EXTERNAL THREATS ASSESSMENT

MOUNT REVELSTOKE AND GLACIER
NATIONAL PARKS
1992 - 1994

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Mount Revelstoke and Glacier
National Parks
Executive Summary

Since 1960, Mount Revelstoke and Glacier National Parks have experienced considerable changes both internally and externally. The construction of the Trans-Canada Highway, completed in 1962, changed the internal structure and operations of both parks from a wilderness park operation to one of considerable visitor use.

During the 1970's and 1980's an increase in demand for wood products in the forest industry, combined with a shortage of timber supply in the lower valley areas of the Columbia River drainages, resulted in timber harvesting into areas adjacent to national park boundaries. This, in turn, created a greater ease of access to the national park boundaries mainly due to established logging roads.

The purpose of this assessment was to determine exactly what are the external threats to the present and future of these two national parks. External threats in this assessment are defined as any threat to the park that is unnatural to the park environment. In addition, recommendations were to be provided for management action or to assist in the decision making process.

There were a considerable number of external threats identified using various sources of information; university library research, questionnaires, discussions and interviews with other government agencies, recreational activity operators, business operators, academic professionals and private individuals, on-site inspections, sample analysis and other literature review.

The relatively new term "Biocultural Diveristy" was a consideration in this assessment. "Cultural diversity and biological diversity need to be conserved together if either is to prosper, the local knowledge that people have about their resources and how they should be managed provides a critical resource for all of humanity" - McNeely J., Nature and Culture: Conservation needs them both; 1992.

Generally, the threats identified were due to activities in areas adjacent to the park boundaries; fragmentation of wildlife habitat due to timber harvesting, helicopter skiing, helicopter hiking, hunting, trapping, mining, snowmobiling, and the establishment of huts and lodges. The TCH and the CP Railway create an impact because of the influx of highway traffic and railway locomotives causing various forms of pollution including fumes, noise, spillage of toxic chemicals and mortality of wildlife.
Other types of external threats such as acid rain are also included in this assessment by using analysis of lake water samples to establish their TA (Total Alkalinity) and therefore natural resistance to the effects of acidification.

Progressive total alkalinity decline in these mountain parks could be expected to lead to distributional changes in vegetation and wildlife (T. Crowley, pers. comm.).

Recommendations are intended to suggest possible alternate methods of ecosystem management, to prevent or mitigate the effects of the external threats.

A quote from "Protected Areas of Western Canada", should be remembered and practiced by all of us as Canadian citizens who have control of land management:

We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect." - Aldo Leopold.
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1.0 INTRODUCTION

1.1 Problem Description

Mount Revelstoke and Glacier National Parks were predominantly wilderness until the Trans-Canada Highway was completed in 1962. The Canadian Pacific Railway, from 1886 to 1925, brought in tourists to the Glacier House hotel located approximately in the center of Glacier National Park, but these visitors used the area in the vicinity of Mt. Sir Donald, upper Illecillewaet and Asulkan valley peaks and glaciers for mountaineering. The Glacier House was dismantled in 1925 and visitors were no longer accommodated in the park until the TCH was completed. During that time, 1925-1962 Glacier National Park was considered relatively undisturbed wilderness except for the railway trains passing through the center of the park.

Mount Revelstoke National Park had somewhat more visitor use after 1927 when the road was completed to Balsam lake. The area of use, however, was mainly restricted to the summit of Mount Revelstoke and to the lakes; Eva, Millar and Jade. The rest of the park remained undisturbed wilderness.

After 1970, both parks began to experience pressures from outside influences such as forest timber harvesting which created access roads towards the park boundaries. The Revelstoke Hydro dam and the C.P. Rail Tunnel and Grade Reduction mega projects added to the external threats situation, (internal activities are regarded as external threats when the impact is from external sources), because of land manipulation and disturbance to wildlife.

In 1992, the Superintendent of Mount Revelstoke and Glacier national parks requested an assessment of external threats to the two parks to determine the extent of all the activities and developments occurring in adjacent areas. The reason for the assessment at this time was to assist in developing a strategic plan to preserve the very existence of the parks, prevent fragmentation of wildlife habitat and to gain cooperation with other agencies and private enterprise for ecosystem management.

The initial assessment identified many insignificant impacts. These were prioritized to concentrate on those impacts that could be controlled or mitigated.
A. Subalpine area in the Purcell Mountains. Bald Mountain ridge showing Purcell Lodge Adjacent to Glacier National Park boundary. Photograph by Mas Matsushita.
When the older national parks were conceived, (such as Mount Revelstoke and Glacier) the main objective and selection was for aesthetic reasons and lacked the range of considerations such as appropriate size, ecologically sound boundaries, and habitat area necessary to maintain ecological integrity. This problem was also expressed by various other sources (Newmark, W.D. 1985, and discussion with UBC Dept. of Forest Sciences 1992).

With this in mind, one can understand that most national parks are now facing a considerable potential for external threats to their existence.

An attempt was made to identify ecosite and ecosection boundaries in trans-boundary zones (combining park and provincial areas). This, however, was not possible because the provincial habitat mapping did not correlate with the national park ecological land classification system for Mount Revelstoke and Glacier national parks. Also, the lack of research information in the area surrounding the two national parks at this time does not allow for even an estimate of the location of those transitions.

1.2 Discussion and Questions

1.2.1

Since most of the environmental effects to these two parks have occurred during the past twenty years, the cumulative result has been considerable. When one considers that before that time the region was predominantly wilderness and most wildlife species had not encountered the presence of humans, they had to either adapt or suffer pressured relocation to unfamiliar habitat.

From this perspective, it is important to consider whether these two parks in their present state can recover from such an accumulation of sudden detrimental impacts and can they maintain a condition of environmental sustainability.

When external threats are considered, the highway and railway corridors are included since they are a source of allowing pollution and other impacts to enter the park environment.

1.2.2

The following questions are addressed in the contents of this assessment:

1.2.2.1
What are the sections of these two parks most affected by the impacts?
1.2.2.2
What are the natural and/or cultural resources impacted?

1.2.2.3
With effective management, can these resources recover and maintain viability?

1.2.2.4
Will the poorly selected boundaries of Mount Revelstoke and Glacier national parks allow for adequate future wildlife habitat, without fragmentation, under cooperative management?
B. Clearcut logged areas north of Mount Revelstoke National Park.
Photograph by Mas Matsushita.
My thanks to those who provided individual information and/or assistance outside of the agencies listed above:

Dr. B. Lieff, Dr. P. Achuff, and D. Poll (Western Regional Office, C.P.S.)

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2.0 STUDY AREA

2.1 The area of study encompassed all of the adjacent areas surrounding the two parks and included cumulative impacts that may have originated at a greater distance from the parks, but have a direct or indirect effect on the two parks. Impacts within the two parks are also identified and regarded as external threats since they are not part of the natural environment and are caused by the highway or railway.

Glacier National Park, after 1930, has an area of 1,349 sq. km. Originally, in 1887, the park included only an area surrounding Rogers Pass and Glacier House.

Revelstoke National Park, in 1914, comprised an area of 246 sq. km. In 1915, this park was proclaimed Mount Revelstoke National Park and has remained the same area in size.

2.2 The Ecological Land Classification of Mount Revelstoke and Glacier National Parks, Vol. 1: Integrated Resource Description (Achuff, Holland, Coen and VanTighem 1984), provided an "integrated resource inventory of landform, soil, vegetation and wildlife information presented in both report and 1:50,000 map format". The system used the national guidelines for the ecological land classification divided from Ecoregions to Ecosections and then Ecosites.

For this assessment of external threats to the two parks, the information contained in the ELC was used to identify the fragile areas vulnerable to environmental impacts, in Section 5.1.

3.0 OBJECTIVES

3.1 The Objectives Of This Assessment Are Threefold:

3.1.1 The identification of the external threats to Mount Revelstoke and Glacier National Parks, and the natural and cultural resources affected. The biocultural diversity concept is the overall consideration.
3.1.2 Describe consequences if threats continue and/or increase without cooperative ecosystem management.

3.1.3 Provide recommended management actions and mitigative measures, and prioritized lists in order of urgency.

In many of the park boundary areas adjacent to high activity outside the parks, the fragility of the natural resources is such that even minimal impacts can destroy or change that ecosite environment. These areas are predominantly in the alpine and subalpine zones.

In the publication, "An assessment of some factors affecting Natural Values ---" (R. D. Muir, 1967); he stated that "Alpine meadows may be cited as the most fragile environment known. The soil is highly organic and very soft. In wet weather it is mushy and can be quickly turned into a thick "stew". Such soils depend on rather high water content to support their lush meadow flora. If these soils dry out through alteration of the water supply, the living plant cover usually dies. Erosion results."

4.0 PROCEDURES

4.1 Collection of Information

4.1.1 Biophysical Resource Inventory

To identify the natural resources which may be environmentally affected by external influences, the Ecological Land Classification of Mount Revelstoke and Glacier National Parks - Integrated Resource Description (Achuff, Holland, Coen and VanTighem - 1984), was used to identify and/or refresh knowledge of a particular area/section of the parks. The ecosites were each individually analyzed to determine which resources were sensitive or vulnerable to the effects of the identified detrimental impacts.

4.1.2 University Library Research

The search for past and present natural resource study information was conducted at the university and college libraries in B.C. and Alberta. The library search was done during the 1992-93 period, at the University of Calgary, University of Alberta, University of British Columbia, University of Victoria, Selkirk College, Castlegar and Nakusp, Okanagan University College, Kelowna and Salmon Arm, and Lethbridge Community College.
The information relevant and adjacent to the national park boundaries was reviewed and applied where appropriate in this assessment. Unfortunately, a limited amount of research has been conducted in the south-central region of B.C.

4.1.3 Aerial Photography

The existing air photos (1979, 1987) were analyzed to determine if there were old access roads or trails that may not have been known of by present residents. Any large disturbed areas (manmade or naturally eroded) were also recorded to be later investigated during on-site inspections.

4.1.4 Questionnaires

The University of British Columbia - Resource Management Section (Dr. H. Schreier, Dr. B. Thompson, A. Kliskey, L. Cooper), after consultations with Canadian Parks Service MRG, prepared and distributed questionnaires to recreational activity operators and participants in areas surrounding both these national parks. The questions were designed to determine the attitudes of people involved in the activities, in protecting the environment from detrimental impacts.

The results of these questionnaires were partially used to determine the extent of the potential external threat caused by each of those activities to the parks.

4.1.5 Discussions and Interviews

During the length of the assessment discussions and interviews were held with many individuals and groups (as listed in the acknowledgements section). There were differing opinions and ideas regarding the potential external threats, and valuable information was received. Most of the parties that were consulted were very cooperative and helpful in these discussions.

4.1.6 On-site Inspections

All of the trans-boundary sections and access points were investigated on-site using horses, helicopter or on foot depending on the accessibility of the area. The purpose of these inspections was to ground-proof information or assumptions and to observe first hand the fragility of some of the sites.
4.1.7
Sample Analysis

The sampling of air and water were the two resources that require direct analysis since neither had previously been studied completely in the potentially affected ecosites.

Air was to be sampled and analyzed for Nitrogen Oxide and Sulphur Dioxides from local in-park sources to determine the extent of effects which could in turn contribute to acidification of soils and water.

We (C.P.S.), took samples of lake water and these were taken for analysis to Dr. Crowley and J. Chadwick, (Okanagan University College) to determine the TA (Total Alkalinity) and therefore natural resistance to acidification. A representative sampling of eight lakes in the region of the Selkirk-Purcell area was conducted.

Results of this survey were also sent to Atmospheric Environment Services, Vancouver, who provided information on the upper air movements for this area which could transport acid deposition particulate effects.

4.1.8
Literature Review

Many documents and publications were reviewed from park files and in the C.P.S. Western Region libraries. A considerable amount of general information was collected in this review although few specific research studies relevant directly to this area (MRGNP) were located.

5.0 SUMMARY AND CONCLUSIONS

5.1
Park boundary section descriptions (Ecological Land Classification System - MRGNP, Achuff et al. 1984), by Ecossections using locations most subject to impact in that section. (Geology: Taylor; Geomorphology: Walker; Soils: Taylor, Walker and Allan; Vegetation: Achuff & Dudynsky; Wildlife: Gyug & VanTighem).

Glacier National Park:

5.1.1
Bald Mountain Ridge (Copperstain Pass to Caribou Peak)

The section of this part of the park boundary that would most likely be environmentally impacted is in the WR-JN-JD Ecossections. The lower forested BU Ecossections are also vulnerable to disturbance.
This landform is Till B, (non-calcareous and medium textured, slaty and schistose strata) blanket and veneer over inclined and ridged bedrock. Soil types are in the Gleysol, Brunisol/Podzol Orders which are moderately well drained and acidic. Vegetation types are Engleman Spruce – Subalpine Fir open forest combined with open herb meadow. This is considered an unusually low Alpine area (approx. 2200 m) which may be caused by the wind exposure. Also, perhaps due to the wind as a controlling factor, the Alpine in this Ecoregion may not receive significantly more precipitation than Alpine areas in the Rocky Mountains (Walker and Achuff, 1984).

Wildlife species include:

- Ungulates: moderate elk numbers for this area, and potentially important to caribou although little sign has been evident in recent years.
- Carnivores: moderately important to grizzly bear and short-tailed weasels.
- Small Mammals: high importance for Columbia ground squirrels, water voles and jumping mice.
- Breeding Birds: highly important for Water Pipit, raptors and White-tailed Ptarmigan.

Throughout this area, particularly in the lower sections, poor drainage from ground water discharge and seasonal seepage, create a fragile environment. It is sensitive if disturbed since a change to hydrological patterns may occur. In the higher sections erosion can result if vegetation is disturbed.

5.1.2 Caribou Peak to Silent Mountain

The section of potential impact here is in the JD-AK Ecossections. Landform is Till B, veneer over inclined and ridged bedrock, and 15 to 70% complex slopes. Non-calcareous, moderately well drained Brunisol/Podzols soils. Vegetation cover is Subalpine Fir/Mountain Hemlock open forest combined with heath tundra.

- Ungulates in the JD1 Ecosite: highly important to caribou in both winter and summer, and low to mule deer and mountain goat in summer. The HE3 Ecosite in the vicinity of Silent Mountain, however, is highly important winter range for goats.
- Carnivores: important to marten and lynx, and somewhat to weasels.
- Small Mammals: high importance to Columbian ground squirrels, Northern bog lemmings, and Richardson's water voles. Snowshoe hares occur moderately in this area.
- Breeding Birds: highly important to Ruby-crowned Kinglet and hunting ground for Red-tailed Hawks. Golden Eagles are also prominent searching for ground squirrels.

This section is generally highly important to wildlife and vegetation particularly in lower areas and mid slopes. It is sensitive to any disturbance or manipulation in adjacent areas.

5.1.3
Duncan-Beaver Watershed (Silent Mountain to Mt. Duncan)

This area is in the JD-BU-LK-CT-CF Ecossections and subject to ease of accessibility directly to the park boundary from the Duncan river valley. The landform is Till B, mainly blanket veneer over inclined bedrock. Slopes vary from valley bottom to 70% open slope. Soils are non-calcareous, medium textured, Gleysol/Brunisol/Podzols, with high water content but well drained. Main vegetation on slopes is Subalpine Fir/Mountain Hemlock open forest and heath tundra. Lower sections are a mixture of Englemann Spruce/Western Hemlock/Western Red Cedar. The BUI Ecosite has a distinctive accessory of lodgepole pine/false azalea/grouseberry (Achuff and Dudynsky, 1984).

- High importance to ungulates in the GF2 Ecosite for moose, elk and white-tailed deer but low importance to ungulates in the LK1 and BUI Ecosites.
- The lower slopes and valley bottom are highly important to carnivores: lynx, coyote, weasel and marten. Small Mammals: high to beaver, porcupine, snowshoe hare, red squirrel, red-backed vole and deer mouse.
- Breeding Birds: highly important to Pileated Woodpecker, Northern Pigmy Owl and Barred Owl in the CT5 Ecosite. High density of a variety of song birds throughout.

This area of the park boundary is vulnerable to environmental damage due to ease of access from the Duncan river valley.

5.1.4
South Boundary Section (Mount Duncan to Tomatin Peak)
This southern part of the park boundary is predominantly rock and ice in the R&GL-GL-T&M-RD Ecosites. The RD area landform is Colluvium B non- to weakly calcareous and course textured. The rest is Till A, B or C and has no soil development. Vegetation is heath tundra and patchy heather-everlasting, mountain avens, snow willow, moss campion and the heathers. The RD5 Ecosite is of high importance to mountain goats but of low importance to small mammals. Breeding Birds: not sampled.

Generally, due to the rugged terrain, snow and ice throughout this area, it is not subject to significant impact other than climatic and hydrological influences.

5.1.5
Incomappleux Valley (Tomatin Peak to Hope Peak)

This area of the boundary is in the AK-HR-NC-LR Ecosections. The NC5 and LR2 Ecosites are the most subject to impact. The landform is Colluvium B & A, blanket and veneer over inclined bedrock in the NC5 and is non-calcareous. The valley bottom is fluvial material A and weakly calcareous.

Soils are of the Brunisol/Podzol/Regozol orders. Vegetation is Western Hemlock/Western Red Cedar forest and moist shrub thicket in the valley bottom.

- The area is important to goat in winter and summer, and moderately to moose and caribou in the winter at lower levels.
- Carnivores: highly important overall in valley, particularly weasels.
- Small Mammals: highly important to pikas, hoary marmots, deer mice, chipmunk, masked shrews and water voles, snowshoe hare, beaver and red squirrels. Breeding Birds: highly important to various song birds. This section is subject to impact from the Incomappleux river valley access.

5.1.6
Hope Peak to Fortitude Mountain (south-west boundary)

This portion of the boundary is predominantly rock and ice with areas of heath and tundra. It is in the R-GL-RD-T&M Ecosections at high elevations.

- Ungulates: high summer importance to goats and medium in winter.
- Carnivores: none.
- Small Mammals: marmot, pika and Columbian ground squirrels.
- Breeding Birds: high importance to White-tailed Ptarmigan and Golden Eagles.

Steepness and culluviation in this area are major limitations to access. Natural erosion is evident, shallow soils limit use but the rugged, difficult terrain is a natural barrier to man-caused impact and therefore a minimal problem area.
5.1.7

Illecillewaet Valley (Fortitude Mountain to Mt. Fidelity)

The section is in the HE-HR-NC-LR-CT-AK Ecossections and crosses the valley intersected by the Trans-Canada highway. The higher elevations in the HE3 and HR6 Ecosites are the Residium A and the Colluvium B & A landform respectively. It is veneer over inclined bedrock, non-calcareous. Soils are Dystric Brunisols and Ferric Podzols. In the NC3 and LR1 Ecosites, the landform is Colluvium A and fluvial material A in the valley bottom, non-calcareous to weakly calcareous.

Vegetation: heath tundra and at upper to mid slope Englemann Spruce/Subalpine Fir open forest. Western Hemlock/Western Red Cedar dominate the lower levels with moist shrub thicket in the LR1 site.

- Ungulates: at the higher levels, important to goat and caribou.
- Carnivores: diversity is high, particularly weasel.
- Small Mammals: important to deer mice and red-backed voles, masked shrew and water vole, and snowshoe hare.
- Breeding Birds: high density of various birds.

This portion of the boundary has high potential for serious environmental impact due to ease of access from the TCH and CP Rail.

5.1.8

Farm Creek Pass Section (Fidelity to Mount Carson)

The section of potential impact in this area is in the AK-JD-HE-BU-LK Ecossections. The landform is predominantly Till B, blanket and veneer over inclined and ridged bedrock. Non-calcareous. Soils are Brunisol/Podzols and moderately well drained. Vegetation: Mountain Hemlock/Subalpine Fir, Engelmann Spruce, willow, heathers, and heath tundra.

- Ungulates: elk and mule deer in summer, important to caribou and to goat at upper levels.
- Carnivores: marten and weasels in winter.
- Small Mammals: snowshoe hare in winter, yellow-pine chipmunks, pikas and hoary marmots, Columbian ground squirrel, porcupines.
- Breeding Birds: high density of birds, the JD3 Ecosite is highly important to Fox Sparrow, Gray Jay and Pine Siskin. The BU3 Ecosite is important to Boreal Chickadee, Hermit Thrush and White-winged Crossbill. Presence of raptors in this area is common.
In this portion of the boundary, the potential impact on ungulates and forested areas is severe along with associated small mammals and raptors, if disturbed. Access is moderate via Farm creek.

5.1.9

Mystic Pass Section (Mount Carson to Mystic Mountain)

This again is an area which is vulnerable to environmental damage. The Ecosections JD-AK-LK-RD are the main considerations. The description of this section is similar to the previous Farm creek pass area. The RD4 Ecosite has a high summer importance to goats. Steepness and colluviation cause the area to be subject to erosion if vegetation is removed.

The presence of a small lake just outside the park boundary in Mystic pass probably increases the wildlife populations and therefore their vulnerability to impact. Access is from the Tangier valley.

5.1.10

North-west Boundary Section (Mystic Mountain to Sorcerer Mountain)

An area that is rugged and mainly rock and ice, this section is in the R+GL-GL Ecosections. Concerns here ecologically involve long term climatic and hydrological influences of the environment. Access is difficult except by helicopter.

5.1.11

Headwaters Mountain Creek (Sorcerer Mountain to Iconoclast Mountain)

The portion of the boundary here that is subject to impact is in the AK-JD-RD Ecosections. The landform is Colluvium B, non-calcareous and weakly calcareous in the RD section. Soils are Brunisols or Podzols and are well drained. Vegetation: mainly open forest and tundra, with the heathers and sedge. This is associated with exposed bedrock which add to its distinctiveness.

- Ungulates: important to mountain goat year around, and low to caribou in summer. Also important to elk and mule deer.
- Carnivores: important to martens and lynx and somewhat to weasels in the JD1 Ecosite.
- Small Mammals: medium importance overall and high to Columbian ground squirrels.
- Breeding Birds: moderate density of birds, high importance to Ruby-crowned Kinglets, Golden Eagles and White-tailed Ptarmigan.

This area is highly sensitive to potential disturbance due to the fragile heath tundra combined with exposed bedrock. Access is moderate from the Bachelor creek valley logging roads.

5.1.12
North Boundary Section (Iconoclast Mountain to Mt. McNicol)

A portion of the north boundary that is in the JD-RD-AK Ecoserions combined with rock and glaciers. Landform is Till B & A in the JD2 Ecosite and Colluvium B & A in the RD4 Ecosite. Since limestone occurs locally in some bedrock areas, those are calcareous. Other sites are non-calcareous in the JD2 and AK5. Soils are Brunisols/Podzols and well drained. Vegetation: subalpine fir-mountain hemlock open forest in the JD2 Ecosite and heath tundra with the heathers, snow willow-moss campion and mountain avens throughout.

- Ungulates: highly important to goats in summer and winter.
- Carnivores: medium importance overall in the JD2 Ecosite.
- Small Mammals: high importance to porcupines, hoary marmots, pikas and Columbian ground squirrels.
- Breeding Birds: low density of birds recorded but highly important to Clark's Nutcracker and Townsend's Solitare, White-tailed Ptarmigan, Golden Eagles, Rosy Finch and Horned Lark.

This area is highly sensitive to disturbance and encroachment with access from Ventigo and Alder creek drainages.

5.1.13
Beaver Valley Section (Mt. McNicol to Heather Mountain)

This section crosses the Beaver valley and is intersected by the Trans-Canada highway and C.P. Rail. The BU-CT-GF-HR Ecoserions are those identified. The landform is Till B, Colluvium B and Fluvial Material A in the valley bottom. Non-calcareous except for weakly calcareous where small limestone sources contribute to fluvial sediment. Soils Brunisols/Podzols in the higher levels and Gleysols, Brunisols in the valley area.
Vegetation: mountain and western hemlock, Englemann Spruce-Subalpine Fir, western red cedar, Balsam poplar/horsetail, devils club/oak fern and wet shrub thicket.

- Ungulates: highly important to ungulates especially elk and moose, and white-tailed deer in summer.
- Carnivores: coyotes, marten, weasels and lynx are predominant. Mink are also in evidence.
- Small Mammals: high importance to porcupines, snowshoe hare, heather voles, red-backed and long-tailed voles. Also high to beaver and muskrats.
- Breeding Birds: high density of birds recorded. The GF2 is one of the most important Ecosites in these two parks for the Barred Owl. The CT5 Ecosite is also highly important to the Pileated Woodpecker and the Northern Pygmy-Owl.

This zone is subject to severe impacts due to ease of access and high occurrence of fragile resources in the boundary area.

5.1.14 Praire Hills Section (Heather Mountain to Dauntless Mountain)

This portion of the boundary area is in the AK-Rd-JD-HE Ecosections. The landform ranges from Colluvium B, veneer over inclined bedrock, to Till B/Residuum veneer over inclined and ridged bedrock. The majority is calcareous with the JD1 Ecosite non-calcareous. Soils are Brunisol/Podzols and non-soil. Vegetation: subalpine fir-mountain hemlock open forest combined with heath tundra and herb tundra. Some Englemann spruce and some unvegetated sites are evident.

- Ungulates: caribou habitat is low in summer, elk and goat (summer) goat (winter). Also medium importance to moose and mule deer (summer).
- Carnivores: martens and lynx, low to weasels.
- Small Mammals: snowshoe hare, Yellow-pine chipmunks, pikas and hoary marmots, Columbian ground squirrels.

This area is sensitive to erosion if vegetation is removed. Stoney surfaces and shallow soils over most of the area limit use. The open cliffs are highly important to mountain goats that may be killed or stressed where their winter ranges are in avalanche zones, if ever controlled. Accessible by Quartz creek drainage and logging roads adjacent to Heather mountain.

5.1.15 East Section (Dauntless Mountain to Copperstain Mountain)

This area is in high elevation terrain in the RD-HE-JN-JD-R & GL Ecosections. Landform is Till B, Colluvium A and Residuum A, blanket and veneer over inclined and ridged bedrock. Non-calcareous medium to course textured. Soils are Brunisol/Podzols and well drained. Vegetation: heath tundra and herb tundra, heathers, avens and moss campion.
- Ungulates: high importance to goat, caribou and elk (in summer).
- Carnivores: marten and weasels in low densities.
- Small Mammals: snowshoe hare and Yellow-pine chipmunks, Columbian ground squirrels, heather voles and deer mice.
- Breeding Birds: Horned Lark, Water Pipit and White-tailed Ptarmigan, Rosy Finch, Golden Eagles and Red-tailed Hawks.

Generally, the accessible areas in this zone are characterized by good caribou and goat habitat. Mainly accessible by Canyon creek and the Spillumacheen river valley.

Mount Revelstoke National Park

5.1.16
Revelstoke Townsite North To St. Cyr West Shoulder

This area of the boundary is in the CT-NC Ecossections. The landform is Stratified Drift C and Colluvium A&B, ridged, hummocky and blanket and veneer over inclined bedrock. Non-calcareous, course textured. Soils are moderately well drained, Brunisols or Podzols. Vegetation: western hemlock, red cedar, Douglas fir, western yew.

- Ungulates: high importance to caribou in winter. Also, medium to mule deer and moose in winter. In the NC4, low to mountain goat in winter.
- Carnivores: high importance to martens, and the only recorded fisher track in the park in the CT4 Ecosite. High importance overall.
- Small Mammals: high to snowshoe hares, red-backed voles and deer mice.
- Breeding Birds: high density of birds recorded, important to Warbling Vireo, Brown Creeper.

This section is subject to impact from adjacent areas influenced by the Revelstoke dam and associated effects.

5.1.17
North-west Corner Of park To Mount St. Cyr

This portion of the boundary area is in the BU-JD-AK-RD Ecossections. The landform is Till B & A, blanket and veneer over inclined bedrock. Non-calcareous. Soils are Brunisol/Podzols and well drained. Vegetation: mountain hemlock/subalpine fir, Englemann Spruce which may be related to fire history in the BU4 Ecosite. The rest of the section is open forest, and heath and herb tundra.

- Ungulates: high importance to caribou and low to mule deer. Very high importance to mountain goat in the AK5 Ecosite.
- Carnivores: medium importance to marten and weasels.
- Small Mammals: high importance to Columbian ground squirrels and porcupines. Red-backed voles and red squirrels are prevalent in the BU4 Ecosite.
- Breeding Birds: high to Boreal Chickadee, Hermit Thrush and White-winged Crossbill. Important habitat for Golden Eagles, Red-tailed Hawks and Northern Hawk-Owls. Also high to Rosy Finch and White-tailed Ptarmigan in the AK5 Ecosite.

The ease of access into this section from the Sale Mountain basin creates a vulnerable area subject to severe impact. Erosion may be increased by removal of vegetation.

5.1.18
Mount St. Cyr To Woolsey Creek

This zone is in the AK-HR-CT-NC Ecossections and follows the Maunder creek drainage. The landform is Till and Colluvium A & B, blanket and veneer over inclined bedrock. Non-calcareous. Soils are well drained Brunisols or Podzols. Vegetation: Englemann Spruce, mountain and western hemlock, subalpine fir and western red cedar. The AK5 Ecosite is open forest and heath tundra.

- Ungulates: high importance to goat and caribou in winter.
- Carnivores: important to marten, weasels, wolverines and lynx.
- Small Mammals: high to deer mice, long-tailed voles and in some areas, pikas and hoary marmots.

Most of this section is steeply sloped with access moderate up Maunder creek. Since it is important goat range it is subject to outside influence disturbance.

5.1.19
Maunder Creek To Illecillewaet River (West Boundary MRNP)

The west boundary section is in the CT-LR Ecossections. The landform is Till B & A, and Fluvial Material A in the LR1 Ecosites. Non-calcareous to weakly calcareous in the lower sections. Soils are Brunisol/Podzols and well to poorly drained in the valley bottom. Vegetation: western and mountain hemlock, red cedar, subalpine fir, western yew.

- Ungulates: very high importance overall, high to mule deer, white-tailed deer, moose, caribou and elk.
- Carnivores: high to weasels, very high importance overall.
- Small Mammals: high to masked shrew, Richardson's water voles, hares, beaver and red squirrel.
Breeding Birds: high density. Important to Blackpoll Warbler, Evening Grosbeak, Hammond's Flycatcher and Veery. Prevalent to Barred Owl, Northern Pygmy-Owl, Red-tailed Hawk, American Kestral and other raptors.

This area is highly sensitive to impact although protected in many areas by Woolsey creek and its rugged, steep, stream banks. The LR1 Ecosites are sensitive due to their location in valley bottoms and therefore prone to disturbance.

5.1.20
Woolsey - Illecillewaet Confluence To Clachnacudainn Creek
(South-East Boundary Section)

This section is in the LR-GF-CT-NC-KX Ecosections. The landform is Colluvium B & A, Fluvial Material A and Glaciofluvial Material B. Level horizontal fen, or blanket and veneer over inclined bedrock. Weakly calcareous. Soils are Brunisol/Gleysol/Fibrisol and poorly drained. Vegetation: western hemlock - red cedar, mixed open forest, wet shrub thicket, sedge fern.

- Ungulates: highly important to moose, mule and white-tailed deer and somewhat to elk in small numbers. The NC6 Ecosite is important to goat.
- Carnivores: coyotes, weasels, mink and occasionally wolves observed. Also important to martens and lynx.
- Small Mammals: meadow vole, beaver, muskrats, deer mice, long-tailed voles and red squirrels.
- Breeding Birds: very high density. High to Vaux's Swift. This is a unique bird community rare elsewhere in the parks.

This section is very sensitive to disturbance particularly to ungulates, bears, small mammals and bird populations. Accessible by the Trans-Canada highway which passes through the area.

5.1.21
Clachnacudainn Creek To Revelstoke Townsite

The south boundary section is in the CT-NC Ecosections. The landform is Till B and Colluvium B, non-calcareous to weakly calcareous and medium textured. Soils are Brunisol/Podzols and well drained. Vegetation: western hemlock - western red cedar forest.

- Ungulates: medium importance overall, high to caribou, low to mule deer and white-tailed deer.
- Carnivores: high importance to martens and coyotes.
- Small Mammals: high importance to snowshoe hares, red-backed voles and deer mice.
Breeding Birds: high density of birds recorded. Highly important to Brown Creeper, Blackcapped Chickadee, Calliope Hummingbird, Dusky Flycatcher, Warbling Vireo and others.

Due to ease of access, T.C.H., this area is very vulnerable to disturbance particularly since a portion borders on the City of Revelstoke.

5.2 External Threats To Mount Revelstoke And Glacier National Parks

The U.S. National Park System developed a questionnaire that formed the basis for the State of the Parks Report - from "National Parks and the Politics of External Threats" (Freemuth, J.C., 1991). This questionnaire used the following list of potential threats:

- Air Pollution
- Water Quality Pollution
- Aesthetic Degradation
- Physical Removal Of Resources
- Exotic Encroachment
- Visitor Physical Impacts
- Park Operations

Each heading was further broken down into all of the possible sources from which environmental impacts could occur.

For our purposes, in Mount Revelstoke and Glacier National Parks, similar headings will be used to identify the external threats but each will be modified relative to the area. In the conclusion section (5.3), only those threats regarded as significant with a possible action will be addressed. The term "significant", is defined here as an action that has obvious environmental effects or that requires further research study so that any effect is positively identified.

5.2.1 Air Pollution

5.2.1.1 Suspended Particulates - Smoke
- Chemicals

The main problem area in these two parks where suspended particulates are causing detrimental impacts is from C.P. Rail ventilation emissions from the tunnels, and from our own operation in Rogers Pass - the power generators that supply electrical power for the facilities. Smoke from slash burning in areas adjacent to the parks is not included in this section because the distance from the source of the burning would probably not contribute particulates to the park environment (included in Aesthetic Degradation section).
The C.P. Rail ventilation areas are shown (Figures 1 and 2), which shows the movement of exhaust from the tunnels and the locations of potential damage to the environment. The east portal of both the Connaught and MacDonald tunnels have by far the heaviest concentrations of haze and fumes that hang over the Beaver valley for extended periods dependent on the wind movements.
Glacier National Park

C.P. Rail Lines

C.P. Rail Vent Shfts

Mount Macdonald Tunnel

Connaught Tunnel

Illecillewaet River

Figure 1

CP Rail Tunnel Ventilation Areas
SCHEMATIC OF VENTILATION SYSTEM AIR FLOW FOR VARIOUS TRAIN LOCATIONS IN THE TUNNEL

FIGURE 2

West Portal

East Portal

COOLING FAN

GATE OPEN

GATE CLOSED

Train Direction

Air Flow

Train Direction

Air Flow

Train Direction

Air Flow

Train Direction

Air Flow

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Since the exhaust is emitted at low elevations in the valley and predominantly the wind is calm to moderate levels, most of the emissions would tend to settle in the area. It can be assumed therefore that the fumes (consisting of Nitrogen oxides, Sulphur dioxide and other chemicals) remain in the areas long enough to settle onto vegetation and soils. The effects of these emissions may also contribute to the acid rain problems as they dissipate into the upper air levels.

In 1982 the Rogers Pass Project Brief listed the expected tunnel pollutant concentrations as shown in (Table 1). The actual emissions now occurring from the tunnel are appearing much higher than those projected by the appearance of the black snowcover in winter and dense smoke (or smog), in the areas of the vents. In addition, the aesthetic values of the park environment are eroded because of the heavy smog associated with the exhaust which hangs in the valley for extended periods after a train has entered the tunnel. The vent shaft at the summit of Rogers Pass, from the new MacDonald tunnel, does not appear to be a problem since upon continuous observation, the smoke and fumes appear to dissipate up and over the col between Avalanche Mountain and Mt. MacDonald. However, that particular vent area (Rogers Pass Summit) was the only one analyzed by the Environmental Impact Statement Committee during the construction of the tunnel (1984-88). From this it would appear that the other areas of concern were overlooked or judged minimal by those responsible.

Open rail cars carrying coal, potash and other materials are also a source of air pollution.

Assessment: significant. Action: possible.

The Rogers Pass power generating plant is another suspected source of environmental damage. Two large diesel generators (210 kw and 250 kw, 3406 BT engines [which are equivalent to the engines of a D8 Caterpillar] provide power to the Rogers Pass (Government owned facilities)). Only one plant runs at a time, but the exhaust from these engines contributes suspended particulates to the surrounding area because it is constant and localized. This is the same type of exhaust emitted from the C.P. Rail tunnels. Glacier Park Lodge also uses diesel generating plants in Rogers Pass which add to the problem.

Assessment: significant. Action: possible.
Table 1
*C.P.Rail Tunnel Pollutant Concentrations

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Tunnel Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Piston Only(4)</td>
</tr>
<tr>
<td></td>
<td>PPM</td>
</tr>
<tr>
<td>Nitrogen Oxide</td>
<td>74</td>
</tr>
<tr>
<td>Nitrogen Dioxide</td>
<td>16</td>
</tr>
<tr>
<td>Carbon Monoxide</td>
<td>52</td>
</tr>
<tr>
<td>Hydrocarbons (2)</td>
<td>8</td>
</tr>
<tr>
<td>Suspended Particulates (3)</td>
<td>9</td>
</tr>
<tr>
<td>Sulphur Dioxide</td>
<td>8</td>
</tr>
</tbody>
</table>

(1) Manufacturers tests  
(2) Assumed formaldehyde  
(3) Concentrations and limiting values given in Mg/m  
(4) 5 Unit design train  
(5) 6 Unit design train

* from Rogers Pass Project Brief, 1982 (concentrations that were expected from the proposed MacDonald tunnel)
The Trans-Canada Highway corridor also contributes to the suspended particulate problem. Transport trucks and other vehicles in large numbers and on a continuous basis move through this corridor emitting nitrous oxides, sulphur dioxide and carbon monoxide. In addition, chemicals transported in dry form may occasionally be spread from open, moving vehicles.

Assessment: significant. Action: unlikely, monitoring required.

5.2.2
Water Quality

5.2.2.1
Acidification - nitrogen oxides - sulphur dioxides

The water in eight lakes located in or adjacent to the two parks was sampled at both surface and depth levels to determine their TA (Total Alkalinity) and therefore extent of natural resistance to acidification. The location of these lakes (Figure 3) is shown in relation to the two parks.

The water was sampled using an instrument provided by Okanagan University College - Salmon Arm, B.C. The depth sample was taken at approximately the centre of each lake, lowering the instrument from a helicopter to the lake bottom and allowing the cylinder to fill (designed to fill without sediment). The samples were taken as soon after the lakes were ice free as possible and before the lake turnover occurred (generally at 39 F. (3.8 C.) water temperature). Samples were then transported to Okanagan University College and analyzed by Dr. Crowley and J. Chadwick in the college laboratory (Table 2).

The "eutrophic" lakes which are highly acidic and therefore can be rich in nitrogen and phosphates have a tendency to create excessive growth of algae. As the plants die and decompose they consume the oxygen available in the lake causing the death of other living things. As that occurs the lake will become "oligotrophic". If pollution, such as acid rain is eliminated, the lakes may cleanse themselves.

As is shown (Table 3), the lakes on Mount Revelstoke proved to be the most sensitive to acidification. In other words, the T/A was lower than comparative results in the center of the Selkirk Mountains where the T/A was high, particularly in Schuss lake. A possible explanation for this condition could be because Schuss lake is surrounded by limestone formations and situated in a basin where leaching of these alkalines probably occur into the lake.
C. Trans-Canada Highway in Glacier National Park showing average traffic. Photograph by Mas Matsushita.
Location Of Lakes Sampled (T/A)

Figure 3
<table>
<thead>
<tr>
<th>Calculations of Total Alkalinity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Alkalinity = 50000 M (V1 + V2)</strong></td>
</tr>
<tr>
<td>V3</td>
</tr>
</tbody>
</table>

where  
M = molarity of standard HCl titrant  
V1 = ml of HCl to pH 8.3  
V2 = ml of HCl to pH 4.5  
V3 = ml of water sample

(Reference: Standard Methods for Analysis of Water)
<table>
<thead>
<tr>
<th>Lake Name</th>
<th>Elevation</th>
<th>MG Coordinates</th>
<th>Surface</th>
<th>Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bald Hills</td>
<td>6971/2125</td>
<td>MG 758 844</td>
<td>17.64</td>
<td>16.62</td>
</tr>
<tr>
<td>Ventego</td>
<td>7054/2150</td>
<td>MG 495 993</td>
<td>10.00</td>
<td>10.87</td>
</tr>
<tr>
<td>Glacier Circle</td>
<td>5741/1750</td>
<td>MG 731 688</td>
<td>25.65</td>
<td>25.67</td>
</tr>
<tr>
<td>Schuss</td>
<td>6151/1875</td>
<td>MG 507 766</td>
<td>38.37</td>
<td>46.88</td>
</tr>
<tr>
<td>Butters</td>
<td>6234/1900</td>
<td>MG 755 502</td>
<td>8.10</td>
<td>7.74</td>
</tr>
<tr>
<td>Eva</td>
<td>6397/1950</td>
<td>MG 224 593</td>
<td>4.05</td>
<td>4.26</td>
</tr>
<tr>
<td>Upper Jade</td>
<td>6069/1850</td>
<td>MG 248 579</td>
<td>4.26</td>
<td>5.28</td>
</tr>
<tr>
<td>Miller</td>
<td>6332/1930</td>
<td>MG 227 581</td>
<td>7.39</td>
<td>8.00</td>
</tr>
</tbody>
</table>
The T/A for the "Bald Hills" lake is also considerably higher (approx. 4 times greater than the Mount Revelstoke lakes). The reason for this may be due to past extensive forest fires in the area, and subsequent loss of acidic conifer deposit could contribute to higher alkalinity (T. Crowley, pers. comm.).

The water bodies most susceptible to effects, such as acid rain, are those that are presently highly acidic. If the T/A is high then the lake is more resistant to those effects.

The area in which the Columbia Mountains are located is prone to acid rain effects carried by upper air currents (Figure 6). These effects could originate from mid-distant industrial plants such as the pulpmills in central and northern B.C. or possibly intercontinental movement of pollutants, i.e. Japan, Russia, although there is not conclusive evidence of that as yet (B. Thomson, A.E.S., pers. comm.). Atmospheric Environment Services provided information regarding the upper air movements at approximately the 1800 ft. (5486 m.) levels (Figure 4 and 5), which change depending on the season of the year. These are shown for the autumn and winter periods. Most acid rain pollution is carried on these currents and could be deposited anywhere around the world (W. Belzar, A.E.S., pers. comm.). These upper air currents have been analyzed and found to be carrying "rivers" of vapours and liquids for extended periods of time.

The effects of acid deposition in Mount Revelstoke and Glacier national parks could be considerable over time since those lakes that are sensitive to acidification could succumb and become "oligotrophic" (poorly life supporting) for both aquatic animal and plant life.

Dr. T. Crowley (pers. comm.) - "A long standing generalization involving acid precipitation (Scandanavia, Eastern Canada and Eastern U.S.) is that high elevation sites receive the most impact due to interception of acid-containing clouds by mountain peaks. Hence, the high montane character of Mt. Revelstoke and Glacier national parks would be expected to be at higher risk than surrounding valley environments."

Assessment: significant. Action: possible.
Figure 4

Vector Mean Wind (knots) and Normal Geopotential Height (100's gpm)

S00 mb

AUTUMN (Sept - Nov)
5.2.2.2

Other Pollutants - sewage
- salt/sediment deposition
- toxic spills

The sewage lagoon and treatment plant in Rogers Pass was designed to eliminate any possibility of raw sewage entering the water tributaries of Connaught creek. When the plant is operating efficiently it appears to be effective, however, occasionally when water samples are taken below the outlet, the faecal coliform count is above standard.

Assignment: significant. Action: possible.

The maintenance of the Trans-Canada highway through both parks requires the use of Sodium Chloride mixed with the sand, in the winter so that the sand adheres into the ice on the highway to prevent slippery conditions. The use of this salt is assumed to be detrimental to vegetation, wildlife, soils and water adjacent to the highway (requires further research).

Assessment: significant Action: possible.

Toxic spills occur occasionally on the T.C.H. when transport trucks are involved in accidents and overturn, or are ruptured. An effective toxic spill plan and immediate action have generally controlled the effects of these spills before extensive environmental damage occurs. However, some damage can occur before these actions can be initiated particularly into water tributaries. C.P. Rail derailments also occur occasionally which can also cause serious environmental damage. So far, the various agencies have cooperated to clean up these spills effectively.

Assessment: significant. Action: possible, on-going

5.2.3

Aesthetic Degradation

The threat of aesthetic degradation will be regarded here as any visual detrimental impact caused by unnatural sources.
5.2.3.1
Forest Industry Clearcuts

The forest (logging) industry adjacent to Mount Revelstoke and Glacier national parks has increased consistently since 1980. The resulting clearcut areas are the most obvious aesthetic impact when viewed from the Mount Revelstoke Summit Drive, particularly from the viewpoints looking across the Columbia River Valley in the direction of the Monashee mountains (Frisby Ridge and Mount McPherson). The mosaic of clearcut forest areas distorts the landscape in what was previously solid green forest with mountain snow covered peaks in the background.

A sight from within Glacier National Park that is aesthetically impacted is from the Heather Hill viewpoint across the Beaver valley to the east slopes of Mt. McNicoll. Here, one large clearcut next to the park boundary and others to the east, fragment the landscape.

Other clearcut areas are not visible from within these two parks unless viewed from some of the mountain peaks or in backcountry areas near the park boundaries.

Some of the more obvious impacted views are from the Bald Mountain ridge looking east across the Spillimacheen river valley, from the headwaters of Mountain creek to the north across Bachelor creek, the Beaver-Duncan watershed area and the view from Farm Pass to the west across the Tangier river valley.

Another impact related to the clearcut forest industry, that is aesthetically detrimental to the national parks, is the slash burning in areas adjacent to the parks. This burning is conducted during the fall period of the year and fills the valleys with smoke dense enough to obscure most views that are farther than a few kilometres distance.

Assessment: significant. Action: possible.

5.2.3.2
Access Roads And Railway

The Trans-Canada highway through both parks is an aesthetic impairment but being a national transportation corridor it will continue to exist. The greatest visual detriment is through rock cuts where erosion and rockfall continue to deface the landscape. The snowsheds and other avalanche defences are also an eyesore in this natural environment.

Assessment: significant. Action: possible, continuing
Access roads both inside and outside these parks are also a visual impairment. Within the parks, one of the obvious is the Mount Revelstoke Summit Drive when viewed from the City of Revelstoke or sites from Highway 23 south, close to Revelstoke. Another obvious intrusion is the Fidelity Mountain Observation Station road that provides access for management purposes to assist avalanche control in Glacier National Park. Parts of this road can be seen from the T.C.H. when approaching the area from the east.

Outside and adjacent to the two parks are the logging access roads that can be seen from sites on Mount Revelstoke and the viewpoints on Heather Hill on the east side of Glacier National Park. Other logging roads can be seen from various points on the periphery of the parks.

Assessment: significant. Action: possible.

The Canadian Pacific Railway through Glacier National Park is an aesthetic impact. However, since the railway was constructed before the park was established and since it is of national importance, it has become a "necessary evil". The new "Grade Reduction and Tunnel Project" caused more detrimental impact but was strictly monitored to minimize the effects. The most serious aesthetic impact is in the Beaver valley where backslopes had retaining walls constructed of cantilevered reinforced concrete walls leave considerable visual impairment when viewed from the T.C.H.

Assessment: significant. Action: unlikely.

5.2.3.3
Land Development - Huts and Lodges

Aesthetically, this section deals with the land development around and adjacent to the two national parks. There are nine (9) huts/lodges located adjacent to the parks as shown in (Figure 6). These structures are noticeable if viewed from the air, but do not aesthetically impact the area. Any new development proposals are referred to the park administration for recommendations, by B.C. Lands in Cranbrook, before approvals are finalized.

Assessment: significant. Action: possible for future development
The Columbia-Shuswap Regional District have a plan (Bylaw No. 2200) that promotes development outside the City of Revelstoke, in the regional district. This plan encourages the establishment of small business in the vicinity of the Revelstoke damsite and areas adjacent to the City of Revelstoke with emphasize on "commercial and industrial activities in locations that take full advantage of existing access and roadways" - (Rural Revelstoke Land Use, Bylaw No. 2200). The proposal could have a serious visual impact on Mount Revelstoke National Park since some of this development could be directly adjacent to the boundary.

Assessment: significant. Action: possible.

Other developments that may aesthetically impact Mount Revelstoke National Park are controlled by the City of Revelstoke and the city borders next to the park at the southwest corner. New housing and/or commercial structures could be developed in this area in the near future.

Assessment: significant. Action: possible.

5.2.3.4 Vista (Road Signs, Inholdings, etc.)

The visual impact in these national parks from visitor/park information signs, is moderate. The signs that exist are numerous although most are designed for public safety or to assist the visitor while in the parks. The design of the park entrance signs are aesthetically pleasing and generally well received by visitors.

Other inholdings, park buildings and other structures, may not be aesthetically pleasing to the visitor and some should perhaps be considered for redesign as they deteriorate i.e., Rogers Pass compound area, the Rogers Pass Centre and the One Mile Compound area.

An informal survey was conducted to determine visitor opinions of the buildings in Rogers Pass. The consensus was that the park buildings could be designed more compatible with the environment, i.e. similar to the hotel and service station. Opinions of the Rogers Pass Centre building were generally negative regarding the exterior although most were impressed with the interior design. Comments of the exterior included the fact that "it looked like an old deteriorated building of some kind that needed a great deal of maintenance". Others thought it was something that "was falling down and needed the props on the outside to hold it up".
This could be perceived as another example of government "double standard" in that we do not design our own buildings to the standard that we require other developers (private or otherwise, i.e. C.P. Rail), to design theirs.

Assessment: significant. Action: possible.

5.2.3.5 Overcrowding And Vandalism

In these two parks, overcrowding is generally not a problem except in two locations. The Mount Revelstoke summit area during the summer months is occasionally crowded and the effect to the summit sub-alpine wildflower environment is detrimental. The other area of concern during the peak periods is the Illecillewaet campground and trailheads in that location where congregations of visitors could be an environmental problem. Most of the overcrowding in these areas can be monitored and controlled to minimize the detrimental effects.


Vandalism is primarily a problem in Mount Revelstoke National Park where destruction has occurred at the cross-country ski chalet, and the Monashee picnic site at 5 Mile on the summit road. This vandalism is assumed to be done generally by local area residents. The extent of this damage includes window breakage, picnic table destruction or defacing, partial burning of building interiors, breaking bottles and strewn garbage.

Assessment: significant. Action: possible.

5.2.4 Physical Removal Of Resources

This section deals with the protection and preservation of the natural resources in these two parks by identifying the threats that have potential to remove or destroy the resources.

5.2.4.1 Trapping And Hunting (Areas Adjacent To Parks)

Mount Revelstoke and Glacier National Parks are entirely surrounded by trapping and guided hunting areas bordering on the park boundaries.
The major species trapped are the Mustelids (Pine marten, weasel, mink), beaver, muskrat, and a few coyote, squirrel, otter, wolverine and lynx. The impact on the parks may be from traplines located directly adjacent to the park boundary and mainly to Pine marten that range in and out of the park in those areas. There are only three sites where that may occur; the Woolsey creek area and the Hamilton creek east and west area of Mount Revelstoke National Park, and the Caribou Pass south area of Glacier National Park.

This impact is regarded as minimal, however, and may assist in "controlling" these populations which could prevent mortality due to overpopulation (G. Woods, pers. comm.). (Figure 7 shows trapline lease areas).

Assessment: significant. Action: possible.

The legal hunting (guided or by local residents) in areas adjacent to the parks is fairly well controlled by the British Columbia Wildlife Branch. The main season is open mainly to mule and white-tailed deer with a short season for elk in two Management Units (MU's) next to the park. A black bear season is open also in all units.

There is no open regular season or limited entry for grizzly bear in MU's adjacent to the park boundaries. However, a hunting season is open for bull caribou in MU's adjacent to the north and between these parks. A LEH (Limited Entry Hunting) is open for mountain goat on the north side of G.N.P. Most provincial regulations are beneficial to park management in the protection of the important wildlife species, although the open caribou and goat season could be detrimental.

The other concern is the open season on wolverine (Nov. 1 - Jan. 31) in all of the MU's surrounding the two national parks. The wolverine population may be seriously affected. The grizzly bear and mountain caribou populations also appear to be on a serious decline when observation records are compared with those of the 1950's and 60's. (Figure 8 shows the guided hunting territories).

The distribution of the large species of wildlife in these two parks is shown in (Figures 9, 10, 11, and 12).

A problem that continues to be a concern to the parks is the B.C. Hunting and Trapping Regulations Synopsis map for the Kootenay region. The MU's are outlined to include the national parks instead of terminating at the park boundaries. This confuses hunters who might otherwise be hunting legally. The B.C. Wildlife Biologist (G. Woods, Nelson Region) indicated this would be an agenda item at the next review meeting of the hunting regulations.
During the past two years, Canadian Parks Service has erected park information signs at strategic locations in access areas adjacent to these parks (backcountry areas). The signs show a map of the park with a list of the major regulations. When discussing these signs with Conservation Officers, W. Cibulka and B. Klassen (pers. comm.), they indicated that numerous people had expressed confusion regarding these signs because they had been placed a considerable distance outside the park boundary and did not indicate where they were in relation to the park.
Trapline Lease Areas

Figure 7
Guided Hunting Territories

Figure 8
Moose Sightings

Figure 10
Grizzly Sightings

Figure 11
Elk Sightings

Figure 12
The illegal hunting pressure (poaching) may be a problem because of the easy access to many of the park boundary locations created by logging roads. Access roads into former wilderness areas around the two parks are shown in (Figure 13). The use of 4-wheel drive and all-terrain vehicles allow indiscriminate hunting in most of the areas where prime wildlife species range. These types of hunters are in search of trophy animals that are often protected by the existence of the national parks and the fact that some of these animals migrate into the parks during hunting season.

Assessment: significant. Action: possible.

5.2.4.2 Wildlife Mortality

Wildlife mortality occurs along the T.C.H. in these two parks when wildlife, especially mountain goats, are attracted to the highway to lick salt residue and are frequently killed or injured by vehicles.

Birds are also attracted to the highway surface (particularly Pine Siskins, Red Crossbills and White-winged Crossbills) to pick up salt saturated sand particles. Many of these birds are killed by vehicles after they appear to become "dulled or stunned" from the effects of the sand.

Assessment: significant. Action: possible.

5.2.4.3 Specimen Collecting

The collection of specimens of natural resources in these two parks for research purposes are of some concern and occasionally may be regarded as a threat. Often, permits are issued for collections in the parks when the research could as easily be conducted outside park boundaries. Some species identified as rare or endangered can be particularly vulnerable when those issuing the permits may not be aware of the status of those species or conditions related to the area of research. Often, research is done in a study area and other flora and/or fauna are disturbed or detrimentally affected, i.e. use of a helicopter to access the study area, or direct damage done while collecting a particular specimen.

Assessment: significant. Action: possible.
5.2.4.4
Fishing

Fishing in these two parks has not attracted many recreational fishing enthusiasts. Some of the lakes support a fish population but are at high elevations (over 6000 ft./1850 m.) with a short productive season and therefore, small-sized fish. Only one lake has a fairly productive fish population (Rainbow Trout), Upper Jade lake, but hiking distance is approximately three hours which discourages extensive use by recreationalists. The rivers and tributaries support a fair number of various fish species i.e. Dolly Varden, Cutthroat, Eastern Brook, Whitefish, etc., just before and during spawning, but few people use the area for fishing. The issue of stocking the Mount Revelstoke lakes with non-native fish (as occurred in the late 1960's and early 70's) will not be repeated, however, the cumulative effects of that stocking now and in the future may be considerable.

Assessment: significant. Action: possible.

5.2.4.5
Berry Picking

The picking of berries in national parks is restricted by the National Parks General Regulations, Section 10 - "No person shall remove, deface, damage or destroy any flora-----, etc. However, a considerable number of local residents have picked berries in Mount Revelstoke and Glacier national parks as an annual recreation before and since the parks were established. The main species of interest in this area is the huckleberry, blueberry (Vaccinium Spp.), Salmonberry (Rubus spectabilis) and Mountain Cranberry (V. vitis-idae L. ssp. minus). A berry is definitely "flora", but the practice of picking berries was seldom enforced because the resource replaced itself annually.

This park use is not damaging to vegetation unless the berry bushes or surrounding vegetation are damaged while picking the berry, which has occurred due to negligence. In several cases, the whole bush has been removed with the berries intact which was a deliberate case of ignorance. However, picking berries is detrimental to the bear populations that rely on the berry crop as an important food source for their nutrition, mainly carbohydrates. Berries are also important to some of the smaller mammals and particularly various birds.

Assessment: significant. Action: possible.
5.2.4.6 Soil Erosion

Erosion occurring in man-disturbed areas, i.e. highway, roadways and railway backslopes is detrimental to vegetation which becomes dislodged after soil and rocks fall away. Stream siltation also occurs which affects spawning areas and invertebrates. Many of these backslopes were properly stabilized at the time of construction while others are continuously eroding from weather. The main problem areas are the Mount Revelstoke summit road, the Mount Fidelity Observatory road and the Trans-Canada highway. The C.P. Railway has stabilized most of their backslopes since they cannot afford slippage onto the rail line. Some of the park trails also have serious erosion areas, the worst of which are the Beaver and Copperstain trails in a number of locations. Erosion is also seriously affecting the stability of the historic stone pillars and stone arch bridges from the old railway grade in Rogers Pass. The main areas of concern are the pillars located along Loop Brook, the bridge on the old Stoney creek grade and the bridge over the Illecillewaet river behind the campground.

Assessment: significant. Action: possible.

5.2.4.7 Archaeological Collecting

In Glacier National Park, collecting of artifacts from the old Glacier House site was conducted over several years. The collection was done carefully, by Historic Resources staff, to minimize the environmental effects to the surrounding area. In past years, much illegal "pot hunting" has occurred in this site resulting in digging up of the ground cover. Since the historical collecting has been completed, some warning signage and enforcement has effectively reduced further damage. This is the only area in either park where collecting of historical artifacts has been conducted. No other archaeological sites have been discovered. If that occurs in the future, guidelines should be formulated to prevent destruction of the specific natural resources.

Assessment: insignificant. Action: possible
5.2.4.8

Mining

Two active mining claims remain in Glacier National Park, none in Mount Revelstoke National Park. In this case, "active" refers to claims that the lessee continues to pay the annual tax fee but the mine is not actively worked. Restrictions such as access to the claim area in a national park is the controlling factor for any mining claims that have not been "expropriated" since the area was designated as park lands.

If the mine site is not accessible by a road, no new access can be constructed for that purpose, and helicopter transport is not permitted. The two claims in this case should not be a threat to environmental protection in the park if the park policy is in effect. No staking for placer mining is permitted, only hard rock mining.

Mining claims in and adjacent to the two parks are shown in (Figure 14).

The Florian Fraction Claim #001591 is owned by Amalgamated Mining Western Ltd., and is taxable only, no work requirement. This claim is located adjacent and inside the boundary of the west Glacier Park. It is assumed that this claim is speculative, and waiting for an offer either from government or otherwise to purchase the site.

Another claim, the Silver Bell #2431, is west of Glacier Park and south of the T.C.H., near Jumping creek and is owned by a local resident. Any threat to the park should not be a problem since it is somewhat removed by a mountain ridge and the area is difficult, rugged terrain. In the Woolsey creek drainage, the only claims are Midas 1-6 and should not impact the park except by access due to maintenance of the mining and logging roads.

The Elizabeth claim #002785 is located just inside the Glacier park boundary above the Incommapleux river. It is owned by a resident of Los Angeles, California and although the ore is of poor grade, could be productive if a railway was available nearby to transport large quantities of ore. This is not possible, however, and the owner cannot obtain surface rights to access the mine site. Considered speculative only.

No other claims are active near the park boundaries.

Assessment: insignificant. Action: unnecessary
5.2.5
External Encroachment

This section addresses the effects to the natural environment by unnatural introductions, usually man-caused.

5.2.5.1
Unnatural Fire

These types of forest fires occur occasionally and usually originate from C.P. Rail or the T.C.H. Fire control plans for both are in effect, however, and are generally effective. Other unnatural fires are caused by campfires left unattended or by acts of vandalism which is always a threat. Encroachment in these cases can also be the result of methods used in fire suppression; i.e. use of fire retardant, equipment etc. which have residual and other unnatural effects.

Assessment: significant. Action: on-going.

5.2.5.2
Noxious Weeds (non-native plants)

These plants are becoming a problem in both parks, along the Trans-Canada Highway in the Beaver valley and in the Lauretta and Giant Cedars areas. These sites in particular have extensive infestation of Spotted knapweed (Centaurea maculosa), with some Diffuse knapweed (Centaurea diffusa), occurring but not as prevalent. Numerous various other non-native plants are prolific along the T.C.H. right-of-way in both parks; Sow thistle (Sonchas asper), Blueweed (Echium vulgare), Canada thistle (Cirsium arvense) and Dalmation toadflax (Linaria dalmatica) are some of the more predominant species.

Successful non-native plant management will require a sustained effort over many years (Achuff, P. 1991: Non-native Plant Management - Canadian Parks Service). During the past 6 years in Mount Revelstoke and Glacier national parks a control program using the hand-pulling method and later, the use of "Tordon" herbicide, was undertaken. The results were only minimally effective, however, probably because the root systems were not destroyed.

The Columbia Shuswap Regional District now have a Noxious Weed Control Program that is being initiated in the south-east portion of the province. In discussions with the C.S.R.D., Paul Goodkey (Coordinator, Noxious Weed Program, pers. comm.) indicated that land owners or occupiers of property within the CSRD will be held responsible for the control of these weeds (particularly knapweed) on their properties. A Weed Inspector will identify the areas and the property owner or renter will be notified.
If the problem is not remedied by that person, a contractor will be hired by the regional district to carry out the control measures, and the owner invoiced for the work done. If the invoice remains unpaid, the cost is included with the property tax of the land in question.

If not controlled, the noxious weed problem on agricultural land results in lost productivity and the cost to the CSRD will be even greater.

With this in mind, the Canadian Parks Service has a responsibility for weed control on national park lands to prevent the spread and transport of weed seeds by passing vehicles. This will also assist the province with their weed control program since the spread is no doubt transported from the parks to the province and vice versa.

Assessment: significant. Action: necessary and possible.

5.2.5.3

Noise - motor vehicles
- aircraft
- railway locomotives

The noise factor from the transportation corridor in these two parks is considerable and the effects to wildlife and park visitors in the park environment must be detrimental. Again, since the highway and railway are a "necessary evil" because of their national importance, it is an encroachment that must be endured although may be minimized. Wildlife probably adapt to some extent but many no doubt leave the valleys, where the noise level is intense, to the more remote solitude of the backcountry areas to avoid this disturbance.

The use of aircraft is increasing, in occurrence, over the park lands often at low altitudes. The majority of these are helicopters, many of which are being used for park management. The noise factor of these machines is often detrimental to both wildlife and park visitors. During the winter months, the larger helicopters used for heli-skiing in surrounding areas must often cause stress to wildlife close to the landing sites. Observations by various individuals i.e. R. Beglinger (Selkirk Mountain Experience, pers. comm.), and V. Sherm (Monashee Outfitters, pers. comm.) have supported this assumption, seeing wildlife scatter from the disturbance. (Figure 15 and 16 show the heli-ski areas and landing sites adjacent to the two parks.)

5.2.5.4

Industrial Effects - Revelstoke Dam Project
- C. P. Rail and Tunnel Project

The two large projects, both of which were completed in the 1980's, have had some detrimental effect on the park environment.
The Revelstoke dam project, completed in 1983 by B.C. Hydro, had some effect on the movement of wildlife between Mount Revelstoke National Park into and across the Columbia valley. As the water backed up behind the dam, a lake 120 kilometres long and 1-2 kilometres wide was created. The movement of wildlife, mainly mule deer, moose and caribou at various seasons of the year were affected to some extent. Figure 15 and 16.

Other effects from the Revelstoke dam may be a slight change in the humidity due to the creation of the large body of water to the west and north of the parks. This theory has not been substantiated by any known research, however, the unpublished document: Climate Data Guide Summary (Kimmel, P. 1978), could be used as a comparative information source to determine differences to data collected by the Snow Research and Avalanche Warning Section - Rogers Pass, since 1983 when the dam was filled and Revelstoke lake was created. This could determine if there is a trend to changing weather patterns perhaps due to the large body of water adjacent to the two national parks. (Figure 17 shows the extent of the Revelstoke Hydro Dam Lake).

The C.P. Rail and Tunnel Project completed in 1988 in Glacier National Park has industrial effects that were addressed in (Section 5.2.1 - Air Pollution). Other effects from that project are the introduction of plant species brought in on railway cars by the increased rail traffic. These exotic plants may have a cumulative impact effect on the natural environment of the park lands.

Assessment: significant. Action: unlikely.

5.2.5.5 Habitat Destruction - Fragmentation

The destruction of wildlife habitat by clearcut logging in areas adjacent to the park boundaries is considered here as exotic encroachment. The unnatural changes in successional growth patterns in the logged over areas often cause fragmentation of wildlife habitat between the park environment and the routes followed by the migratory ungulate and carnivore species. This view is supported by (Simpson, K. and Woods, G., 1987) in their research on movements and habitats of caribou.

This process has cumulative impact by cycling over geographic space and time (CEARC Workshop, Baskerville 1986). "Each year, a portion of the forest is clearcut adding to the total of cutover area."
Heli-ski Dropoff Areas

Figure 16
Dams and Reservoirs

Figure 17
Since cutovers are not static they always recover, however, not necessarily to the right species. Over time there is a dynamic balance between the annual addition of total cutover by harvesting, and the annual removals by plant succession. The effect of this is that the impact of clearcutting migrates across the geographic area through time."

Detrimental effects to other ungulates and their predators from these logged over sites should also be an obvious conclusion, although logging tends to benefit early successional species such as moose, white-tailed deer and elk (latter - D. Poll, pers. comm.).

Timber harvesting need not always be totally destructive, however, if the industry is conducted with environmental sustainability in mind. Clearcut logging, if done in reasonably sized areas leaving strips of protected forest on a rotation basis, can be done effectively for mutual benefit to the industry and to wildlife. If the clearcut area is reforested by planting with the compatible species, the result may be acceptable.

An example of this success appears to be in the logged over site immediately east of Hamilton creek and adjacent to the south boundary of Mount Revelstoke National Park. This area was logged in 1982-83 and was re-planted in 1985 with Douglas Fir (*Pseudotsuga mensiesii*) and White Pine (*Pinus monticola*). Natural regeneration of Western Red Cedar (*Thuja plicata*), and various deciduous trees are also prevalent. All of the regrowth is progressing well, with the fir, pine and cedar exceptionally successful (to 15 ft. height), in an eight year period. The forest cover during the next ten year period will provide the beginning of an adequate wildlife habitat, except for caribou.

This type of a forestry program should be generally compatible in all areas adjacent to the park boundaries in the future, if clearcuts are kept to an acceptable limit.

There are several areas of immediate concern if timber harvesting were to continue using recent clearcutting methods. These are the upper Spillimacheen-Baird brook, the Tangier river valley, the north-west and the south boundary areas of Mount Revelstoke Park. In these locations, marketable timber is close enough to the park to have a direct wildlife habitat fragmentation effect. The B.C. Forest Service policy now requires a "Total Chance Plan" for areas such as these, however, which involve total consultation with all agencies affected before timber harvesting is approved.

As an example, the Upper Spillimacheen river (Crestbrook Forest Products Ltd.) operation have no further approval for timber cutting before 1997. At that time, any activity is subject to total agreement of all cooperating management groups.
Any further logging activity in the Upper Tangier river valley will depend on the decision of the Protected Areas Strategy for B.C. Committees for the Serenity Peaks proposal. If approved, scheduled for 1995, the area covering the majority of the Tangier valley will have extended environmental protection including restrictive timber harvesting.

Assessment: significant. Action: probable.

5.2.6 Visitor Physical Impacts

The direct result of visitors in the national parks and the environmental impacts that occur from this pressure, is discussed in this section.

5.2.6.1 Campfires (Campgrounds)

Only Glacier National Park has campgrounds for visitor use; Illecillewaet and Loop Brook. The environmental impacts of the campfires allowed in fire grates in these two parks can be considerable in the local area of the campgrounds. The smoke, during periods in the summer months when the air movements are minimal, adds particulates to the air. At times, this concentration is also dense enough to cause human respiratory problems.

A study was conducted in Jasper National Park by R. Bailey (AES) and A. Stendie (CPS) 1992-93, (the Atmospheric Environment Service and the Canadian Parks Service): "The study was designed to measure the levels of total suspended particulate (TSP) in the Whistlers Campground, and to determine whether these levels were above the national "acceptable" level for a 24 hour sample of 120 mg/m3. The national "acceptable" level defines the maximum level of air pollution at which human health is not considered to be at risk. This level is also designed to prevent the deterioration of visibility---." The results of that study during the fall of 1992 (Sept. 30 - Oct. 6) showed that during the peak periods of campground occupancy the levels of TSP exceeded the maximum acceptable levels. The "National Ambient Air Quality Standards for Total Suspended Particulate" (NAAQS) is shown in Table 4.

In Glacier National Park the campgrounds are relatively small in comparison to Whistler in Jasper National Park. However, observations during the peak summer periods indicated enough smoke pall hanging over the two campgrounds to warrant further study into the effects on the local environment and to humans.

Assessment: significant. Action: possible.
Table 4
National Ambient Air Quality Standards for Total Suspended Particulate

<table>
<thead>
<tr>
<th>NAAQS</th>
<th>TSP (µg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>24-Hour Acceptable</td>
<td>120</td>
</tr>
<tr>
<td>24-Hour Tolerable</td>
<td>400</td>
</tr>
<tr>
<td>Annual Desirable</td>
<td>60</td>
</tr>
<tr>
<td>Annual Acceptable</td>
<td>70</td>
</tr>
</tbody>
</table>
5.2.6.2 
Trampling

The higher use areas in both parks during the summer months have a problem with trampling of soils and vegetation. The most severe damage has occurred at the summit of Mount Revelstoke between Balsam lake and Heather lake, with some impact at Eva lake. The main reason for the destruction was the poorly designed trail system and the period of time that snow remained on the trails in early summer causing visitors to detour onto vegetated areas. Due to the short growing season at high elevation, the damaged areas take a long time to rejuvenate.

The other area of concern is in Glacier National Park at the Illecillewaet trailheads and Old Glacier House site. Here, the damage is the result of large numbers of people in a concentrated area during peak periods.

There are no other areas in either park that show significant signs of trampling impact as yet. However, the Bald Mountain area in G.N.P. has a fragile alpine-subalpine vegetative cover that could potentially be damaged if the guests from the Purcell Lodge are not controlled with a trail network and if the newly cleared "Caribou" trail attracts large numbers of hikers on the circle route of the Beaver river-Copperstain-Bald Mountain area.

Assessment: significant. Action: possible.

5.2.6.3 
Wildlife Harassment

The impact on wildlife in these parks from visitor pressure is concentrated along the highway corridor and the Mount Revelstoke summit road.

The highway corridor could be considered as a source of visitor impact on wildlife since many animals and birds are killed or injured by tourist vehicles as well as commercial vehicles. If the TCH is expanded in the future to accommodate increasing traffic volumes, wildlife resources will be impacted even more as well as removing already limited habitat in the corridor. Bears are an example of wildlife that are harassed through human ignorance when they are fed by visitors and become habituated to garbage. As a result, they are frequently hit by vehicles.
The feeding of Columbian ground squirrels by visitors at the Rogers Pass Center and the summit of Mount Revelstoke is also another form of harassment because of the unnatural food sources which interferes with their natural nutrition and could be detrimental in hibernation.

Dogs accompanying visitors are frequently a source of wildlife harassment whether or not they are on a leash. Their barking is disturbing, and even their presence is scented causing stress to park wildlife if they are in the vicinity.

Assessment: significant. Action: possible.

5.2.6.4 Offroad Vehicles - Snowmobiles - ATVs

During the past number of years, snowmobile use has been permitted in Mount Revelstoke National Park on the Summit Parkway. This is for a one day period, usually in January of each year, and is called the Snowarama. It is a fund raising event sponsored by the Lions Club and the local Revelstoke Snowmobile Club. The effects of this event to the park environment is somewhat detrimental since up to 100 machines have participated and the noise factor alone can be extremely disturbing to both wildlife and visitors. Other alternative locations exist for holding this event outside of the park.

Illegal snowmobile use is occurring in Glacier National Park in the Prairie Hills-Copperstain-Bald Mountain area. Snowmobile users access the park by the Spillimacheen, Canyon, Gorman and Quartz creek logging roads and roam over the alpine and subalpine tundra where the park boundary is located. They have ventured a considerable distance into the park, in some instances, particularly in the East Grizzly and Copperstain creek headwaters.

These encroachments occur in late winter/early spring periods when the snowpack is "set up" allowing easy snowmobiling. In Alberta, snowmobile use is restricted in alpine areas of the province so these club members often come to B.C. where no such restrictions apply. The effects to the park environment from this use could be considerable although no conclusive research has been found to verify the impact. (Figure 18 shows snowmobiling encroachment.)

My observations and those of other various individuals have determined obvious damage to the tops of small sub-alpine coniferous trees from snowmobiles, and predator tracks following the snowmobile tracks allowing easy travelling for them and perhaps abnormal ease of predation on susceptible wildlife species.
Figure 18

Snowmobiling Encroachment
Dr. P. Achuff, (pers. comm.), discussed the possibility for different vegetation patterns (depending on snow depth) due to being less frost tolerant, caused by compaction of extensive snowmobile use of an area. He mentioned possible species shifts in vegetation due to later meltout because of snow compaction, and that small mammal movements may also be affected by this factor.

The effects by snowmobiles on caribou on their winter range, could be stressful (Simpson, K. 1985). The caribou have been observed as being disturbed by the noise initially although if the noise is continuous in their environment, they may adapt somewhat.

Dr. T. Crowley (pers. comm.), indicated that if the snow is compacted by snowmobiles, the alpine lakes and ponds' aquatic life can be affected. The lakes continue to photosynthesize during the winter under the snowpack and if it is compacted, it does not allow light passage as readily. He also mentioned that aquatic life may also be disrupted by noise such as snowmobiles passing over the frozen lakes. Noise is accentuated due to the snow and ice on the surface (drum affect).

In discussions with Snowmobile Association members from Alberta and B.C. it was felt that association members are generally well informed of environmental protection policies and issues. These club members are also self-regulating within their groups and therefore it is not likely that these people are responsible for illegal activities. It is assumed that most of the encroachment on park lands is done by snowmobilers that are not associated with clubs, but are from the local area and do not have the guidance, knowledge or understanding of environmental sensitivity or regulations.

The U.B.C. Resource Management Science (Dr. B. Thompson), collected information by questionnaire sent to snowmobile participants throughout this area. Table 5 shows the results of "desireability of area attributes for snowmobiling".

An Interim Project Report (Dr. A. Kliskey), from the same department of U.B.C., indicated that "in areas of free snowmobiling and no trails, short term changes in behaviour, activity and energy budgets may occur on ungulates, while long term consequences include reduced production. There is undoubtedly some effect by snowmobiles on wildlife but the actual extent and detrimentality is largely unknown".

The U.B.C. Revelstoke Survey Project (Laurie Cooper), results also indicated that of all responses received 51.59% of snowmobilers used the Revelstoke/Golden area for their activity. This interest is likely due to the existence of logging access roads, mild climate and extensive snowfall in this area.
Table 5

Desirability of area attributes for snowmobiling
(1 = least desirable; 3 = neutral; 5 = most desirable)

<table>
<thead>
<tr>
<th>Attribute</th>
<th># resp</th>
<th>Range</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Near home</td>
<td>189</td>
<td>1 - 5</td>
<td>3.54</td>
</tr>
<tr>
<td>Challenge</td>
<td>196</td>
<td>1 - 5</td>
<td>4.52</td>
</tr>
<tr>
<td>Wildlife</td>
<td>194</td>
<td>1 - 5</td>
<td>3.34</td>
</tr>
<tr>
<td>Scenery</td>
<td>197</td>
<td>3 - 5</td>
<td>4.73</td>
</tr>
<tr>
<td>Solitude</td>
<td>193</td>
<td>1 - 5</td>
<td>3.97</td>
</tr>
<tr>
<td>Hunting</td>
<td>187</td>
<td>1 - 5</td>
<td>1.75</td>
</tr>
<tr>
<td>Wilderness</td>
<td>195</td>
<td>1 - 5</td>
<td>4.03</td>
</tr>
<tr>
<td>Amenities</td>
<td>194</td>
<td>1 - 5</td>
<td>3.46</td>
</tr>
<tr>
<td>Variety</td>
<td>197</td>
<td>3 - 5</td>
<td>4.67</td>
</tr>
<tr>
<td>Steepness</td>
<td>196</td>
<td>1 - 5</td>
<td>4.18</td>
</tr>
<tr>
<td>Snow conditions</td>
<td>197</td>
<td>3 - 5</td>
<td>4.72</td>
</tr>
<tr>
<td>Access</td>
<td>197</td>
<td>1 - 5</td>
<td>4.55</td>
</tr>
<tr>
<td>Logging roads</td>
<td>198</td>
<td>1 - 5</td>
<td>3.53</td>
</tr>
<tr>
<td>Forest</td>
<td>193</td>
<td>1 - 5</td>
<td>3.76</td>
</tr>
<tr>
<td>Alpine</td>
<td>198</td>
<td>3 - 5</td>
<td>4.62</td>
</tr>
<tr>
<td>Groomed trails</td>
<td>197</td>
<td>1 - 5</td>
<td>3.62</td>
</tr>
<tr>
<td>Unploughed roads</td>
<td>196</td>
<td>1 - 5</td>
<td>3.73</td>
</tr>
<tr>
<td>Untracked</td>
<td>196</td>
<td>1 - 5</td>
<td>4.61</td>
</tr>
<tr>
<td>Remote</td>
<td>196</td>
<td>1 - 5</td>
<td>4.15</td>
</tr>
<tr>
<td>Commercial</td>
<td>192</td>
<td>1 - 5</td>
<td>2.44</td>
</tr>
</tbody>
</table>
The Alberta Snowmobile Association did indicate that national park boundaries were poorly marked in the winter and it was difficult to know where they were in relation to the park. Park boundary markers that were once in place have deteriorated or in some areas have disappeared. They also felt that the park regulations were over-restrictive and that associations such as theirs are environmental protectionists and would like consideration for compatible snowmobile use within the national parks.

The use of All Terrain Vehicles during recent years has escalated in backcountry areas particularly during hunting season. Hunting is not permitted from an ATV, but the use is allowed to access a hunting area on provincial lands. Since logging roads have made access more convenient in towards the national park boundaries in B.C., the potential for poaching on park lands has also increased.

Assessment: significant. Action: possible and necessary.

5.2.6.5  
Heli-skiing

The activity of helicopter skiing in this area adjacent to these two parks has increased considerably in recent years. (Figure 15 shows the Helicopter Skiing areas adjacent to Mount Revelstoke and Glacier national parks).

The activity is of great interest, particularly to the European clientele, because of the rugged Columbia mountain terrain, the mild climate and deep snowpack. The helicopter skiing companies use the larger type helicopters (205A or 212 Twin), to transport skiers since they can accommodate more people/trip. These machines have a loud, throbbing sound effect that can actually release avalanches under suitable conditions. This sound also has a detrimental affect to wildlife as discussed in Section 5.2.5.3. The most severe effects may be to gregarious wildlife herds, i.e. mountain goats, in areas close to the park boundaries. The noise from these helicopters may scatter the herd for a time causing stress in an otherwise wilderness environment.

Areas of concern in these two parks are the Inverness Peaks, Silent Mountain and Iconoclast Mountain goat herds. Other species of wildlife have not been observed affected by the sound although caribou in the Mystic Pass area and on Mount Revelstoke could be vulnerable to helicopters passing directly overhead.

Assessment: significant. Action: possible.
Heli-skiing Areas

Figure 15
5.2.6.6  
Heli-hiking

Helicopters are also used to transport hikers into remote areas adjacent to the parks during the summer and fall periods. The activity provides accommodation for the people who stay at a lodge and hike the area for a period and are then usually flown back out, i.e. Purcell Lodge operation.

This activity is not extensive at the present time but has future potential to expand in areas around both parks. The impact is again on wildlife disturbed by helicopter noise, although presently a smaller helicopter 206B is used which is not as loud and disruptive.


5.2.6.7  
Park Operations

These operations can be considered an external threat to some degree because they are not part of the natural process within a park and the highway is maintained for external purposes as a national transportation route. The issue addressed here is not the fact that the source of the impact is present, but how the resulting threat to the park environment can be identified.

5.2.7.1  
Roads and Highway Corridor - Avalanche Control
- Road Maintenance

The highway in Glacier National Park, through Rogers Pass was completed in 1962 and avalanche stabilization began during the winter months to maintain the Trans-Canada highway open in a safe condition from snow avalanches. The method chosen was to use the howitzer military gun, at first the 75 mm and then the 105 mm was found most effective for the distance required to release avalanches.

From the beginning, although Avalanche Forecasters directed the firing of the gun (by an RCHA military unit), Park Wardens were responsible for the safety of the public and the monitoring of the effects to wildlife. Park wardens manned strictly controlled road blocks under the direction of the Chief Park Warden, during the period of avalanche stabilization. This was done in cooperation and coordination with the Snow Research and Avalanche Warning Section (SRAWS) in Rogers Pass.
The effects on wildlife, particularly mountain goats on Mt. Tupper and area, were uncertain but it was assumed that there were mortalities from the constant shrapnel and the released avalanches directly. The occasional carcass of a goat was found in the spring in the avalanche deposits.

A goat study entitled "The Goats of Mount Revelstoke/Glacier National Parks" (McCrory, W. 1979), determined that "4 known goat winter ranges receive artillery fire" in Glacier National Park. 'Indirect evidence suggests that some goats might receive injury/mortality from shrapnel, but this was difficult to prove.' and, 'some goats showed mild reactions to the loud boom of the gun or the exploding shell; 1 was observed to panic and leave the area.' also, 'the study was incomplete and inconclusive. Both winters had below average snowfall. One of the SRAWS' staff observed that, during the heavy snowfall winter of 1971/72 they might have "shot the hell" out of some of the goat herds."

Observations since the goat study was completed indicate that the goat herds may, in fact, adapt somewhat to the avalanche control program since they do not appear to attempt relocating to other more remote areas of the park. Population densities seem to remain static which could indicate mortality is offsetting reproduction, but direct causes are yet to be determined. (Figure 19 shows the Mt. Tupper goat herds in relation to avalanche control target areas).

Assessment: significant. Action: unlikely.

The highway maintenance program through both parks is somewhat detrimental to the park environment. The most serious is the use of salt (sodium chloride) to facilitate sand application to the road surface by preventing the freezing of the material in the sander hoppers, and to keep the highway surface ice-free. The effects of salt deposits on the roadsides to both vegetation and wildlife is not fully understood and little research could be found which analyzed the problem. It is obvious, however, that the effect is an impact to the natural resources and is an interference in the natural process. One of the obvious impacts is that salt is an attractant to ungulates and birdlife, on the road surface (as was discussed in previous section 5.2.2.2).

Other detrimental effects originate mainly from the Rogers Pass and One-Mile compounds. The storage and/or leaching of highway maintenance materials i.e. paints, petroleum products, etc., was a serious problem in the past, however, much of this source of residue was "cleaned up" although some of the effects still remain.
Mount Tupper Goat Herds
-Area of Avalanche Stabilization-
Another source of pollution originating from the Rogers Pass highway maintenance operation is the extensive use of diesel powered vehicles and equipment. The start-up emissions from these engines contribute to the nitrous oxide and sulphur dioxide particulate problem. Other alternatives are now available to minimize the harmful effects, i.e. computerized engine controls (R. Magarian, pers. comm.).

Assessment: significant. Action: possible.

5.2.7.2
Facilities - Park Buildings
- Old Buried Storage Tanks
- Campgrounds and Waysides
- Trails

The facilities in these parks are or have been necessary for park operations but some of these threaten the integrity of these national parks.

The park operational buildings are an example of this threat because of their design that is not compatible with the park environment (discussed in Section 5.2.3.4, Aesthetic Degradation).

In Rogers Pass there are a number of old buried storage tanks or objects that may contain harmful substances, some of which have existed since the Canadian Pacific Railway was in operation over Rogers Pass (before 1916). The area of Rogers Pass was mapped using electromagnetic (inductive) instrumentation, (arranged by the Conservation and Protection Service (C&P), who commissioned a consultant (ARECO Canada Inc.) 1991, to record all of the locations of contaminated sites. This report is available at the Canadian Parks Service office, Revelstoke, B.C. (titled: Geomagnetic Survey-Rogers Pass). Some of these tanks may contain petroleum or toxic chemicals that could be/or may in the future be, leaching into the surrounding area.

Assessment: significant. Action: possible.

The campgrounds and picnic areas in these parks are well maintained on a daily basis during the summer months. The sewage systems are the most probable source of pollution in the future by deterioration of pipe lines and septic tanks. Both campgrounds are located immediately adjacent to river tributaries.
At the present time most of the systems appear to be in satisfactory condition, except that the Illecillewaet campground and Giant Cedars picnic site sewage fields are not large enough to handle the demand; and the Tractor sheds wayside privy holding tanks area leaking into the surrounding area.

Assessment: significant  Action: possible.

The proper maintenance and/or construction of park trails is important to prevent erosion problems in those areas. The resulting cumulative effects of poor trail building can affect surrounding vegetation and water tributaries. Examples of problem areas can be seen in Glacier National Park, particularly in the Beaver valley and Bostock creek where constructed trail banks and backslopes have eroded and fallen away. The source of the problem is more from poor route selection rather than techniques of trail building. In some locations, the type of terrain is not compatible with trail construction mainly due to water seepage in conjunction with steep sidehills.

Assessment: significant  Action: possible.

5.2.7.3
Research Collecting, Bird Banding, Collaring

Research collection by park staff has been a controversial issue in national parks, in the past and still continues. Much of this controversy is caused by lack of understanding and poor communication between park staff. In the publication "Islands Under Siege", J. C. Freemuth, in the "Conclusion: Resolving Threats to Pars", he quotes from a journal dedicated to promoting research in U.S. national parks:

"What happens -- when park science is viewed as an end in itself rather than as a tool of park management? When significant numbers of scientific and lay people (presumably environmentalists) view certain parks primarily as scientific benchmarks, gene pools, and relict environments of inestimable value to mankind in a trembling biosphere?-----."  

In our parks, the objective, as stated in Parks Canada Policy, 1983, Section 3.1 Resource Protection: "Natural resources within national parks will be given the highest degree of protection to ensure the perpetuation of a natural environment essentially unaltered by human activity."
The banding of birds is one example of questionable purpose since the stress of capturing and holding the birds is obviously detrimental particularly during the nesting period. Although the reasoning for this research is international in scope, the birdlife in the parks may be better left undisturbed.

Collaring of wildlife, i.e. caribou, grizzly bear or any larger animal, causes stress to that individual and could lead to injury or death (i.e. if a snag or tree branch is run through the collar while the animal is rubbing, etc., if the collar is not the break away type). The procedure used to attach the collars by netting adds to this stressing factor. There are alternatives to the study involving tracking of wildlife (D. Poll, pers. comm.), that may be more compatible with park purposes. (see recommendations section).

Assessment: significant. Action: investigation

5.2.7.4
Suppression Of Natural Fires

The suppression activity generally used in fire control for naturally occurring fires has cumulative effects that are abnormal to adjacent vegetation and aquatic life. If fire retardant is used, it has a fertilizing agent (ammonium sulphate or diammonium phosphate) ref. Ministry of Forests, B.C., that may cause excessive growth in vegetation causing ultimate die-off. This affect is similar to the objective sought using herbicides.

Residues form the retardant are also thought to affect aquatic life if allowed to enter water tributaries in areas below the fire control zone, due to runoff. Other effects of fire suppression using hand tools or equipment cause soil disturbance contributing to later erosion problems.

Assessment: significant. Action: possible.

5.2.7.5
Bear Management

The existence of the City of Revelstoke municipal dump has been a detriment to Mount Revelstoke National Park. This site has attracted numerous bears and it is suspected that some of the grizzly bear home range is in these parks, although their range covers a large area. The impact on the park grizzly population is not known but assumed to be significant. During the 1993 season, 18 grizzly bears were removed from the Revelstoke dump by Conservation Officers. Most of these bears were relocated to areas east and north of these parks in the upper Columbia/Bush river areas (J. Hollingsworth, pers. comm.). There is no legal open hunting season for grizzly in those zones, however, illegal hunting may account for the loss of many of these bears.
D. Grizzly bear in Glacier National Park.
Photograph by warden service.
An electric fence was installed around the new dump site which should stop these bears from becoming habituated to garbage. It will be in operation in 1994, however, the old buried site does not yet have an electrified fence and bears still dig for garbage in that area.

Black bears have also been attracted to the townsite (some from Mount Revelstoke National Park) because of fruit trees and garbage. A "Save the Bears Committee" was formed as a cooperative venture between the park and the City, which appeared to be quite effective.

Assessment: significant. Action: necessary.

5.2.7.6

Employees' Ignorance

Many of the problems associated with environmental effects in the past, in park operations, were due to the lack of understanding, or guidance to park employees responsible for that area of work. Carelessness in the handling or disposing of chemicals or materials occurred and as a result, effects particularly to water tributaries, may have been detrimental to both land and aquatic life. Since then, employees have become much more knowledgeable and informed of the effects to natural resources.

Assessment: insignificant. Action: not required.

5.2.7.7

Political Pressures

Occasionally, political issues arise, (provincially and federally) the effects from which may interfere with natural resources.

These issues are usually controversial between industry and environmental concerns, and can be centered in areas adjacent to the national parks boundaries. The effects of decisions to these conflicts can be detrimental to park management if they are swayed in favour of industry or the economy.

Assessment: significant. Action: possible.
6.0 RECOMMENDATIONS

"Don't run before you're chased", is an attitude that can often be applied to industry, developments or activity operators who are causing environmental damage. If they are not forced to change bad practices, they don't, in many cases.

A general recommendation in dealing with the external threats problem in Mount Revelstoke and Glacier National Parks, is to develop an integrated ecosystem management plan to include cooperative arrangements with provincial and private agencies. The objective of this plan should define appropriate measures to manage lands adjacent to the park boundaries for cooperative protection of the relative ecosystems. The "outside looking in" approach to this management of the parks should be considered, rather than the internal to outward style.

The issue of "limits of acceptable change", must be considered when planning measures to deal with external threats. To envision what is acceptable and where to draw the line can be difficult.

Within the park management, complete coordination between Heritage Resource Conservation and Heritage Communications sections is critical for the successful implementation of a plan.

Many of the identified areas have cumulative environmental effect possibilities, and these should be given top priority.

The following points discuss the recommended mitigative actions and/or alternatives that could minimize the impacts of the threats identified in the previous section:

6.1 Suggested Management Actions

6.1.1 Air Pollution

This pollution, caused primarily by the Trans-Canada highway and C.P. Rail, could be minimized if regulatory processes were instituted to filter exhaust fumes on both transport vehicles and railway locomotives. C.P. Rail installed "scrubbers and filters" in the ventilation equipment, in the new MacDonald tunnel. However, the appearance of the exhaust indicates a considerable amount of black smog and during the winter the snow near the vent areas is covered with black deposits.

In both cases the actual extent of the suspended particulates is still to be determined because instrumentation monitoring has not been installed in the proper locations. The Air Quality Station, established 1986 in Rogers Pass, was set up to monitor the emissions from the new C.P. Rail vent shaft at the summit.
However, it was located approximately 1-1/4 km. (behind the Rogers Pass compound) from the shaft, and because most of the emissions from the shaft dissipated up over the mountain ridge above due to updraughts, limited indications of air pollution were recorded.

It is recommended that instruments be installed at the MacDonald Tunnel portal (east) and the Connaught Tunnel portal (east) areas, sensitive enough to effectively record the extent of the suspended particulates affecting the Beaver river valley environment.

The motor vehicle emissions on the Trans-Canada highway are difficult to determine since due to air movements and through traffic, the effect is neutralized at any given point.

A recommendation in these parks is to construct a third lane section at alternating locations, to create a passing lane, which would dissipate traffic faster and thereby reduce emission pollution.

An interim solution to minimize dry chemicals and other materials emitting from transport vehicles is to ensure by cooperative agreements with the trucking industries (Alberta and British Columbia), that no transportation of uncovered chemicals or loose materials in dry form will be permitted through a national park.

An alternative for electrical power in Rogers Pass has been investigated by park managers in conjunction with the western regional office. An agreement to acquire electrical power from Revelstoke via the C.P. Rail power line is under review.

This proposal should be actively pursued and every effort made to have this power established in cooperation with C.P. Rail and B.C. Hydro by 1995, to eliminate the requirement for diesel generating plants in Rogers Pass.

If both the park facilities and Glacier Park Lodge removed that source of emissions, it would greatly benefit the park environment.

6.1.2 Water Quality

The only aquatic areas that are affected by acidification in these parks are the lakes or "still" bodies of water. Since effects of acid rain cannot yet be controlled (sources may be international in scope), the regular monitoring of the lakes Total Alkalinity (ref. Section 5.2.2.1) is the only recommendation possible at this time.

This monitoring program could maintain a record, with an on-going data base, of changing alkalinitities to evaluate how the unmanipulated natural sites will respond to acidification. A "partnership" program with Okanagan University College (Salmon Arm) would be valuable to both the parks and the college. They have expressed interest in that venture.
The other pollutants affecting water quality can be minimized and in some cases eliminated. The sewage lagoon and treatment plant in Rogers Pass must be maintained in peak operating condition.

A monitoring program taking water samples every two weeks, at the lagoon outlet, should be conducted. Problem periods where faecal coliform counts are evident indicate that the treatment system is not functioning efficiently.

The use of Sodium Chloride on the Trans-Canada highway has become a "necessary evil" to maintain the highway in safe driving condition. Other alternatives to the use of salt have been investigated by various agencies. A product, "Urea", has been found effective but too expensive, and the same applies to other chemicals tested to melt snow and ice. (Recommendation: See Section 6.1.7)

A concerted effort should be instituted, by park managers, to find alternatives to this problem of salt residues leaching into water tributaries. More research is required to establish a satisfactory and feasible substance to replace sodium chloride for winter highway maintenance.

Toxic spills occurring on the Trans-Canada highway and C.P. Rail are usually handled effectively using the existing Toxic Spill Plan.

Care should be taken to update this plan annually to include changing contact numbers and agency names.

6.1.3 Aesthetic Degradation

The forest industry clearcut areas adjacent to the park boundaries create the more obvious aesthetic impact. The suggested management action for Mount Revelstoke and Glacier National Parks is a cooperative management program between the Canadian Parks Service and B.C. Ministry of Forests.

A mutual agreement can be formed whereby the forest industry can harvest areas in smaller cutovers and utilizing selective logging methods. This will then reduce the visual impact and if reforestation is practiced properly, minimal degradation should be the result.

Slash burning of the cutover areas is beneficial to the reforestation process by "cleaning up" the site and providing nutrient cycling to soils (Match, R., USA Forest Service). Since the effect of the smoke to adjacent areas is detrimental, however, particularly aesthetically, other methods can be employed that may be less of an environmental impact.

Through the proposed cooperative management program, alternate methods, such as mulching and spreading of the debris, instead of burning should be considered. The natural "breakdown" process will take longer but the end result is compatible land preparation for reforestation.
The Trans-Canada highway and other internal access roads in both parks should be given a critical assessment and a program instituted to rehabilitate the backslopes and rockcut areas. Since these are some of the most obvious aesthetic impacts within the parks that can be managed, that responsibility lies with park management to conserve credibility.

Negotiations with C.P. Rail should be renewed to complete the camouflage effect to the backslopes and retaining walls along the new railway grade in the Beaver valley. The view from the T.C.H. would then be improved, which was in the agreement - "Surface Route: Conceptual Design Evaluations" and the Rogers Pass Project Brief 1982".

Land development adjacent to the two parks is not extensive as yet, but the potential exists and the cooperation between B. C. Lands and Park Management to review any new development referrals must continue.

In Mount Revelstoke National Park, the potential for serious detrimental aesthetic impact exists because of the program to promote small business development by the C.S.R.D. Bylaw #2200 and the City of Revelstoke. Some of this development could be established immediately adjacent to the boundary near the town and the Revelstoke damsite.

Communication with these agencies must be established and maintained to ensure the park is involved in any development proposals.

The internal visual impact of road signs and other park inholdings requires a review and consideration during any future construction or design. If the park is to develop and maintain credibility against the perceived "double standard" of the past, these considerations are a priority.

The problem of vandalism occurring in these parks is both aesthetically degrading and expensive to repair. An increased enforcement presence and other deterring mechanisms should be considered. Consultations with other agencies involved with similar problems may provide improved methods of prevention.

6.1.4

Physical Removal Of Resources

Legal trapping and hunting in areas adjacent to these two parks is not considered a problem as yet, because of the regulations and control by the provincial authorities. There are the three wildlife species: mountain goat, caribou and wolverine, open hunting seasons that should be discussed with the B.C. Wildlife authorities and perhaps gain restrictions in those areas.
The illegal activities of both trapping and hunting are of concern, however, and perhaps much more widespread than was previously realized. Some of this activity occurs due to ignorance of the individuals, and partly due to problems with the management of the park and the B.C. Hunting and Trapping Regulations Synopsis.

The information signs erected by the park in 1991, on access roads outside park boundaries, require relocating in a number of areas. They are presently too far away from the park boundary and do not specify where the sign is in relation to the boundary. This has caused some confusion with backcountry travellers, particularly hunters and snowmobilers. A complete review of that project is recommended.

The B.C. Hunting and Trapping Regulations Synopsis requires revision to eliminate the wildlife management unit zones from within park boundaries (shown in the regulations map for the Kootenay region). Continued communication/cooperation with the provincial authorities is necessary to accomplish this important change.

A more active and effective law enforcement program is necessary in these parks to curb the suspected poaching activity in the more isolated areas, which are accessible from provincial logging roads. Park warden presence in these backcountry areas must be escalated, not just during the hunting season. To accomplish these duties, an increase in enforcement staff is necessary and they should be totally dedicated to the objective.

The mortality of wildlife on the Trans-Canada highway caused by vehicles, is a significant problem in these two parks. The use of fencing along the highway corridor is not a practical solution in this area because the snow "creep" during the winter would destroy the fence.

Aversive conditioning (using constant negative methods to discourage habituation) has been attempted on bears, with limited success, to repel them from garbage in campgrounds and other areas "Bear Attacks" (Herrero, S., 1985). A form of aversive conditioning may be applied on other wildlife species, i.e. goats at the snowshed areas in Glacier National Park, to discourage them from licking salt on the highway.

Another method that has been found partially effective on highways in the U.S. parks, to warn motorists to slow down through wildlife areas, is a single post with "twin eye" reflectors resembling those of an animal. These are erected at various locations beside the highway.

Specimen collection for research purposes requires a complete review to define more specific guidelines for the protection of the natural resources. Personnel assigned to this review should be those qualified and experienced in resource protection and preservation, in cooperation with representatives from the universities and colleges.
The removal of flora, i.e. berry and mushroom picking, should be more stringently controlled in accordance with the National Park General Regulations.

A more active media coverage of this regulation and a few actions against violators should be all that is necessary to control this activity.

Soil erosion occurring in man-disturbed areas contributes to the removal of natural resources by dislodging of vegetation.

The effective rehabilitation of road backslopes and rockcuts, where possible, may arrest this problem to some extent. Improved trail routing and construction techniques will help minimize erosion in backcountry areas.

The two mining claims that still have active leases, in Glacier National Park, should be monitored to ensure that no encroachments occur on park lands i.e. attempts at mining those sites may be detrimental to adjacent areas. This is not likely to happen since any transport of equipment into those sites is restricted by park regulations.

A provincial mines committee, chaired by Andrew Whale, (Energy, Mines and Petroleum Resources), Cranbrook, B.C., reviews all applications for mining claims in this area. Park management should arrange to receive referrals of these applications before approvals are finalized, for those areas adjacent to the national park boundaries.

6.1.5
Internal Encroachment

Unnatural fire must be suppressed in a most efficient and immediate action as possible. The effects of the suppression methods must be the first consideration, however, to minimize encroachment on other resources.

The use of fire retardant should be used only when water is not effective, and heavy equipment used only as a last resort.

Fire line construction is often more damaging than the fire itself and signs of these lines are evident for many years after the fire scars are obscured by natural processes. The fire lines, due to being grubbed or scraped down to mineral soil or rock, are generally naturally revegetated with deciduous growth. This vegetation shows in contrast to the predominantly coniferous new forest, appearing as "snakelike" lines throughout the old burn area. New methods of fire line control are available and should be investigated.
The noxious weed infestation in both of these parks, along the Trans-Canada highway, must be controlled with a regular control program.

Continuous efforts of hand-pulling of these weeds should continue making sure that the root system is also destroyed. The pulling is best done in the flowering stage and before the weed develops into the seed stage. All plants pulled must be carefully bagged and burned in an incinerator to ensure any seeds escaping the burning are not spread to regenerate.

If the spraying of herbicides is again approved for the noxious weed control, a thorough application is required while the weed is in the flower stage. Regular monitoring is then necessary and any new growth or evidence that some of the plants were not affected, will need a second application of herbicide.

Participation by the park management from these two parks, in the Noxious Weed Control Program, with the Columbia Shuswap Regional District is recommended to maintain contact and continue discussion on the effectiveness of the weed control. The contact with the C.S.R.D. is through the coordinator of the program (Salmon Arm Regional Office).

Noise from sources in and above Mount Revelstoke and Glacier national parks, is an encroachment that should be reviewed and some possible forms of minimizing the effects are possible.

The noise level on the T.C.H., particularly from transport trucks, probably cannot be reduced by any significant amount without restricting the number of trucks permitted on the highway. Since this is a national transportation corridor, those restrictions cannot even be considered. An alternative, however, is recommending that truck trialers be transported by C.P. Rail which should be more economical and less environmentally damaging.

Aircraft flying over the parks could be controlled to a greater extent than is presently the case. Helicopters flying at low altitudes, much of this activity for park management, are disruptive to wildlife and visitors.

A review of when and how often helicopters should be used in these parks is recommended. Specific guidelines should be prepared for this use, particularly regarding the frequency that the machines should be permitted to land in areas of wildlife habitat.

An agreement should be developed with helicopter skiing operators and lodge owners adjacent to the two parks, to minimize the flying of the larger helicopters over park lands. Often, these machines fly directly over the parks taking the shortest route to their destination. Alternate routes could be arranged that would minimize the disturbance.
The encroachment of industry; in this case the B.C. Hydro Revelstoke dam and C.P. Rail Tunnel and Grade Reduction projects, on these two parks is now permanent since both developments are now complete.

Monitoring of the detrimental effects, however, is necessary on a continuous basis to establish a program of mitigative measures.

Wildlife habitat destruction in areas adjacent to the park boundaries, because of the forest industry clearcutting large sections, creates extensive encroachment on park lands. Cooperative management with the forest industry and the B.C. Ministry of Forests is a requirement on a continuous basis to maintain wildlife habitat for those species that range over a large sized area. Reviews of the "Total Chance Plans", required for each timber harvesting area, is essential.

Changing forest harvesting practices, stimulated by cooperative management discussions, should minimize the wildlife habitat destruction in the near future.

6.1.6 Visitor Physical Impacts

Campfires in the two campgrounds, located in Glacier National Park, require monitoring to determine the extent of the smoke (suspended particulates) problem during the summer months.

Using the final result analysis from the Whistler campground study in Jasper National Park (to be available in 1994), it should be possible to apply that data to the lesser impact effects observed in Illecillewaet and Loop Brook campgrounds because of their smaller size.

This further research is necessary in the near future before any redesign of the campgrounds is complete. New methods of smoke filtration from campsite fire grates may be available, or if not, the requirement to burn only manufactured "artificial" type firewood could be considered that does not emit the harmful emissions. A complete restriction on the use of campfires is also an alternative.

Trampling by visitors in the higher use areas also requires further monitoring. A study completed "Subalpine Revegetation and Disturbance Studies - Mount Revelstoke National Park" (Campbell and Scotter, 1975), indicated that "it is vital to route people away from wet meadow areas" to allow revegetation which will then take considerable time for natural regeneration. The Mount Revelstoke Summit Area Plan currently in progress should eliminate or at least minimize the problem in that area, however, continuous monitoring is also necessary.
The trampling occurring at the Illecillewaet trailheads area can be effectively reduced by communication with the visitors. The lack of information (protection of park) signs at this location and the lack of attendants to control the activities of the visiting public, are the main problems in this area. For this reason, it is recommended that a more pro-active approach to the visitor monitoring program be considered.

The Bald Mountain area activities is another concern that potentially can be an impact to the natural environment, from trampling.

If an effective network of trails, (constructed to withstand extensive foot-traffic, i.e. hard surfacing), is established, most of the impact should be controlled. However, on park lands i.e. part of the Bald Mountain section in this case, the presence of a park warden is recommended on a regular basis to ensure that visitors obtain proper information and their activities are controlled. The warden should be based at the Copperstain warden cabin for the summer months with daily patrols scheduled.

Wildlife harassment or interference such as feeding, or allowing dogs in the vicinity should be more effectively controlled. Increased communication with park visitors to improve public relations is the best management tool. If the reason for regulations are explained to visitors, they will usually give full cooperation. "Heavy handed" enforcement, in cases such as this, is not the most effective remedy.

The use of off-road vehicles encroaching on park lands in these two parks must be more effectively controlled. In the Bald Mountain area of Glacier National Park, the illegal snowmobile use inside the park must be terminated by using strict enforcement and charging violators.

It will be difficult to do this because of the speed of the machines and their method of access in the remote areas.

The recently erected park information signs at access points outside these parks must be relocated closer to the park boundary and/or have more clearly defined "you are here" directions placed on the sign maps.

The use of "all terrain vehicles" to the park boundaries from outside can also be effectively prevented using the same enforcement method as with snowmobiles, but also with increased warden presence in the park backcountry areas.

The recently erected park information signs at access points outside these parks must be relocated closer to the park boundary and/or have more clearly defined "you are here" directions placed on the sign maps.
Park boundary markers and cairns must be re-erected where they have deteriorated or otherwise may have been removed. A complete park boundary identification project should be planned with necessary funding secured. The most critical areas are the Mountain Creek boundary, the Beaver Valley north boundary, the Bald Mountain ridge from Copperstain mountain to Silent mountain, Mountain Creek boundary, Mystic Pass and Farm Pass in Glacier National Park, and Mt. St. Cyr, Woolsey Creek and the total south and west boundaries of Mount Revelstoke National Park. These areas have adjacent access roads and/or activities pressuring the parks.

The helicopter skiing industry in areas adjacent to these two parks should be monitored more closely to determine any detrimental effects to the park environment.

Cooperative agreements should be maintained with these companies to minimize low elevation flying over park lands. There is potential for encroachment on park lands with these helicopters landing inside the park boundaries to "pick up" skiers. There has been no such activity found as yet, however, and regular contact with the heli-ski operators will help prevent this from occurring.

6.1.7 Park Operations

The effects of the avalanche control program in Glacier National Park should be monitored regularly for a three year period to determine if there are harmful affects to the mountain goat populations on Cougar Mountain and Mount Tupper. This research is necessary for a period, preferably during a heavy snowfall winter, when more artillery fire is used.

Alternatives to the use of salt on the highway during the winter operation, should be pursued. Acquisition of funds for this research could be adequately justified because of both the effects to wildlife, and the deterioration of vehicles from the salt. Cooperative funding may be possible between the federal and provincial governments if this were investigated. The B.C. Ministry of Environment and Environment Canada may assist with that research since the impacts are province/nation wide.

The extensive use of diesel powered engines in equipment and vehicles in Rogers Pass is necessary for highway maintenance. Alternatives to control nitrous oxides and sulphur dioxide particulates, from these engines, are now available using up-to-date computerized equipment to minimize the "start-up emission problems on these engines (R. Magarian, pers. comm.). This action should be considered when purchasing new equipment.
The old underground storage tanks located in Rogers Pass should be given further examination to determine if they can be safely removed without causing more contamination. The deteriorated state of these tanks may be such that this removal is not possible. If it is found that they no longer contain oil, fuel or chemicals, leaving these containers buried may be the most logical action.

Sewage systems in Illecillewaet campground and Giant Cedars picnic site should be redeveloped to handle the increased demand. The Tractor Sheds wayside privy holding tanks require replacement.

Park trails, particularly in the backcountry areas, require considerable project work and in some cases relocation to minimize erosion and constant maintenance. The Beaver river and Copperstain trails are a priority and justify a major capital project status.

The research methods used in these two parks for wildlife studies should be thoroughly reviewed and the purpose of each weighed against the stress caused to that species.

If the study does not contribute to the future protection of these resources in a national park, the justification is questionable.

Duplication of research must be avoided. If interpretation of the resource is the objective, often the information already exists in libraries or files without requiring further study.

An example of alternatives to stress-causing methods of tracking wildlife, is transmitter implants. Better quality implants are now available (D. Poll, pers. comm.) using lithium batteries with a 3-year lifespan. Instead of installing radio collars on the animal, the small transmitter is implanted under the hide. The instrument is expelled naturally from the animal after a period and therefore does not require a second capture for removal.

The use of fire retardant to suppress naturally occurring fires in these parks should be used only if water has been found not to be effective. Quite often a spot fire caused by lightning strike does not require immediate action, but can be monitored and will smoulder for a time before being extinguished by rainfall.

Construction of fire lines can often cause more cumulative damage than the fire itself, be erosion and other long-lasting effects.

Bear management between Mount Revelstoke National Park and the City of Revelstoke must continue on a cooperative basis.

Bear population in the park appears to be on a decline which is assumed to be due to the attraction of the dump and the town. The park is not large enough to have bears relocated there and hope to have them remain, with the town in the near vicinity.
Probably the only logical management is the effective cooperative actions to save the bears, through the committee. Cooperative agreements between the park and the Conservation Officer Service in the management of grizzly bears is also a continued necessity.

The historic or cultural structures in Glacier National Park require regular maintenance to ensure their preservation which is part of the park biocultural mandate.

Water erosion is the main problem in areas such as Loop Brook where water has undermined some of the old stone pillars of the first C.P. Railway grade.

The effects of political pressures on the protection and preservation priorities of a national park are generally controlled from higher levels than the park management.

It is suggested, however, that all park staff keep "in tune" with occurrences and developments on a regular basis to perhaps become aware of critical information that may not otherwise be immediately apparent. This information should then be "passed on" to park management.

6.2

Summary - Monitoring/Research

A summary of the recommended monitoring or research required in or around Mount Revelstoke and Glacier national parks for the near future years is as follows:

6.2.1

Air Quality

The C.P. Rail tunnels, particularly the new MacDonald Tunnel, should have effective sensitive instrumentation installed at the east portal to analyze the suspended particulate emissions. Research into the effects of those chemicals on the environment in the Beaver valley and area, is essential to perhaps prevent irreversible damage.

6.2.2

Water Quality

Cooperative research into the effects of acid rain is in progress by the Atmospheric Environment Service - Canada. Okanagan University College, Salmon Arm, B.C., should be involved in this research on a continuing basis in these parks because of their expertise and near proximity to the area.
E. Historic structures - Loop Brook pillars
Glacier National Park.
Photograph by warden service.
The lakes in these parks that we have sampled and analyzed for Total Alkalinity in 1993, should continue to be monitored and the information forwarded to the AES for their national records.

The Rogers Pass sewage lagoon and treatment system requires water sample monitoring every two weeks at the outlet into Connaught creek.

An alternative to the use of sodium chloride for winter highway maintenance should be researched with the cooperation of Universities/Colleges.

6.2.3 Aesthetic Degradation

Activities with the forest industry in areas adjacent to the two parks should be monitored on a continuous basis. Clearcut logging and development of access roads are the most detrimental to the parks from both an aesthetic and park protection viewpoint.

Monitoring of any land development plans around both parks is important to ensure the extent of the industrial and private development is realized, and to minimize the effects to park resources.

6.2.4 Physical Removal Of Resources

Trapping and hunting activities on lands adjacent to the parks should be regularly reviewed in cooperation with provincial conservation officers and the B.C. Regional Wildlife office, Nelson. Field monitoring of the location of these activities within each territory, and methods used could determine specific effects on wildlife next to park boundaries.

Continued communication/monitoring regarding the B.C. Hunting and Trapping Regulations Synopsis is important in order to advise provincial authorities of any detrimental effects these regulations might be having on the national parks.

The collecting permit system should be monitored after the system review is completed to ensure that the specimens collected relate to those specified on the permit.

Monitoring of the mining claims, to detect any activity, in and adjacent to the parks, should be done on a regular basis.
External (exotic) Encroachment

The effects of forest fire suppression using fire retardants has been studied with some inconclusive results. Most of this research was done in the mid 1970's. At this time that field should be re-examined with the purpose of determining any detrimental effects to vegetation and aquatic life.

The noxious weed infestations and control methods require regular monitoring during the July-August period.

More research into the effects of excessive noise on wildlife is necessary. The disturbance levels from low flying aircraft and transport trucks has not been documented but presumed to be detrimental.

Much more information is required on the effects of habitat fragmentation to wildlife. Many theories and assumptions have been papered in this field, without a great deal of conclusive evidence. However, work in this area is progressing rapidly and "this phenomenon is a major agent of ecosystematic change" (T. Crowley, pers. comm.).

Encroachments caused by the developments of the Revelstoke dam lake, and the C.P. Rail Tunnel and Grade Reduction projects should be monitored to determine further preventative measures.

Research is required to determine possible effects of water reservoirs (dams) on climate within these two parks, since they are now surrounded by these water bodies.

Grizzly bear research is critical if the species is to survive in this ecological area. At the present time, the lack of information restricts any management action that could be applicable.

Research is required into the status of the wolverine in these two national parks.

Forest insect and disease infestations in these parks require more in-depth research. The Canadian Forest Service have conducted annual surveys within national parks and provide an annual report. Research into the source of these infestations, i.e. whether they are introduced from the province or vice-versa, is necessary, although Parks Canada Policy does not require the control or interference of insects or disease in this natural environment.

The helicopter skiing activities should be monitored more closely for the effects to wildlife in the heli-ski areas adjacent to the park boundaries.
6.2.6
Visitor Physical Impacts

Smoke from campfires in the two campgrounds should be monitored during the months of June, July and August. (National Ambient Air Quality Standards for Total Suspended Particulate). The results should be compared to the research done in Jasper National Park, in Whistler campground. The different climatic zones of the Selkirk mountains may produce a variant in the action of suspended particulates.

Trampling of sensitive vegetated areas in both parks during the summer months requires monitoring on a regular basis to determine if action is needed to prevent permanent damage.

A backcountry monitoring program is necessary to determine the extent of use by all-terrain vehicles and snowmobiles both within and outside the park boundaries.

6.2.7
Park Operations

The avalanche stabilization program, with regard to determining the effects of gunfire on the goat populations, should be monitored each time that avalanche control is in progress during daylight. An observer with the gun crew could perhaps monitor the effects with binoculars.

Research is also required on effects of avalanche control on avalanche slope vegetation composition.

The effects of fire suppression methods for naturally occurring fires should be monitored during the months and years after the fire is extinguished. This may indicate the detrimental effects, of erosion and the use of retardant, to water tributaries and vegetation growth.

6.3
Conclusions - Addressing The Questions

In Section 1.2, a number of questions were outlined for this assessment. The conclusions to these are summarized as follows:

6.3.1
The sections of Mount Revelstoke and Glacier national parks that are most affected by the external threats are some of the park boundary areas, and the highway/railway corridor.

In Mount Revelstoke, the north-west portion of the boundary on the west shoulder of Mount St. Cyr are affected because of the logging activity in adjacent areas, and recreational activities; heli-skiing and snowmobiling in the Sail mountain area.
The west and south boundaries have pressure because of the near vicinity of the City of Revelstoke, the Revelstoke Hydro dam and logging activity near the Hamilton creek area.

The summit of Mount Revelstoke attracts considerable visitor pressure during the summer months.

Glacier National Park is pressured by activities in the sub-alpine, alpine areas of the Bald Mountain, Prairie Hills and Mountain Creek headwaters.

The Beaver river valley north boundary is subject to constant pressure due to the accessibility of the area via the TCH and railway.

The Beaver/Duncan watershed boundary section is affected due to the clearcut logged area and the associated logging road to the boundary.

The Trans-Canada highway and C.P. Rail cause considerable impact to both parks and are a prime example of wildlife habitat fragmentation.

6.3.2

The natural and/or cultural resources affected are many and varied. Generally, air, water, wildlife and vegetation are impacted in varying degrees by the external threats. The historic stone pillars and bridges of the old railway grade will continue to deteriorate unless maintained on a regular basis.

6.3.3

To define "effective management" relative to this assessment, a program of integrated cooperative effort will be the only effective tool.

Gaining cooperation with provincial and other federal agencies, and private operators of the various activities, is difficult. Each have their own objectives and interests, and few are accustomed to regarding the values of a national park as a mutual benefit.

The most important initial action within park management is a strong cooperative effort between the Heritage Resource Conservation and Heritage Communications sections. This is a critical stage necessary to gain the trust and support of the outside agencies and activities. Once these "partners" understand that the national parks also belong to them, and their future, the first hurdle is overcome.
6.3.4

Since the national park boundaries were originally established without considering the importance of ecosystems, they must now be managed with a holistic approach. It is not necessary to consider changing park boundaries if integrated cooperative efforts are successful and these two parks are managed from the outside looking in, as well as internally.
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