoming less fragmented, having lower patch density and decreased patch diversity, which often results in more homogeneous large patches (Hann 1990, Hessburg et al. 1999, Keane et al. 1998, Li et al. 1996). This reduces habitat diversity as forest habitats move towards a more homogeneous state and can produce major changes in floral and faunal communities.

It is generally accepted that the montane ecoregion of the mountain parks has been dominated by a mixed-severity fire regime during the past several hundred years. Therefore, the cumulative effects of nearly 50 years of fire exclusion have likely altered the habitat diversity within this region of the mountain parks ecosystem and similar landscapes surrounding the mountain parks.

5.5.4.3 Wildlife diversity

Decreased habitat diversity, as a result of lack of fire, can affect wildlife, especially wildlife that depend on frequent fires to create the diverse landscape structure and composition necessary for forage, protection, migration, reproduction, and shelter. While impacts on overall species diversity may be minimal, changes in population size and distribution are negatively affected if habitat quality and diversity are reduced.

Large herbivores and carnivores

Many ungulate species including big horn sheep and elk depend on fire’s influence on the landscape to regenerate forb and grass species for forage. As homogeneous forest stands of shade-tolerant species replace fire-tolerant mixed forest stands, forage quality and plant vigour decrease. These changes negatively impact important habitat characteristics for ungulate species and diminish carrying capacity (Gruell 1979, Peak et al. 1985). These conditions force wildlife to seek out new habitat patches. Unfortunately, for many ungulates attractive patches tend to be in lower elevation, cleared areas where human-wildlife interaction is greater and the chance of human-wildlife conflict or wildlife mortality greater.

Since populations of large carnivores and omnivores (wolves, bears) tend to thrive in areas where their preferred prey or forage is most plentiful – often areas that have experienced recent burns – prolonged fire exclusion can negatively impact the diversity of these species populations in these areas (Paquet et al 1996, Smith 2000). Because carnivore populations have been found to be spatially and temporally correlated to prey movement, their populations also experience increased human-wildlife conflict and mortality as a result of habitat changes due to long-term fire exclusion.

Small mammals

Conifer encroachment and organic matter build up as a result of fire exclusion reduces the size and alters the vegetation complexes of grasslands which are important habitat for small mammals. Groves and Steenhof (1988) showed that the diversity of small mammals, such as ground squirrels, pocket gophers, deer mice is less in unburned areas compared to recently burned areas. This is attributed to the decreasing complexity of forest habitat (reduction in grassland, shrubland and juvenile forest mosaics) as succession moves forests towards a more homogeneous state in the absence of fire. Fire has also been associated with improving black bear (Landers 1987) and grizzly bear habitat quality and effectiveness (Hamer 1995, Morgan et al. 1994). Predators and scavengers (wolves, foxes, and ravens) suffer from forests becoming denser because food is less abundant and less exposed in these conditions than in previously burned areas. Raptor species of birds tend to be more abundant in burned areas than in unburned areas due to improved visibility of prey.

Birds

Many bird species depend on stand replacing fires to produce the conditions necessary for nesting success. However, other species are dependent on the live unburned forests for survival, especially foliage gleaners (Saab et al. 2005). High-elevation habitats created by rare, stand-replacing fire are necessary for the long-term persistence of the associated bird communities. However, due to the remote nature of this habitat, fire suppression is generally difficult and likely does not threaten the natural fire regimes or associated bird communities (Saab et al. 2005). Therefore, fire exclusion is more likely to have a negative effect on bird communities in lower elevation ecosystems that depend on heterogeneous habitat (high variability in patch size, shape, and type) for their existence (Hejl 1992).

Fire exclusion can, however, create attractive habitat for some species. For example, amphibians often proliferate in areas with accumulated material and woody debris. In forests of British Columbia, the proportion of non-mammalian vertebrates (mainly amphibians) using woody debris was positively correlated with the length of the fire rotation (Bunnell 1995). Successional shifts in fire-excluded landscapes lead to conifer dominated landscapes and broad-leafed trees decay. This process creates snags and adds to dead wood on the ground, enhancing habitat for cavity nesters and some small mammals. It also creates openings that are invaded by shrubs and saplings. Dense patches of shrubs and tree regeneration in long-unburned forests provide excellent cover for ungulates and large predators. Birds (for example crossbills, nuthatches, brown creeper, and woodpeckers), tree squirrels, and American marten find food, cover, and nest sites within the structure of the old-growth coniferous forest. However, the usefulness of snags and old-growth to fauna is enhanced or reduced by the surrounding habitat, since cavity nesters vary in their food and cover needs. These conditions also tend to benefit generalist species that are capable of using all stages of succession rather than specialist species found in heterogeneous landscapes. These conditions can lead to more homogeneous populations of generalist species – further decreasing overall species diversity.

5.5.4.4 Species at Risk

Rare and threatened species can experience decline with the reduction of fire in the landscape (Greenlee 1997). This is because many threatened, endangered, and rare species depend on fire or the processes within fire-adapted ecosystems for their survival (Hessl and Spackman 1995).

American badger, *jeffersonii* subspecies

<table>
<tr><td colspan="2">Cumulative effect of fire exclusion on badger populations: Prolonged fire exclusion can decreased high quality habitat for this endangered badger subspecies.</td></tr>
<tr><td>Direction: negative</td><td>Magnitude: moderate</td></tr>
<tr><td>Geographic extent: Kootenay National Park</td><td>Duration: long-term</td></tr>
</table>

Habitat for the American badger (*jeffersonii* subspecies) listed as Endangered under the Species-at-Risk Act (SARA), has been degraded by forest encroachment and in-growth in LLYK. Fire suppression has fostered the growth of young forests and increased forest density in areas that were historically cleared by regular low-intensity fires. Increased forest canopy closure may reduce habitat quality for prey species. Research in British Columbia has shown badgers do use forested landscapes (Apps et al. 2002, Hoodicoff 2003,Weir et al. 2003), but this is limited to where prey populations are plentiful and soils are friable, usually associated with logging or wildfire disturbance (jeffersonii Badger Recovery Team 2005).

Grizzly Bear

<table>
<tr><td colspan="2">Cumulative effect of fire exclusion on grizzly bear populations: Prolonged fire exclusion decreases habitat quality and effectiveness.</td></tr>
<tr><td>Direction: negative</td><td>Magnitude: moderate</td></tr>
<tr><td>Geographic extent: Rocky Mountain ecosystem</td><td>Duration: long-term</td></tr>
</table>

The habitat quality and effectiveness of grizzly bear, a species of special concern, is also compromised by prolonged fire exclusion (Gibeau et al. 1996). Lack of fire in mountain landscape decreases the production of buffaloberries and hedysarum roots –important components of grizzly bear diets in the mountain national parks. Without this vital food source bears must seek out other sources of food to fulfill their dietary needs.

Woodland caribou

Cumulative effect of fire exclusion on woodland caribou populations: no direct loss of caribou habitat and potentially less overlap in habitat with carnivores that prey on caribou.	
Direction: neutral to positive	Magnitude: moderate
Geographic extent: Jasper and Banff National Parks, Wilmore, Kakwa and non-protected forest lands of Alberta	Duration: long-term

Woodland caribou are listed as threatened under SARA (SARA Registry 2002). This species is old-forest dependant and forages mainly on terrestrial lichens in the winter in stands that are at least 75 years old (Shepherd et al. 2007). Terrestrial lichens take at least 75 years to reach sufficient cover to be of use to caribou (Shepherd et al. 2007). In general, young seral stands are avoided by caribou as they do not provide sufficient forage. As such, the late seral forests that proliferate due to prolonged fire exclusion are preferred habitat for caribou. Fire exclusion allows existing trees stands to advance to older stands.

5.5.5 Effects on terrestrial ecosystem health

Fire exclusion and suppression can lead to a myriad of cumulative impacts across terrestrial ecosystems. These impacts can occur gradually and are manifest in nearly every portion of the landscape, especially vegetation composition and structure, nutrient cycles in soil, and insect and disease epidemics. These effects negatively impact the health of terrestrial ecosystems.

5.5.5.1 Vegetation structure and fuel loads

Cumulative effect of fire exclusion on vegetation structure and fuel loads: The cumulative effects of fire exclusion and suppression on the structure and composition of terrestrial ecosystems within the mountain parks has negatively impacted the long term health of this system.	
Direction: negative	**Magnitude:** major
Geographic extent: Rocky Mountain ecosystem	**Duration:** long-term

A major cumulative effect of fire exclusion on terrestrial ecosystems is the change in forest structure and composition at both the stand and landscape level. Stand-level effects include increases in woody fuel loading, canopy cover, vertical fuel distribution, canopy stratum, and fuel continuity. Landscape-level effects include increases in landscape homogeneity and fuel build up. Such shifts have been identified in Banff National Park and in Jasper National Park (Rhemtulla et al. 2002, Rogeau 1996).

A healthy terrestrial ecosystem is composed of many elements including species diversity, balanced ecosystem processes, capacity of physical and chemical systems to cycle nutrients, minerals, water and other materials through the landscape, and lack of infection and disease epidemics. As mentioned in section 5.5.1 above fire exclusion decreases the diversity of vegetation and wildlife thereby negatively impacting terrestrial ecosystem health. But perhaps the greatest threat to terrestrial ecosystem health as a result of prolonged fire exclusion is the rapid shift from mixed-severity regime to a high-severity regime and the increased risk of an extreme fire event.

Over successional time the amount of dead and live biomass, or fuels, in late seral forests increases in the absence of fire. Surface fuel loadings increase because crown biomass ultimately accumulates on the forest floor without the recycling process of fire. Young shade-tolerant species fill in the understory and tree crowns may extend to the forest floor (Brown 1978). These thick crowns coupled with high densities and many size classes create multilayered stand structures with sparse undergrowth (Frost 1998). This leads to the development of "ladder fuels", which include low branches, young trees and any other vegetation that allow fire to climb into the upper branches of the tree and become a crown fire (Figure 5.10).

Figure 5.10 Ladder fuels allow surface fire to climb into the upper canopy of trees and become a crown fire.

As a result of fire exclusion, the fire regime in fire excluded landscapes shifts from a mixed-severity regime towards a crown-fire regime characterized by high intensity stand-replacing fires. Subalpine forests typically experience stand-replacing crown fires, which tend to be associated more with extreme weather events than with fuel build up (i.e. drought coupled with high winds) (Bessie and Johnson 1995). In contrast, the natural fire regime in lower elevation landscapes, such as the montane, tends to be a mixed-severity regime with more frequent and less intense fire. Therefore, extended periods of fire exclusion in these montane areas increases the potential risk for extreme fire events as fuel loads accumulate overtime. Without the frequent low severity burns typical of a mixed-severity regime fuel loading can accumulate to dangerous levels. If a stand replacing crown fire is ignited, coupled with extreme weather conditions including drought and high winds, the consequences to ecosystem health could be significant (see section 5.6). This is, however, dependent on the biophysical complexity of the landscape. Not all regions will experience the same risk. For instance, in some areas fuel conditions may be within the historical range, even though the fuel loadings appear to be high. In these areas the risk of high-intensity fire is more a factor of weather conditions, not fuel loads (Schoennagel 2004).

Under extreme weather conditions all stands may exhibit crown fires regardless of the range of fuel conditions (Bessie and Johnson 1995). Since most large fires occur in years when there are elevated weather variables it is unlikely that fuel variation is the strongest factor influencing fire behaviour in forested landscapes (Bessie and Johnson 1995). Fire behaviour depends on only certain fuel structural components that change over time. The role of fuel in influencing extreme fire is much smaller than extreme weather. Increases in weather variability due to climate change may be more influential is shaping fire behaviour compared to fuel accumulation. However, interconnected patches of continuous fuel sources under certain conditions may further increase fire hazards during extreme weather thereby increasing the risk to terrestrial ecosystem health.

5.5.5.2 Soil

Cumulative effect of fire exclusion on soil: The cumulative effects of fire exclusion and suppression can alter soil properties thereby affecting nutrient cycling within ecosystems.	
Direction: negative	**Magnitude:** major
Geographic extent: Rocky Mountain ecosystem	**Duration:** long-term

Fire exclusion can positively and negatively change soil properties in a landscape as succession advances. Build up of organic matter, due to lack of fire in a landscape, increases pore space in soil, which improves water holding capacity and soil aggregation (Keane et al. 2002). This attribute can help prevent soil erosion in areas prone to erosion such as steep sloping areas with fine soil aggregates that experience heavy precipitation or snowmelt runoff. However, these benefits tend to be localized to very specific terrain and vegetation conditions.

At the landscape scale, the cumulative effects of fire exclusion on soil tend to be negative. Fire exclusion increases tree densities and crown closure, which reduces solar radiation attenuated to the forest floor, thereby decreasing soil temperatures. This results in decreased decomposition rates and still greater build ups of organic matter (Borchers and Perry 1990, Brown and Bevins 1986). Soils in fire prone landscapes that are deprived of fire are less likely to stimulate decomposing bacteria compared to burned soils (Higgins et al 1991). This is because the temperatures of burned soils rise earlier in the season creating the conditions necessary for bacterial activity.

Fire exclusion prevents large amounts of organic matter that have accumulated as a result of fire exclusion from being made available to plants through decomposition by soil organisms (Waring and Running 1998). Without the combustion process of fire, which releases some of the nitrogen sequestered in the fuels and makes it available as ammonium-N to the plants, soils in fire excluded landscapes can experience nutrient deficits. Phosphorus and sulphur availability are also reduced over time in the absence of fire (DeBano 1991, Keane et al. 2002). The cumulative effects of fire exclusion negatively impact nutrient cycling and soil health in the drought-frequent Rocky Mountains.

5.5.5.3 Insect outbreaks and disease

Cumulative effect of fire exclusion on terrestrial ecosystem health: The cumulative effects of fire exclusion and suppression can increase insect and disease activity to epidemic levels.	
Direction: negative	**Magnitude:** major
Geographic extent: Rocky Mountain ecosystem	**Duration:** long-term

Fire exclusion can increase the potential for insect and disease epidemics. Their presence is largely attributed to increased stress and reduced vigour of early seral, fire dependent tree species (Heinriches 1988, Hessburg et al. 1994, Kolb et al. 1998). Stressed plants and dense canopies are usually a recipe for severe insect and disease infestations (Heinriches 1988). Tree density increases associated with successional changes in fire excluded landscapes also facilitates the migration of insects from stand to stand as dispersal distances are decreased. Ecosystems with intact fire regimes have lower levels of plant stress, which reduces insect and disease infestations.

Perhaps the most studied insect infestation in the mountain national parks is mountain pine beetle. Lack of natural wildfire in British Columbia during the past 80 years has allowed the amount of mature lodgepole pine to increase to three times its normal occurrence in interior forests (Filmon 2004). Lodgepole pine is the main host of mountain pine beetle. Excessive mature pine, together with warming climates, has created an epidemic mountain pine beetle infestation across the Interior of British Columbia (Filmon 2004). This poses a serious threat to susceptible pine stands in the mountain parks and surrounding fire excluded landscapes in Alberta (Phillips et al. 2007). In addition, MPB attacked stands have the potential for greater ground level fine and coarse woody fuel volumes which can significantly alter forest fire behaviour and increase the fire hazard within the stands.

Increase in homogeneity of forest stands may facilitate the spread of insect disturbance. Stands greater than 80 years of age are considered highly susceptible to mountain pine beetle (Shore and Safranyik 1992), and large, pure mature and overmature stands would sustain an outbreak more so than relatively younger, more vigorous stands, especially in mixed compositions (Rhemtulla et al. 2002)

Table 5.6 and Table 5.7 show other insect outbreaks and disease that have the potential to build up to epidemic levels in the absence of fire.

Table 5.6 The effect of lengthening historic fire cycles on forest insect populations.

Agent	**Fire cycle three times historic cycle**	**Fire cycle > three times historic cycle**
Major Insects		
Black-headed budworm	Increase	Large increase
Mountain pine beetle	Increase	Large increase
Northern lodgepole needle miner	Unknown	Unknown
Spruce beetle	Increase	Large increase
Spruce budworm	Increase	Large increase
Minor Insects		
Aspen leaf miner	Increase	Increase
Bruce spanworm	Increase	Increase
Cottonwood leaf beetle	No change	No change
Gray willow leaf beetle	No change	No change
Larch sawfly	Decline	Decline
Lodgepole pine beetle	Increase	Increase
Pine engraver	Increase	Increase
Pine leaf chermid	No change	No change
Pine terminal weevil	Increase	Decline
Pitch nodule maker	Increase	Decline
Poplar borer	Increase	Increase
Red turpentine beetle	Increase	Decline
Spruce-gall aphid	Increase	Increase
Spruce spider mite	No change	No change
Two-year budworm	Increase	Major increase
Willow leaf beetle	Non change	No change
Yellow headed spruce sawfly	No change	No change

Source: Banff Field Unit Fire Management Plan 2008

Table 5.7 The effect of lengthening fire cycles on forest diseases.

Agent	**Fire cycle three times historic cycle**	**Fire cycle > three times historic cycle**
Major diseases		
Dwarf mistletoe	Increase	Large increase
Shoe-string root rot	Increase	Large increase
Aspen cankers	Large increase	Large increase
False tinder fungus	Increase	Large increase
Minor diseases		
Atropellis canker	Increase	Decline
Black leaf spot	Increase	Increase
Black stain root disease	Unknown	Increase
Brown cubical butt rot	Increase	Large increase

Douglas fir needle rust	Increase	Increase
Lodgepole pine blister rusts	No change	No change
Lodgepole pine needle casts	Decline	Decline
Red heart rot	Increase	Large increase
Red ring rot	Increase	Large increase
Spruce needle rusts	Increase	Large increase

Source: Banff Field Unit Fire Management Plan 2008

5.5.5.4 Aquatic ecosystem health

Cumulative effect of fire exclusion on aquatic ecosystem health: The landscape level changes caused by fire exclusion and suppression can have minor cumulative effects on the hydrologic regime of mountain watersheds.	
Direction: negative to neutral	**Magnitude:** minor
Geographic extent: Rocky Mountain ecosystem	**Duration:** long-term

The cumulative effects of fire exclusion can impact the hydrologic regime of a watershed. Fire excluded landscapes tend to develop denser forests of late seral species which generally increase transpiration, snow ablation, and canopy interception. This can result in periodic seasonal depletion of soil water, increased canopy evaporation, and decreased streamflows and drying of springs (Hann 1990; Kaufmann et al. 1987; Skidmore et al. 1994, Waring and Running1998). Tree canopy closure, as a result of fire exclusion, limits solar radiation attenuation to the forest floor. This can delay snow thaw causing increases or decreases in monthly and annual stream flow measurements. Such changes can limit the amount of water available to downstream users, such as irrigators and municipal water suppliers, especially in late summer and early autumn.

Fire exclusion generally reduces soil water and overland flow thereby reducing surface erosion, mass movement, and sediment yield, depending on geomorphic landforms (Swanson 1981). The increased vegetation cover near streams on fire excluded landscapes would probably decrease stream water temperatures, increase long-term inputs of coarse woody debris to streams, and delay and reduce peak runoffs which can protect water quality (Dennis 1989).

5.5.5.5 Atmosphere (climate & air quality)

Cumulative effect of fire exclusion on the atmosphere: Decreased fire frequency, due to decades of fire exclusion has reduced negative cumulative effects on regional air quality.	
Direction: positive	**Magnitude:** minor
Geographic extent: Rocky Mountain ecosystem	**Duration:** long-term

The cumulative effects of fire exclusion on air quality are positive. Lack of fire and lengthened fire regimes reduce the amount of smoke entering the atmosphere therefore does not increase atmospheric particulate levels and does not contribute to air pollution. However, any improvements in air quality due to fire exclusion happen at the expense of ecosystem health (Brown and Bradshaw 1994, Covington et al. 1994).

5.5.5.6 Summary of the cumulative ecological effects of fire exclusion

Table 5.8 summarizes the cumulative ecological effects of fire exclusion and suppression. Figure 5.11 outlines the cause and effect relationships of the cumulative ecological effects of fire exclusion as outlined above.

Table 5.8 Summary of the cumulative ecological effects of fire exclusion and suppression.

Key components affected by Fire Management plans	Other stressors on key components	Additive or counteracting effects of historical fire exclusion practices on key components	Overall Trend
BIODIVERSITY			
Vegetation	- non-native plants - over-abundant herbivores - climate change	- decreased diversity of vegetation at stand and ecosystem level - decreased early seral communities - increased landscape homogeneity - increase in dominance of one patch type	- -
Habitat	- habitat fragmentation (roads, towns, agriculture, oil and gas activities, logging) - non point source pollution (pesticides) and toxins	- decrease in patch diversity and landscape heterogeneity	- - -
Wildlife	- direct human-caused mortality - human-caused displacement and habituation - habitat fragmentation (roads, towns, agriculture, oil and gas activities, logging) - non point source pollution (pesticides) and toxins	- decrease in high quality habitat and habitat effectiveness - decrease in forage, protection, shelter, migration and reproduction - increased hiding and thermal cover	- - -
TERRESTRIAL ECOSYSTEM HEALTH			
Vegetation structure and fuel loads	- human activity (logging, development, agriculture) - non-native plants	- decreased diversity of forest structure and composition - increased number of shade tolerant species - decreased number of fire tolerant species - decreased plant vigour - increased vertical stand structure, canopy closure, vertical fuel ladder - increased risk of larger more destructive crown fires - short term increase in stand productivity	- -
Soil nutrient cycling	- human activity (logging, development, agriculture) - non-native plants	- decreased nutrient (N,P,S) availability and cycling - decreased soil temperatures - decreased decomposition - increased pore space, water holding capacity	-
Insects and disease	- climate change (?) - human activity (logging, development, agriculture)	- increase in insect and disease populations and epidemics - increase in migration due to elevated tree densities in stands - increased number of host species	- - -

Key components affected by Fire Management plans	Other stressors on key components	Additive or counteracting effects of historical fire exclusion practices on key components	Overall Trend
SPECIES AT RISK			
American badger, jeffersonii subspecies (Endangered)	- habitat fragmentation (roads, towns, agriculture, oil and gas activities, logging) - direct human-caused mortality - sensory disturbance by humans	- decreased high quality habitat over time	-
Woodland caribou (Threatened)	- habitat fragmentation (roads, towns, agriculture, oil and gas activities, logging) - direct human-caused mortality - sensory disturbance by humans	- allows for the development of late seral forests, preferred habitat by caribou	+
Grizzly bear (Special concern)	- habitat fragmentation (roads, towns, agriculture, oil and gas activities, logging) - direct human-caused mortality - sensory disturbance by humans	- decreased high quality habitat over time	-
AQUATIC ECOSYSTEM HEALTH			
Hydrologic regime	- non-point source pollution (pesticides, fertilizer, sewage effluent, heavy metals) - surface and groundwater withdrawals, supply - human activity (logging, development, agriculture)	- increased leaf area, increased evapotranspiration, rainfall interception - increased snow ablation - decreased stream flows and drying springs - decreased stream sediment	-
ATMOSPHERE (climate & air quality)			
Air quality	- non point source pollution (fossil fuel emissions)	- reduction in smoke - decreased levels of atmospheric particulate levels	+

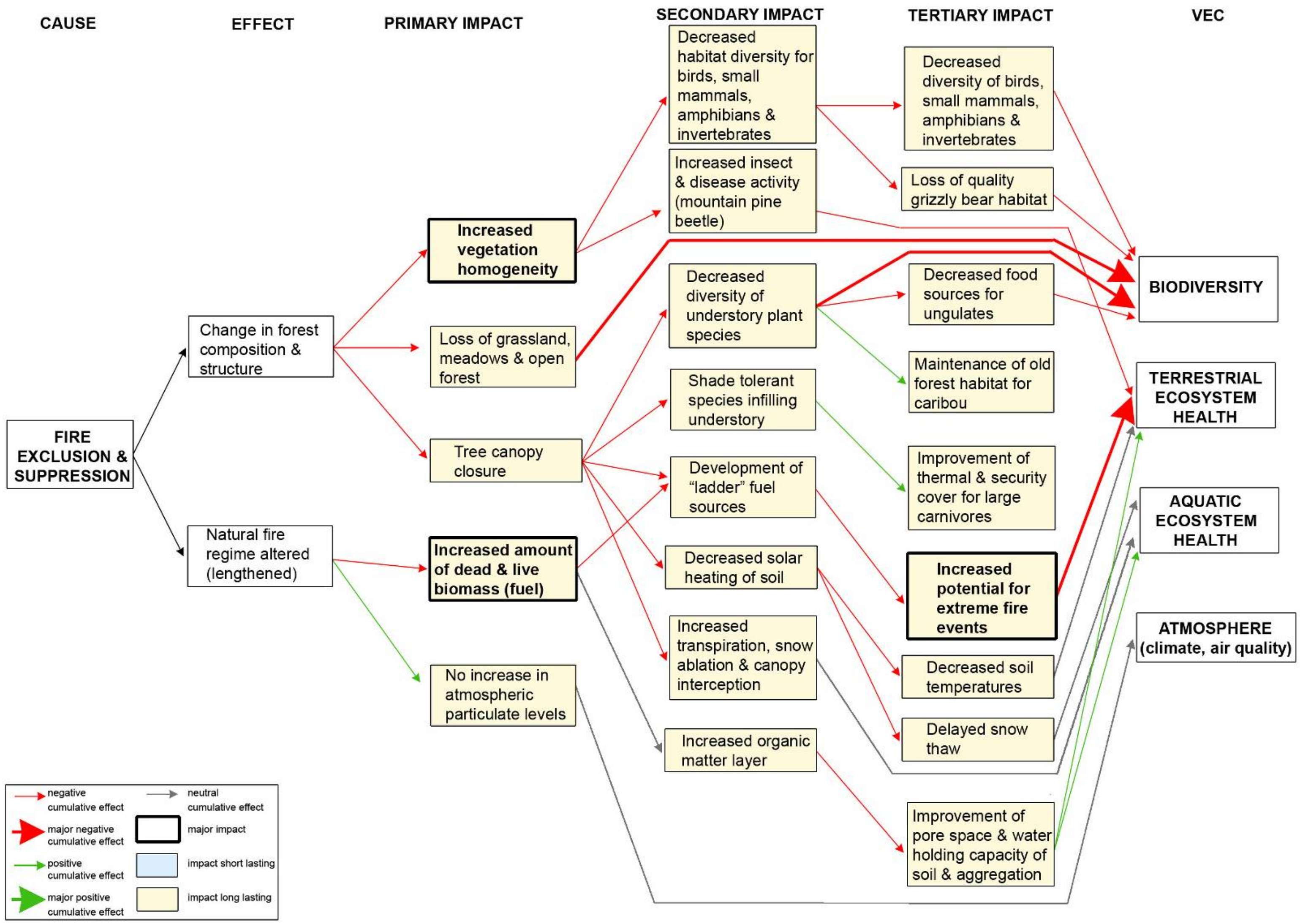


Figure 5.11 Network diagram of the cumulative ecological effects of fire exclusion and suppression on VECs.

5.5.6 Cumulative effects on social, cultural and economic VECs

5.5.6.1 Human health and safety

Cumulative effect of fire exclusion on human health and safety: The cumulative effects of fire exclusion and suppression have lengthened the natural fire regime resulting in accumulations of fuels that pose a hazard to human health and safety.	
Direction: negative	**Magnitude:** major
Geographic extent: Rocky Mountain ecosystem	**Duration:** long-term

Fire intervals in the lower subalpine and montane regions within the mountain national parks have lengthened to more than two times the length of the normal fire cycle (White 1985). As a result, dense stands have developed in which fine grass fuels are less abundant and dense ladder fuels, capable of carrying fire up into the canopy, are accumulating. Consequently, the risk of high-severity fires in areas where historically they were rare has increased.

In British Columbia, recent fire seasons showed a large upward trend of dangerous fires in the vicinity of the urban-wildland interface when compared to the 10-year average (Westhaver et al. 2007). In 2003, more than 100 of 2,517 wildfires in British Columbia burned in interface areas, and 15 were major incidents that caused evacuation of 50,000 people and destroyed 334 homes or businesses.

High-severity crown fires are the most dangerous and difficult to control, especially in and around urban settings, as burning embers can be spread by the wind to start new fires beyond the main fire perimeter. Accumulation of fuels in conjunction with hot, dry and windy weather puts forests that have undergone long term fire exclusion at extreme risk of wildfires and also increases risks to the health and safety of fire fighters called in to manage these dangerous fires. The more dangerous the fire (high intensity crown fire) the greater the risk on the health and safety of fire fighter's engaging in suppression. Such hazards include risks of entrapment, asphyxiation, heat exhaustion, falling, and other injuries.

Risks to the health and safety of residents and visitors in the montane and lower subalpine are also heightened due to the potential for an extreme fire event as a result of increased fuel loads and reduction in fire across the landscape.

5.5.6.2 Infrastructure and built assets

Cumulative effect of fire exclusion on economic values: The cumulative effects of fire exclusion and suppression on the landscape have increased the potential risk for extreme fire events in the urban-wildland interface and loss of built assets in the backcountry.	
Direction: negative	**Magnitude:** major
Geographic extent: Rocky Mountain ecosystem	**Duration:** long-term

Fire exclusion has heightened fire hazards in the montane and lower subalpine ecoregions of the mountain national parks. The risk of destruction of built assets in the urban-wildland interface continues to increase as people continue to develop and settle lands in these areas (Fischer and Arno 1988). This is caused by the surrounding forest advancing in succession, accumulation of canopy and surface fuels (Freedman and Fischer 1980).

Many major structures in the mountain parks, especially along the urban-wildland interface are constructed with wood frames and may be surrounded by vegetation. These structures constitute forest fuel (Arbor Report 1991). Fire fighting resources under a fire exclusion management paradigm must be very large because of the need for more equipment and personnel to save these structures. There is a risk that there may not be enough of these resources to fend off a massive fire event, such as a fire that could result in areas that have experienced decades of fire exclusion.

5.5.6.3 Social and cultural values

Cumulative effect of fire exclusion on social and cultural values: The cumulative effects of fire exclusion and suppression have increased the risk of losing irreplaceable historical and cultural assets and traditional knowledge.	
Direction: negative (long-term)	**Magnitude:** major
Geographic extent: Rocky Mountain ecosystem	**Duration:** long-term

Loss of traditional use of fire

There is substantial evidence that portions of the Rocky Mountain landscape were extensively humanized by the early 16th century (Denevan 1992). Considering the low frequency of lightening ignited fires east of the Continental Divide, the principal source of historical ignitions was likely man. Military reports from the 1860s recognized that these early inhabitants had a profound bearing on forest structure and composition resulting primarily from fires they set. They started fires for many reasons including land clearing, wildlife habitat improvement, cultivation, defence, signals, and hunting (Bahre 1991, Gruell 1985, Kay and White 1995, Lewis 1985). Generally, they burned parts of the ecosystems in which they lived to promote a diversity of habitats which gave the First Nations greater security and stability to their lives.

The settlement of white man in the Rocky Mountains eventually led to the expulsion of native people from these landscapes, decreasing their fire activity. With the implementation of fire exclusion policy, fire was even further suppressed in these landscapes. As a result, the traditional knowledge of the benefits of using fire as a land use management tool has largely been lost.

Risk of losing historical assets, cultural sites

The cumulative effect of fire exclusion has increased the potential for an extreme fire event, which has increased the risk of losing historical assets and cultural sites located throughout the mountain parks in fire excluded areas. Potential sites at risk may include sacred First Nations sites such as sacred/spiritual sites, burial grounds and other sites with historical or cultural significance. Fire may also negatively impact populations of plants used by First Nations for medicinal purposes although many of these plants are likely adapted to periodic fire.

5.5.6.4 Economic Vitality

Cumulative effect of fire exclusion on local economic vitality: The cumulative effects of fire exclusion and suppression increase the risk of major economic impacts to the local economy.	
Direction: neutral - negative	**Magnitude:** major
Geographic extent: Rocky Mountain ecosystem	**Duration:** long-term

The elevated risk of an extreme wildfire event due to prolonged fire exclusion and suppression activities within the contiguous mountain parks poses a potential economic threat to the local economies. Businesses that rely on the natural beauty of the mountain parks to draw in visitors could be at risk of losing significant revenues if a major wildfire event were to take place near or within the area occupied by their operations. In addition, if a major wildfire event occurs in close proximity to the urban-wildland interface residents could be evacuated. This could have impacts on local businesses that rely on local populations to support their business.

5.5.7 Summary of the cumulative social effects of fire exclusion

Figure 5.12 outlines the cumulative social effects of fire exclusion as outlined above.

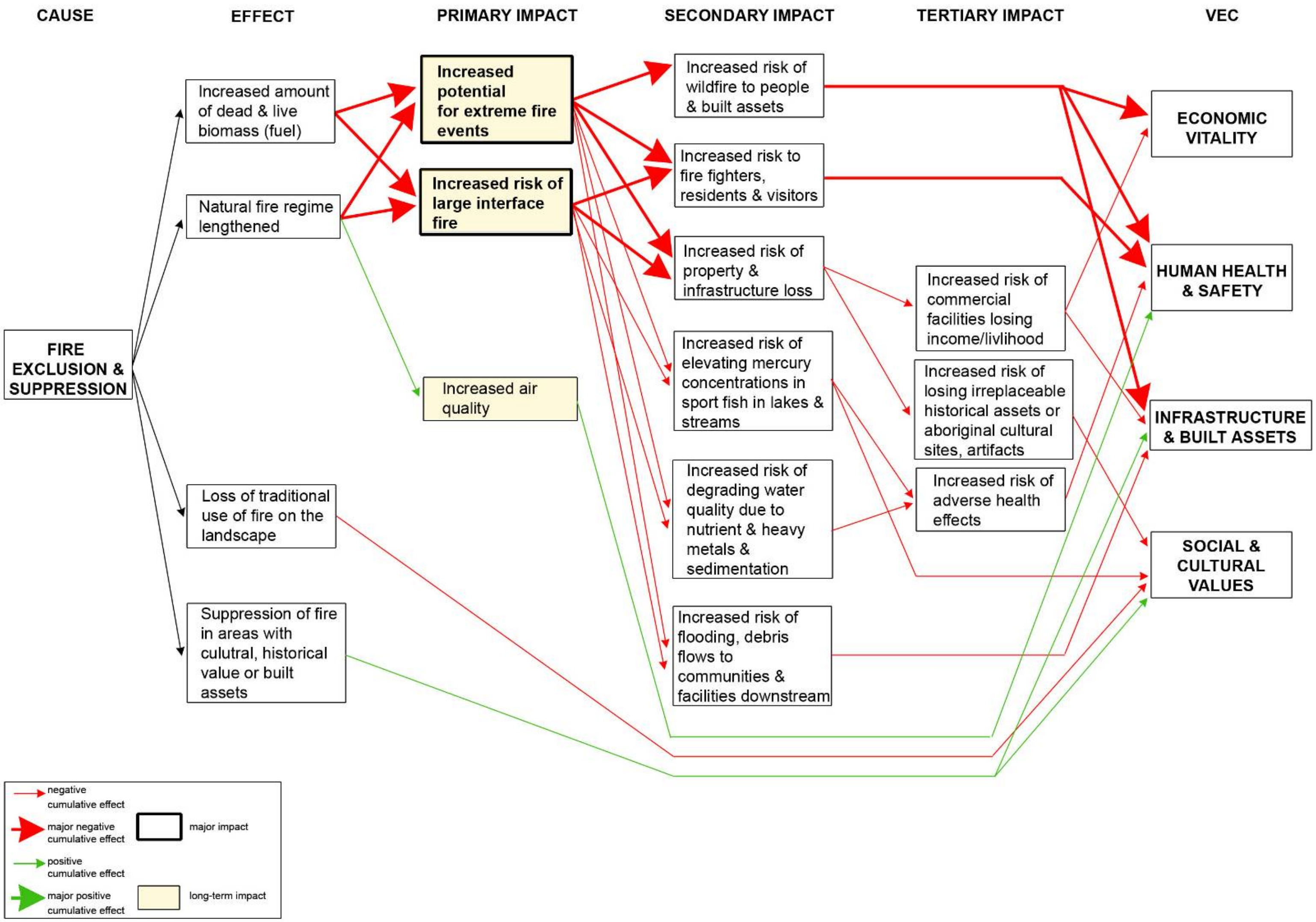


Figure 5.12 Network diagram of the cumulative social effects of fire exclusion and suppression on VECs.

5.6 Cumulative Effects Assessment of Current Fire and Fuels Management Program

This section discusses the cumulative effects of the current fire and fuel management programs in Banff, Jasper, Yoho and Kootenay National Parks and surrounding provincial lands in B.C. and Alberta on the ecological and social VECs (section 5.3).

5.6.1 Current fire management context

The current fire management plans are based on the paradigm that ecological integrity is maintained by maintaining the historical or long-term variability in ecosystem states and processes (White et al, 2003) as directed under the park management plans (Shepherd and McDonald 2007, Parks Canada 2008, DeLong et al. 2008). The principles of the paradigm are: 1) current ecosystems are the product of past conditions and processes; 2) spatial and temporal variability in disturbance regimes are a vital attribute of ecosystems; and 3) maintenance or restoration of long-term ecosystem states and processes will conserve biodiversity (Landres et al. 1999). In the Rocky Mountain ecosystem the main disturbance agent and source of variability across the landscape is fire and therefore this process is necessary to the maintenance of ecological integrity in the mountain national parks.

Under the current fire management plans prescribed fire is used to restore and maintain the ecological integrity of ecosystems in areas of the parks where other values-at-risk are not threatened. Fuel management through forest thinning and prescribed fire is used to reduce risks of uncontrolled wildfire to people and built assets and allows for the safe application of prescribed fire for ecosystem restoration purposes over a larger area in the parks. Fire suppression is also used in areas where fire directly threatens people and built assets. In this section the cumulative effects of prescribed fire and fuel management on identified VECS is discussed.

5.6.2 Cumulative Effects of Prescribed Burning on Ecological VECs

5.6.2.1 Extent of prescribed fire on the landscape

Under the current fire management plans, there are two types of prescribed fire that occur in the mountain parks: (1) random ignition prescribed fires: accidental fire ignition by humans or lightning that is allowed to burn “under prescription” in intermediate and extensive fire zones to meet ecosystem management objectives under certain circumstances, and (2) management–ignited prescribed fires: fire that is ignited by Parks Canada to meet ecosystem management objectives.

In the mountain parks 25% of the total landbase (excluding non-fuel zones) is in extensive fire zones where random ignition prescribed fire could be allowed to burn under most circumstances and 31% is in intermediate zones in which wildfires are only allowed to burn under certain circumstances where other values-at-risk are not threatened. These fire management zones are located primarily in areas with few built assets and backcountry areas of the parks where accidental human ignition is uncommon (Figure 5.13). In addition there is low probability of lightning-ignited fire in 85% of the mountain national park land base on the eastern side of the Continental Divide (Wierzchowski et al. 2002). Therefore to date random ignition prescribed fire has been rare in the mountain national parks especially in Banff and Jasper on the eastern side of the divide. Since the inception of fire management zoning there has only been one lightning-caused wildfire that has been allowed to burn under prescription in Kootenay National Park.

When they do occur, these fires are usually ignited when fire hazard ratings are high in mid-summer and consequently burn large areas in a short time with high severity (White 1985). Historically in BNP 2% of fires result in greater than 95% of the total area burned.

The use of management-ignited prescribed fire (hereafter referred to simply as prescribed fire) in the mountain national parks started in 1983 with small scale fires in the Banff field unit but these burns were implemented with the objective of training fire management personnel and were therefore small in size (Table 5.9). The first prescribed burns in Jasper were carried out in 1988, 1998 in Kootenay and 1999 in Yoho.

Over the last three decades the number and size of fires on the landscape of the mountain national parks has been steadily increasing (Table 5.9, Figure 5.14). From 1998-2007 there were 70476 ha burned by prescribed fire and wildfire, a ten-fold increase from the previous decade. The proposed prescribed burns for the next decade from 2008-2017 total 41000ha of park land (50% of the long-term fire cycles in the parks) and when the likelihood of having several large random-ignition prescribed fires is factored in there is a high probability that the trend of increasing fire on the landscape will continue for the next decade.

In addition, prescribed fires are now being ignited on adjacent provincial lands in Alberta (Kananaskis, R11 Forest Management Area and Willmore Wilderness) and British Columbia (Kakwa and Mount Robson Provincial Park) to control the outbreak of mountain pine beetle and to restore fire to ecosystems negatively affected by fire suppression and exclusion. The strategies to manage fire on these adjacent provincial lands are detailed in protected area management plans, forest health strategies and dedicated fire management plans which have recently been completed (Table 5.10). From 2008-2017 there are a total of 54 proposed prescribed burns covering a total of 66258 hectares on Alberta provincial lands bordering the national parks along the eastern slopes of the Rocky Mountains. Together with the prescribed fires planned for the mountain national parks, more than twice the amount of land will be burned by prescribed fire in the Rocky Mountain ecosystem from 2008-2017 than in the previous decade.

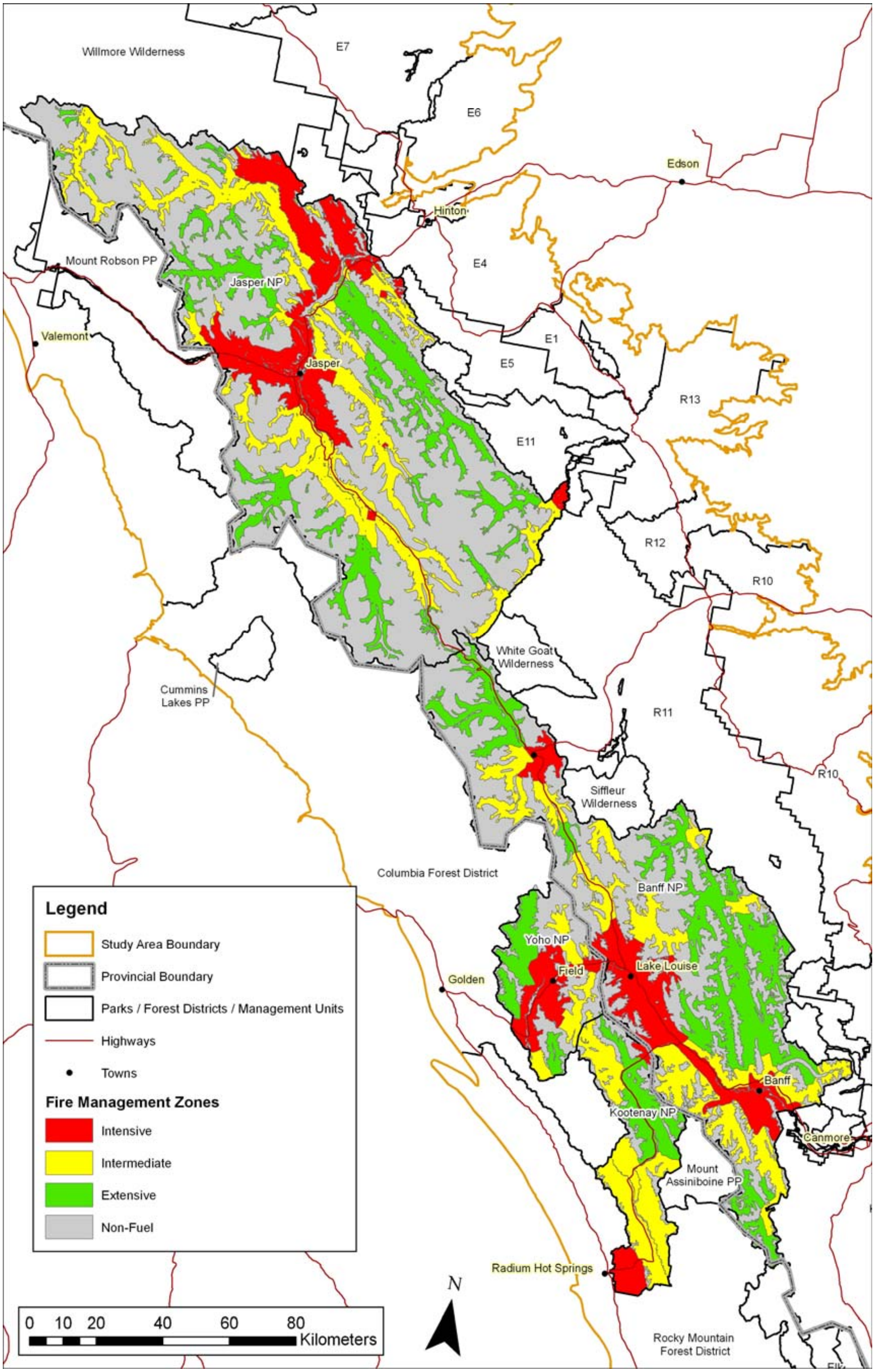


Figure 5.13 Fire management zones in the mountain national parks.

Table 5.9 Prescribed burns, wildfire and proposed prescribed burns from 1978 to 2017 in the mountain national parks and adjacent provincial lands in Alberta and British Columbia.

Numbers in parentheses are percent of area burned by prescribed fires.

Protected area/forest management area	Jurisdiction	1978-1987[a]		1988-1997		1998-2007		2008-2017		TOTAL by park/ area
		# of fires	ha	# of fires	ha	# of fires	ha	# of fires	ha	
Banff NP	Parks Canada	14	419 (99)	27	5531 (99)	76	17432 (98)	41	14000(100)	37382
Jasper NP	Parks Canada	66	822 (0)	74	1077 (97)	103	31553 (91)	53	19000 (100)	52452
Kootenay NP	Parks Canada	13	36 (0)	43	637 (0)	60	20095 (7)	8	5000 (100)	25768
Yoho NP	Parks Canada	18	55 (0)	19	17 (0)	17	1396 (99)	7	3000 (100)	4468
Kananaskis	SRD, Alberta	0	__	0	__	0	__	21	23058 (100)	23058
R11 FMU	SRD, TPRC, AB	1	234		926	5	3699	28	10427[c] (100)	15286
Other Alberta FMUs	Forest licensees, AB	3	836	6	3302	25	9629	0	__	13767
Willmore Wilderness	CD, SRD, Alberta	1	1083	0	__	4	21990	5	32773 (100)	55846
Columbia Forest District	B.C. For Serv., B.C.	100	2452	92	1562	178	8134	0	__	12148
Headwaters Forest District	B.C. For Serv., B.C.	116	1561	81	1560	139	3030	0	__	6151
Rocky Mountain Forest District	B.C. For Serv., B.C.	207	11794	79	1135	284	13814	0	__	16151
Height of the Rockies Prov. Park	B.C. Parks., B.C.	3	1	0	__	7	14098	0	__	14099
Mt. Robson Prov. park	B.C. Parks, B.C.	10	5	7	116	14	10549	0	__	10670
Mt. Assiniboine Prov. Park	B.C. Parks, B.C.	2	5	3	2	5	421	0	__	428
TOTAL by decade		554	22303	431	15865	917	155840	236	107258	

a The prescribed fire program was initiated in Banff NP in 1983, for Jasper, Yoho, and Kootenay the prescribed fire program was initiated in the next decade.
b Target burned areas from Fire Management Plans for Banff, Jasper, Kootenay and Yoho National Parks, this number may be higher due to random ignition prescribed fires
c R11 fire management plan is for 50 years, numbers in the table reflect totals divided/5 to get average prescribed burn area per decade

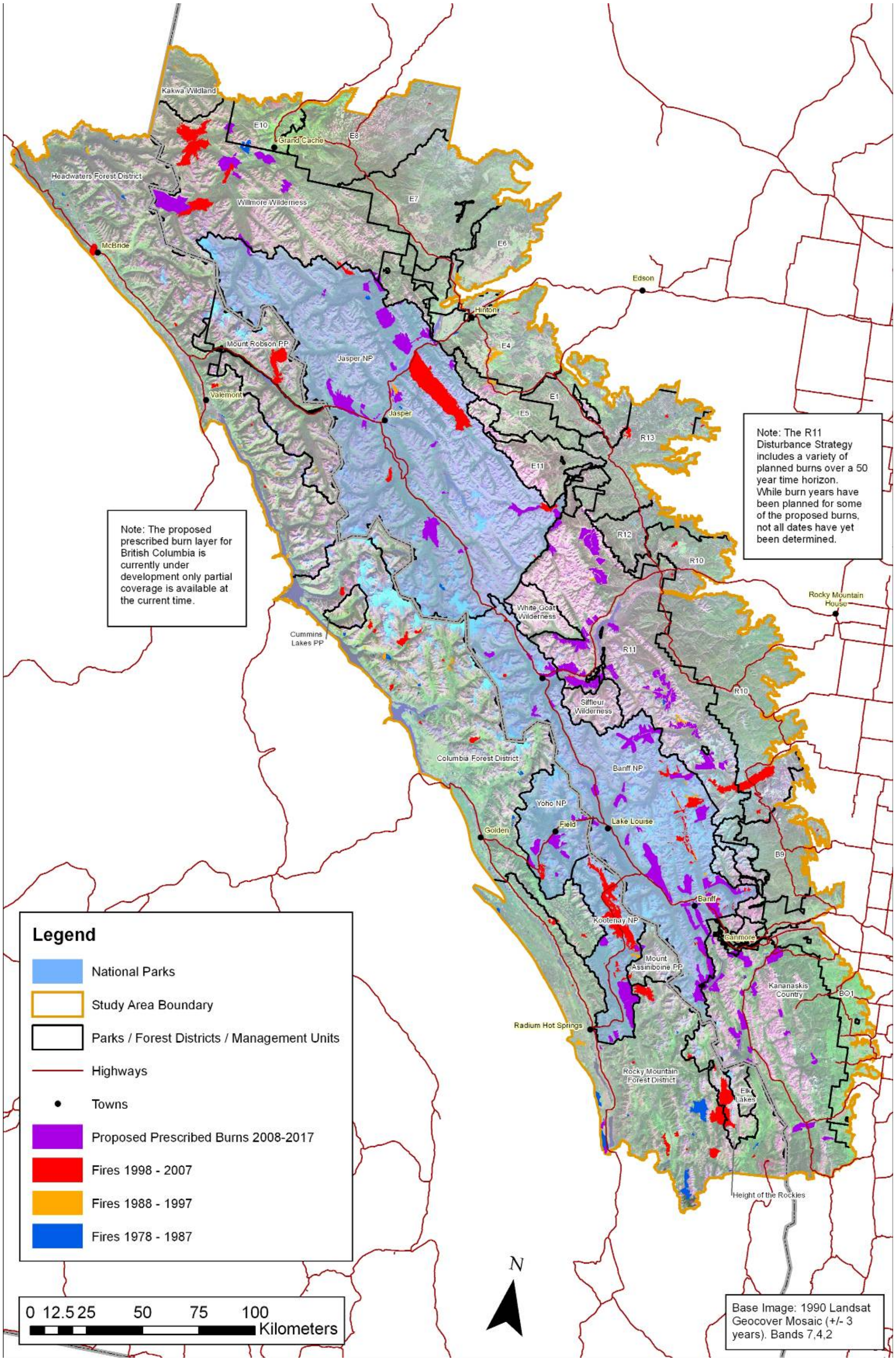


Figure 5.14 Wildfire and prescribed fire in the Rocky Mountain ecosystem from 1978-2007 and proposed prescribed fire from 2008-2018.

Table 5.10 Management plans and strategies guiding fire management in adjacent provincial lands in Alberta and B.C.

Protected area/ Forest Management Area	Jurisdiction	Management Plan or Strategy
Kakwa Provincial park and protected area	B.C. Parks, B.C. Min. Env. and AB SRD[1]	Management Plan for Kakwa Provincial Park and Protected Area (B.C. Min. Env. 2006)
Mt. Robson Provincial Park	B.C. Parks, B.C. Min. Env.	Forest Health Strategy for Mt. Robson Provincial Park (Blackwell and Assoc. 2005)
Kananaskis Country	Alberta SRD and TPRC[2]	Kananaskis Country Vegetation Management Strategy (Walkinshaw 2007)
R11 Forest Management Area	Alberta SRD	R11 Forest Management Plan (Alberta SRD 2007)
Willmore Wilderness Park	Alberta CD[3] and SRD	Willmore Wilderness Park Fire Management Plan (Graham and Quintilio 2006)

1 Alberta Sustainable Resource Development
2 Alberta Tourism, Parks, Recreation and Culture
3 Alberta Community Development

5.6.2.2 Fire Deficits

The underlying goal for the fire management program is to restore fire to park ecosystems to maintain the long-term range of variability in ecosystem states and processes. Recent fire cycle calculations and analysis for Banff National Park (the only park for which this data is available) up to and including 2007 reveal that despite 25 years of fire restoration in the parks fire deficits are accumulating in all fire cycle classes (Rogeau et al. 2004, White et al. 2003) (Figure 5.15). This is due to:

- Lightning-caused wildfires east of the Great Divide that could be managed as prescribed fires through indirect containment options have been rare in Banff National Park during the past 25 years. Lightning strikes that do occur tend to happen within zones designated as full suppression (Intensive management zones) where significant values at risk exist (Wierzchowski et al. 2002).
- By definition the Parks Canada goal of achieving 50% of the long-term fire cycle will result in ever-increasing fire deficits if there is no significant wildfires to contribute to the overall area burned
- Prescribed fires to date have been primarily limited to light severity burns during the short spring and fall seasons. In many years, wet weather has forced fire managers to defer burns to subsequent years further increasing fire deficits.

These fire deficits are even greater when considering the entire study area for this project including provincial lands in B.C. and Alberta where fire suppression has been the dominant fire management policy to date (Walkinshaw 2007, Rogeau 2004)

A detailed analysis of burned area by fire cycle class for each Ecological Management Area (EMA) in BNP reveals that currently the Parks Canada objective of achieving 50% of the long-term fire cycle is being attained or exceeded in 4 of 11 fire cycle classes from 2001-2007 (Figure 5.15).

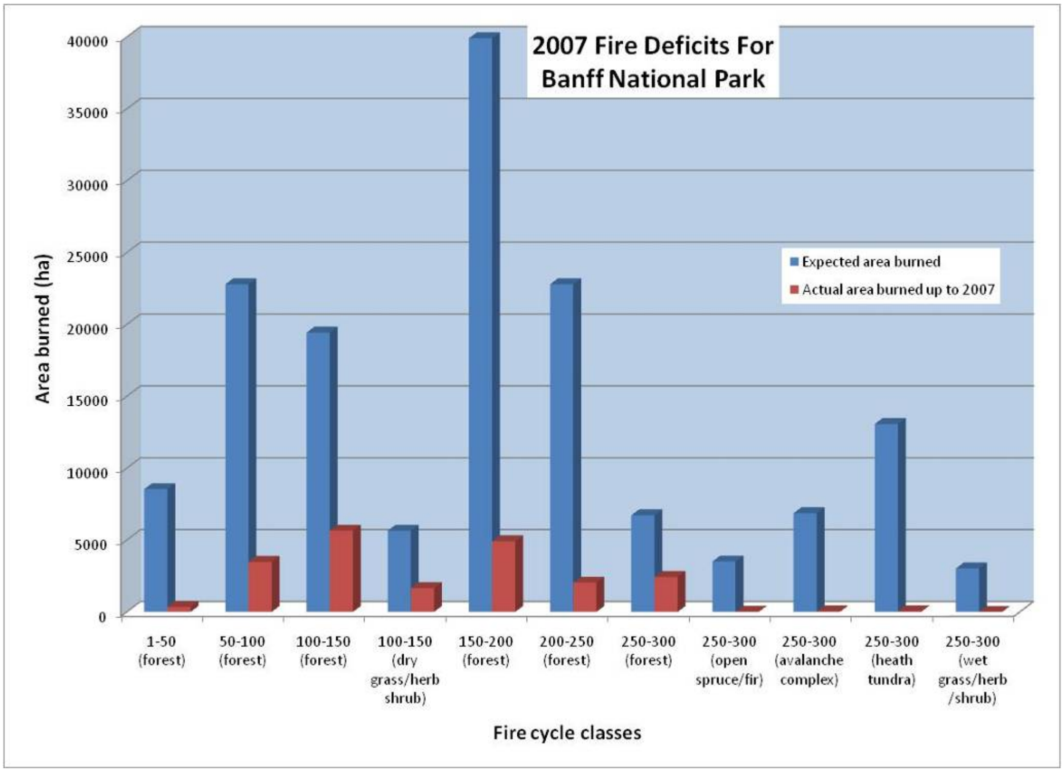


Figure 5.15 Cumulative fire deficits for Banff National Park as of 2007 (start of monitoring period varies from 1900 to 1983 between fire cycle classes).

In general there has been a lack of burning in the shortest fire cycle class of 1-50 years (open montane forest) in all three EMAs and in the rarely burned areas in the high subalpine and alpine areas of the park (Figure 5.16). In the Spray/Bow EMA which encompasses the lower Bow Valley there also needs to be more burning in the 150-200 and 200-250 fire cycle classes to meet the 50% objective (Figure 5.17). The proposed prescribed burns under the BNP fire management plan for the next decade will address many of these deficits with burns planned for older forest age classes in the subalpine.

Currently a project is underway to calculate fire deficits for Jasper National Park by fire cycle class (D. Smith pers.comm.). In the future more detailed planning of prescribed fire to address area burned targets by fire cycle class will likely become consistent across the parks as fire deficit information becomes incorporated into fire planning in all three field units.

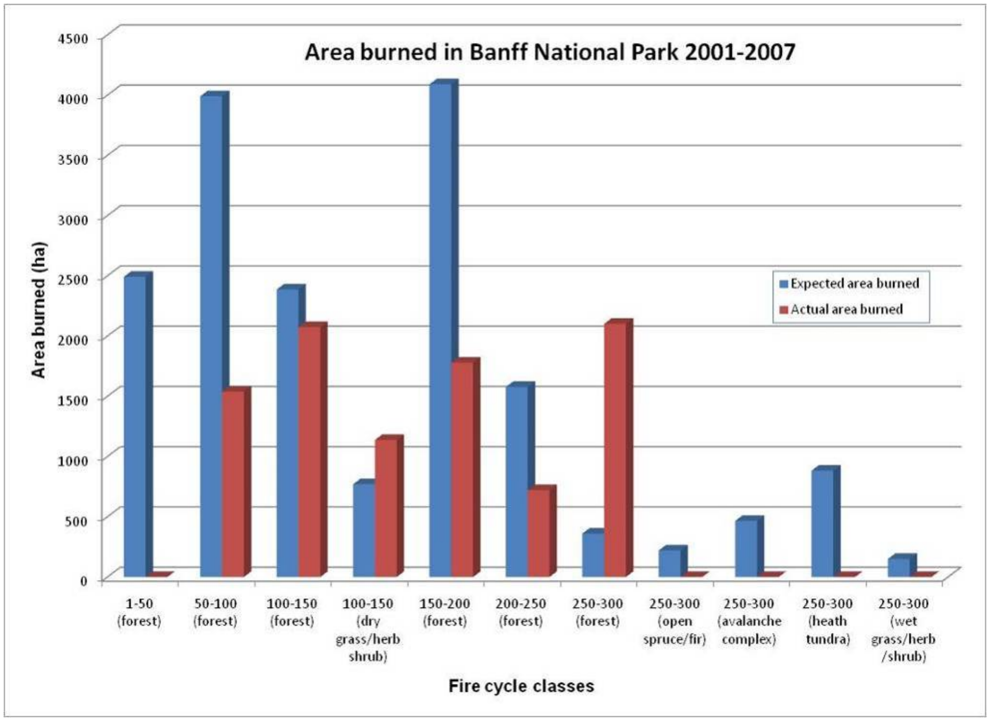


Figure 5.16 Area burned in Banff National Park from 2001-2007 compared to expected rate of burning (according to historical fire cycles).

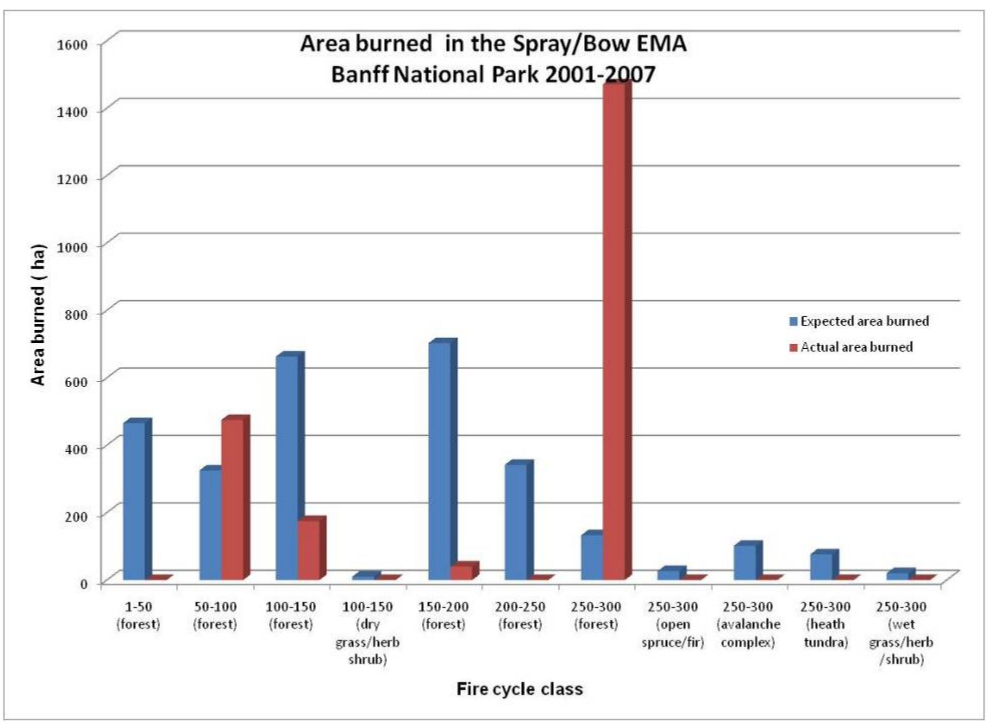


Figure 5.17 Area burned in the Spray/Bow EMA in Banff National Park from 2001-2007 compared to expected rate of burning relative to historical fire cycles.

5.6.2.3 Biodiversity

Cumulative effect of prescribed fire on biodiversity: In the short-term some organisms may have increased mortality and decreased survival rates during and in the first few years following fire but over the long-term prescribed fire will increase the diversity of vegetation, habitats and wildlife on park landscapes.	
Direction: positive (long-term)	**Magnitude:** major
Geographic extent: Rocky Mountain ecosystem	**Duration:** long-term

As discussed in section 5.5, fire exclusion has negatively impacted biodiversity at all trophic levels in the ecosystems of the mountain national parks. The prescribed fires that have been and will be implemented on park landscapes and surrounding provincial lands will have increasing effects on the structure and function of park ecosystems for the next few decades as fire restoration programs mature and all the mountain parks achieve the goal of restoring 50 % of the long-term fire cycle. Over the next 50 years there will be an ever-increasing amount of land that is relatively recently burned in park ecosystems and during this period the reburning of previously burned areas with short fire cycles will be initiated (B. Low, pers.comm). The resulting mosaic of stand ages on the landscape will have cumulative effects on biodiversity of both aquatic and terrestrial ecosystems in the parks. There are positive and negative effects of fire on biodiversity that operate over short (0-5 years post-fire), medium (5-20 years post-fire) and long timescales (20-100 years post-fire).

Vegetation and soil

Prescribed fire has direct effects on two main parameters in ecosystems. Firstly, fire consumes or partially consumes trees and understory vegetation and resets the ecosystem back to an earlier stage of succession. Secondly, it partially or wholly burns the top organic layers of the soil and heats the soil to varying degrees thereby changing the soil properties. Fire severity is a measure of fire effects on vegetation and soil and is a function of fuel loads, fire residence time, soil moisture, terrain, and weather conditions during the fire. Fire severity varies greatly from fire to fire and at local and landscape scales within the same fire (Turner and Romme 1994, Andison 2004). This results in a complex of unburnt islands and corridors within most fires and can result in highly irregular and convoluted burn edges (Andison 2004). In addition most riparian zones burn as often, and as severely, as upland forested areas (Andison 2002). Local fire weather conditions are likely the main variable determining how often riparian areas burn and how severe the fire is in these zones (Andison 2002). Disturbance by fire is a common and therefore presumably important process for all riparian zones in the study area.

Unburnt areas within fires serve an important function as refuge for small mammals, amphibians, invertebrates and soil microorganisms, during fire and a source for recolonization post-fire. These areas are also a critical source of seed and rhizotomous plant species that recolonize adjacent burned areas where above and belowground plant structures have been killed by fire.

The variability in fire severity and burn pattern within and between fires corresponds to an increase in the species and structural diversity of regenerating post-fire vegetation communities. This increase in diversity operates at multiple scales from increases in plant species richness (alpha diversity) at the local level to increased patchiness of vegetation complexes within a burned watershed (beta diversity) to creation of mosaics of stand ages and composition at the regional level (gamma diversity) (Whittaker 1972) (Figure 5.18).

Fire results in a range of fire effects on vegetation from a light burning of surface fuels and understory vegetation to almost complete consumption of all overstory trees and understory vegetation. Low to moderate severity fire associated with most prescribed burns in the mountain parks serves to open up dense conifer canopies and allow regeneration of species such as lodgepole pine, aspen, balsam poplar, willow, and buffaloberry which have gradually succeeded to shade tolerant spruce and subalpine fir in the absence of fire (Hamer 1996, White 1985). The understory vegetation becomes more diverse post-fire with moss dominated understories being replaced by a range of perennial forb and shrub species which are often present with low cover and vigour under closed conifer canopies (Brown et al. 2000).

Following fires many plant species also re-establish in burned areas from extensive seedbanks contained in partially consumed duff layers. Many of the species whose seed is stored in forest floor duff layers are fire-adapted and are stimulated to germinate differentially according to the amount of soil heating and duff consumption (Brown et al. 2000). Most conifer species regenerate from seed contained in serotinous cones on the forest floor or canopy (lodgepole pine) or are released from maturing cones on partially burned or unburned trees (Brown et al. 2000). Therefore the composition of the tree, shrub and forb layers in regenerating forests in the mountain national parks can vary widely according to fire severity and post-fire conditions.

Prescribed fires in the national parks have variable effects on soil as well, creating a patchwork of post-fire soil conditions from removal of surface litter to complete consumption of organic layers in soils and alteration of the underlying mineral soil (Wells et al. 1979). When the organic layers are thin or moisture content is low, fire consumes more of the forest floor and has the potential to change mineral soil properties (Reinhardt et al. 1991) which in turn affects the rate of vegetation recovery and composition of post-fire communities over time. With increasing fire severity there are more patches of mineral soil exposed following fire which provides suitable habitat for establishment of early seral species such as fireweed, and other pioneer species like nitrogen fixing plants (Newland and DeLuca 2000) that are adapted to colonizing these open post-fire habitats.

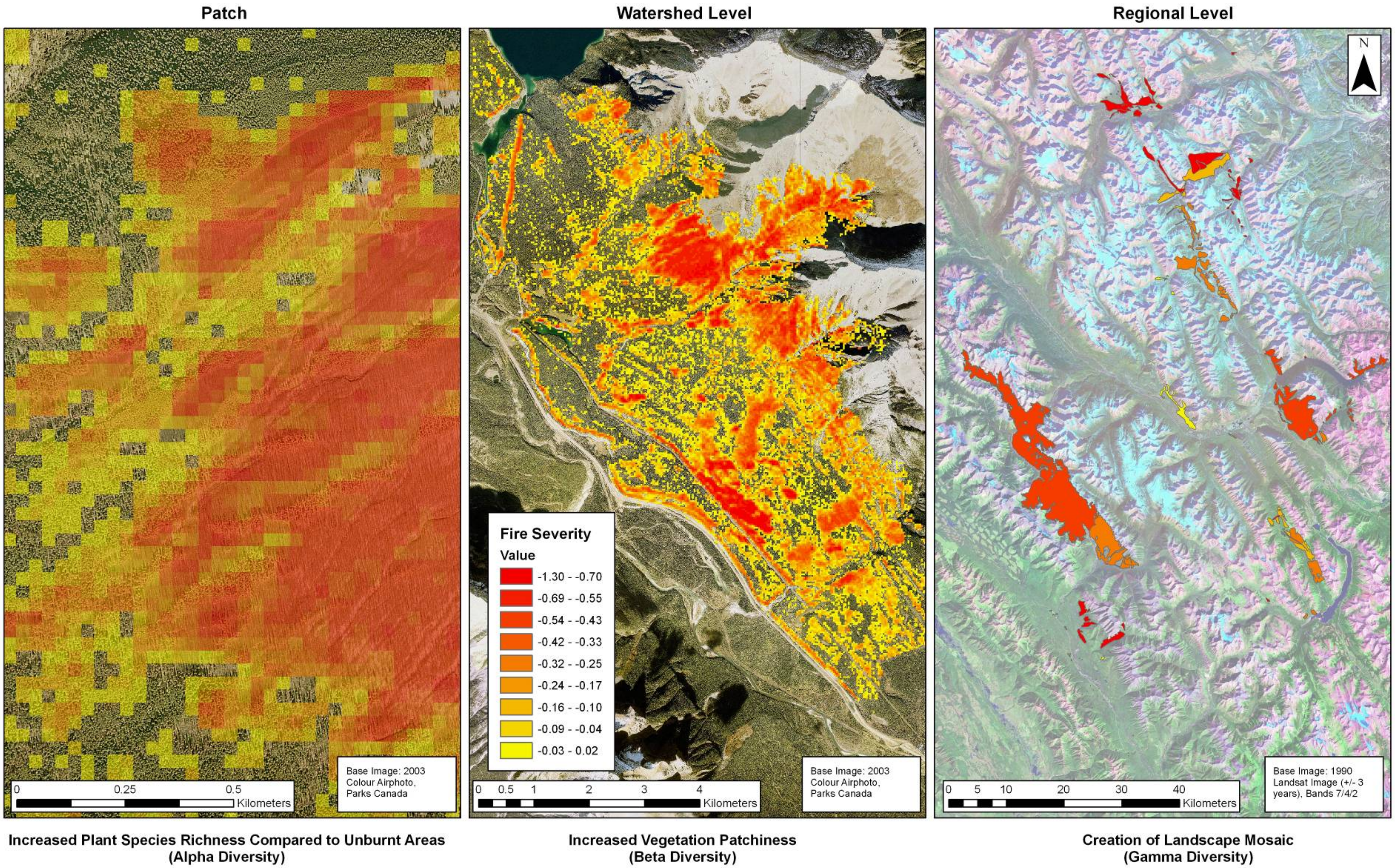


Figure 5.18 Multiple scales of vegetation and habitat diversity resulting from fire at the patch, watershed and regional levels.

Rare plants

The effect of prescribed fire on rare plants in the mountain parks is likely to be positive or neutral. Fire helps maintain open habitat where many rare plants are found, increases reproduction, and decreases the cover and abundance of competing plants (Hessel and Spackman 1995).

In the montane areas of the parks the rare plants in these fire adapted grasslands and open forests are adapted to and benefit from fire since they evolved in an environment which experiences fire on average every 25-40 years. Common responses of grassland plants to fire include increased flowering, increased vigour and productivity, and increased germination and recruitment (Daubenmire 1968,Vogl 1974, Glenn-Lewin et al. 1990).

In the mountain parks many of the rare plants are found in wet areas (wetlands, seepage areas) or high alpine areas (Gould 2006). These habitats rarely burn and when they do burn the fire is generally of low intensity and severity due to low fuel loads and/or high moisture content of fuels. Consequently rare plants in these habitats would likely be minimally affected by fire and even if fire does affect the upper portion of the plant most would resprout from unaffected belowground structures and root systems. In the U.S. a review of the habitat requirements of 186 federally listed rare plant species that occur on National Forest System Lands revealed that 25% were fire adapted and needed fire to maintain populations, 35% were fire tolerant (fire has no affect on long-term persistence of these species) and 38% were unaffected because they grow in habitats that never experience fire (e.g. aquatic plants) (Owen and Brown 2005). In this survey only 2% of the rare plants (4 species) were found to be negatively affected by fire and these are associated with old-growth forests. Based on the list of rare plants known to occur in the mountain parks (Gould 2006, BC CDC 2007), the majority of these species would be positively affected or unaffected by prescribed fire.

Habitat diversity

Fire increases not only the diversity of vegetation but also increases the variability in ecosystem states and processes at the landscape scale. The within and between fire variability in fire severity produces variability in post-fire hydrological cycles and nutrient cycles in these burned areas compared to unburned areas as well as contributes to an increase in overall structural diversity of ecosystems. All of these factors lead to increased habitat diversity across park landscapes over the long-term which contributes to the maintenance of diversity of organisms at all trophic levels.

Wildlife diversity and abundance

Despite the perception by the general public that wildland fire is devastating to animals, fires generally kill and injure a relatively small proportion of animal populations (Lyon et al. 2000). However, fire may have detrimental effects on a population of a species that is already small and at risk of extirpation if the species is limited in range and mobility or has specialized reproductive habits (Smith and Fischer 1997).

Large herbivores

Prescribed fire has little effect on alpha diversity (species richness) of large herbivores in the mountain national parks but it can influence size of populations and their distribution on park landscapes (J. Whittington, pers.comm.). Prescribed fire serves to increase habitat quality for large herbivores such as elk, deer, moose, and sheep by opening up closed canopies and increasing growth of palatable forage such as grasses, willow, and forbs in the understory (Smith et al. 1999, Sachro et al. 2005). This can have a positive influence on recruitment rates and overall population levels. Prescribed fire can be used to create high quality ungulate habitat away from areas of high human use (e.g. townsites, unfenced highways, railway) to reduce human-wildlife conflicts and highway mortality. Thus prescribed fire contributes to the maintenance of healthy herbivore populations on park landscapes which are a vital component of park ecosystems and an integral part of the overall biodiversity.

Carnivores

Prescribed fire on park landscapes has an indirect positive effect on large carnivore populations although fire doesn't directly affect diversity of predators because they have such large home ranges. Cougar and wolf abundance has been found to be spatially and temporally correlated with ungulate abundance (Riley and Malecki 2001, Paquet et al. 1996) The patchwork of prescribed fires across park landscapes serves to create patches of high quality habitat for their prey in turn increasing habitat effectiveness for predators such as wolves, cougars, and grizzly bears especially in areas of low human use (Paquet et al. 1996).

Forest carnivores such as fisher, marten, and wolverines, and lynx prefer habitats with high structural diversity and abundant course woody debris (CWD), usually in coniferous forests. Marten and lynx are found in early seral post-fire habitats. In Alaska martens have been reported to occur in early post-fire stages where tree boles have fallen to the ground in dense networks or where herbaceous growth is dense (Buskirk 1994). Lynx favour landscapes with a mix of mature forest patches and post-fire early seral stands that have abundant snowshoe hare, their primary prey (Koeler and Aubry 1994).

Wolverines have large home ranges but in the absence of human disturbance are mostly influenced by abundance of forage and prey (Banci et al. 1994). Prescribed fire increases habitat for microtine species, snowshoe hare, ungulates which are all preferred prey of wolverines. Habitat for fisher is comprised primarily of closed conifer stands with high structural diversity for resting and denning. However, the high amount of edge produced by low-moderate intensity fire can create open habitat with abundant prey adjacent to patches of mature forest (Powell and Zielinski 1994). Therefore the reintroduction of fire to the landscape through prescribed burning serves to improve landscape variability that provides high quality habitat for all of these carnivores rather than favouring some species over others.

Birds

The increased diversity of vegetation communities and stand ages associated with reintroduction of fire to the landscape will have positive effects on the diversity of avifauna at the landscape scale. This effect has been documented in many fire-dependant ecosystems in the Rocky Mountains (Saab et al. 2005) and the boreal forest (Stuart-Smith et al. 2002). Many studies indicate that avian species richness and abundance increases in burned areas compared to adjacent unburned areas, despite the fact that many mature forest dependant species decline in abundance post-fire. In general cavity nesters, insectivores that feed on insects that colonize recently burned trees, and ground foragers benefit from fire (Schiek and song 2006) whereas foliage and bark gleaners are less abundant in burned areas.

Some species such as black-backed woodpeckers and American three-toed woodpeckers are specialists adapted to both immediate post-fire habitats and old-growth and generally experience large increases in populations in recent burns (Hoyt and Hannon 2002, Murphy and Lehnhausen 1998). However, current research in Jasper National Park indicates that woodpecker response to burned areas may vary according to post-fire ecosystem attributes, which vary among and between burns (Shawna Pelech pers. comm.) In particular, large areas of very high burn severity, as seen in portions of Syncline fire in JNP (2003), may not provide suitable foraging habitat for these birds because food sources (i.e. beetle larvae) can be reduced in highly charred trees (Saint-Germain et al. 2004). This variation in avian species response to varying fire severity has been documented in other studies (Kotliar et al. 2007) and adds another layer of habitat variability which contributes to overall increases in avian diversity that will occur as a result of prescribed burning on park landscapes.

Small mammals

Most of the literature describing fire effects on small mammal populations is from studies of stand replacement and mixed-severity fire both of which occur in the mountain national parks. Like birds, small mammals respond directly to fire-caused changes in cover and food. Some species increase in abundance following fire whereas some decrease following fire according to the extent to which post-fire habitats meet their food and cover needs (Smith et al 2000). At the landscape scale increased landscape heterogeneity caused by fire serves to increase or at least maintain the diversity of small mammals over time in park ecosystems. In general these species including mice, voles, squirrels ground squirrels, and snowshoe hares, have high reproductive rates. Therefore if post-fire habitat provides food and shelter for them, their populations recover rapidly from any direct mortality caused by fire.

Invertebrates

Invertebrates account for over half of the total animal diversity in many ecosystems including forested landscapes (Niwa et al. 2001). A recent review of fire effects on diverse groups of invertebrates including detritivores, predators, herbivores and pollinators indicates that response to fire is highly variable in accordance with the diverse life histories, breeding locations, timing and severity of fires, and how quickly they can repopulate burned areas from source populations in unburned refuge (Pilliod et al. 2006). The species richness and abundance of many invertebrate species responds positively to fire, while others are negatively affected by fire and still others are unchanged by fire. There are many species of insects that are post-fire specialists that invade dead and dying trees immediately following fire. These insects (mainly beetles) are a large food source of the woodpeckers that occupy recently burned habitats. Therefore similar to birds and small mammals, increased variability across the landscape created by prescribed fire increases the overall diversity of invertebrates at the landscape scale (McCullough et al. 1998).

Amphibians

Similar to birds and small mammal, there are several probable pathways that amphibian populations can follow following fire depending on whether they are adapted to post-fire habitats and whether they are a rare or particularly sensitive species (Figure 5.19). Some amphibian species can increase in abundance immediately following fire, some can decrease in response to disturbance and then increase after the habitat has regenerated, sensitive species may decline dramatically in response to fire while other populations may be unchanged (Bury et al. 2002, Pilliod et al. 2003,Bury 2004). Generally response to fire varies by species, and timing and location of burn relative to breeding habitat.

The literature on the effects of prescribed fire on amphibians from the mountain parks is limited. Currently there is one long-term research project in Banff National Park looking at the effect of prescribed fire and fuel management on amphibian populations (Lepitzki, 2006).

Preliminary evidence from a study in Oregon and California suggests no negative effects of wildfire on terrestrial amphibians, but stream amphibians decrease following wildfire (Bury 2004). In a review of research conducted in the southeastern states , Russell et al. (1999) suggested that prescribed fire would likely benefit herpetofauna in the southeastern coastal plain and other fire-maintained ecosystems by restoring historical mosaics of successional stages, habitat structures, and vegetative species compositions. Kirkland et al. (1996) found American toads (*Bufo americanus*) in higher abundances in burned than unburned areas and boreal toads (*Bufo boreas*) also increased in abundance following fire in Glacier National Park, Montana (Guscio 2007).

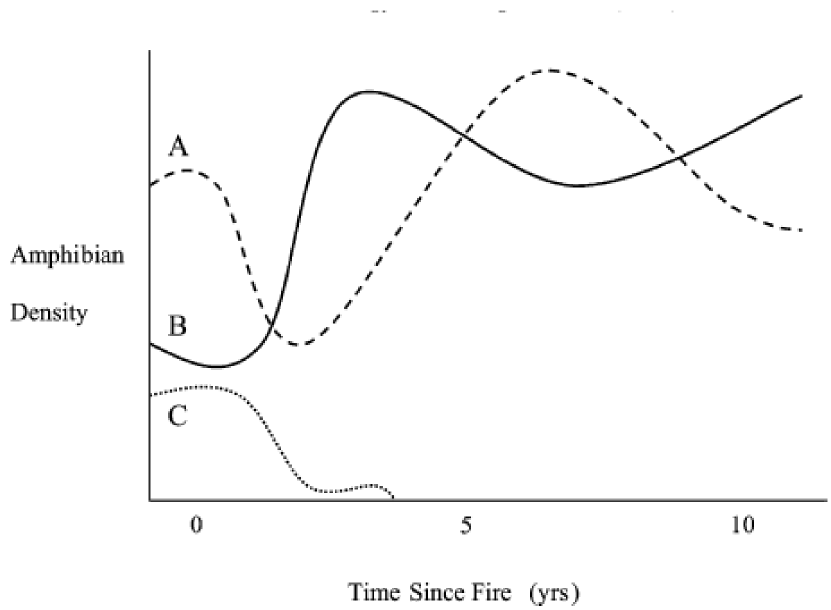


Figure 5.19 Predicted responses of different amphibians to fire and fire-related habitat changes over time.

Line A represents a possible response to fire for species that are initially sensitive to disturbance but benefit from long-term increases in productivity. Line B represents a possible response to fire for species that benefit from predator release, competitive release, or opening of forest canopy that was closed due to years of fire suppression. Line C represents a possible response to fire for rare, sensitive species (low densities or limited distribution) that are negatively affected by fire. (source: Pilliod et al. 2003).

The creation of heterogeneous habitats through prescribed fire and the varied responses of amphibian species to this activity will maintain or increase amphibian diversity on park landscapes over time.

Aquatic organisms

In the short-term prescribed burns may have a significant negative effect on aquatic organisms by altering habitats including causing large inputs of sediments and increased stream temperatures. In the first few years post-fire these habitat alterations can cause significant mortality in invertebrates (Minshall 2003), amphibians (Pilliod et al 2003; Bury 2004), and fishes (Rieman et al. 1997; Burton 2005).

However, all of the native aquatic species in fire-dependant ecosystems such as those in the mountain national parks are adapted to these large disturbance events (Reiman and Clayton 1997). Following the short-term mortality many populations of fish recover and exceed pre-fire levels in 1-10 years after a large fire event (Minshall 2003, Sestrich 2005, Dunham 2007), repopulated from refugia in unburnt stream reaches created by the variation in fire severity on the landscape (Figure 5.18). Fire causes episodic or “pulse disturbances” in aquatic ecosystems causing large inputs of course woody debris and sediment which contribute to the creation and maintenance of complex instream habitats (Reiman and Clayton 1997). Native aquatic organisms are adapted to this spatial and temporal complexity created by fire and will recover quickly to these large-scale disturbances if they have large, well connected and complex habitats minimally influenced by anthropogenic disturbance (e.g. habitat degradation, roads, culverts) and non-native species. In fact the vulnerability of many species to fire-related losses has increased due to fire suppression (Minshall 2003) which can lead to uncharacteristically severe and intense wildfires that are not part of the historical fire regime especially in montane ecosystems. Therefore in the mountain parks restoring fire through prescribed burning is essential to the long-term maintenance of native aquatic organism diversity.

Current spring and fall prescribed burning program

<table>
<tr><td colspan="2">Cumulative effect of current prescribed fire program on biodiversity: The current spring and fall prescribed burns do not replicate the full range of variability in fire size, severity, intensity and pattern across park landscapes and may lead to decreased biodiversity over time.</td></tr>
<tr><td>Direction: negative</td><td>Magnitude: minor</td></tr>
<tr><td>Geographic extent: Rocky Mountain ecosystem</td><td>Duration: long-term</td></tr>
</table>

As discussed, there is a large volume of literature that supports the idea that fire maintains or increases biodiversity of fire-dependant ecosystems. However with the prescribed fire programs under the current fire management plans for the four mountain national parks the full range of historical fire severities, intensities, sizes and patterns have likely not been realized on park landscapes (Wierzchowski 1995, White et al. 2003). To date almost all of the prescribed fires have been ignited in spring and fall to reduce the risks of escaped fires and minimize the negative effects of prescribed burns on visitor and residents of the parks (smoke, disruptions during tourist season). However, infrequent stand-replacing fires in sub-alpine forests ignited by lightning under very dry conditions in the summer are not being replicated under the current prescribed burning program. Most of the prescribed burns implemented also have different ignition patterns and fire spread patterns than natural wildfires due to cooler, wetter weather conditions, little wind and higher duff moisture contents associated with spring and fall burns compared to mid-summer fires (Weirzchowski 1995).

The main differences between the fire effects of prescribed fire and stand-replacing wildfire on the landscape appear to be lower overall fire severity and increased patchiness (unburnt areas within fires) in prescribed fires. This continued exclusion of high to very high severity fires on the landscape and the associated large-scale effects they have on ecosystem structure and function could have negative effects on maintaining the full complement of biodiversity over the long-term.

Mitigation measures for impacts of prescribed fire on biodiversity:

- *Initiate some prescribed fires later in spring or earlier in the fall to get some fires that burn with higher intensity and severity to better mimic historical patterns of wildfire and maintain historical variability in ecosystem states and processes*

5.6.2.4 Species at Risk

American badger, *jeffersonii* subspecies

Cumulative effect of prescribed fire on badger populations: Prescribed fire can create high quality habitat for this endangered badger subspecies.	
Direction: positive	**Magnitude**: moderate
Geographic extent: Kootenay National Park	**Duration**: long-term

The jeffersonii subspecies of the American badger (*Taxidea taxus* ssp. *jeffersonii*) is found only in southern B.C. within Canada and is listed as Endangered in Canada under SARA (SARA Public Registry 2000). The current range of one population is in the East Kootenay region of British Columbia as far north as Golden and into the eastern edges of Kootenay National Park (jeffersonii Badger Recovery Team 2005). The two main habitat requirements for these badgers are friable soil and abundant prey (Rahme et al. 1995). In B.C. badgers prefer low elevation habitat in dry regions including grasslands, open Douglas-fir and Ponderosa pine stands but have been recorded in diverse habitats including alpine tundra (Apps et al. 2002, Weir et al. 2003, Hoodicoff 2003). The threats to the remaining badgers include trapping, persecution, urban development, agriculture, poor range management, reservoir flooding, road mortality, loss of prey, and forest in-growth and encroachment due to fire suppression (jeffersonii Badger Recovery Team 2005).

In the Rocky mountain trench and in KNP the main prey species for these animals are Columbian ground squirrels which increase in abundance in post-fire habitats (T. Kinley, pers. comm.). Fire can serve to create suitable habitat for ground squirrels, particularly severe fire that sets succession back to open grassland and shrubland that the ground squirrels can colonize. These badgers have very large home ranges and can disperse over long distances to occupy new territories. Therefore if sufficient high quality habitat (high severity burns) can be created for ground squirrels in KNP through a series of prescribed fires and creation of a "burnt corridor" from the Kootenay River valley downstream of the park there is a high likelihood that the badgers will disperse to occupy these new habitats within the park (T. Kinley, pers. comm.). Habitat created in the park away from roads is especially valuable to the long-term persistence of the badger population as there would be few of the anthropogenic threats that are present in the highly developed Trench. Even an increase of a few badgers in the regional population as a result of habitat creation through prescribed burning would have a significant positive effect on the long-term viability of the East Kootenay metapopulation (T. Kinley, pers.comm.).

Woodland caribou

<table>
<tr><td colspan="2">Cumulative effect of prescribed fire on woodland caribou populations: direct loss of caribou habitat and increased incidental predation of caribou by wolves attracted to burned areas used by ungulates within caribou range</td></tr>
<tr><td>Direction: negative</td><td>Magnitude: moderate</td></tr>
<tr><td>Geographic extent: Jasper and Banff National Parks</td><td>Duration: long-term</td></tr>
</table>

Woodland caribou are listed as threatened under SARA (SARA Public Registry 2002). The current range of the two mountain caribou herds in the national parks encompasses a large portion of JNP and a small area in the north of BNP (Figure 5.17). The Banff-Bighorn herd in BNP has declined from 20-30 animals before 1990 to less than 5 caribou today. Potential causes of population decline include climatic change, fire regime change, regional timber harvesting and road access, direct displacement by human recreational use, predation, and cumulative effects of changes in human land use at lower elevations (Parks Canada 2006).

Woodland caribou species is an old-forest dependant species and forages mainly on terrestrial lichens in the winter in stands that are at least 75 years old (Shepherd et al. 2007). In general, young seral stands are avoided by caribou. Prescribed fire in caribou habitat within JNP and BNP may have a cumulative negative impact on caribou populations over time through direct loss of old forest with high abundance of terrestrial lichens in combination with increases in ungulate abundance in burned areas that can attract increased predator activity within caribou range. Wolves in particular may prey incidentally on caribou within the parks (Parks Canada 2006).

Operational guidelines for fire management in woodland caribou in Banff and Jasper National Parks have been created by park managers and caribou biologists in the short-term until more research can be done on the effects of fire on caribou populations (Parks Canada 2007a). These guidelines include a requirement for fire managers to avoid known caribou habitat when planning prescribed fires. The prescribed fires for the next ten years in the mountain parks overlap very little with the entire range of the woodland caribou ensuring that caribou have enough suitable habitat (Figure 5.20). Current research underway in the parks is investigating the current habitat usage by wolves, caribou, moose, in relation to previous prescribed burns and current mountain pine beetle infestations (H. Robinson , in progress).

Mitigation measures:

- *Continue to observe the "Operational guidelines for fire management in woodland caribou habitat" developed by Parks Canada biologists and fire specialists to maintain habitat for woodland caribou.*

Boreal Toad

Cumulative effect of prescribed fire on boreal toad populations: Prescribed fire can create high quality habitat for the boreal toad.	
Direction: positive	**Magnitude**: moderate
Geographic extent: Rocky Mountain ecosystem	**Duration**: long-term

The boreal toad (*Bufo boreas*) is listed as Special Concern under SARA (SARA Public Registry 2000). Current boreal toad range is in the southern half of B.C., parts of the Yukon and western Alberta including the mountain parks. Threats to this species include non-native fish which transfer diseases to the toads, degradation and loss of habitat, pesticides, road mortality, and environmental contaminants (Environment Canada 2006).

The effect of fire on boreal toads and their habitat has been documented in several studies. In Glacier National Park, Montana boreal toads preferentially selected burned areas over unburned areas and were found in highest abundance in severely burned areas compared to areas that experienced low-moderate fire severity (Guscio 2007). Hossack et al. (in prep. as cited in Guscio 2007) documented immediate dramatic increases in the numbers of western toad breeding sites in areas burned by wildfires in Glacier National Park. While these increases were consistent for multiple fires occurring across multiple years, no increases were documented in unburned areas of the park. Other work supports the fact that this species and other toad species in the same genus benefit from disturbance in some portion of their range (Crisafulli and Hawkins 1998, Kirkland 1996).

In recent years an alternate hypothesis for declines in boreal toads and other amphibians have included an increase in UV-B exposure due to ozone depletion (Corn 1998). This hypothesis would contraindicate fire in critical boreal toad habitat due to decreases in canopy cover in burned areas and increases in sunlight exposure for tadpoles and embryos. However research on UV-B effects on toads has been contradictory with several studies citing a negative effect of UV-B on certain life stages of toads (Blaustein et al. 1994) and several others citing no effects on boreal toads (Corn 1998) and other amphibians (Grant and Licht 1995, Blaustein et al. 1996, Ovaska et al. 1997). Even in high severity fires there is a high likelihood of unburned riparian and wetland areas that can serve as refugia for boreal toads in their aquatic life stages which would reduce the potential for increased UV exposure and detrimental effects on boreal toad populations.

Based on the available literature, prescribed fire appears to have a cumulative positive effect on boreal toad populations. However, more research is needed to determine the cumulative impacts of prescribed fire on boreal toads in light of the other threats to this amphibian population in the mountain park ecosystems.

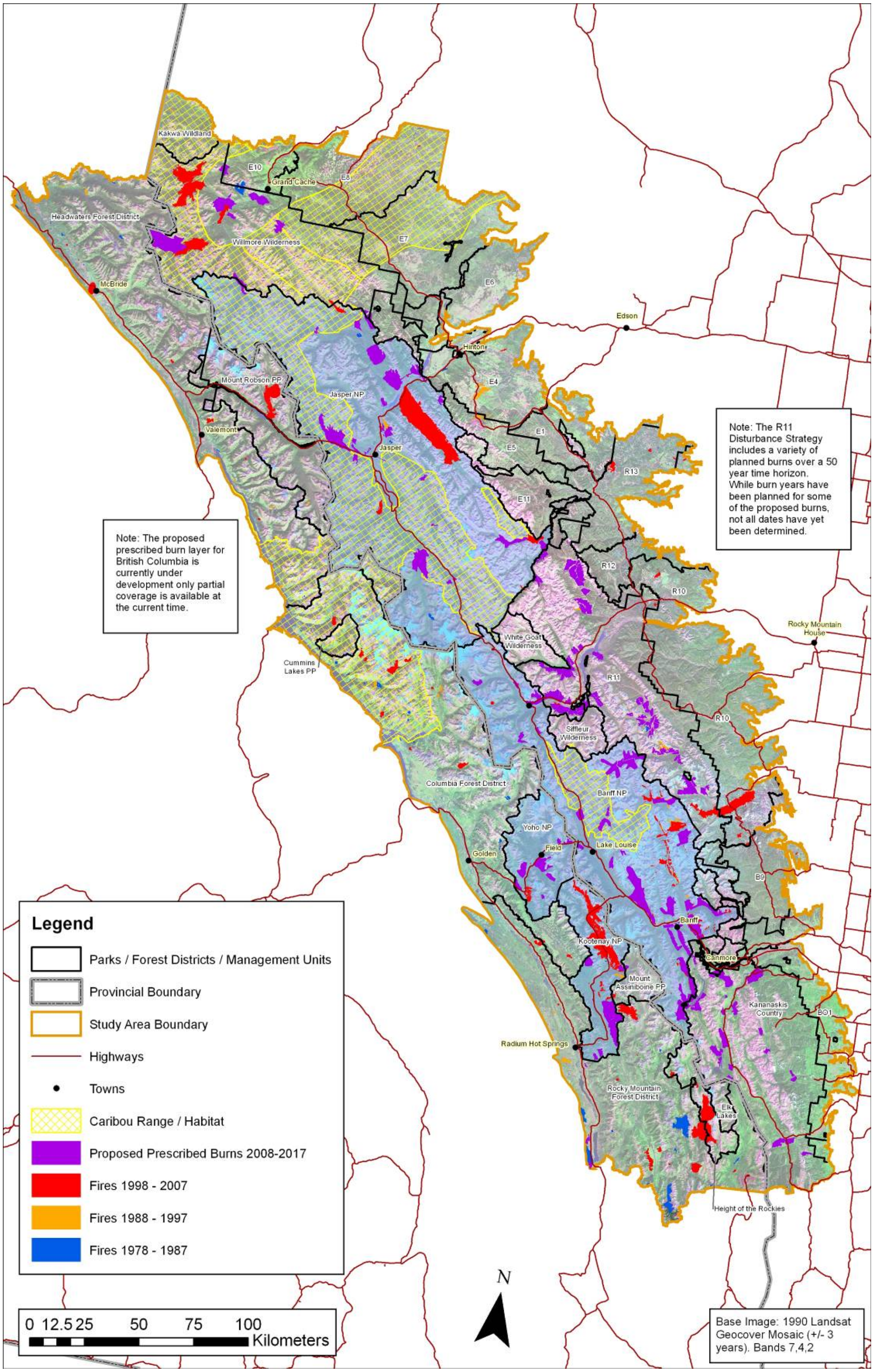


Figure 5.20 Past and future prescribed and wildfires in the mountain national parks and adjacent areas in B.C. and Alberta in relation to woodland caribou habitat.

Grizzly bear

Cumulative effect of prescribed fire on grizzly bear populations: Prescribed fire can increase habitat quality and effectiveness	
Direction: positive	**Magnitude**: moderate
Geographic extent: Rocky Mountain ecosystem	**Duration**: long-term

Grizzly bears are listed as Special Concern by COSEWIC (SARA Registry 2002) but have not been formally listed on Schedule 1 of SARA. However, grizzly bears are regarded as a keystone species in the Rocky Mountain ecosystem and park populations are under threat from development, human activity and direct human-caused mortality (Herrero 2005).

One of the identified negative influences on grizzly populations is the decline in high quality habitat over the last several decades with fire suppression (Gibeau et al. 1996)). Grizzly bears select for areas with high levels of vegetation diversity, and heterogeneity, as well as edge habitats (Theberge et al. 2005). At a finer scale they prefer to forage in graminoid and shrub meadows as well as avalanche paths.

Prescribed fire increases all of these habitat attributes on the landscape (see section 5.6.1.2). Fire also greatly increases the berry production of buffaloberry and the growth and abundance of hedysarum, two important bear foods in the mountain parks (Hamer and Herraro 1987, Hamer 1999).

Modelling undertaken as part of the Ecological Futures project within the Banff Bow Valley study showed that fire reintroduced onto the landscape will increase overall habitat quality for grizzly bears in the parks (Gibeau et al. 1996). Therefore the cumulative effect of the prescribed burn program will be positive for grizzly bears especially if habitat in areas of low human use can be improved through burning resulting in an overall increase in habitat quality and habitat effectiveness for bears.

Westslope cutthroat trout

Cumulative effect of prescribed fire on westslope cutthroat populations: Prescribed fire can have short-term negative impacts but can improve habitat quality and productivity of this species in the long-term in healthy, connected aquatic ecosystems.	
Direction: negative and positive	Magnitude: moderate
Geographic extent: Rocky Mountain ecosystem	Duration: short-term-long-term

Westslope cutthroat trout are listed as Special Concern in British Columbia and Threatened in Alberta and are currently in the process of being listed on Schedule 1 under SARA (SARA Public Registry 2006). In Alberta, the native range of westslope cutthroat trout was limited to the Bow and Oldman drainages of the South Saskatchewan River.

Originally this species was found from the extreme headwaters above Bow Lake in Banff National Park, downstream to the plains below Calgary. Today, populations in the Bow drainage are generally small and restricted to the extreme headwaters in the mountain parks and surrounding areas. In Banff National Park the population is found in the Bow River only above Lake Louise (SARA Public Registry 2006). Westslope cutthroat trout tend to be more abundant in watersheds or headwater streams with low anthropogenic disturbance (Sestrich 2005).

Known threats to westslope cutthroat trout populations include habitat loss (forestry, mining and hydro-electric projects) and the landscape changes associated with these activites (i.e. hanging culverts, roads); overharvesting; hybridization with introduced non-native fish species; predation from introduced fishes; and competitive exclusion from habitat by introduced species (SARA Public Registry 2006). Most of these threats are linked to human activities in watersheds and tend to have serious and often lethal impacts on the species.

Wildfire and fire-related management have been identified to have short-term negative impacts on native populations but then improve fish habitat quality and productivity of this species in the long-term. Although empirical studies of fire effects on native fishes are only beginning, there is a growing body of evidence that suggests that many native fish species evolved with large disturbances, such as fire, and may even benefit from the creation of more complex habitats that result post-fire (Rieman et al. 2003). Given that most existing native fishes have persisted in North America for hundreds of thousands to millions of years (Stearley and Smith, 1993), they undoubtedly evolved strategies to survive large disturbances that occurred at the spatial extent and frequency of even the most extreme wildland fires. In watersheds with adequate connectivity and sufficient diversity in habitats, many populations persisted and perhaps even flourished (Rieman et al. 2003).

In the short-term, however, fires can strongly influence water chemistry, water quantity, and channel stream structure through changes in transpiration, infiltration, ground water recharge, erosion and mass wasting, riparian shading, and the recruitment and delivery of coarse debris. These conditions may lead to fish mortality. If the disturbance is a high intensity wildfire, the potential exists for significant alteration of stream habitat and for invasion of nonnative species on a large scale, thereby exacerbating threats to remaining native fish populations (Sestrich 2005). In high severity fires water temperatures may increase to temperatures that are lethal for fish species, including native westslope cutthroat trout whose predicted ultimate upper incipient lethal temperature is 21.8°C (Sestrich 2005). However, if the fires are less severe and more frequent, such as prescribed fires, the impacts may be beneficial to fish populations in the medium to long term.

Sestrich's research in the Bitterroot River basin in western Montana showed that the recovery of native trout populations was rapid with populations approaching or surpassing pre-disturbance levels within three years after fire (Sestrich 2005). Studies across western North America indicate that periodic, large influxes of sediment to channels are a fundamental part of stream ecosystems. In addition, new perspectives in riverine ecology focus on the patchy distribution of aquatic habitats (Benda et al. 2003).

The ultimate effects of fire on aquatic organisms and fishes in particular may be apparent only some time after the fire has occurred (Rieman 2003). Native westslope cutthroat trout populations are resilient to high-severity wildfire disturbance and appear to recover rapidly (Sestrich 2005). However, maintenance of connectivity of stream networks and metapopulations to allow repopulation of native fishes in reaches defaunated by wildfire is important for long term healthy populations (Dunham and Rieman 1999; Rieman and Dunham 2000). Therefore, the cumulative effect of prescribed fire on westslope cutthroat trout is likely to be positive if other threats to these populations including competing non-native fishes and habitat fragmentation can be mitigated.

5.6.2.5 Terrestrial ecosystem health

Forest health

Cumulative effect of current prescribed fire program on forest health: Prescribed fire will decrease mountain pine beetle populations directly and decrease the availability of suitable hosts on the landscape	
Direction: positive	Magnitude: major
Geographic extent: Rocky Mountain ecosystem	Duration: long-term

Populations of the endemic mountain pine beetle (MPB) (*Dendroctonus ponderosae* Hopk.) have reached epidemic proportions in pine forests of the interior of British Columbia (Safranyik and Wilson 2006) MPB populations are cyclical but this most recent outbreak has been exacerbated by past fire suppression, warmer average winter temperatures due to climate change and forestry practices that have created older stands of even-aged lodgepole pine. The MPB populations have also increased dramatically over the last decade in the mountain parks as large populations of beetles move eastward toward Alberta (Figure 5.21).

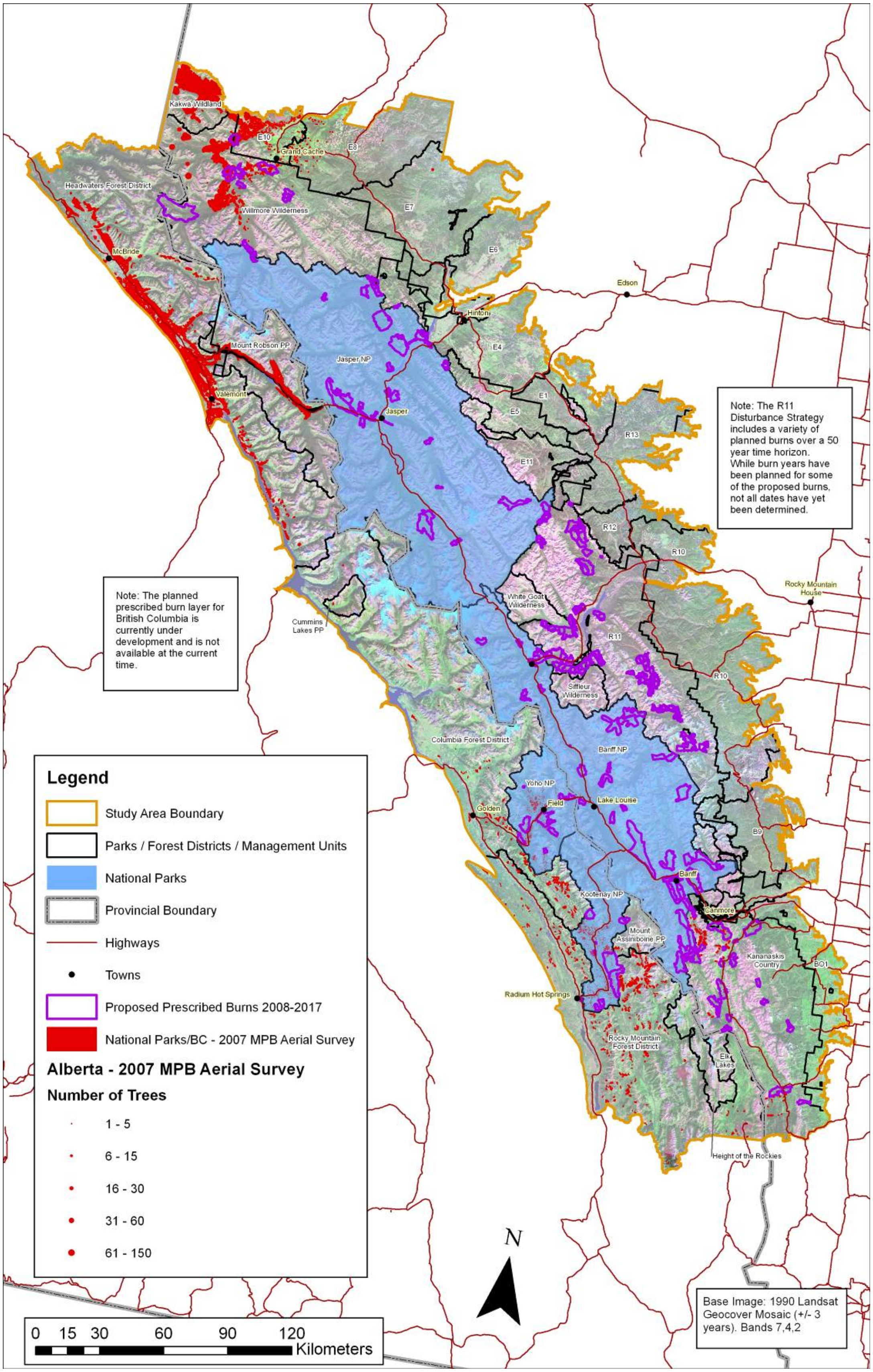


Figure 5.21 Current mountain pine beetle infestations within the Rocky Mountain ecosystem in B.C. and Alberta (2007 data) and proposed prescribed burns for the next decade.

Research in B.C. indicates that extensive fire control since the 1930's has allowed a greater proportion of the pine forests to be in age classes that are susceptible to beetle attack (Figure 5.22, Figure 5.23) (Barclay et al. 2006). An age-class projection model using contemporary forest inventory data in combination with wildfire and harvesting statistics suggests that during the early 1900s, approximately 17% of lodgepole pine stands were in age-classes susceptible to mountain pine beetle attack (Taylor et al. 2006). With fire-return cycles of 40 - 200 years, the long-term average susceptibility to mountain pine beetle was about 17% - 25% over large areas. However, during the past 80 years the amount of area burned by wildfire in pine forests in British Columbia has significantly decreased. This reduction in large-scale disturbance has resulted in an increase in the average age of pine stands so that today approximately 55% of remaining pine forests are in age-classes considered susceptible to mountain pine beetle (Taylor et al. 2006). In addition, the recent predominance of warmer summers that favour beetle reproduction, and mild winters that allow their offspring to survive, have also been critical factors in increasing beetle populations (NRC 2008).

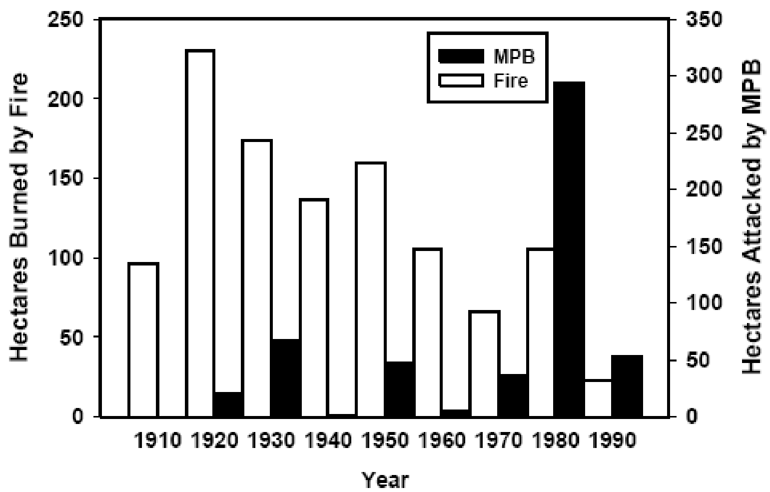


Figure 5.22 Mean annual area burned by wildfires (hectares, times 1000) and areas attacked by mountain pine beetles (hectares, times 10000) in British Columbia for each of nine decades starting in 1912 and ending in 2000 (source: Barclay et al. 2006).

The area of pine stands susceptible to MPB outbreak in the mountain parks and forests of Alberta rose over the same time period (Phillips et al. 2007). This has serious implications for the forest industry in Alberta as the MPB populations continue to increase on the eastern slopes of the Rocky Mountains (Phillips et al. 2007). In response to the threat Parks Canada and Alberta officials created the Forest Management Strategy for Banff National Park and surrounding provincial lands to the east (Parks Canada 2002).

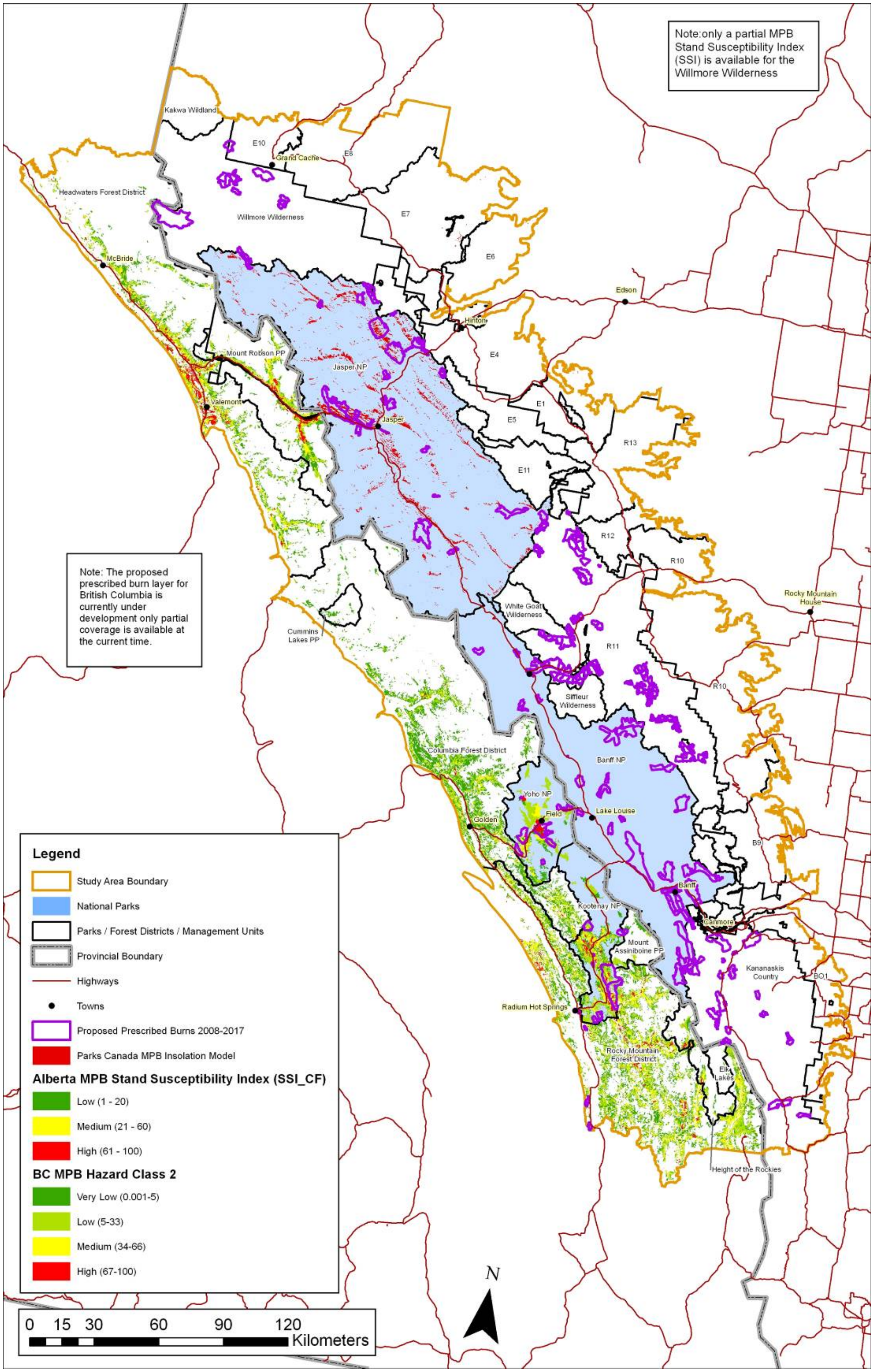


Figure 5.23 Forest stand susceptibility to mountain pine beetle within the Rocky Mountain ecosystem including lands in B.C., Alberta and the mountain national parks overlaid with proposed prescribed burns for 2008-2017 in Alberta and the parks.

In the Strategic Forest Management Area (SFMA) laid out by this Strategy prescribed fires have been rescheduled to burn susceptible pine stands along the eastern edge of BNP and prescribed fire is being introduced as one of the MPB management tools in non-commercial forests in Alberta including Kananaskis and the R11 FMU (Figure 5.23)(see section 5.6.2.1).

In the short-term prescribed burns will reduce the amount of suitable habitat for reproduction and movement of MPB within the mountain national parks (Olson+Olson Planning and Design Consultants 2001). Over the long-term, the regional scale mosaic of different stand ages and species on the landscape created by the Parks Canada and Alberta Sustainable Resource Development prescribed burn programs will break up the continuous stands of even-aged pine. This will reduce the risk of similar MPB outbreaks over large areas in the parks and Alberta in the future (Safranyik et al. 1974; Cole and Amman 1980; Bradley et al. 1992; Samman and Logan 2000).

However, research indicates that the effectiveness of prescribed fire in reducing MPB susceptibility of pine stands is related to the size of the burn (Barclay et al. 2006). For burns 100 hectares or less, the tranversability or ability of MPB to disperse across unsuitable habitat (e.g. burned areas) to find suitable mature lodgepole pine habitat, was 100%. To be effective at slowing spread of epidemic MPB populations it was calculated that fire sizes on the landscape must be much greater than 100 ha and ideally at least 10,000 ha or more (Barclay et al. 2006). The model indicated that large infrequent fires, such as that associated with subalpine areas in the parks, tended to yield a landscape that MPB cannot easily traverse. This is another reason to plan for larger prescribed fires on park landscapes and allowing lightning-ignited fires to burn in the extensive fire management zones.

Mountain pine beetle does not just affect forest health it also affects regional hydrology. The rate and timing of run-off can be dramatically altered in forest stands that have been killed by mountain pine beetle. This is because interception (the capture of precipitation) by the tree canopy is reduced allowing more water to reach the forest floor and less water being evapotranspired. Understanding the dynamics between landscape changes from fire and hydrological regimes in the mountain national parks – the headwaters of many important rivers in the region – will be important for planning future prescribed burns to manage mountain pine beetle outbreaks.

Input from Banff workshop:

- *While large scale MPB infested stands do not presently exist in the contiguous mountain national parks, there is potential for an epidemic invasion. Currently funding for MPB research is secure through to the end of 2009 at which time the program will be re-assessed. In the short-term there is an opportunity to gather valuable information on the dynamics of the MPB populations in the mountain parks for use in the development of fire management activities.*

- *Investigate possible management alternatives in response to situations where MPB killed stands pose a wildfire threat to public safety and infrastructure.*
- *Investigate the threats of MPB on hydrological processes within the mountain parks through a preliminary literature search. Should the need for further research be identified, a research proposal to Natural Resources Canada will be submitted to further address this issue.*

Keystone species interactions in montane ecosystems

Cumulative effect of current prescribed fire program on montane keystone species interactions: Prescribed fire can potentially help to regenerate declining willow and aspen stands if elk densities are kept at low levels through predation by wolves.	
Direction: positive	**Magnitude**: minor
Geographic extent: areas surrounding townsites	**Duration**: long-term

Aspen and willow in the parks are in decline due to fire suppression and increased herbivory from hyper-abundant ungulates especially around the communities of Jasper and Banff (White 2001, Kay 1997, Kay et al. 1999). Prescribed fire can help to regenerate these important montane species by stimulating production of abundant shoots from their root systems. However, fire is only one part of the process involved in restoring these species and overall ecosystem health in the montane areas of the parks.

Aspen, willow, elk, wolves and fire are part of a keystone species model developed for the montane areas of BNP that has been used to guide management actions and ecosystem restoration in the park (White et al. 2007) (Figure 5.24). A recent study evaluated 26 years of active management in the Bow Valley aimed at restoring long-term ecosystem states and processes involving highway mitigation to reduce wildlife mortality, prescribed fire, and wildfire corridor restoration around areas of high human use (White et al. 2007). This analysis and several supporting studies revealed that the use of prescribed fire for aspen and willow restoration was only effective when elk numbers were reduced below threshold levels by increased predation by wolves (White et al 2007, Hebblewhite et al. 2005, White et al. 2003, Neitvelt 2001). Thus, prescribed fire carried out under the fire management plans can have a cumulative positive effect on montane ecosystem health if it happens in conjunction with continued efforts to keep elk populations at low levels through predation or direct human control.

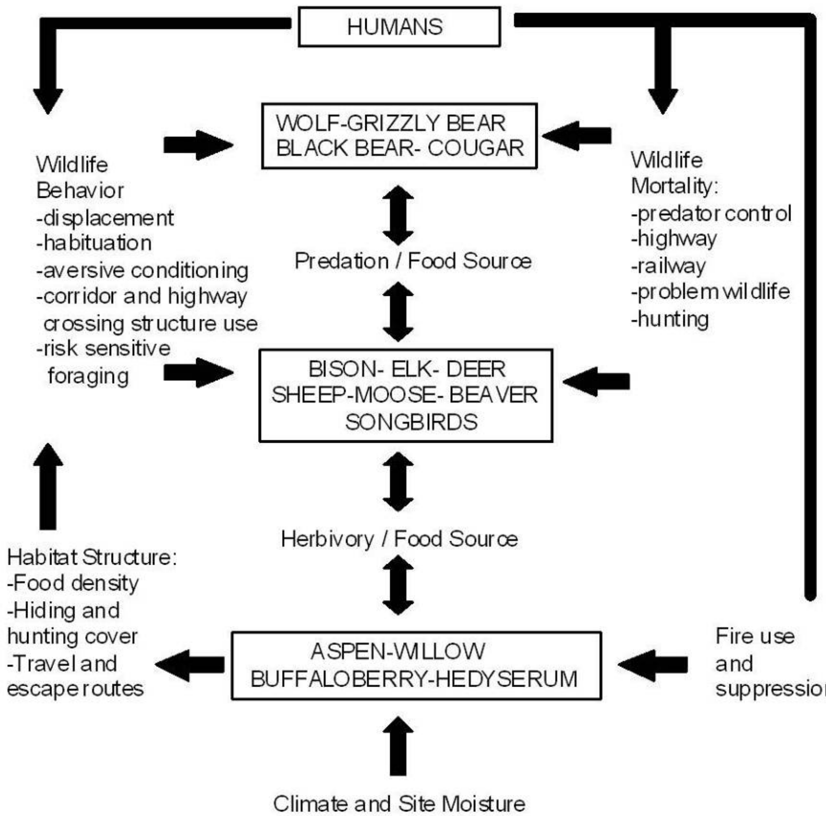


Figure 5.24 Montane ecosystem model developed for Banff National Park showing the interaction of keystone species and processes including fire.

Non-native plants

Cumulative effect of prescribed fire on non-native plants: Prescribed fire can increase or decrease abundance and cover of non-native species, effects are dependent on species and pre and post-burn conditions	
Direction: positive/negative	**Magnitude**: minor-major
Geographic extent: Rocky Mountain ecosystem	**Duration**: long-term

There are dozens of non-native invasive plants established in the mountain national parks in previously disturbed areas. Most of the non-native species are found in sites disturbed by human activity including transportation corridors, existing and decommissioned facilities and landfills, and construction sites. Non-native plants pose a serious threat to the ecological integrity of park ecosystems and under park management plans every effort is made to “monitor, control or eliminate non-native species that threaten native plant communities or species” (Parks Canada 2007b).

The exposed mineral soil, increased light levels and increased soil nutrient availability associated with recently burned areas provide optimal conditions for the establishment and growth of invasive non-native plants. Post-fire succession in areas where all or most of the understory vegetation is killed by fire is initiated by annual and perennial forb and grass species with high reproductive capability that are gradually replaced by longer-lived shrubs and trees over time (Robichaud et al. 2000). All of the non-native species of concern in the mountain parks are annuals or perennials that are adapted to establishing in these early seral disturbed habitats (DeLong et al. 2005, McPhee et al. 2003).

The ability of non-native invasive plant species to invade a site following prescribed fire is dependent on whether the species was present prior to the fire, the overall integrity of the ecosystem prior to the burn, the amount of disturbance caused by any fire ignition or suppression activities (i.e. machinery and people), and the amount of exposed mineral soil created by the fire (related to fire severity). In general, most of the highly invasive non-native species in the mountain parks have the ability to re-sprout from root systems or re-establish from seedbanks following a prescribed burn if they were already present on a site (DeLong et al. 2005). There are many invasive species that are unaffected (leafy spurge, Canada thistle) or increase in cover or abundance (spotted knapweed, diffuse knapweed, toadflax sp.) following fire (Rice et al. 2007). Some species including Dalmatian toadflax have increased flowering and seed production after fire (Jacobs and Sheley 2003). Invasions by nonnative plant species are more likely in plant communities where the fire regime has been significantly lengthened by fire exclusion such as in native grasslands (Zouhar et al. 2007).

However, some species with easily dispersed seed may establish after fire in closed canopy forest even if they were not present in the aboveground vegetation or in adjacent areas before fire (Rice et al. 2007). Non native species with either wind-dispersed seed (e.g. bull thistle and Canada thistle) or a long-lived seed bank (e.g. spotted knapweed) may become established in areas with no prior infestation. In addition, species with animal-dispersed seed may become established within a few years after fire.

To what degree non-native plants will dominate a site post-fire, and for how long, is not clear from the literature (Zouhar et al. 2007). But post fire dominance of invasive non native plants is likely to vary with plant community, fire frequency, and fire severity. Several researchers have reported increased cover and abundance of non native invasive species following severe fire compared to low-moderate severity fire (Hunter et al. 2006, Crawford et al. 2001, Turner et al. 1997). However, if the fire is hot enough it has the potential to kill everything including non native plants (Zouhar et al. 2007). In these cases the invasability of severely burned ecosystems will depend on the amount of non native plant propagules that arrive on the site immediately post-fire before the native vegetation recovers.

In Jasper National Park the Syncline fire was a high severity prescribed fire that escaped control and burned thousands of hectares in mid-summer (D. Smith, pers.comm.). Surveys for non-native plants in the year following revealed that relatively few sites had infestations of non native invasive species and of these infestations many were nuisance weeds rather than invasive species of concern (McPhee 2004). All of the reported infestations were in areas disturbed by fire suppression activity including helipads, fuel breaks, and staging areas. However, one helipad site had a few spotted knapweed plants which if left untreated, could have spread rapidly into adjacent burned areas. It is likely, given the pattern of infestations found on this fire that many of these species were introduced by machinery, equipment or people involved in fire suppression efforts. Given the potential negative ecological consequences of invasive non native plants getting established and spreading in areas burned by prescribed fire, monitoring for invasive species should be an important part of post-fire monitoring protocols in the mountain parks.

Mitigation measures:

- *Continue to monitor and record non-native plant infestations through field unit non native plant management programs so that the location of significant infestations relative to proposed prescribed burns is known. At a minimum monitoring (i.e.non native plant surveys) should be conducted on burns the year following the fire and appropriate control measures should be used to control any non native infestations found. Ideally monitoring should be repeated every two years after until all populations have been controlled.*
- *Treat all significant non native plant infestations on the restricted or noxious lists (B.C. and Alberta) within the boundaries of a planned prescribed burn prior to the burn being implemented using methods previously approved in field unit Non-native plant management plans and associated EAs.*
- *Minimize disturbance in or adjacent to burned areas caused by machinery, people and equipment involved in prescribed burn operations (including ignition and suppression activities)*

Primary Productivity

Cumulative effect of prescribed fire on primary productivity: Prescribed fire will increase the primary productivity of montane grasslands and plants in the understory of forested ecosystems	
Direction: positive	**Magnitude**: major
Geographic extent: Rocky Mountain ecosystem	**Duration**: long-term

Low-moderate intensity prescribed fire consumes some of the soil duff layers and causes a flush of nutrients to be released into the soil that are readily taken up by early seral species colonizing burned areas (Neary et al. 2005). In addition fire warms the soil directly through heat transfer downward during the fire and indirectly over the long-term through increased solar radiation reaching the forest floor in previously closed stands opened up by fire. These factors combine to provide ideal growing conditions for understory grasses, forbs and shrubs that establish immediately post-fire. These conditions are conducive for high plant growth rates in the first few years to a decade after fire. In the mountain parks the montane grasslands likely show an immediate response to fire with increased growth of grasses and increased overall productivity. In addition although overall net primary productivity in stand-replacing fires decreases following fire due to loss of large trees, there is usually an increase in net primary productivity in the understory plants in all except the most severe fires (Sachro et al. 2005). This has positive implications for herbivore populations and bears inhabiting these early seral habitats with increased quality and quantity of available forage.

Hydrological regime

Cumulative effect of current prescribed fire program on hydrological regime of a site: Prescribed fire can cause decreased soil infiltration, increased run-off, increased erosion, debris flows, and slope failures after high severity fires.	
Direction: negative if it is outside the historic range of variability due to anthropogenic factors	**Magnitude**: minor-moderate
Geographic extent: Rocky Mountain ecosystem	**Duration**: short-term

Fire can destroy the forest floor and vegetation, altering water infiltration by exposing soils to raindrop impact or creating water repellent conditions (DeBano et al. 1998). If the organic layers are consumed and mineral soil is exposed, soil infiltration and water storage capacities are reduced (Robichaud 1996). Burning also reduces the amount of rainfall interception by the forest canopy and reduces evapotranspiration by the forest vegetation. This can lead to increased runoff, increased peak flows, and increased sediment delivery to streams which may have negative impacts on aquatic organisms. These impacts may last weeks or decades, depending on the severity and intensity of the fire, any remedial measures, and the rate of vegetative recovery (Baker 1990). Loss of soil from mountain slopes through increased surface water causing post-fire erosion and slope failure produces several significant ecosystem impacts and may decrease future site productivity.

Within a watershed, sediment and water responses to wildfire are often a function of fire severity and the occurrence of hydrologic events. For a wide range of fire severities, the impacts on hydrology and sediment loss can be minimal in the absence of precipitation. However, if a large precipitation event follows a large, high-severity fire (as in a summer thunderstorm), impacts can be substantial (Rinne 1997). High severity burn areas experience higher rates of soil loss from erosion (McNabb and Swanson 1990), increased peak flows of runoff, greater duff reduction, loss in soil nutrients (Harvey at al. 1989), and soil heating (Hungerford et al. 1991). Erosion and sediment yield also increases with increasing slope in the mountains.

Fire severity is variable within fires (see Figure 5.15), leading to variable potential for erosion across burnt slopes (Robichaud 1996). Spatial variability is an important characteristic of burned slopes and affects the amount of sediment produced during post-fire precipitation and runoff events. Under experimental conditions a high severity burn above a low severity burn on a slope produced about 50 percent more sediment in a logged and burned area than vice versa (Robichaud and Monroe 1997). When the upper two thirds of the slope had been severely burned, it produced twice as much sediment compared to when the upper two-thirds were in low-severity burn conditions. The arrangement of high-severity burn conditions above the low-severity burn condition on a mountain slope is common.

Generally soil water repellency and associated soil erosion is highest in the first year following fire (Robichaud 2000). Over time infiltration increases because the hydrophobic substances responsible for water repellency in soils are slightly water soluble and slowly dissolve, thereby increasing wet ability (DeBano, 1981). In general, water repellency has disappeared in affected soils within one to two years after a fire (Robichaud 2000).

Erosion on burned areas also declines as the site stabilizes, but the recovery rate varies depending on fire severity and the rate of vegetation regrowth. In a study in eastern Oregon erosion rates were one to two orders of magnitude less by the second year after a fire due to fast vegetation regrowth (Robichaud and Brown 1999). Soil nutrient losses followed the same pattern as the sediment losses with most losses occurring in year one. In a Ponderosa pine forest DeBano et al. (1996) demonstrated that following a wildfire in sediment yields from a low severity fire recovered to normal levels after three years but moderate and severely burned watersheds took 7 and 14 years, respectively.

In general accelerated erosion and hydrological responses due to fire events are part of natural ecosystem processes. In some regions over 60 percent of the total landscape sediment production over the long-term is fire-related (Robichaud 2000). In the short-term some vegetation and small animals may be negatively affected by local erosion events, debris flows and mudslides but overall these events add to the variability of ecosystems at the landscape scale. Therefore, the changes in hydrological regimes due to prescribed fires in the mountain national parks will either have a positive long-term effect or have little impact on terrestrial ecosystem health and biodiversity.

5.6.2.6 Aquatic ecosystem health

Aquatic organisms

Cumulative effect of current prescribed fire program on aquatic organisms: Prescribed fire can cause significant short-term mortality but in the long-term provides large pulses of sediment, course woody debris and nutrients which restructure aquatic habitats and provide increased diversity of instream habitats	
Direction: negative/positive	**Magnitude**: major
Geographic extent: Rocky Mountain ecosystem	**Duration**: short-term/long-term

Fires can have immediate effects on native fishes and other aquatic organisms and their habitats as well as long-term impacts (Rieman and Clayton, 1997; Dunham et al., 2003; Minshall 2003, Spencer et al2003). Fires reduce riparian cover, increase temperatures of streams (Dunham et al. 2007), and alter water chemistry (Robichaud and Brown 1999, Spencer et al. 2003) immediately during and after fire due to loss of riparian vegetation and large inputs of nutrients and other substances from smoke, ash and burned soil organic layers Spencer et al. 2003). Longer-term fire effects on aquatic systems include increased sediment and water yields resulting from reduced infiltration and increased run-off (see Hydrological Regime above). Large inputs of sediment combined with recruitment and delivery of large amounts of coarse debris into streams as burned trees fall over combine to cause significant changes in stream morphology and structure (e.g. Benda et al 2003, Bisson et al 2003, and Reeves et al 1995).

These large and sometimes dramatic changes in post-fire aquatic habitats can cause major changes in aquatic community structure and significant mortality of invertebrates, amphibians and fishes depending on the size and severity of the fire, the local climate (likelihood of high rainfall events) and the season of burning (Minshall 2003, Pilliod et al. 2003, Bury 2004, Rieman et al. 1997, Burton 2005). In previous studies in Idaho entire reaches of streams were seemingly devoid of fish and other organisms immediately following wildfire (Reiman and Clayton 1997). Similarly local extirpations of fish and benthic macroinvertebrate have been recorded following fire in the southwestern U.S. (Rinne and Neary 1996).

However, healthy aquatic ecosystems appear to recover quickly from large disturbances such as fires. The increased nutrient availability, especially nitrogen and phosphorus, in post-fire aquatic systems increases productivity of these systems at all trophic levels including invertebrates and fish populations (Spencer et al. 2003). Burned over stream reaches are repopulated from unburned stream refuge or from distant connected populations in the same system. In the Idaho study fish populations rebounded quickly and 10 years post-fire there was no difference in distribution and abundance of fishes between burned and adjacent unburned streams (Rieman and Clayton 1997). Native rainbow trout recovered from near extirpation from streams in high severity wildfires in Idaho within one year despite large increases in stream temperatures (Dunham et al. 2007). In another study in native cutthroat and bull trout populations recovered rapidly with mean abundance exceeding the pre-fire mean in over half of the burned reaches (Sestrich 2005). In contrast, and contrary to the author’s hypothesis, non native brook trout in this study exhibited delayed recovery with mean abundance in five of six fire-affected reaches remaining below the pre-fire mean three years following the fire. Other studies of salmonids subjected to fires and other comparable disturbances in other areas have shown populations to be resilient as well (Lamberti and others 1991; Roghair and others 2002, Bisson and others 2005).

In the mountain parks little formal monitoring of fish populations post-fire has taken place. Following the high severity Tokuum-Verendrye fire in KNP in 2003, some limited sampling was done on burned reaches of three creeks to determine if native west slope cutthroat trout and bull trout had survived in these creeks (S. Humphries, pers. comm.). Anecdotally, Hawk and Haffner creeks which are connected to the Vermilion River in the valley bottom had bull trout in them 3 years following fire (Figure 5.25). The third stream, Honeymoon creek, had a cutthroat trout population in it 3 years post-fire that must have survived the fire as this creek is disconnected from the Vermilion River right at the mouth due to a hanging culvert (S. Humphries, pers. comm.). These observations point to the resiliency of these native aquatic organisms and their apparent adaptation to periodic fire.

Figure 5.25 Haffner Creek in Kootenay National Park three years after a severe wildfire in 2003 destroyed almost all of the riparian vegetation. Native bull trout were found in this creek 3 years after the fire (S. Humphries, Parks Canada).

Given that most existing native fishes have persisted in North America for hundreds of thousands to millions of years, they likely evolved strategies to survive large disturbances including the more extreme stand-replacing fires (Reiman et al 2003). Native fishes in fire-dependant ecosystems like the mountain parks, may actually be adapted to and even dependent on disturbances like fire to maintain the diversity of habitats necessary to sustain diverse and productive populations. In healthy aquatic systems where native fish populations live in diverse interconnected habitats and can still express the full range of life histories even large fires likely pose little threat to the persistence of these populations (Dunham et al., 2003). In contrast, where fish populations have been stressed by habitat loss, fragmentation, and exotic species, there is an increased probability for local extinctions linked to fires (Rieman et al 2003).

Mitigation measures:

- *Continue program initiated by Parks Canada aquatic specialists to identify disconnected aquatic habitats due to roads and culverts.*
- *Restore fragmented, disconnected aquatic habitats where appropriate (i.e. in those places where restoration of connectivity won't subject previously pure populations of native fishes to non-native fish populations) to increase or maintain resilience of native fishes to large disturbances such as fire.*
- *Reduce non native fish populations if feasible to increase integrity of aquatic habitats and native fishes.*

Persistent organic pollutants including mercury

<table>
<tr><td colspan="2">Cumulative effect of current prescribed fire program on persistent organic pollutants: Prescribed fire can cause increased mobilisation of pollutants found in soil, vegetation and water and result in bioaccumulation of these substances in aquatic organisms which can negatively the health of these organisms and those that consume them</td></tr>
<tr><td>Direction: negative</td><td>Magnitude: major</td></tr>
<tr><td>Geographic extent: Rocky Mountain ecosystem</td><td>Duration: moderate-term</td></tr>
</table>

Persistent organic pollutants (POPs) including mercury PCBs, dioxins, DDT, and chlordane are transported long distances in the atmosphere from industrial sources that may be thousands of kilometres away (Blais 2005). Snowflakes are very effective scavengers of these POPs from the air. In alpine areas these POPs are deposited and accumulate in the significant snowpack found at high elevations (Blais et al. 2001). Once on the ground, some of these contaminants volatilize back to the air as the snowpack matures, while other compounds with higher water solubilities tend to become dissolved in meltwater and either get deposited on the soil (Wania 1997) or result in a pulse of contaminants to surface streams and lakes (Blais et al. 2001).

This phenomenon has been studied in alpine and subalpine lakes in the mountain parks. A study in 2001 in Bow Lake in Banff National Park indicated that organochlorines including pesticides and PCBs were deposited in subalpine lakes from melting glaciers (Blais et al. 2001) and are bioaccumulated in aquatic food webs ultimately ending up in fishes which are top predators in these aquatic systems (Demers et al 2007). Recently a study in Jasper National Park recorded inputs and bioaccumulation of mercury in fishes in high subalpine lakes (Kelly, 2007). A study looking at the levels of selenium in aquatic organisms in mountain park lakes is also underway (D. Schindler, pers. comm.).

In 2000, a wildfire burned 72% of the catchment of Moab Lake, one of the lakes in the JNP mercury study (Kelly et al 2006). The fire caused significant increases in accumulation of mercury by fishes compared to fish sampled before the fire. The mechanism for increased Hg accumulation appears to be increased productivity and restructuring of the lake food webs in response to post-fire nutrient pulses into the lake.

Increased nitrogen and phosphorus concentrations in the lake increased productivity of phytoplankton, zooplankton invertebrates and caused fishes in the lake (rainbow trout, bull trout, lake trout and cisco) to switch to consuming abundant young fry. There was also an increase in total mercury and methyl mercury in the lake water which was mobilized from burned areas and carried to the lake through post-fire run-off.

This phenomenon of increasing POPs following fire in lakes and streams within or downstream of burned catchments has important consequences for the health of fish populations in the mountain parks as well as birds and mammals (including humans) which may consume them. More information is needed on the magnitude and duration of these increased post-fire POP concentrations in aquatic organisms from a range of fire severities resulting from prescribed fire and mid-summer wildfire.

Mitigation measures:

- *Establish thresholds for maximum percentage of watershed burned /decade that will minimize increases in POPs in aquatic systems while still meeting ecosystem objectives (more research needed).*
- *Track the number of prescribed burns and wildfires per watershed over time (taking into account established thresholds for % of watershed burned) and incorporate this information into prescribed fire planning in the mountain parks and downstream areas in B.C. and Alberta to minimize the potential cumulative negative effects of POPs on aquatic ecosystems over time (Figure 5.26).*
- *If research and monitoring indicate POPs concentrations in fish exceed health guidelines after fire, take appropriate actions to protect human health (e.g. issue health warnings or temporary closures of sport fisheries in affected lakes).*

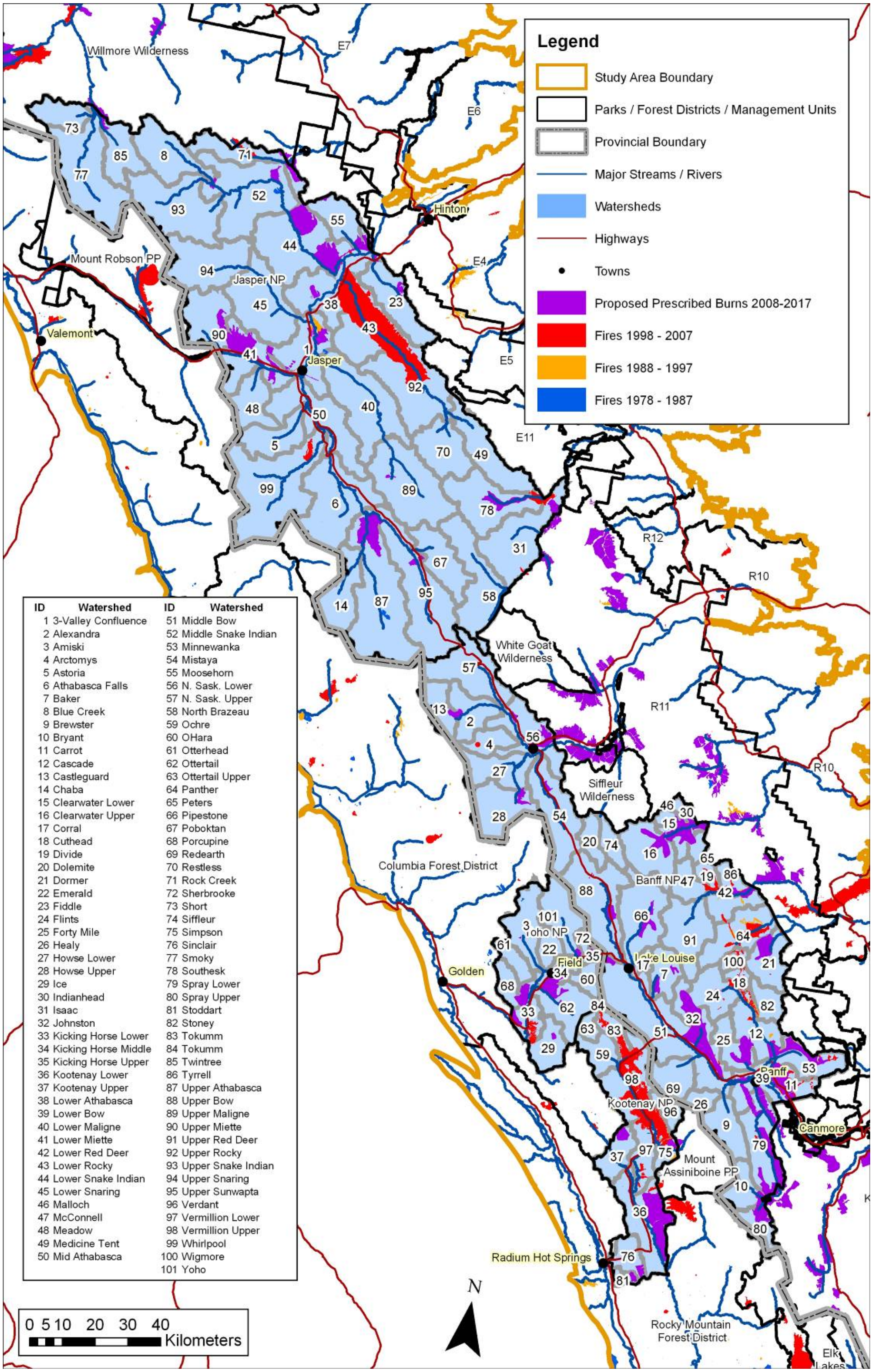


Figure 5.26 The location of wildfires and proposed prescribed fires for the next decade in each watershed within Yoho, Kootenay, Jasper and Banff.

Water quality

<table>
<tr><td colspan="2">Cumulative effect of current prescribed fire program on water quality of a site: Prescribed fire can cause decreased soil infiltration, increased run-off, increased erosion, debris flows, slope failures after high severity fires</td></tr>
<tr><td>Direction: negative</td><td>Magnitude: major</td></tr>
<tr><td>Geographic extent: Rocky Mountain ecosystem</td><td>Duration: short-term</td></tr>
</table>

As described in the preceding sections, fire results in large pulses of nutrients into aquatic systems through ash, smoke and mobilization of soil nutrients (Spencer et al. 2003). The high sediment yields and increased stream flows in the first few years post-fire can result in increased turbidity and increased suspended sediments in streams and lakes (Woodsmith et al. 2004). These stream changes can result in altered water chemistry including changes in pH. Fire can also result in increases in the concentrations of persistent organic pollutants that accumulate in snow and ice in high alpine environments (Blais 2005). All of these parameters can affect the water quality for aquatic and terrestrial organisms as well as humans consuming the water downstream of areas burned by prescribed fire and wildfire (note for discussion of impacts and mitigations associated with retardants used in fire suppression see Section 4.0, Project-level impacts)

For example, for methylmercury, the interim Canadian Water Quality Guideline is maximum 4 nanograms per litre of water (Environment Canada 2005). These freshwater guidelines are based on many scientific studies that examined the impacts of mercury on plants, invertebrates, and fish that live in Canadian lakes and rivers. The methylmercury interim guideline is recommended for direct exposure to methylmercury in water. Two streams in the burned Moab Lake catchment in JNP had maximum MeHg concentrations of 0.13 and 0.14 ng/L (Kelly et al. 2006), which are well below the guideline.

The magnitude of these changes to water quality is largely dependent on fire severity with low severity fires having little effect on sediment and water delivery to streams and high severity fires potentially causing significant increases in sediment, nutrient loading, pollutant concentrations and run-off (Elliot and Vose 2006). For this reason prescribed fires have fewer effects on water quality in general than high severity wildfires because, as in the mountain parks, they are generally ignited when fuels have high moisture content in the spring and fall and therefore consume less fuels and forest floor (Debano et al. 1998, Weirzchowski 1995).

Research indicates that even following severe fires changes in water quality are generally short-lived, lasting from a few weeks to several years after fire (Spencer et al. 2003). A comprehensive review of fire effects research on water quality from across the U.S. concluded that, regardless of ecosystem, burned areas are most vulnerable to surface erosion immediately post-fire and during extreme rainfall effects (Elliot and Vose 2006). If forest floor remains largely intact and vegetation regrowth is rapid the magnitude and duration of sediment transport, sediment delivery and high run-off effects will be minimized (Elliot and Vose 2006).

Watershed Hydrology, Fire and Climate Change

Cumulative effect of current prescribed fire program on hydrological regime of a site: Prescribed fire can cause decreased soil infiltration, increased run-off, increased erosion, debris flows, slope failures after high severity fires	
Direction: negative	**Magnitude**: major
Geographic extent: Rocky Mountain ecosystem	**Duration**: short-term

Restoration of fire to mountain parks landscapes and areas beyond (i.e. Alberta and British Columbia lands) through use of prescribed fire rather than waiting for inevitable more intense/severe wildfires to occur is preferable when considering the potential impacts of the latter on regional hydrological regimes. High intensity, large scale severe wildfires have a much greater effect on regional hydrological regimes (e.g. increased rate of run-off and alteration of run-off timing) than low intensity, small scale controlled prescribed burns (R. Sandford, pers.comm.). Upland forests capture and slowly release water. This storage and release process is extremely important for downstream water supply security and human settlement stability. Therefore, strong pulses of debris and run off post-wildfire can disrupt the dynamics of a watershed and threaten water supply and quality.

Historically, it is likely that such significant changes may have occurred throughout many of the watersheds in mountain parks and over time the hydrological regimes in the watersheds rebounded. However, the growing presence of human activity within mountain parks watersheds and the reliance of downstream populations on watershed functions in the mountain parks means that large scale disruptions within a watershed could be detrimental to human water quality and quantity needs.

This challenge may be further exasperated in the future by the impacts of climate change. Recent climate change research suggests that the increase in temperatures associated with climate warming have been predicted to lengthen fire seasons and increase intensity due to warmer, drier climatic conditions (Macias Fauria and Johnson 2007). In the mountain parks these changes increase the risk of large uncontrollable stand-replacing wildfires in the future.

Mitigation measures:

- *Fire management plans should take climate change into account, such as factoring climate succession models and performance indicators for prescribed burns in montane forests, involving vegetation with a life cycle of decades to centuries.*
- *Investigate opportunities to conduct collaborative research and monitoring to assess hydrologic impacts of fire management alternatives within the mountain parks. Since this information is important on both a local and regional scale, consistency in methodologies regionally will be important to the success of this*

type of research and monitoring. For this reason, linkages with ongoing research and monitoring in this area of study should be given a high priority within the mountain Parks and surrounding provincial lands.

5.6.2.7 Summary of the cumulative ecological effects of prescribed fire

Table 5.11 summarizes the cumulative ecological effects of prescribed fire. Figure 5.27 outlines the cause and effect relationships of the cumulative ecological effects of prescribed fire as outlined above.

Table 5.11 Summary of the cumulative ecological effects of prescribed fire, fuel management and fire suppression activities on VECs in the mountain national parks.

Key components affected by Fire Management plans	Stressors on key components	Effect of fire management practices on key components						Overall trend
		Prescribed fire		**Fuel Management**		**Fire Suppression**		
		Effect	**+/-**	**Effect**	**+/-**	**Effect**	**+/-**	
BIODIVERSITY								
Vegetation	- non-native plants - past fire exclusion - over-abundant herbivores	- increased diversity of vegetation on local and landscape scale	+++	-increase in diversity of understory plant communities	+	- additive neg. effect on diversity of vegetation	-	+++
Rare plants	- habitat loss -habitat fragmentation -fire exclusion (montane plants)	- increased diversity of vegetation on local and landscape scale - increase in abundance of fire-adapted species - decreased competition - may cause declines in old forest dependant species	++	- may increase abundance of some shade intolerant species that are in decline due to high canopy cover	+	- decrease in fire-adapted species over time	-	+
Large herbivores	- direct human caused mortality - human-caused displacement and habituation	- increase in available habitat	+	- increase in available habitat	+	- decrease in available habitat	-	+
Large carnivores	- direct human caused mortality - habitat fragmentation (roads, towns, agriculture, oil and gas activities, logging) - displacement	- increase in high quality habitat for prey in backcountry areas with high habitat effectiveness	+	- decrease in cover for wary carnivores in fuel breaks adjacent to high human use areas	_	- decrease in habitat quality	-	+

Small mammals	- habitat fragmentation by human activity - past fire suppression	-Increased diversity of small mammals on landscape scale	++	- increase or decrease diversity	+/-	-decreased diversity with increasing time since disturbance	-	++
Birds	- habitat fragmentation due to human activity (inside and outside parks) - past fire suppression	- increased diversity of habitat resulting increased diversity on landscape scale	++	- increase or decrease diversity	+/-	-decreased diversity with increasing time since disturbance	-	++
Invertebrates	- pesticides and other pollutants - habitat loss	- increased diversity of habitat resulting increased diversity on landscape scale	++	- increase or decrease diversity	+/-	-decreased diversity with increasing time since disturbance	-	++
Amphibians	- pesticides - habitat fragmentation - human activity (roads, infrastructure, disturbed wetlands, logging)	- decreased diversity in short-term due to losses/changes in habitat - increased diversity on landscape scale due to increased diversity of habitats (long-term)	- - + +	- decrease abundance and diversity in cleared stands depending on amount of overstory removed	-	-decreased diversity with increasing time since disturbance	-	++
Aquatic fauna	- non-native species - pollutants and toxins	- decreased diversity in short-term due to changes/losses of habitat -increased diversity on landscape scale due to increased diversity of habitats (long-term)	- ++	-decreased diversity due to loss of structural diversity and CWD - increased diversity at landscape scale	-	-decrease diversity over time	-	+
TERRESTRIAL ECOSYSTEM HEALTH								
Forest health	- past fire suppression	-direct reduction of mountain pine beetles populations -decrease in extent of susceptible stands on landscape	++	-direct reduction of mountain pine beetle populations -small decrease in extent of susceptible stands on landscape	+	- continued upward trend of MPB populations	-	++
Keystone species interactions in montane	- past fire suppression leading to loss of aspen and	- allows for increased regeneration of fire-	+	- increase in available forage for elk near areas of high human	-	- additive negative effect on decline in aspen,	-	+

(aspen/elk/wolves/fire)	willow -habituation and displacement of elk leading to additive downward pressures on fire –dependant vegetation - reduction in wolf population due to human activity and human-caused mortality causing increased numbers of elk	dependant vegetation - must occur in conjunction with high stable wolf populations		use		willow		
Native plant communities	- human disturbance (loss of native habitat) -non-native plants -	- may increase or decrease non-native plant populations depending on if non-native species can survive fire and are adapted to post-fire environments - more work needed to assess fire effects on individual species	+/-	- can increase non-native plant species abundance and cover if forest floor is disturbed	_	- no effect on non-native plant populations	N	+/-
Primary productivity	- past fire suppression	- increased plant growth and increased soil organism activity in light-moderate severity burns due to flush of available nutrients immediately after burn	+	- small increase in primary productivity of understory plants for first few years post-treatment	+	- primary productivity decreases slowly over time with time since fire	-	+
SPECIES AT RISK								
Banff Springs snail (Endangered)	- habitat destruction - human activity	- no effect or negative effect on populations if aquatic hot springs habitat altered by burns (e.g. change in water chemistry, water quality)	?	- no effect on snail habitat (need more information)	?	- no effect on snail habitat (need more information)	?	?

American badger jeffersonii subspecies (Endangered)	- Habitat fragmentation due to human land use - Human-caused mortality (road , railway) - Past fire suppression resulting in loss of open habitats favoured by this species	- PB maintains or restores open Douglas-fir stands, & grasslands required by ground squirrels and other prey -if linked habitat patches are created using PBs, wildfire and fuel breaks from adjacent areas currently supporting badgers (in trench), can create high quality habitat in the parks that will very likely be colonized by badgers (can occupy sites up to the alpine)	+++	- fuel management may create good habitat for this species if it increases prey abundance	+	- reduced amount of high quality secure habitat for this species over time	- -	+
Woodland caribou (Threatened)	- Habitat fragmentation by human activity - Secondary predation by wolves and other predators (Habitat overlap with ungulates, esp. elk) - sensory disturbance by humans (rec. users)	- PB in caribou habitat creates high quality ungulate habitat (esp. elk) which draws predators who then kill caribou they encounter - PB causes direct loss of lichen and other caribou habitat assoc. with old forest - increased rec. use of roads and areas created by fire activities in provincial protected areas	- - -	- fuel management on large scale in caribou habitat results in loss of caribou habitat	- -	- maintains old forest habitat preferred by caribou - maintains predators at low density on landscape	+	- -
Haller's apple moss (Threatened)	- limited distribution in specialized habitats	- low risk of direct loss from PB because habitat is rocky crevices and talus slopes in the alpine	N	- no effect on moss habitat	N	- no effect on moss	N	N

Westslope cutthroat trout	- non-native fishes (displacement and hybridization) - habitat fragmentation -over fishing	- increased risk of short term mortality -long-term increased diversity of aquatic habitats -post-fire increase in productivity if populations are healthy and not fragmented	-/+	- potential for sedimentation of streams due to machinery crossing - potential for loss of riparian cover of streams	-	- neutral or positive effect on aquatic ecosystem health in the short-term - decreased diversity of aquatic habitats over long-term	+/-	+
Boreal toad (Special concern)	- pesticides and other contaminants - habitat modification and loss - lack of disturbance - disease carried by non-native stocked fish	- increase in high quality terrestrial habitat	++	- may provide open habitat preferred by this species	?	- loss of high quality habitat over time	- -	++
Grizzly bear (Special concern)	-direct human caused mortality (roads, railway, hunting) - human activity (displacement) - past fire suppression	- increased habitat quality in low human use areas	++	- may increase bear foods in fuel breaks adjacent to high human use areas around facilities and townsites	-	- decline in habitat quality with time since disturbance	-	+
AQUATIC ECOSYSTEM HEALTH								
Hydrological regime	- removal of forest in watersheds due to human activity (logging, industry, roads, infrastructure)	- increased surface run-off and increased erosion potential (short-term)	- -	- potential for increased run-off due to increased snowpack in thinned areas	-	- no net effect	N	-
Primary productivity		- increased primary productivity of aquatic food webs following pulse of nutrients into system immediately post-fire (short-term)	+	- negligible effect on aquatic productivity	N	- no net effect?	?	+

Water quality	- polluants and toxins (pesticides, fertiliser, sewage effluent etc.) -	- increased nutrient concentrations in surface water(short-term) - increased heavy metal concentrations in subalpine lakes and streams (mercury) - in creased turbidity and debris flows in streams and lakes (short-term) - increased temperatures due to loss of riparian vegetation and direct heating	- - - - - - -	- negligible effect on nutrient and heavy metal concentrations in surface water - small increase in turbidity of streams possible if there is significant soil disturbance - small increase in temperatures possible if riparian vegetation removed	N - -	- no net effect	N	- -

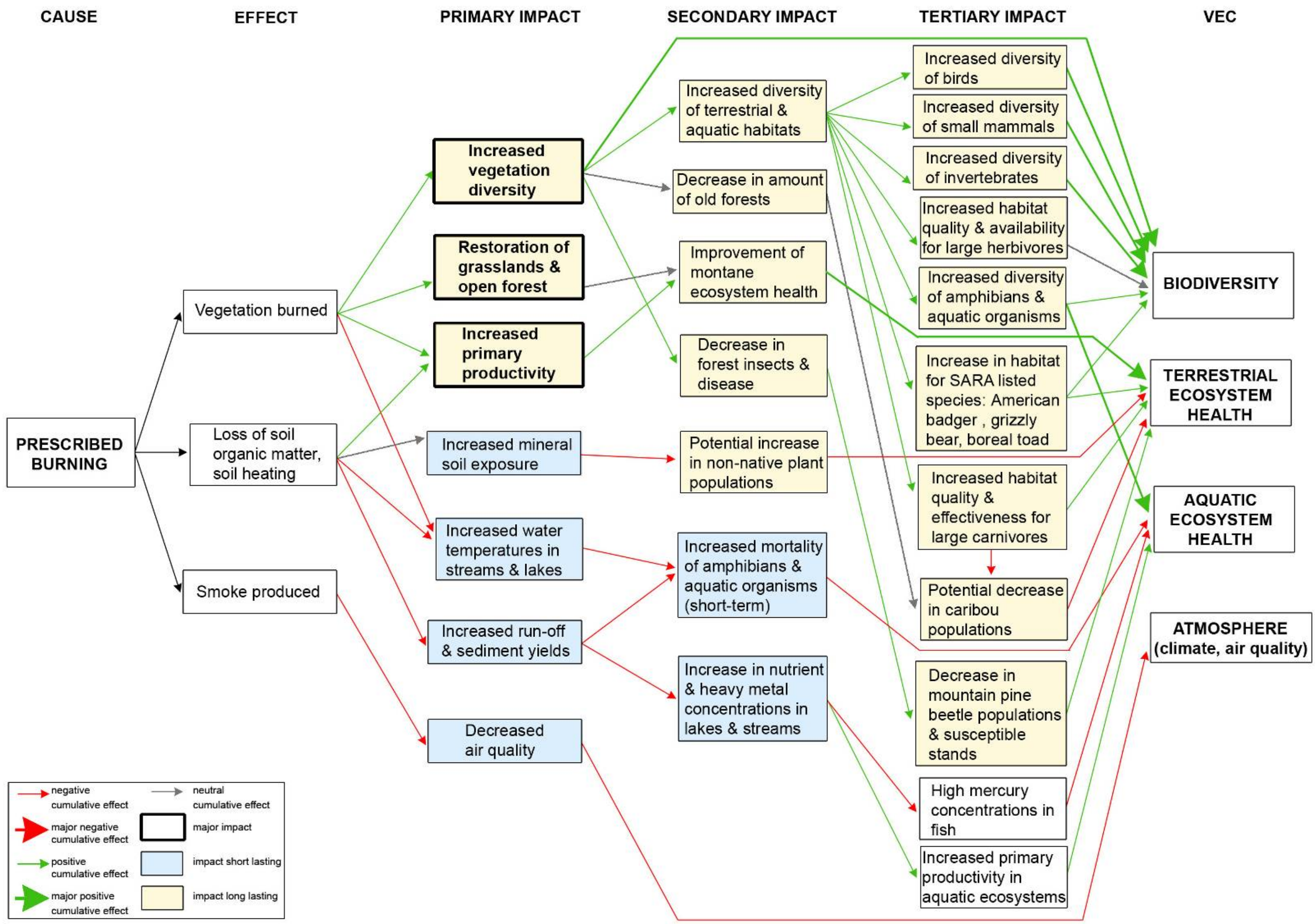


Figure 5.27 Network diagram of the cumulative ecological effects of prescribed fire on VECs.

5.6.3 Cumulative Effects of Fuel Management on Ecological VECs

The following sections discuss the cumulative effects of mechanical fuel treatments. Mitigation measures for these impacts are discussed in the project level impact and mitigation section (see section 4.0).

5.6.3.1 Extent of fuel management on the landscape

Under the fire management plans for the three mountain park field units, fuel management involves reducing fuels through thinning canopies of closed forests, removal of ladder fuels and removal of course woody debris on the forest floor to reduce the risk of uncontrolled wildfire and large-scale prescribed fire to people and built assets. Fuel reduction treatments are generally implemented to change fire behavior (reduce the likelihood of crown fire), provide firefighter access, serve as an anchor point for initial attack on fires that threaten communities and facilities, or contain prescribed fires (Agee et al. 2000). Fuel management is carried out by mechanical thinning and fuel removal (i.e.logging) which may be followed by low intensity prescribed fire to remove additional fine surface fuels and reduce the loading of flash fuels (e.g. juniper and grasses) (B. Low, pers. comm.). This type of low intensity and severity prescribed fire is an important tool in long term maintenance of fuel breaks around communities.

Fuel management projects fall into two main categories: community/facility protection under the FireSmart program (Westhaver 2003) and the creation of landscape fuel breaks that allow for the safe implementation of large prescribed fires. All fuel management activities serve to support prescribed fire, suppression, and facility protection activities carried out under the FMPs, and therefore cover a very small percentage of the landbase in the parks in comparison to the total number of hectares subject to prescribed fire**.** To date, approximately 2000 hectares have been treated in the four mountain parks combined or 0.2% of the montane and subalpine areas of the parks (excluding rock, ice and high alpine areas) (Table 5.12). In the next few years, another roughly ~500 ha of land will be subject to fuel reduction across the four parks (R. Kubian, B. Low, pers.comm.). Once the facility protection and fire guard fuel reduction projects are complete in the parks, there should be little if any future addition to the total landbase treated for fuel reduction. That is, there is a finite aerial extent to fuel reduction treatments in the parks unless there are new facilities built which need protection (an unlikely scenario). Therefore the overall cumulative negative impacts on native diversity, terrestrial ecosystem health and aquatic ecosystem health of fuel management treatments is expected to be limited to local effects and will be relatively minor on a regional mountain park wide scale**.**

Table 5.12 Amount of land subject to fuel reduction treatments for facility protection and fire guards in Banff, Jasper, Yoho and Kootenay National Parks.

Field Unit	Facility Protection (ha)	Fire guards (ha)
Banff	190	605
LLYK	334	109
Jasper	555	173
TOTAL	1079	887

The following sections discuss the important potential negative effects of mechanical fuel treatments. Mitigation measures for these impacts are discussed in the project level impact and mitigation section (see section 4.0).

5.6.3.2 Biodiversity

Cumulative effect of current fuel management program on biodiversity: Fuel management can cause variable effects on species richness and abundance of some birds, small mammals, and invertebrate species, may cause declines in amphibian populations	
Direction: negative	**Magnitude**: minor
Geographic extent: Rocky Mountain ecosystem	**Duration**: short-term

Vegetation

The increased light reaching the forest floor after forests have been thinned can increase plant species richness in the understory. However, this effect is likely to be minimal in situations where ground disturbance by machinery is minimized, as dictated by best management practices and mitigation measures laid out in project-level EAs for fuel reduction projects (see section 4.3, soil). The establishment of new plants from seedbanks requires at least partial removal of the forest floor layers and exposure of mineral soil. However, soil compaction is a possibility where the forest floor is significantly disturbed by machinery repeatedly driving over areas such as skid trails and landings in which case regeneration by native plants would be slow and patchy.

Instead the largest effect on the understory plants is likely to be increase in abundance, growth rates and net productivity of existing plants resulting from increased light, water and nutrient availability when the competing overstory trees are removed. This will result in increased growth of grasses, forbs and increased fruit production by berry-producing shrubs like buffaloberry (Hamer 1996).

Perhaps of most significance to wildlife and their habitat, removing shrubs, small trees and course woody debris results in an overall loss of structural diversity in areas treated to reduce fuels. The resulting stands generally have simplified structure with fewer layers, more homogeneous size trees and fewer downed trees on the forest floor interspersed with open areas in which all of the trees have been removed (Figure 5.28). In the mountain parks, given the number of hectares treated by mechanical thinning all of these effects on vegetation are expected to have minimal impact on the overall diversity of vegetation communities.

Figure 5.28. Fuel management area adjacent to Banff showing decreased structural diversity and large openings created by these fuel treatments.

Large herbivores

For large herbivores including elk, deer and moose the fuel treatments serve to open up stands and create more palatable grasses and forbs for these species similar to prescribed fire (Wishart et al. 1993). However, thinned areas also reduce the amount of hiding cover and thermal cover for ungulates. Ultimately, the trade-off between cover loss and forage availability means that ungulates prefer open areas associated with nearby cover which is what the fuel treatments provide (Tomm et al. 1981, Smith 1985,Morrison et al. 2003). A recent evaluation of the fuel management areas surrounding the Town of Banff indicates that the overall effect of these treatments on deer and elk are populations are neutral or positive (Kortello 2007). However the fact that over half of the area treated for fuel reduction is within the WUI surrounding park communities, there is potential for increased conflicts with humans, and increased habituation of these species causing exacerbation of the hyperabundant elk populations surrounding Banff and Jasper.

Large predators

For predators including wolves, cougars and grizzly bears the fuel breaks around communities in the parks could have a cumulative negative impact on these animals due to incremental loss of security cover in wildlife corridors. This may be exacerbated by increased human use of the fuel management areas around communities due to ease of access and ease of travel through these thinned areas. This could lead to further displacement of predators from important habitat for hunting and movement and increase the potential for conflicts with humans around high human use areas (Kortello 2007). Recently carnivore use of fuel reduction areas around the Town of Banff in the years prior to and after thinning was evaluated (Kortello 2007). The results indicate that in areas where human use is low fuel reduction treatments have had no significant impact on carnivore use of these areas.

For grizzly bears and black bears, fuel reduction areas may provide increased production of preferred bear foods like bufflaloberry as plants respond to increased light levels (Hamer and Herrero 1987, Kansas 2002). However, thinned stands provide less security cover for these wary animals and may result in increased human-bear conflicts if bears are attracted to thinned areas adjacent to communities and other facilities (Kortello 2007).

Amphibians

The loss of course woody debris in fuel management areas can potentially have a negative effect on amphibians as this is an essential part of their habitat. Course woody debris on the forest floor provides necessary substrate and nutrients for the invertebrates and fungi upon which amphibians feed (Kortello et al. 2007). Downed wood also creates a cooler, moister microclimate which is essential for amphibians that cannot tolerate extremes in temperature or humidity. The thin, highly vascularized skin of amphibians makes them sensitive to environmental changes (Welsh 1990) like the removal of forest canopy associated with thinning in fuel reduction areas that can potentially dry out site conditions (Johnson and Pengelly 2004). The literature suggests that the effects of forest clearing on amphibians are variable with some studies reporting no effects and others reporting decreased abundance of some species in logged areas (Graham 1997, Naughton et al. 1999, Gibbs 1998, Wind and Dupuis 2002).

Protecting habitat features such as ponds, wetlands and seeps, downed woody debris, and understory vegetation will minimize threats to amphibian populations (De Maynadier and Hunter 1995). Fuel management treatments within amphibian habitat in the mountain parks maintain a buffer of mature trees around all wetlands and deciduous shrubs are left intact over the whole treatment as well as an established minimum of 200 pieces/ha of course woody debris (Woodley and Forbes 1997) is left on the ground (Westhaver 2003, Kortello et al. 2007). The Fairholme Amphibian Monitoring Project currently underway in BNP will provide more information specific to the effects of mechanical fuel treatments on amphibian populations (Lepitzki & Lepitzki 2003, Murphy 2004).

Birds and small mammals

The literature does not suggest a clear trend for the effects of logging on small mammals and birds (Ferguson et al. 2001). Some species in these groups decline in thinned sites in relation to unlogged areas whereas some species benefit from the increased edge or increased forage availability in fuel reduction openings. The effects on these small animals will be dependent on the amount of structure and diversity of vegetation remaining on the site after completion of the fuel reduction treatments.

In general if deciduous shrubs, deciduous trees, some course woody debris, and most wildlife trees (snags with cavities) are left on sites as prescribed in fuel reduction environmental screening reports in the mountain parks (e.g. Westhaver 2003, Kortello et al. 2007) the effects on birds and small mammals should be minimal over the scale of the entire mountain park ecosystem.

5.6.3.3 Terrestrial ecosystem health

Non-native plants

Cumulative effect of current fuel management program on non-native plant populations: Fuel management can cause increases in abundance of non native plants where there is significant soil disturbance	
Direction: negative	**Magnitude**: moderate
Geographic extent: local	**Duration**: long-term

Disturbance is considered one of the primary factors promoting invasion of ecosystems by non native plants (Rejmanek 1989, Hobbs and Huenneke 1992). A number of studies have documented an association of nonnative plant species with disturbed areas similar to fuel breaks, such as logging sites, roads, trails, and pipeline corridors (D'Antonio et al. 1999). A recent non native plant survey in Banff National Park revealed a strong correlation between anthropogenic disturbance involving removal of the forest floor and soil organic layers by machinery and people and invasion by non native plants (R. DeLong, personal observation).

Therefore soil disturbed by machinery and slash pile burning during the creation of fuel breaks may be vulnerable to invasion by non-native plants (Korb et al. 2004). The location of community fuel breaks adjacent to areas of high human use increases the potential for non native plant invasions in areas where the soil is disturbed and mineral soil is exposed. In the case of landscape fuel breaks for prescribed fires, non native plants that establish in mechanically thinned fire guards could potentially spread into adjacent areas burned by prescribed fire. Thus, the fuel management treatments implemented under the fire management plans in the mountain parks could facilitate spread of non native plants into new areas of the mountain parks. Mitigation measures have been developed to minimize the spread of non native plants in fuel reduction treatments and are implemented in each project (see section 4.0).

5.6.3.4 Aquatic ecosystem health

Cumulative effect of current fuel management program on aquatic ecosystem health: Fuel management can cause increased run-off, increased sedimentation, and loss of riparian cover in aquatic systems	
Direction: negative	**Magnitude**: moderate
Geographic extent: local	**Duration**: long-term

In general the effects of mechanical fuel reduction on aquatic ecosystems are similar to those from prescribed fire (see section 5.6.1.5). Removal of overstory trees, exposure of mineral soil during harvest operations, and subsequent prescribed burning have the potential to increase run-off (through decreased evapotranspiration and increased snowpack) and increase sediment inputs into streams and wetlands. However, given the mitigation measures in place to reduce soil disturbance, the fact that most fuel reduction areas have some mature trees retained, and the low intensity fire that these areas are sometimes subject to, these effects are likely to be minimal and local in scale (Kortello 2007). In addition most of the fuel reduction treatments around communities occur on valley bottom habitats with little slope further reducing the potential for run-off and sediment transport. Finally, the scale of fuel reduction treatments across the mountain parks is quite small on a regional basis and therefore unlikely to cause drastic changes to aquatic habitat or organisms. Instead these treatments add an incremental stressor to the major ones affecting aquatic organisms such as habitat fragmentation and non native species.

5.6.3.5 Summary of the cumulative ecological effects of fuel management

Table 5.11 (see Section 5.6.2.7 above) summarizes the cumulative ecological effects of fuel treatment. Figure 5.29 outlines the cause and effect relationships of the cumulative ecological effects of fuel treatment outlined above.

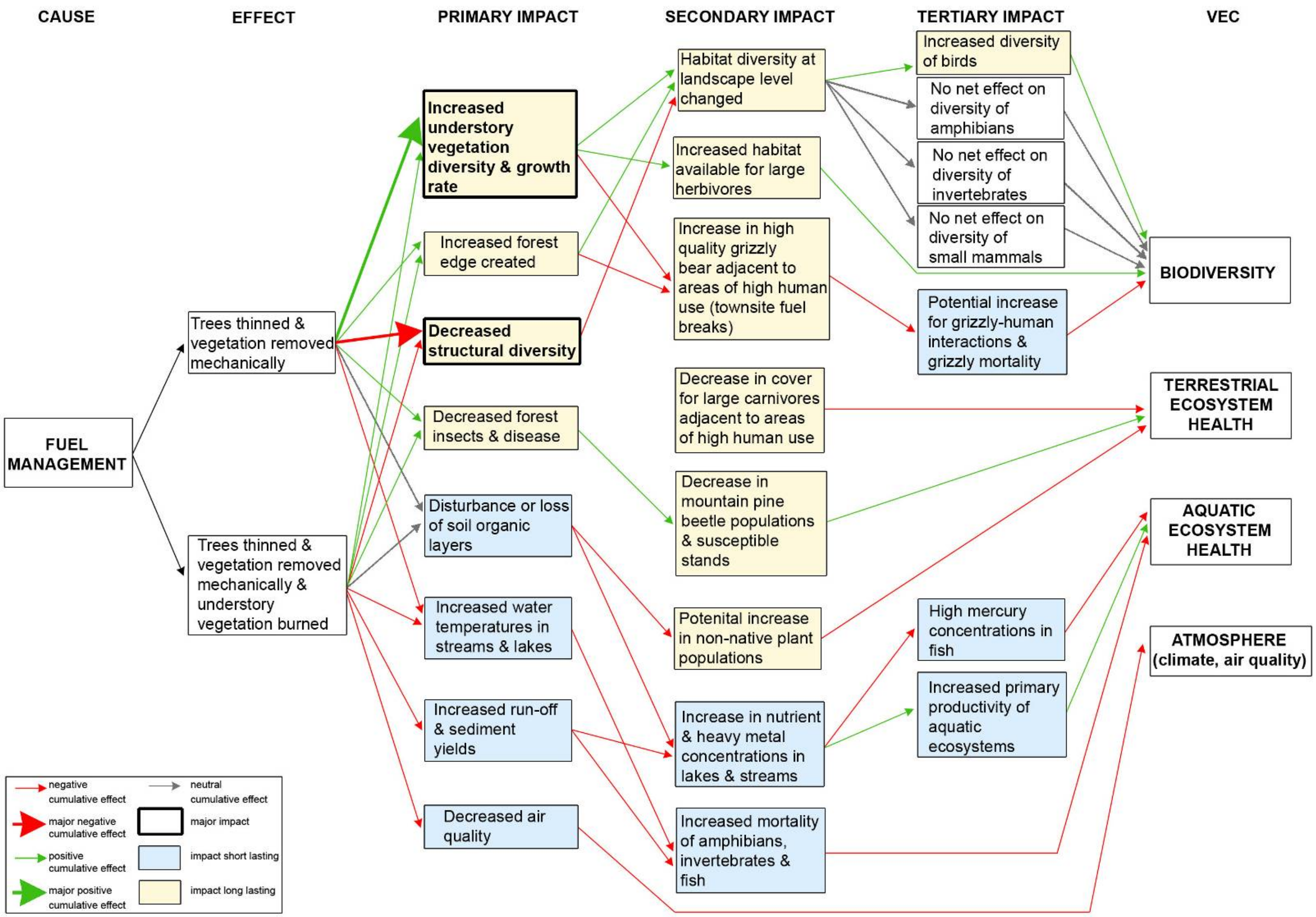


Figure 5.29 Network diagram of the cumulative ecological effects of fuels management on VECs.

5.6.4 Cumulative Effects of prescribed fire and fuel management on Social, Cultural and Economic VECs

5.6.4.1 Human health and safety

Cumulative effect of prescribed fire and fuels management on human health: The smoke produced by prescribed fire and fuel management can have negative effects on human health.	
Direction: negative	**Magnitude:** minor
Geographic extent: Rocky Mountain ecosystem	**Duration:** short-term

Smoke

A major concern of prescribed burning and fuel management in a social context is adverse health effects. Smoke produced by prescribed burning and burning of materials removed by fuels management activities constitutes a health concern for persons with heart or lung disease and the elderly, and, in extreme fire situations, the health of the general population. While seasonal burning restrictions reduce negative impacts to air quality during summer months, the risk of decreased air quality does increase in the early spring and late fall when prescribed burning is allowed. However, these risks do dissipate over time as the smoke production decreases. Under hazardous air quality conditions the risks of adverse health effects can be reduced if precautionary measures are taken such as avoiding any indoor and outdoor exertion and remaining indoors whenever possible. Prescribed burning and fuels management are critical for reducing the risk of a major fire event, which would produce significant amounts of smoke and have a much longer lasting negative impact on air quality in comparison to smaller prescribed burns during the spring and fall.

Impacts of airborne particulates and chemical compounds (e.g. nitrogen oxides, carbon monoxide, organic compounds) from forest fires may be compounded as a result of climate change. Poor air quality, especially in urban areas, aggravates cardiovascular and respiratory diseases.

Another risk associated with smoke is the short-term reduction in visibility (depending on weather conditions), which can be a hazard on roadways.

Mitigation Measures and SEA Workshop Input:

- *Smoke management is an integral component of Parks Canada prescribed burn planning and implementation. There are many considerations with respect to smoke management including ecological, social and economic and health related considerations. More work on this particular front is required including the analysis of smoke impacts on tourism and how these impacts can be mitigated to the greatest degree possible.*
- *Minimizing the impacts of smoke to the public is an operational objective of all prescribed burns. This can be achieved to a large degree by limiting ignition operations*

to times when atmospheric venting conditions are optimal and wind direction carries smoke away from populated areas.

- *Parks Canada is in the process of examining several options for improved information sharing on the topic of smoke. One endeavor that holds considerable promise is real-time updating of fire management information on the Parks Canada fire management website. Links to this information will be developed from various sections of the Parks Canada website, including a link from the visitor information page in an effort to better apprise individual visitors and businesses of fire management activities including prescribed fires and fuel reduction.*
- *Parks Canada will continue to work closely with Alberta Environment and regional health authorities to monitor smoke impacts on a local and regional scale. To improve current practices Parks Canada will investigate the option of purchasing handheld nephalometers to monitor air quality on a regular basis.*

Persistent Organic Pollutants (including mercury)

Cumulative effect of prescribed fire and fuels management on human health: The pollutants (including mercury) mobilized by prescribed fire that accumulate in fish can potentially have negative health effects on people that consume them.	
Direction: negative	**Magnitude:** moderate
Geographic extent: Rocky Mountain ecosystem	**Duration:** short-term

The bioaccumulation of persistent organic pollutants can be increased in fish in the mountain national parks following fire which can have negative effects on the health of people that harvest and consume fish from affected lakes in the parks (See section 5.6.2.6, Persistent Organic Pollutants above). Methyl mercury in particular, known to accumulate in the tissues of fish in the parks (Kelly et al. 2006), is a neurotoxin and can pose significant health risks if ingested in high enough concentrations over long periods (see 5.6.2.6 for mitigation measures).

However, it is unlikely that POPs pose a significant risk to anglers in the mountain parks given the remoteness of many of the affected lakes in the backcountry and the low overall harvest rates per person per season.

Water quality

Cumulative effect of prescribed fire and fuels management on water quality: The increased nutrients, pollutants and sediment in surface water following prescribed fire can have negative effects on water quality for downstream consumers.	
Direction: negative	**Magnitude:** minor
Geographic extent: Rocky Mountain ecosystem	**Duration:** short-term

Water quality could be negatively affected downstream of large prescribed fires or locally by fuel management projects around communities. However, the research done on fire effects on water quality (Elliot and Vose 2006) suggests that the effects are short-lived. Post-fire pulses of sediment and nutrients are also likely to be diluted to insignificant levels (well below water quality guidelines) by the time they flowed into the large rivers that provide the drinking water for communities within and downstream of the parks.

Public and firefighter safety

<table>
<tr><td colspan="2">Cumulative effect of prescribed fire and fuels management on safety: Prescribed fire and fuel management reduce the risk of a catastrophic wildfire that can have major negative effects on human health and safety.</td></tr>
<tr><td>Direction: positive</td><td>Magnitude: major</td></tr>
<tr><td>Geographic extent: Rocky Mountain ecosystem</td><td>Duration: long-term</td></tr>
</table>

Prescribed fire and fuels management are important pre-fire preparation strategies that can ameliorate the danger of potentially catastrophic fire events and are also important for controlling wildfires. Following the catastrophic 2003 fire season in British Columbia, a Provincial Review (Filmon 2004) concluded past fire suppression has contributed directly to fuel build-up in forests and that this build-up will result in more significant and severe wildfires, including more urban-wildland interface fires, unless action is taken.

Any wildfire, especially high intensity crown fire, poses serious risks on the health and safety of fire fighter's engaging in fire suppression. Hazards include risks of entrapment, asphyxiation, heat exhaustion, falling, and other injuries. The only effective perimeter control, therefore, is on the flanks of the fire until it reaches some barrier or the weather changes. Therefore precautionary prescribed burning and fuel treatment efforts are vital for reducing risks to the health and safety of fire fighters.

Dangers of wildfire on people have accelerated with greater numbers of visitors to the mountain parks and increased populations in the mountain parks as a result of the trend to live and work in wilderness areas. Historically the Bow Corridor supported the most active fire regime and the most fire-prone forests, as well as the highest concentration of people and built assets (Arbor Report 1990). Prescribed burning and fuels management are therefore critical for reducing the risk to the health and safety of uninvolved citizens (residents, tourists) from large interface fires.

A major social concern related to prescribed burning is the risk of potential fire escape. However, prescribed burning is a controlled practice and the risk of escape is actually quite low. In addition the capacity to successfully conduct prescribed fire is continually improving through adaptive management.

Prescribed fire escapes represent a very small fraction of the number of prescribed burns completed by agencies in North America. In the United States a study of prescribed fire escapes found that most were not significant in that they did not burn private lands, did not significantly damage natural resources or result in the need for costly suppression actions (Dether and Black

2006). The increase in the average success rate of prescribed burns from 99.0% (1996-2001) to 99.7% (2003-2005) suggests that the control of prescribed burning is improving over time.

Potential risk for escaped prescribed fires in the mountain national park is also quite low. There have only been 2 recorded escapes out of the 136 prescribed burns that have taken place since the prescribed burning program began in 1983 (Brian Low, pers. comm.). Neither of the escaped fires negatively impacted human health and safety or built assets within the parks, with the exception of a warden cabin which was consumed in the Jasper Syncline fire (Dave Smith, pers. comm.). The success rate for prescribed burning in the mountain parks is 98.5% to date. Continual improvement of this success rate through improved training and adaptive management whereby knowledge gained from each fire is used to better prepare and implement the next fire will further reduce the overall risk of escaped prescribed burns on human health and safety and built assets.

Fuels management often involves piling thinned material and burning it on or near the managed site. While seasonal burning restrictions do reduce the time when such methods can be used, it is a powerful and effective tool in protecting urban areas, backcountry facilities, campgrounds and other areas occupied by humans from wildfire. Trees may be more susceptible to blow down due to thinning (fuel treatment). This can pose a risk to human safety on hiking trails in fuel treated areas during strong winds.

Climate change and associated outcomes may increase risks to human health and safety due to increased forest fire hazards and heightening the potential for more extreme fire events due to lengthened fire seasons and less predictable seasonal climates.

Another set of safety concerns relates to the danger posed by post-fire landscapes. Depending on the extent of the prescribed burn there may be restrictions to visitor facilities including Day Use Areas and campgrounds in the area of the fire. Unstable standing dead fire killed trees may be a long term public safety issue in these areas as well as the potential for increased human wildlife interactions if post-fire landscapes create optimal habitat for certain species and are in close proximity to high use areas.

Mitigation Measures and SEA Workshop Input:

- *Continue the cooperative training opportunities between local fire departments and Parks Canada (e.g. S115 course) to continually improve interagency fire response. Diversify training through the use of scenarios with hands-on exercises.*
- *Post-fire maintenance assessments should be made publicly available so that visitors, residents and tour operators are aware of the potential dangers of entering a burned landscape.*

Infrastructure and Built Assets

Cumulative effect of prescribed fire and fuels management on economic values: Prescribed fire and fuel management serve to reduce the risk of economic loss or loss of built assets and infrastructure.	
Direction: positive	**Magnitude:** major
Geographic extent: Rocky Mountain ecosystem	**Duration:** long-term

Risk to structures at the interface with wildfire is a major economic concern in the mountain parks. The owners of structures in or near wildland fuels cannot depend on fire suppression efforts of public agencies alone to protect their buildings from fire destruction, especially when their structures are located in or adjacent to areas where fire has been excluded for many decades and fuel loading is extreme (Tokle 1987, Arbor Report 1990). The use of tax funds to pay for enough fire fighters and equipment to contain every fire that starts on the few days of very high and extreme fire weather conditions is both economically and politically infeasible. Preconditions and treatments taken in advance of fires are an effective protection measure for built assets and may reduce economic losses in the long term.

Preventative measures such as prescribed burning and fuel treatment in the surrounding landscape can greatly reduce the risk of destruction of built assets. Modifying pertinent components of the fuel complex minimizes the chances for development of a dangerous fire within sensitive areas and reduces the potential for crown fires. This offers reasonable protection of structures from forest fires starting in the vicinity and from fires approaching from a distance.

Structures and facilities within the montane and lower subalpine forests in the mountain national parks can be considered a fuel source similar to the vegetation that surrounds them. In built-up areas such as Banff, Lake Louise, and Jasper, structures and facilities in close proximity to the wildland edge are at the greatest risk to damage or destruction from wildfire. In the case of high-intensity fast-moving fire this risk increases. Consequently, fire commanders often have to make difficult decisions about controlling wildfire or defending buildings in these areas (Tokle 1987, Arbor Report 1991). Therefore, preventative actions such as the treatment of surrounding combustibles also alleviate some of the stress on fire commanders of having to choose between wildfire control and defending built assets.

Structures and facilities within the montane and lower subalpine forests can be considered a fuel source similar to the vegetation that surrounds them. In built-up areas such as Banff, Lake Louise, and Jasper structures and facilities in close proximity to the coniferous forest edge would be at the greatest risk. However, in the case of high-intensity fast-moving fire, there would be substantial additional risk to all structures from falling embers. Consequently, fire commanders often have to make difficult decisions about controlling wildfire or defending buildings in these areas (Tokle 1987, Arbor Report 1991).

Prescribed burning can be a risk to structures in the wildland-interface zone if the surrounding stand has not been thinned and surface and ladder fuels reduced. Conducting a prescribed burn without having completed fuel maintenance beforehand means the entire stand will have reached a level of flammability that could flare up into an uncontrollable crown fire. Therefore, periodic fuel maintenance around structures in the wildland interface zone is important for creating conditions that reduce the risk of prescribed burns in the same area from flaring up to dangerous levels. In some cases thinning may lead to an increase in the potential for fire spread rates in spring and fall when grasses and herbs are cured. However, such fires will be of relatively low intensity, amenable to control or initial attack, and pose little threat to the values at risk such as human life and property.

Fuel treatments in and around the urban-wildland interface creates a relatively fuel free zone in which firefighters can stage their attack to stop structure fires from spreading to the surrounding wildland vegetation or prevent wildfires from spreading to the structure. Without defensible space, fire intensity and rate of spread can make firefighting difficult if not impossible increasing the risk of losing built assets.

However, fuel treatments vary in their effectiveness in slowing or stopping the spread of wildfires. A paired plot study of 5 wildfires that burned through fuel treatment areas in the western U.S. revealed many attributes of effective fuel treatments (Omi et al. 2006).

1. *Fuel treatment effectiveness depends on type of treatment.*
Treatments that included reduction of surface fuels were generally effective, with or without prior treatment of canopy fuels. But thinning followed by slash treatment produced the most impressive results. Thin-only treatments were generally ineffective and in some cases produced greater fire severity than adjacent untreated areas.

2. *Fuel treatment effectiveness depends on treatment age.*
While thin-only treatments were generally not effective, the most recent treatments of this type did produce significant reductions in fire severity. Treatments that included reduction of surface fuels were effective for up to a decade, while older treatments were not found to have a significant effect on fire severity at any site, regardless of treatment type.

3. *Fuel treatment effectiveness depends on weather severity*.
It is generally presumed that fuel treatments must be overwhelmed at some threshold of weather extremity. However, the researchers observed fire severity reductions in several fuel treated areas that were affected by wildfire under some of the most extreme weather conditions on record. Only treatments that reduced both canopy and surface fuels in combination showed a significant correlation to weather conditions and the effectiveness of these treatments actually increased with weather severity. But whether this relationship will hold under the increasingly extreme weather conditions predicted by climate change scenarios remains to be seen.

Getting rid of the great amounts of woody material that result from large scale fuel management programs can be costly. However, failure to remove or dispose of this debris can result in a higher fire hazard, possibly greater than prior to treatment. Overall, the cost incurred to reduce fuel loads is necessary to protect built assets. Compared to burying and chipping of woody debris, which is only effective if decomposition rates are high enough to assimilate the material, piling and burning is considered to be the most cost effective method for fuel treatment (Green 1977, Arbor Report 1990).

The combined impact of higher temperatures and increased drought due to future climate change may create a ‘tipping point’ beyond which fire suppression is no longer feasible (Lemmen et al. 2008). Prescribed fire helps to reduce the need for full suppression activities by reducing fuel loads in a pre-emptive strike to reduce the risk of infrastructure and built assets being destroyed by fire.

Risk of flooding, mudslides and debris flows

Since prescribed burning can increase run off and peak flows in streams in the first few years following fire there is potential for flooding in areas downstream from burned watersheds. The risk to built assets from flooding is likely very low in the mountain parks because flooding and associated stream channel changes would likely be local in nature and restricted to small streams where the gradient was low in valley bottoms before they flow into the larger rivers. Flooding at the local scale would only impact facilities immediately adjacent to the stream experiencing the higher flows. This might include warden cabins, backcountry lodges, picnic areas, etc. The flooding would likely only be short-term following intense rain events associated with summer thunderstorms or could be associated with spring run-off in years where snowpack is high and peak water yield is significantly increased in burned catchments.

Socio-Mitigation Measures and SEA Workshop Input:

- *Improve awareness of the challenges relating to fire and critical infrastructure. Parks Canada will continue to work with utility companies on an ongoing basis to address these concerns through the CEAA process and correspondence with the utility companies.*
- *Tactical response planning requires interagency funding. Approach local government with a motion to have resources and funds directed towards fire management, cooperative training, fire control and infrastructure.*

5.6.4.2 Social and cultural values and aesthetics

Cumulative effect of prescribed fire and fuels management on socio-cultural values and aesthetics: Prescribed fire and fuel management reduces the risk of loss of irreplaceable historical or First Nations artefacts and sacred places. These activities may also result in reduced aesthetics.	
Direction: positive	**Magnitude:** major
Geographic extent: Rocky Mountain ecosystem	**Duration:** long-term

Historical Sites and Aesthetics

Perhaps the greatest socio-cultural concerns associated with the cumulative impacts of prescribed burning and fuel treatments includes the risk of compromising valued aesthetic landscapes (natural viewscapes), reductions in wildlife sightings due to habitat loss (bird watching) and other historical, cultural (e.g. traditional First Nations ceremonial sites) or scientific assets that hold value for people (e.g. old growth trees). Secondary environmental impacts, such as soil erosion or stream pollution, which may result from mechanized fuel treatment, have also been identified as potential social or cultural concerns (Westhaver 2003).

Currently, some historical areas in the mountain parks have applied FireSmart practices to reduce the risk of damage by fire. These practices increase public awareness and better equip people to suppress fires at the local level. Higher risk areas include isolated structures in the backcountry (e.g. single residences, cabins, oil and gas facilities, backcountry campsites) where these practices have yet to be implemented.

The documentation of cultural heritage sites within the mountain parks has improved in recent years and more tools for preventing damage to such sites have been developed and implemented. Fire may increase exposure of sensitive archaeological sites that were previously undocumented.

The aesthetic effect of prescribed burning and fuel management is negative in the short-term and neutral or positive in the long-term depending on the effectiveness of communications with the public. By opening up tree canopies, fire and fuel management generally improve viewsheds. However, people tend to dislike the look of recently blackened areas immediately after a burn.

Mitigation Measures and SEA Workshop Input:

- *Continue to document the locations of historically significant areas in the mountain parks and employ appropriate strategies to protect these areas from possible damage or destruction due to prescribed burning and fuel management.*
- *Fire managers should consider aesthetic values and preservation of viewscapes when proposing burn and treatment locations.*
- *Inevitably tradeoffs must be made and actions that align best with the overall ecosystem management goals of the mountain parks must be taken. The long-term benefits of prescribed burning and fuel treatment in restoring natural fire regimes, reducing impacts to human health and safety and protecting built assets must be considered.*

First Nations

First Nations people were the original “fire managers” of the mountain parks ecosystem. For hundreds of years before European settlement and subsequent to the onset of fire exclusion practices, fire was used by native communities for a variety of reasons including: promoting a diversity of habitats which was directly linked to improved hunting and crop management activities; fireproofing areas for protection of communities and/or resources; pest management and insect collection; signalling and warfare; and clearing areas for travel or resource cultivation (Williams 2003). These purposeful fires differed from natural fires (lightning strikes) by their seasonality of burning, frequency in certain areas and the intensity of the fire. Thus, they resulted in different effects in the ecosystem compared to wildfires. For First Nations people fire was a tool used for managing landscapes and to create desired effects in an ecosystem that were outside the natural cyclic fire ecology patterns in the area. Fires tended to be set in the late spring just before new growth appears, while in areas that are drier fires tended to be set during the late summer or early fall. Selected areas were burned yearly, every other year, or intervals as long as five years (Williams 2003).

The process and the rationale for prescribed burning within the current fire management is not unlike that which prompted First Nations people to use fire - improved biodiversity, terrestrial ecosystem health, aquatic ecosystem health, human health and safety, and the protection of valuable resources. The traditional knowledge of fire and the landscape changes that fire can have on an ecosystem is an invaluable resource, not only for the current fire management programs in the mountain parks but also as a significant part of First Nations history. However, as generations pass, traditional knowledge of fire is slowly being lost within First Nations communities.

This is concerning as the incorporation of First Nation traditional knowledge of fire into the current fire management program and regular consultation with First Nations communities on the subject has been slow to evolve. As a result, little is known about the impacts of the current fire management program on the cultural values of First Nations communities in the region including impact on medicinal plant resource harvesting and potential risks of damaging sacred sites.

Mitigation Measures and SEA Workshop Input:

- *Invite First Nations elders to attend the Parks Canada basic fire management course. This would serve as an opportunity for elders to share their knowledge of fire history in the region, discuss the benefits and challenges of using fire, and identify specific concerns with the current fire management program.*
- *Provide a couple of seats for younger First Nations band members to attend the Parks Canada basic fire management course. This would serve as an opportunity to teach youth about present day fire management as well as the historical role of First Nations as fire managers.*
- *Incorporate a First Nations module into the curriculum of the Parks Canada basic fire management course. This module could include discussions about First Nations historical role in maintaining fire regimes, incorporating traditional knowledge/traditional use considerations into current and future prescribed burn planning and implementation.*
- *Establish developmental fire management positions for members of local First Nations communities. Once established, Parks Canada will provide training opportunities relating to these positions and include awareness of First Nations issues in basic/intermediate fireline training. Through a cost-sharing/matched funding arrangement with First Nations, provide a developmental opportunity for band members to participate in Banff Field Unit fire program as Initial Attack crew members.*
- *Have a First Nations representative on the site prior to any prescribed burn or fuel management activity to identify sacred sites and traditional land use areas. Identify the location of First Nations cultural sites and how they should be avoided/preserved in the tactical response plan.*
- *Develop a system that will be used to determine if a prescribed burn or fuel management activity will impact previously identified sites of cultural significance to First Nations*

communities (confidentially by local First Nations representatives) and indicate the appropriate mitigations to avoid/protect these sites.

- *Notify First Nations residents downwind of prescribed burning or wildlife of smoke using various methods including local newspapers and local radio.*
- *Have a First Nations representative participate in rare plant surveys to identify important medicinal or herbal plants that could be impacted by fire or fuel management activities.*
- *Each Fire Management Unit will build relationships with respective First Nations stakeholders individually, while continually keeping staff in the other Fire Management Units apprised of progress and regularly sharing information. This will serve as a way to collectively build a consultation toolbox most suitable to the unique needs of First Nations communities throughout the mountain parks and improve consistency between Fire Management Units. The Parks Canada Handbook for Consulting with Aboriginal Peoples (Parks Canada Fall 2006) will be used as a guideline for consultations.*
- *Parks Canada is committed to working closely with First Nations stakeholders on these important mitigations (B. Low pers. comm.). Specific solutions will be formulated as part of an effort to improve the consultation process with impacted First Nations stakeholders. These recommendations will be incorporated into the final version of the fire management plans, project-level EA's relating to prescribed fires, fire management best practices, and the burn plans themselves.*

Communications

Parks Canada is working closely with neighbouring fire management agencies to cooperatively plan and implement prescribed fires. In the contiguous mountain parks during 2008, three such interagency (transboundary) units will be implemented. A regional interagency prescribed fire planning team has been established in order to ensure that this approach becomes a cornerstone of fire management regionally.

Since the inception of the prescribed burning program significant progress has been made in fire education in the mountain parks. Park Canada is committed to public education and awareness and will continue to enhance existing communications tools and pursue innovative methods in meeting our public education and awareness mandate.

Mitigation Measures and SEA Workshop Input:

- *Strengthen linkages with existing advisory groups throughout the mountain national parks to keep stakeholders up to date on fire management activities. Continue to actively seek out such opportunities with established advisory groups (e.g. Montane Ecosystem Advisory Group) and interagency planning initiatives. Parks Canada will work closely with co-delivery agents in the pursuit funding sources to facilitate this recommendation.*
- *Forge new partnerships and strengthen existing ones through consultation and education forums to improve stakeholder awareness of fire management goals, make existing information more accessible to the stakeholders and leverage support for the program. These efforts will be the primary objectives of the Fire Information Officer position.*

Engaging with sister fire management agencies on provincial lands to ensure that these messages are being communicated effectively will also be a critical part of this position.

- *Develop a communications product that shows prescribed burning priority areas with associated information as to how the prescribed burn locations were selected and the anticipated length of the burn and size (simplifying the methodology and results for a wider public audience) including which burns are vital for the protection of human and built assets (e.g. Town of Banff).*
- *Existing initiatives, including outreach tools such as education kits and web-based learning opportunities, will be examined for improvement. In addition, Parks Canada will continue to pursue innovative ways of reaching a wide public audience based on recent demographic and community education research.*
- *Implement more progressive communications tools including live internet broadcasts of prescribed burning with commentary, develop an educational video on fire and fuel management for local businesses to inform staff, set up viewing platforms to view prescribed burning (if safe and permissible with current safety standards), and guided interpretive walks through previously burned and treated areas.*

Economic Vitality

Cumulative effect of prescribed fire and fuels management on regional economic vitality: Prescribed fire and fuel management reduces the risk of major devastating fire events which could have significant impacts on the regional economy. However, short term economic impacts may be attributed to prescribed fire activities.	
Direction: positive	**Magnitude:** major
Geographic extent: Rocky Mountain ecosystem	**Duration:** long-term

Economic Impact of Fire Management Activities

Prescribed fire and fuel management activities assist in the long term protection of communities and improving the overall ecological integrity of the mountain parks. In the short term the individual activities of prescribed burning and fuel management can disrupt the day-to-day activities of local residents and businesses in and around the mountain parks. This is an especially sensitive issue for tourism operators and other businesses dependent on visitors coming to the area.

The mountain National Parks are a premier attraction in western Canada. The Bow Valley alone sees millions of visitors every year - which is the driving force behind the local economies of Banff and Lake Louise. A significant proportion of that revenue comes during the busy months of May, June, July, and August. In 1996, tourism accounted for 100% of Banff’s economy (Page et al., 1996). To this day tourism is still the dominant economic force in the mountain park communities of Banff and Lake Louise.

In the Canadian Rockies region tourism generated $1.048 billion in consumer spending in 2004 and the region was responsible for 23% of Alberta’s total tourism revenues (Statistics Canada 2006). Benefits of the local economic activity generated in the region include direct expenditures, the additional economic activity generated by those direct expenditures and tax revenues. As such, attractions in the Banff and Lake Louise areas are marketed intensively regionally, nationally and especially internationally, and tourist operators in the Bow Valley anticipate steady growth and adequate return on their investment (Page et al., 1996).

The purpose of this assessment was to identify and evaluate the regional cumulative effects of prescribed fire and fuel management on the economic vitality of the contiguous mountain parks. An intensive economic assessment of the impact of prescribed burning on the local economies of park communities, and the tourism industry in particular, was beyond the scope of this project.

Prescribed fire and more specifically the smoke and closures that accompany prescribed fire, may deter visitors from coming to the mountain parks thereby weakening their contributions to the local, regional and national economies. This may have a negative short term effect on the local economies in Banff, Lake Louise and Jasper if the burns are in close proximity to high traffic areas and occur during peak summer visitation months. However, how much of an impact prescribed burning has had or could have on the local economies of Banff, Lake Louise, and Jasper is difficult to pin-point. There is little evidence in available literature that shows a direct link between prescribed burning and local economic activity. Thus, drawing a definitive correlation between the cumulative impacts of these prescribed burns and impacts on economy at a regional scale, in isolation of wildfire impacts and other regional or international factors (e.g. SARS, 9/11, fluctuating US economy) over the past 30 years may not be possible. If businesses do suffer from the impacts of prescribed burning the losses incurred are likely to be short term and able to be recovered due to the fact prescribed burning is presently restricted to spring and fall months in the mountain parks having minimal impact on peak tourism months.

Since the late 1980s there have been over 130 prescribed burns throughout the mountain parks, many of which have burned at the same time as wildfires in other areas within the park, in adjacent provinces or to the south in the United States. For example, in the summer of 2003 most of the smoke and ash settling in the Bow Valley was attributed to wildfires in Kootenay National Park carried by prevailing winds, not the result of prescribed burning in the area.

In contrast, the economic losses from a major wildfire that threatens a community directly can be significant. The major forest fires in the interior of British Columbia during peak tourism season in 2003 serve as an example. The wildfires burned mostly during July, August and September, the three months of the year when most hotel room revenues are typically generated. The devastating fires forced the BC government to issue a restrictive travel advisory in late July, banning people from entering the backcountry, which includes tourism locations such as forested areas.

In August of 2003, the Okanagan Mountain Park Fire raged through Southeast Kelowna creating the largest evacuation in British Columbia history. Beyond the disruption and suffering for visitors and residents alike, were the losses suffered by small businesses throughout the region. The tourism industry suffered the greatest harm as a result of the Okanagan Mountain Park fire (Economic Impact Okanagan, 2003). During the fire the average decrease in business revenue was found to be between 30-40%. Because the fire impacted Kelowna during the height of the summer tourist season, this resulted in many businesses losing a major portion of their yearly business revenue (Hystad and Keller, 2005). Weaker tourism activity was also recorded in other regions of the province close to wildfire activity including the Kootenay valley (BCStats, 2003).

The range of impacts due to the wildfires went far beyond specific dollar losses. Some of the external costs associated with the impacts of the fires included evacuations from location of business, inability to get to a place of business, employee impacts, cancelled events or activities, damaged or trapped equipment, stress, smoke, and closure (Economic Impact Okanagan, 2003). However, the British Columbia Tourism Sector Monitoring Report for November 2003 stated that “despite the forest fires raging in the Interior, room revenues were down or virtually unchanged in the affected regions” (BCStats, 2003). Considering the magnitude of these fire events, the economic impact to the regional tourism industry appeared to be temporary. This indicates that the tourism industry was able to gradually rebound from a traumatic peak season large-scale wildfire.

In Alberta, there is evidence that the 2003 fires in BC impacted consumer spending in the Canadian Rockies tourism destination region including the four contiguous Mountain national parks (Table 5.13). Total trip spending in the Canadian Rockies region decreased from $1.1 billion in 2002 to $888 million in 2003. The summer wildfires of 2003 likely contributed to this decrease. However, in 2004 consumer spending increased to $1.04 billion indicating that the tourism industry rebounded quickly from 2003. Similar to BC, the economic impact of the fire on the regional tourism industry in the Alberta Rockies appeared to be temporary.

Table 5.13 Trip Spending in the Canadian Rockies Tourism Destination Region

Trip Spending in Canadian Rockies Tourism Destination Region * (In $ Millions)									
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Alberta	$166.5	$192.7	$215.0	$196.4	$274.6	$198.7	$196.9	**N/A**	**N/A**
Other Canada	$112.6	$102.8	$123.6	$129.7	$187.2	$117.4	$178.6	**N/A**	**N/A**
United States	$307.7	$285.3	$306.2	$337.9	$249.4	$256.7	$271.9	$228.5	$247.5
Overseas	$353.5	$390.8	$470.5	$415.1	$391.3	$315.2	$400.3	$447.9	$408.5
TOTAL	**$940.3**	**$971.6**	**$1,115.3**	**$1,079.1**	**$1,102.5**	**$888.0**	**$1,047.8**	**N/A**	**N/A**
Source: Statistics Canada, Canadian Travel Survey, International Travel Survey									

N/A - Data not available

* Visits by domestic visitors (Alberta and Other Canada) are same-day and overnight trip while trips from international visitors (U.S. and Overseas) are overnight trips.

Prescribed burns are completed in the spring and fall, outside peak tourism season, and tend to be much smaller in size and severity than wildfires. In contrast to the economic impacts experienced in 2003 due to wildfire, it is unlikely that isolated prescribed burning activities throughout the mountain parks during the spring and/or the fall have had a significant impact on the regional economic vitality within the mountain parks.

Fire management is about trade-offs. If there are short-term economic losses that can be attributed to prescribed fire and fuel management activities, they are likely minimal given the protection benefits they ultimately provide – including reducing the potential for an extreme fire event which could have significant impacts on the local economy of park communities. Looking forward, climate change may bring less rainfall and longer, hotter summers, which could increase the danger of wildfires. Prescribed burning and fuel management activities reduce this risk, and therefore may be critical in preventing extensive economic losses in the future.

In addition, prescribed fire and fuel management activities also help to maintain and/or improve the ecological integrity of fire dependent landscapes. Since the natural physical beauty of the mountain parks is a major attraction that brings visitors to the region, prescribed burning helps to protect the resource upon which the tourism industry in the mountain parks depends. The perpetuation of natural ecosystem function is just as crucial to the sustainability of the local tourism economy as it is to the protection of ecological integrity of national park landscapes.

Regardless of the fact that prescribed burning likely has less of a long term impact on local economic activity in comparison to the impacts of a major peak season wildfire event, there remains a strong concern amongst local business operators over the short term economic impacts of prescribed fire on their business. There is a perception that within the current fire management program ecological integrity goals out-weigh the goal of maintaining a positive visitor experience. Restricting prescribed burning to spring and fall may only be a temporary solution for reducing economic impacts to the local tourism industry. With climate change the opportunities for snow-based recreation will decline, but overall visitation levels are expected to increase as an aging population takes advantage of warmer shoulder seasons (Welch 2006). This will extend the summer tourism season into the spring and fall, which are currently months in which prescribed burning takes place.

Therefore, specific, regular and open dialogue between Parks Canada and the local business industry throughout the mountain parks needs to be improved to achieve a number of different goals including:

- Better dissemination of fire science information and prescribed burning priority areas to these groups
- Consensus decision-making around timing of fires in order to meet Parks Canada fire management goals while avoiding impacts to health and safety of residents and visitors and having the least possible economic impact on the local economy

Mitigation Measures and SEA Workshop Input:

- *Since the inception of the prescribed burning program significant progress has been made in fire education in the mountain parks. Park Canada is committed to public education and awareness and will continue to enhance existing communications tools and pursue innovative methods in meeting our public education and awareness mandate.*

- *Parks Canada, municipalities, and business stakeholders will work together to development a stakeholder communication plan. This plan will document the information requirements of the business community, the most timely method of information dissemination, as well as updated stakeholder contact lists. In addition, Parks Canada will pursue opportunities to attend regular meetings with the business community in order to present and discuss upcoming fire management initiatives.*
- *Parks Canada will pursue long term liaison opportunities through Fire Information Officer positions and investigate how available information can be accessed more readily by stakeholders and the public so that they may better educate themselves on fire management related issues.*
  Key aspects of this position will include:
    - *Education of the public and stakeholders regarding the complex regional interactions of airsheds and sources of smoke that impact our national parks.*
    - *Encourage local businesses to contribute to a larger vision for the future of the mountain national parks and surrounding regions that considers the economic, environmental and social changes that are eminent in the region.*
- *Addressing knowledge gaps in this area and ensuring that management decisions are based on the best available knowledge is critical.*
- *A balance between public health and safety, visitor experience, ecosystem integrity, and socio-economic well-being of the business sector is vital to the success of the fire management program.*
- *Continue discussions with the Parks Canada Social Scientists to address how fire and socio-economic considerations can become better integrated.*

Parks Canada is committed to working with partners to ensure that both the short term and long term objectives are met. Collaboration with sister agencies and the business community will be critical in the development of an effective action plan to address these concerns. This will involve sharing information databases to accurately assess the potential impacts of fire management activities and determine appropriate mitigation measures.

5.6.4.3 Summary of cumulative social effects of prescribed fire and fuels management

Figure 5.30 outlines the cause and effect relationships of the cumulative social effects of prescribed fire and fuels management as outlined above.

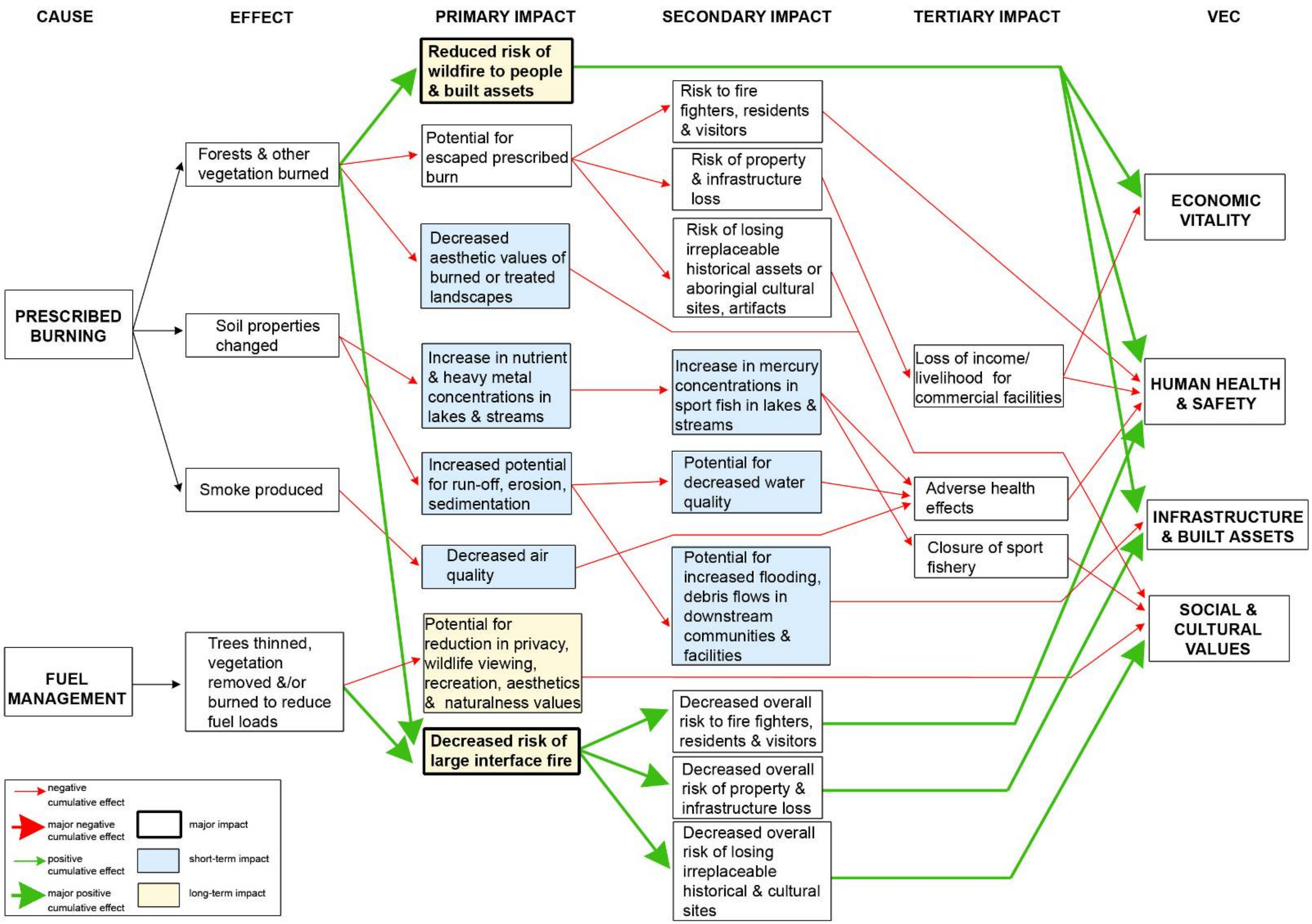


Figure 5.30 Network diagram of the cumulative social effects of prescribed fire and fuels management on VECs.

6 CONSULTATION

6.1 Internal Parks Canada consultation

6.1.1 Purpose

Consultation with Parks Canada experts in fire, wildlife, vegetation, communications, cultural resources, Species at Risk, CEAA and other appropriate experts regarding strategic and project level issues related to fire and forest fuels management.

6.1.2 Methods

A list of eighty-two parks and provincial government personnel was compiled to contact and provide input for the SEA. Each of the eighty-two people was sent a detailed questionnaire to get their input on available information, areas of concern, and any knowledge gaps related to fire and fuels management in the mountain National Parks. A copy of the questionnaire has been included in Appendix I. In the initial round of contact, there were four responses to the questionnaire, two of which were from the Alberta provincial government. In the second and third rounds of contact, Parks Canada personnel with specific expertise related to sections of the questionnaire were targeted. There were a total of eleven responses to the questionnaire. Table 6.1 lists the respondents' area of expertise and organization. All responses were entered into a database that has been provided to Parks Canada for their records. These responses have been summarized and integrated throughout the SEA document where applicable.

Table 6.1 Number of respondents, organization and area of expertise.

Organization	Expertise	Number of respondents
Parks Canada	Communications	3
Parks Canada	Wildlife	1
Parks Canada	Vegetation and Fire Management	1
Parks Canada	Environmental Surveillance	1
Parks Canada	Fire Specialist	1
Parks Canada	Prescribed Burn Planner	1
Parks Canada	EA Specialist	1
ASRD	Wildfire Technologist	1
APP	GIS Specialist	1

6.2 Public consultation

6.2.1 Background

Following the 2003 fire season, and due to the notoriety of the mountain pine beetle issue, the majority of stakeholders throughout the contiguous mountain parks are supportive of fire management programs. This is evident in a survey completed by IPSOS-Reid on behalf of Parks Canada (IPSOS-Reid 2007), a public consultation program completed in March 2007 by Natural Resources Canada (McFarlane, et al, 2007), and a public survey currently in progress by Natural Resources Canada (B. McFarlane, pers. comm. 2008).

While the public is generally supportive, there are varying levels of understanding amongst stakeholders with respect to fire and fuel management issues. Many stakeholders are unfamiliar with the larger plan for fire management in the mountain parks, and unfamiliar with the documented results of fire management activities.

6.2.2 Purpose

Part of the SEA process included a public consultation component, as per the Canadian Environmental Assessment Act requirements. The purpose of the public consultation is four-fold: 1) to raise public interest in the relevance of the FMPs and the SEA; 2) to increase stakeholder knowledge of current and future fire and fuel management practices in the four mountain national parks; 3) to obtain public input on the overall objectives and potential impacts of the FMPs as well as gathering information regarding stakeholder concerns with respect to Parks Canada fire and fuel management practices; and 4) to facilitate communication between Parks Canada and stakeholders so on-going consultation is continued after the completion of the SEA and FMP reports.

The intention of the public consultation component of this SEA is to bridge gaps in public education and resolve ongoing issues with local stakeholders. It is also an opportunity to work together with neighbouring agencies (e.g. Alberta Sustainable Resource Development, B.C. forest Service) and provide them with the current Parks Canada fire and fuel management practices (the current FMPs for each field unit). Neighbouring agencies are moving away from their traditional role of suppression and, through cooperative fire management projects with Parks Canada, are becoming partners in fire management activities.

6.2.3 Methods

A list of stakeholders, including commercial operators, non-government organizations (NGOs), residents in the parks, First Nations, industry operators in the parks and neighbouring agencies was compiled for each park. A representative from each organization was contacted and provided options for input. A Public Participation Plan (PPP) was written and reviewed by the Parks Canada BFU Communication Team. The PPP outlined the audience, key messages they should be receiving, the objectives of the SEA and FMP(s) public consultation and a range of consultation tools (e.g. surveys, workshops). The different consultation tools provided a range of opportunities to accommodate people with varying levels of interest. At a minimum, residents /

business operators and nearby communities were informed about 1) those aspects of the plan that will directly affect them, and 2) the opportunities for participation, so they could make an informed decision about whether or not they wished to become involved. The consultation methods also fostered efficient use of time, internally and externally, by capitalizing on existing avenues to provide information and offer opportunities for input where possible.

There are three general groups in this SEA public consultation process – the general public, concerned parties and stakeholders. These three groups have varying degrees of interest in the SEA process and fire and fuel management in general. Options to obtain feedback from these three groups included the following:

- A full page newspaper ad with background on the project, key messages about the FMP and SEA and an opportunity to contact the local Parks Canada Communication Officer to partake in either of the following four options: review/comment on SEA and fire management plans; review an executive summary of the SEA plan; complete a questionnaire about fire/fuel management issues; and/or submit comments about how fire/fuel management affects the public. The ad was in all local newspapers in the four contiguous mountain national parks.

- FMP and SEA fact sheets, the SEA document and full FMPs for each park were available in local libraries with request for public comment.

- FMP and SEA fact sheets, the SEA document and full FMPs for each park were available electronically on an FTP site. Each stakeholder on the comprehensive list of stakeholders for the four contiguous parks was provided with the link to the documents as well as the survey and fact sheet. The survey and fact sheets have been provided as appendices to this document.

- A 20 minute presentation was provided to existing groups at already scheduled meetings. During the meetings the members were provided with opportunities for input. The presentation highlighted current fire and fuel management practices and objectives. It was accompanied by handouts and opportunities to further participate in the process by completing the survey and/or providing comments on the FMPs and the SEA. The presentation was completed by Parks Canada fire and vegetation specialists that attended/ran the meetings.

- Two full day workshops were provided in Radium and Banff for interested stakeholders to provide feedback on the FMPs and the SEA. There was no workshop in Jasper because JNP had already carried out an extensive public consultation program (see Section 6.2.4.3). The workshop consisted of a presentation, break out groups to discuss any issues and propose mitigations followed by a final discussion with the group as a whole. All key points were amalgamated and the facilitator lead a discussion of possible solutions and management options to mitigate issues brought up in the breakout groups. Parks Canada also provided participants with an opportunity to review the workshop summary documents and provide further input.

- One on one interviews with interested stakeholders are on-going with Parks Canada. These interviews are for stakeholders that have concerns and specific interests but were unable to attend the workshop(s). The interviews that were completed prior to the completion of the SEA have been integrated into this report.

- Affected First Nations were contacted and determined how they wished to be consulted. Additionally First Nations were invited to participate in all public participation activities open to the general public. As a follow up, interested First Nations will be provided with hard copies of this SEA document, as requested during the consultation process.

The details from each public input forum has been summarized and provided to Parks Canada in a database to be referenced and used, where applicable, to modify and improve the fire and fuel management practices in the four contiguous mountain national parks. The information received from the workshops has been integrated into this SEA document where applicable. The consultation tools from the public consultation processes have been provided in the Appendices.

The number of people contacted in the SEA public consultation process has been tabulated and is provided in table 6.2.

Table 6.2 Stakeholder consultation statistics

Category[1]	Option 1: Workshop, SEA-FMP Review, One on One meeting and/or Survey	Option 2: SEA/FMP Review, One on One Meeting and/or Survey
Provincial Government	15	24
Internal Parks Canada Stakeholders	25	82
Environmental Groups	22	10
Business Sector	41	102
Special Interest Groups	8	85
Industry	13	27
Universities	3	2
First Nations	5	2
Towns and Municipalities	20	44
Total	**147**	**378**

[1]Stakeholders have been grouped into categories based on their affiliations and the type of consultation opportunity offered to them.

Note: This does not include invitations to the general public via advertisements in the local papers reaching an audience of more than 20,000 people.

6.2.4 Outcomes

The public consultation options provided a range of opportunities to accommodate people with varying levels of interest in fire and fuel management. The public input will guide fire management for the next ten years of fire and fuel management in the four contiguous mountain national parks. The different methods of public consultation employed as part of this project capitalize on existing avenues to provide information and offer opportunities for input where possible (e.g. existing advisory groups). The result is well documented public issues with existing and future fire and fuel management practices.

One purpose of documenting and attempting to resolve major issues of fire and fuel management within the social context is more cooperation and acceptance from the community for future fire and fuel management in the parks. The public consultation also provides an avenue for Parks Canada to obtain new suggestions/information that may have previously not been considered. During the public consultation process Parks Canada has continually offered an 'open door' policy to instigate on-going public input.

6.2.4.1 Survey Results

Parks Canada has provided communication and education around forest health issues for many years. This survey is one component of the Fire and Fuels Management Strategic Environmental Assessment. A total of 525 stakeholders were provided the opportunity to complete the survey. The survey was one option of several to provide input to Parks Canada for the SEA process. We received completed surveys from 14 stakeholders during the SEA consultation process. A survey response rate of 14 out of 525 is 3%. This is not a representative sample; however the survey responses combined with the responses through other venues (i.e. workshops, one on one meetings with Parks Canada) provide constructive feedback for the public consultation component of the fire and fuel management SEA.

In general the survey respondents were very knowledgeable about fire and fuel management in the parks. The source of information about fire and fuel management in the mountain national parks for most respondents was Parks Canada communications products (website, fact sheets, fire bulletins, roadside interpretation of fires in progress by Parks Canada staff). The majority of respondents were in favour of prescribed fire (68%) and fuel management (70%); while only 10% oppose both prescribed fire and fuel management. Of the 14 respondents, 24% have been negatively affected by the smoke from prescribed fire while 11% were positively affected because the prescribed fire provided photo opportunities as well as increased knowledge and awareness. In terms of timing of prescribed fires, 59% of the respondents favoured a small prescribed fire every year, 9% favoured infrequent larger fires and 32% favoured a mix. Generally the respondents saw fuel management as a positive practice implemented in the parks, and the majority saw prescribed fire as a positive fire management practice in the parks.

The same survey was also used in the summer of 2007 to survey visitors to the Mountain National Parks. The survey, titled *Fires in National Parks: Visitor Experience, Attitudes & Knowledge*, was conducted from June 25 to July 5, 2007. A total of 3,297 panellists were invited to complete the online survey and 687 panellists completed the survey. This resulted in an overall survey response rate of 21%. (IPSOS-Reid, July, 2007) The IPSOS-Reid survey report has also been provided to Parks Canada to provide input on the knowledge and perspective of the general public.

The responses to the surveys provided in the SEA public consultation has been tabulated and are provided in Appendix I.

6.2.4.2 Workshop Results

There were two full day workshops held for stakeholders – one in Banff and one in Radium. Jasper did not have a workshop because they had already completed a detailed public consultation program for their FMP (see Section 6.2.4.3 for Jasper National Park's consultation summary). The total attendance for the Banff workshop was 26 people, not including the facilitators and Parks Canada experts. The total for the Radium workshop was 6 people, not including the facilitators and Parks Canada experts. The total invitees to the workshops were 147 people, thus the percent attendance was 22%.

The purpose of the workshop was to provide detailed, balanced, objective information on the FM program goals; obtain public input on the overall objectives and potential impacts of the FMPs and any knowledge gaps or concerns in the SEA; and to identify stakeholder concerns / issues and discuss recommendations for mitigating negative impacts. These recommendations would be factored into the development of management alternatives by Parks Canada staff.

The general structure of the workshops were introductions, a presentation on the SEA findings, an overview of the current FMPs, breakout sessions with specific questions to address for each group, compilation of the break out group discussions, an "open mike" session and finally a wrap up with information on how the stakeholder input will be integrated into the SEA and FMPs. For the Radium workshop, due to the small number of people, there were no breakout sessions. For the Banff workshop the three break out groups consisted of an operations and tactical group, an ecology based group and a socio-economic and cultural group. The information from each break out group, and the entire workshop, was summarized and added to a public consultation database for Parks Canada records. The workshop summaries were provided to each stakeholder attendee and are included in Appendix II. The public input from the workshops has been used to modify the SEA and the FMPs where applicable.

6.2.4.3 Jasper Public Consultation Program

JNP carried out a detailed public consultation program as part of their FMP, prior to the start of the SEA public consultation. See Table 6.3 for the people contacted and summary of issues/discussions. The stakeholders residing in the Jasper area were also contacted and provided the invitation to attend the Radium or Banff workshops.

Table 6.3 Jasper National Park Consultation and Presentations

Date	Group	Actions taken
Jan. 2006	Westhaver	consultation on Caribou and Fire guidelines
Nov.10/06	Parks Canada staff	Sent of FMP to JNP specialists, R. Quenneville, Dean Mac, Heathcott, Otway, Cardiff
Nov. 2006	Jasper Environmental Association	Sent FMP to JEA representative Jill Seaton - no feedback received
Nov. 2006	National Fire ICT members	Presented decision matrix to national command team members and G. Harrison
Dec.07/06	Alberta SRD	Worked on operational protocols for fire responses in the border agreement zone
Jan.23/07	PC Resource Specialist Group	Presented decision matrix
Jan.25/07	Line leaseholder Work group	Presented Zoning, 1, 2, 5, and 20 year proposed pbs, handed out comment sheets
May 17/07	Hawk Fire Roadside Info Kiosk	Used Hawk Mtn. Prescribed burn as backdrop to discuss JNP Fire Management goals & objectives
June 02/07	Enviro Fair - Municipality	Info kiosk and Display for full day with props
June 09/07	Safety Fair with Municipal Fire	Info kiosk and Display for full day with props
July 12/07	Fitzhugh - local Jasper News	Fires Foster Healthier Forests article
July 17/07	Hinton town council	Presentation of FMP to council presentation on file, feedback: would like advance notice of likely pbs
July 21/07	Parks Day	Presentation, displays, interactive public demonstrations
Aug 27/07	JNP Trails Group	Only one person attended - cancelled
Aug 29/07	JNP Trails Group	Most of trails group attended- presentation and discussion
Sept 11/07	Jasper Chamber of Commerce	~25 people, positive response, few questions and discussion
Sept 18/07	Jasper Town Council	Well received, interest in the Jasper townsite tactical response plan
Sept. 21/07	Centennial Fest	Interactive public demonstrations with fire equipment, info kiosk, presentations
Sept 24/07	Hinton Chamber of Commerce	Well received, interest in communication around timing of pbs

6.2.4.4 One on One Meetings

One on one meetings with Parks Canada public fire specialists were offered to 525 groups/individuals in the public consultation process. The meetings were targeted towards people that wanted to provide some input to the SEA and FMPs but were unable to attend the workshops. What has evolved from this part of the consultation process is an on-going consultation with various groups that have an interest or concerns with the current and proposed FMPs. The input from several meetings with the Stoney First Nation and the Banff/ Lake Louise business community have been incorporated into the social, cultural and economic sections of the cumulative effects assessment. In addition five one on one meetings have been scheduled for the month of April 2008 with other interested stakeholder groups (in Banff and Radium), input from these future meetings will be used to refine this SEA document.

7 MONITORING AND SURVEILLANCE

7.1 Fire Effects

7.1.1 National Fire Monitoring Program

Monitoring is necessary to determine if the objectives of fire and fuel management activities carried out under the mountain park FMPs are achieved. Monitoring also adds to the body of knowledge of fire effects on ecosystems in the mountain national parks. Currently a Parks Canada National Fire Monitoring Guide is being produced by fire ecologists in the Parks Canada Western and Northern Service Center (for use in all national parks using prescribed fire (Dan Perrakis, pers. comm.). As of the writing of this document the guide is due to be complete by 2009. The monitoring protocols laid out in the guide are being designed in accordance with section 52 under *Fire Management Directive 2.4.4* which states:

> Each prescribed fire will be assessed to determine to what extent the objectives stated in the prescribed fire plan were attained. The assessment, along with a summary of the fire operations and observations will form the basis of a prescribed fire report. In addition, each prescribed fire and wildfire will be monitored at a level that meets basic fire behavior, impacts, and effects monitoring requirements to provide input into an adaptive management approach. The monitoring approach will be integrated and consistent with the overall direction from the National Monitoring Program at the national, bioregional and local levels.

This fire monitoring guide will contain general protocols for monitoring the direct effects of fire to vegetation and soil. Protocols will be designed to measure fire effects on canopy cover by species, understory vegetation, fuel loads, and mineral soil. In addition a protocol will be designed for photo-point monitoring whereby semi-permanent monitoring stations are established in recent burns. Photos will then be taken at each station at the same time each year to monitor the regrowth and development of vegetation communities across a range of fire severities and ecosystems.

In addition, techniques to monitor fire attributes using normalized burn ratio (NBR) derived from Landsat satellite imagery have been developed for the mountain national parks (Dan Perrakis, pers.comm.). NBR is a measure of change between pre and post fire landscape conditions and can be used to determine the range of burn severities within fires and to delineate unburned interior polygons within a fire. It also has some value in delineating the perimeter of a fire although sometimes the convoluted outer boundaries of a fire are hard to discern using this technique. The value of this monitoring technique is that it can provide valuable standardized data on fire severity from remote satellite imagery which is a relatively inexpensive and efficient way to monitor post-fire landscape changes in rugged terrain and in remote locations of the mountain national parks. Fire severity is a key parameter to monitor as it is a major determinant of post-fire ecosystem changes and vegetation succession pathways.

This technique has been used to determine fire severity for some of the large wildfires and prescribed burns in the mountain national parks to date but more work needs to be done to adapt these techniques, originally developed in the United States (Key and Benson 2005), to the park ecosystems in Canada. Ultimately the goal of Parks Canada is to have all fires greater than 200 hectares analyzed using NBR. Currently there is a research project being conducted at the University of B.C. to develop a correlation model for some ecosystems in the mountain parks to relate the burn severities and fire polygons derived using remote sensing NBR to actual burn severity and burned area measured on the ground using the Composite Burn Index and GPS data.

7.1.2 Monitoring Needs

To date there has been very little monitoring done on the ecological effects of large high severity stand-replacing fires in the mountain parks which typically occur as midsummer lightning-ignited wildfires. The greatest change in ecosystems comes as a result of these high severity fires which consume most of the forest canopy and have significant effects on the soil. In particular, there is a need to monitor the effects of large, hot fires on the hydrological regime of mountain watersheds since the Rocky Mountains are one of the major sources of water in western Canada (R. Sandford, pers. comm.). In addition, large high severity fires cause the greatest change in vegetation communities and set the ecosystem back to an earlier successional stage than low severity fires. This creates the potential for multiple successional pathways as vegetation regrows and therefore the most potential for variability in vegetation patterns and diversity of wildlife habitat at the landscape scale.

However, the ecological effects of large high severity fires can be difficult to monitor given that wildfires are unpredictable in space and time. The challenge is that resources and people must be mobilized in advance of the fire occurring and the monitoring must be in place immediately after the fire has been put out (or while it is still burning). In the future if Parks Canada implements some mid-summer prescribed burns, much valuable information could be gained by implementing a comprehensive pre and post fire monitoring program on even a single large hot fire. With limited resources more information could be gained from monitoring one large high severity for many years than many monitoring programs which are only in place for one or two years post-fire.

7.1.3 Ecological Integrity

Parks Canada is implementing a national Ecological Monitoring program in all national parks across Canada in the next 5 years (Parks Canada 2006). This program will monitor various indicators of biodiversity; terrestrial ecosystem health; aquatic ecosystem health; landscapes and geology; and climate and atmosphere in the mountain national parks. There is potential for valuable fire effects information to be gained through this large monitoring program if data on the specified ecological integrity measures are collected in the same area for several years both before and after prescribed burns. Examples of indicators from the national ecological integrity program which could provide valuable monitoring data before and after fire are: avian species richness, amphibian occupancy, non-native plant presence and relative abundance, forest insects and disease, aquatic chemical properties, benthic invertebrate diversity and precipitation and snowpack.

7.2 Project –level monitoring

There is an identified need for dedicated resources for monitoring to be attached to each prescribed burn and fuel management project within the mountain parks (see Banff Fire and Fuels Management workshop summary document). This approach would ensure that monitoring is integrated into each project in order to determine if the objectives of the prescribed burn or fuel management project had been met and the effects of the project on valued ecosystem components. Currently monitoring of fire management activities is done on an ad hoc basis and the level of effort is inconsistent between projects.

7.3 Surveillance

There is a perceived need for a more rigorous and transparent process for surveillance of fire and fuel management projects in the mountain parks. Currently all CEAA fire and fuel management projects in the park require that a surveillance officer file a CEAA Project Surveillance report and these reports are available for public review. In addition the feasibility of using independent Surveillance Officers for project surveillance will be investigated by Parks Canada (B.Low, pers.comm.). Using independent people to conduct this work will likely increase the level of accountability by Parks Canada personnel and contractors carrying out fire and fuel management projects.

8 KNOWLEDGE GAPS

Knowledge gaps identified throughout the SEA are presented here. These knowledge gaps span a range of topical areas and have been organized below into the following categories: baseline knowledge of fire ecology within the mountain parks, effects of fire and fuel management on valued ecological ecosystem components and social, cultural and economic ecosystem components, and technological and communication capacity.

8.1 Baseline Knowledge

An investigation of the most progressive fuel reduction methods is needed. Currently there is a lack of mountain park-specific scientific studies and technical documents relevant to fuel reduction in the mountain parks. A review of scientific studies and technical documents about different fire management thinning processes applicable within the mountain national parks (regional and inter-jurisdictional) is needed.

Further research is needed on the structure and composition of mountain parks landscapes further back into the past to determine an appropriate timeline for the future prescribed burning plans such as the locations of usually high amounts of fuel accumulation that are outside the range of normal fuel conditions (i.e. where suppression effects are greatest).

There are some specific calculations relating to annual area burned (decadal variance) and fire severity that are still unknown as well as the historical range of variability. More precise definition of these calculations should be targeted for further research.

Fire behaviour research should be directed towards understanding weather phenomena and their relationship to fire behaviour events as well as to regional fire patterns. This will be extremely important as weather variability in the mountain parks increases due to climate change.

Scientific studies should be conducted and technical documents produced about different fire management thinning techniques that are applicable within the mountain national parks (regional and inter-jurisdictional).

8.2 Ecological Effects of Fire and Fuel Management

It is generally agreed that fire management processes based on valued ecosystem processes or components rather than individual species are more ecologically sound, therefore, more research needs to be done to identify interconnections between fire and fuel management, ecosystem processes and species responses.

A program geared specifically at identifying and monitoring the effects of prescribed burning and fuel management on terrestrial invertebrate biodiversity needs to be developed and implemented. Distribution and abundance of amphibians, especially boreal toad (including the effects of a range of fire severities on these amphibians) needs further research in the parks.

There needs to be further pre and post fire (prescribed and wildfire) investigation on the impacts of fire (likelihood, risk, consequences) on aquatic ecosystem dynamics including erosion rates, run-off volumes, sediment yields, and occurrence of mass wasting, mudslides and avalanches in steep terrain post-fire particularly following large stand-replacing fires.

Further work on bioaccumulation of persistent organic pollutants in aquatic food chains is needed, to determine how long the increased levels of pollutants remain in the ecosystem and fishes following post-fire pulses of these substances into aquatic systems.

Distribution and abundance of birds, especially post-fire needs to be further explored.

Distribution and abundance of native and non-native fish populations and the relative changes in populations between these groups as a result of fire. (I.e. does fire increase the abundance of non native fish relative to native fish in mtn park streams?)

The general impacts of fire and fuel management on wildlife (diversity, species abundance, habitat viability) is covered throughout this document, however, specific cases studies and research within the mountain parks on this topic is limited. Mountain park-specific studies on the impacts of fire on wildlife are necessary to verify that these generalities hold true within the mountain parks ecosystem.

Specific fire effects studies on species at risk including boreal toad, caribou (in progress), American badger (jeffersonii subspecies), and westslope cutthroat trout are needed.

The effects of prescribed burning on the health of non-human organisms (fish, birds) are also considered to be a knowledge deficiency. Distribution and abundance of fish (native versus non-native) and bird (generalist versus specialist) species in post-fire watersheds needs to be further explored.

The effects of prescribed fire and fuel management on rare plant populations and old growth stands within fire adapted landscapes in the mountain parks needs to be further developed as these communities within the mountain parks are not identical to rare plant and old growth populations elsewhere. Their re-establishment potential in specific ecotypes needs to be assessed. An inventory of old-growth is needed as well as a stronger effort to ground truth existing data.

8.3 Social, Cultural and Economic Effects of Fire and Fuel Management

While the historical use of fire by first nations has been well documented, the best process for continual involvement of First Nations in fire management and information exchange needs to be further developed.

As the cost of fuel management and prescribed burning activities are variable and fluctuate, there is a knowledge gap as to how much the current fire management program costs. An analysis and forecast of the cost and labour requirements of the current program should be completed. This study should include a review of cost effective solutions for removal of debris piles post fuel management activities.

There is a lack of information on the impact of fire on services to visitors throughout the mountain parks including Day Use Areas and campgrounds, on the operation of visitor facilities and on the maintenance of trails and roads. This type of information is important for visitors, tourism operators and Parks Canada staff and needs a more in-depth examination.

An economic impact assessment of the short-term and long-term benefits and costs of prescribed fire and wildfires on the economics of local businesses and communities would be a useful exercise for determining the value of prescribed burning from an economic perspective. To avoid any controversy a third party should complete such an exercise.

8.4 Technological and Communication Capacity

There is a need to use landscape computer-based models to look at /forecast broad regional level changes in park ecosystems over time scales of at least 50 years to determine the effects of the increasing fire mosaic that will develop over time as the prescribed burning program continues (i.e. 10 year time period not long enough for meaningful planning as to where PBs should go and how often areas should be reburnt).

Data coordination and sharing across field units is needed to improve fire management at a regional scale. The current lack of an appropriate system for data and information sharing across field units is a knowledge gap.

An analysis of the most effective methods of communication with various stakeholder groups associated with fire and fuel management decision-making and education is necessary.

Innovative strategies for disseminating information and gathering public input at the appropriate times in fire management planning process need to be identified and implemented.

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Appendix I Public Consultation Survey Summary

Fires in National Parks: Fire and fuel management programs, your experience, knowledge and concerns.

"Parks Canada has provided communication and education around forest health issues for many years. We are currently developing a Strategic Environmental Assessment. Your responses will help us to improve our communication strategies and materials. They will also help with fire management decisions where applicable. Please respond with the designated response choice where applicable. Where specific word choices are not provided please type in your response."

Survey Question	Yes/ True	No/ False	No Response	Not Sure	Summarized Response
1.Where do you live?					Jasper, Canmore, Banff and Calgary
2. How many times have you ever visited the mountain national parks (i.e. Banff, Jasper, Yoho, Kootenay, Mount Revelstoke/Glacier or Waterton Lakes National Parks)?					All respondents have visited these mountain parks more than 10 times
3. Have you ever experienced a fire in progress in a national park?	100%				
4. Did you: See smoke or flames from a fire? Experience discomfort or health problems from smoke from a fire? Shorten your planned length of stay in national parks because of fire? 4a. Did the fire in the national park have any other effects on your visit? 4b. What other effects did you experience?	91% 24% 11% 11%	 20% 22% 78%	9% 56% 67% 11%		Excitement, photo opportunities, increased knowledge and awareness
5. Which of the following statements are true and which are false? Fires can be an important force in					

Survey Question	Yes/ True	No/ False	No Response	Not Sure	Summarized Response
controlling outbreaks of disease and insects in forests.	92%		8%		
It takes decades before plants grow in a fire-damaged forest.	9%	80%	11%		
Fires usually result in the death of most animals in a burnt area.		80%	11%	9%	
Fires help recycle minerals and nutrients needed by trees and other plants.	92%		8%		
6. Had you ever heard of mechanical fuel reduction in the mountain national parks (i.e. Banff, Jasper, Yoho, Kootenay, Mount Revelstoke/Glacier and Waterton Lakes National Parks) prior to completing this questionnaire?	100%				
7. Through which of the following methods did you learn about mechanical fuel reduction in the mountain national parks?					
Parks Canada interpretive program or signs	69%	31%			
Parks Canada staff at roadside burn site	47%	53%			
Parks Canada facts sheet or brochure	81%	19%			

Survey Question	Yes/ True	No/ False	No Response	Not Sure	Summarized Response
Parks Canada website	**41%**	**59%**			
Parks Canada information centre staff	**41%**	**59%**			
Parks Canada notifications, advertisements or announcements	**70%**	**30%**			**Email updates, professional park guides, mountain park newspaper, fire staff within the parks, MPHIA.**
A source outside the national parks	**59%**	**41%**			
A source within the national parks (please specify)					
7a. Please specify the source from which you learned about mechanical fuel reduction in the mountain national parks:					
Television	**22%**	**33%**	**45%**		
Radio	**11%**	**44%**	**45%**		
Newspaper					
Public meeting	**44%**	**11%**	**45%**		
Other sources outside the national parks (please specify)	**44%**	**11%**	**45%**		
I do not recall					
8. To what extent to you favour or oppose the use of mechanical fuel reduction in the mountain					**70% of respondents strongly favour** **10% of respondents were neutral** **10% of respondents somewhat oppose**

Survey Question	Yes/ True	No/ False	No Response	Not Sure	Summarized Response
national parks?					**10% of respondents provided no response**
9. Please explain the reason for this answer (in Q8).					**Those who oppose: mechanical fuel reduction goes against EI principles.** **Those who favour: mechanical fuel reduction is safer than prescribed burns near areas used by humans, it's good because it's selective, and that it's best in combination with other management techniques.** **Those who were neutral did not provide an explanation.**
10. How effective do you feel mechanical fuel reductions are at: ***Please choose one of the listed choices for each statement.***					

Survey Question	*Very Ineffective*	*Ineffective*	*Neutral*	*Effective*	*Very Effective*	*No Opinion*	*No Response*
Controlling insects such as the mountain pine beetle	10%			14%	32%	33%	10%
Renewing forest health		21%		10%	32%	25%	11%
Providing habitat for many animals such as deer or elk			10%	25%	32%	21%	11%
Stopping natural forest fires from getting out of control				43%	37%	10%	10%
Protecting park facilities and towns from natural forest fires.				32%	47%	10%	10%

Survey Question	Yes/ True	No/ False	No Response	Not Sure	Summarized Response
11. Had you ever heard of prescribed fires in the mountain national parks (i.e. Banff, Jasper, Yoho, Kootenay, Mount Revelstoke/Glacier and Waterton Lakes National Parks) prior to completing this questionnaire? (y/n)	100%				
12. Through which of the following methods did you learn about prescribed fires in the mountain national parks?					
Parks Canada interpretive program or signs	78%	11%	11%		
Parks Canada staff at roadside burn site	59%	31%	10%		
Parks Canada facts sheet or brochure	81%	9%	10%		
Parks Canada website	42%	47%	10%		
Parks Canada information centre staff	42%	47%	10%		
Parks Canada notifications, advertisements or announcements	92%		8%		
A source outside the national parks	42%	47%	10%		
A source within the national					**Email updates, professional park guides, fire specialists**

Survey Question	Yes/ True	No/ False	No Response	Not Sure	Summarized Response
parks: specify.					**within the parks, MPHIA.**
12a.Please specify the source from which you learned about prescribed fires. ***Please choose all that apply***					
Television	**22%**	**44%**	**33%**		
Radio	**33%**	**33%**	**33%**		
Newspaper					
Public Meeting	**44%**	**22%**	**33%**		
Other sources outside the national parks (please specify)	**44%**	**22%**	**33%**		Interpretation programs, ASRD
I do not recall					
13. To what extent to you favour or oppose the use of prescribed fire in the mountain national parks? (Q5) ***Please choose one.***					**10% of respondents somewhat oppose** **21% of respondents somewhat favour** **47% of respondents strongly favour** **32% of respondents did not provide a response**
14. Please explain the reason for this answer (in Q13).					**Those who oppose: prescribed burns can sometimes get out of control.** **Those who favour: prescribed burns are a more natural process than other types of management practices, it can be use in areas that are too large for mechanical clearing, burns are good for vegetation reduction.**

Survey Question	Yes/ True	No/ False	No Response	Not Sure	Summarized Response						
15. How effective do you feel prescribed fires are at:					*Very Ineffective*	*Ineffective*	*Neutral*	*Effective*	*Very Effective*	*No Opinion*	*No Response*
Controlling insects such as the mountain pine beetle.					11%	11%		11%	44%	11%	11%
Renewing forest health.					11%			11%	67%		11%
Providing food for animals such as deer or elk.					11%			11%	56%	11%	11%
Stopping natural forest fires from getting out of control.					11%	11%		33%	33%		11%
Protecting park facilities and towns from natural forest fires.					11%		11%	11%	44%	11%	11%
16. Each season during which a prescribed fire is set has different ecological benefits depending on the location and vegetation types to be burned. If you were given a choice, which season would you prefer to have prescribed fires (i.e. the intentional and planned use of fire in the forest) occur in the mountain national parks, keeping in mind the positive and negative? **Other (please explain)**					**43% of respondents chose spring** **21% chose fall** **14% chose no opinion: no preference because each season produces different effects or not well enough informed to make the decision.** **21% chose other: there are opportunities to effectively use burns in all seasons, burns should occur when the natural conditions are favorable regardless of season**						
17. The Banff National Park management plan includes the target objective to restore 50% of					**59% of respondents: small fire every year** **9% of respondents: large fire every 5 years**						

Survey Question	Yes/ True	No/ False	No Response	Not Sure	Summarized Response
the historic fire cycle in the park. Achieving this means burning an average of 14 square km per year. This can be done by having one large fire about every 5 years or smaller fires every year. ***Please indicate which you think you would prefer.***					**32% other: there should be a combination of small and large fires, burn should occur as frequently and be as large as the conditions allow for.**
18. Please check any of the following that you believe are factors that contribute to the risk of wildfire in the mountain parks:					
Age of forest	**100%**				
Years of humans putting out wildfires	**70%**	**30%**			
Increased human activity in and around parks (e.g. trains, park visitors, and development)	**70%**	**30%**			
Type of vegetation (e.g. aspen/spruce trees vs brush/grass)					
Density of the vegetation (e.g. dense forest vs open grass land)	**81%**	**19%**			
Illegal campfires					
Dead or damaged trees	**92%**	**8%**			
Mountain pine beetles	**100%**				
Climate change	**81%**	**19%**			

Survey Question	Yes/ True	No/ False	No Response	Not Sure	Summarized Response
Careless cigarette disposal	**70%**	**30%**			
19. Do you have any other comments about prescribed fires, wildfires or mechanical fuel reduction techniques that you would like to pass on to Parks Canada managers?					**-Parks Canada needs to be more aggressive in large scale forest reduction, the fuel load is too high in many areas; -more small fires in lower Bow Valley to stimulate sheperdia growth; -the approach taken by Parks Canada is too conservative; -do more wide ranging presentations on the subject; -since the canopy has been removed the trails don't recover with natural pine needles, bark, etc; the trails therefore become very susceptible to erosion – this issue needs to be addressed; and - improved (wider) fire barriers around the town is recommended.**

Appendix II Workshops Summaries

NATIONAL PARKS FIRE AND FOREST FUELS MANAGEMENT WORKSHOP Radium, BC Wednesday, February 27, 2008

SUMMARY OF STAKEHOLDER INPUT

Prepared by: Avens Consulting and Corvidae Environmental Consulting Inc. (Consulting team)

Background: While significant progress in the area of fire management has been made in mountain National Parks during the past 25 years, some ecological fire restoration objectives are not being met. Fire cycle calculations indicate that fire deficits and associated impairment to fire dependent ecosystems continue to occur. Restoration of historic fire cycles within the range of long-term variability remains an important goal but in order to achieve it, changes to the status quo must take place.

Emulating the full range of historic fire regime characteristics through prescribed fire is required in order to meet ecological goals. The questions is: **how can this be achieved while ensuring that socio-economic, cultural and operational factors are integrated into a fire management strategy?**

The 4 S's: A useful framework for answering this question is to consider the 4 S's of fire regime characteristics:
Size: In order to offset growing fire deficits due to: lack of managed wildfires; deferred prescribed fires due to wet spring weather; and units that require re-burning, unit sizes need to increase. This will not necessarily equate to more prolonged operations.
Season: In order for fire managers to meet restoration objectives, summer prescribed burns may need to take place in more remote valleys on a regular basis. During years when forest fuel moisture levels are within acceptable targets, prescribed fires may also be required in frontcountry areas after the peak visitation period has ended (starting the last week of August). This approach would provide for re-introducing fire into forests with longer fire cycles.
Severity: The concept of fire severity is correlated with season of burn, fuel moisture levels, and biomass consumption. Light severity fires typically occur during the spring season and the severity of fires increase gradually as forest fuels continue to dry out throughout the summer months. Most high severity fires historically occurred in the park between mid-July and mid-August after successive years of drought. In most cases, facilitating burns of this type are not an option due to socio-economic constraints and values at risk. However, in "wetter than average" summers, prescribed burns can be conducted safely in some valleys during mid-summer where

reliable containment lines exist, values at risk are well protected, and impacts on tourism are minimal.

Sequencing: The sequencing of prescribed burns needs to be based on many variables including impacts to airsheds, establishment of containment lines, visitor use and commercial operation impacts. In many cases the sequencing of prescribed burns can be modified if that requirement is identified early enough in the planning process. It is an objective of the workshop for you to examine the proposed sequencing.

Workshop Objectives: Using the 4 S's of fire regime characteristics (size, season, severity, sequencing) as framework, participants were asked to:

- Examine the proposed management actions in the draft fire plan as well as impacts identified in the regional impacts analysis.
- Identify and prioritize your specific concerns as a stakeholder that have not already been addressed in these documents. This information will form the basis for future research and monitoring as well as identifying necessary modifications to the proposed fire management strategy.
- Where possible, propose solutions to address those specific concerns while at the same time striving towards achieving the fire management goals.
- Recommend necessary changes in "the 4 S's" (size, sequence, severity, and season) to better integrate fire management goals with the concerns identified by you in your area of concern.

Summary of Group Discussion: A summary of the comments, concerns and potential mitigations identified during the workshop is presented below:

OPERATIONAL AND TACTICAL CONSIDERATIONS

Interagency training – it was noted that while joint training exercises are useful and have been successful in terms of facilities protections and joint efforts on interface fires, there is room for improvement related to interagency co-operation around fire management and there is a need to run more regular interagency training programs (e.g. Fire Management scenario training).

Role of responsibility – there is a misconception that the fire management is the responsibility of Parks Canada, but local fire departments need to accept some responsibility for protecting communities through FireSmart. This brings up the issues of available resources and leveraging funds.

Mitigations:

Parks should make an effort to engage in more or highlight dual-purpose fire management activities (protection & improved ecological integrity) as these activities tend to be better accepted by the public and there may be more support for these types of activities in the future.

SOCIAL CULTURAL AND ECONOMIC CONSIDERATIONS

Education - It was identified that there is a public perception that more fires have escaped than actually have and that fires are continually out of control. There needs to be better dissemination of fire information from Parks Canada to the public, especially those working in the tourism industry to inform visitors.

Information exchange - It was identified that prescribed burning has been accepted by local businesses as necessary process that is important for protection from large fires (curbing potential for long term road closures) and ecological restoration within the mountain parks. The next step is to have discussions around trade-offs earlier in the planning process to strike a balance between socio-economic and cultural considerations and fire management goals. There are significant differences in tourist regimes as well as the types of tourists coming to Radium area (Calgary-based visitors and second home owners) versus Banff (international visitors, with the exception of Canmore also second home owners). These differences need to be recognized and address in fire management planning.

Road closures – were identified as a major concern for the Radium area businesses dependent on visitors traveling by vehicle form the east to support the local economy. Road closures also impact local industry.

Cost of FireSmart – it was identified the private land owners in the Radium area have been unwilling to engage in FireSmart activities on their lands due to cost.

Mitigations:

Stakeholders in the area may prefer less frequent larger prescribed fires as opposed to many shorter prescribed fires due to concerns related to smoke.

For shorter burns weekday fires are preferable to avoid impacting weekend visitation.

Avoid closure of the highway as much as possible during prescribed burning activities.

No summer burning especially during peak tourist times which occurs in July and August in some areas and May through October in other areas. Discussions with local stakeholders are necessary to flesh out the best times to burn in certain areas as peak seasons fluctuate throughout the mountain parks.

Parks should identify existing tourism operations with interpretive programs and develop a training program for staff to distill information on fire to their patrons.

Stakeholders need up-to-date information on the future planned burns for the area, including location and length of burns, in order to schedule tourist-based activities around the prescribed burns or adapt their business activities around road closures and/or smoke impacts.

ECOLOGICAL CONSIDERATIONS

Ecological considerations related to prescribed burning in the mountains parks are not as strong on this side of the divide, in comparison to bigger environmental issues in the area including the Jumbo development and water quality issues. This differs from Banff and Lake Louise areas in which the local population is extremely concerned with what is happening in the Park, especially prescribed burning.

CONCLUSION

Thank you to all stakeholders who participated in the workshop.
Your input is a valuable component to making fire and fuel management in the National Parks a success.
For more information or to clarify any perspectives expressed in this workshop summary please contact:

Marla Oliver, Fire Communications Officer
Lake Louise, Kootenay and Yoho Field Unit Parks Canada
ph: 250 347-6174, email: Marla.Oliver@pc.gc.ca

STAKEHOLDER FOLLOW-UP AND FEEDBACK TIMELINES

Please not that while these timelines apply to finalization of these draft documents, consultation is an ongoing process and a high priority for Parks Canada. Input from stakeholders is welcome anytime and will be incorporated into regular reviews of Parks Canada management plans.

March 6th, 2008 – National Parks Fire and Forest Fuels Management *Workshop Summary Document* will be available on the following FTP site: www.box.net username: SEA password: Parks (NOTE: these are case sensitive)

March 12th, 2008 - Deadline for stakeholder feedback on the DRAFT *Strategic Environmental Assessment of Fire and Fuels Management* and the mountain parks *Fire Management Plans*. Draft Documents are currently available on the following FTP site: www.box.net username: SEA password: Parks (NOTE: these are case sensitive)

Feedback may be submitted via email to: Marla Oliver, Parks Canada, Marla.Oliver@pc.gc.ca

April 1st, 2008 – FINAL DRAFT of the *Strategic Environmental Assessment of Fire and Fuels Management* will be available on the following FTP site: www.box.net username: SEA password: Parks (NOTE: these are case sensitive) for final stakeholder review.

April 15th, 2008 – Deadline for stakeholder feedback on the FINAL DRAFT *Strategic Environmental Assessment of Fire and Fuels Management*.

Feedback may be submitted via email to: Marla Oliver, Parks Canada, Marla.Oliver@pc.gc.ca

Summer 2008 – *Strategic Environmental Assessment of Fire and Fuels Management* will be complete.

Summer of 2008 – Based on the results of the *Strategic Environmental Assessment,* a final draft of the fire management plan will be made available fore stakeholders review on FTP site: www.box.net username: SEA password: Parks (NOTE: these are case sensitive).

Fall of 2008 – Based on final input from stakeholders the draft fire management plan will be submitted to the Park Superintendent for final approval.

NATIONAL PARKS FIRE AND FOREST FUELS MANAGEMENT WORKSHOP Banff, AB Friday February 29, 2008

SUMMARY OF STAKEHOLDER INPUT

Prepared by: Avens Consulting and Corvidae Environmental Consulting Inc. (Consulting team)

Background: While significant progress in the area of fire management has been made in mountain National Parks during the past 25 years, some ecological fire restoration objectives are not being met. Fire cycle calculations indicate that fire deficits and associated impairment to fire dependent ecosystems continue to occur. Restoration of historic fire cycles within the range of long-term variability remains an important goal but in order to achieve it, changes to the status quo must take place.
Emulating the full range of historic fire regime characteristics through prescribed fire is required in order to meet ecological goals. The questions is: how can this be achieved while ensuring that socio-economic, cultural and operational factors are integrated into a fire management strategy?

The 4 S's: A useful framework for answering this question is to consider the 4 S's of fire regime characteristics:
Size: In order to offset growing fire deficits due to: lack of managed wildfires; deferred prescribed fires due to wet spring weather; and units that require re-burning, unit sizes need to increase. This will not necessarily equate to more prolonged operations.
Season: In order for fire managers to meet restoration objectives, summer prescribed burns may need to take place in more remote valleys on a regular basis. During years when forest fuel moisture levels are within acceptable targets, prescribed fires may also be required in frontcountry areas after the peak visitation period has ended (starting the last week of August). This approach would provide for re-introducing fire into forests with longer fire cycles.
Severity: The concept of fire severity is correlated with season of burn, fuel moisture levels, and biomass consumption. Light severity fires typically occur during the spring season and the severity of fires increase gradually as forest fuels continue to dry out throughout the summer months. Most high severity fires historically occurred in the park between mid-July and mid-August after successive years of drought. In most cases, facilitating burns of this type are not an option due to socio-economic constraints and values at risk. However, in "wetter than average" summers, prescribed burns can be conducted safely in some valleys during mid-summer where reliable containment lines exist, values at risk are well protected, and impacts on tourism are minimal.
Sequencing: The sequencing of prescribed burns needs to be based on many variables including impacts to airsheds, establishment of containment lines, visitor use and commercial operation impacts. In many cases the sequencing of prescribed burns can be modified if that requirement is identified early enough in the planning process. It is an objective of the workshop for you to examine the proposed sequencing.

Workshop Objectives: Using the 4 S's of fire regime characteristics (size, season, severity, sequencing) as framework, participants were asked to:

- Examine the proposed management actions in the draft fire plan as well as impacts identified in the regional impacts analysis.

- Identify and prioritize your specific concerns as a stakeholder that have not already been addressed in these documents. This information will form the basis for future research and monitoring as well as identifying necessary modifications to the proposed fire management strategy.

- Where possible, propose solutions to address those specific concerns while at the same time striving towards achieving the fire management goals.

- Recommend necessary changes in "the 4 S's" (size, sequence, severity, and season) to better integrate fire management goals with the concerns identified by you in your area of concern within the following categories:

Operational and Tactical Considerations
Social, Cultural and Economic Considerations
Ecological Considerations

Summary of Break Out Group Discussions: A summary of the comments, concerns, potential mitigations and suggested key actions brought forward by the stakeholders in each breakout group is presented below:

Operational and tactical considerations

The members of this breakout group were:

Scott Wing – Canmore Fire Department
James Guthrie - Trans Alta
Jim Watt - Town of Banff Fire Department
Russ Geyer – Town of Banff Fire Department
Maurice Tissander - Canmore Fire Department
Gerald Sambrooke - Alberta Sustainable Resource Development
Greg Van Tighem - Jasper Fire Department
Herb MacAulay - Birddog 1
Tom Mcfadden - Ghost River Fire Department, MD Bighorn
Don Mortimer - Fireline Consultants

Interagency Resource Sharing and Training Opportunities

Information is a resource, share it. Communicate, communicate, communicate. There can be a lack of communication, but that is continually being improved. Industry needs to be contacted by Parks Canada and know what is happening in terms of proposed prescribed burns (PBs).

Parks Canada response: Parks Canada is examining several options for information sharing including real-time updating of fire management information on their website. Related information can be found at http://www.pc.gc.ca/pn-np/ab/banff/index_e.asp. Parks Canada maintains an up-to-date stakeholder list to apprise individuals and organizations of fire management activities including prescribed fires and fuel reduction. Parks Canada will also pursue strengthening of linkages to existing advisory groups and regular meeting venues to keep stakeholders up to date on fire management activities. Communications sub-plans contained within our prescribed burn plans are an important aspect of program delivery.

Parks Canada is working on the development of a Fire Website for the Mountain Parks – this would act as a “one-stop-site” for all fire-related information including fire danger ratings, upcoming burns, current fire status, etc.Detailed protocols have recently been developed outlining communication actions required for three stages of prescribed fire activities: burn planning, event-in-progress, and post-event.

PROPOSED MITIGATION/ SUGGESTED KEY ACTIONS:

- **Cooperative training / cross-training (i.e. S115 course). Working together on fire response, assisting each other. The Town of Banff is working with Parks Canada on training for proposed PB’s. Training needs to be provided through scenarios with hands-on experience and well integrated training programs (between Parks Canada, the towns, industry and provincial governments).**

- **Blanket recommendations to respective councils, municipalities, etc. to allocate resources and funding to put towards fire operations. The local governments need to be collectively approached with a motion to have funds directed towards fire management, cross-training, fire control and infrastructure. Officials need to be convinced to put resources into our fire resources. Acquire resources such as sprinklers, more tactical planning. Tactical response planning requires interagency funding.**

Parks Canada response: **Parks Canada will work closely with co-delivery agents in the pursuit funding sources to facilitate this recommendation.**

Powerline/utilities/dams/infrastructure

Have to know the needs of Parks Canada and local governments regarding protection of communities from fires given the evolving development of the local area.

It was suggested that for all PBs, the identified contact person for all utility companies in the area should be contacted prior to the burns. It was discussed that the companies are currently identified in the Emergency Response Plans and contacted in emergency situations (e.g. wildfire) and that communications for PBs are already in place and well maintained.

There should be communication between weather forecasters (meteorological information if there are big winds forecasted) and industry. High winds can cause significant blow-down of trees adjacent to powerlines which can ignite fires.

It is the utility companies' responsibility to maintain right-of-ways as per regulatory guidelines which also covers off fuel reduction in these areas. There are existing right-of-way agreements to keep them clear.

PROPOSED MITIGATION MEASURES:

- **The Critical Electrical Infrastructure Hazard Reduction Map (ToB) has been developed for the Bow Valley. There are currently 15 critical utility lines, 5 of those have been targeted to become underground lines. Burial of lines has greater costs associated with it; if the Town of Banff recommends the burial the town will likely have to bear the cost.**

- **Continue working with utility companies and municipalities on priorities to build awareness of fire management issues and keep things moving forward.**

- **The issue of transmission line integrity between Banff and Lake Louise was also discussed.**

Parks Canada response: **Parks Canada will continue to work with utility companies on an ongoing basis to address these concerns. The workshop provided an opportunity to bring awareness to challenges relating to firesafe critical infrastructure. Parks Canada will continue to work with utility companies on an ongoing basis to address these concerns through the CEAA process and correspondence with the utility companies.**

First Nations Involvement and Cultural Sites

There are First Nations cultural sites that could be affected by PB's and mechanical clearing. Specialized FN crews that currently exist should be trained and utilized.

PROPOSED MITIGATION MEASURES:

- **Have FN on the site prior to any PB's or clearing to identify sacred sites and traditional land use areas. In the tactical response plan identify where FN cultural sites are and how they should be avoided/preserved. Put mechanisms in place so areas where PB's or fuel reduction are proposed will be put into a system and the FN sites previously identified (confidentially by local FN's) will be triggered and mitigations to avoid/protect the site will be put into place.**

- **Have resource identification and training with the FN and Métis so they can work with Parks Canada, municipal and local governments on fire and fuel management. Share the cost of training, etc., with Indian and Northern Affairs Canada.**

Parks Canada response: **Parks Canada is committed to working closely with FN stakeholders on this important mitigation. Specific solutions will be formulated as part of a parallel consultation process**

with impacted FN stakeholders. These recommendations will be incorporated into the final draft of the fire management plans, project-level EA's relating to prescribed fires, fire management best practices, and the burn plans themselves. Parks Canada is working with FN to establish developmental fire management positions for members of the local FN community. Once established, Parks Canada will provide training opportunities relating to these positions and include awareness of FN issues in basic/intermediate fireline training.

Capping and Transboundary Units

Capping and transboundary burn units are critical for adjacent areas to be protected from fire and for proposed PBs to work well. They are much greater in cost than subsequent burns, but essential to prescribed burn operations (e.g. stop fire from moving into adjacent provincial lands). Capping must be 100% successful.

PROPOSED MITIGATION MEASURES:

- **The implementation of these burn units needs to be multi-jurisdictional from the beginning.**
- **The local and municipal governments and industry should support Parks Canada's use of capping units at critical boundary locations. There needs to be a 'united front' implementing capping and transboundary units, keeping stakeholders informed.**

Parks Canada response: **Parks Canada is working closely with neighbouring fire management agencies to cooperatively plan and implement prescribed fires. In the contiguous mountain parks during 2008, three such interagency/transboundary units will be implemented. A regional interagency prescribed fire planning team has been established in order to ensure that this approach becomes a cornerstone of fire management regionally.**

Ongoing consultation and efforts to create awareness/support of fire management goals will assist in forging new partnerships and strengthening existing ones. Parks Canada will continue to actively seek out these opportunities through established advisory groups (eg. Montane Advisory Group/BCEAG) and interagency planning initiatives.AIP: Parks Canada is working closely with neighbouring fire management agencies to cooperatively plan and implement prescribed fires. In the contiguous mountain parks during 2008, three such interagency/transboundary units will be implemented. A regional interagency prescribed fire planning team has been established in order to ensure that this approach becomes a cornerstone of fire management regionally.

Regional Coordination of Burns

Need cooperation involving other agencies as observers on the prescribed burns so that municipal fire departments can learn more about wildland firefighting to aid in preparation for a possible interface fire in the future.

Determine which burns are priorities (politically, financially, socially and environmentally). There needs to be intensive regional coordination with respect to fire management activities.

PROPOSED MITIGATION MEASURES:

- **Give invitations to other fire departments to attend prescribed burns.**
- **Coordinate the different PBs on a regional level.**

Parks Canada response: **Parks Canada is working closely with neighbouring fire management agencies to cooperatively plan and implement prescribed fires. In the contiguous mountain parks during 2008, three such interagency/transboundary units will be implemented. A regional interagency prescribed fire planning team has been established in order to ensure that this approach becomes a cornerstone of fire management regionally.**

Fuel Breaks

Must use both prescribed fire and fuel reduction within fuel breaks. There needs to be support in the concept of fuel breaks, including mechanical and fire manipulation. This does not absolve the homeowner of FireSmart initiatives on their own home. All of these components are critical to reducing wildfire hazard.

PROPOSED MITIGATION MEASURES:

- **Public education is required at a door to door level. There needs to be communication with the public on the importance of fire and fuel management techniques. People need to be aware of their own responsibilities on their properties (e.g. FireSmart).**

Parks Canada response: **While recent public surveys indicate that significant progress has been made in this area, Parks Canada will continue to enhance existing communications tools and pursue innovative methods in meeting our public education and awareness mandate. This mitigation will be partially addressed through staffing of a term Fire Information Officer position and the implementation of the Community Outreach Plan for fire and vegetation management.**

- **Municipal planning and development departments need to be on-side with operations. Firebreaks and FireSmart programs need to be supported in municipal legislation (i.e. by-laws and by-law enforcement).**

Mountain Pine Beetle Priorities

If an area has been attacked by MPB there is a likelihood of higher fire intensity, resulting in completely decimated areas. Prescribed fire is much more desirable than MPB due to the high risk associated with wildfire in beetle-killed stands.

PROPOSED MITIGATION MEASURES:

- **Utilize the MPB problem as an ally – there is funding (federal and provincial), resources and acceptance towards prescribed burning due to the MPB issues.**

Parks Canada response: **Parks Canada MPB funding is secure through to the end of 2009 at which time the program will be re-assessed.**

Air Quality and Regional Smoke Impacts

People are concerned about smoke and they are associating smoke impacts from wildfires in other areas to PBs in the Bow Valley.

The public's most critical concern is air quality.

PROPOSED MITIGATION MEASURES:

- **Need public education on the source of smoke in communities during fire season (i.e. location and prescribed burn versus wildfire). The media can be used as a tool to inform the public on the cause of the smoke. The smoke that the public associates with a prescribed burn is often a smoke event from a wildfire far away from the prescribed burn. Smoke from wildfires is very different from smoke produced by a prescribed burn in that smoke from a prescribed burn is usually of short duration and is controlled to a certain extent.**

Parks Canada response: **Minimizing the impacts of smoke to the public is an operational objective of all prescribed burns. This can be achieved to a large degree by limiting ignition operations to times when atmospheric venting conditions are optimal and wind direction carries smoke away from populated areas. Parks Canada will make use of communication tools such as the fire website, satellite photos, phone recordings, and the media to inform people about the sources of smoke in and around communities.**

- **There should be greater use of air quality monitoring technology. Compliance with operational guidelines (i.e. cure the slash piles instead of burning when green) is essential. Use operational expertise to work with the municipal officials to structure by-laws and guidelines to continue to use burning as a necessary tool. Involve the public health authority in monitoring air quality.**

Parks Canada response: **Parks Canada will investigate the purchase of handheld nephalometers so that air quality can be monitored on a regular basis. In addition, Parks Canada will work closely with Alberta Environment and regional health authorities to monitor smoke impacts on a local and regional scale.**

SOCIAL CULTURAL AND ECONOMIC CONSIDERATIONS

The members of this breakout group were:

Bert Goliath - The Banff Centre
Virgle Stephens - First Nations Elders
Shauna McGarvey - McMaster University
Rose Maunder - Discover Banff Tours
Maria Sharpe - Province of Alberta, Rocky Mountain House
Bart Donnelly - Banff Lake Louise Tourism
Julie Canning - Banff Lake Louise Tourism

Richard Leavens – Association of Mountain Parks Protection Enjoyment
Chad Cavanagh - Baker Creek Chalets

Cultural

First Nations consultation pre and post fire needs to be improved. These communities are concerned about respiratory health, and the protection of traditional and cultural values of First Nations. Also there is a need to share traditional knowledge throughout the long term fire management planning process as it could help shape future fire management decisions.

PROPOSED MITIGATION MEASURES:

- **Parks Canada should engage in separate consultation process with First Nations elders to share traditional knowledge including locations of plants, sacred sites, and burial sites etc. This needs to happen at least 12 months prior to proposed fires and requires face-to-face communication.**

Parks Canada response: ***Parks Canada is committed to working closely with FN stakeholders on this important mitigation. Specific solutions will be formulated as part of a parallel consultation process with impacted FN stakeholders. These recommendations will be incorporated into the final draft of the fire management plans, project-level EA's relating to prescribed fires, fire management best practices, and the burn plans themselves***.

Economic

The lack of information on the potential economic impact of prescribed burning on the local business industries, especially tourism-based industries, was identified as a major knowledge gap within the current fire management plan.

The timing of prescribed burning and the length of burns around the prime season (May to Sept) - which accounts for a significant proportion of tourism revenue in the Bow Valley - is a major concern.

There is a perception that within the current fire management plan ecological integrity goals out-weigh the goal of maintaining a positive visitor experience.

PROPOSED MITIGATION MEASURES:

- **Specific, regular and open dialogues between Parks & the local tourism industry need to be improved to achieve a number of different goals including:**
    - **Better dissemination of fire science information and prescribed burning priority areas to these groups**
    - **Consensus decision-making around timing of fires in order to meet Parks fire management goals while avoiding impacts to health and safety of residents and visitors and having the least possible economic impact on the tourism industry.**

Parks Canada response: **Parks Canada, Municipalities, and business stakeholders will work together on development of a stakeholder information plan. This plan will document the information requirements of the business community, the most timely method of information dissemination, as well as updated stakeholder contact lists. In addition, Parks Canada will pursue opportunities to attend regular meetings with the business community in order to present and discuss upcoming fire management initiatives. Parks Canada will pursue long term liaison opportunities through Fire Information Officer positions and investigate how available information can be accessed more readily by stakeholders and the public in order that they may educate themselves on fire management related issues.**

- **Economic considerations need to be built into the proposed prescribed burning decision matrix used by Parks Canada fire operations when planning future prescribed burning locations and times.**

- **A quantification of the risk of fire on the tourism industry needs to be developed in jointly by the tourism industry and Parks Canada or another third-party. There is extensive information on the economic history of tourism in Banff and historical visitation usage that could be useful for prescribed fire decision-makers. (e.g. Is there evidence of regional market slow down during burns? For everyday in the valley that there is fire or smoke it costs tourism x $? What are the trickle down impacts to the local business owners? What if any is the business case of fire? What is the cost of doing business in a fire dependent ecosystem?)**

- **Re-vamp the prescribed fire planning process to include stakeholders in long term decision-making. This would allow for an analysis of trade-offs earlier in the planning process and ensuring socio-economic and cultural concerns are addressed along side ecological and tactical and operational concerns.**

- **Specific timing requests related to prescribed burning identified during the workshop included:**
    - **Do not conduct prescribed burns between the months of May to September.**
    - **Do not conduct prescribed burns before the September long weekend in the fall burning period.**

Parks Canada response: **Smoke management is an integral component of Parks Canada prescribed burn planning and implementation. There are many facets to the above list of mitigations including ecological, social and economic considerations. Parks Canada is acutely aware of the issues surrounding management of fire dependent ecosystems and how this management interfaces with business and tourism. Much work lies ahead on this particular front including the analysis of smoke impacts on tourism and how these impacts can be mitigated to the greatest degree possible. The challenges include: 1) Education of the public and stakeholders regarding the complex regional interactions of airsheds and sources of smoke that impact our national parks. 2) Addressing knowledge gaps in this area and ensuring that management decisions are based on the best available knowledge.**

Parks Canada is committed to working together with partners in order to ensure that these challenges are met over both the short term and long term. Parks Canada will work collaboratively with sister

agencies and the business community to develop an action plan to address these concerns. This will involve two-way sharing of information databases in order to mitigate impacts on tourism. Discussions with the Parks Canada Social Scientist are ongoing as to how fire and socio-economic considerations can become better integrated.

Social

Social concerns were primarily related to communication, education and cooperation.

There is a general agreement that prescribed burning is a necessary process and is important protection and ecological restoration activity. The tourism industry has accepted this, but would like to be more involved in the prescribed burning planning process.

Two major categories of communications issues identified were:

- The need for both short term and long term communication between Parks Canada and the public.
- Improved communication of local fire activities and regional fire activities and their affect on people within the Banff region between Parks Canada to the public.

It was identified that short term communication is needed when specific prescribed burns are happening in the area – size, season, location, how long burn will be taking place, how long will there be smoke in the valley.

Long term education efforts by Parks on the process of fire (from well before a proposed fire to many years after) were identified as a major knowledge gap. Fire could potentially be a value added tourism opportunity; using stories to educate awareness of fire (e.g. fire ecology tours).

It was identified that there is a definite need to educate the public especially tourism industry and others on the importance of the timing of burning and fire practices. (e.g. Why do we need to have spring burning? What is a controlled fire?) There is a misconception that prescribed fires are out of control when they burn/smolder into the months of June, July and August.

PROPOSED MITIGATION MEASURES:

- **Develop a prescribed burning priority map with associated information as to how the prescribed burning locations were selected and the anticipated length of the burn and size (simplify the methodology and results for public) including which burns are vital for the protection of human and built assets (Town of Banff). This would provide valuable information to the tourism industry, Town of Banff and others public groups so that they can try to schedule activities around the prescribed burning priority areas. This will require regular updates from Parks as prescribed burn locations are constantly changing – but it is better than no information exchange at all. It provides a rough schedule for the industry to work around and also a source of information they can use to inquire on the progress of the fire program within Parks.**

Parks Canada response: **Parks Canada will develop a communications product that provides this information. To a large extent, this is a matter of making existing information more accessible to the public and business/tourism stakeholders. This will be a priority for the Fire Information Officer workplan.**

- **Synthesize the SEA into a 1-2 page briefing note for public education purposes.**
- **Build reassurance and trust through detailed and directed discussions and consensus meetings on time sensitivities and geographic concerns with various individual groups to determine burning windows and locations that all parties can agree to.**
- **To address the disconnect between Parks and various public groups, Parks Canada should have a "fire specialist liaison" to work with the public to specifically address fire related concerns. This representative should join a hotel/motel association and leverage partnerships with tourism associations to get a "foot-in-the-door" with other groups. This role could potentially be filled by the existing "Fire Information Officer" role that was established after the 2003 fire season – but still does not have a well-defined job description.**
- **Diversify the toolbox of communication techniques and tools used to consult with the public. For example, real time website updating of fire information within each field unit, look at the Alberta Sustainable Resource Development hotline as a precedent (updated hourly). Consider a communications study to identify the most effective tools for effective information exchange with various stakeholder groups.**

Parks Canada response: **Parks Canada, Municipalities, and business stakeholders will work together on development of a stakeholder information plan. This plan will document the information requirements of the business community, the most timely method of information dissemination, as well as updated stakeholder contact lists and time/action schedules. In addition, Parks Canada will pursue opportunities to attend regular meetings with the business community in order to present and discuss upcoming fire management initiatives. Parks Canada will pursue long term liaison opportunities through Fire Information Officer positions and investigate how available information can be accessed more readily by stakeholders and the public in order that they may educate themselves on fire management related issues.**

Parks Canada is examining several options for information sharing including real-time updating of fire management information on their website. Related information can be found at http://www.pc.gc.ca/pn-np/ab/banff/index_e.asp. Parks Canada maintains an up-to-date stakeholder list to apprise individuals and organizations of fire management activities including prescribed fires and fuel reduction. Parks Canada will also pursue strengthening of linkages to existing advisory groups and regular meeting venues (eg. Hotel/motel association meetings) to keep stakeholders up to date on fire management activities. Communications sub-plans contained within our prescribed burn plans are an important aspect of program delivery.

The Community Outreach Plan '07 will be updated to reflect stakeholder requirements. Communication strategies for each prescribed burn will also be updated .

ECOLOGICAL CONSIDERATIONS

The members of this breakout group were:

Dave Finn - Alberta Sustainable Resource Development

Steve Donelon - Alberta Tourism, Parks, Recreation and Culture
Scott Jevons – Alberta Tourism, Parks, Recreation and Culture
Robert Sandford - Western Watersheds Climate Research Collaborative
Mike McIvor - Bow Valley Naturalists
Murray Hagel - Friends of the Eastern Slopes
Dale Marshall - Friends of the Eastern Slopes

SARA Species

The effects of the fire management program on two species listed under the federal Species at Risk Act (SARA) were discussed.

There needs to be more information on the effects of fire on the endangered Banff Springs snail and its habitat given that prescribed fire may affect the habitat of the snail in the future.

Also there is a need for more information on the effects of fuel management activities on the snail and their habitat.

The significant land disturbance outside the national parks to the east in Alberta (e.g. oil and gas activity, forestry, recreation) has a large negative effect on woodland caribou and their habitat, a threatened species under SARA. The opinion was expressed that small scale prescribed fires within caribou habitat in the mountain national parks may reduce the risk of further large-scale habitat losses (i.e. old-growth forests) due to large wildfires within the parks and surrounding provincial lands.

It was felt that compared to large wildfires prescribed fire may have the least intrusive impact on critical caribou habitat. Managed fire may also be a better option than full suppression operations associated with wildfire situations where there can be significant habitat degradation and sensory disturbance to caribou due to use of heavy machinery and helicopters .

PROPOSED MITIGATION MEASURES:

- **Implement small scale prescribed fires in woodland caribou habitat in the mtn. parks to reduce the risk of loss of large areas of critical habitat associated with a large wildfire**

Parks Canada response: **This recommendation will be forwarded to the committee responsible for development of the woodland caribou recovery strategy for consideration.**

Mountain Pine Beetle

Currently on Alberta lands and within the mountain national parks the location of proposed prescribed fires is based on ecological considerations but the sequencing of those burns is driven by mountain pine beetle (MPB) in order to reduce the amount of available host (mature lodgepole pine) on the landscape and slow the spread of the outbreak populations into Alberta.

A concern was expressed that the very high fuel loads left behind after the beetle has killed all the pine in stands across the mountain parks leads to potential for very high intensity/severity wildfires. This "post MPB" effect should be addressed within the mountain parks.

The pine bark beetle “disaster” does not just affect forests. It also affects regional hydrology by dramatically increasing the rate and timing of run-off. We need to know much more about these dynamics especially in our mountain national park headwaters.

SUGGESTED KEY ACTIONS:

- **Address the potential problem of large scale beetle-killed stands and, if active management of these stands is deemed necessary within the parks, find solutions to deal with the wildfire hazard posed by these stands**

Parks Canada response: **While large scale MPB beetle-killed stands do not presently exist in the contiguous mountain national parks, the potential for this situation exists. Parks Canada will investigate possible management alternatives in response to situations where MPB killed stands pose a wildfire threat to public safety and infrastructure.**

- **Implement research on the effects of MPB killed stands on hydrology, especially if they are subsequently burned**

Parks Canada response: **Existing populations of MPB do not presently pose a significant threat to hydrological processes within the contiguous mountain parks but the potential does exist. This knowledge gap will be investigated through a literature search. If a need for research is identified through further consultation, a research proposal will be submitted to Natural Resources Canada for consideration and appropriate funding.**

Fire and hydrological regimes

It was pointed out that many national parks, including Jasper, were originally protected in order to preserve all-important watersheds so as to ensure naturally high water quality and to minimize downstream flooding and other effects and that this function will become even more important in the future. We need to acknowledge the role of upland forests in capturing and slowly releasing water as a foundation of downstream water supply secure ty and human settlement stability.

Hydro-ecological management is the management of landscapes and ecosystem composition to optimize water production. The recent rise to prominence of hydro-ecological management tools has come about as a result of an urgent need to marry water management practices with land-use policy. While this has proven impossible in heavily settled areas, integrated watershed management is still possible in our mountain national park headwaters.

An opinion was expressed that the larger urgency of broader thinking on the role of fire management must be brought forward publicly. The careful and thoughtful management of fire (through carefully managed prescribed fire) will not just benefit the national parks and the tourism industry cannot be allowed to define the fire agenda.

It was also stated that “the perpetuation of natural ecosystem function is just as crucial to the sustainability of our tourism economy as it is to the protection of national park landscapes. Fire must be managed [through use of prescribed fire rather than waiting for an inevitable wildfire] to protect infrastructure, preserve ecological integrity, assure regional water security and moderate climate change impacts, not just around Banff townsite but throughout the mountain West”.

There is a need for enhanced hydro-meteorological monitoring in the mountain parks with respect to effects of fire on water and hydrology (e.g. snowpack, stream flows, groundwater etc.). This monitoring should be done before and after a fire to accurately capture fire effects on water flows and should be done on a broad watershed scale.

There is also a need for research on the effects of fire on water supply and regional hydrology. The Western Watersheds Climate Research Collaborative is interested in exactly this kind of work and is prepared to find funding and researchers to conduct such research in association with already existing fire management programming.

SUGGESTED KEY ACTIONS:

- **Implement pre and post burn monitoring projects in the mountain parks to determine fire effects on regional hydrology**
- **Fund and initiate key research into the effects of prescribed fire and wildfire on regional hydrology and water supply.**
- **Use existing data to conduct watershed-scale modeling of various disturbance regimes (including prescribed fire and wildfire) on regional hydrology in the mountain parks and adjacent provincial lands**

Parks Canada response: **Opportunities to conduct collaborative research and monitoring to assess hydrologic impacts of fire management alternatives will be investigated by Parks Canada. Since this information is important on both a local and regional scale, consistency in methodologies regionally will be important to the success of this type of monitoring. For this reason, linkages with ongoing research and monitoring in this area of study will be given a high priority.**

Fire Deficits

There needs to be a discussion of fire deficits in the Strategic EA of fire and fuel management. Calculations of area burned versus area expected to burn according to known historical fire cycles deficit calculations are necessary to evaluate how Parks Canada is doing at meeting its stated goals of achieving 50% of the long-term fire cycle.

There should be a recognition that we are falling further and further behind given the stated goal of achieving only 50% of the long-term fire cycle. A question was asked if the stated goal of 50 % of the fire cycle (or burning half as much area as burned historically per time period) was within the long-term range of variability for the mountain national park ecosystems.

It was stated that originally the 50% goal was established with the idea that the other 50% would likely be taken care of by lightning ignited wildfires. This has not happened so far since the 50% goal was established for Banff National Park on the eastern side of the Rockies due to low incidence of lightning.

This may be different from parks like Kootenay and Yoho on the west side of the Continental Divide which receive more lightning and are subject to occasional large lightning ignited fires like that in 2003.

SUGGESTED KEY ACTIONS:

- **Add a section discussing fire deficits in the mountain national parks into the fire SEA and an evaluation or "current state of affairs" with respect to Parks Canada's stated goal of achieving 50 % of the long-term fire cycle**

Parks Canada response: **A thorough analysis of fire deficits, associated impacts, and mitigations form an integral component of the SEA.**

Interagency Cooperation

There needs to be cooperation between Parks Canada, Alberta Sustainable Resource Development, and municipalities with respect to fire management activities.

These agencies need to share information gained through research and should collaborate on large-scale monitoring and research project. Some of this is already happening between Sustainable Resource Development and Parks Canada (e.g. mercury monitoring project for Mt. Nestor burn).

SUGGESTED KEY ACTIONS:

- **Formalize interagency cooperation to share information gained through fire related research and monitoring**

Fire Research, Monitoring and Knowledge Gaps

It is imperative to communicate the need for fire management programs, this is vital to the long-term success of prescribed fire programs within and outside the national parks. There is a need for social science research to bridge the gap between the science community, policy makers and the public with respect to the need for managed fire. Also Parks Canada must get more information about the need for prescribed fire and fuel management to communities outside the Bow Valley on the eastern slopes.
There needs to be more funds allocated to monitoring within each prescribed burn or fuel management project.
More baseline data should be collected for ecological systems subject to fire management activities so that we have a better understanding of the effect of these activities on organisms and ecosystem processes.
Fire managers should tap into First Nations knowledge of fire given their use of fire for thousands of years in this area prior to the arrival of European settlers.

SUGGESTED KEY ACTIONS:

- **Conduct social science research on the need for fire in park landscapes and beyond to bridge the gap between the science community and the public**

Parks Canada response: **Parks Canada is committed to our public education and awareness mandate. Existing initiatives , including outreach tools such as edukits and web-based learning opportunities will be examined for areas requiring improvement. In addition, Parks Canada will continue to pursue innovative ways of reaching our public audience based on recent demographic research.**

- **Allocate dedicated funds for monitoring to PBs and fuel management projects**

***Parks Canada response*: This recommendation will be submitted to the National Fire Management Committee for consideration.**

- **Collect more baseline data on ecological systems to better understand the effect of fire management activities on park ecosystems**

***Parks Canada response:* Fire managers are working closely to establish strong links between the national ecological integrity monitoring protocols and fire management issues. The EI monitoring program is a multi-year initiative that will be implemented effective spring 2009. Fire managers will draw on this knowledge base to enhance fire management decision making.**

- **Utilize existing First Nations knowledge of fire use on park landscapes**

***Parks Canada response:* This recommendation will be actively pursued during ongoing parallel consultation processes with FN stakeholders.**

- **Communicate need for fire management programs to communities outside the Bow Valley on the eastern slopes since they are impacted by smoke etc. as well.**

***Parks Canada response*: Parks Canada will work with sister fire management agencies on provincial lands to ensure that these messages are being communicated effectively.**

Biodiversity

Different scales of biodiversity must be accounted for in determining fuel management and proposed prescribed fires. Biodiversity occurs across very fine scales as well as large landscape scales in park ecosystems and this must be considered when burning in unique habitats like the Vermilion wetlands.

"Open Mike" Comments

Communications and Economics

Comment: There needs to be more open and regular conversation between Parks Canada and key stakeholders; have more regular consultation instead of one meeting (like this workshop) to flush it all out. Keep the communication open and more often. There are meetings every month with the different associations that Parks could be a part of. For burning times, if everyone leaves the meeting 'equally unhappy' because it is hard to please everyone.

Brian Low, Parks Canada response: Parks Canada's objective with regard to fire management is to achieve operational goals while not having large impacts on the public and tourism. Parks Canada takes about 12 months to plan for a PB. There is a communication plan within the prescribed burn that Parks Canada follows. The contacts need to be kept up to date. Parks Canada needs to know what stakeholders would like to see, i.e. Parks Canada attending an annual meeting to let the businesses know what is in place. Parks Canada has tried to take a targeted poll for burning times.

Comment: The business industry could use the "story of fire" as a tourism benefit. Visitors can be informed: this is what is happening, this is why, with respect to fires. Re-educate the public with the perception that fire is good and beneficial.

Comment: Information is available on tourism occupancy and gate numbers to determine what the number of visitors were in those years with high fire activity (like 2003). *To what degree could that fire activity be correlated to visitation rates in Banff and other areas given local fires, distance fires, SARS, 911 and other effects?* These other variables may confound the results of such a study and make it difficult to tease out the effect of fires on visitation rates.

Could this visitation information be used by Parks Canada in determining burning times?(no response)

Comment: It could be looked at objectively and openly. Look at the positive and negative impacts of burning and smoke.

Comment: The question is if you are an ecologist or an accountant. We all know that nobody likes smoke and that everybody gets smoke. If the research has been done (economic and social effects of smoke) then it needs to be on the list.

Comment: Use the media as a tool. Show aerial photos to show where the fires are and where the smoke is coming from. It allows people to know what is happening where.

Fire and First Nations

Comment: There is an advisory committee that works with Parks, however there needs to be a step after that. The consultation needs to go further with Parks Canada spending more time in the First Nations communities so the right elders can be identified and come out to the site of a prescribed burn and identify what important cultural sites are there. The process needs to be on the ground with an aboriginal community. With FN people, they need to be contacted in different ways besides e-mail or newspaper (i.e. phone trees, going door to door).

Ecological

Comment: There are benefits and impacts of fire to different species. *How does Parks Canada decide which species is more important?*

Brian, Low, Parks Canada response: Parks Canada manage the process that drives the system (i.e. fire) instead of individual elements within the ecosystem to the level possible.
Comment: The people privy to the ecological knowledge with respect to fire is a 'select' group. Perhaps there needs to be more contact to the general public.

Operational

Comment: The methods of lighting the prescribed burns could be changed. The fires ignited in the 1988 were long lines, burned with too much intensity compared with what would occur naturally. Need point source ignition rather than line ignition to preserve old-growth forests and get more patchiness on the landscape. More attention to where and how the fires are being lit, more point source.

***Brian Low, Parks Canada, response*:** The weather and fuel conditions will determine the burning pattern. This issue is a cross section of operational and ecological considerations and is something that needs to be acknowledged in the EA's and prescribed burn plans.

Comment: The utility lines in the park need to be addressed. No more wooden power poles on the ROW's, these should be replaced by metal poles. The right utility company needs to be contacted (i.e. AltaLink).

Comment: There is a lot of guessing as to who to contact for stakeholders – need to somehow figure out what the best way is to talk to stakeholders (where and when).

Conclusion

Thank you to all stakeholders who participated in the workshop. Your input is a valuable component in making fire and fuel management in the National Parks a success.

For more information or to clarify any perspectives expressed in this workshop summary please contact: Brian Low, Fire Operations Specialist, Banff Field Unit (brian.low@pc.gc.ca, 403 762-1493)

STAKEHOLDER FOLLOW-UP AND FEEDBACK TIMELINES

Please not that while these timelines apply to finalization of these draft documents, consultation is an ongoing process and a high priority for Parks Canada. Input from stakeholders is welcome anytime and will be incorporated into regular reviews of Parks Canada management plans.

March 6th, 2008 – National Parks Fire and Forest Fuels Management *Workshop Summary Document* will be available on the following FTP site: www.box.net username: SEA password: Parks (NOTE: these are case sensitive)

March 12th, 2008 - Deadline for stakeholder feedback on the DRAFT *Strategic Environmental Assessment of Fire and Fuels Management* and the mountain parks *Fire Management Plans*. Draft Documents are currently available on the following FTP site: www.box.net username: SEA password: Parks (NOTE: these are case sensitive)

Feedback may be submitted via email to: Brian Low, Parks Canada, Brian.Low@pc.gc.ca

April 1st, 2008 – FINAL DRAFT of the *Strategic Environmental Assessment of Fire and Fuels Management* will be available on the following FTP site: www.box.net username: SEA password: Parks (NOTE: these are case sensitive) for final stakeholder review.

April 15th, 2008 – Deadline for stakeholder feedback on the FINAL DRAFT *Strategic Environmental Assessment of Fire and Fuels Management*.

Feedback may be submitted via email to: Brian Low, Parks Canada, Brian.Low@pc.gc.ca

Summer 2008 – *Strategic Environmental Assessment of Fire and Fuels Management* will be complete.

Summer of 2008 – Based on the results of the *Strategic Environmental Assessment,* a final draft of the fire management plan will be made available fore stakeholders review on FTP site: www.box.net username: SEA password: Parks (NOTE: these are case sensitive).

Fall of 2008 – Based on final input from stakeholders the draft fire management plan will be submitted to the Park Superintendent for final approval.

Workshop Attendees

As per the request of the workshop attendees, the emails of all participants have been provided.

Name of Attendee	Organization	Email
Bart Donnelly	Banff Lake Louise Tourism	bart@banfflakelouise.com
Bert Goliath	The Banff Centre	bert_goliath@banffcentre.ca
Dale Marshall	Friends of the Eastern Slopes	N/A
Dave Finn	Alberta Sustainable Resource Development	Dave.Finn@gov.ab.ca
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Gerald Sambrooke	Alberta Sustainable Resource Development	gerald.sambrooke@gov.ab.ca
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