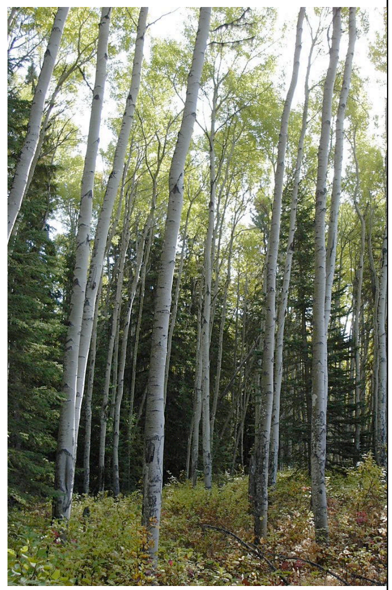
RUBYROCK PROVINCIAL PARK ECOSYSTEM MANAGEMENT PLAN



BY B.A. BLACKWELL & ASSOCIATES LTD.

RUBYROCK
ECOSYSTEM MANAGEMENT
PLAN

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INTRODUCTION

In January 2001 Fleming Protected Area was designated a Provincial Park and renamed Rubyrock Lake Provincial Park. The Park has a total area of 41,233 ha and is located 70 km northwest of Fort St. James. The Fort St. James 1999 LRMP outlines that Rubyrock's key values include: wetland complexes that serve as a stopover for migrating waterfowl and high wildlife values.

In 1996, the Land Use Coordination Office published a "Provincial Overview and Status Report" of the Protected Areas Strategy. The report identified that Sub-Boreal Interior ecoprovinces containing sub-boreal spruce forests (all successional stages) are one of the most significant conservation features/values of this ecoprovince. These forests were cited as being internationally significant and represented a major gap in the existing system of protected areas.

In the fall of 2002 B.A. Blackwell and Associates Ltd. was contracted by B.C. Parks to evaluate the current status of pine beetle attack in relation to goals and objectives outlined in the Fort St. James LRMP for the Rubyrock Protected Area. This evaluation included a review of all significant resource values in the Park and the risks to management of these resources. Additionally this work has included a review of resource information, disturbance history, and biodiversity within the area. Based on this evaluation a comprehensive ecosystem management strategy for the Park is proposed. From the onset of this project it was evident that mountain pine beetle and Douglas-fir bark beetle are having a significant impact on the Park at this time, and that efforts to contain the high level of attack are at best considered a stop gap measure. These forest health problems are likely related to two factors; 1) climate change and 2) long-term fire exclusion. Fire exclusion associated with successful fire suppression over the last 60 years has likely impacted the short interval fire ecosystems (Douglas fir and the open mosaic of grassland and deciduous forests) of the park

Over the past several years Mountain Pine Beetle (IBM) has negatively impacted a significant number of pine stands causing mortality within and adjacent to Rubyrock Provincial Park. These attacks are part of a larger scale beetle epidemic that is currently affecting the Prince George and Caribou Forest Regions. During this period a number of contracts have been let to survey the problem and follow- up with fall and burn treatment programs in an attempt to control IBM spread within and adjacent to the park boundaries. This is part of a larger beetle management strategy within the Fort St. James District. Recent park policy changes restrict bark beetle control options to the following control measures:

- Pheromone baits and traps
- Individual tree fall and burn on-site
- Prescribed burning
- Skid, pile and burn on site with low impact tools

The degree to which this situation has evolved poses a dilemma to park managers. Should the beetle be left to run it's course throughout the park and accept the risk of a larger infestation that could dramatically alter stands within the park and in adjacent commercial forests? Any actions within the park should be defined by the need to conserve park features and resources. Natural disturbances such as wildfire and bark beetle attacks are essential components of biodiversity. The distribution of seral stages present in the park is a function of disturbance patterns and therefore understanding disturbance and its influence on biodiversity should be of primary importance to park managers.

Objectives of Current Work

- The first objective of the project was to document all significant ecosystem values and biodiversity attributes critical to management of the park.

- The second objective was focused on identification of areas where application of prescribed burning had the potential to alter the current distribution of seral stages within the park. Change in the distribution of seral stages provides several benefits including; a reduction in the landscape level beetle and fire hazard, establishment of significant firebreaks, and improved conditions for regeneration of new stands of fire tolerant species. This second objective was accomplished through an aerial reconnaissance of the park to identify areas where the use of prescribed fire is ecologically appropriate.

- The third objective of the project was to review the levels of current beetle attack and establish how they potentially impact park resources.

- The fourth objective was to determine the status of grasslands and open deciduous forests within the park and the value for forage and habitat for important wildlife species.

BACKGROUND INFORMATION

This portion of the report will discuss all significant biological, physical and social aspects to be considered for the development of the ecosystem management recommendations.

Physical Features

Rubyrock Provincial Park covers a topographically varied terrain that includes many small lakes, wetlands, creeks and rock outcrops. Three large lakes border the park. These are Trembleur Lake on the northeast boundary, Cunningham Lake on the southwest boundary and the northern arm of Stuart Lake on the southeast boundary. Fleming, Butterfield, Sidney and Paula creeks are all major tributaries that flow into Trembleur Lake.

Biogeoclimatic Units

The biogeoclimatic subzones of the park are shown in Figure 1. The park contains 2 biogeoclimatic zones: the Sub-boreal spruce zone (SBS) and the Engelmann Subalpine fir (ESSF) located at higher elevations (Meidinger and Pojar 1991). The park is dominated by the SBS zone, with 19,460 ha within the SBS mc2 biogeoclimatic unit, 7670 ha within the SBS dw3, 7057 ha within the SBS dk and approximately 586 ha in the SBS wk3. The remainder of the protected area (6467 ha) falls within the ESSF mv1 biogeoclimatic unit. The portion of ESSF is restricted to the central high elevation portion of the park.

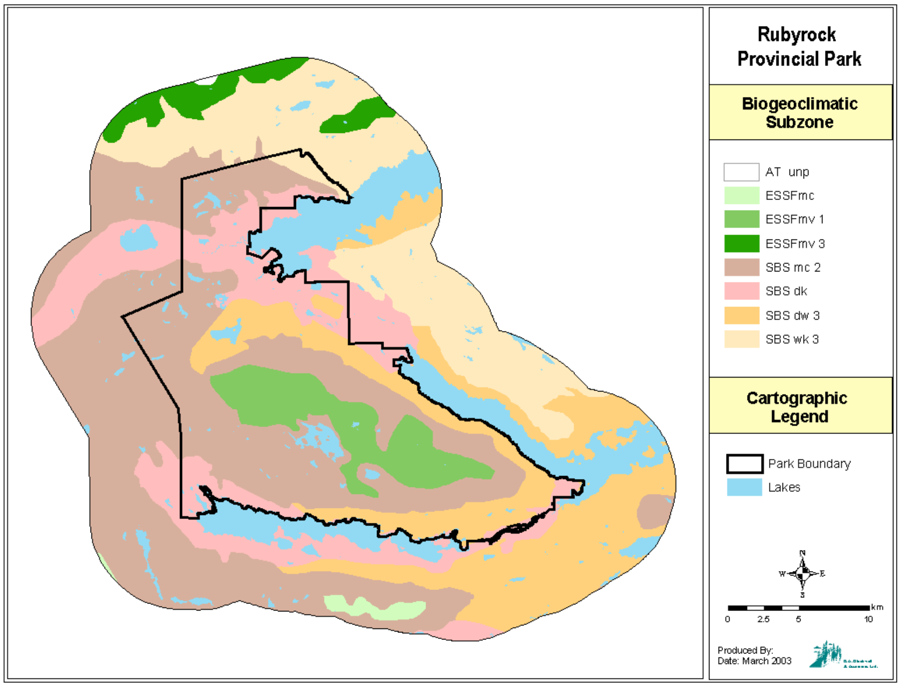

Figure 1. Rubyrock Provincial Park biogeoclimatic subzone map.

Biological Features

VEGETATION

Rare and Endangered Plant Species and Ecosystems

The Conservation Data Centre (CDC) in Victoria was queried for red and blue listed species and ecosystems. There were no occurrence records found within the park. The Fort St. James LRMP notes that there is one blue-listed habitat in the park, the SBS dw3 (06) (Figure2). This is a unique Douglas-fir shoreline ecosystem (association of Douglas-fir, Saskatoon, and False Sarsaparilla) that is found mainly along the northern shore of Cunningham Lake in the southern portion of the park. Some of the difficulties associated with identification of important conservation features are a function of ecosystem distribution. Currently, there is no ecosystem (site series) inventory available for this park. This information is considered important to the management of the park and should be a focus of future inventory work.

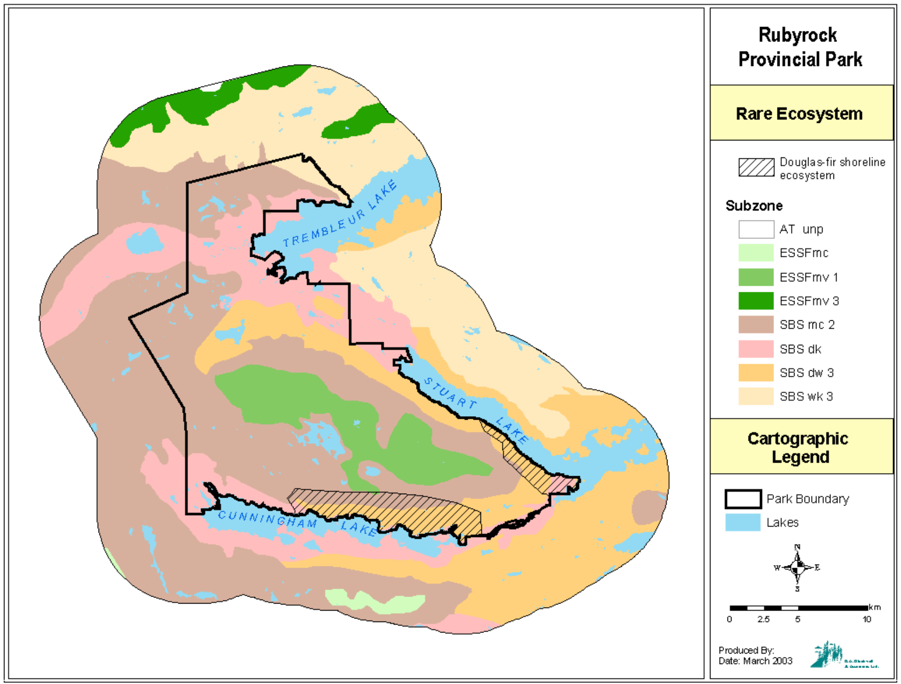

Figure 2. Area of unique Douglas-fir shoreline ecosystem (association of Douglas-fir, Saskatoon, and False Sarsaparilla)

Grassland and open forest communities

The park contains two small, but significant grassland communities (Figure 3). Although these areas are small, because of their rarity and location on warm south facing slopes, they are considered important forage areas for a number of wildlife within the park. These areas likely provide early spring forage given the aspect and topography that may be critical to some species. They may also contain vegetation communities that are rare to the region. During the field reccy to the park this areas was full of animal trails and a black bear was foraging within the open vegetation.

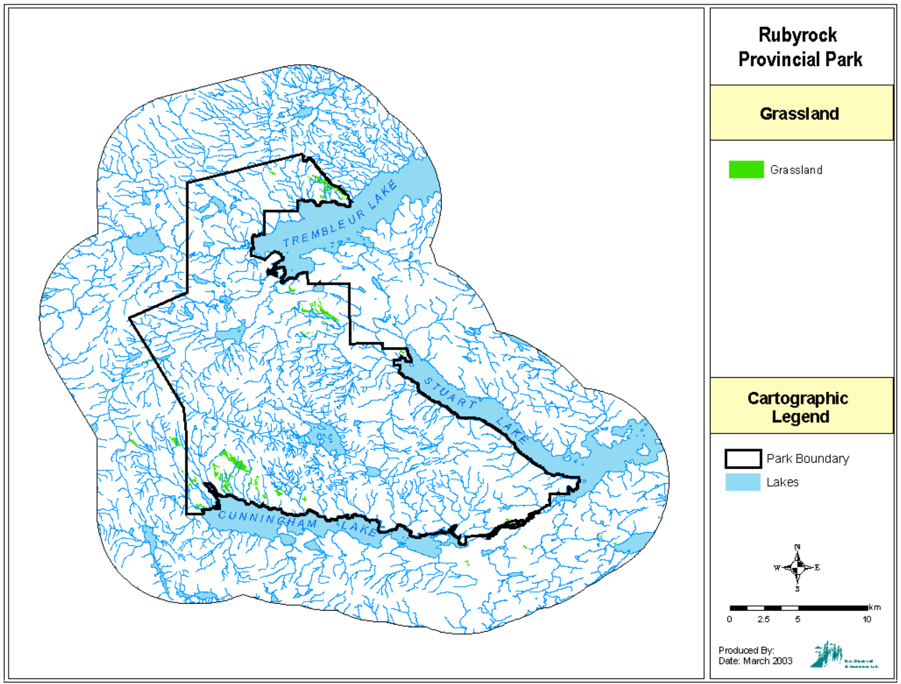

Figure 3. Grassland and open forest communities contained within Rubyrock Provincial Park.

Seral Stage Distribution

This section provides a summary of seral stage distribution in the park. The different seral stages typically recognized in B.C. are described in Table 1. The distribution of seral stages is important for two reasons. Firstly, it is an excellent indicator of historic disturbance in the park. Secondly, in combination with forest cover it highlights the distribution of old growth forests.

Table 1. Description of the Seral Stages used in the Biophysical Vegetation Inventory (adapted from Ecosystems Working Group, 1993)

Seral Stage	Approximate Age Range (yrs)	Age Class[1]	Description
1. Shrub Herb (SH)	1-20	1	early successional stage dominated by herbs and shrubs; some invading or residual trees may be present
2. Pole Sapling (PS)	20-40	2	trees >10 m tall have overtopped shrub-herb vegetation; stands are typically dense and understory vegetation of low cover in conifer-dominated stands; forest canopy in one continuous layer
3. Young Forest (YF)	40-80	3,4	self-thinning has occurred and forest canopy has begun differentiation into dominant, codominant and suppressed trees; understory vegetation often poorly expressed
4. Mature Forest (MF)	80-150	5-7	trees established after the original disturbance have matured and a second cycle of shade-tolerant trees have become established; main canopy less continuous and understory vegetation may be well developed in places
5. Old Forest (OF)	> 150	8, 9	old, structurally complex stands comprised mainly of climax tree species, although seral remnants may be found in the upper canopy; standing and downed snags are common; death of some canopy dominants has created gaps where understory vegetation and coniferous regeneration is well established

1 age class as per B.C. Ministry of Forests forest inventory age classes

Table 2 shows the relative percentage of seral stages of forested ecosystems within the five subzones of the park. Within these subzones, the majority of stands are in the mature forest seral stage (Figure 4). Approximately a quarter of the park contains old forest stands. According to the most recently available forest cover data, very little of the park contains young seral stage stands.

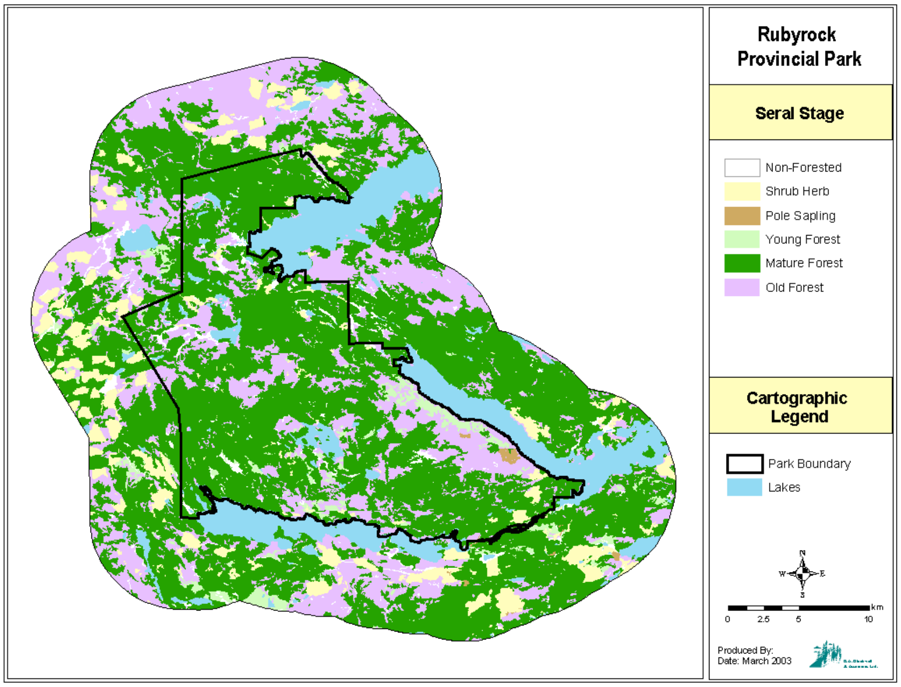

Figure 4. Distribution of seral stages within the Rubyrock Provincial Park.

Table 2. Forested seral stages expressed as a percentage of the total area of each of the five subzones in Rubyrock Provincial Park: Seral stage abbreviations are described in Table 1.

Subzone	SH	PS	YF	MF	OF	Total Area (ha)
ESSF mv1	0.0 (14)		0.3 (98)	11.0 (4137)	5.1 (1913)	6162
SBS dk	0.6 (221)		0.1 (42)	12.1 (4542)	2.9 (1101)	5906
SBS dw3	0.7 (276)	0.2 (77)	1.7 (626)	11.6 (4367)	4.5 (1708)	7054
SBS mc2	0.6 (216)	0.1 (31)	1.5 (557)	32.3 (12,121)	13.3 (5003)	17,928
SBS wk3	0.0 (4)		0.1 (46)	0.9 (336)	0.2 (94)	480
Total	1.9 (731)	0.3 (108)	3.6 (1370)	68 (25,524)	26 (9819)	37,552

Note: Numbers in parenthesis ( ) are total forested area in hectares.

In both the lower elevation subzones and the high elevation ESSF, the mature forest seral stage is the most dominant seral stage within the park (Table 2). Much of this area will be recruited to old forest over the next 50 to 70 years. With continued harvesting outside of the park boundaries and a shift to more area in shrub herb, pole sapling, and young forest the component of old forest within the park will be of increasing importance for conservation management within this landscape unit. Based on harvesting related changes outside the park, maintenance of the current seral distributions is an important management goal for BC Parks.

Old Growth Forests

The area of old forest (>150 years) within the park is just under 10,000 ha and represents 26% of the gross area (Table 2 and Figure 5). These older age classes are scattered throughout the park. The curent area of old forest is most likely a function of disturbance history (fire and IBM attack).

An area summary of the forest cover inventory confirms that almost 6000 ha (or 60%) of the old forest has a component of spruce in the stand. Within these stands spruce accounts for more than 50% of the species composition. These stands are typically associated with wetter site series and this may be part of the reason in combination with fire suppression that this area has seen limited recent fire disturbance. Figure 6 shows an old growth spruce and pine forest in the park.

Stands dominated by old seral stage Douglas-fir make up just over 1600 ha (or 16%) of old forest area in the park. This is predominately along the northern shore of Cunningham Lake in the blue-listed Douglas-fir shoreline ecosystem. These forest types are blue listed within the Conservation Data Center (CDC) and considered very important to ungulate populations within and adjacent to the park. These forested stands are all located on fire-dominated south facing slopes. If fire suppression continues within the park these ecosystems may be negatively impacted over the long term. Serious consideration should be given to prescribed fire in these forested types to maintain desirable structure and function. Further fire suppression in these stand types may negatively impact forest health and vegetation composition.

Stands dominated by old seral stage (subalpine fir or Lodgepole pine), cover approximately 900 ha each. These lodgepole pine stands are at greatest risk to attack from Mountain Pine Beetle.

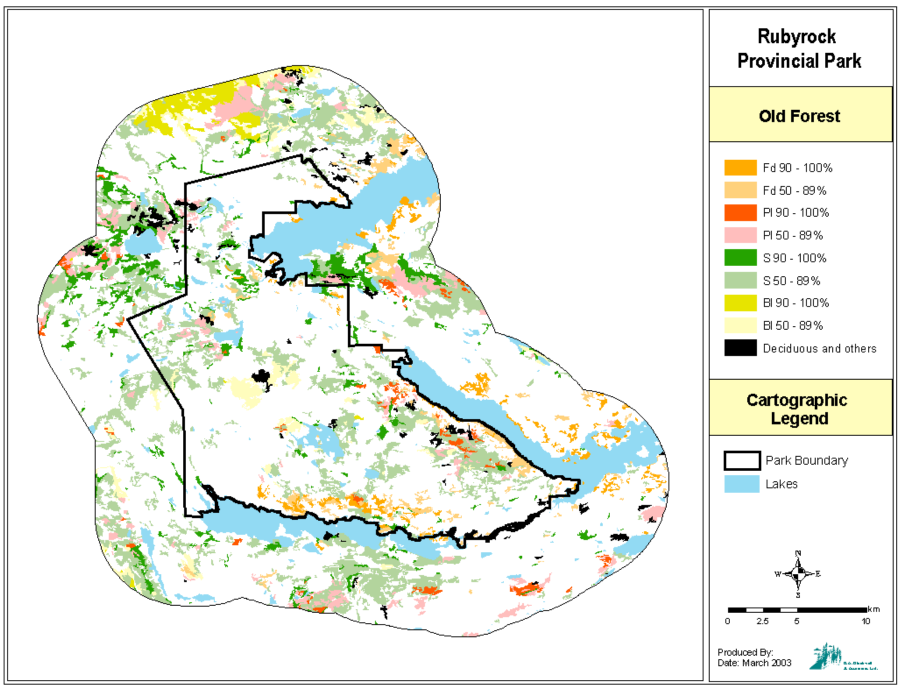

Figure 5. Distribution of old growth (>150 years) forests within and adjacent to Rubyrock Provincial Park.

Figure 6. Old growth spruce and pine forest within the ESSF subzone of Rubyrock Provincial Park.

Tree Species Composition

One third of the park is dominated by spruce, while lodgepole pine and deciduous species each dominate stands in approximately 20% of the park area (Table 3). Figure 7 shows the dominant species composition across the landscape. Most of the Douglas-fir occurs along the warm slopes that line the northern shore of Cunningham Lake. There is also a significant patch along the eastern shore of Stuart Lake. The northern section and southwest corner of the park contain stands with significant amounts of deciduous species while coniferous species (spruce, pine and subalpine fir) dominate the central portion of the park. The largest areas of deciduous forest cover are associated with the SBS, while coniferous cover dominates the ESSF. The deciduous forest cover types appear to be associated with richer parent materials, although no sources could confirm these observations.

Table 3. Species composition in Rubyrock Provincial Park (expressed as a relative percent)

Species	Relative Percent
Fd	7
Pl	20
S;Sw;Sb	33
B;Bl	5
At;Ac;E;Ep	19
Mixed	16
Total	100

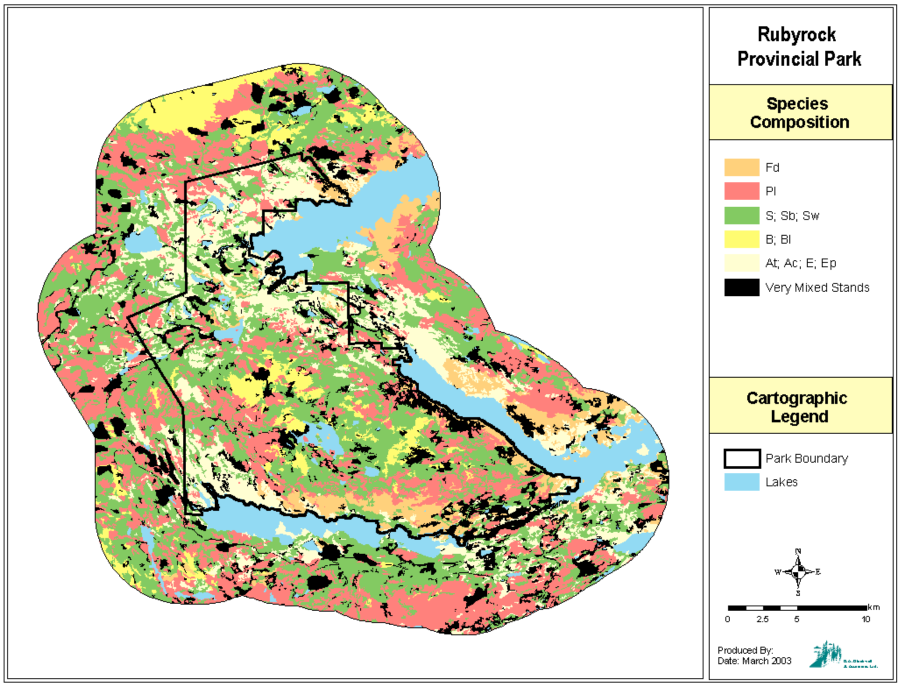

Figure 7. Species composition within and adjacent to Rubyrock Provincial Park.

WILDLIFE

Limited information is available for wildlife within Rubyrock Provincial Park. Inferences have been made about several species and some habitat information is available for moose, caribou, and mule deer. The Fort St. James LRMP backgrounder (1999) states (http://srmwww.gov.bc.ca/rmd/lrmp/ftstjames/412.htm)

> "Diverse habitats in this area support a wide variety of wildlife species, including grizzly bear, moose, furbearers and waterfowl. The area offers good aquatic furbearer habitat, and provides waterfowl migration stopover and nesting grounds. Riparian/wetland habitats include broken terrain, dotted with numerous small lakes, rock outcrops and wetlands."

This assessment appears reasonable given the ecology of this area, however no documented information could be found on grizzly bear habitat or activity within the park. Given the importance of grizzly bear conservation in the province and potential significance of this area to bears it is recommended that a detailed habitat inventory and research be undertaken to determine the importance of grizzly bear management in Rubyrock Provincial Park.

An area north of the park has been designated as winter caribou habitat (UWR Name: Takla Caribou) but none has yet been identified within the park (Figure 8). The warm south facing Douglas-fir are identified as moderate-high mule deer habitat. These areas are important as they provide forage and cover in the critical winter period. The low lying moist to wet deciduous forests (Figure 7) are identified as moderate to high moose habitat as these areas provide critical browse. Additionally, mule deer winter range has been identified outside of the park within the Fort St. James Forest District (UWR Names:

Whitefish and Trembleur West). Much of the remainder of the park provides low to nil habitat values for these species with the exception of moderate mule deer habitat located along the north shore of Trembleur Lake. The poorer habitat attributes are primarily a function of forest age and the relationship to available forage. In the central portion of the park, the forest is dominated by mature to old coniferous forest types that provide little or no forage that can be considered valuable to these ungulates.

There has been some discussion about the introduction of elk to the park. Although the habitat within the park is well suited to this species it is not recommended that any introductions be considered. Discussions with resource managers indicated that elk are migrating from the east and will eventually establish within the park. Therefore any introductions are considered unnecessary at this time. Introductions of this species would likely result in habitat displacement of other ungulates currently within the park and may impact on the ecological balance of wildlife within park boundaries.

As discussed previously there is no site series ecosystem inventory available for the park. This lack of information severely limits an assessment of park wildlife habitat and vegetation resources. It is recommended that an inventory be conducted to improve the current wildlife habitat information base, and to identify rare and endangered wildlife and vegetation resources within the park.

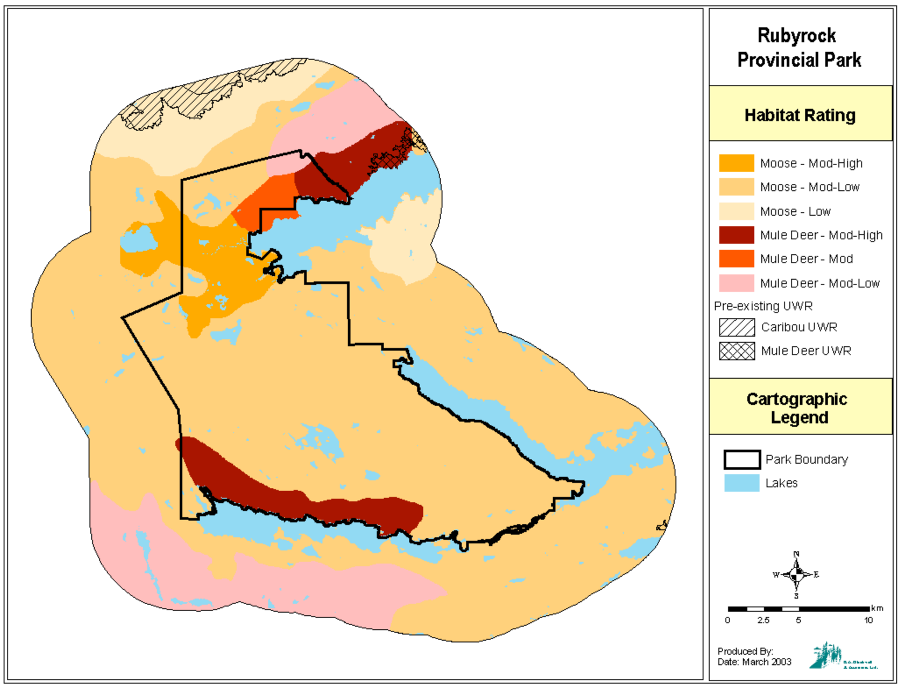

Figure 8. Wildlife habitat rating within and adjacent to Rubyrock Provincial Park.

Fisheries

Fisheries and lakeshore management is one of the key resource management areas identified in the Fort St. James LRMP (1999). The major objectives identified in the Ft. St. James LRMP for fisheries management are summarized as follows:

The management intent of this LRMP is to maintain the natural physical and biological diversity and abundance of fish populations and aquatic habitats across the planning area. The LRMP supports effective management of riparian areas, especially adjacent to fisheries sensitive zones. The plan also supports enhancing fish habitats and populations where appropriate, and where opportunities exist.

Relevant LRMP management objectives include:

The Stuart Lake system is an extremely valuable spawning ground for the Stuart Sockeye run and its protection is critical to this important fishery within the Fraser River system. The park also includes numerous lakes and streams that are important for a wide range of fish species. These are identified in Figure 9. All available fisheries information available for these systems is summarized in Table 4

Objective — Use conservation and enforcement activities effectively to manage fish and fish habitat.

- Conduct fish and fish habitat inventories to identify fish populations and fisheries habitat that require protection and specific management actions.

Objective — Conserve valuable aquatic habitat.

- Identify valuable fish habitats, including flood plains, off-channel sites, non-natal tributaries, spawning habitats, and other areas of biological significance.
- Support projects to maintain (or enhance where appropriate) valuable fish habitats.

Objective — Maintain the viability of salmon populations and habitat.

Objective — Maintain populations of sensitive genetic fish stocks or fish species.

- Manage lake trout (char) populations in the plan area by:
  - inventorying shorelines to identify sensitive lake trout spawning habitats.

Specific Inventory information available for fisheries within the park are listed in Table 4.

Table 4. Fish distribution lists in Rubyrock Provincial Park.

Name	Reference #	Fish Species
Stuart Lake	EDI0373	Chinook Salmon Dolly Varden Kokanee Longnose Sucker Lake Trout Mountain Whitefish Peamouth Chub Rainbow Trout Sockeye Salmon
Nancut Creek	HQ1904	Prickly Sculpin Longnose Dace Mountain Whitefish Northern Pikeminnow (formerly N. Squawfish) Rainbow Trout Redside Shiner White Sucker
Cunningham Lake	BCLKS5835 & BCLKS5836	Burbot Kokanee Lake Trout Lake Whitefish Mountain Whitefish Northern Pikeminnow (formerly N. Squawfish) Peamouth Chub Pygmy Whitefish Rainbow Trout

		Redside Shiner Unidentifiable Trout - only fry <70mm in length
Rubyrock Creek	EDI0345	Rainbow Trout
Rubyrock Lake	BCLKS5838 & EDI0345	Rainbow Trout Longnose Sucker
Butterfield Creek	EDI0133 & EDI0225 & 291-27	Rainbow Trout Unidentifiable Trout - only fry <70mm in length
Fleming Creek	HQ1517 & HQ0864 & 291-27 & EW203	Rainbow Trout Lake Chub Sockeye Salmon Prickly Sculpin Burbot
Paula Creek	HQ1023 & EW203 & 291-27 & 291-3	Dolly Varden Kokanee Rainbow Trout Sockeye Salmon
Sidney Creek	EW203 & 291-27 & 291-3	Kokanee Rainbow Trout Sockeye Salmon

The management objectives related to fisheries within the park should be focused on the maintenance of the forested riparian zones along all fish bearing creeks and tributaries and at the outlets to each of the lakes (Figure 9). Maintenance of these zones will limit fluctuations in stream temperature, provide large organic debris important to stream morphology and integrity, and stabilize stream channel banks limiting inputs of undesirable sediments and debris. The following are recommended management guidelines that should be followed to protect these important riparian zones. They include:

- Map and classify all fish bearing streams within the park identifying riparian management zones to the standard of the BC Forest Practices Code.
- Limit the use of falling and burning within identified riparian management zones. Where treatments are deemed absolutely necessary use MSMA as an alternative to fall and burn to maintain snags and input of CWD.
- Consider falling and burning when human safety concern has been identified.

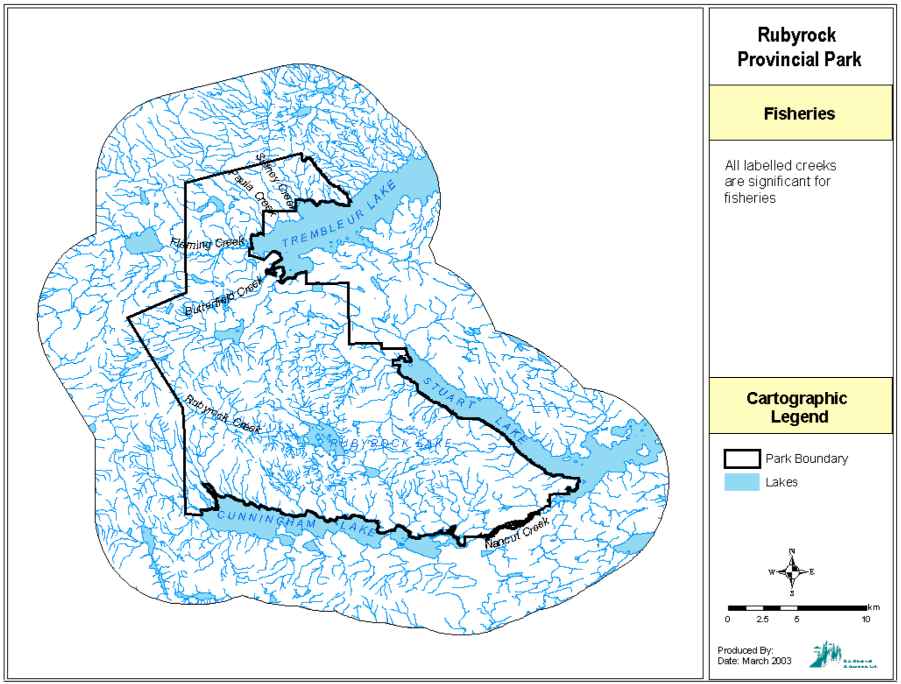

Figure 9. Fish bearing creeks and tributaries in Rubyrock Provincial Park.

FIRE

Recent Fire History

The Ministry of Forests fire reporting system was used to compile a database of fires back to 1950. The average number of fires per year by decade is as follows: 1950-59 – 0.2; 1960-69 – 0.1; 1970-79 – 0.2; 1980-89 – 0.4; 1990-1999 – 0.3. The most significant fire year in recent history was 1992 when a total of 3 lightning fires were reported for the park. Recent fires in the park have not significantly impacted the current forest and ecological integrity of the park.

Table 5 summarizes fires that have occurred between 1950 and 2002 in the park by size class and cause (lightning and human caused). The total number of fires during this period was 12, of which 10 (83%) were the result of lightning ignitions. The remaining 2 (17%) of fire ignitions were human caused. Almost all fires that burned between 1950-2002 were smaller than 4 ha. The largest fire within the park since 1950 occurred in 1953, starting in the southeast corner of the park and burning an area of 138 ha. The cause was non-compliance open burning. There is one other noteworthy fire. This one occurred in 1955 and started just outside the southeast corner of the park, burning 340 ha. The cause was undetermined.

Table 6 summarizes fire cause by decade and provides some interesting insight into the nature of fire within the park. The total number of fires by decade has remained constant. Compared to other parks the numbers of fires within Rubyrock have been very low and have for the most part been inconsequential with the exception of the 1953 fire. Figure 10 shows the distribution of fires across the landscape within and adjacent to the park.

Table 5. Fire history summary for Rubyrock Provincial Park from 1950 - 2002.

Size Class (ha)	Total Number of Fires	% of Total	Lightning Caused	Human Caused
<1.0	10	83	9	1
1.0-4.0	1	8.5	1	
>4.0	1	8.5		1
	12	100%	10	2

Table 6. Summary of fire cause in Rubyrock Provincial Park

Decade	Lightning	Human	Total
1950-1959	1	1	2
1960-1969	1		1
1970-1979	2		2
1980-1989	3	1	4
1990-1999	3		3
Total All Years	10	2	12

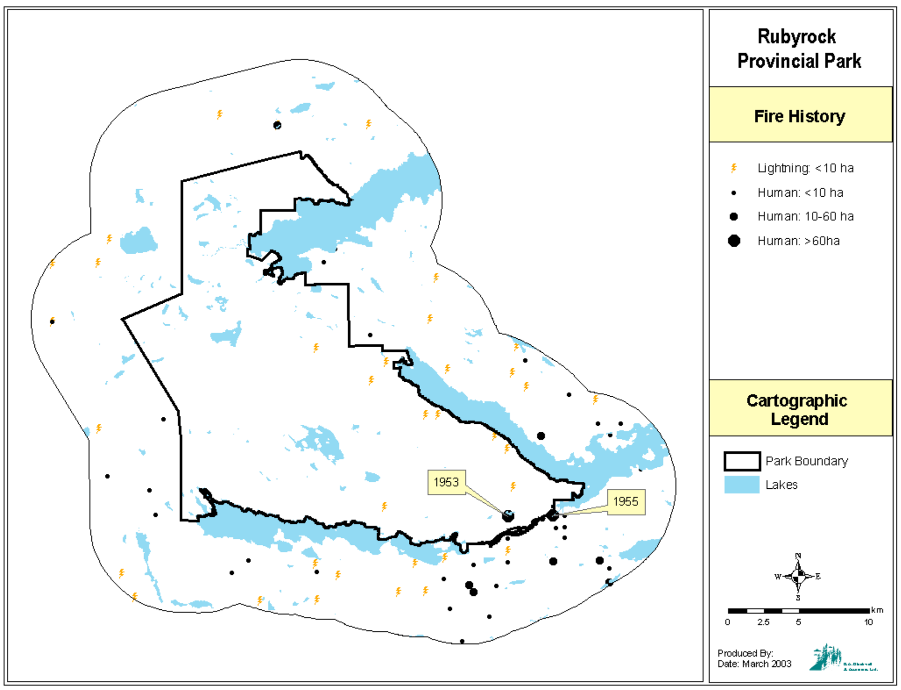

Figure 10. Distribution of fires within and adjacent to Rubyrock Provincial Park.

Development of Forest Fire Hazard Ratings

Topographical and biological data generated from the TRIM and forest cover databases were used to develop the forest fire hazard ratings for the Park (Table 7 and 8). This forest fire hazard rating system was designed to provide a framework from which to begin understanding the nature and relationships of the forest fuel complex, and provides a basis for developing forest fire management strategies.

Table 7. Terrain/Biological Variables used for Fire Hazard Assessment and Modeling in Rubyrock.

	Variable	Scale	Weight
Topography	Slope (average percent)	< 10	2
		10 - 20	3
		20 - 40	4
		40 - 60	5
		.> 60	6
	Aspect	301^{0} – 65^{0} (N)	2
		66^{0} – 110^{0} (E)	2
		111^{0} – 150^{0} (SE)	4
		151^{0} – 240^{0} (S)	5
		241^{0} – 300^{0} (W)	4
		Levels - flat	3
	Elevation	< 300m	5
		300 – 600m	4
		600 – 900m	3
		> 900m	3
Biological	Biogeoclimatic subzone	SBSdw	6
		SBS dw3	6
		SBS mc2	5
		SBS wk3	4
		ESSF mc	3
		ESSF mv1	2
		ESSFmv3	2
	Successional Stage	Pioneer stage (1) 0-20 years old	2
		Pole sapling forest (2) 20 - 40 years old	8
		Young seral forest (3,4) 40 - 80 years old	6
		Mature seral forest(5-7) 80 – 150 years old	4
		Old growth (8.9) > 150 years old	3
	Species Composition	Pinus contorta (PL), Pseudotsuga menziesii (Fd) > 60%	6
		Abies lasiocarpa (BL and B), Picea engelmannii (S), Picea glauca (SW) > 60%	4
		40 - 60 % Deciduous (AC, AT, EP) and Picea mariana (SB)	3
		> 60% Deciduous (AC, AT, EP) and Picea mariana (SB)	1
	Crown Closure	0	0
		1 – 35%	1
		36 – 45%	2
		46 – 55%	3
		56 – 65%	5
		66 – 80%	6
		> 80%	10

Table 8. Fire Hazard Rating Score Ranges for Stands in Rubyrock

Hazard Class	Score Range
Low	0 - 24
Moderate	25 - 30
High	31 - 40
Extreme	>40

Rankings for topographical variables are based on the effects of fire spread for slope and the climatic influence of aspect. Rankings for biogeoclimatic subzones are related to historical fire evidence found in the literature and other studies. Successional stage, species composition, and crown closure class are all stand level variables that describe the fuel complex. The divisions for biogeoclimatic subzones were arbitrary as no other information was available.

The fire hazard rating class for a given polygon was based on the sum total of individual variable rankings, and is summarized for the park in the fire hazard map (Figure 9). The hazard code represents individual stand susceptibility to fire on a landscape level, relative to other polygons. The algorithm used to generate hazard was modified from the Mount Robson Ecosystem Management Plan (B.A. Blackwell & Associates *et al*., 1996).

Present Forest Fire Hazard

The forest fire hazard map (Figure 11) is a graphical representation of landscape-level fire hazard within the park. The purpose of this hazard map is to provide a basis for presuppression planning, fire control, and as a decision-making aid for prescribe fire planning. The hazard map is a spatial representation of the relative variation of fire hazard in the park and attempts to provide a framework for assessment of forest fire hazard. It is provided strictly for managers for risk assessment of prescribed fires, natural wildfires, and fire suppression resource requirements. The hazard assessment is not directly related to diversity and wildlife objectives although inferences about fire effects can be determined from this map. The rating scheme makes relative comparisons between stand types.

Almost two thirds of the park is classified as low fire hazard (> 25,000 ha). In most cases low ratings correspond with wetlands adjacent to streams, rivers, lakes, and forest stands dominated by deciduous tree species. It should be noted that prior to leafing out, aspen stands are susceptible to early spring fires in this region of the province. A third of the park is classified as moderate fire hazard. These areas correspond to coniferous stands within the SBS zone with high crown closure. Only 6% of the park has a high fire hazard rating. These are mainly scattered patches of young lodgepole pine and Douglas-fir stands with very high crown closure (>80%). Past studies have shown high hazard areas correspond well with similar stand types that have been affected by similar disturbance events (eg. blow down, root rot, or historic fire). Field visits carried out in 2002 verified similarities in stand attributes between high hazard polygons. There are no stands within the park rated as extreme fire hazard.

Fire detection and control capabilities are quite limited in Rubyrock Provincial Park given the large park area and very limited access routes. Susceptibility to human caused fires is considered low due to limited access and vegetation composition.

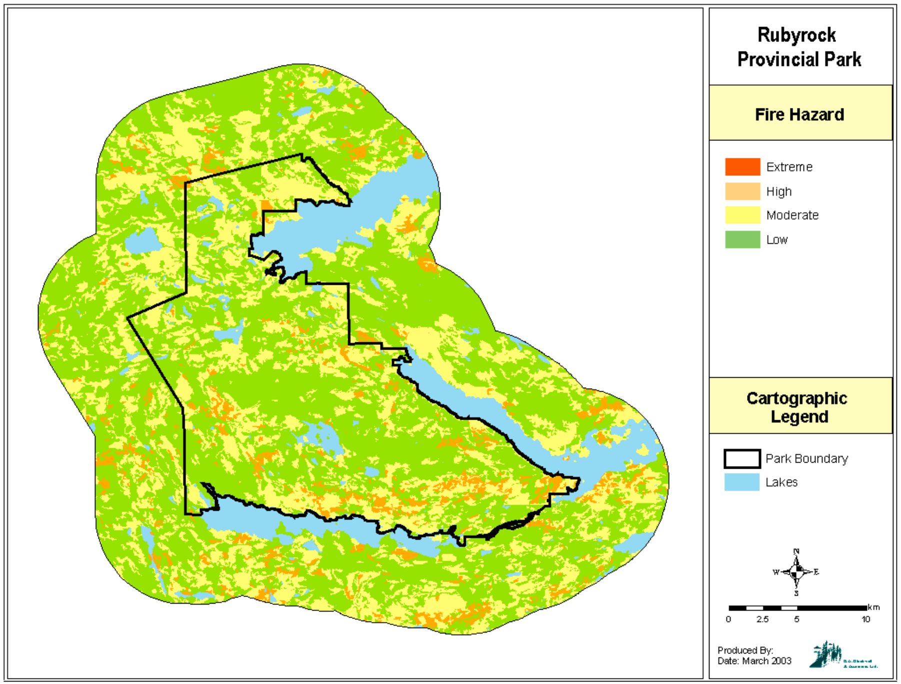

Figure 11. Fire hazard rating within and adjacent to Rubyrock Provincial Park.

The Estimated Fire Cycle

Given the size of the park and adjacency concerns the reintroduction of fire should be based on only prescribed fire, which attempts to mimic natural fire cycles of the past. Prescribed fires, which meet specific prescription criteria, should be used to remove fuel loadings (eg. blowdown or dead beetle killed trees) and improve regeneration conditions. The fire cycle is an estimate of the amount of time required to burn over an area equal to the entire forested area being managed. This may not mean all stands burn as some stands may burn more than once during the fire cycle. Fire cycle estimates provide an indication of the timing and probability of fire related disturbance occurring within a certain ecosystem based on historical fire evidence, fire behavior, and successional pathways.

An approximation of the fire cycle operating within this region can only be determined by a review of the species compositions, age and distributions, and inferred from the biogeoclimatic zones and other studies. Andison (1996) studying the Sub-Boreal Zone suggested that wildfire in the past was probably the single most significant force driving stand dynamics in this ecosystem. He suggested that the majority of wildfires would on average be small (50 to 500 ha), however occasional fires could be as large as 15,000 ha. From this work Andison (1996) concluded that under natural conditions (ie. no suppression) the age class distribution would fit a negative exponential curve. This means that a large number of young stands would be expected, with fewer mid-age stands, and very few old growth stands. A review of the age-class distribution in Rubyrock indicates that the majority of the area is dominated by mature forests (>80years old). These areas have helped to provide some balance to the age class distribution and will provide recruitment areas for old forest in the future.

To aid in the selection and planning of species and ecosystem fire regimes, Heinselman (1978) described six fire regimes based on an analysis of the literature on fire history of northern ecosystems. These are:

0 = No natural fire (or very little)
1 = Infrequent light surface fires (more than 25-year return intervals).
2 = Frequent light surface fires (1- to 25 year return intervals).
3 = Infrequent, severe surface fires (more than 25-year return intervals).
4 = Short return interval crown fires and severe surface fires in combination (25-100 year return intervals).
5 = Long return interval crown fires and severe surface fires in combination (100- year to 300-year return intervals).
6 = Very long return interval crown fires and severe surface fires in combination (over 300-year fire return intervals).

A fire cycle of 50-150 years (Heinselman Regime 4) is appropriate for the lodgepole pine and spruce forests of SBS zone. Within the ESSF zone of the park fire regime 5 best approximates the fire cycle. This is a conservative estimate based on studies reviewed in the literature and the work of Andison (1996), Parminter (1993), and Parminter (1992).

Fire Weather

Fire weather data was obtained from Augier Lake (station 1311) and Leo Creek (station 1315) climate stations located in the vicinity of the park. The weather record for the station is short, 1984 to present. The daily historical record of 13:00 temperature, precipitation, relative humidity, wind speed and all Canadian Fire Weather Codes and Indices were obtained. The digital file for the station was imported into an Excel spreadsheet where variables could be summarized by month and year. The total number of days in which recorded fire weather conditions would promote ignition and spread of fires in the spruce/abies fuel type were compiled by month (June, July, August and September). The fire weather conditions for this analysis were defined as:

1. Fine fuel moisture code (FFMC) $\geq$ 88
2. Duff moisture code (DMC) $\geq$ 40
3. Drought code (DC) $\geq$ 250
4. Initial Spread index (ISI) = 8

Summary graphs were also produced for the number of days, by year that the DC was > 500 and for the average August maximum and mean DC by year (see Figures 12,13,14).

Some general observations from the summary include:

- Within the last few years a limited number of periods where the mean and maximum drought code exceed 500
- Burning windows vary considerably between 0 to 10 days in any given year. In a number of years there are no good opportunities between May and October
- Not every year provides a burning window within the prescription criteria outlined above.

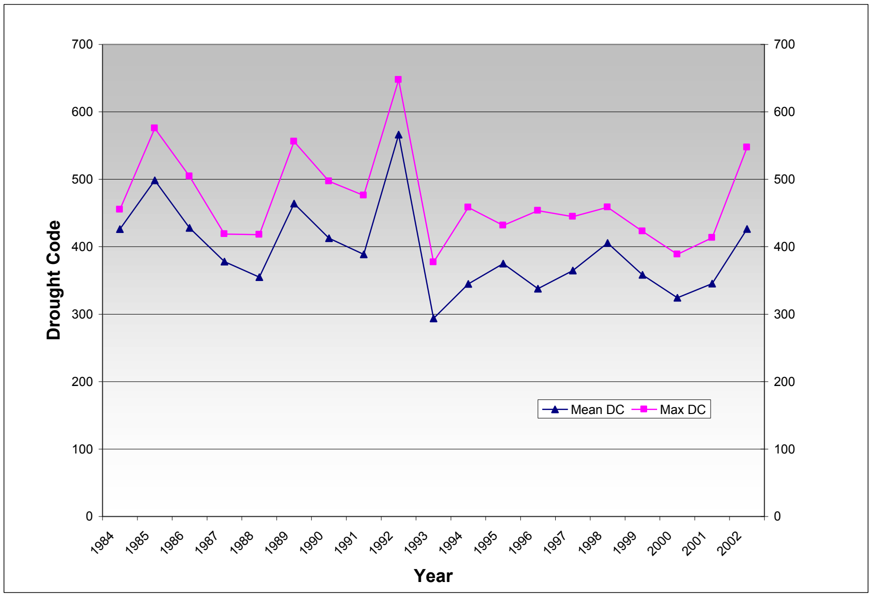

Figure 1. **Figure 12.** Mean and maximum August drought codes for Augier Lake stn 1311 and Leo Creek stn 1315.

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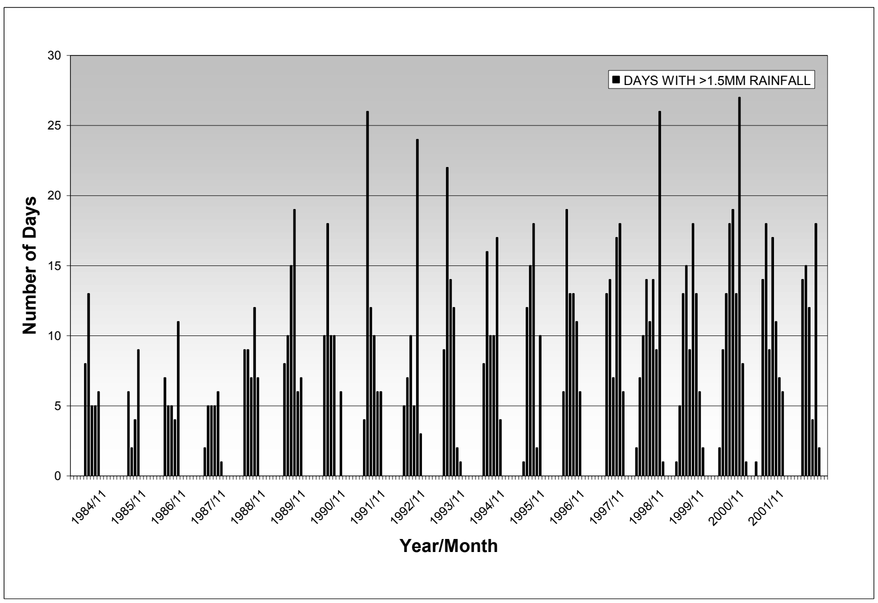

Figure 13. Number of days/month with rainfall >1.5mm for Augier Lake stn 1311 and Leo Creek stn 1315.

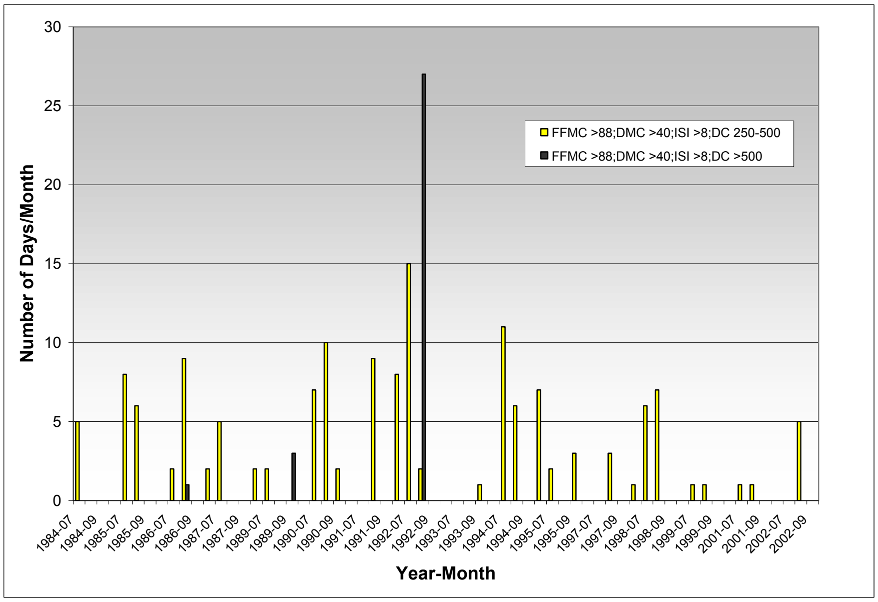

Figure 14. Number of days/month with high risk of significant ignition and rate of spread for Augier Lake stn 1311 and Leo Creek stn 1315.

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FOREST HEALTH

Mountain Pine Beetle Biology and Population Dynamics

The mountain pine beetle (IBM)(*Dendroctonus ponderosae* Hopkins) is a significant pest of pine in Rubyrock. While this insect poses a significant threat to timber values in industrial forestlands, it is a natural part of the ecosystem and does not usually require management in parks or protected areas unless park management objectives or key ecosystems are threatened by uncontrolled beetle infestations.

The mountain pine beetle, a native pest, is the most serious insect of mature pines in western Canada (Unger 1993). Mountain pine beetle is an extremely aggressive bark beetle attacking and killing older age, live lodgepole pine trees (Pl). In British Columbia, major outbreaks occur in all areas with a significant pine component, except for the northern quarter of the province (Unger 1993). The mountain pine beetle is distributed throughout British Columbia north to 56^{o} latitude (Unger 1993).

The IBM attacks all native and introduced species of pine (Furniss and Carolin 1980). Living, large-diameter, mature seral and old seral lodgepole pine (*Pinus contorta* var. *latifolia* Engelm.) are preferred by the IBM. However, they will also attack western white (*P. monticola* Dougl.), whitebark (*P. albicaulis* Engelm.) and ponderosa (*P. ponderosa* Laws.) pines (Furniss and Carolin 1980). Adults initiate attack early in July, depending upon weather conditions, and flight continues until late August. Females initiate attack on suitable hosts in response to visual cues and host odours (primary attraction), and begin emitting species-specific aggregation pheromones. These chemicals attract other females and males, initiating mass-attack and allowing attacking beetles to overcome the natural resistance of the host tree. After mating, egg galleries are constructed beneath the bark, and adults introduce a pathogenic blue-stain fungus.

Trees are killed as the flow of food and water in the phloem is disrupted by feeding larvae and fungal growth in the vascular tissues (Furniss and Carolin 1980). Beetles usually overwinter as larvae, and the life cycle is typically completed within one year (Anonymous 1995).

Epidemic infestations of the IBM have been recorded since the turn of the century with the first attempts at control occurring in the 1920's (Richmond 1986). Across the province, the last major epidemic (1979-1986) resulted in almost 200 million dead trees with a peak of 80 million pines over 460,000 hectares in 1983 (Forestry Canada 1992). In the 2000 alone, the outbreak in the Prince George region affected 66,439 ha in 2000.

In most years, populations of the IBM remain at low, endemic levels. They breed in individual or small groups of pines stressed by climatic extremes, diseases, activities of other bark beetles and/or small, low-intensity fires (Amman and Cole 1983; Young 1988). Epidemics occur when sufficient numbers of stressed trees result in the emergence of a large population of beetles in one year. Large numbers of beetles can attack large diameter, mature seral lodgepole pines, killing them within one year of attack. Localized outbreaks in stands generally last from four to eighteen years (Safranyik et al 1974), ending when host material is exhausted or climatic extremes result in high mortality of brood (Amman and Cole 1983). Epidemics at the landscape or regional level may last thirty years or more since outbreaks in stands are not necessarily synchronous (Schmid and Amman 1992).

Development of Mountain Pine Beetle Hazard Ratings

The susceptibility of lodgepole pine to mountain pine beetle (IBM) has been well characterized by Shore and Safranyik (1992). Their hazard rating system is a stand-based analysis of tree form, elevation and stand density. The system was intended for use in specific stands when complete cruise type data are available to describe the stand characteristics. As a decision making tool, the hazards can be interpreted as an estimate of the percentage of trees that could be killed during a bark beetle outbreak. The reliability of the mortality estimation is directly related to the accuracy of the data used to describe the stands.

The IBM hazard, or the percentage of stands that could be killed during an outbreak, is based on how suitable the trees are for attacking beetles and how well the beetles will do once they colonize the stand. As such, the predicted mortality estimate is a function of the number of susceptible lodgepole pine trees and the number of beetles that could be produced within a stand. The hazard rating data for Rubyrock Provincial Park was obtained from the Ministry of Forests in Prince George in 2001.

Mountain Pine Beetle Hazard Assessment

The IBM hazard map of Rubyrock and surrounding forestland is presented in Figure 15. There is no hazard rating available for any of the area in white. The IBM hazard algorithm should to be re-run to calculate hazard for these missing polygons. A large amount of area in the park has been rated as having no susceptibility. This is due to species composition. These stands have little or no lodgepole pine. In the central portion of the park where there are numerous pine dominated stands there is a significant amount of area rated as moderate hazard. This area represents the most vulnerable portion of the park susceptible to attack. Within Rubyrock the total area of moderate to high hazard is just under 4000 ha which represents approximately 10% of the park area. Given that pine is the dominant species over approximated 8000 ha of the park, this indicates that about half of the inventory of lodgepole pine is currently susceptible to IBM attack.

It would be prudent to continue to monitor for the occurrence of this pest in conjunction with adjacent stakeholders, especially in high-risk areas.

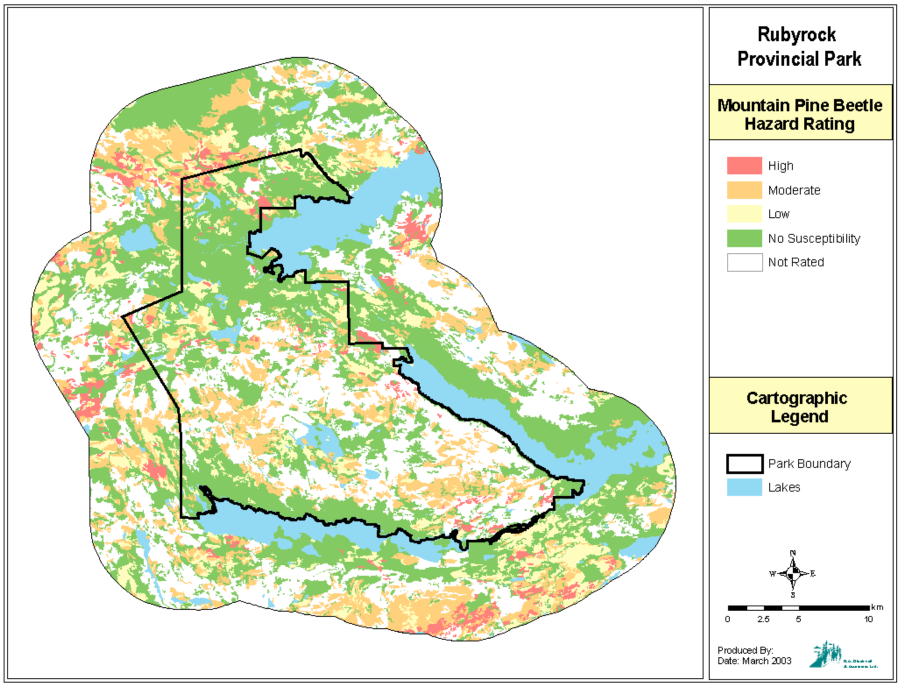

Figure 15. Mountain Pine Beetle Hazard within and adjacent to Rubyrock Provincial Park (data source: Prince George MOF).

Current Mountain Pine Beetle Incidence

Mountain pine beetle incidence in 2001 and 2002 is scattered throughout the park and in adjacent areas along all boundaries (Figures 16 and 17). Incidence records were obtained from the Ministry of Forest aerial overview data available on their ftp site (ftp.for.gov.bc.ca /Branches /ForestPractices /External /publish /AerialOverview).

During the field visit in the fall of 2002 there were many areas of IBM incidence noted which do not show on either the 2001 or 2002 incidence maps. These areas were mainly in the central portion of the park where there are many pine dominated stands. Figure 18 shows a stand attacked by mountain pine beetle in Rubyrock Provincial Park.

The current survey results are indicative of increasing beetle populations that have expanded both within and adjacent to park during the past five to six years.

Mountain Pine Beetle Management and Treatment

Given the current hazard, and the incidence of beetles which have heavily attacked significant areas of pine both within and adjacent to the park, fall and burn treatments are no longer considered effective in limiting IBM damage and may in fact be negatively impacting the protected area.

Falling and burning on a small scale has a limited impact on the conservation goals of BC Parks. However when these treatments are conducted over larger scale areas they have the potential to alter stand structure through removal of standing snags, reducing inputs of coarse woody debris, and through creation of numerous gaps that are not part of the normal succession pathway within these stands. At a large scale fall and burn treatments can influence fuel dynamics and resultant fire severity which may be undesirable within a protected area. Figure 19 represents a schematic that compares natural stand dynamics to those following extensive fall and burn treatments.

Given the current incidence levels and the potential negative impacts of extensive falling and burning "Monitor" and "Abandon" are the recommended strategies for the protected area. Specific treatments may be applied in areas of human safety concerns and for mitigation of damage and loss in campgrounds and high-use areas. Any management activities aimed at controlling the beetle will only "buy time" to reduce short-term negative effects on Park management objectives. Current beetle populations are at a level where they can no longer be controlled (except in very limited areas) with the use of single-tree or patch treatments.

In the long-term prescribed fire may provide an alternative treatment but should be considered only if the IBM causes extensive mortality over a large area (>1000 ha). Prescribed fire may help to break up the susceptibility of pine stands in the protected area, and may also help to reduce the risk of larger-scale fires. Prescribed fire should be used cautiously, however, and should first be integrated into ecosystem and fire management plans when they are completed. The use of prescribed fire should not be viewed as a method to stop or significantly reduce current beetle attack levels but rather as a method to reduce and buffer the landscape susceptibility of future large-scale disturbances.

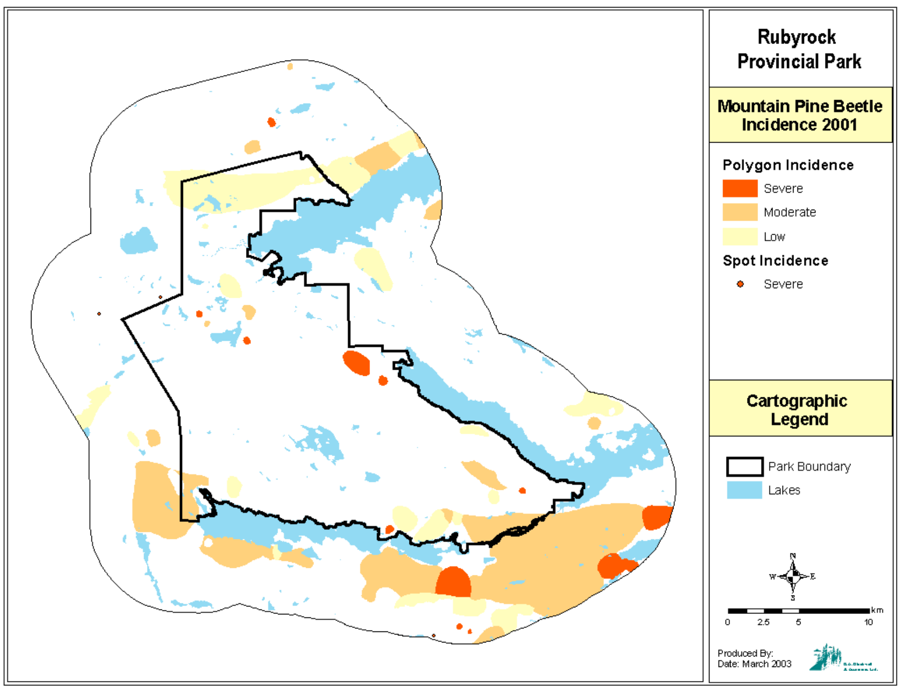

Figure 16. Incidence of IBM attack in Rubyrock Provincial Park (based on 2001 survey).

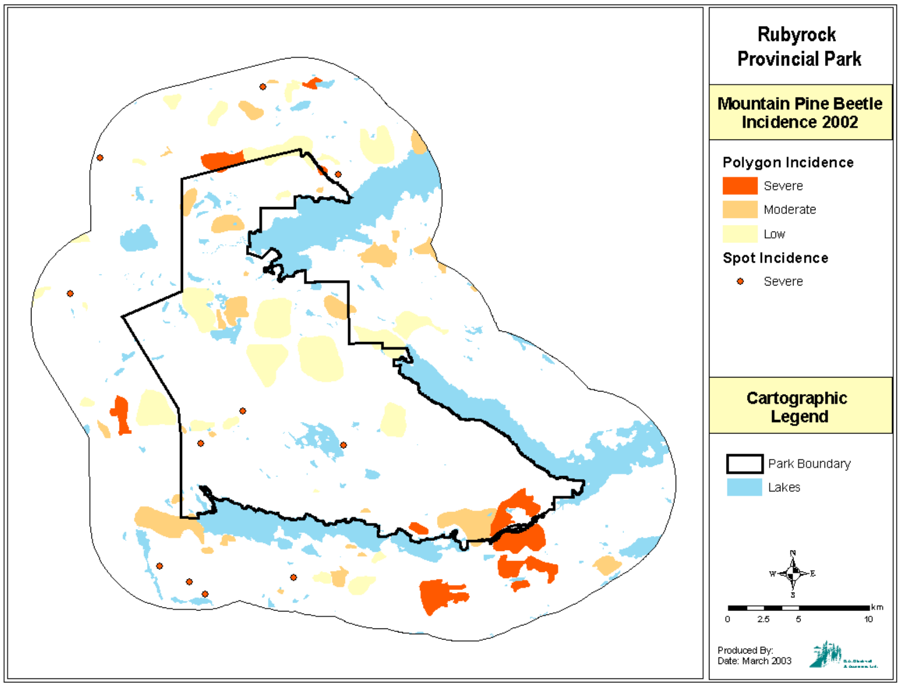

Figure 17. Incidence of IBM attack in Rubyrock Provincial Park (based on 2002 survey).

Figure 18. Example of IBM attack in Rubyrock Provincial Park.

Relationship between Mountain Pine Beetle and Fire

The intimate relationship and critical role that bark beetles and fire play in natural succession of lodgepole pine forests has been well documented. These forests, which occupy millions of hectares in the B.C. Interior, are generally even aged stands younger than 120 years old. This is a result of periodic wildfires which follow high mortality from bark beetle attacks (Fellin 1979; Mitchell and Martin 1980; Koch 1996; Price 1991; Schowalter et al. 1981) These forests have adapted to these natural rotations, which tend to repeat every 120 years. Recent examples illustrating this cycle including the 1988 wildfires in Yellowstone Park, the 1961 wildfire in the Bitterroot National Forest in Montana, and fires in Washington and Idaho in 1994.

Mountain pine beetle outbreaks occur mainly in mature forests, which are 80-150 years old. These outbreaks subside when most of the large diameter trees are killed. The dead trees from these outbreaks then fuel subsequent fires that regenerate the stand (Amman 1990; Fellin 1979; Geiszler et al. 1980; Price 1991). It has been hypothesized that these two agents of disturbance interact to maintain the structure and function of pine forests. Fire regulates forest regeneration in space and time, which is necessary for the pine beetle, and the pine beetle regulates the turnover of patches of dead trees conducive to burning (Schowalter et al. 1981).

In the past, agents of disturbance were viewed as a threat to the health of the valuable forest resource. Therefore standard policy has been to suppress all wildfire and eliminate forest pests. In pine forests this has resulted in unstable forests, which are increasingly susceptible to physical and biological stresses.

Managing forests by mimicking natural disturbances has become widely accepted. Prescribed fire is a management tool that mimics the ecological process, which has historically shaped these forests. Fire can kill forest pests or alter their habitat depending on the fire behavior and on the fuel characteristics.

There has been mixed success using prescribed fire to control bark beetles. A heavily infected 25 ha Pl stand was clearcut and burned in British Columbia. It was found that mortality was 100% in burned plots but 0% in unburned plots. As a result of the fire there was a heavy IBM outbreak in standing timber along the fire boundaries (Stock and Gorley 1989).

It has been suggested that fire may weaken trees and therefore predispose them to beetle infestation (Fellin 1979). Surveys in Yellowstone National Park show that insect infestation was strongly and positively correlated with the percent of the basal circumference of the tree that was killed by fire (Rasmussen et al. 1996). As a result it is likely that infestations will increase in the greater Yellowstone area. In Oregon, Gara et al. (1984) found that adult IBM landed on lodgepole pine with fire scars and decay in preference to non-decayed and unscarred trees. Following surface fires in stands of climax Pl in southern Oregon in 1980 and 1982, a high proportion of unscorched and lightly fire damaged trees were attacked by IBM (Geiszler et al. 1984). Additionally, fires may also destroy habitats for natural enemies of the bark beetle such as the woodpecker (Fellin 1979). These findings suggest that using prescribed fire to eliminate the IBM may result in increasing the stand susceptibility to future outbreaks.

Other observations show that prescribed fire could be used to decrease stand density. This would increase tree vigor and as a result reduce the severity of IBM attacks. It has been found that thinning ponderosa pine stands to below $46m^2$/ha significantly reduces the likelihood of western pine beetle infestation (Dahlsten and Rowney 1983). There has been contradictory evidence that suggests the lodgepole pine infested at the beginning of an outbreak are the largest most vigorous trees in the stand as they have the thickest phloem and produce the largest beetle broads (Amman 1978). According to this research, thinning a stand would actually encourage outbreaks rather then prevent them.

Historically attempts to stop insect outbreaks have been unsuccessful and expensive. An epidemic of IBM in Crater Lake National Park, Oregon in the early 1900’s led to the first large-scale project to control the outbreak. Efforts including burning felled trees and exposing infested logs to solar radiation, which started in 1925 and continued until 1934. The decline of the outbreak was attributed not so much to control efforts but to the cold winter in 1932 and 1933 and the depletion of susceptible host trees (Wickman 1990). In B.C., significant efforts were made to control Mountain Pine Beetle in E.C. Manning Provincial Park. Since 1978, significant resources have been allocated by the B.C. Ministry of Forests and B.C. Parks in efforts to reduce IBM losses in the park and to prevent the spread to adjacent areas. The latest control efforts were conducted in 1995, and mountain pine beetle populations have continued to increase, leading to severe mortality along the eastern highway corridor. The management efforts and expenditures in Manning highlight the fact that small-scale control through bait and burn or fall and burn programs are only considered as stopgap measures. These types of treatments really only work if they are combined with more aggressive intervention.

The risk of wildfires and insect outbreaks are more easily reduced in commercial forests through intensive silviculture such as precommercial and commercial thinning, and clear cut harvesting before the stand becomes over mature (Koch 1996). As well, salvage harvesting of infested stands and felling and burning techniques allows managers to control IBM populations (Schmid and Parker 1990). These types of measures are neither feasible nor appropriate in parks and reserves. Within B.C. Parks the only real treatment option for landscape scale beetle outbreaks is prescribed fire.

Ecological Restoration and Fire

Many of the ecosystems within the park depend on fire for maintenance of ecosystem structure and function. In the absence of fire (fire exclusion) ecosystem function and structure are altered. In surface and mixed severity fire regimes where the fire return interval ranges from 20-150 years exclusion of fire can result in negative impacts such as reduced productivity and forage availability, increased fuel accumulations and fire hazard, and susceptibility to forest insects and disease.

Within Rubyrock fire exclusion has the potential to negatively impact the warm Douglas-fir ecosystems on south aspect slopes of Cunningham Lake and the open grassland communities on the northwest side of Cunningham Lake and to the southwest of Trembleur Lake. The first stages of fire exclusion can be described as encroachment (where tree cover encroaches into the grasslands) and ingrowth (understory trees create increased stand density and canopy continuity). Brief field visits to these areas suggested that they are fire-dominated ecosystems, however improved fire history information is required to better understand the relationship between fire and these vegetation communities. It is suspected fire exclusion has begun to impact these ecosystems and some form of ecological restoration may be required. It is recommended that further study of this issue be carried out to determine:

- the fire return interval in these ecosystems,
- if fire exclusion has lead to either ingrowth and or encroachment,
- what rehabilitation techniques can be applied within these vegetation communities.