EXTERNAL THREATS TO NATIONAL PARKS:
A Case Study of Pacific Rim National Park Reserve, British Columbia

by

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B.Sc., University of Victoria, 1988

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of

MASTER OF ARTS

in the Department of Geography

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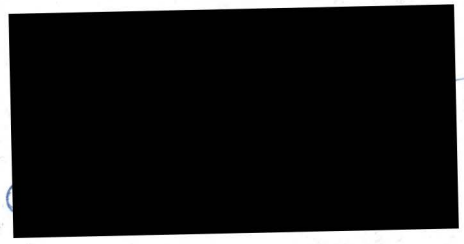

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ABSTRACT

National parks in North America are protected by legislation which states they shall be left "unimpaired for the enjoyment of future generations." A growing body of literature suggests, however, that national parks are being increasingly threatened from sources outside their boundaries - external threats. Documentation of external threats to national parks began in 1980 in the United States but little work has been done in Canada.

This thesis describes the external threats and their source(s) to Pacific Rim National Park Reserve, British Columbia as perceived by the managers of Pacific Rim Park. Structured, personal interviews were conducted with park managers as well as with agencies identified as the source(s) of those external threats. The research revealed a total of 104 external threats to the park.

Interviews with agencies identified as the source(s) of external threats to the park revealed a lack of communication with park managers as well as a general lack of knowledge concerning the purpose and meaning of national parks in Canada. The thesis includes specific recommendations for the possible mitigation of several individual external threats.

The thesis concludes with a possible long-term solution to terrestrial external threats in the form of a biosphere reserve and the rationale for its application to Pacific Rim National Park Reserve.

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ACKNOWLEDGEMENTS

I would first like to thank the members of my supervisory committee: Dr. Philip Dearden, Dr. Stephen Lonergan and Dr. Duncan Taylor. In particular, I would like to acknowledge the inspiration provided by Dr. Philip Dearden. Dr. Dearden's dedication to wilderness and protected area research, in addition to his tireless efforts at motivating and directing my research and editing my writing, have made my own research effort a most enjoyable and memorable experience. I am also indebted to Dr. Dearden for providing me with partial funding for my research through a grant from the Social Science and Humanities Research Council of Canada. I would also like to thank Dr. Stephen Lonergan for taking the time to sort out my questions regarding both methodology and the philosophical questions regarding geographical research. I am most grateful to Dr. Duncan Taylor for helping me place my specific research into the context of "the big picture", and for his thoughtful comments in regards to the philosophical underpinnings of my research methodology.

My research efforts were enthusiastically supported by the staff at Pacific Rim National Park, Reserve, and I would particularly like to thank former Park Superintendent Tom Heggie for putting his entire staff at my disposal and for providing me with as much time as necessary with each staff member "to get at the heart of the problem." I would like to thank all the staff at Pacific Rim Park and, in particular, to Barry Campbell for his keen insight into ecological conditions in the park; to Dan Vidova for his critical review of park policy; to Kathy Findlay-Brooke for sharing her knowledge regarding threats to Pacific Rim Park; and finally to acting Park Superintendent Howie Hambleton for keeping me up to date on the most recent events at the park.

I would also like to acknowledge my fellow graduate students at the university. To Larry Berg, who graciously allowed me to reproduce one of his maps indicating the location of Indian Reserves within and adjacent to the park, and provided helpful insights into specific issues regarding Pacific Rim Park, I am most indebted. To Steve Garner, who provided me with his painstaking cartographic skills on figures 1, 3, 4, 5, 6, 8 and 9, I am most grateful. To Mike Tripp, who probably understands more than most the perils of graduate research with small children running about, I say: thank you for your understanding counsel.

There are many other people to whom I am indebted: Dr. Paul West, Director of the Environmental Studies Program, provided me the opportunity to develop and gain self-confidence in my work; Gil McDade, Senior Lab Instructor in the Department of Geography, allowed me to develop skills as a lab instructor and gain valuable self-confidence; Dr. Mark Flaherty for putting me on the right track in regards to research methodology and to Dr. Colin Wood for his thoughtful comments on a draft of Chapter one.

Finally, I would like to thank my wife Kathy, who took on a greater proportion of work in caring for our two children and gave me loving support while I wrote this thesis. Without her effort this thesis would not have been possible.

DEDICATION

to my parents, Patrick Joseph Doyle and Margaret Stouffer Doyle
and to my children, James Louis Doyle and Hannah Rose Spiro Doyle -
may the desire to protect wilderness continue to span the generations

CHAPTER ONE

1.1 INTRODUCTION

National parks have been established as protected areas with a legislated mandate which provides that they be left "unimpaired for the enjoyment of future generations" (National Parks Act of Canada 1930: Section 4; United States Organic Act 1916). However, the rising level of documented damage to the biophysical and socio-economic resources of our planet from both natural and anthropogenic sources has caused significant concern among many researchers. There is a growing perception that our present course of action may be pushing the planet to the brink of environmental collapse. The Report of the World Commission on Environment and Development cautions:

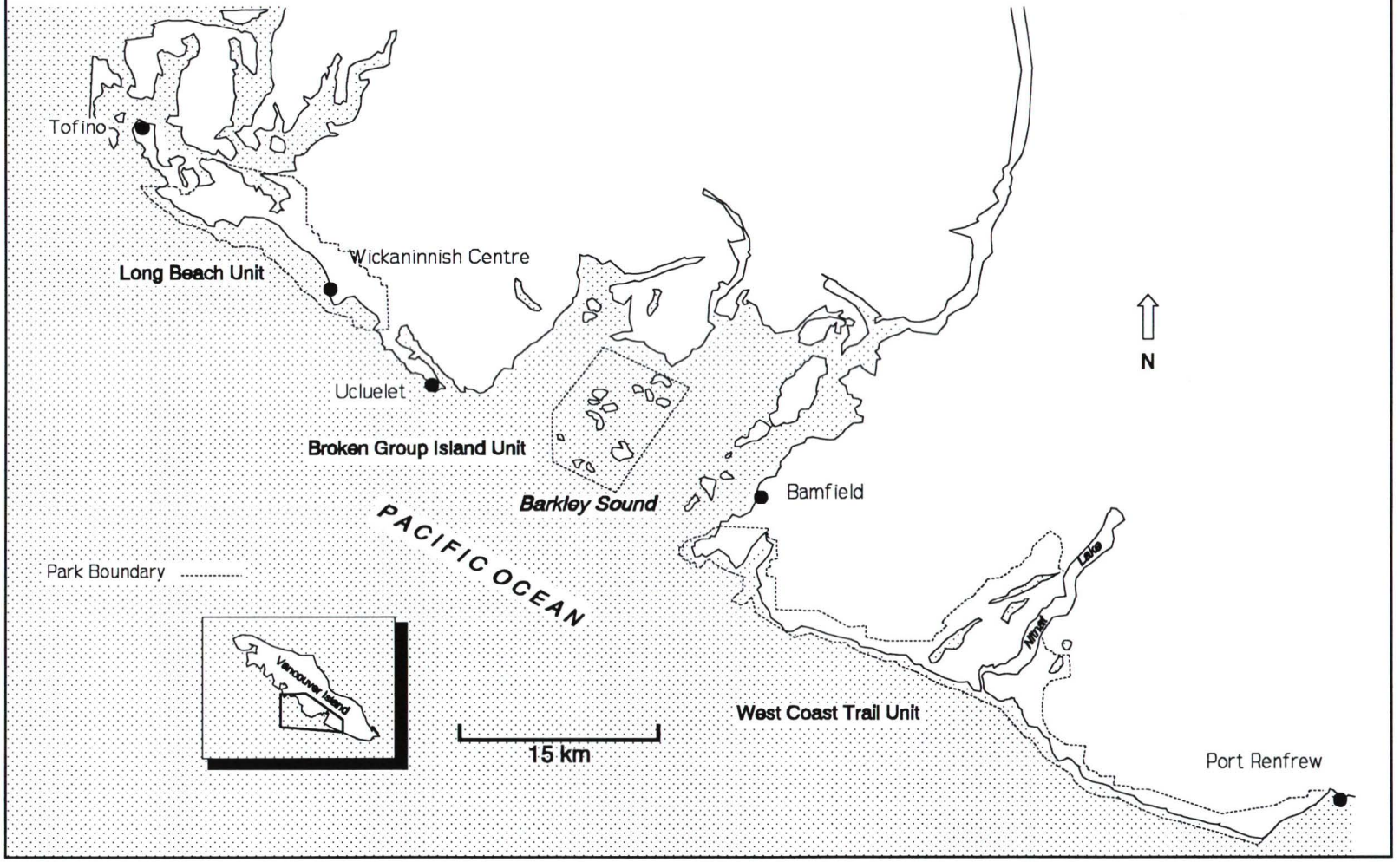
> Nature is bountiful, but it is also fragile and finely balanced. There are thresholds that cannot be crossed without endangering the basic integrity of the system. Today we are close to many of these thresholds; we must be ever mindful of the risk of endangering the survival of life on Earth. Moreover, the speed with which changes in resource use are taking place gives us little time in which to anticipate and prevent unexpected effects (World Commission on Environment and Development 1987: 32-33).

Lester Brown of the Worldwatch Institute believes: "We are losing at this point, clearly losing the battle to save the planet. (Failure) will shake the world to its foundation" (Brown, in M'Gonigle 1989: 351).

Because national parks generally prohibit development inside their boundaries and are managed under a policy which emphasizes preservation, they have come to represent the values of untouched wilderness. There is a growing perception that wilderness areas, such as national parks, are vital to the planet for their ecological, scientific and educational benefits. If trends of

Figure 1

Pacific Rim National Park Reserve, British Columbia



environmental degradation increase to the planet, the value of wilderness areas for their above-mentioned benefits is likely to increase (Dearden 1989).

A growing body of literature suggests that, in fact, various forms of pollution and development outside some national parks are having detrimental effects on those resources protected inside the park boundaries. The fundamental question this thesis will address is: are activities outside national park boundaries causing impairment to protected park resources inside park boundaries? Specifically, the research will focus on external threats to Pacific Rim National Park Reserve[1] (see Figure 1) and will attempt to answer the following questions:

1. What, if any, are the most significant external threats to the protected resources of Pacific Rim National Park Reserve?
2. How much information is available concerning these threats?
3. What information, if any, is lacking concerning these threats, and how may it be obtained?
4. What possibilities exist for mitigation of these threats?

1.2 BACKGROUND

Because national parks have typically been located in areas isolated from industrial development and human settlement they have traditionally been considered areas of pristine wilderness simply by virtue of their remote locations. However, a growing body of literature describes damage to park

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[1] Because this protected area has yet to be gazetted, it does not yet possess legal status as a National Park Reserve. National Park Reserve status will occur pending final settlement of the Nuu-chah-nulth land claim. However, because this protected area is generally referred to as a national park and is generally managed as such, it will be treated as a national park for the purposes of this thesis.

resources from sources outside park boundaries. These are termed "external threats" and are defined as:

> those conditions of either human or natural origin that cause significant damage to park resources, or are in serious conflict with the objectives of park administration and management (Machlis and Neumann 1987: 5).

Sources of external threats, by definition, lie outside park boundaries and may be immediately adjacent to the boundary such as clear cut logging (see e.g. Keiter 1985; Little 1987; Coggins 1987; Sax and Keiter 1987) or may be located thousands of miles away such as point sources of sulphur dioxide which contribute to the creation of acidic precipitation (see e.g. United States Department of Interior 1980a, 1988; Lippincott, Baron and Herrmann 1982; Armentano and Loucks 1983; Machlis and Tichnell 1985; Pielke, et. al. 1986).

Many researchers now believe that external threats pose the greatest danger to national parks (Schneebeck 1986; Stottlemyer 1987; Edwards 1987; Sax and Keiter 1987; Dasmann 1988). In addition to increasing levels of industrial pollution and human development as reasons for this, the literature suggests another important factor in national park's susceptibility to external threats - the failure of park boundaries to contain entire ecosystems (Wright, et. al. 1933; Fuller 1970; Cowan 1970; Houston 1971; Isakov 1978; Kushlan 1979; Sadler 1979; Miller 1984; Newmark 1985; Wilcove and May 1986; Noss and Harris 1986; Little 1987; Chase 1986; National Parks and Conservation Association 1989). The lack of congruence between a national park's legal boundary and the park's ecosystem boundary has been identified, for example, as a major cause in the reduction of resident large carnivore and ungulate populations (Wright 1933; Leopold 1963; Miller and Harris 1977;

Newmark 1985; Little 1987). Newmark (1985), for example, believes no single national park in North America is large enough to maintain a "minimum viable population" of large carnivores and ungulates. The fate of these animals will therefore depend on cooperative management between national parks and adjacent land managers.

The failure of national park boundaries to protect entire ecosystems has exacerbated the effects of development adjacent to parks. For example, water pollution caused by mining and clear-cut logging has entered the surface water of Glacier National Park, Montana (Sax and Keiter 1987) and several smaller eastern U.S. parks (National Parks and Conservation Association 1979). Adverse hydrologic changes to Everglades National Park, Florida have resulted from agricultural, industrial and urban development within the park's ecosystem (Kushlan 1987; Finley 1987).

Timber harvesting on land adjacent to national parks can have adverse effects on protected resources. A classic example is the case of Redwood National Park, California. In 1968 the U.S. Congress set aside 23,490 hectares of redwood trees (*Sequoia sempervirens*) in the lower Redwood Creek watershed as Redwood National Park. The original park failed, however, to include the upper watershed of Redwood Creek where logging continued. Shortly after park status was conferred on the area, extremely high run-offs of rainwater from the logged upper watershed caused severe erosion in the protected lower watershed which resulted in the toppling of a large number of mature redwoods. Subsequently, Congress increased the size of the park in order to protect the remaining trees in the lower watershed (Wayburn, et. al. 1984; Keiter 1985).

Other documented sources of external threats to national parks include: the introduction and proliferation of non-native species (see e.g. Hendrix and Morehead 1983; Machlis and Tichnell 1985; Chase 1986), energy and mineral development (see e.g. Keiter 1985) and air pollution (see e.g. Armentano and Loucks 1983; Bennett, et. al. 1986; Peterson, et. al. 1987; United States Department of Interior 1988).

As population increases along with its attendant forms of development and urbanization, the national parks will face an increasing number of threats from outside their boundaries. The mitigation of these external threats will require more complex solutions than past internal threats because the legislative mandate of national parks does not extend beyond park boundaries. Recent attempts at cooperative management between the parks and adjacent agencies such as the Biosphere Reserve Programme (a program of the United Nations) have had only limited success due to a lack of legal basis, inadequate understanding of the concept and the reluctance of resource managers to "take on another layer of bureaucracy" (Lieff 1985a; Sax and Keiter 1987).

Existing legislation, particularly in the United States, has been used with limited success to protect national parks from external threats. Court cases in the United States have demonstrated that while the Act which protects national parks in the United States (United States Organic Act 1916) does impose a duty on the Secretary of the Interior to respond to external threats, the Act does not offer a mechanism to assure an effective response other than revision of park boundaries (e.g. the Redwood National Park case) which requires Congressional consent - an expensive, uncertain and time-consuming process. Other statutes aimed at protecting specific resources have been used with

limited success in protecting U.S. parks from external threats. The Endangered Species Act, the Marine Mammal Protection Act and the Clean Air Act are statutes which have been used by some national parks in the U.S. to challenge external threats (Hiscock 1986; Luhn 1986; Sax and Keiter 1987; Coggins 1987). However, a major impediment to establishing a legal basis for challenging external threats to parks in the U.S. is the lack of scientific information available to park officials. It has been recommended, therefore, that parks should establish sound databases and should routinely monitor air pollutants at diverse locations in the park, monitor rivers for water quality and sediment and monitor for acidic precipitation (Keiter and Hubert 1987).

In Canada, a major impediment in using the National Park Act of 1930 to mitigate external threats to national parks has been the lack of 'standing' given to interested parties by Canadian courts. In order for a party to maintain an action in the Federal Court of Canada he/she must show a "demonstrable interest" in the subject matter which is over and above the interest of the general public. Historically, the Federal Court of Canada has been reluctant to grant 'standing.' However, a recent landmark decision granted standing to the Canadian Broadcasting League in an appeal case with the Canadian Radio-Television and Telecommunications Commission. This decision

> may open the doors to the judicial process for groups advocating public interest causes, particularly in the environmental field. It may also have important ramifications for the national parks (Rounthwaite 1986: 63).

An example is the Canadian Parks and Wilderness Society, which can trace its role as the watchdog of national parks administration back to the 1920's when it opposed hydro development inside Banff National Park by the Calgary Power

Company, may now have court-recognized standing in matters related to national parks.

Beginning in 1980, there have been several attempts to document threats to national parks through mail surveys. The United States Department of Interior, for example, undertook a generic survey of threats to all U.S. national parks in 1980. This was a mail survey and while it generated a great deal of data it provided few details concerning specific threats. Machlis and Tichnell (1985) conducted a similar mail survey of national parks worldwide and were criticized for providing too much data, too many cross-tabulations and not enough explanation of the interactions between variables (Fortmann 1986). While this type of survey may provide a useful overview of threats to national parks, it does not provide a comprehensive examination of specific threats to individual parks. Machlis and Tichnell (1985) recognized this limitation of their survey and made several recommendations concerning future threat surveys. Among them were: "attempt to correlate certain specific land uses and specific threats [and] Study in detail specific threats to identify their pathways" (Machlis and Tichnell 1985: 94).

The research, therefore, focuses on external threats to one national park in Canada - Pacific Rim National Park Reserve, British Columbia. The park is vulnerable to external threats from many sources, for example, international attention recently focussed on damage to the park from an oil spill originating in Washington state. The response to the oil spill brought to light several problems concerning the ability of both the provincial and federal government to work together effectively in dealing with the clean-up. For example, the British Columbia Ministry of Environment initially refused to help in the clean-up

because the shoreline was a federal jurisdiction not a provincial one (Middleton 1989). This caused a delay in a full, coordinated response to the oil spill and may have contributed to the overall damage to the park (Burrows 1989).

The importance of the interaction between parks and adjacent land use has long been recognized within the framework of an "ecosystem perspective":

> Within a given land area, all parks, no matter how large they may be, or for what purpose they were established, are related to each other, to the use or resources in the landscape which includes them, and to the society which supports them (Hart 1966: XI).

The key components that make up a park ecosystem can be described with several different subsystems: air, water, soil, flora, fauna, cultural resources, management and administration and visitors. Further, the park ecosystem is embedded in a regional ecosystem and is influenced by the population, organization, technology and environment that surrounds and interacts with it (Machlis and Wright 1984; Machlis and Tichnell 1985). The examination of external threats by the research, therefore, fits into an ecosystem perspective.

Recent work has shown that park boundaries are permeable filters through which elements detrimental to park values can filter. A Boundary Model theory proposed by Schonewald-Cox and Bayless (1986) has focussed on impacts on biophysical elements in parks: atmospheric, hydrological, floral and faunal (Kushlan 1987; Peterson, et. al. 1987; U.S. Dept. of Interior 1988; Usher 1988). Dearden (1988) has recently extended the Boundary Model theory to include the intrusion of visual impacts across the administrative boundaries at Pacific Rim National Park Reserve.

On global, national and regional levels a major threat to protected park resources (e.g. flora, fauna, air, water and aesthetic values) is incompatible

activity on adjacent land. The Boundary Model provides a conceptualization of the interaction between parks and adjacent land use. The research attempts to further develop the Boundary Model's application to protected areas through a detailed case study of external threats to Pacific Rim National Park Reserve.

1.3 THE STUDY AREA

Pacific Rim National Park Reserve, located on the west coast of Vancouver Island, B.C., was formally dedicated in 1971 and consists of three distinct and separate units (see Figure 1): the Long Beach Unit, the Broken Group Islands and the West Coast Trail Unit. Both the Long Beach Unit and the West Coast Trail Unit comprise narrow strips of coastline, with the Broken Group Islands consisting of a number of small islands in Barkley Sound, which separates the two aforementioned units.

The long, linear shape of both the Long Beach Unit and the West Coast Trail Unit yields a high perimeter/area ratio for these units and therefore affords them particular susceptibility to external threats, thus making them excellent subjects for a case study (see e.g. Schonewald-Cox and Bayless 1986; Buechner 1987). All three units are either adjacent to or in close proximity to active forestry operations along their terrestrial boundaries, and all three units are exposed to external threats along their marine boundaries (e.g. oil spills). This combination of potential threat from both terrestrial and marine sources makes Pacific Rim National Park Reserve an especially good protected area in which to study external threats. Park management recognizes the challenge associated with external threats and therefore has been very interested and

supportive of research efforts in this area (Heggie 1991, Park Superintendent, pers. comm.).

1.4 THESIS OUTLINE

The thesis consists of six chapters. Chapter two reviews the literature concerning threats to protected areas worldwide, focussing primarily on threats to national parks in North America. The chapter begins with a review of historical threats to national parks and a brief discussion of attempts at their mitigation. This is followed by a review of more recent and current threats affecting national parks, including a brief review of research tools used in the identification of threats to national parks and concludes with a review of management strategies aimed at mitigating external threats to national parks.

Chapter three describes the study's methodology. A brief review of the philosophy of resource management based on human ecology, which is the philosophical basis for the thesis, will be presented followed by a detailed explanation of the research methods used in the thesis.

Chapter four is a discussion of the results of the structured interviews conducted with staff at Pacific Rim National Park Reserve. The chapter focuses on both the documented and suspected external threats to Pacific Rim National Park Reserve which emerged as the most serious (based on both spatial and temporal elements). Linkages to source of the threat are described with maps, where appropriate.

Chapter five discusses the interviews with adjacent land managers (e.g. managers for Fletcher Challenge Canada Limited) to gain a further understanding of the relationship between the park managers and those who manage resources adjacent to the park. The chapter also examines and

evaluates mitigative techniques that are currently being used by park management and makes recommendations for mitigation where applicable.

Chapter six discusses the significance of the research findings and presents recommendations which may be useful in mitigating external threats to Pacific Rim National Park Reserve and which may be beneficial to other protected areas.

CHAPTER TWO - THREATS TO NATIONAL PARKS

2.1 The Purpose of National Parks

Many authors suggest that the idea of setting aside areas as wilderness preserves originated in the United States and was put forward by men such as George Catlin, Henry David Thoreau, John Muir, Horace Greeley, Frederick Law Olmstead and George Perkins Marsh (see e.g. Nash 1982; Sax 1980; Harmon 1987). Within this group of individuals, however, the reasons for preserving wilderness differed. Catlin, Greeley, Thoreau and Muir believed wilderness should be preserved not only for its aesthetic and spiritual values to humans, but also for its intrinsic value. Thoreau believed, for example, that wilderness should be set aside "for modesty and reverence's sake, or if only to suggest that earth has higher uses than we put her to" (Thoreau, in Nash 1982: 103). George Perkins Marsh contended that the preservation of forests served utility. Marsh believed, for example, the clear cutting of the forests in watersheds resulted in drought, flood, erosion and unfavorable climatic change and that that was the reason for the decline in the Mediterranean empires (Nash 1982). Frederick Law Olmstead, one of America's premier landscape architects and designer of Central Park in New York, believed that preservation of striking scenery was the primary purpose in setting aside wilderness areas (Sax 1980).

It was against this backdrop of differing values of wilderness that the world's first national park came into being on March 1, 1872 when over two million acres of northwestern Wyoming were designated as Yellowstone National Park.

A number of authors believe that the U.S. government's motive for setting aside Yellowstone National Park (and subsequent national parks) was not for preserving wilderness *per se* (i.e. not for its aesthetic and spiritual values to humans) but rather for displaying nature's "wonderful natural curiosities" and "the freaks and phenomena of Nature" (Nash 1982: 113). Bella (1987) believes that the primary purpose in establishing national parks in Canada was to stimulate the economy through increased tourism.

The differing values behind the initial impetus for establishing national parks have caused a continuing dilemma for national park managers, one that can be characterized as a dualism between managing the park for the enjoyment of its visitors or managing the park for the preservation of the wilderness. The former philosophy has seen some national parks develop large recreational facilities inside the park boundaries to attract visitors which has caused damage to park flora, fauna and aesthetics (Sax 1980). The latter philosophy of park management supports the preservation of wilderness which has evolved from the management of wildlife (see Wright, et. al. 1933), to managing for static bio-physical processes (e.g. the practice of suppressing forest fires) and today translates into managing for the preservation of ecosystem processes (see e.g. Herrman and Stottlemyer 1990). Van Tighem (1985) argues that even if the latter philosophy is applied to national park management, it establishes a dangerous dichotomy in the way humans perceive national parks. The dichotomy is that national parks have encouraged humans to believe that as long as large protected areas are established, then developments that damage the environment outside park boundaries are justified. Humans are not allowed to live in national parks, indeed, they are not

allowed to utilize any resources in national parks and this, according to Van Tighem, perpetuates the myth that humans are not a part of nature, rather they are apart from it.

The above discussion suggests that even though the legislation protecting national parks in both the United States and Canada is clear that national parks be left "unimpaired for the enjoyment of future generations" (National Parks Act of Canada 1930: Section 4; United States Organic Act 1916) there are conflicting underlying values in human society which may be causing national parks to be threatened from both outside and inside their boundaries. A review of the literature indicates that there have been and continue to be various threats to national parks that may be seriously impairing the resources protected by national park legislation (see definition of 'external threats' in section 1.2).

The sources of threats to national parks can be traced both temporally (from the 1870's to the present) and spatially (threats emanating from inside park boundaries termed 'internal threats'; threats arising from sources outside but close to the park boundaries termed 'local/regional external threats'; and threats arising from sources distant from park boundaries termed 'national/global threats'). The following sections review the literature concerning threats to national parks based on the above-mentioned temporal and spatial criteria.

2.2 Early Threats to National Parks

The earliest recorded threat to national parks was the poaching of mammals in several western North American national parks in the late 1800's. This situation prompted the U.S. government to send the United States Cavalry into Yellowstone National Park in 1886, and later into Yosemite and Sequoia

National parks to prevent "the endemic vandalism, poaching and trespassing which threatened their existence" (Hampton 1971: 3). This type of threat is termed "internal" because the source of the threat (poachers) was inside the park boundaries.

Another internal threat which affected many national parks in western North America was resource extraction inside park boundaries. Initially, preservation of national parks did not preclude various types of resource development. Mining and timber harvesting were conducted in the parks and even endorsed as a compatible activity. Mining operations, particularly coal, were evident in several national parks in western Canada in the early 1900's. For example, the superintendent of Banff National Park described Bankhead, a coal town inside the park, as:

> The new village of Bankhead, instead of being a detriment to the beauty of the Park, will, on the contrary add another to the many and varied attractions of the neighbourhood ... Nestling under the shadow of Cascade, with its beautiful homes and its teeming industrial life it has already become a popular stopping place for tourists (Lothian 1976: 53).

Some historians, however, refute the superintendent's version of "idyllic" Bankhead. Bella (1987) claims, for example, the Chinese contingent lived in conditions in Bankhead described by a medical officer as a "disgrace to civilization" (p. 69).

Another historical threat to national parks has been hydroelectric development. For example, a proposed hydroelectric development on the Spray River inside Banff National Park boundaries in 1923 by the Calgary Power Company led to the enactment of a new National Park Act for Canada in

1930 which allowed no further mining, logging or hydro development in national parks[2] (Lothian 1981).

Forestry operations continued inside some national parks until the 1960's. By then, however, national park managers recognized the inherent conflict between logging operations and preservation[3] and new park policy reflected this change in attitude. For example, in 1964 Canadian national park policy took a firm stand against logging in the parks:

> The existence of licensed timber berths is not consistent with the purposes of National Parks and cutting rights presently held should be extinguished. Where it is practicable to do so, timber berths should be acquired by negotiation, but failing this the holders should be notified to complete their operations so that the berths can be extinguished as soon as possible. No further timber cutting rights of this type will be granted in any National Park (Lothian 1981: 116).

Despite the above Canadian Parks Policy regarding logging operations in national parks, one such operation still exists in Wood Buffalo National Park, Alberta/Northwest Territories. Canadian Parks Service managers continue to honor a long-standing timber license in the park because it provides local employment.

Not all historical threats to national parks were due to resource extraction inside park boundaries. George Wright, et. al.'s (1933) seminal work regarding

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[2] The new Act did allow the hydroelectric facility to be built, but only after the Act changed the boundaries of Banff National Park so as to exclude the dam from the park (Lothian 1981).

[3] Logging operations inside national park boundaries were at times incompetent, wasteful and illegal. For example, in 1960 a forest fire started by a careless logger in Yoho National Park, British Columbia resulted in a net loss of $35,000 to the Park Service due to unrecovered fire fighting costs. The Park Service was criticized for making a "monumental error" when it chose to allow a forestry management operation instead of "reclaiming the timber license by purchase" (Lothian 1981: 118.)

threats to fauna in national parks in the United States, for example, recognized three basic causes responsible for wildlife problems in U.S. national parks:

1. Adverse early influences;
2. Failure of parks as independent biological units;
3. Conflict between humans and animals in the park.

In examining the first cause Wright noted:

> The status of wild life was impaired directly and immediately where animal populations were decimated by trapping, shooting, or poisoning. Some species were actually exterminated from the areas before they became parks. Others had been reduced to small numbers and recuperation has not resulted from park protection. Drains on a species from natural causes which are not ordinarily fatal because of an ample breeding stock may be overwhelming when it has been reduced to a few mated pairs per unit area (Wright 1933: 23).[4]

The most serious problem that Wright discovered, however, was the "failure of parks as biological units" and that "not one park is large enough to provide year-round sanctuary for adequate populations of all resident species" (Wright, et. al. 1933: 37). A problem that arises from this shortcoming is that animals may drift out of the protection of park boundaries and fall prey to hunters, ranchers and poachers or become exposed to diseases and influences of alien species (e.g. a hoof-and-mouth epidemic which wiped out over 22,000 deer in California in 1924). As Wright, et. al. point out, most of the national parks in the western U.S. protect only high elevation mountain top areas which may provide adequate summer range, but are lacking in critical winter range.[5]

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[4] Wright, et. al. cited the examples of grizzly bears in Sequoia National Park, mountain sheep in Yosemite national Park and wild turkey in Mesa Verde National Park as species which were extirpated before park status was conferred.

Thirty years after George Wright's research, A. Starker Leopold submitted a report in 1963 to the United States Department of Interior with the following observations:

> Few of the world's parks are large enough to be in fact self-regulatory ecological units; rather, most are ecological islands subject to direct or indirect modification by activities and conditions in the surrounding areas. These influences may involve such factors as immigration and/or emigration of animal and plant life, changes in the fire regime, and alterations in the surface or sub-surface water[6] (Leopold 1963: 42).

Though Leopold's work primarily revealed threats to fauna, he also described threats to flora. Specifically he observed the encroachment of exotic plant species on native park species. Leopold also observed the build-up of many small, young trees and in general a "vegetative tangle" which he believed the result of a prolonged practice of fire suppression.

The observations and subsequent recommendations made by George Wright and A. Starker Leopold in the 1930's and 1960's still have relevance to problems associated with national parks today. While there have been some boundary changes made to parks and new parks created since the days of Wright and Leopold, the problem of inadequate habitat for certain fauna still exists today. Exacerbating the problem, however, has been the slow, progressive encroachment of human development (industrial, commercial and

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[5] As examples of this type of problem, Wright, et. al. (1933) cite the lack of adequate winter range for the American wapiti in Rocky Mountain National Park, and similar problems faced by the elk in Yellowstone National Park.

[6] Leopold used the example of excess populations of elephants in some African parks and of ungulates in some mountain parks (such as Bighorn sheep in the California Sierras) being caused by alterations to their habitat just outside park boundaries.

residential) on many national parks which were initially established far from civilization.

2.3 Modern Threats To National Parks

Internal threats to national parks today have come about primarily as result of visitor over-use and poor park management (Lucas 1970; Marsh 1970; Nicol 1970; Rowntree, Heath and Voiland 1978; White and Bratton 1980; Stottlemyer 1987). These threats include:

1. Visitor pressure: campers and hikers;
2. Internal development to accommodate visitors;
3. Transportation corridors;
4. Illegal removal of park resources;
5. Suppression of natural disturbances;
6. Inappropriate park management.

Visitor pressure has come about as a result of the popularity and greatly increased numbers of visitors to the parks in the 1960's and 1970's (see e.g. Hendee, et. al. 1978). Large numbers of visitors, inadequately managed, have produced threats to flora (through removal and trampling -- see e.g. Kuss, Graefe and Loomis 1986), fauna (e.g. greater frequency of grizzly-human encounters resulting in reduction of bears -- see e.g. Servheen 1986), soil (through erosion on over-used trails -- see e.g. Kuss 1986), and aesthetic values (through proliferation of garbage and human excrement -- see e.g. Dearden 1985).

Internal development to accommodate increased numbers of park visitors has led to additional threats to fauna (e.g. conversion of prime elk, deer and moose winter habitat to campgrounds, townsites, visitor service centres and

roads -- Cowan 1970; Herrero 1979), air (e.g. localized pollution from automobiles), water (e.g. the pollution of the Bow River from untreated sewage in Banff townsite -- Victoria Times-Colonist 1989), flora (e.g. removal for development -- see e.g. Cowan 1970 and Herrero 1979), and aesthetic values (e.g. recreational facilities development such as downhill skiing and golf courses conflict with visitor expectations of wilderness -- see e.g. Sax 1980).

An example of the type of modern threat that can affect national parks was a spill of diesel fuel in a subalpine area of Mount Rainier National Park, Washington in 1988. A total of 9,600 gallons of fuel leaked out of an underground storage tank over a period of several months under the snow into a subalpine meadow at 5,400 feet in elevation and resulted in the destruction of some flora (Rochefort and Bivin 1988).

Transportation corridors through national parks adversely affect fauna (e.g. road kills involving fauna and displacement of fauna through loss of habitat -- Cowan 1970), and aesthetic values (noise from construction and use, unsightly placement -- see e.g. Marsh 1970).

Illegal removal of park resources is a serious problem worldwide. Illegal removal of fauna was the most reported threat to parks in less-developed countries in Machlis and Tichnell's (1985) report on the state of the world's parks, and was the second most reported threat to parks in developed countries. Illegal removal of flora was the third most reported threat to parks in less-developed countries in the same international survey, and was the ninth most reported threat to parks in developed countries. Overall, Machlis and Tichnell (1985) reported illegal removal of fauna as the number one threat worldwide, occurring in 76 percent of parks surveyed. Contributing to the

problem was a reported lack of personnel in the parks (reported by 73 percent of the parks). The following is a vivid description of the problem in one unnamed African park:

> Poaching is widespread, exacerbated by the shape of the park, population density on its border, its position on the [frontier] and the dense vegetation on rugged terrain. Primary poaching targets are elephant, antelope and gorilla. Poacher's dogs, plus feral dogs from the surrounding farmlands, are now found throughout the park hunting on their own.... The major worry in [ ] National Park today is commercialized poaching for elephant and rhino. These two species are threatened because of high demand of ivory and rhino horn in outside countries. The poaching is done right inside the park. Law enforcement officers are challenged at times because they carry single-shot firearms as opposed to machine guns used by these sophisticated poachers (Machlis and Tichnell 1985: 50).

The 1980 U.S. State of the Parks survey reported that 14 percent of all threats to U.S. national parks were in the category of "physical removal of resources." Examples cited include: removal of fossils from Badlands National Monument, South Dakota and illegal removal of cactus from both Big Bend National Park, Texas and Organ Pipe Cactus National Monument, Arizona (United States Department of Interior 1980a).

Suppression of natural disturbances, most notably fire, is an internal threat the management of which continues to be debated. It is now largely recognized that allowing wildfires to burn in national parks may be an appropriate tool for wilderness management (Kilgore 1986).[7] Past policies of fire suppression

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[7] It should be pointed out, however, that this refers primarily to developed countries. Uncontrolled fire still is still a perceived threat in national parks in less-developed countries. Fire as a threat to vegetation and fauna emerged as the fourth and seventh most reported threats respectively to parks in less-developed countries in Machlis and Tichnell's (1985) worldwide threats survey.

have allowed the gradual accumulation of fuel which, when allowed to build up over long periods of time, has resulted in severe fires or fire-storms with devastating results to park flora, fauna and soil (Saveland 1986).[8] In addition, the suppression of fires in some parks has allowed the uncontrolled spread of forest pests resulting in the death of large numbers of trees (e.g. beetle-killed forests in northwestern Glacier National Park, Montana -- Ringstad 1990).

Inappropriate park management has been held responsible for internal threats ranging from lack of park personnel to allowing recreational development inside park boundaries which threatens other sub-systems (see e.g. Bella 1987). Some critics in fact blame all internal park threats on park management because the national parks legislation explicitly states that parks shall be maintained unimpaired for future generations. Why then cannot park managers prevent internal threats altogether given both their mandate to protect park resources and the legislative tools to enforce decisions made within a park's boundaries? Part of the answer lies in the reason parks were set aside to begin with: to attract tourists. Catering to tourists' desires led perhaps to inappropriate development of early parks such as Yellowstone, Yosemite and Banff which today has, in some cases, spawned cities inside parks. Park management today has inherited problems such as these and it will continue to struggle with management practices which seek to satisfy the dual mandate of national park policy in North America: preservation of wilderness versus recreational use.

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[8] A great deal of literature exists concerning wilderness fire management. For a good review see: Lotan, J.M.; Kilgore, B.M..; Fischer, W.C.; Mutch, R.W., compilers. *Proceedings -- symposium and workshop on wilderness fire;* 1983 November 15-18; Missoula , Montana. Gen. Tech. Rep. INT-182. Ogden, Utah: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 1983.

2.4 Local and Regional External Threats To National Parks

It is instructive to expand on the theme first identified by Wright, et. al. (1933) regarding the failure of park boundaries to protect the park's entire ecosystem. Several authors now believe that one of the greatest threats to national parks today is the failure of park boundaries to protect entire ecosystems (Fuller 1970; Cowan 1970; Miller 1984; Nelson 1984; Newmark 1985; Wilcove and May 1986).

Newmark (1985) has attempted to define more clearly the ecosystem boundaries of national parks and refers to them as "biotic boundaries":

> The biotic boundaries are hypothetical boundaries which would be necessary to maintain existing ecological processes and a given assemblage of species within a national park. Practically, the biotic boundaries are defined as those hypothetical boundaries encompassing the entire watershed of a park and an area of sufficient size to maintain a minimum viable population (MVP) for the terrestrial non-volant species with the largest home range found within the current legal boundaries (Newmark 1985: 197).

Newmark's definition of the biotic boundary, in addition to encompassing enough range to maintain MVP's of species such as grizzly bears, also allows for protection of complete watersheds "because of the necessity of water quality and quantity to the adequate protection of the aquatic flora and fauna of the park" and ... "reduces the potential for soil erosion and flooding"[9] (Newmark 1985: 199). Newmark applied his definition of biotic boundaries to eight of the

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[9] Recent work by Herrmann and Stottlemyer (1990) has confronted the problem of threats to U.S. national parks through a "watershed approach" with the goal of understanding impacts to ecosystem structures and functions: "Water and many ecological issues are most conveniently studied and best managed within the theoretically confined system--the watershed. This unit is more easily comprehended than the generic term 'ecosystem'." (Herrmann and Stottlemyer 1990: 20).

largest national parks (Grand Canyon, Olympic, Yosemite and Rocky Mountain) and park assemblages (Sequoia-Kings Canyon, Grand Teton-Yellowstone, Glacier-Waterton Lakes and Kootenay-Banff-Jasper-Yoho) and found only one, the assemblage of Kootenay-Banff-Jasper-Yoho, to fit his criteria that would support MVP's. Newmark's work verifies that most national park units do not have congruence between legal and biotic boundaries and therefore, cannot extend legal protection to resources that may be external to the park, but essential for the continued well-being of park resources.

The literature suggests that a large number of local/regional external threats to national parks have sources located within the biotic boundary of the park and are caused by activities such as forestry operations, energy exploration and development, mining exploration and development and urban/commercial/industrial development (see e.g. Hiscock 1986; Coggins 1987; Little 1987).

2.4.1 External Threats Arising From Forestry Operations

Major threats to fauna from forestry operations include:

1. Fragmentation of surrounding forests resulting in parks becoming "habitat islands";

2. Proliferation of forestry roads adjacent to previously inaccessible areas allowing increased access to hunters and poachers, in addition to creating conditions adverse to sensitive species.

Fragmentation of forests, caused by cutting large patches of forests, has left many national parks islands of unaltered forest habitat surrounded by altered habitat. This condition has generated a great deal of research in the area of "island biogeography." Island biogeography uses the concept of the "equilibrium theory of island biogeography" to predict that as islands of

unaltered habitat are decreased in size (by logging for example), the equilibrium number of species will decrease (Diamond 1975). Kushlan (1979) refined Diamond's initial work by stating: "The isolation of a continental reserve may lead to a phenomenon of ecosystem degeneration, the extent and rapidity of which depends on the ecological condition of adjacent habitat" (Kushlan 1979: 281). Kushlan's point is that the more altered the adjacent habitat, the greater the threat to species diversity inside the protected area.[10]

Considerable debate was generated following Diamond's work in island biogeography. One such debate concerns the merits of a single large versus several small (thus the acronym SLOSS) reserves. Simberloff and Abele (1982) point out that in some cases several small reserves may be better than one large reserve due to the possibility of a catastrophe such as fire wiping out an entire reserve. In addition, the money spent procuring a large reserve may be better spent on developing sound management practices on a smaller reserve. The most recent research in this area suggests that nature reserves should be as big as possible in order to minimize depletion of species (Soule and Simberloff 1986).

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[10] This theory is supported by Miller and Harris (1977) whose observations of large mammals in several East African Savanna Parks led them to conclude: "Recent evidence implies that reserve faunal communities may experience species depletion as a result of isolation from contiguous gene pools....Available data from one such area [in east Africa] reveal four extirpations in recent times. This may support the hypothesis that isolated reserves may be experiencing species depletion due to isolation from surrounding natural habitats" (Miller and Harris 1977: 311). Janzen's (1983) work in Santa Rosa National Park, Costa Rica revealed that "in some circumstances, it may be better to surround a small patch of primary forest with species-poor vegetation of non-invasive species of low food value (e.g. grain fields, closely cropped pastures, cotton fields, sugar cane) than to surround it with an extensive area of secondary succession rich in plants and animals that will invade the pristine forest" (Janzen 1983: 410). [Note: It is doubtful whether Janzen's research is applicable to the temperate forests of North America. The work's value is in noting the extreme complexities and unknown factors involved in research of fragmented forests.]

It is estimated that 77 percent of the Yellowstone National Park ecosystem is located outside the park boundary in seven national forests and is subject to various types of resource extraction including logging (Little 1987). Yellowstone is one of the few parks in the United States that maintains a population of grizzly bears and there is concern that Yellowstone Park grizzlies are suffering from inadequate protection in the national forests.[11]

Another example of logging as a threat to protected park fauna was the well-publicized logging of the Akimina-Kishenina area which makes up the extreme southeast tip of British Columbia and is adjacent to Glacier-Waterton International Peace Park. According to Clifford Martinka, then assistant supervisor of Glacier National Park, Montana, the logging operations in the Akamina-Kishenina, in addition to causing increased sediment into streams which could affect fish, would cause "grizzly bears to leave the area if logging continues .... increased human access is one of the keys. One of the last really good habitats for bears is here. If you increase human activity, it isn't going to do any good"[12] (Victoria Times 1978).

One of the best examples illustrating the effects of logging adjacent to a national park is the case of Redwood National Park, California. Following a long period of negotiations and studies, the U.S. Congress in 1968 set aside

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[11] For example, Ed Lewis, Executive Director of the Greater Yellowstone Coalition believes important bear denning areas have been clearcut just outside Yellowstone Park (Little 1987).

[12] Sax and Keiter (1987) reported that Glacier Park officials considered ongoing clearcutting in the Akimina-Kishenina to be a severe threat to a park watershed and reports from a well-informed citizen suggested that "clearcutting virtually decimated the native trout population in several important spawning streams tributary to the North Fork [Flathead River]" (Sax and Keiter 1987: 224). In addition, Parks Canada officials were concerned the logging would affect "wildlife that moves between the valley and the two national parks" (Victoria Times 1978).

23,490 hectares of *Sequoia sempervirens* (coast redwoods) in the lower Redwood Creek watershed as Redwood National Park. The original park failed, however, to include the upper watershed of Redwood Creek where logging continued. Shortly after park status was conferred on the area, extremely high run-offs of rainwater from the logged upper watershed caused severe erosion in the lower protected watershed which resulted in the toppling of a large number of mature redwoods. Following litigation, Congress increased the size of the park in order to protect the remaining trees in the lower watershed (see e.g. Keiter 1985).

Some nature reserves (zapovedniks) in the U.S.S.R. are suffering from a fate similar to that experienced by Redwood National Park. Large scale clear-cut logging in the Oka-Don watershed has led to the "steady lowering of the ground-water level, and this in turn is causing the drying-out of the oak stands of the upper of the river valley slopes. This process is now making itself felt in Khopyorsk Zapovednik." (Isakov 1978: 541).[13]

Other types of problems associated with logging operations adjacent to national parks are: increased sedimentation of streams flowing into the park (United States Department of Interior 1980a; Elder 1990[14]), proliferation of logging access roads which creates the problem of uncontrolled access[15], dust

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[13] Another major problem threatening several zapovedniks are dams and water diversions which alter hydrologic regimes causing drops in water levels, straightening of channels, crumbling of banks and drying up of middle elevation forests due to decrease in water flows from above (Isakov 1978).

[14] For example, Mack Elder (1990), Chief Park Warden at Pacific Rim National Park, British Columbia reported that increased sedimentation of several streams flowing into the park from adjacent land which has been clearcut has resulted in large build-ups of sediment at stream mouths where they flow into the Pacific Ocean.

and noise (United States Department of Interior 1980a), threats to aesthetic values due to clear-cuts on adjacent land being visible to park visitors (Sax 1976; Dearden 1988) and pesticides and herbicides entering park surface water and groundwater (United States Department of Interior 1980a; State of California 1984).

In commenting on the effects to national park wildlife from logging on adjacent land Coggins (1987) concludes:

> No one can define precisely the contours of all threats to park wildlife resources, yet no one can deny the existence of such external threats. The range and magnitude of external threats to park wildlife seems to require a broad and flexible remedy in the form of new legislation (Coggins 1987: 7).

Coggins' statement could also apply to the effects of adjacent logging operations on the park resources of air, water, soil, flora and aesthetic values. Many threats to park resources are suspected in national parks, but few are adequately documented. In *The State of the Parks - 1980* report, for example, 75 percent of all reported threats needed more research to be adequately documented.

2.4.2 External Threats Arising From Energy and Mineral Development

Energy and mineral exploration and development, can have serious impacts on national parks resources. The specific threats vary depending on

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[15] Pacific Rim National Park reported an increase in the number of hikers entering from an uncontrolled entry point along the West Coast Trail Unit because of a new logging road into the adjacent Carmanah Valley, resulting in a presumed decrease in visitor satisfaction (Elder 1990).

the type of energy/mineral being sought and developed. The four major types of energy exploration and development are:

1. Oil and gas;
2. Coal;
3. Nuclear;
4. Hydroelectric.

Threats from oil and gas operations result from; exploratory seismic work (blasting) which can disrupt wildlife and aesthetic values; test bores which can disrupt wildlife, pollute surface water and create noise; and development drilling which disrupts wildlife, creates noise, develops access roads and may cause pollution of surface and ground water.

National parks in western North America are particularly affected by oil and gas operations. Glacier National Park, Montana officials, for example, identified oil and gas activity near the park's boundaries as one of the park's most serious threats.[16] Specifically, Glacier officials "feared that oil and gas activity would intensify human impact in critical corridors for park wildlife (particularly grizzly bears), directly through mineral work itself [blasting and drilling] and indirectly by increasing road access for hunters (especially poachers) and recreationists" (Sax and Keiter 1987: 216). In addition, Glacier Park officials cited impacts on the quality of wilderness experience for park visitors as being associated with oil and gas activity (Keiter 1985).

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[16] Glacier Park, Montana reported 56 external threats in 1980 with oil and gas development; timber harvesting, the proposed Cabin Creek Coal mine in B.C. and road improvement in the North Fork Flathead River area as being the four most serious external threats to the park (Sax and Keiter 1987).

National marine parks and national parks located on coastlines are susceptible to damage from oil spills. The source of the oil can be either from the transport of oil, or from offshore development. There has been concern, for example, that if British Columbia lifts the moratorium on oil exploration in Hecate Strait, South Moresby National Park Reserve could be at risk. Even though a 20 kilometre "exclusion zone" prohibiting drilling has been established around South Moresby, critics say there should be no drilling at all in Hecate Strait due to the frequency of earthquake activity, high average wind speed and exceptionally high waves (Parfitt 1988).

Padre Island National Seashore, Texas suffers from the adverse effects of oil and gas development just offshore in the Gulf of Mexico. Toxic wastes in 55-gallon drums, oil, tar, trash and other debris frequently wash up on its beaches causing impacts to aesthetic values, soil, flora, fauna and water (Houck 1988). Fort Jefferson National Monument, Florida is concerned about potential oil spills from drilling platforms offshore and the resulting impacts on the park's protected coral reefs (United States Department of Interior 1987).

Oil spills resulting from accidents during its transport pose serious threats to parks worldwide. The west coast of North America has seen two major spills affecting national parks in both Canada and the United States since early 1989. For example, the worst oil spill in British Columbia in ten years struck all three units of Pacific Rim National Park Reserve in January 1989 killing hundreds of seabirds, and causing an unknown amount of damage to other fauna (see section 4.1.1). Compounding clean-up problems is the on-going jurisdictional battle between the Canadian federal and British Columbia provincial governments. This was a particular problem in this latest oil spill because the

British Columbia Minister of Environment refused to send aid to the spill site "because it was a federal problem" (Middleton 1989). Subsequent to this spill the British Columbia government hired a special advisor to review oil tanker traffic along the west coast. The report lists 184 recommendations, described by the author as "common sense." However, as long as oil continues to be transported along the west coast "the issue of tank vessel oil transportation is real and urgent" (Anderson 1989).

Development and potential development of coal mines has emerged as a major threat to several national parks in North America. Surface run-off from strip mines has polluted streams in Allegheny Portage Railroad National Historic Site, Pennsylvania; Johnstown Flood National Memorial, Pennsylvania and; Big South Fork National River and Recreation Area, Kentucky. In addition, at the latter unit acid drainage from deep mines has sterilized some streams. These changes in water quality have affected flora and fauna. There is concern at Hovenweep National Monument, Colorado that careless and illegal exploratory drilling could puncture and contaminate the monument's groundwater which could affect human health (National Parks and Conservation Association 1979; United States Department of Interior 1980b).

A large open-pit coal mine and associated thermal generation facility have been proposed just outside the boundary of Bryce Canyon National Park, Utah. Projected impacts on park resources are: noise, degradation of scenery (the open-pit mine would be visible from the park's most popular overlook, Yovimpa Point) and air pollution (Martin 1981; Johnson and Haspel 1983). Already, overlooks at some parks have been closed due to visual impacts from coal strip

mining - Cumberland Gap National Historical Park for example (National Parks and Conservation Association 1979).

A well-documented proposal for an open-pit coal mine is the Sage Creek Coal Company's plans for development on Cabin Creek, a tributary of the North Fork Flathead River which flows along the western boundary of Glacier National Park, Montana. Glacier Park officials consider this proposal to be "the gravest external threat to the park" (Sax and Keiter 1987: 237). Primary concerns to park resources are degraded water quality, threats to fish habitat and air pollution. Because the proposed mine is located in Canada, and the State of Montana vociferously opposed it, the International Joint Commission became involved and appointed the Flathead River International Study Board to investigate possible impacts of the proposed mine on water quality and quantity, fisheries, and water uses of the Flathead River at the International Boundary and downstream through Flathead Lake. The Board concluded there would be some adverse effects on water quality and later submitted a supplementary report outlining possible mitigation (Flathead River International Study Board 1988). An official of the British Columbia Ministry of Energy, Mines and Petroleum Resources who, during the time of the study was a provincial biologist studying the potential impacts of the proposal to the Flathead River summed up the situation: "The biggest threat to Glacier National Park is the fact that the Akamina-Kishenina [the southeast tip of British Columbia that lies adjacent to both Water Lakes National Park, Alberta and Glacier National Park, Montana] was not added to Waterton Lakes National Park" (Ringstad 1990).[17]

Threats from nuclear development result primarily from uranium mining and the problem of nuclear waste storage. Existing and proposed uranium mines five to sixteen miles outside the boundaries of Grand Canyon National Park, Arizona have park officials concerned about threats to fauna, water quality and air quality. Threats to water quality are of special concern to the Grand Canyon's only permanent residents, the Havasupai Indians, who are already aware of one spill of contaminated water (Dagget 1987).

A nuclear-waste storage facility has been proposed one mile from the eastern border of Canyonlands National Park, Utah. Included in the proposal would be the construction of two shafts 3000 feet deep as repositories for the nuclear waste, 787 boreholes, a tower 225 feet high and four to six miles of roads (Bryan 1986). Potential threats to the park include: noise from drilling, dust, water pollution and unknown effects of long-term storage of nuclear waste.

Hydroelectric development can have severe effects on park resources. Research at Grand Canyon National Park, Arizona has indicated severe and drastic changes to the aquatic systems in the Colorado River have occurred since the construction of the Glen Canyon Dam 26 kilometres upstream from the boundary in 1963. Specific problems created by the dam include: reduction of nutrients carried in the water below the dam resulting in less production of biomass causing a decline in native fish populations; the daily cycle of releases of water from the dam have replaced the natural cycle of high water in the spring and low water in the summer causing the sandy beaches along the river

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[17] The implication here is that because the Akamina-Kishenina is within the watershed of Glacier National Park, Montana the only way to ensure the protection of Glacier Park is to adequately protect the Akamina-Kishenina through national park status.

to be slowly eroded away. In addition, the released water is very low in sediment and highly erosive thereby not allowing for the natural build-up of beach sediments; water released by the dam is now a steady 10 degrees C. whereas previously it ranged between 0 degrees C. and 21 degrees C. and it is suspected that native populations of fish are being replaced by other species. Changes to the protected resources in Grand Canyon National Park created by the Glen Canyon dam have led researchers to conclude the park now contains new ecosystems[18] (National Parks and Conservation Society 1979; Johnson and Carothers 1987; Kushlan 1987; Stottlemyer 1987).

In Canada, alterations to the hydrologic regime in Wood Buffalo National Park occurred following the construction of the W.A.C. Bennett Dam on the Peace River in British Columbia. Reduced water flow into the Peace-Athabasca River delta in the park has resulted in the drying up and disappearance of some meadows. A proposed hydroelectric dam on the Slave River along the eastern boundary of the park "could further erode the park's integrity" according to park superintendent Ken East (Stott 1990: 55).

2.4.3 External Threats Arising From Other Development

Various types of commercial, industrial, residential and agricultural development located adjacent to national parks threaten park resources. Included in these problems are:

1. Habitat altered by development;

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[18] Johnson and Carothers (1987) have described the Grand Canyon's new aquatic ecosystems as having "been modified so much as to preclude considering them natural, indigenous systems. They are best considered exotic ecosystems. Even native species have had drastic changes in their populations, and processes (such as reproduction and growth) have often been modified or halted" (Johnson and Carothers 1987: 104).

2. Hydrologic changes from water impoundments and diversions;
3. Pollution from adjacent agricultural practices;
4. Threats to aesthetic values;
5. Changes in air quality.

Development of land adjacent to national parks which has a negative impact on wildlife populations inside the park continues to be a major problem for many national parks.[19] Residential development adjacent to several North American national parks is putting stress on, and in some cases reducing park wildlife populations. Examples include threats to deer populations in Yosemite National Park,[20] threats to fauna in Saguaro National Monument, Arizona that utilize riparian habitats adjacent to the park,[21] threats to both terrestrial and marine fauna from residential development adjacent to Biscayne National Park, Florida[22] and; residential development along the North Fork Flathead River is threatening grizzly bears in Glacier National Park, Montana (see e.g. Sax and Keiter 1987).

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[19] For example, in a 1978 survey of U.S. national park superintendents habitat altered by commercial and residential development on land adjacent to park boundaries emerged as the top threat to national parks (National Parks and Conservation Association 1979).

[20] The superintendent at Yosemite explains: "The park may maintain the majority of its deer habitat in relatively pristine condition. However, since the deer .... must migrate to winter ranges outside the park, development and intensive uses there can virtually destroy the deer resources" (National Parks and Conservation Association 1979).

[21] Suburban development at the border of Saguaro National Monument is destroying sensitive riparian habitats that are used by protected park fauna. This has led to the establishment of a zoning ordinance by the Pima County Planning and Zoning Committee to institute a buffer zone overlay ordinance (BOZO) which would restrict residential development in a buffer zone around the park (Bisconti 1988).

[22] Residential, commercial and industrial development surrounding Biscayne National Park, Florida including the planned development of a major office building could have direct and cumulative impacts on the park's fauna (United States Department of Interior 1987a).

Agricultural development in the form of cattle ranching adjacent to Waterton Lakes National Park has led to conflicts between grizzly bears and local ranchers. The bears will occasionally wander through this area and kill cattle. This results in either the death or removal of the bear responsible. In either case it means stress on the Waterton grizzly population. Since 1979, for example, 77 grizzly bears have been either killed or relocated from the Poll Haven community pasture which abuts the western side of Waterton Park (Masterman 1990).

In a bizarre reversal of the above mentioned problem, diseased bison in Wood Buffalo National Park are alledgedly threatening domestic cattle adjacent to the park with tuberculosis and brucellosis.[23] Local ranchers recommend wiping out the entire herd of 4,000 animals and replacing it with bison free of disease. Some biologists agree the herd should be wiped out because of its potential for spreading the disease to the bison herd in nearby Mackenzie Bison Sanctuary, North West Territories. Even though the Environmental Assessment Review Panel appointed by the Federal Minister of Environment decided not to eliminate the bison herd, the controversy continues. Wood Buffalo Park superintendent Ken East believes "the very reason for the existence of this park is under profound direct threat" (Stott 1990: 54).

Hydrologic changes from commercial and residential development adjacent to national parks which can adversely affect fauna inside the park can best be illustrated by the example of Everglades National Park, Florida, which is

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[23] Ironically, the bison at Wood Buffalo initially were affected because the herds that were shipped to Wood Buffalo from central Alberta in the 1920's had been allowed to graze alongside cattle known to be afflicted by tuberculosis and brucellosis (Stott 1990).

described by its superintendent as "probably one of the most threatened in the National Park System and faces greater problems now than perhaps ever before" (Finley 1988:2). The park is on the downstream end of a large flow of water (both surface and underground) which has been altered and diverted for various human uses that began in 1883 (Hendrix and Morehead 1983). This has resulted in the lowering of water levels in the park allowing salt water intrusion into fresh water aquifers and ecosystems, disruption of nesting sites, and the decimation of wildlife.[24]

Agricultural development adjacent to national parks can have adverse impacts on the park. For example, the draining of wetland habitat adjacent to Everglades National Park, Florida for commercial agricultural uses has resulted in the lowering of the park's watertable by as much as one and a half feet (Finley 1987). A typical operation in the area is commercial tomato growing, an industry which requires the ground to be dry enough for farming by mid-October. In wet years, this requires the growers to artificially draw down the water levels "adversely affecting vegetation, fish production and salinity in the [park] estuaries" (U.S. Dept. of Interior 1987b).

The introduction of pesticides and fertilizer from adjacent agricultural land that enters the park's aquifer is another problem in Everglades National Park. Hydrologic studies have shown that the general direction of groundwater

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[24] Problems arising from external threats to Everglades National Parks are among the best documented in the threats literature. One of the results of all this research has been an emergence of the issue into the popular press in the U.S. culminating in then Governor Bob Graham using the issue of protecting the Everglades from external threats as a successful campaign issue (see e.g. Graham 1985; Kushlan 1987). In addition to hydrologic changes, several U.S parks are experiencing deterioration of park water quality due to pollution from septic tanks in residential areas adjacent to the park. (National Parks and Conservation Association 1979).

movement in the park is from north to south. Therefore, these pollutants are of particular concern when applied on land just north of the park. Research of heavy metal content in crocodile eggs in the park has revealed high concentrations of lead, mercury and cobalt (Stoneburner and Kushlan 1984).

Another problem facing the Everglades is the nutrient loading of Lake Okeechobee from the runoff of fertilizers containing phosphorus.[25] This has caused large blooms of blue-green algae which are threatening the quality of the lakes's water and, because the lake supplies most of the Everglade's water, there is concern there could be adverse impacts to the park.

Threats to park aesthetic values as a result of adjacent development are widespread and include noise, odor and visual threats. For example, noise from aircraft in southwestern U.S. national parks not only disturbs park visitors but sonic booms from jet aircraft have been responsible for the destruction of cliffs in Mesa Verde National Park and the destruction of 3000 year-old Indian ruins in Yellowstone National Park (Brownbridge 1986). In addition, several U.S. parks located in the east suffer noise pollution from autos and trucks on nearby freeways (National Parks and Conservation Society 1979).

Sources of odor pollution include the close proximity of sewage pumping stations, fish processing plants and landfills. Proposed landfills adjacent to several North American parks have met with stiff opposition from park superintendents at Fort Caroline National Memorial, Florida (United States

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[25] Phosphorus is also used in a feed supplement for the estimated 50,000 cows in the basin that drains into Lake Okeechobee. This phosphorus also eventually enters the lake after it is excreted from the cows and runs off into the lake (Mitchell 1986).

Department of Interior 1987a) and Elk Island National Park, Alberta (Blake 1988).

Visual threats include: smokestacks visible inside Indiana Dunes National Lakeshore (National Parks and Conservation Association 1979); garish billboards visible inside Manassas National Battlefield Park, Virginia (United States Department of Interior 1987a) and; commercial development visible inside Gettysburg National Military Park (United States Department of Interior 1987a).

The remaining major regional and local threat to national parks is air pollution. The source of this threat is generally difficult to trace unless it is a nearby point source[26], and even then clear identification of the source is problematical due to the generally polluted condition of the atmosphere from many widespread, distant point and non-point sources (see e.g. Hinrichsen 1988). Therefore, air pollution problems in national parks will be examined in section 2.2 which deals with external threats from sources of national and global origin.

2.4.4 Other External Threats

Two threats of major importance to national parks worldwide that do not have a direct link to one particular form of development are the invasion of exotic species and the illegal removal of fauna (poaching).

The introduction of non-native species of flora and fauna into national parks is a widespread problem and one that is not new. As early as 1901 in

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[26] Officials in Shenandoah National Park, Virginia were successful in tracking down point source polluters in the Luray Valley just west of the park, and by using legislation in the Clean Air Act were able to force them to cut down their pollution (Haskell 1990).

Yellowstone National Park plains bison were introduced and interbred with the park's resident population of mountain bison, resulting in a new species which later contributed to the decimation of Yellowstone's grassland habitat (Chase 1986). The stocking of exotic varieties of fish began in Yellowstone at the same time and included Machinaw from Lake Superior, brown trout from Germany, Atlantic salmon from eastern North America and black bass and yellow perch from unidentified sources. The yellow perch succeeded so well that they were eventually eradicated with the poison from derris root and in many streams the brown trout drove out the native cutthroat and grayling. However, most visitors at this time simply enjoyed the fabulous fishing in Yellowstone. "Exotic species might be destroying original conditions in the park, but these conditions were never so nice as those man had made" (Chase 1986: 18).

After park philosophy turned toward preserving intact ecosystems[27], deliberate introduction of non-native species declined. However their proliferation into national parks is still a major threat. The introduction of exotic plants and animals has recently been reported as a threat to 43 percent of national parks worldwide, but was found to be a much more significant problem in parks in developed countries than in less-developed countries (Machlis and Tichnell 1985). This could, however be due as much to a lack of knowledge on

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[27] Several authors contend that national park management in North America began to develop a "slowly growing ecological consciousness" (Machlis and Tichnell 1985: 20) in the 1960's. This growing awareness of the role of ecology in park management was attributed to three factors: 1) expanding scientific knowledge of ecology, 2) ever-higher numbers of obvious impacts to parks and 3) increasing management experience. This new awareness, for example, viewed suppression of wildfires to be a threat to park resources in some circumstances. Preservation of diversity and natural change were now major objectives of national park management in contrast to the earlier management strategy of preservation of disparate and static features.

local fauna and flora in some countries, as a reflection of the relative severity of the problem.

Everglades National Park, Florida has had a particular problem with exotic introductions of three particular types of trees: the Brazilian Pepper, the Punk tree and the Australian Pine. All three colonize faster than native trees, and once established, their dense stands eliminate native species. The Brazilian Pepper is particularly difficult to remove as it fruits in the winter when migratory birds eat and carry the seeds throughout the park. The Brazilian pepper has established large monocultural stands in former agricultural fields and has also taken hold in the coastal mangrove forests of the Everglades. (Hendrix and Morehead 1983). Recently, a coordinated effort to combat the invasion of exotic species has begun. The Exotic Pest Plant Council of South Florida was formed in 1989 to "facilitate communication and exchange of information regarding all aspects of exotic pest plant control and management" (Doren 1989: 5).

The invasion of feral goats and pigs into Haleakala and Hawaii Volcanoes National Parks, Hawaii has caused considerable damage to park ecosystems. The proliferation of feral pigs has in part been due to the introduction and invasion of earthworms, an important part of the pig's diet. Feral pigs have become "the single major factor contributing to the spread of many introduced plants - not only by creating open habitats through digging, but also by transporting propagules in their hair and faeces" (Stone and Loope 1987: 247). To date, management has consisted primarily of fencing, poisoning and shooting the pigs from helicopters.

Usher (1988) believes that all nature reserves, except those in Antarctica, have invasive species. In a study of 24 nature reserves worldwide, it was found

all contained invasive species. In a discussion of management techniques for the eradication of invasives, Usher lists three methods of control: manual (e.g. physical removal, shooting), chemical (poisoning), and biological. The first two categories are the predominant methods currently used, though biological methods have potential. For example, it has been suggested that biological techniques will be the only method of removing *Tamarix* in the American southwest reserves and *Chromolaena* in African savanna reserves (Usher 1988). Due to budget restrictions cost will continue to influence the method employed in the eradication of invasives.

Illegal removal of park animals was cited as the number one threat to national parks in Machlis and Tichnell's (1985) survey of threats to parks worldwide. Furthermore, it made no difference whether the national park was in a developed or less-developed country - illegal removal of animals was still the number one threat.

In Nigeria, wildlife is typically viewed as "bushmeat, a God-given inexhaustible bounty" (Anadu 1987: 247) which results in local residents hunting in Nigeria's national parks. Further pressure on protected animals is a result of Nigerians preference for "bushmeat" and the high cost of meat from livestock. This has created a lucrative market for commercial hunters who typically set up camp inside preserves, smoke illegally-killed meat and transport it out to middlemen (Anadu 1987).

The situation is not so much different in some North American national parks. Mud turtles from Big Bend National Park, slender salamanders from Channel Islands National Monument and black bears from Shenandoah National Park are but a few examples of poachers' targets in North America.

Commercial hunting of large mammals in North American national parks for their meat, teeth, gall bladders, hides, etc., has become a major problem. The U.S. National Park Service has recently developed an anti-poaching program for its interpreters and some individual parks such as Shenandoah, have created "Anti-Hunting Strike Teams" which have had limited success to date in apprehending poachers (U.S. National Park Service 1988).

2.5 National and Global External Threats To National Parks

The primary national/global threat to national parks is air pollution, in the form of suspended particulates, dust, sulphur dioxide, nitrogen oxides, carbon dioxide and other toxic substances. Effects of air pollution may subsequently have an impact on other park resources. Emissions of sulphur dioxide, for example, may produce acidic precipitation hundreds or thousands miles distant from its source thereby affecting pH levels in park surface water and damaging biological resources ranging from in-stream life to soil, micro-organisms and trees. Problems of transboundary air pollution are well recognized throughout the world and have resulted in several treaties of international significance being signed by participating nations in order to reduce emissions of certain types of pollutants (see e.g. Brown 1989).

The U.S. National Park Service has recognized the seriousness of air pollution threats to national parks:

> Air pollution is clearly one of the most important environmental issues facing the National Park Service, the nation, and the world. Air pollution is affecting natural resources throughout much of the National Park System. Visibility reduction and biological effects, such as foliar injury to plants and trees, are some of the known effects of air pollution. Several park units are serving as key areas for research on air pollution, and studies are yielding valuable baseline data and basic

> information on the effects of air pollution (United States Department of Interior 1988: i).

In a worldwide survey of threats to national parks Machlis and Tichnell (1985) reported that threats to air were reported much more frequently by national parks located in developed countries. This seems to suggest that while it may be true that air pollution is global in nature, it is a more severe problem in developed countries where there are a greater number of sources. This is supported by a survey of threats to U.S. national parks in 1980 which showed the total number of threats to air being second only to threats to aesthetic values (United States Department of Interior 1980a).

From the literature, the following major points regarding air pollution can be made:

1. Air pollutants have the ability to travel long distances and as a result can have significant impacts on park resources which are far from the source of pollution. This makes specific identification of the pollutants' source difficult or impossible.

2. Air pollutants that are known to be present in national parks include acidic deposition (oxides of sulphur and nitrogen), sulphur dioxide, ozone (a photochemical oxidant) heavy metals (lead, zinc, mercury and arsenic) and carbon dioxide.

3. The most obvious impact of air pollution on the sub-system of air is reduction in visibility. Fine sulphate aerosols which combine with water vapor and fall as acidic precipitation, or fall on the surface during rain-free periods, are responsible for most of the visibility reduction in national parks that monitor for visibility.

4. Air pollution can have adverse effects on the protected sub-system of soil. Acidic precipitation, for example, may enter the soil resulting in reduction or elimination of some aquatic organisms and tree roots (see Grigal 1988). Because of complex interactions between soil, water, flora and fauna, it can further be expected that adverse changes to the soil will result in adverse changes to the other interrelated sub-systems.

5. Flora can be directly affected by some airborne pollutants (e.g. acidic precipitation, ozone) resulting in foliar damage, reduced growth and even death (see e.g. Hinrichsen 1988). Additional adverse changes to flora can occur through changes in soil characteristics.

6. Air pollution, in the form of acidic precipitation can have impacts (erosion and discoloration) on park buildings constructed of susceptible materials (e.g. concrete, masonry, marble, stucco). Research in this area has yielded little thus far for mitigating these adverse effects.

Finally, it should be pointed out that there is considerable scientific uncertainty regarding the nature and impacts of air pollutants on ecosystems. Some researchers believe that ecosystems that are currently stressed and damaged from air pollution have the ability to restore themselves quickly should the adverse effects of air pollution be significantly reduced. An examination of the long-term trend of acidic precipitation in the United States indicates that emissions of both sulphur dioxide and nitrogen peaked in the 1970's and have, for now, leveled off. Trends in levels of ozone (and other photochemical oxidants) are not as encouraging and most likely "it will require a high level of public awareness, probably expressed as legislation, to help hold oxidant levels at either constant or declining" (Grigal 1988: 130).

2.6 Management of External Threats To National Parks

The management of threats to national parks cannot be undertaken until threats have been identified. Surveys have been successful in identifying threats, and in those cases where the surveys have been commissioned by government agencies (e.g. State of California 1984; United States Department of Interior 1980a), management strategies to eliminate or mitigate the identified threats have directly resulted from the surveys.

Other sources which can contribute to the management of threats include: the large body of legal research (mostly from the U.S.) that examines the viability of using legislative tools to mitigate threats to national parks from adjacent land; cooperative concepts such as the Biosphere Reserve Program; and on-going scientific research dealing with the identification and mitigation of individual specific threats (see e.g. Dearden 1988) and broad conceptual frameworks which deal with threats at the ecosystem level (see e.g. Schonewald-Cox 1988).

2.6.1 Recommendations From Surveys

Recommendations made by two international surveys of threats to national parks examined (Machlis and Tichnell 1985; Machlis and Neumann 1987) are necessarily broad and general for several reasons. First, a wide range of parks in different countries at different stages of development and in different biomes were studied and specific recommendations for one park may not be applicable to another. Second, only a sample of the world's parks were studied (approximately ten percent) and even though care was taken to choose a representative sample, important threats may have been missed. Third, the survey was not undertaken by a park agency and therefore was not mandated

to provide specific recommendations as were both the U.S. Department of Interior and the State of California surveys.

The recommendations by a national survey (U.S. Department of Interior 1980b) and a regional survey (State of California 1984) did provide some specific guidelines for preventing and mitigating threats such as additional training for superintendents in natural resource management practices and the addition of Regional Resource Ecologists. However, all of the national and regional surveys warned that without additional funds little could be accomplished toward successfully implementing their recommendations.

2.6.2 Legal Tools

The legislation responsible for protecting national parks in both Canada and the United States provides that parks be left "unimpaired for the enjoyment of future generations" (1930 National Parks Act of Canada; 1916 U.S. National Park Service Organic Act). A large body of literature exists in the United States legal journals that examines court cases involving the U.S. Organic Act's ability to protect national parks from threatening activities. Legal precedents have clearly established the U.S. Act's power to control activities inside park boundaries which threaten park resources (Keiter 1985; Bryan 1986). What is not so clear, however, is the ability of the legislation to protect park resources from threats originating outside their boundaries - external threats.

The U.S. Organic Act was used by the Sierra Club in the early 1970's to prevent clear-cut logging adjacent to Redwood National Park. In the case of *Sierra Club v. Andrus* (Cecil Andrus was then Secretary of Interior) the Sierra Club commenced litigation against the Secretary of the Interior "alleging that he had failed to protect the park under the Organic Act, the Redwood National Park

Act and his public trust obligation" (Keiter 1985: 371). The ensuing court battle went through three decisions. In the first decision the court overruled the Secretary's motion to dismiss for failure to state a cause of action against him and held that the Secretary did have a legal duty to protect park resources. The second decision found the Secretary had violated his statutory and public trust duties and ordered him to take steps to protect the park. The third and final decision on the matter saw the court dismiss the suit when it determined that the only effective protection available to the park was through congressional legislation which went beyond the authority of the court to order. The case did, however, prompt Congress to increase the size of the park to provide greater protection to the park's resources (Wayburn, McCloskey and Howard 1984; Keiter 1985).

The *Sierra Club v. Andrus* was an important case and several conclusions can be made regarding the power of the Organic Act to control adjacent land activity:

1. The Act's net of protection extends far enough outside park boundaries to prohibit activities that adversely impact on protected park resources;
2. The Secretary of the Interior is charged with a judicially enforceable duty to invoke his/her authority to protect park resources which are immediately threatened;
3. The Secretary of the Interior may choose from several general and regulatory powers to protect the parks, but he/she "must not exercise his/her authority in a manner that results in derogation of the fundamental values and purposes for which the parks were established" (Bryan 1986: 111).

Another implication of the *Sierra Club v. Andrus* case is the court's recognition of the "public trust obligation." The first decision in the case ruled the Secretary of the Interior had a "separate legal duty to protect the parks under his trust obligation" (Keiter 1985: 374). This was the first time the public trust obligation was imposed in the U.S. national park context (see Sax 1970) and the precedent that it established is that the Secretary of the Interior can clearly be charged with a legal duty to protect park resources.

The public trust doctrine has been examined for its potential use for national park protection in Canada by Rounthwaite (1986). The first hurdle to its use in Canada is the matter of "standing." In order for a party to maintain an action in the Federal Court of Canada he/she must show a "demonstrable interest" in the subject matter which is over and above the interest of the general public. In a landmark case, *The Canadian Broadcasting League (CBL) v. The Canadian Radio-Television and Telecommunications Commission (CRTC)* the Federal Court of Canada decided:

> In my opinion this well-established role and assumed responsibility as a public interest advocate .... gives it a sufficient interest not only for status before the CRTC but for status to appeal (Rounthwaite 1986: 63).

The implications of this decision are that "it may open the doors to the judicial process for groups advocating public interest causes, particularly in the environmental field. It may also have important ramifications for the national parks" (Rounthwaite 1986: 63). An example is the Canadian Parks and Wilderness Society, which can trace its role as the watchdog of national parks administration back to the 1920's when it opposed hydro development inside Banff National Park by the Calgary Power Company, may now have court-

recognized standing in matters related to national parks. However, it has not yet been demonstrated in Canadian courts if the public trust obligation is enforceable against the government in actions initiated by individuals or groups who can demonstrate standing.

There are several other legal tools available in the United States that have potential to prevent or mitigate external threats to national parks. There are broad comprehensive planning statutes that call for recognition of environmental values such as the National Environmental Policy Act of 1969 (NEPA), the Wilderness Act of 1964, the Wild and Scenic Rivers Act of 1968 and more specific planning acts which establish management guidelines for the Fish and Wildlife Service, the Bureau of Land Management and the United States Forest Service. There are statutes aimed at protecting specific resources frequently found in parks including the Endangered Species Act, the Marine Mammal Protection Act, the Migratory Bird Treaty Act, the Natural Historical Preservation Act and the Clean Air Act. Finally, there are statutes which regulate specific aspects of development and include the Mineral Lands Leasing Act and the Surface Mining and Reclamation Act (Hiscock 1986; Luhn 1986; Sax and Keiter 1987; Coggins 1987).

While it is beyond the scope of this review to examine all the above mechanisms for their potential to protect national park resources from external threats, an important point to be made is that there is little comparable legislation in Canada with as much potential to protect national parks. For example, the closest equivalent to NEPA in Canada is the federal Environmental Assessment and Review Process (EARP), with a major difference being that EARP is an administrative rather legislative procedure. It

is the lack of legislative mandate for EARP that has drawn the most criticism, but EARP has other flaws as well. Very few proposals proceed from the initial screening process in EARP to a full public review (it has been estimated that only one in every 1000 proposals reaches public review -- Elkin and Smith 1988) and the screening process has been criticized for being obscure, secretive, undocumented, impossible to evaluate and done in an *ad hoc* manner (Elkin and Smith 1988). As with NEPA, the EARP process could be a powerful tool in protecting national parks from external threats but in current practice is too handicapped by inferior screening procedures and lack of legislative mandate to be a reliable tool.

Another example is there is no federal equivalent to the U.S. Wilderness Act in Canada, but in British Columbia there is a new provincial designation under the Forest Act which can designate areas as "wilderness." It is not a legislated designation and does not preclude mining exploration and development and has been criticized for its *ad hoc* application. Nevertheless, this type of designation could prove to be an extremely useful tool in combatting external threats to national parks in the future.

The only legislation in Canada somewhat comparable to that of the U.S. Endangered Species Act (ESA) is the Fisheries Act. Administered by the Department of Fisheries and Oceans (DFO), the Act authorizes the Minister to stop any project "that is likely to result in harm to fish habitat or the deposit of a substance deleterious to fish into waters frequented by fish" (Andrews and Higham 1986: 13). The Act applies to all tidal water and waters frequented by anadromous salmon, steelhead trout and resident freshwater species. This Act has the potential to be a very useful tool in protecting parks from external threats

to its water and resident fish. On-going problems with the application of the Act include lack of DFO staff in the field and the sensitive relationship between the federal and provincial governments regarding the management of resources.

A major impediment to establishing a legal basis for challenging external threats to parks is the lack of a scientific data base concerning park resources. This is needed to document damage to the park and/or to determine threats which could lead to damage. In a survey of the scientific information available (e.g. published literature, agency reports, file documents and park correspondence) to Glacier Park, Montana officials, Keiter and Hubert (1987) found little data on the location and magnitude of activities such as logging, mining and oil and gas development. As a result it was recommended that park officials prepare a detailed mapping system to inventory land use adjacent to the park. Additional recommendations from Keiter and Hubert (1987) were that park officials should routinely monitor air pollutants at diverse locations in the park, monitor the rivers bordering the park for water quality, sediment and macroinvertebrates and monitor for acidic precipitation.

The establishment of a sound database and routine updating could provide information to demonstrate legal violations or trends suggesting impending violations and would enable park officials to challenge or mitigate threatening activities covered by existing legislation.

Actions at local levels of government have occasionally been successful in altering development plans on land adjacent to national parks. The buffer overlay zone ordinance (BOZO), approved by the Pima County, Arizona Planning and Zoning Commission in 1988, created a one-mile buffer zone around Saguaro National Monument which requires developers to leave 60

percent open space and no building within 300 feet of the Monument's boundaries (Bisconti 1988). BOZO requires little change to existing agency structure that only *modifies* all existing land uses (i.e. development) in a policy that marginally protects the adjoining national park.

2.6.3 Cooperative Methods

Cooperative methods of managing for external threats can take several forms ranging from informal arrangements to more formal arrangements such as biosphere reserves. Cooperative arrangements between agencies hold three major advantages over legal methods:

1. Certainty is provided because an agreement is reached by negotiation involving two or more parties, each of which would receive some benefit from upholding the agreement;
2. Arrangements can be adapted to meet the needs of a particular park;
3. Cooperative action, by its very nature, promotes good relations between managers in various agencies or between government agents and owners of adjoining land.

An increasingly popular program of cooperation in managing land adjacent to national parks is the Biosphere Reserve Program. Established in 1976 by the United Nations Educational, Scientific and Cultural Organization (UNESCO) a biosphere reserve is an international designation created and awarded by UNESCO to an area which has been nominated by a Man and the Biosphere (MAB) National Committee, and which has met the selection criteria. Selection criteria require an area to be typical of its biogeographic region (the goal of the program is to represent all 227 of the world's natural regions) and contain a core area of protected, minimally disturbed ecosystems (typically a national

park). The core area is then surrounded by a "buffer zone" which in turn is surrounded a "zone of cooperation" (Canadian Commission for UNESCO 1987).

The buffer zone is a specially designated area that surrounds and helps protect the core. Resource uses in the buffer zone are restricted to those which do not threaten the core. Effects of usage are closely monitored to provide information on ecosystem processes and resiliency through comparative research in the core.

The zone of cooperation is the outermost part of the biosphere reserve and typically surrounds the core and buffer zone. This is a flexible and dynamic zone "where conservation knowledge and management skills are applied, where economic and social activities are allowed and where management is cooperative and in harmony with the objectives of the biosphere reserve" (Canadian Commission for UNESCO 1987: 4). The zone of cooperation may contain settlements, farming, forestry, intensive recreation, small industry and other types of resource development.

The goals of the Biosphere Reserve Program are generally to maintain the biological integrity of representative ecosystems, to promote research and education, and to provide for the well-being of nearby human populations. "In the final analysis, the biosphere reserve is a new, over-arching concept aimed at welding together a combination of land uses to the common purpose of conserving representative ecological areas" (Sadler 1982: 86).

In Canada, there are currently six biosphere reserves: Mont St. Hilaire Biosphere Reserve, Quebec (designated in 1978), Waterton Lakes Biosphere Reserve, Alberta (designated in 1979), Riding Mountain Biosphere Reserve,

Manitoba (designated in 1986) and Long Point Biosphere Reserve, Ontario (designated in 1986), Charlevoix Biosphere Reserve, Quebec (designated in 1990) and Niagara Escarpment Biosphere Reserve, Ontario (designated in 1990).

The Waterton Lakes Biosphere Reserve has received considerable attention in the literature due to its active promotion of new ideas at the national and international levels in conservation, research, monitoring, local involvement and regional development (see e.g. Lieff 1985a). The success of the program at Waterton has been in large part due to the cooperation of local private land owners (ranchers) in altering some of their activities to benefit the reserve.

As external threats become of greater concern to national park managers, the concept of the Biosphere Reserve Program should become more appealing. The program is useful in both developed countries for use as buffer zones and less-developed countries who have neither the ability nor the desire to set aside large areas as pristine wilderness. In the final analysis the success of the Biosphere Reserve Program will largely depend on it overcoming three factors:

1. The concept has no legal base and relies heavily on volunteers;
2. Lack of adequate understanding of the concept by resource managers and local people;
3. Reluctance by resource managers to take on "another layer of bureaucracy" (Lieff 1985b; Francis 1985; Sax and Keiter 1987).

In addition to such formalized methods of cooperative management arrangements, national park managers continue to rely on informal, *ad hoc* arrangements with adjacent land users to mitigate and prevent external threats. For example, officials in Glacier Park, Montana helped local landowners along

the North Fork Flathead River to form an "interlocal agreement" which encourages large-lot, low intensity use. In this, as in any form of cooperative arrangement, compromises must be made. For example, officials there, to ensure a certain protection of the North Fork Flathead from adjacent landowners, have agreed to accept a slight loss of quantity of water (from stock watering, irrigation and domestic supply) and a slight increase in turbidity.

In an on-going dispute involving cattle trespassing and grazing in the park from the neighboring Blackfoot Indian Reserve, Glacier Park officials have proposed the Blackfeet replace grazing with a trophy-hunting industry which would rely on migratory park animals. Park officials contend this solution would be both more profitable to the Blackfeet and less ecologically destructive to the park despite the loss of some park animals. This is a further example of a willingness of park officials to compromise and work with their neighbors in attempt to develop mutual respect and good working relationships.

Regardless of which approach national park managers take to prevent or mitigate external threats, be it legal or cooperative techniques, one clear impediment has emerged to the useful resolution of most external threats - the lack of scientific data. Without good, reliable data to back up park claims from damage or potential damage from external threats to the parks, neither the courts nor adjacent land managers will be likely to undertake mitigative action. It is up to the parks therefore to establish a base of valid and reliable scientific data in order to effectively deal with external threats in the future.

2.6.4 Scientific Research

A review of the literature has clearly established the need for on-going scientific research dealing with external threats to national parks. Two

conceptual approaches to the threats problem include the Watershed Approach and the Boundary Model.

The Watershed Approach (WA) is a program of long-term watershed research and monitoring in selected U.S. national parks undertaken by the U.S. National Park Service with the purpose of achieving a better understanding of how natural watersheds function as ecosystems, and how the changing chemical environment is altering them. The National Park Service policy is:

> ... to assemble baseline inventory data describing the natural resources under its stewardship, and to monitor those resources forever - to detect or predict changes that may require intervention, and to provide reference points to which comparisons with other, more altered parts of the home of mankind may be made (Herrmann and Stottlemyer 1990: 4).

Specific research objectives of the WA are:

1. Detection of chemical and biological change within each ecosystem;
2. Partitioning cause and effect relationships in long-term ecosystem change;
3. Evaluation of how different unmanipulated natural sites will respond to acidification;
4. Establishment of an early warning system for measuring ecosystem response (Herrmann and Stottlemyer 1990: 7).

Preliminary data from this research have revealed chronically acidified and poorly buffered streams in Shenandoah National Park (NP), the documentation of temporarily acidified streams following some rainfall events in Great Smoky Mountains NP, an increase in forest ecosystem nutrient leaching due to sulphate in acid deposition in Isle Royale NP, no influence on ecosystems in

Rocky Mountain NP and the temporary acidification of lakes and streams in Sequoia and Kings Canyon NP.

The WA has made significant strides in documenting actual deterioration of national park resources - an essential step to the successful management of external threats to national parks.

The Boundary Model theory (BM) is a new area of research which examines the permeability of a reserve's boundary to outside influences and hence the reserve's vulnerability to degradation. The method is multidisciplinary, including biogeography, ecology, and human effects, influences and attitudes (Schonewald-Cox and Bayless 1986).

The boundary model approach suggests there are other factors to consider in regards to reserve design and protection than just size. For example:

1. The reserve's area-to-perimeter (a/p) ratio. The lower this ratio (e.g. elongated shape such as Pacific Rim National Park, British Columbia) the greater the influence of external processes.
2. The permeability of the boundary. If there are strong external forces acting on a boundary combined with weak enforcement of the reserve's legal boundaries, the external forces will penetrate into the reserve. The model suggests that if these external areas are given some form of protection (e.g. buffers), reserve protection will be more effective.

The value of the boundary model theory lies in its ability to pinpoint precise locations of breakdown and failure in a reserve's boundary which could lead to (or have already allowed) penetration of undesirable external forces into the reserve. Researchers are currently applying the BM theory to an in-depth analysis of Organ Pipe Cactus National Monument, Arizona where they are

attempting "to determine how to interpret the condition and effectiveness of the nature reserve boundary for protection" (Schonewald-Cox 1988: 485). Further research is also underway at Pacific Rim National Park to assess some of the interactions between the park and adjacent Indian Reserves (e.g. Berg and Dearden 1990).

The prescription for problems discovered by boundary model research is, in most cases, the creation of buffer zones (e.g. biosphere reserves, zoning ordinances) to help establish a management framework which will extend the generated edge of a protected area beyond the administrative boundary. Raymond Dasmann (1988) believes "the greatest problems that face reserves now lie on their boundaries" (p. 489). As the pressure of external threats increase, managing interactions across park boundaries will undoubtedly become a major focus of park management in the future.

CHAPTER THREE - RESOURCE MANAGEMENT AND HUMAN ECOLOGY AS A MODE OF INQUIRY INTO EXTERNAL THREATS TO PACIFIC RIM NATIONAL PARK RESERVE

This chapter discusses the role of both resource management and human ecology in geographical research and their relation to the specific methods employed in this research. The specific methods of literature search, structured interviews and semi-structured interviews conducted for this research will be described in the following sections.

3.1 Resource Management

The Dictionary of Human Geography (Johnston, Gregory and Smith 1989) defines resource management as:

> A broad multi-disciplinary area or programme of study concerned with the management of all natural resources, renewable and non-renewable, whether managed by private enterprise or public sector agencies. It seeks to:
> (a) explain the processes (physical, socio-economic and political) involved in resource supply, exploitation and consumption;
> (b) analyse the allocation of resource products and services over space and time;
> (c) evaluate management systems, practices and policies;
> (d) develop alternative management strategies and evaluatory tools (p. 410).

The objectives of this thesis generally correspond to the above mentioned definition of resource management. The objectives are:

1. To determine the most significant external threats to the protected resources of Pacific Rim National Park Reserve;
2. To assess the information available concerning these threats;

3. To identify what information, if any, is lacking concerning these threats, and how it may be obtained;
4. Whether any possibilities exist for mitigation of these threats.

Mitchell (1989) distinguishes between resource analysis, resource management and resource development. According to Mitchell, the resource analyst is a researcher who performs some or all of the following functions:

1) studies natural resources themselves: surveying, mapping and measurement of the supply and demand for resources;

2) studies alternative allocations of resources;

3) studies the variables (biophysical, technological, economic, social, political, legal) which condition resource allocation or development;

4) studies the impact of specific resource allocations (Mitchell 1989: 2-3).

For the resource analyst then, the focus of inquiry is on examining the way resources are used and an exploration of alternative ways they could be utilized. As Mitchell (1989) succinctly puts it: "As resource analyst, the geographer seeks to understand the fundamental characteristics of natural resources and the processes through which they are, could be, and should be allocated and utilized" (p. 3).

Whereas resource analysis is concerned with understanding the characteristics and processes of allocation of resources, resource management is concerned with controlling resource development:

> [resource management] may be defined as a process of decision making whereby resources are allocated over space and time according to the needs, aspirations, and desires of man within the framework of his technological inventiveness, his political and social institutions, and his legal and administrative arrangements (O'Riordan 1971: 19).

The process of resource management then is an exercise in control and power, i.e., the governing body with the mandate for controlling a particular resource will decide on a course of action (policy) based, ideally, on input from resource analysts. According to Sewell and Mitchell (1984), policy making consists of four stages:

> (1) identification of a significant problem, for which either there is no policy or else presents policies which are inadequate; (2) formulation of a policy which attempts to solve the problem; (3) implementation of policy; and (4) monitoring the effects of policy (p.25).

Sewell and Mitchell (1984) argue that resource analysts typically have input to only stages one and four, with stage two being primarily decided at the political level. This is not to say, however, that resource analysts cannot have influence in shaping policy, as Mitchell (1989) points out:

> As a professional, the geographer is more likely to function in one of the roles of Internal Advisor, External Advisor, Consultant, or Critic. In these roles the geographer may exert considerable influence in shaping policy. Because elected officials do not always have the time or expertise to understand the complexities of a resource management problem, they often rely heavily on the advice of their advisers. All of these roles demand an ability to bring geographical concepts, methods and techniques to bear on problems, to appreciate fundamental research issues which must be overcome, and to recognize basic resource management problems (p.8).

3.2 Human Ecology

The word ecology is derived from the Greek *oikos*, meaning "household," combined with the root *logy*, meaning "the study of." Thus,

> "ecology is the study of households, including the plants, animals, microbes, and people that live together as interdependent beings on Spaceship Earth ... hence we can think of ecology as the study of the earth's life-support systems" (Odum 1989: 23-24).

The concept of human ecology became popular in geography in 1910 when it was a term used for the study of humans and environment together - not in the sense of suggesting that humans were determined by their environment, but in implying that they were not apart from nature and that they had a place in "the web of life or the 'economy of nature'" (Pepper 1984: 103). In 1923 the president of the Association of American Geographers, H.H. Barrows, called on his colleagues to to make geography

> the science of human ecology... Geography will aim to make clear the relationships existing between natural environments and the distribution and activities of man... from the standpoint of man's adjustment to environment rather than environmental influence (Barrows, in Pepper 1984: 103)

Barrows saw human ecology as a way to determine the relationships that exist between the natural environment and the distribution of human activities. The underlying importance of this view is that humans are a part of nature. Machlis and Tichnell (1985) have suggested that this approach uses the 'human ecosystem' as its basic unit of analysis, where "the human ecosystem is defined by the interaction of population, social organization, and technology in response to a set of environmental conditions" (p. 30).

Bennett (1984) cautions that human ecosystems are more than simply systems with humans added as an afterthought:

> If human activities are to be inserted into ecosystems, the system itself has to be reconceptualized: it is not a matter of a natural system being invaded by humans, but a complex whole system involving an interaction between the physical resources, animal species, and the human activities. This requires a shift in values as well: human components must be viewed an analytically equal to environmental components (Bennett, in Machlis and Tichnell 1985: 30-31).

3.2.1 Park Ecosystems

There can be many classifications of types of ecosystems based on either structural or functional characteristics. As Odum (1989) states:

> The human mind seems to require, or we might even say delights in, orderly categorization or classification when it comes to dealing with a large variety of entities... Ecologists have not agreed upon any one classification scheme for ecosystem types or even upon what would be a proper basis for one -- and this is as it should be, since many different arrangements can be instructive (p. 58).

In the case of this research, park ecosystem refers to the biotic community, all abiotic elements and human-built structures and management arrangements that fall inside the delimiting boundaries established for national parks.

The key components that comprise a park ecosystem can be described as subsystems of the park which are embedded in a larger regional ecosystem. The park ecosystem then, "is influenced by the population, organization, technology, and environment that surrounds and interacts with it" (Machlis and Wright 1984: 12 - see figure 2). Elements of the regional ecosystem that influence the park ecosystem include: settlement patterns of the population; the structure of political organization; large corporations; migration rates; and nearby communities. The regional ecosystem surrounding a park ecosystem is linked to it through "shared" (common) resources such as air, water and wildlife ranges, as well as by human-built technologies such as highways and electric power distribution.

In addition to linkages between the park ecosystem and the surrounding regional ecosystem, there can be linkages between the park ecosystem and national or global events and policies (the "global system"). For example,

emissions of carbon dioxide from sources distant to a park ecosystem could contribute to global warming which could cause profound changes in the biophysical parameters of the park ecosystem. External threats to a park ecosystem, therefore, can originate in the regional ecosystem surrounding the park ecosystem, and in areas far removed.

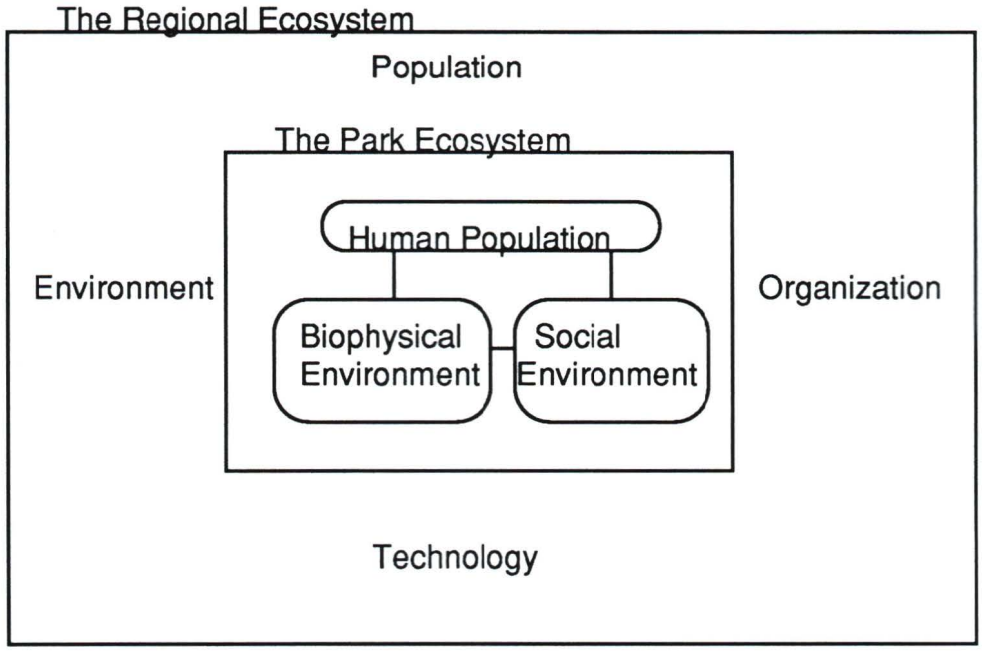

Figure 2 Conceptual diagram of park ecosystem (from Machlis and Tichnell 1985)

Within the park ecosystem, the key components are: the biophysical environment, the social environment and human populations. The biophysical environment within the park can be subdivided into the subsystems of: air, water, flora, fauna, soil, the major energy flows (e.g. solar), and the major ecosystem processes (e.g. erosion). The social environment within the park consists of the subsystems of park management, cultural resources (e.g. abandoned indigenous village sites) and aesthetics (e.g. noise from human-made activities which detracts from visitor satisfaction). The third element within

the park ecosystem is the human population (e.g. park visitors) which has been described as "the dominant species in every National Park" (Campbell, in Machlis and Tichnell 1985: 34).

It should also be noted that there are social, economic and political influences on both the regional ecosystem and park ecosystem from the "global system." In addition to the biophysical influences from the global system already mentioned, influences from the global system can be in the form of changing societal values. For example, societal attitudes towards wilderness have evolved from an anthropocentric view in the 1800's to a view that today is more biocentric (see e.g. Dearden 1989). This type of shift in values has had implications for park management. National parks today are managed more for the maintenance of ecosystem processes than for the encouragement of potentially damaging recreational activities inside park boundaries.

Dividing the park ecosystem into the above mentioned subsystems allows closer examination of threats due to the complex linkages which exist between subsystems, i.e. a particular threat may not have similar effects on all subsystems. For example, removal of vegetation along a stream bank upstream from the park boundary may result in the die-off of some fish in the protected portion of the stream (through elevated water temperatures, for example), but may cause no damage to the subsystem of air. A further rationale for dividing the park ecosystem into subsystems is that *Bill C-30, An Act to amend the National Parks Act and to amend An Act to amend the National Parks Act* (1988) specifically lists the following resources to be protected under the Act: flora, fauna, soil, waters, fossils, natural features, air quality and cultural, historical and archaeological (p. 6).

3.2.2 The Boundary Model

Schonewald-Cox and Bayless (1986) and Schonewald-Cox (1988) have suggested the Boundary Model as a conceptual framework for identifying incursions of external threats across park boundaries (see section 2.6.4). The Boundary Model concept is particularly useful in identifying and locating weaknesses in a park's boundary which may more easily allow the penetration of external threats. A technique utilized for this by the Boundary Model is the mapping of a park's "generated edge." The generated edges of a park are described as "ecological edges generated primarily as a result of the effects of protection" (Schonewald-Cox and Bayless 1986: 307). The generated edges of the park ecosystem do not necessarily coincide with the legislated boundaries of the park (referred to as the "administrative boundary" by Schonewald-Cox and Bayless 1986). In the presence of strong external forces combined with weak enforcement and management of park regulations, a park's generated edge may move inside the administrative boundary and therefore effectively reduce the size of the protected area for some species. An ideal situation for a protected area would be to have the generated edge move outside the administrative boundary producing an increase in the effective size of the reserve thus resulting in a benefit for some species.

The concept of the Boundary Model is used to enhance the understanding of the effects of external threats to Pacific Rim Park (see Chapter six).

3.3 Threat Surveys

There have been several survey instruments used worldwide since 1979 to ascertain both the internal and external threats to national parks (National Parks and Conservation Association 1979; United States Department of Interior

1980a; State of California 1983; Machlis and Wright 1984; Machlis and Tichnell 1985; Machlis and Neumann 1987). No comprehensive survey instrument has yet been used to determine external threats to Canada's national parks, though a recommendation to do so was made by a study conducted by Nelson (1984) at the request of the Canadian Parks Service: "no comparable studies of land use pressures and their effects have been conducted for the Canadian national parks.... [Such a survey should] have high priority in the development of the Parks Canada strategy for 1986-2001" (p. 52).

All surveys of threats to national parks conducted to date have consisted of mail survey questionnaires. According to Dillman (1978) there are several problems associated with mail surveys. One problem is that of the three major survey methods (face-to-face interviews, telephone interviews and mail questionnaires), mail survey questionnaires tend to have the lowest response rate. According to Dillman (1978), there is a particular likelihood that unknown bias from "refusals" (i.e. people who fail to complete and return the questionnaire) will be high in mail survey questionnaires. Another problem associated with mail survey questionnaires is they tend to have little success with open-ended questions, i.e. questions that require more time, thought and creativity than questions that simply require a 'yes', 'no' or short answer. Another shortcoming of mail survey questionnaires is that the wording of the question can be misinterpreted by the respondent who has no recourse for explanation. Furthermore, mail survey questionnaires generally have a low ability to successfully control the sequence in which the questionnaire is completed.

All of the above problems associated with mail survey questionnaires can be lessened by conducting face-to-face interviews (see Dillman 1978) and it is for this reason that face-to-face interviews were selected for this research. This is not to say face-to-face interviews do not have potential problems. According to Dillman (1978) mail questionnaires are superior to face-to-face interviews in the area of "interviewer distortion and subversion." This means that the appearance and style of the interviewer may elicit biased remarks from the respondents. A ramification of this would be the possibility of not being able to replicate the data if a different person interviewed the same respondents.

Another shortcoming with the mail survey questionnaires used thus far to determine threats to national parks is that they have surveyed a large number of parks at one time, sending one questionnaire to each park. This poses two specific problems: the generation of a great deal of data and secondly, the possibility that the data is lacking in specific detail because the survey has been typically sent only to the park superintendent who may or may not consult with other park personnel who could be more knowledgeable than she/he. In regards to the first specific problem, Machlis and Tichnell (1985) have been criticized for providing too much data, too many cross-tabulations and not enough explanation of the interactions between variables (Fortmann 1986). In addition, Nelson (1990, pers. comm.) suggested that a survey of threats to national parks would be more valuable if one park was examined in depth in an attempt to uncover the linkages to the sources of external threats. In regards to the second specific problem, the obvious solution would be to interview all those park employees who have knowledge of the park (e.g. wardens and interpreters).

3.4 Research Methods

The foregoing serves as the rationale for conducting research into the external threats affecting one national park, utilizing face-to-face interviews with all knowledgeable park staff to obtain information regarding the external threats. The research for this thesis consisted of three main phases: 1) literature review regarding threats to national parks worldwide; 2) face-to-face interviews with staff at Pacific Rim National Park Reserve, and 3) face-to-face and telephone interviews with those agencies identified in phase two as the sources of external threats to Pacific Rim Park in order to gain an understanding of the relationship between them and the park, and ultimately to suggest possible methods for mitigating the threats.

3.4.1 Literature Search

This phase of the research involved standard library searches for material concerning external threats to national parks worldwide. Many agencies were directly contacted to collect literature, particularly the U.S. National Park Service's research station in Fort Collins, Colorado and individual U.S. national parks (e.g. Shenandoah National Park, Virginia). Collectively, the search for literature sought to synthesize:

1. historical threats to national parks;
2. the most recent information regarding external threats;
3. survey instruments used in collecting data regarding external threats;
4. programs and proposals designed to mitigate external threats.

The results of this initial work are reported in Dearden and Doyle (1990).

3.4.2 Interviews: Pacific Rim National Park Reserve Staff

The objective of this phase of the research was to document:

1. the most significant external threats to the protected resources of Pacific Rim National Park Reserve;
2. the availability of information regarding the threats;
3. the information lacking regarding the threats;
4. the park staffs' actions and recommendations for mitigation of the threats.

To obtain the information outlined above, structured personal interviews were conducted with all park staff deemed knowledgeable concerning the park threats. Information regarding the identification of knowledgeable staff was obtained from the park superintendent (the first staff member interviewed) and by suggestions from subsequent interviewees, notably the Chief Park Warden, the Chief Park Interpreter and the Head of Visitor Services. A total of 16 park staff were interviewed, with the following breakdown regarding the duties of those interviewed: Superintendent, eight wardens, five interpreters, one engineer and the Head of Visitor Services. All requests for interviews were granted. The success of this stage of the research was due in large part to the cooperation of then Superintendent Tom Heggie, who put all his staff at my disposal for interviews that took up to three hours each to conduct.

The interview with individual park staff members was divided into nine sections (see Appendix IV). Each of the first seven sections pertained to external threats to one of the park's protected subsystems: air, water, vegetation, fauna, soil, cultural resources and management and administration. The eighth section asked questions concerning external threats to any park

resources not covered in the first seven sections. The final section of the interview probed the respondents views concerning the external threats most likely to be a problem in the future.

Each of the first eight sections asked if certain specific threats to a particular subsystem were present in the park (e.g. is there smoke in the air?). Respondents were then asked if there were any other threats to that particular subsystem. Four questions were asked in regards to each specific threat: 1) what is the current status of the threat?; 2) what is the origin of the threat?; 3) what is the seriousness of the threat?; and 4) what is the areal extent of the threat?

In regards to the *current status of the threat*, respondents could choose one of four answers: either the threat was absent, suspected, documented or unknown in the park. If, for example, the threat was documented, the respondent was then asked to provide the documentation (e.g. the title of a publication). This question served to provide information regarding objectives two and three of this phase of the research (i.e. the availability of information regarding the threats and the information lacking regarding the threats).

Regarding the *origin of the threat*, respondents were asked to identify the source of the threat and were asked if the source was: inside the park; outside the park; both inside and outside the park; unknown. If the source was known, the respondent was then asked if he/she knew the specific source (e.g. landfill fire). This question provided information regarding objectives two and three of this phase of the research (see above).

Regarding the *seriousness of the threat*, respondents were asked to choose from one of three categories: very serious, moderately serious or slightly

serious. This question is a measure of the temporal aspects of the threat where: very serious corresponds to a threat which may cause damage to park ecosystems that might not be corrected within a human lifetime; moderately serious corresponds to a threat whose effects may last a decade or more; and slightly serious corresponds to a threat whose effects may last a period of a few years.[28] This question provided information regarding objectives one, two and three of this phase of the research.

Regarding the *areal extent of the threat*, respondents were asked to identify the total area in the park affected by a specific threat. Because of the complex nature of the identification of threats, respondents were only asked to give a qualitative answer to this question. This question provided information regarding objectives one, two and three of this phase of the research.

In terms of gauging the significance of the external threats to the park (objective one of the thesis), three factors are important: the documentation of the threat; the spatial aspect of the threat; and the temporal aspect of the threat. In other words, a threat to Pacific Rim Park would have the greatest significance if it were documented; had a spatial aspect which covered all three park units; and had a temporal aspect of 'very serious' (e.g. see section 4.1.1)

Respondents were also asked if there were any suspected or documented external threats to the park for which the park had undertaken mitigative action, and if so, what were they? If the answer to this question was negative, the respondent was then probed for suggestions concerning mitigative action. This

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[28] These criteria for determining the temporal aspects of threats to protected areas were first proposed by Machlis and Wright (1984). Though never used in an actual survey of threats to national parks, these criteria existed in a questionnaire that was pre-tested six times at various locations worldwide by Machlis and Wright.

question provided information regarding objective four of this phase of the research -- the park staff's actions and recommendations for mitigation of the threats.

3.4.3 Interviews: Agencies Responsible for External Threats

The objectives of the third and final phase of the research were to document:

1. the level of knowledge the agency possessed concerning the threat to the park;
2. the amount of communication between the agency and the park;
3. actions for mitigating the threat(s).

The identification of agencies responsible for external threats to Pacific Rim Park was conducted at the end of phase two of the research. Agencies that park staff believed were the source of the threats were then contacted either personally or by telephone and asked the following questions:

1. Are you aware of the concerns the park has regarding this [specify] problem?
2. Do you feel their concerns are justified?
3 Have you discussed this problem with them?
4. How do you think the problem could be mitigated/resolved?
5. How would you characterize your relationship with the park?
6. How do you feel about the area around the park becoming a Biosphere Reserve?

The sources of threats to Pacific Rim Park were grouped into the following categories (the numbers in parentheses following the source indicates the number of interviews conducted with officials in associated agencies. For

example, under forestry operations a total of 15 officials were interviewed from the following agencies -- Ministry of Forests, Ministry of Environment, Department of Fisheries and Oceans, MacMillan Bloedel Limited and Fletcher Challenge Canada Limited:

1. Forestry Operations (15)
2. Residential/Urban (7)
3. Natives/Indian Reserves (4)
4. Airport (3)
5. Recreation (terrestrial) (2)
6. Light Stations (1)
7 Mining (3)
8. Other (terrestrial) (13)
9. Marine transportation (2)
10. Commercial fishing (2)
11. Sport fishing (2)
12. Fish farms (7)
13. Other (marine) (2)
14. Canadian Parks Service Policy (2)
15. Natural

A total of 65 interviews were conducted during this phase of the research 10 of which were face-to-face interviews with the remaining 55 being telephone interviews. The high percentage of telephone interviews was due to both time and money constraints. People interviewed during this phase of the research were located in scattered locations such as Tofino, Ucluelet, Port Alberni,

Nanaimo, Duncan, Franklin River Camp, Caycuse River Camp and Vancouver thus making travel to all these locations expensive and problematic.

In addition to information gathered directly from the 65 interviews conducted during this phase of the research, a large amount of written material, both published and unpublished, was obtained from the respondents. Information from this written material is discussed in chapter five.

3.5 Study Limitations

There are several limitations to the methodology used in this study. First, the research only interviewed park staff and therefore obtained only the perspective of Canadian Park Service employees regarding external threats. If other groups had been interviewed, such as natives in the area, it is possible that different external threats could have been identified (for a good review of the native perspective regarding Pacific Rim National Park Reserve, see Berg 1990).

Secondly, phase two of the research (interviews with park staff) only assessed respondents' *perceptions* of threats to Pacific Rim National Park Reserve. Documentation and scientific knowledge may have been lacking in some cases possibly because staff were simply unaware of certain studies. Therefore, as a measure of actual problems, this survey may be invalid to an unknown degree. However, the survey was able to pinpoint where deficiencies in knowledge of some threats occur.

A second limitation of the research is the fact that it was undertaken at a point in time. The transferring and termination of park staff and changing conditions in the park would undoubtedly cause future surveys of this type to

vary. Therefore, a certain amount of caution should be observed when interpreting the results of the structured interviews with park staff.

A final limitation of the study is the possibility that all of those people with knowledge of threats to the park were not interviewed. This is particularly applicable to phase three of the research (interviews with agencies responsible for external threats to the park) which cast a very wide net to gather information.

CHAPTER FOUR - EXTERNAL THREATS TO PACIFIC RIM NATIONAL PARK RESERVE

The following sections describe and explain the external threats to Pacific Rim National Park Reserve (referred to hereafter as Pacific Rim Park) as provided by the survey instrument. Each of the eight subsystems in Pacific Rim Park will be discussed in turn regarding: the specific types of threats affecting each subsystem (e.g. chemical pollution -- for a complete explanation of threat descriptions, e.g. what constitutes chemical pollution, see Appendix II), the level of documentation the park has concerning the specific threats and an assessment of the significance of the various threats based on spatial and temporal elements. This will be followed by a section describing the sources of the external threats to Pacific Rim Park.

4.1 Subsystems Threatened

The survey yielded a total of 104 specific threats to the park based on source (see Table 1). In other words, if the source of one form of threat (e.g. chemical pollution) was different and discrete from that of another occurrence of chemical pollution, then they were treated as two distinct and different occurrences. Some individual and discrete threats were mentioned by all those interviewed, while other threats were mentioned only once. In either case it would be recorded as one distinct and separate threat.

Chemical pollution was the most frequently reported threat at 14 occurrences followed by organic pollution, 10 occurrences, legal removal, 10

occurrences, noise, 9 occurrences and illegal removal, 8 occurrences (for a complete listing of threats see Appendix III).

Several of the specific threats affected more than one subsystem. For example, one of the 14 specific threats of chemical pollution was the spill of oil off the Washington coast (referred to hereafter as the Nestucca oil spill) which affected the shoreline of all three units of the park in November 1988. This one oil spill affected the five subsystems of water, flora, fauna, soil and aesthetics. On the other hand, noise, the fourth most frequently reported threat, which was reported in nine specific threats, only affected two subsystems - aesthetics and fauna.

Table 1. External Threats To Pacific Rim National Park Reserve

Description	Number of Discrete Occurrences
Chemical pollution	14
Organic pollution	10
Legal removal	10
Noise	9
Illegal removal	8
Harassment of fauna	4
Smoke	4
Exotics	4
Erosion	3
Sediment in water	3
Odor	3
Reduction of biodiversity	3
Disease	3
Litter	3
Others (with number of times reported of 1)	23
Total	104

Five discrete threats: lack of clearly defined park boundaries, lack of enforcement authority, lack of research information, not enough personnel and

inadequate training of personnel, affected all eight subsystems.

To understand the type of threat to individual subsystems in the park it is instructive to examine a breakdown of the threats to the subsystems. It can be seen from Table 2 that the two subsystems of fauna and water were involved in nearly half (47 percent) of the reported threats to subsystems. It should be emphasized that the reason the total number of threats to subsystems (212) is greater than the total number of specific threats (104) is because a single specific threat may threaten more than one subsystem.

Table 2. External Threats to Subsystems

Subsystem	Number of Threats
Fauna	59
Water	40
Aesthetic	33
Vegetation	32
Soil	19
Air	13
Administration	10
Cultural	6
Total	212

The following sections will briefly examine the threats to the individual subsystems of fauna, water, aesthetics, fauna, soil, air, administration and cultural.

4.1.1 Subsystem: Fauna

The subsystem of fauna recorded the most threats - 59, which means that 57 percent of the reported specific threats affected fauna. The high number of threats to fauna at Pacific Rim Park is consistent with the results obtained from a survey of threats to the world's national parks by Machlis and Tichnell (1985)

where fauna was found to be the most threatened subsystem[28]. Table 3 indicates the eight most frequently reported threats to fauna in Pacific Rim Park.

Table 3. External Threats To Fauna

Threat	Number of Discrete Occurrences
Legal removal	10
Chemical pollution	10
Illegal removal	5
Harassment of fauna	4
Exotics	3
Reduction of biodiversity	3
Organic pollution	3
Litter	3
Erosion	2
Disease	2
Others (with number of times reported of 1)	14
Total	59

Despite the large number of threats to fauna in the park from external sources, only six of the 59 (11 percent) are documented by park staff. Four of the documented threats (litter, harassment of fauna and two citations of illegal removal) involve only a small number of animals at specific locations. However, the other two documented threats involve higher numbers of animals. For example, a significant number of sea lions which frequent the park's marine environs in the summer have a disease known as leptospirosis and it is believed this disease is contracted from sea lions in California where the "park" sea lions overwinter. There is a fear that more sea lions will contract the

[28] Machlis and Tichnell (1985) recorded three categories of location of reported threats: inside the park (internal threats), outside the park (external threats) and both. Overall, fauna recorded the most threats and as well it recorded the most threats for the category of inside and both. However, for the category of outside (external threats) fauna was second in total behind management.

disease and that seals could also become infected with the disease (Alleziak, 1991).

The other documented threat to fauna involves the Nestucca oil spill which occurred in November, 1988. A report prepared jointly for Environment Canada and the B.C. MInistry of Environment documented 632 dead, oiled birds picked up on park beaches in a two month period following the spill. Several other types of fauna are thought to have been killed by the oil spill but proving a linkage between oil and cause of death is difficult, particularly so when no carcasses are found. For example Duval, et. al. (1989) state that: "There were no observations of dead fish following the Nestucca spill, although the difficulties associated with detection of dead fish (particularly salmonids) are substantial" (p. 45). The survey instrument provided a temporal aspect to yield information concerning the significance of individual threats. In the case of fauna, only six threats had a known temporal aspect with the remaining 53 threats having an unknown aspect. All of the six threats with a known temporal aspect were reported as 'very serious' indicating that these threats may cause damage to the park ecosystem that might not be corrected within a human lifetime. Three of these threats involved 'a reduction in biodiversity' stemming from a perceived over-harvesting of marine fauna, loss of mature forests adjacent to the park and damage to some terrestrial habitats close to the park. All of these six threats considered 'very serious' also possess a spatial aspect which covers all of the three park units. Therefore these six threats, in terms of the survey instrument, can be considered most significant. The problem is,

however, none of the six are documented[29] . The lack of documentation is repeated for the other subsystems.

4.1.2 Subsystem: Water

The subsystem of water was cited in 40 threats, the second highest number for the eight subsystems which indicates that 39 percent of all reported external threats affected the subsystem of water. Compared to Machlis and Tichnell's (1985) survey of threats to the world's parks, Pacific Rim Park shows a considerably higher number of external threats to water[30] . The obvious explanation for this is that Pacific Rim Park has a substantial marine component therefore many terrestrial sources not only affect fresh water but affect the marine environment as well. Also the park is susceptible to a host of threats with a marine source which affect the marine environment.

Table 4. External Threats To Water

Threat	Number of Discrete Occurrences
Chemical pollution	14
Organic pollution	10
Erosion	3
Sediment in water	3
Others (with number of times reported of 1)	10
Total	40

[29] Recall from section 3.4.2 that in terms of gauging the significance of an external threat, the survey instrument utilizes three measures: the level of documentation of the threat; the spatial aspect of the threat; and the temporal aspect of the threat. Therefore if a threat possessed the attributes of a spatial aspect which covered all three park units, had a temporal aspect of 'very serious', and was documented, it would have the greatest significance.

[30] In the Machlis and Tichnell (1985) survey water was affected by only 16 percent of all external threats.

As with fauna, threats to the subsystem of water are not well documented. Only three of the 40 reported threats (8 percent) are documented by park staff. The documented threats to water consist of two cases of chemical pollution (the Nestucca oil spill and leachate entering Sandhill Creek from the Tofino-Ucluelet landfill site) and one case of organic pollution (the spraying of nitrogen fertilizer into Hobiton Lake by the Department of Fisheries and Oceans). In the last case, the Department of Fisheries and Oceans in Nanaimo (DFO) has been spraying Hobiton Lake, located in the West Coast Trail unit, with urea ammonium nitrate since 1976 to increase algal growth which in turn increases the amount of phytoplankton available for returning sockeye salmon. The end result has been a "two-fold increase in the sockeye salmon population" (Hyatt, Pers. comm. 1991). The net benefits of the increase in sockeye salmon population accrue to the Ditidaht Band and the commercial fishing fleet. DFO claims there is "no inherent risk" in the fertilization program (Hyatt, Pers. comm. 1991), despite the fact that this type activity is clearly not in keeping with national park policy (see also sections 4.2.1.8 and 5.1.7).

None of the 40 threats to water had a known temporal aspect, therefore no information was obtained regarding any of the threat's longevity in the environment. In terms of spatial aspect, 23 of the threats (58 percent) affected large areas of two or all three park units (e.g. Nestucca oil spill) and the remaining 17 threats (42 percent) affected localized areas of the park (e.g. chemical pollution in Esowista Creek).

4.1.3 Subsystem: Aesthetics

The subsystem of aesthetics recorded 33 threats which means 32 percent of all reported external threats affected this subsystem (Table 5). The Machlis

and Tichnell (1985) survey of world parks did not contain this specific category of subsystem but it did contain a category referred to as "other" which listed threats such as degradation of scenic views, litter, noise and odors and therefore corresponds closely with the aesthetic category used in this survey. The "other" category in the Machlis and Tichnell (1985) survey of threats to world parks received far fewer threats proportionately than did this survey of Pacific Rim Park[31] . A possible reason for this is the narrow linear nature of the park which exposes it to a number of threats (e.g. noise) from nearby adjacent commercial activity with sources both marine and terrestrial.

Table 5. External Threats To Aesthetics

Threat	Number of Discrete Occurrences
Noise	9
Smoke	4
Chemical pollution	3
Litter	3
Odor	3
Others (with number of times reported of 1)	11
Total	33

Five of the 33 reported threats to aesthetics (15 percent) were documented by park staff which is the highest proportion of documented threats of all eight subsystems. Two of the documented threats are litter washing up on the shores of all three park units and both were termed "slight" threats temporally. Litter has a relatively short residence time in the park due to the success of the park's annual "litter blitz" which uses volunteer help to pick up litter along the beaches.

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[31] "Other" received only nine percent of all external threats in the Machlis and Tichnell (1985) survey.

Another documented threat to aesthetics is noise at the Schooner Cove walk-in campsite. The source of the noise is the adjacent Esowista Indian Reserve where park staff have recorded several incidents of dogs from the reserve barking and chasing shore birds. The most serious documented threat to aesthetics is degradation of scenic views. Temporally this was stated as a "very serious" threat with a spatial component which covers all three park units. Documentation of this threat is in the form of university research (see Dearden 1988) and numerous anecdotal reports from park staff describing the displeasure expressed by visitors upon viewing massive clear-cut logging from locations in the park.

In the case of aesthetics, six of the 33 threats had a known temporal aspect with only one mentioned as "very serious" (see above). The remaining five were termed "slightly serious." The spatial aspects of threats to aesthetics revealed 11 localized threats (e.g. noise from a logging operation near Port Renfrew could be heard in the southern portion of the West Coast Trail), 20 threats which affected large areas of at least two units (e.g. smoke from slash burning on adjacent forestry operations affecting all three park units) and two threats of unknown spatial aspect.

4.1.4 Subsystem: Vegetation

The subsystem of vegetation recorded 32 threats, indicating 31 percent of all reported threats to the park affected this subsystem (Table 6). Three of the 32 threats (9 percent) were documented by park staff: two case of chemical pollution and one case of illegal removal.

One case of documented chemical pollution was the Nestucca oil spill and the other case was leachate from the Tofino - Ucluelet landfill entering Sandhill

Creek which flows from the landfill site through the park to the ocean at Combers Beach (see Figure 3). The only other documented threat to vegetation was the alleged illegal removal of mature timber just inside the park boundary

Table 6. External Threats To Vegetation

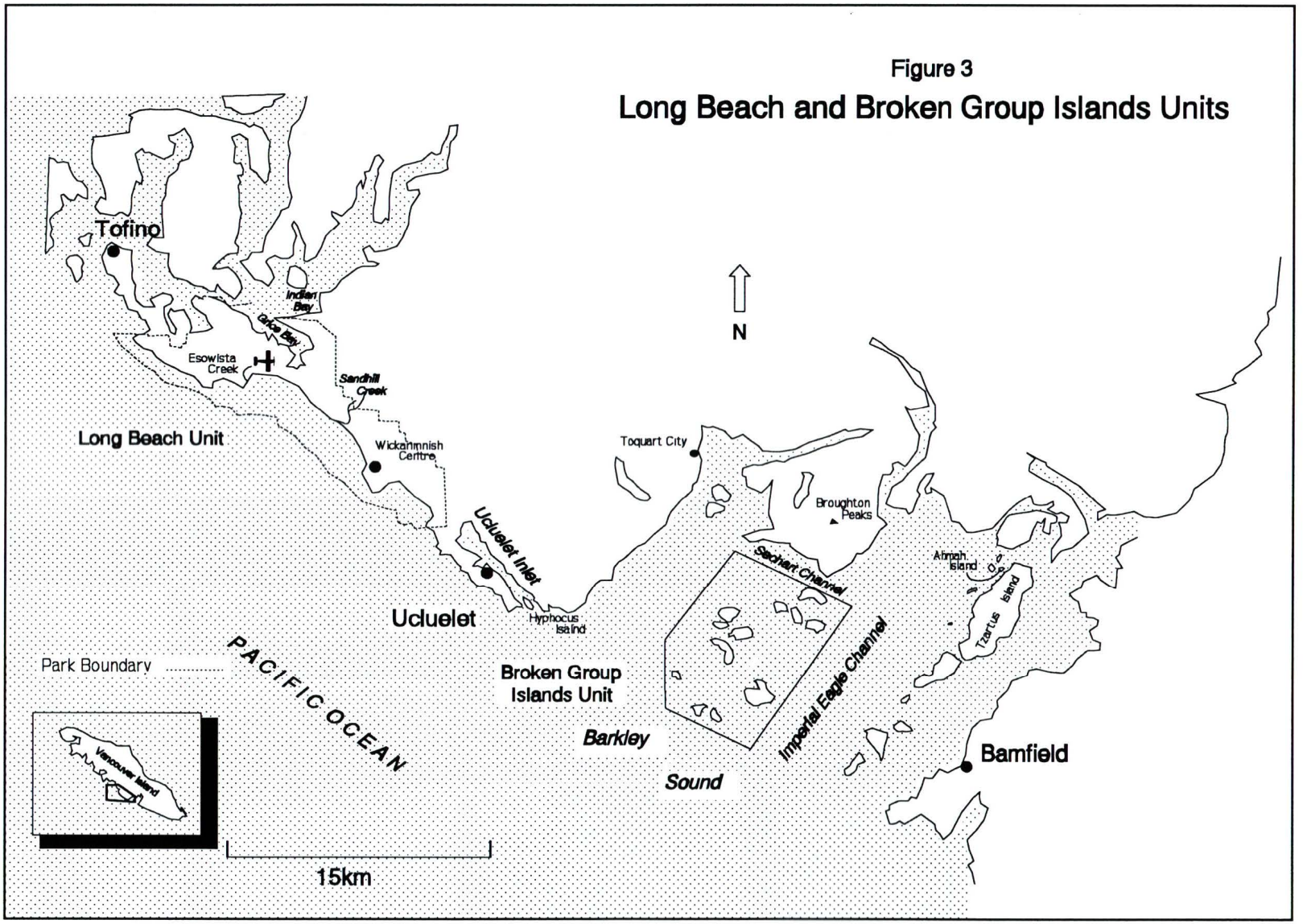
Threat	Number of Discrete Occurrences
Chemical pollution	8
Reduction of biodiversity	3
Exotics	3
Legal removal	2
Organic pollution	2
Illegal removal	2
Erosion	2
Others (with number of times reported of 1)	10
Total	32

near the Darling River in the West Coast Trail unit by a logging operation (see Figure 4). The logging company guilty of the infraction claimed ignorance concerning the precise location of the park boundary and was charged for the infraction by the Ministry of Forests. This threat was termed "very serious" by park staff indicating it might take more than a human lifetime to correct the problem. Interestingly, however, the Ministry of Forests eventually concluded that Pacific Rim Park was in error, and that the logging operation in question did not remove trees from inside the park boundary. The park subsequently sent a formal apology to the logging company (MacMillan Bloedel Limited) admitting their survey of the boundary at the alleged infraction was incorrect.

In the case of vegetation, six of the 32 threats had a known temporal aspect, five of which were listed as "very serious." In addition to the one "very serious" threat described above, three are reductions in biodiversity (all suspected) and

Figure 3

Long Beach and Broken Group Islands Units



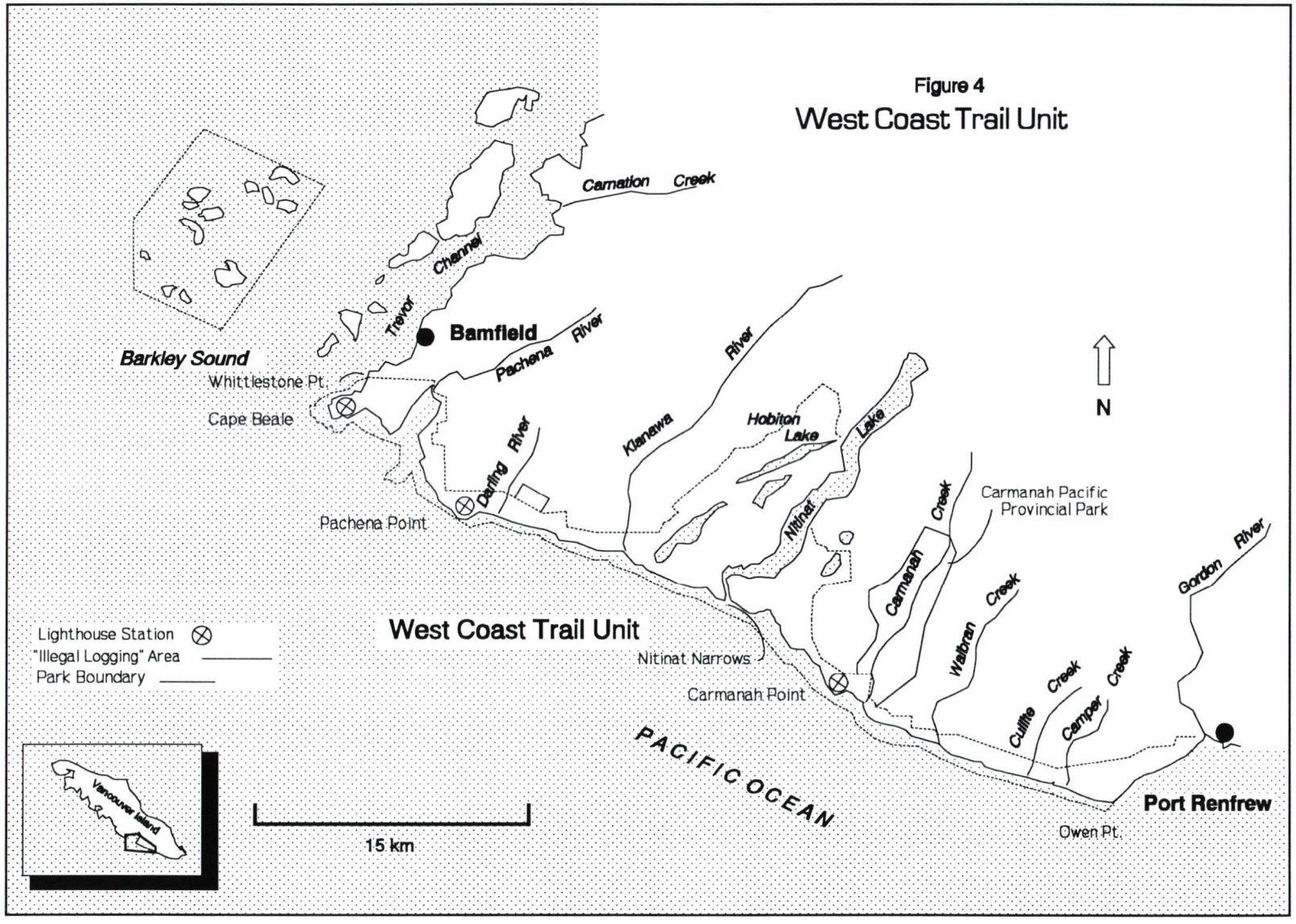


Figure 4
West Coast Trail Unit
Carnation Creek
Channel
Trevor
Bamfield
Barkley Sound
Whittlestone Pt.
Cape Beale
Pachena River
Darling River
Pachena Point
Klanawa River
Hobiton Lake
Lake
Nitinat
Carmanah Creek
Carmanah Pacific Provincial Park
Carmanah
Walbran Creek
Gordon River
Cullite Creek
Camper Creek
N
West Coast Trail Unit
Lighthouse Station
"Illegal Logging" Area
Park Boundary
Nitinat Narrows
Carmanah Point
PACIFIC OCEAN
Port Renfrew
Owen Pt.
Vancouver Island
15 km

the other is the possibility of the Ditidaht Band logging (legal removal) on four of its Indian Reserves located within the boundaries of the West Coast Trail unit. In terms of the spatial component of threats to vegetation, 22 of the threats affect large areas of two or more units of the park (e.g. Nestucca oil spill), eight of the threats are localized (e.g. encroachment of exotic vegetation from the golf course on Department of National Defense land to the Esowista Creek vicinity), and two threats are of unknown spatial aspect.

4.1.5 Subsystem: Soil

The subsystem of soil recorded 19 threats which means 18 percent of all recorded threats affected this subsystem (Table 7). Two of the 19 threats were documented:

Table 7. External Threats To Soil

Threat	Number of Discrete Occurrences
Chemical pollution	6
Erosion	3
Others (with number of times reported of 1)	10
Total	19

one case of chemical pollution (Nestucca oil spill) and an incident of a spilled cargo of logs that washed up on Long Beach requiring the use of heavy equipment on the beach which resulted in soil compaction and contamination due to small spills of oil and fuel from the machinery.

None of the 19 reported threats to soil had a known temporal aspect. The spatial aspects of the threats were: five localized threats (e.g. erosion in Sandhill Creek) and 14 threats which affected generalized areas of at least two park units (e.g. the pollution of sediment and soil in the creeks in the West Coast

Trail unit and Long Beach unit from the use of herbicides on land adjacent to the park).

4.1.6 Subsystem: Air

The subsystem of air recorded 13 threats, indicating 13 percent of all threats to the park affected the air. Two of the threats to air were documented: both were smoke.

Table 8. External Threats To Air

Threat	Number of Discrete Occurrences
Smoke	4
Odor	3
Others (with number of times reported of 1)	6
Total	13

One of the documented cases of smoke was from the burning of slash on adjacent forestry operations which was reported to affect all three units of the park approximately ten days a year and was considered only "slightly serious" in its temporal aspect. The park has documentation of this threat in the form of photographs showing the reduced visibility during times the smoke is present. The other documented case of smoke in the air was from the burning of garbage at the Tofino-Ucluelet landfill site. Smoke was reported by several park staff in the Long Beach unit as a result of the frequent fires.

Only one of the 13 threats to air had a known temporal aspect which was slash burning ("slightly serious") mentioned above. Eight of the threats to air had a spatial aspect that was generalized over two or more of the park units (e.g. emissions from large urban centres), three of the threats to air were

localized (e.g. the odor of oil located near a light station in the West Coast Trail unit) and two threats were of unknown spatial aspect.

4.1.7 Subsystem: Administration

The subsystem of administration recorded 10 threats, indicating 10 percent of all threats to the park affected the administration. None of the threats to administration were reported more than once, and none of the threats were documented. None of the threats had a known temporal aspect. It should be noted, however, that one of the threats to administration appeared very significant to park staff. That threat was the possible prevention of gazetting of the park by Native Bands in the area. Park staff fear that because the Natives are not getting full cooperation from the provincial government regarding their land claim in the area they may attempt to get the courts to prevent the gazetting of the park. Gazetting of the park has clearly become a priority issue for park management as they feel frustrated by their inability to manage the park with the full legal power of the Park Act.

In terms of spatial aspect, three of the threats to administration are localized (e.g. Ditidaht Band's threat to blockade the West Coast Trail) and seven of the threats were generalized over large areas of at least two of the park units (e.g. not enough park personnel).

4.1.8 Subsystem: Cultural

The subsystem of cultural recorded six threats, indicating six percent of all threats to the park affected this subsystem. None of these threats were mentioned more than once and none were documented. One of the threats, however, was indicated as "very serious." This was the proliferation of guidebooks written about the park without the endorsement of the park which

indicate to visitors where sites of historical importance to Natives are located. This has resulted (suspected) in several midden sites being dug up by "pot hunters" looking for items such as glass trade beads which have lately become popular jewelry items.

The spatial aspects of all six threats to this subsystem are generalized over two or more units of the park.

4.1.9 Summary of Threats to Subsystems

In terms of the survey instrument, the greatest degree of significance of a specific threat to the park would be one that fulfilled the following criteria:

1. documented;
2. temporal aspect of "very serious";
3. affecting large or generalized areas of two or more park units.

It was pointed out in sections 4.1 - 4.1.8 that very few of the reported threats were documented. Overall, only 23 of 212 (11 percent) reported threats to the park's subsystems were documented. Insofar as the temporal aspects, only 20 of the 212 (nine percent) threats reported any temporal aspects (the remaining 192 were unknown) and of these, 12 were reported as very serious.

The spatial aspect of the reported threats was much better known as 206 of 212 (97 percent) reported threats to the park's subsystems recorded a spatial aspect. Only six threats to the park's subsystems reported an unknown spatial aspect. Threats which affected localized specific areas numbered 60 while threats which covered a generalized area of two or more of the park units numbered 146.

Therefore, due to the acute lack of documentation and lack of knowledge concerning the temporal aspects of the reported threats, only one of the 212

reported threats to the park's subsystems satisfies the three criteria listed above - degradation of scenic views, which is listed as a threat to the subsystem of aesthetics. It is the only documented, very serious threat which affects large portions of all three park units and therefore qualifies as the most significant *documented* threat to the park using the criteria of the survey instrument.

However, the survey instrument did find other significant threats to the park. These are threats which affect large or generalized portions of two or more park units but are either lacking documentation or lacking in knowledge of the temporal aspect of the threat.

The chemical pollution which resulted from the Nestucca oil spill was documented as affecting four subsystems, affected generalized areas of the marine and foreshore environment in all three park units, but it is unknown how long detrimental effects will linger and therefore has an unknown temporal aspect. Spills of oil offshore of Pacific Rim Park in varying quantities, from small chronic spills of a few gallons to the rare extremely large spill clearly frighten park staff, and the threat of future oil spills is considered one of the most severe potential threats.

Another threat to the park which is of much concern to park staff is the reduction of biodiversity in both fauna and vegetation. An example of the latter is the suspected loss of a *Batyrichrium* species (grape-fern) and *Lloydia* species from park environs. The threat of reduction of biodiversity is not documented but it was reported as very serious and affects all three units. Park staff fear the park is becoming (or perhaps already has become) an "ecological island." This is based on the theory of "island biogeography" which theorizes that the number of species on islands of similar habitat in the same latitudes

depends on the size and isolation of the islands (in this case not a true island but a "habitat island"). Immigration of species is supposed to decrease with increasing isolation and the extinction rate to increase with decreasing area (see MacArthur and Wilson 1967). The implications for Pacific Rim Park are onerous considering the rate and amount of change taking place on land adjacent to the park. As the park becomes more isolated from unaltered land due to residential development, various commercial enterprises and clear-cut logging, the park can expect to lose more species according to the theory of island biogeography.

Another threat to the park which is not documented but considered very serious and affects all three units is the proliferation of guidebooks to the park which are not endorsed by park staff. One problem that has developed from this (suspected) is the publishing of the location of historic Native cultural sites which in many cases contain middens which are dug up and pilfered by visitors to the park.

Another possible very serious threat in the future is the stated intent of the Ditidaht Band to log timber off four of their Reserves located in the West Coast Trail unit. This is very significant because the West Coast Trail traverses these Reserves and impacts to visitor satisfaction (and fauna, vegetation and soil) would most likely be detrimental.

An all-pervasive problem which came up many times in interviews with park staff is the fact that Pacific Rim Park is not gazetted and therefore the park administration cannot legally use the Park Act to manage the park. It has therefore been by "huff and bluff", as one staff member suggested, that Pacific Rim Park has been managing. The reason the park has not yet been gazetted

as a national park reserve is because of "bureaucratic feet-dragging in Ottawa" (see section 5.3.1). Furthermore, park staff feel it could take years to drop the "reserve" status from the park once it is gazetted, due to the unresolved issue of the Nuu-chah-nulth comprehensive land claim. The present political climate in the province does not give park staff much optimism that the Native land claim issue will be settled soon and there is a growing fear amongst park staff that they are caught in the middle of an on-going dispute with the Natives and the provincial government (see Berg 1990).

4.2 Sources of External Threats to Pacific Rim National Park Reserve

To carry out the final objective of the thesis - *to assess opportunities for mitigating these threats* - the sources of the threats need to be identified. The following sections identify and describe those sources.

All of the 104 specific threats to the park could be traced back to either a specific source (e.g. the Tofino-Ucluelet landfill site) or a general source (e.g. offshore marine traffic). Table 9 lists these sources of external threats. The physical setting of the park exposes it to both marine and terrestrial sources of external threats. Table 9 shows that eight of the 15 groupings of threat sources are terrestrial (forestry operations, residential/urban, other, Natives/Indian Reserves, airport, recreation, light stations and mining), five are marine (marine transportation, commercial fishing, sport fishing, other and fish farms) and two are both marine and terrestrial (Canadian Parks Service policy and natural). The sources of external threats will be discussed under these three major headings: terrestrial, marine and marine/terrestrial.

Table 9. Sources of External Threats To Pacific Rim National Park Reserve

Source	Number of Discrete Occurrences
Forestry Operations	19
Marine Transportation	10
Residential/Urban	10
Other-Terrestrial	10
Natives/Indian Reserves	9
Canadian Parks Service Policy	6
Natural	6
Commercial Fishing	6
Sport Fishing	6
Airport	6
Recreation	4
Light Stations	4
Other-Marine	4
Fish Farms	3
Mining	1
Total	104

4.2.1 Terrestrial Sources of External Threats

The eight categories of terrestrial sources are sources that are land-based but whose threat(s) may affect terrestrial and/or marine resources in the park.

4.2.1.1 Forestry Operations

This source recorded the most threats - 19. Several of the 19 threats affected more than one subsystem. Table 10 gives a breakdown of the subsystems affected by forestry operations.

The majority of forestry operation threats to fauna (six of nine) directly affected fish, particularly anadromous species, with the remaining three threats to fauna affecting a wide variety of land-based fauna. Five of the six threats to fish were blamed on timber harvesting and related silvicultural practises that are

occurring along the terrestrial boundaries of the Long Beach unit and West Coast Trail unit (see Figures 5 and 6). These five threats are: organic debris in

Table 10. Forestry Operations: Distribution Of Threats To Subsystems

Subsystem	Number of Threats
Fauna	9
Water	6
Aesthetic	6
Vegetation	6
Soil	4
Air	2
Administration	1
Cultural	0
Total	34

streams, silt/sediment in the water, stream temperature changes, herbicides entering stream courses and reduced biodiversity (i.e. fearing some species of fish may already be lost to the park). Park staff specifically mentioned several fresh water streams they suspected of being threatened by timber and related silvicultural activities. [Proceeding from north to south in the park -- see Figures 5 and 6]:

1. Lost Shoe Creek, Long Beach unit - it is suspected that upstream clear-cut logging just outside the park boundary has caused a "massive log jam" near the park boundary which is blocking the passage of returning adult spawning salmon. Also it is suspected that clear-cuts adjacent to the creek have caused an increase in the water temperature in the summer which may adversely affect the fish. Pink salmon no longer return to Lost Shoe Creek.

2. Pachena River, West Coast Trail unit - it is suspected that upstream log jams, increases in stream water temperature and increased water turbidity are adversely affecting fish stocks and various stream macro-invertebrates.

3. Klanawa River, West Coast Trail unit - numerous large log jams just upstream of the park boundary which are suspected to be the result of clear-cut logging may be adversely affecting anadromous species.

4. Camper Creek, West Coast Trail unit - suspected there is increased water turbidity from upstream logging outside the park boundary.

It was also noted by park staff that the impending logging of Carmanah Creek and Walbran Creek may result in the same types of threats to the park. During the course of the interviews with park staff concerning the above-mentioned problems, none of the staff were aware of any documentation which could confirm a linkage between specific forestry practices and the problems of stream temperature increases, increased turbidity, log jams and herbicides in the water. Park staff were also unaware of a 17 year multi-disciplinary study concerning the effects of logging activities on the Carnation Creek ecosystem, located approximately 15 kilometres northeast of the northern boundary of the West Coast Trail unit (see Figure 4). One result of the 17 year study has been 154 publications concerning the effects of stream-side logging on vegetation, soil, water and fish. In a synthesis of the research conducted at Carnation Creek, Hartman and Scrivener (1990) conclude:

1. Average stream temperatures increased by 0.8 degrees C. in January and increased by 3.2 degrees C. in August after logging;

2. Road construction and clear-cut logging increased groundwater levels, peak flows and water yields;

Figure 5

Long Beach and Broken Group Islands Units
Adjacent Land Tenure

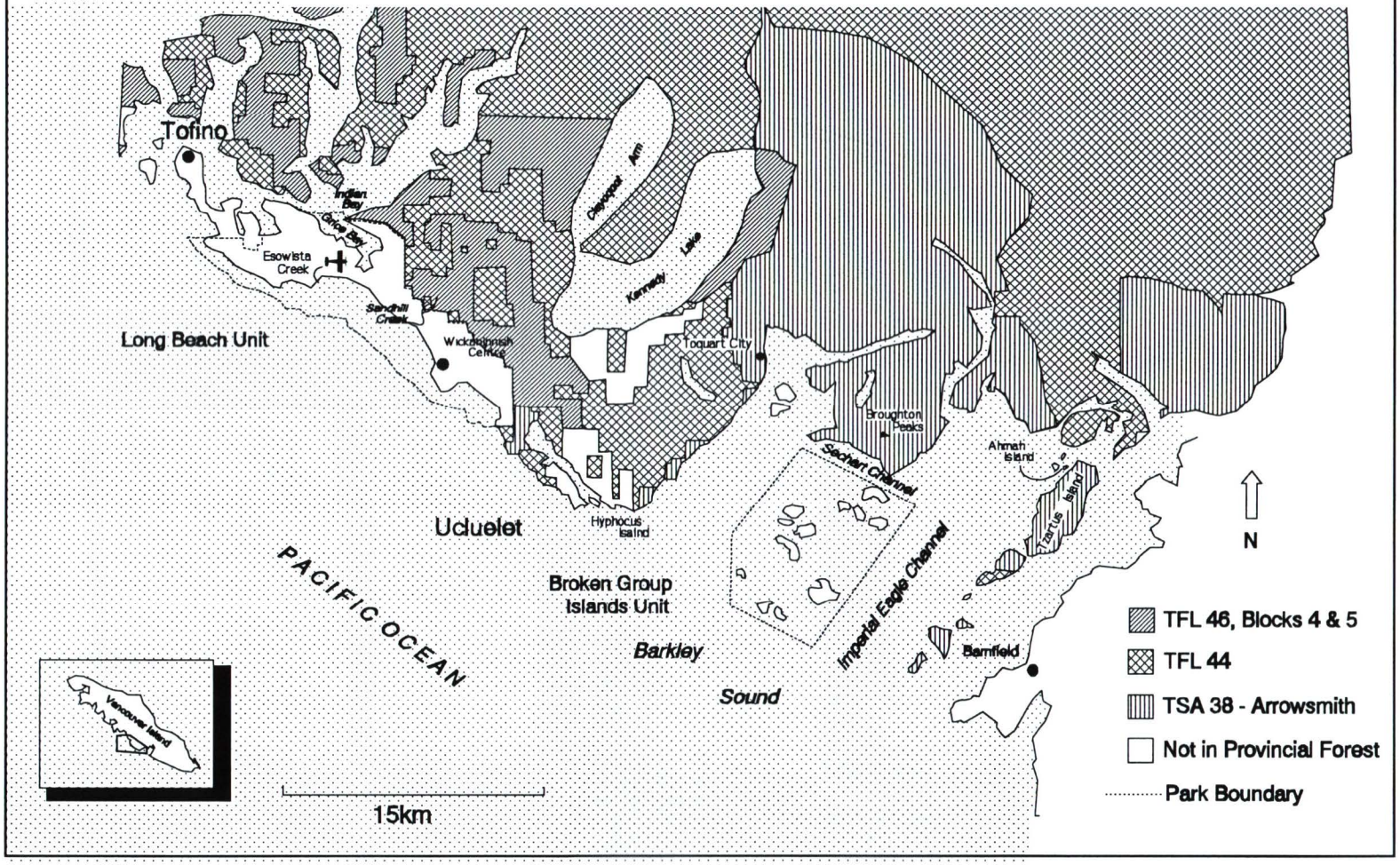
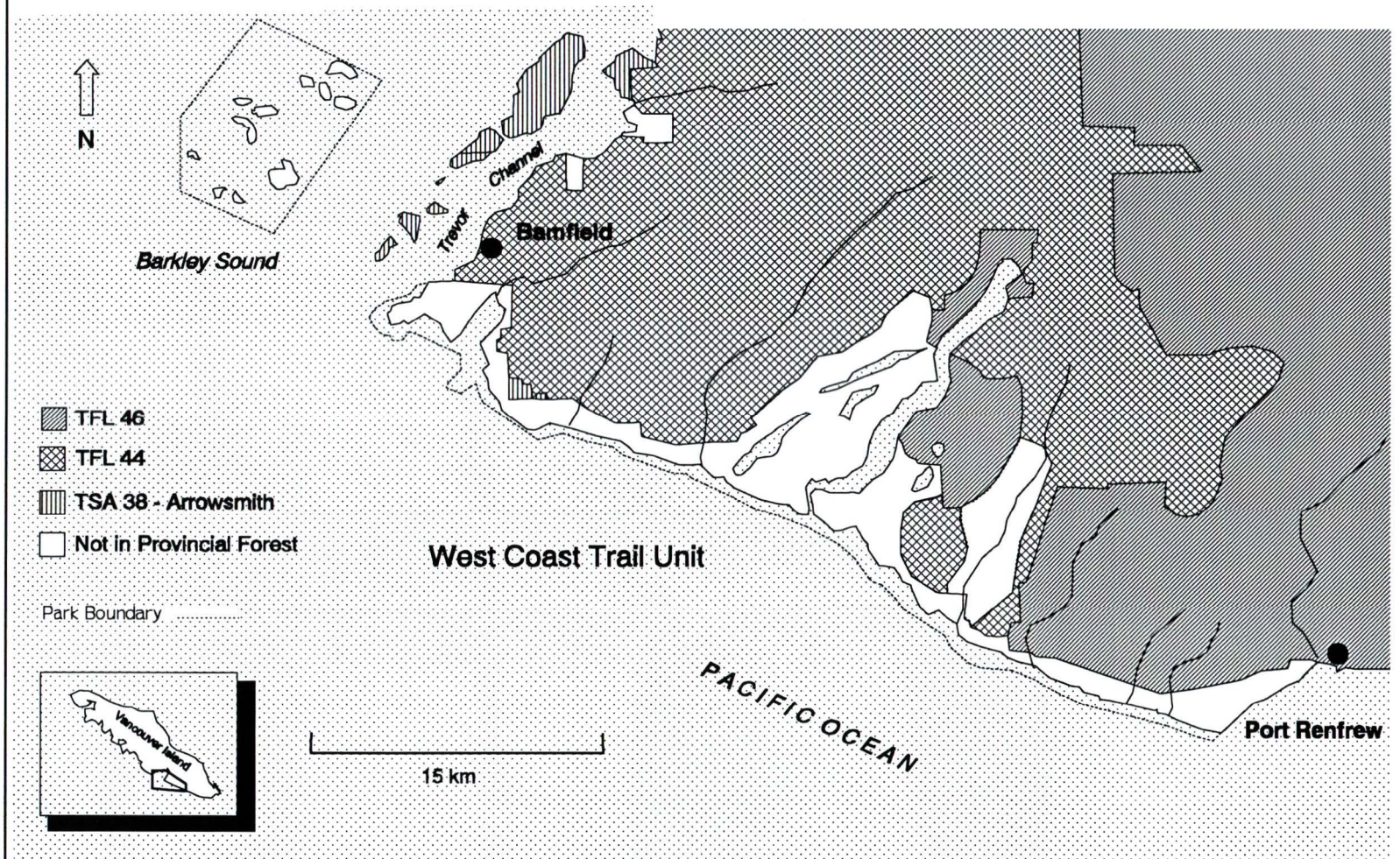


Figure 6

West Coast Trail Unit
Tree Farm Licenses



3. Nitrate concentrations were increased by logging and slash burning;

4. Annual changes in channel form and location were accelerated by stream-side cutting and rates of scour, deposition and bank erosion increased;

5. Densities of stream macroinvertebrates decreased by 42 percent following application of the herbicide Roundup[32] ;

6. Logging effects reduced the number of returning adult chum salmon by 26 percent;

7. Logging effects reduced the number of returning adult coho salmon by six percent.

While the above report cautions the reader in drawing comparisons between Carnation Creek and other west coast streams due to variables in logging practices and biophysical parameters, the report does suggest several "processes which have been elucidated [which] point to the following" (Hartman and Scrivener 1990:135):

1. The long-term impacts of changes in LOD [large organic debris], channel and gravel quality can overcome, within 4-6 years, the positive effects of temperature increase[33] .

2. Upper slope activities (above fish-bearing areas) create impacts downstream. Four conditions prevail from the upper slopes to the delta: (1) LOD and sediment can move from intermittent and non-fish-bearing channels to

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[32] A comprehensive review of the effects of Roundup (glyphosate) on the Carnation Creek ecosystem can be found in: B.C. Ministry of Forests and Government of Canada. 1989. *Proceedings of the Carnation Creek Herbicide Workshop.* Reynolds, P. (ed.), 349 pp.

[33] Elevated temperatures of stream water were found initially to increase egg-to-fry survival in coho salmon, but these gains were offset in 4-6 years due to other detrimental effects of logging.

the creek mainstem in torrents; (2) debris accumulates at the base of these torrents; (3) gravels scour below and deposit above the debris piles; (4) fine gravel and sands are transported and deposited in the lowermost part of the stream.

3. Stream temperatures are affected throughout the year by logging, however, the greatest impact on fish occurred in winter, when the smallest change in absolute temperature occurred (Hartman and Scrivener 1990).

While the completed work at Carnation Creek cannot confirm the suspicions of Pacific Rim Park staff concerning the adverse effects to park resources from upstream logging just outside the park boundaries, the study's *process* should provide park staff hope that a good research design and the dedicated execution of it can yield information which directly links forestry practises to park threats.

A major concern of park staff, and one mentioned many times during the interviews with them, is the uncontrolled access provided to (and close to) the park by the proliferation of logging roads close to the park boundary. Park staff suspect poaching (cited under the threat 'illegal removal' of fauna) of Columbia black-tailed deer, black bear and possibly cougar is occurring as a result on land just outside the park boundaries, and perhaps in the park itself. The local conservation officer of the B.C. Ministry of Environment, Wildlife Branch, Port Alberni, is also concerned about the poaching problem and has pin-pointed two locations where he knows Columbia black-tailed deer are being poached but has yet to apprehend the perpetrators. These two areas are the Darling River (northern portion of the West Coast Trail unit -- see Figure 4) and the golf course built on Department of National Defense land located adjacent to the airport in

the vicinity of the northern portion of the Long Beach unit (see Figure 3). It is not known the number of animals illegally killed near the park boundary, therefore no information exists concerning loss of park animals.

Park staff were also concerned about suspected chemical pollution from the pulp mill in Port Alberni, which is located at the head of Alberni Inlet. The concern is that effluent from the mill and an on-going program of dredging the Inlet's bottom near the mill may be introducing pollutants into the Inlet and carrying them out to Barkley Sound in the vicinity of the Broken Group Islands unit. According to a Senior Habitat Biologist with the Department of Fisheries and Oceans (DFO) the mill has been recently charged under the Fisheries Act with a "spill of deleterious material" stemming from a recent illegal release of "black liquor" from the mill. The DFO speculates that this spill in addition to the on-going dredging in the Inlet is adding hydrogen sulphide, polychlorinated hydrocarbons and heavy metals to the marine environment. The DFO stated there is a "severe impact" from these effluents at the head of the Inlet but do not suspect there is any significant pollution at the mouth of the Inlet in Barkley Sound.

4.2.1.2 Residential/Urban

This source recorded 10 threats and affected 19 subsystems (see Table 11).

A source of seven of the 19 threats mentioned above is the landfill site serving the Tofino-Ucluelet area which is located adjacent to the park boundary along Sandhill Creek, approximately three kilometres north of the Wickaninnish Centre (see Figure 3). The threats from the landfill are: smoke (documented) from fires at the landfill site which are set to reduce the volume of combustible

solid wastes, chemical pollution of Sandhill Creek from leachate escaping from the landfill site (documented), and poaching (suspected) of black bears that are attracted by the garbage at the site.

Table 11. Residential/Urban: Distribution Of Threats To Subsystems

Subsystem	Number of Threats
Fauna	5
Water	4
Aesthetic	4
Air	3
Vegetation	2
Soil	1
Cultural	0
Total	19

A concern frequently mentioned by park staff was air pollution such as sulphur dioxide, resulting in acidic precipitation, from source areas near the large urban centres of Seattle, Vancouver and Victoria. Park staff could not cite any research or data relating to this suspicion. The only studies known to the B.C. Ministry of Environment and Environment Canada regarding acidic and/or toxic precipitation to the Pacific Rim Park area was one study conducted by each ministry in the mid 1980's to determine the precipitation chemistry of southern Vancouver Island and the southwest lower mainland of British Columbia. The studies included recording stations located in Bamfield and Port Renfrew which are respectively, the northern and southern terminus of the west coast trail.

Both studies indicate that Bamfield and Port Renfrew have an excess sulphate concentration in precipitation which is above background conditions

but consider this amount to be "low to moderately low" (Kotturi, et. al. 1990:7). The source area for this excess sulphate is believed to be the Puget Sound region in northern Washington where several large point sources of sulphate emissions exist (Kotturi, et.al. 1990; Faulkner 1987). In addition, Faulkner (1987) discovered slightly elevated levels of vanadium in precipitation at Bamfield and Port Renfrew. The source of the vanadium is believed to be an oil refinery at Cherry Point, Washington which uses vanadium in the refining process. Both of the studies also examined changes in precipitation chemistry to southern British Columbia following the closing (in 1985) of the ASARCO copper smelter in Tacoma, Washington, a major emitter of sulphur dioxide and atmospheric arsenic. Faulkner (1987) found a slight decrease in the amount of atmospheric arsenic at Port Renfrew and no change at Bamfield. Overall, the results suggest that the West Coast Trail unit of Pacific Rim Park receives low to moderately low amounts of acidic precipitation and that the source area is northwest Washington. Further, the studies show that after the closing of the ASARCO smelter, amounts of sulphate decreased at Port Renfrew but not at Bamfield which may indicate that from Bamfield north, there is little or no effect from major point sources of sulphur dioxide in Washington.

A study of the composition of snow on the west slope of the Vancouver Island Range Mountains inland from Clayoquot Sound (located just north of the Long Beach unit) revealed low ion concentrations resulting in a pH of 5.4 of the deposited snow (McBean and Nikleva 1986). Normal snowfall and rainfall (i.e. without the presence of unnatural ions which increase acidity) has a pH of approximately 5.6. The study showed pH levels of 5.0 in snow in the

mountains surrounding Vancouver suggesting an increase in the acidity of snowfall from western Vancouver Island to the lower mainland region.

The study is in general agreement with the previous two in that acidic precipitation levels are low for the area around Pacific Rim Park. It should be pointed out, however, that all the mentioned studies do indicate some amount of acidic precipitation and no studies have been done to examine the effects of low-level acidic precipitation on the park. Simply because acidic precipitation levels are lower than in the lower mainland does not mean they are not a problem. Another biophysical parameter associated with the potential for damage to an ecosystem by acidic precipitation is the sensitivity of soil to acid. Areas with soils of low buffering capacity are particularly sensitive to acidic precipitation and the area around Pacific Rim Park is classed "high sensitivity" (i.e. low capacity to buffer acidic precipitation), therefore, even a small increase in acidity of the precipitation could be damaging to park resources (Environment Canada 1988).

Five other threats to the park affect eight subsystems, and are related to residential activity in Tofino and Ucluelet: smoke (from wood stoves), organic pollution (from sewage dumped into Ucluelet Inlet), illegal removal of vegetation (cutting of trees in the park for Christmas trees), introduction of exotic fauna (the release of cats and possibly dogs into the park) and residential encroachment (due to growth in both Tofino and Ucluelet).

4.2.1.3 Natives/Indian Reserves

This source recorded nine specific threats affecting 12 subsystems. The nine threats, however, can be grouped into three categories:

1. threats resulting from activity on the Esowista Indian Reserve (IR3);

2. possible development of Indian Reserves located within or adjacent to park boundaries;

3. threats arising from the Native land claims issue.

From the first category, park staff reported three threats: organic pollution (dumping of sewage from Esowista IR3 near the airport on Department of National Defense (DND) land which is suspected of polluting Esowista Creek which flows through one of the park's designated campgrounds), noise (barking dogs belonging to residents of the reserve), and harassment of fauna (dogs from the reserve have been seen chasing shorebirds). The subject of problems with Esowista IR3 (see Figure 7) was a popular one amongst park staff and several were concerned over the significant increase in population living there (see Berg 1990:109-116)[34]. For example, the problem of dumping sewage on DND land developed after a breakdown occurred in the original method used to dispose of sewage on the reserve (septic field). Park staff believe this breakdown was due to an overloading of the system caused by too many residents. Sewage now has to be trucked away from the reserve and dumped near the airport on DND land. Park staff suspect pollution is occurring in Esowista Creek as a result of the dumping of sewage despite two consultants' reports which say there will be no impact on the park.

The second category, possible development of Indian Reserves, involves three specific threats and is the cause of much concern to park staff. One such

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[34] Esowista Reserve (IR3) had few inhabitants at the time park planners designated the campground site at Schooner Cove, which is located adjacent to and within site of the reserve. The rapid increase in population at the reserve was not foreseen by park planners and has caused problems recently in the form of conflict between the reserve and park values.

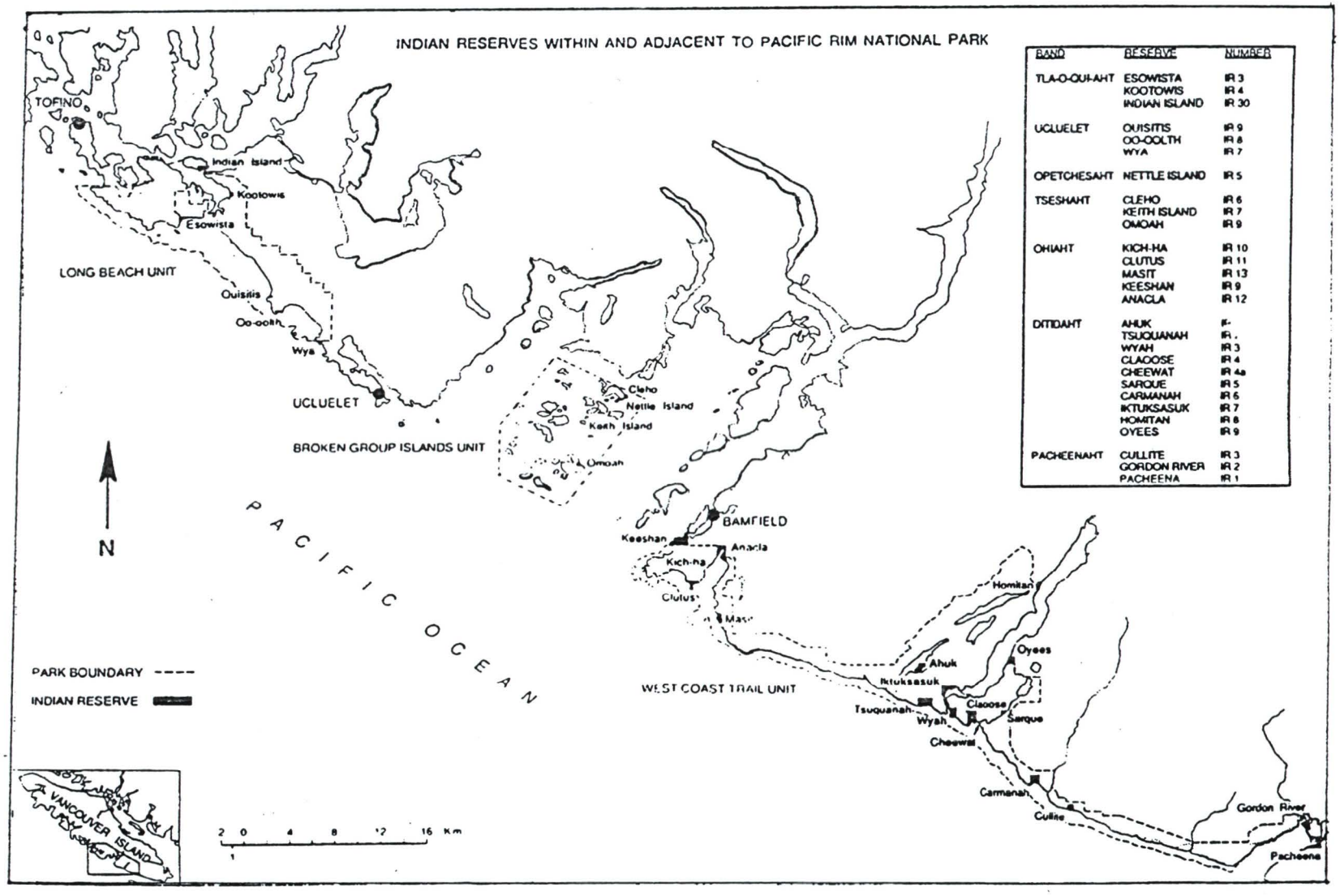


Figure 7. Indian Reserves Adjacent to and Within Pacific Rim National Park Reserve, British Columbia. Reprinted with permission of Lawrence Berg (1990).

example is the stated intention of the Ditidaht Band to cut timber off four of their reserves in the West Coast Trail unit. These reserves occupy land traversed by the popular west coast trail (see Figure 7). To log these reserves, the Ditidaht Band has requested road access through the park which the park has refused. The Band's remaining option would be to helicopter-log the timber at a much-reduced profit. The park has offered to purchase the timber rights from the Ditidaht Band at a price reflecting the profits from helicopter logging. The Band is not in agreement with this price and believes it is unfair of the park to refuse access and then offer a low price for the timber. The acting superintendent of the park is fearful the Ditidaht Band may blockade the west coast trail to facilitate negotiation over this issue.

The third category of threats by Natives is the speculation by park staff that some Band(s) will attempt to obtain a court order to halt gazetting of the park until the issue(s) of Indian Reserve development is resolved, an issue that is inextricably tied to settlement of the Nuu-chah-nulth land claim. In his Master of Art's thesis regarding the relationship between Pacific Rim National Park Reserve and the Nuu-chah-nulth people, Lawrence Berg (1990) concludes:

> Since Pacific Rim National Park Reserve was designated without recognition of the Nuu-chah-nulth people's aboriginal right to land, the park is seen as impinging on that right. Therefore, until the land question is resolved, it is unlikely that significant improvement can be made in the relationship between the park reserve and the Nuu-chah-nulth people (p. 166).

4.2.1.4 Airport

The land occupied by the Tofino airport is surrounded by the park in the Long Beach unit approximately 10 kilometres north of Wickaninnish Centre (see Figure 3). The land is owned by the Department of National Defense (DND) but

is managed by Transport Canada. In addition to the airport, the land contains a privately-operated nine hole golf course which operates under a five-year lease by Transport Canada.

There are six specific threats originating on this DND land, three from the airport and three from the golf course. Threats from the airport include smoke (land clearing), chemical pollution (runoff containing chemicals from the the runways and taxiways entering Esowista Creek) and noise (aircraft landing and taking off).

Threats from the golf course are: chemical pollution (herbicides and pesticides used on the greens and fairways running off and into Esowista Creek), sediment in water (construction of golf course caused sediment to enter Esowista Creek) and exotics (golf course has planted non-native species and park staff fear this may affect park vegetation).

Park staff expressed a fear that the golf course is planning expansion to 18 holes with a grandiose scheme to develop an expensive resort catering to international clientele. Park staff claim that due to the long length of the runway at the airport (5000 feet) aircraft could be brought in carrying large numbers of holidaying golfers. Transport Canada officials admitted there may soon be an expansion to 18 holes but said the original course "always was supposed to be 18 holes but was never finished because they ran out of funds" (Eastham 1991, Pers. comm.). In regards to large aircraft landing at the Tofino Airport, Transport Canada states that the largest commercial jet transport the 5000 foot runway at the airport can accommodate is a Boeing 737, some configurations of which seat over 100 passengers and have a maximum non-stop range of close to 3000 miles. Currently, the largest commercial aircraft using the airport are four

engine turbo-prop DeHavilland Dash 7's and twin-engine turbo-prop DeHavilland Dash 8's both with seating capacities well under 100. Transport Canada claims to have received no noise complaints to date regarding these or other aircraft at the Tofino Airport.

4.2.1.5 Recreation

Threats from recreation were reported from three sources: low-flying aircraft harassing fauna, the concentration of people at "Toquart City", a location on the west side of Toquart Bay (see Figure 3) popular with campers, and the impending development for tourist accommodation of an abandoned whaling station at the base of the Broughton Peaks on Sechart Channel by the company that owns and operates the Lady Rose, a coastal freighter popular with tourists which travels between Port Alberni and Ucluelet.

The problem for the park from the latter two threats is the concentration of large numbers of visitors staying in an area very close to the park. According to park staff, large numbers of these visitors travel into and utilize a concentrated area of park resources in the Broken Group Islands unit. This becomes a problem of uncontrolled access for the park and can develop into over-use in particular locations.

Another threat to Pacific Rim Park partially due to recreational pressure is the uncontrolled access of hikers onto the West Coast Trail from Carmanah Pacific Provincial Park. Pacific Rim Park staff are concerned about day hikers entering the West Coast Trail at about its halfway point (see Figure 4) and spoiling the wilderness character of the West Coast Trail for its users. Pacific Rim Park has requested that Carmanah Pacific Provincial Park close this trail and not allow hikers access to Pacific Rim Park.

4.2.1.6 Light Stations

Four threats were reported from this source: odor (two - suspected spill of oil or fuel and seepage of sewage into the ocean), chemical pollution (from the above mentioned spill of oil) and organic pollution (from the above mentioned seepage of sewage).

Three light stations were mentioned as being the suspected source of these threats: Carmanah Point, Pacheena Point and Cape Beale, all located in the West Coast Trail unit (see Figure 4). These light stations are operated and maintained by the Canadian Coast Guard and when asked to verify the suspicions of park staff regarding the possibility of an oil spill from the light stations, a coast guard spokesperson replied: "that's a load of crap" and suggested that the source of any oil or fuel near the light stations was a result of one of numerous small oil spills constantly coming ashore along the west coast (Weber, Pers. comm. 1991). When asked to comment on the method of sewage disposal at the light stations the same person stated: "the same way Victoria does" (indicating that raw sewage is going into the ocean from the light stations).

4.2.1.7 Mining

One threat was suspected from mining and that was chemical pollution from an abandoned magnetite mine located in the vicinity of "Toquart City" on the west side of Toquart Bay. Park staff suspect tailings dumped into the ocean from the abandoned Brynnor mine (owned by Noranda) could be polluting the waters around the Broken Group Islands unit. Park staff also mentioned their boat compasses went "haywire" when in the vicinity of the dumped tailings.

The B.C. Ministry of Energy, Mines and Petroleum Resources claims there is nothing to fear from the dumped tailings because magnetite is "very stable and safe underwater, at least with knowledge we have now" (Wilton, Pers. comm. 1991). The Ministry also stated there was no threat of acid rock drainage from the mine because the host rock was limestone, not an acid producing sulphide rock.

4.2.1.8 Other Terrestrial Threats

This category lists 10 specific threats ranging from guidebooks not endorsed by park staff (see section 4.1.8) to the introduction of exotic species of fauna and vegetation from unknown sources. One threat in this category is the suspected threat to the water in Hobiton Lake (West Coast Trail unit -- see Figure 4) due to the spraying of urea ammonium nitrate fertilizer into the lake by the Department of Fisheries and Oceans (DFO).

DFO began spraying fertilizer into Hobiton, Henderson and Great Central Lakes in 1976 to increase algal growth in what the DFO describe as "ultra-oligotrophic" lakes, meaning the lakes are very nutrient-poor and do not produce much algae naturally. The introduced fertilizer increased the growth of phytoplankton. The increased amount of phytoplankton provided more food for juvenile salmon and the experiment has resulted in a two-fold increase in the returning sockeye salmon population. When questioned about the possibility of any negative effects regarding the spraying program DFO stated: "the influence on the quality of water is not a threat - you would have to add 50 times the amount we are adding to pose a threat" (Hyatt, Pers. comm. 1991).

It should be noted that DFO began their work at Hobiton Lake before the lake was within the boundaries of the park and at the time was simply within

Crown land and was "simply going about our business as we would anywhere" (Hyatt, Pers. comm. 1991). It was not until several years after the start of the fertilization program that Hobiton Lake came under park jurisdiction with the addition of the Nitinat Triangle.

4.2.2 Marine Sources of External Threats

The five categories of marine sources are sources that are marine-based but whose threat(s) may affect marine and/or terrestrial resources in the park.

4.2.2.1 Marine Transportation

This category provided the largest number of threats from a marine source and second most overall - 10. The breakdown of threats from marine transportation yielded six cases of chemical pollution, two cases of litter, one case of harassment of fauna and one case of clean-up problems after a large spill of logs accumulated at Long Beach.

The Nestucca oil spill (see section 4.1.1) and the threat of more oil spills in the future were the most concern to park staff regarding threats in the marine transport category. Published literature documents threats to the park's water, vegetation, fauna and soil from the Nestucca oil spill. While there is certainly concern for the short-term direct damage the Nestucca oil spill has done to the above mentioned park resources, perhaps a more ominous threat is the damage this spill (and others like it) will do to the park over the long term. To this, the literature cites the ubiquitous phrase: "The long-term effects on these has not yet been determined" (Duval, et. al. 1989).

It should be noted that park staff contend that oil is still "constantly coming ashore" (Heggie, Pers. comm. 1991) and it may, or may not, be residual oil from the Nestucca spill. The oil coming ashore now could be attributed to small spills

from passing ships that are cleaning their bilges. The point is, the source of oil on the beaches now is unknown. The Canadian Coast Guard claims it is "almost impossible to to track down and convict ships that discharge or spill oil off the west coast" (Weber, Pers. comm. 1991).

Another threat of chemical pollution originating from marine transportation is containers of unknown chemicals washing up on park beaches. Some of these containers have been found to leak their contents with unknown damage occurring to fauna, vegetation, soil and water. On one occasion park staff discovered a 55 gallon drum freshly washed up on Long Beach. Upon discovering it contained 55 gallons of 30 weight motor oil, the barrel was moved to a park maintenance shed where it still provides oil for the park's chainsaws. As one staff member said: "we have come to expect anything and everything to wash up on our beaches. It is a sad fact of life that the oceans are treated like dumps by the ships on the Pacific Ocean."

A considerable amount of litter accumulates along the shore of the park's three units and not all of it simply threatens aesthetic values. There is at least one documented case of a sea lion found dead entangled in a small piece of fish net. Styrofoam "beads", used to make blocks of Styrofoam for packing, are washing up by the millions from freighters transporting them. Park staff fear that birds and perhaps other fauna may be ingesting them with unknown consequences. The beads are also difficult to completely remove from the shore.

4.2.2.2 Commercial Fishing

There were six threats reported from this source: four cases of legal removal, one case of illegal removal and one case of noise.

The overwhelming case against the commercial fishery, from the park's standpoint, is they are taking too much. Park staff pointed out examples of overfishing of the Dungeness crab, overfishing and damage done by the redsnapper dragnet fishery and the problem with what they termed the "new fisheries." The "new fisheries" are the large number of species now harvested that were previously not taken for commercial use. These include: herring roe, turban snails, hagfish, geoducks, gooseneck barnacles, horse clams, sea cucumbers and sea urchins (see also Section 5.2.2).

Park staff use the example of the crab fishery to show how the park and DFO (the agency with the authority in marine matters concerning fish) have "been close to negligent in holding the line" in regards to allowing fisheries to proliferate in and close to the park. When the park boundaries were first established in 1971 there were two crab fishermen in the Long Beach area. It was decided to allow the crab fishery to continue and not to limit the number fishing. The crab fishery has now expanded to Grice Bay where 500 traps are set in addition to the 300 traps set at Long Beach. Park staff fear the stocks of crab are diminishing.

In addition to the legal removal of fauna there is a threat of the legal removal of vegetation in the form of kelp and various other seaweeds. Park staff explain that removal and/or depletion of kelp beds would facilitate increased erosion of some beaches because the kelp dampens down large waves and acts like a "floating reef" in some cases to protect the shoreline.

4.2.2.3 Sport Fishing

There were six reported threats from this source and they tended to be similar to those reported for commercial fishing: four cases of legal removal, one case of organic pollution and one case of litter.

A major concern to park staff is that sport fishing in the Broken Group Islands, northern portion of the West Coast Trail unit and the Clayoquot Sound area is promoted as a world class sport fishing destination. The proliferation of fishing camps and lodges throughout the area has made park staff question whether sport fishing is compatible with the protection and preservation of fish species (see also Section 5.2.3). Many visitors to the park only come for the sport fishing. DFO has already reported that they suspect overfishing in the Broken Group Islands of bottomfish and rockfish.

Other threats related to sport fishing are litter and organic pollution from sport fishermen some of whom set up camp for the duration of summer in Barkley Sound.

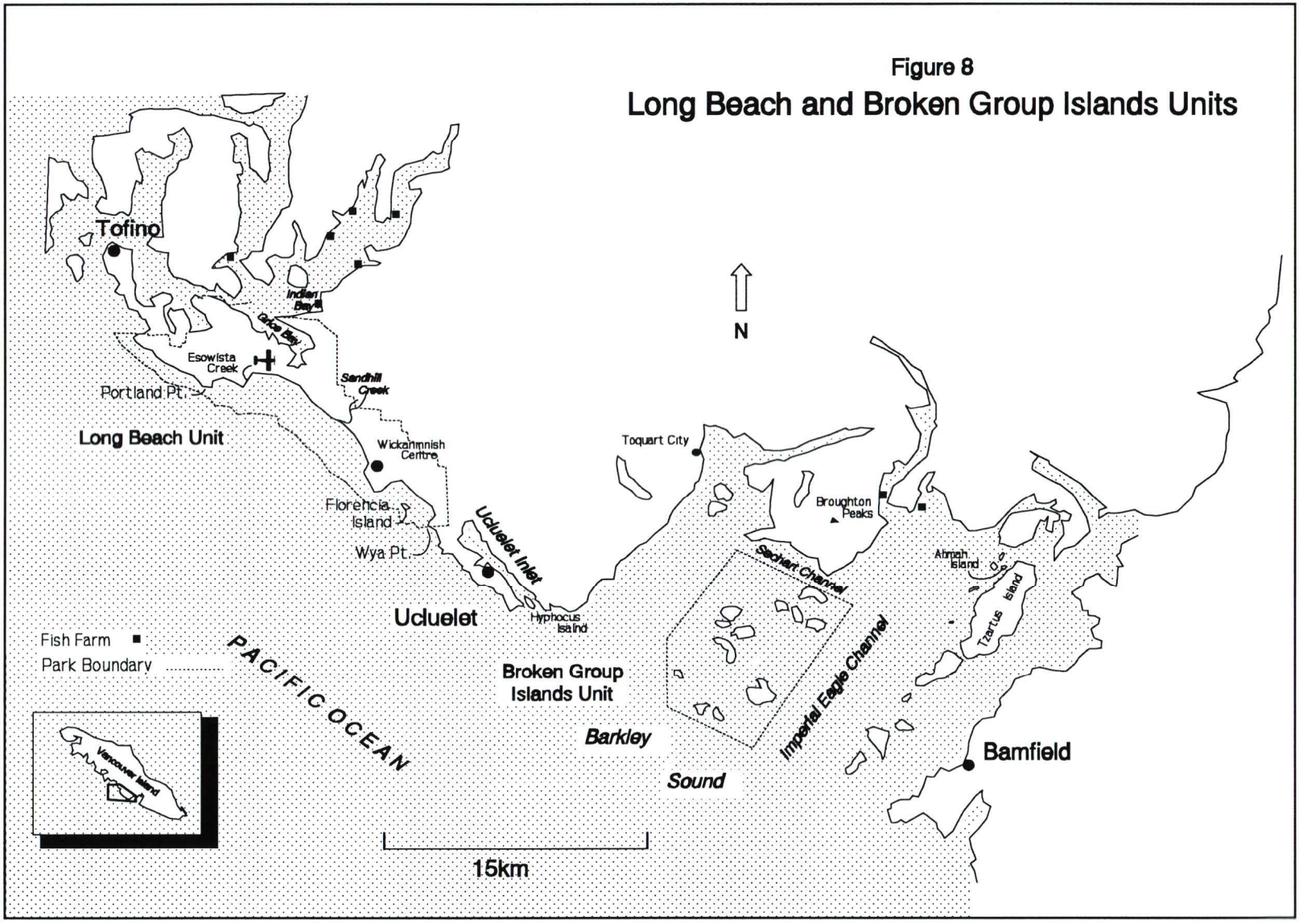
4.2.2.4 Fish Farms

Three specific threats were reported from this source: organic pollution, disease and illegal removal. Fish farms in Tofino Inlet (Indian Bay) and Barkley Sound (see Figure 8) have recently been established and park staff are concerned regarding pollution problems from the build-up of feed and feces on the ocean floor under the net pens and the possibility of the transference of disease from penned fish to wild stocks. There have also been reports of fish farmers shooting predators (particularly seals) found near the net pens.

The lead agency responsible for approving fish farms in British Columbia is the Ministry of Crown Lands. However, the B.C. Ministry of Agriculture and

Figure 8

Long Beach and Broken Group Islands Units



Fisheries (MAG) determines whether a particular fish farm's application is technically feasible. Officials at MAG claim there is "some impact" on fauna and vegetation directly under the net pens but 10 metres outside there is "almost none." Further, they claim there is no evidence of disease transference and do not view it as a problem.

In the case of the illegal shooting of predators around the net pens MAG says the DFO has issued some permits to shoot problem seals. These seals are guilty of "attacking the net pens and sucking out the soft tissue of between 400 and 600 penned fish a night" (Trescott, Pers. comm. 1991).

In none of the above cases does either the Ministry of Crown Lands or MAG believe that fish farms pose any threat to Pacific Rim Park.

4.2.2.5 Other Marine Threats

The four threats with sources that did not fit other categories were: disease, illegal removal, noise and reduction of biodiversity.

The reduction in biodiversity referred to by park staff was in regards to overfishing by both commercial and sport fishermen and the unknown amount of damage done by the cumulative impacts of oil and fuel spills.

The problem of noise pollution was in reference to the sound of "loud explosions" off the west coast heard approximately 15 days per year. Park staff claim this is DND gunnery practise. When contacted concerning this matter, DND stated they do not perform gunnery practise off the west coast but do perform it off the east coast of Vancouver Island at Nanoose Bay.

One other threat in this category is the spread of leptospirosis among California sea lions. The disease is contracted in California among the wintering populations of sea lions and transferred to the park population when

the sea lions return for the summer (Alleziak, Pers. comm. 1991). The disease causes a paralysis of the hindquarters of the sea lions rendering difficulty in terrestrial movement. Park staff fear the disease could spread to Stellar sea lions and perhaps even seals.

4.2.3 Terrestrial and Marine Sources of External Threats

The two categories of this type of threat have sources that are not confined to either terrestrial or marine environments but can originate in either. The threats produced can affect either marine or terrestrial resources in the park.

4.2.3.1 Canadian Parks Service Policy

Six specific threats were mentioned concerning this source which had wide ranging implications for park resources: legal removal, lack of clearly defined boundaries, lack of enforcement authority, lack of research information, not enough personnel and inadequate training of park staff.

The lack of clearly defined boundaries was brought up many times in the interviews and generally presented the problem of people venturing inside the park boundary and not being aware of it. This has produced problems such as illegal timber cutting on park property, illegal fishing in the Broken Group Islands and generally an ignorance of the purpose of a national park. Some staff have suggested marking the marine boundary in the Broken Group Island unit with buoys and marking the terrestrial boundary by cutting a swath through the vegetation. All agree that whatever course of action is agreed upon will not occur due to lack of funding.

The lack of enforcement authority stems from the park not being gazetted as a national park and therefore not empowered by the Park Act. Park staff point out that this threat could affect every subsystem in the park, particularly if the

public chose to challenge park policies (e.g. camping for prolonged periods anywhere they wished in the park). Park staff feel particularly encumbered by this and believe the park's lack of gazetting has allowed some adjacent resource management agencies to "treat the park like a second class citizen."

Park staff unanimously agreed that there is an acute lack of research information regarding park resources. It is recognized by park staff that this lack of information can be a threat to the integrity of the park. For example, the lack of scientific knowledge of linkages between threats and their sources, leaves park staff with little effective mitigative opportunities. Part of the reason for this lack of research information is there is a lack of personnel in the park. Increasingly, wardens are spending more of their time in the office dealing with paper work. As one warden stated: "we are not honoring our tradition - wardens are no longer spending much time in the field." Some staff suggest that too much of the park budget is spent on visitor services (e.g. paving campgrounds) and not enough on resource conservation.

This latter policy is recognized by the Canadian Parks Service (CPS):

> It is apparent that a relatively small portion of resources are dedicated to the protection of heritage resources. In all cases there is insufficient staff time and resources available to deal with the resource management issues now facing the parks....the lack of an adequate resource base will only become more acute with the challenges that lie ahead (Zinkan, et. al. 1990:10).

At Pacific Rim Park only eight percent of the overall operating and management budget is dedicated to resource conservation activity (Zinkan, et. al. 1990).

It is perhaps ironic that the park utilizes only eight percent of its budget for resource conservation when one reads the following excerpt from a report to the CPS regarding the use of science in park protection:

> The process of encroachment by incompatible land uses is the largest single threat to the western national parks and will require identification of threats and an understanding of socio-economic as well as ecological factors. Ecological integrity and sustainability are the basis for future park management, and drive the need to conduct scientifically based resource management (Zinkan, et. al. 1990:3).

4.2.3.2 Natural

There were six threats in this category: organic pollution (two-red tide and animal feces in fresh water), harsh natural environment, erosion (two-tsunamis and erosion caused by the slumpage of shoreline escarpments due to earthquakes) and rise in sea level caused by climate warming.

One threat in particular, earthquakes, was mentioned several times as a distinct possibility. Staff speculate that a major earthquake could collapse the ubiquitous steep shoreline escarpments in the park with subsequent erosion by wave action. There is an on-going erosion problem along the escarpment in Florencia Bay in the Long Beach unit and considerable effort by the park has gone into buttressing the escarpment to prevent its erosion.

Global warming and its subsequent problems (e.g. sea level rise, alteration of climate) is also a concern to park staff. Even though scientists at this point are not in agreement as to the exact changes that will take place, it is possible that the changes will be so catastrophic as to completely alter the nature of protected area ecosystems within the span of one human generation. As a result of these changes

> treelines could migrate northward. Species adapted to the changed climate will replace our current forests. However, in some areas of suitable climate, other factors such as soil may not be suitable to support forests (Environment Canada 1990:5).

4.3 Summary of External Threats to Pacific Rim National Park Reserve

The survey of external threats to Pacific Rim Park revealed a wide range of threat categories -- 37 (see Appendix I). However, almost half of the external threats reported by park staff (49 percent) fell into the five categories of chemical pollution, organic pollution, legal removal, noise and illegal removal. While the number of times a specific type of external threat was reported is not necessarily an indication of the significance of the threat (see section 3.4.2), it is an indication that threats in these categories are chronic and ubiquitous.

Threats which were only reported once, on the other hand, were not necessarily insignificant. For example, the threat of degradation of scenic views was reported only once, yet it was reported to have a temporal aspect of 'very serious' and it affected all three park units. In addition, it was a documented threat. In fact, these characteristics of this particular threat make it the only reported threat that satisfies all three criteria established in the survey instrument, thus qualifying it as the most significant external threat to the park (see section 4.1.9).

The threat of degradation of scenic views falls under the source of forestry operations, the largest single source of threats to the park (18 percent). Despite the fact that the largest single source of external threats to the park was reported as forestry operations, only two of the 19 reported threats were documented. Furthermore, only six of the 19 reported threats from forestry operations had a known temporal aspect. This lack of documentation and lack of knowledge concerning temporal aspects of threats is common to all 15 threat categories.

The next phase of the research, which explores the level of communication and shared knowledge between the park and agencies identified by the park as sources of external threats, shows that as a result of the park's general lack of documentation concerning external threats, agencies which were identified as the source of theses threats sometimes doubted the veracity of the park's claims.

CHAPTER FIVE - EXPLORATION OF MITIGATIVE MEASURES CONCERNING EXTERNAL THREATS TO PACIFIC RIM NATIONAL PARK RESERVE

This chapter focuses on the agencies responsible for external threats as identified by managers at Pacific Rim Park As discussed in chapter four, it was possible to trace the source of all 104 threats to Pacific Rim Park (see section 4.2) as perceived by managers at the park. A survey instrument, consisting of six questions, was applied to managers of agencies identified by Pacific Rim Park staff as being responsible for specific external threats. The questionnaire was conducted by telephone interview and by personal interview where possible. The questionnaire consisted of both open-ended questions and close-ended questions aimed at ascertaining:

1. the level of knowledge the agency possessed concerning the threat to the park;
2. the amount of communication between the agency and the park;
3. actions for mitigating the threat(s).

Results of the questionnaire are discussed under the 13 specific groupings of threat sources (see section 4.2) and first with the general grouping of terrestrial sources of external threats followed by marine sources of external threats and finally by sources of both terrestrial and marine external threats.

5.1 Agencies Responsible for Terrestrial External Threats To Pacific Rim National Park Reserve

The eight categories of sources responsible for external threats to the terrestrial resources of Pacific Rim Park are: forestry operations, residential/urban, Natives/Indian Reserves, airport, recreation, light stations, mining and other terrestrial threats. These eight categories will be discussed in turn.

5.1.1 Forestry Operations

With few minor exceptions, the terrestrial boundary of Pacific Rim Park directly adjoins land designated under the Forest Act as "provincial forest." Provincial forest land can only be used for the production of timber, forage for wildlife and livestock, forest-oriented recreation, and water, fisheries and wildlife purposes (Vance 1990). The provincial Forest Act provides for several types of tenure on provincial forests and in the case of land adjoining Pacific Rim Park two types of tenure presently exist: tree farm licenses (TFLs) and small business licenses located in Timber Supply Areas (TSAs).

There are two TFL-holders on land adjoining Pacific Rim Park: MacMillan Bloedel Limited (TFL 44) and Fletcher Challenge Canada Limited (TFL 46 -- see Figures 5 and 6). Two small business licenses will be given out in the near future by the British Columbia Ministry of Forests, one in the Broughton Peaks area (Barkley Supply Block - Cataract Lake-Broughton Peaks Area) and one on Tzartus Island in Barkley Sound. While the latter two small business licenses are not on land directly adjacent to the terrestrial boundaries of Pacific Rim Park, they do have potential impact on the park in terms of scenic degradation

to visitors in the Broken Group Islands unit and marine impacts from log dumps proposed in Sechart and Imperial Eagle Channels.

Because most of the land adjoining Pacific Rim Park is held under TFL's to two companies, it is instructive to examine the statutory framework behind this form of tenure. Section 27 of the Forest Act provides that the Ministry of Forests (MOF) may issue a Tree Farm License covering a large area of Crown land, managed by the license holder. Once established, the holder of a TFL is subject to Section 28 of the Forest Act which outlines the conditions of tenure to the license holder. Germane to this research, are the following points under Section 28:

1. a TFL is for a term of 25 years and renewable thereafter;

2. it is a requirement of the license holder "to submit for the approval of the chief forester, once every five years or more often where the chief forester consider that special circumstances require, a management and working plan prepared by a registered professional forester" (Forest Act 1979). Included in this five year management and working plan is to be information regarding recreation, fisheries and wildlife.

In interviews with officials from both MacMillan Bloedel and Fletcher Challenge it was stated that there are two avenues for input into their cutting plans for Pacific Rim Park: through the five year management and working plan and through the companies' five year resource development plans. The latter is included in the former, and is updated every year by each company and is referred to the Ministry of Forests (MOF), the Ministry of Environment and the Department of Fisheries and Oceans (DFO) for their input.

The Ministry of Forests requires holders of TFL's to advertise in the local press announcing the development of a management and working plan, and to provide at least 30 days for public response (including response from agencies such as Pacific Rim Park). Once the draft management and working plan has been prepared, the licensee must then advertise in the local press that it is available for public review and must provide a minimum of 30 days for response. While the chief forester for the MOF reviews all input into the five year management and working plan, it is purely discretionary on his/her part to include any input into the final approved plan. Pacific Rim Park provides input into the five year management and working plans but as the former superintendent commented: "we feed information in but we get no formal feedback" (Heggie, Pers. comm. 1991). None of the officials with either MacMillan Bloedel (MB) or Fletcher Challenge (FC) would comment on this, but all said the avenue for meaningful dialogue between the logging companies and the park has been through the preparation of the five year resource development plans that each logging company is required by the MOF to prepare.

The five year resource development plans produced by both MB and FC are used for more specific planning by the companies and are done at the local level by the licencees. These plans are used to establish details of how resource development will take place (e.g. precise location of a particular logging road) and are updated annually. The five year resource development plans are referred to MOF, MOE and DFO for their input and are then returned to MOF for final approval. All three agencies (MOF, MOE and DFO) were questioned as to whether they had ever referred an issue arising out of a five

year resource development plan to Pacific Rim Park and all three responded "not to our knowledge." Therefore it has been up to the discretion of the local licencees to notify the park of any development plans they feel the park would be interested in.

In the case of communication of resource development plans between FC and the park, FC states that "we do have a system in place, its nothing official, but some local arrangements are made." Specific local arrangements between FC and the park have dealt with the placement of cut blocks and public access to logging roads which are close to the park boundary. In the case of cut block placement, in 1988 an engineer with FC worked with park staff in the Long Beach unit to alter a planned cut block (near the airport) so as to prevent windthrow in the park by moving the edge of the proposed cut block 200-300 feet further from the park boundary.

According to FC, the greatest amount of input from the park concerns the placement and accessibility of logging roads. As one FC official stated: "the park is adamant - it does not want access made into the park." On several occasions the park has requested FC to close logging roads after timber has been extracted and while FC is somewhat sympathetic to this concern, FC has cited several reasons why they cannot generally comply: follow-up silvicultural practises require roads to remain open; timber protection practises (i.e. forest fire fighting) requires open logging roads and the fact that "the MOF does not like roads locked."

Aside from the logging road access issue there is little else FC officials felt was a justified concern of the park in regards to external threats from logging practises. One FC Divisional forester at Crofton stated: "the park's concerns

are not justified concerning logging." Another FC official admitted that FC has "not talked directly lately to the park." In fact, this particular FC official identified the last person talked to at the park as Mack Elder, then-Chief Park Warden, who retired from service over one year ago. This would indicate that it has been at least one year since FC has contacted the park regarding logging issues.

Another FC official stated:

> We have to be concerned with park concerns, but things do happen. Windthrow is the biggest problem. The boundary of the park should be placed where windthrow will not occur. The boundary should be fitted in properly. Its not that bad in the West Coast Trail unit. A biosphere reserve might help but it must have legal status. But what we are doing now is almost that. Maybe we should feather around the boundary, but there has to be a desire on both sides.

In interviews with officials at MacMillan Bloedel (MB) it was learned that MB passes on their five year development plans to the park superintendent. MB stated that they have sat down with park staff for about one hour of discussions and that the two main concerns of the park have been "blowdown [windthrow] and public access." MB stated they do not mind closing spur roads at the request of the park and gave the examples of closures on Bonilla Main and Rossander logging roads which came at the request of the park.

MB conceded that they felt the park was justified in its concern over noise pollution from logging operations near the south end of the west coast trail. Therefore MB has attempted to adjust the timing of low elevation logging operations to winter when there are few visitors to that area of the park. It should be pointed out, however, that this type of timing adjustment is normal operating procedure for logging operations along the British Columbia coast as heavy winter snowfall generally curtails winter logging at higher elevations and logging operations shift to low elevations where snowfall is nil or light.

In regards to park concerns over scenic degradation, MB says it shares the park's concerns. However, MB states that "we have to please MOF regarding the visual impact of clear-cuts and that automatically pleases the park."[35]

In discussion with officials from FC and MB it was found that the only concerns cited by the park in regards to forestry operations (recall from Chapter 4 that 19 threats from forestry operations were cited) that the two companies were aware of were: logging too close to the park boundary (windthrow), degradation of scenic views, uncontrolled access into the park from adjacent logging roads and noise from logging operations. Either one or both logging companies were sympathetic toward these concerns of the park and in each case either FC or MB believed the problem was either solved or out of their hands as in the case of the MOF not allowing some logging roads to be closed.

A potential problem to the park which was cited by several park staff members was the fragmentation (or possible complete elimination) of old growth forests adjacent to Pacific Rim Park which may result in the park becoming an "habitat island" (see section 2.4.1). In fact, some sources suggest that all old growth forests of commercial quality on southern Vancouver Island (including the area adjacent to the West Coast Trail unit of Pacific Rim Park) will be eliminated by 2001 (Sierra Club of Western Canada and The Wilderness Society 1991). MB, however, says this will not occur in TFL 44 until 2034 (MacMillan Bloedel Limited 1991). Because of these conflicting projections concerning the time remaining for old growth forests on southern Vancouver

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[35] This statement was made by Gord Eason, manager of MacMillan Bloedel Limited's Franklin River Division. The statement reveals that this MB official is not in touch with Pacific Rim Park staff on the issue of scenic degradation. No staff at Pacific Rim Park were pleased with the Ministry of Forests handling of visual impacts of clear-cut logging.

Island, it is difficult to predict the effects on the park. Further complicating the issue is the fact that Blocks four and five of TFL 46, which belong to Fletcher Challenge Canada, and are adjacent to the Long Beach unit of Pacific Rim Park, will be converted to TFL 54 early in 1992 will be managed by International Forest Products. A new five year management and working plan will have to be developed for this area.

The remaining 15 threats due to forestry operations cited by the park were dismissed by FC and MB as not being justified. In fact, they admitted they had never heard any of the 15 concerns before. This response says a great deal regarding the level of communication between the park and FC and MB. The amount of communication and meaningful dialogue between the park and FC and MB is obviously inadequate. From interviews with park staff and FC and MB this lack of communication is due primarily to the following reasons:

1. the failure of Section 28 of the Forest Act to provide for legislated input from the park in either the five year management and working plans or the five year resource development plans drawn up by the TFL holders FC and MB;

2. lack of staff at Pacific Rim Park to keep up with on-going logging plans of FC and MB;

3. lack of staff at Pacific Rim Park to do the baseline research necessary to back up their concerns over various aspects of forestry operations close to the park's boundaries;

4. lack of respect on the part of adjacent resource managers to the existence and purpose of Pacific Rim Park. The park believes it is viewed as the "new kid on the block" and because creation of the park "alienated" a significant amount of commercial timber (particularly in the Nitinat triangle),

there is no way any more concessions will be made to the park by either FC or MB (i.e. no buffer zones which call for reduced timber extraction near the park boundary will be supported by FC or MB).

Improvements to this situation which could lead to some mitigation of problems to the park regarding adjacent forestry operations therefore are:

1. Legislation requiring input from Pacific Rim Park at an early phase of logging plans of TFL-holders such as the five year management and working plan, instead of the present system which only allows the park to be notified of impending logging plans in the five year resource development plan at the discretion of the TFL-holder. Only notifying the park at the latter phase of development plans does not allow the park proactive input into overall forestry operations, it only allows reaction to decisions already made. Currently, Section 28 of the Forest Act requires the five year resource development plan of TFL-holders to be referred to MOF, MOE and DFO. As a minimal improvement, Pacific Rim Park should be added to this list of agencies referred to in regards to activities on TFLs 44 and 46. This would not only allow the park a more certain avenue of communication to the TFL-holders, it would elevate the status of the park from a second-rate agency to a fuller player in the resource management of the area and would hopefully, succeed in gaining more respect for the park from other agencies.

2. The lack of staff problem at the park can only improve in two ways. One, the Canadian Parks Service (CPS) could allocate more funding to the park to hire additional staff to work on baseline scientific studies and liaise more closely with TFL-holders, or two, the park could allocate more of its present funding to these pursuits. Scenario number one is extremely unlikely to occur

as funding for national parks is already stretched, it is, therefore, scenario number two which holds the most promise. In interviews with the former superintendent of the park it was clear he supported the strategy of "redirecting staff from people control to monitoring studies" to eliminate what he referred to as "a pathetic lack of scientific information." Furthermore, it has recently been recognized by a CPS task force that external threats now pose "the largest single threat to western national parks", the mitigation of which is likely to require a considerable amount of money and research (Zinkan, et. al. 1990:3).

3. Pacific Rim Park needs to improve its image and elevate its stature to at least being equal to the other resource management agencies in the area. To achieve this, the park must educate its neighbors regarding the purpose and importance of national parks. This will be an admittedly difficult task in regards to FC and MB who generally view input from the park into logging operations outside the park boundaries as a usurpation of their tenure and a misdirected excursion onto their turf. Historically, TFL-holders in British Columbia have generally been left alone to manage their TFL but in the last 20 years there has been increasing pressure on the holders of TFLs 44 and 46 to accommodate other users of the forest resource. The creation of Pacific Rim Park in 1971 "alienated" a significant amount of timber from the area, the controversy over logging on Meares Island in the early 1980's has "locked up" the forests there indefinitely (see Searle 1986), and the on-going conflict over logging in Clayoquot Sound has made both FC and MB wary of any additional potential inroads into their holdings. For these reasons it is unlikely that FC and MB will accept the addition of input from Pacific Rim Park without a fight or a change in legislation.

One other means of achieving a rise in the stature of the park would be to apply a designation such as the Biosphere Reserve Program to Pacific Rim Park (see section 2). This could help focus greater attention and interest in the park on a national and global scale. In addition, the program provides a means of cooperative land use management on land adjacent to the "core", which, in this case, would be the park. It is possible that this type of working arrangement between the park and FC and MB could foster a new sense of respect for one another and could allow meaningful changes to take place.

A drawback to the Biosphere Reserve Program is the fact that there is nothing legally binding regarding the management of buffer zone areas. Any agreements reached are of a purely cooperative arrangement and, as mentioned earlier, one FC official has already stated that "a biosphere reserve might help, but it must have legal status." This seems to indicate that unless working arrangements between the park and FC are legally binding, FC is not willing to enter into them.

4. Another avenue possibly open to the park concerning problems with adjacent forestry practises is the Clayoquot Sound Sustainable Development Task Force. The task force was established in 1990 to bring together all the resource users in the Clayoquot Sound area to establish a plan of sustainable development. Conspicuously absent, however, from the list of invited participants was the Canadian Parks Service. No one was asked to represent Pacific Rim Park on the task force. Nevertheless, one manager from the park sat on the task force as a representative of Tofino. During his tenure on the task force, he was able to convince FC and MB to reduce the number of slash fires the companies set in the fall, smoke from which adversely affected the park's air

quality (see section 4.1.6). This tactic worked in this instance in the park's favor because "what is good for Tofino is good for the park." This may not always be the case, however, and therefore the park should seek representation for itself on the task force.

Forestry operations on provincial forest land, but not on land under a TFL agreement, will soon be taking place under the small business license agreement in the Cataract Lake-Broughton Peaks area and on the northeast side of Tzartus Island (see Figure 5). Neither of these areas directly border onto Pacific Rim Park, but both could threaten the park through scenic degradation and problems generated from log storage sites.

Unlike the arrangement under a TFL agreement, the planning of resource activities under the small business license is carried out by the Ministry of Forests (MOF), not the tenure holder. The production of the five year development plan is the responsibility of MOF and when interviewed, an MOF official in Port Alberni said the five year development plan was sent to the park. Furthermore, he said the MOF was aware of concerns the park has over possible scenic degradation from clear-cuts in the Broughton Peaks area and that "a landscape inventory has been conducted from the Broken Group Islands and the cut blocks will be designed accordingly." The cut block being designed will be approximately 30 hectares in size and "probably will not be visible at all from the Broken Group Islands" according to the same MOF official. The planned cut block on Tzartus Island will be on the northeast side of the island which is not visible from the Broken Group Islands.

The other potential problem associated with these two cut blocks will be the construction and maintenance of two log storage facilities, one at the base of

Broughton Peaks in Sechart Channel (see Figure 5) and the other near Ahmah Island in Imperial Eagle Channel (see Figure 6). The park has conveyed to MOF its concerns regarding the log storage facilities and in response MOF is sending the park a schedule of works for the construction that will be done and has promised to work with the park to ensure the work done is "environmentally sound." An official with MOF said this kind of liaising with the park "comes from getting our heads knocked against the wall" and that "it would be suicide not to." It was unclear, however, if the MOF's motivation for environmentally sound planning came from the park or the general furor over logging practises in the Clayoquot Sound area.

5.1.2 Residential/Urban

A number of various problems and concerns for the park are in this grouping of external threats and all but one have sources which are local in origin. The one suspected external threat that is not local in origin is air pollution resulting from emissions from large urban centres and/or industrial sites.

Several agencies were questioned regarding the possibility of the long-range transport of emissions into the Pacific Rim Park area: the British Columbia Ministry of Environment (MOE), Canadian Forestry Service (CFS) and the Department of Fisheries and Oceans (DFO).

An official with the Air Quality Branch of the MOE could not confirm the park's suspicion regarding long-range transport of emissions because "there is no monitoring done in that area [western Vancouver Island] to base an opinion on." He did speculate that emissions from the pulp mill located in Port Alice (in northern Vancouver Island) may be affecting Pacific Rim Park. These emissions

would be sulphur dioxide, a result of the high sulphur content of the fuel burned by all the pulp mills on Vancouver Island. If these emissions were affecting the Pacific Rim Park area, it would likely be manifested as acidic precipitation. Officials with MOE are "looking to locate an acidic deposition monitoring station on western Vancouver Island" but admit that this type of research "is not high on the priority list at MOE."

The CFS is conducting studies on the effects of acidic precipitation on foliage and soils at 15 stations located in the Gulf Islands and the east coast of Vancouver Island, but none on the west coast of Vancouver Island. To date, the studies show "no evidence of adverse effects to trees." Similar to MOE, the CFS could not comment on the possibility of damage occurring from acidic precipitation in the Pacific Rim Park area because there are no monitoring stations there.

The DFO (Institute of Ocean Sciences, Sidney, B.C.) conducted a study on precipitation chemistry in 1984 which did include one station in the Pacific Rim Park area at Bamfield. This study found "low to moderately low" excess sulphate in the precipitation at Bamfield. However, the monitoring station at Bamfield ceased operation in 1985 after only two years of operation and therefore is of little use in establishing a long-term pattern of precipitation chemistry along the west coast of Vancouver Island.

All of the interviews with officials in regards to precipitation chemistry along the west coast of Vancouver Island suggest that unless a monitoring station is established in that area no reliable data will be available. Without the collection of baseline data there can be no information regarding linkages between sources of air pollution and effects on the park. As a first step in gaining this

knowledge, therefore, MOE or other agency should establish a precipitation monitoring station along the west coast of Vancouver Island, preferably in Pacific Rim Park.

The remaining nine threats to the park in the category residential/urban have sources that are close to the park boundary but are not located on provincial forest land and can be grouped in the following manner:

1. residential development and growth in areas that are adjacent or close to the boundary;

2. the landfill site for the Tofino-Ucluelet area located adjacent to the park boundary approximately three kilometres north of the Wickaninnish Centre.

The first category contains six threats, one of which is a general threat (pressure on the park from the growth of Tofino, Ucluelet and Chesterman Beach-Cox Bay) and the remaining five are specific threats. The second category contains three specific threats.

In regards to pressure on the park from growth in the Tofino-Ucluelet area, park staff believe that eventually "there will be solid development from the northern boundary [of the Long Beach unit] to Tofino." This area is currently under the planning jurisdiction of the City of Tofino and Alberni-Clayoquot Sound Regional District ACSRD (in fact the ACSRD does all the planning for the area as Tofino contracts out the planning to the ACSRD). According to the ACSRD "all agencies are contacted" regarding development of the area and "Pacific Rim Park is on our list and has recently been sent a letter regarding the updated planning for Tofino."

The ACSRD did not seem to think the park's concerns were justified regarding the future development of the area and suggested "the park wants to

have its cake and eat it too." When discussing the issue of a buffer zone around the park to protect it from residential development, the ACSRD said "the park is of such a size they provide their own buffer" and pointed out that the heavily visited day use area of Long Beach was "a long way" from the northern boundary of the Long Beach unit. This type of statement suggests a lack of understanding on the part of the ACSRD concerning the purpose of national parks which may or may not be a result of the park's failure to articulate its function and purpose to its neighbors. Regardless of the reason for the ACSRD's lack of understanding, it appears obvious that the park could benefit from an increased program of education in regards to its purpose and function.

A specific threat from the first category is the reportedly increased amount of wood smoke in the Long Beach unit from wood stoves in both Ucluelet and Tofino. The ACSRD has said they have had no complaints concerning wood smoke in the area, have no bylaws regarding this and are not contemplating any for the Tofino-Ucluelet area, but they are considering a bylaw restricting the use of wood stoves in Port Alberni as a result of many complaints from residents. This bylaw would be similar to one instituted in Whitehorse, Yukon which does not allow the burning of wood stoves on certain days unless it is the only means of heating a residence. According to an official with the ACSRD "it works, but is a pain in the ass to enforce." The ACSRD did not seem to think a bylaw of this sort would be necessary in either Tofino or Ucluelet.

Another specific threat from the first category is the problem of sewage in Ucluelet Inlet. Sewage from Ucluelet is piped to Hyphocus Island, near the mouth of Ucluelet Inlet where it is "aerated" before being pumped into the Inlet. The aeration of the effluent adds oxygen to sewage which causes it to break

down more quickly. The ACSRD reported that the aerator in the sewage treatment plant in Ucluelet malfunctioned recently causing raw sewage to enter the Inlet "for some time." The Ministry of Environment - Waste Management Branch was unaware of this occurrence but did say there were times when the aerator "does not function well" particularly during high demand times as during shrimp processing. Waste from the shrimp processing apparently overloads the aerator system because it has a high biochemical oxygen demand. The MOE admitted this could cause temporary pollution problems in Ucluelet Inlet. Overall, however, the MOE stated "the village of Ucluelet has been diligent in regards to maintaining the sewage treatment system."

One specific threat from category one is the on-going problem of people illegally cutting small second-growth conifer trees along the park boundary (both inside and outside) for use as Christmas trees. The park would like to see maximum regrowth of timber just outside the park boundary in order to prevent certain adverse events occurring in the park (e.g. windthrow). An interesting solution proposed by park staff is to allow and encourage people to cut small conifer trees for use as Christmas trees along the B.C. Hydro right-of-way which runs parallel to the Highway 4 through the Long Beach unit of the park. At the time of the interviews with park staff they had not yet received word from either B.C. Hydro or CPS Western Region whether an agreement could be reached to facilitate the policy.

While this may be an interesting and innovative solution proposed by park staff it underlines the dilemma faced by the park. While the Parks Act clearly legislates that parks "shall remain unimpaired for the enjoyment of future generations", the reality of Pacific Rim's situation is that it was established on

land that was neither virgin nor void of human development. The park inherited the B.C. Hydro right-of-way when the boundaries were established in 1971 and B.C. Hydro is determined to not allow trees to interfere with the power lines thereby necessitating an on-going program of vegetation control. While park staff may feel the benefits of allowing local people to cut Christmas trees outweigh the negative aspects there was a feeling among some of the park staff that this policy may not be a good one. The benefits of the policy to the park would primarily be concentrating an illegal activity in a defined area that requires cutting anyway, and cultivating a positive relationship with its neighbors - neighbors who sometimes complain about the park's presence. However, the policy could have detrimental effects in the long-term because it establishes the precedent of allowing a prohibited activity to take place in a national park. One could ask the question - what is next? Should we now allow people to legally pick mushrooms in a specific area in the park because they are already picking them everywhere in the park?

The remaining threats in category two directly result from the landfill site serving Tofino and Ucluelet. One such reported threat is leachate entering Sandhill Creek from the site. The ACSRD is responsible for managing the site but is also under permit to the British Columbia Ministry of Environment's Waste Management Branch (MOE). According to the MOE, the ACSRD must monitor on a monthly basis whether leachate from the site is entering Sandhill Creek. The schedule of the monitoring is expected to begin in September, 1991. According to the ACSRD, which has done some preliminary monitoring of the site "no leachate is now entering the creek and most likely will not until substantial rainfall occurs." The MOE anticipates that heavy rainfall will carry

leachate into Sandhill Creek and the MOE has made the following recommendations:

1. excavate a "leachate lagoon" which will trap and prevent the leachate from flowing into Sandhill Creek;
2. add an aerator to dilute the leachate;
3. cover more of the open landfill site and slope the covering overburden to allow quicker runoff which will prevent some rainfall from entering the site.

According to the MOE the above recommendations "may become requirements of the permit." When probed on this, the MOE admitted they have "not been happy with the landfill site" and suggested enforcement of the above recommendations is not a matter of "if" but rather "when" they will be enforced. The MOE suggested that when leachate is found to be directly entering Sandhill Creek (as they anticipate during this fall's heavy rain) the recommendations will be enforced.

Another threat generated by the landfill site is smoke from fires lit to burn some of the material dumped there. The ACSRD said this situation is improving as it now prohibits the burning of anything but woodwaste and this is restricted to only four days a year. Furthermore, the contractor cannot burn without the permission of the ACSRD which weighs factors such as weather conditions before allowing a burn to take place.

One final threat attributed to the presence of the landfill site is the illegal shooting of black bears attracted to the garbage. The ACSRD admitted they had also heard this rumor and were sympathetic to the park in this regard. The ACSRD said the contractor only opens the locked gate to the site for a total of

20 hours per week and has orders to take the license number of anyone seen shooting a bear in the landfill site. To date, no one has been reported.

The landfill site is one source of external threats to Pacific Rim Park that appears to be diminishing in the intensity of threat to the park. In large part this appears to be due to the efforts of the MOE in first recognizing the seriousness of the situation and secondly in having some jurisdiction in the matter. The park should take note of the role played by the MOE in this situation and determine whether their powers could be used elsewhere to benefit the park.

5.1.3 Airport

The Tofino Airport is located on land owned by the Department of National Defense (DND) and is wholly surrounded by land designated as Pacific Rim Park. DND has turned over the management of the land to Transport Canada and the person responsible for overseeing operations on the land is located at Victoria International Airport. In addition to the operation of the airport, Transport Canada has leased a portion of the airport land to private developers who have constructed, and now operate, a nine-hole golf course.

Park staff cited six specific threats arising from activities on the airport land, three from the operation of the airport and three from operations on the golf course. Three of the six threats involve suspected pollutants entering into Esowista Creek which flows from airport land into Pacific Rim Park land where it empties into the Pacific Ocean at Schooner Cove, the location of the only walk-in campsite in the Long Beach unit. Any pollution of Esowista Creek very much concerns park staff because it is a source of drinking water for campers at Schooner Cove.

When interviewed, the Transport Canada official responsible for managing the airport land said although he was not aware of the concerns the park had over the possible pollution of Esowista Creek, he was not surprised over their concern because "under our older leases no monitoring [of the environment] was done - there was no concern for the environment." However, he added that the lease for the golf course was renewable every five years and a new lease requires an environmental impact statement which would mean "the CPS will be contacted and advised."

Park staff also expressed concern over the possible expansion of the golf course from nine to 18 holes (see section 4.2.1.4) and Transport Canada did admit that "we do seek to maximize our return in investment." An expansion to 18 holes would require the lease holder to apply for an Alteration Permit from Transport Canada which will "address environmental concerns", according to Transport Canada.

Another complaint park staff had concerning the airport was noise from aircraft landing and taking off, particularly on the north-south and northwest-southeast runways which require aircraft to fly low directly over Long Beach, an area of high visitor concentration. Some park staff have suggested at least one of these runways should be closed. When questioned about this a Transport Canada official said "we have received no noise complaints to date."

The situation with the airport and the park is analogous to the situation regarding the B.C. Hydro right-of-way discussed earlier (section 5.1.1.2) in that the park "inherited" the airport when the park boundaries were established in 1971. It is an unfortunate circumstance that the airport lies inside the park boundaries. Other than relocating the airport which would be prohibitively

expensive, the only thing the park can do is communicate its concerns to Transport Canada. Interviews with Transport Canada officials indicate the park has not been communicating their concerns, however, Transport Canada also admits that previous leases were issued on airport land without regard for the environment. Transport Canada claims this policy has now changed and will in future consult with the park and CPS regarding new leases and Alteration Permits.

Insofar as noise from aircraft utilizing runways at the airport, it is unlikely the park would be able to persuade the airport to shut down any runways. Transport Canada is sensitive to safety issues regarding pilots and one of those issues is maximizing the number of runways in use. Transport Canada does not want to force pilots to make cross-wind landings because an existing runway has been taken out of service.

The park could perhaps be more successful in dealing with the golf course expansion issue. New, more stringent environmental standards will apply to the proposed expansion and the park should take advantage of the opportunity by hiring a consultant to assess the expansion. The park may also want to question Transport Canada's policy of "maximizing their return on investment" in regards to the golf course expansion when this increase in return on investment may be damaging the resources of another federal agency.

5.1.4 Recreation

The major concern of the park in this category, which involves two specific threats, is the over-use of a recreation site in Toquart Bay. Suspected threats to the park are organic pollution of Barkley Sound which could affect the Broken

Group Island unit and noise from a large concentration of campers in one area close to the Broken Group Island unit.

The recreational facility in Toquart Bay is a designated Ministry of Forests Recreation Site which has been in operation since 1972. The Ministry of Forests Recreation Branch (MOF) in Port Alberni is responsible for the facility and when contacted regarding the park's concern, the MOF said "there is a problem with the sheer number of visitors to the site" and reported that this recreation site is the most heavily used in the province, averaging between 36,000 to 40,000 user days per year. In regards to the specific threats mentioned by the park the MOF said that visitors to the site were "not your typical beer drinking yahoos, but predominantly families and kayakers going into the Broken Group Islands." However, the MOF did report a problem of overloaded outhouses which have recently been replaced with privies that retain waste and are regularly pumped out by truck. The MOF admitted that there have been occurrences of people dumping their toilet holding tanks "into the sand on the beach" but claim this is not a major problem. However, the MOF also stated they only actually visit the site once a week during the summer and therefore do not have an accurate account of how much dumping takes place.

The MOF said they are implementing measures to mitigate some of the problems at the site:

1. a limit of 14 days maximum stay;
2. the construction of more "sealed vault" toilets;
3. a survey of the users of the site to aid in future planning.

The MOF reported they have had no contact with park in regards to the site and expressed surprise at the park's concerns. The MOF stated: "if the park has major concerns regarding this site they should make it a priority to contact us - they must take the time."

In discussion of other options for mitigating some of the problems at the site, the MOF ruled out closing the 17 kilometre logging road that accesses the site because it is a MacMillan-Bloedel main haul road and the fact that there would be a great deal of opposition from the public.

The park's relationship with the MOF in this matter demonstrates, yet again, the lack of communication between agencies. Pacific Rim Park needs to acquire either the will or the resources to liaise more closely with the MOF in this matter. The MOF has indicated a willingness to listen to the park's concerns which is the first needed step toward any meaningful mitigation.

5.1.5 Light Stations

There are three Light Stations operated by the Canadian Coast Guard that occupy Government Reserve land which is wholly surrounded by Pacific Rim Park land. All three Light Stations are located within the West Coast Trail unit at Cape Beale, Pachena Point and Carmanah Point. Some park staff suspect that some or all of the Light Stations have been guilty of spilling oil or diesel fuel into the ocean (it was smelled by a warden during patrol) and that the Light Stations have been dumping their sewage into the ocean.

When these concerns were presented to an official with the Coast Guard headquarters in Victoria, it was with a measured amount of anger that he replied: "That's a load of crap." It was this official's contention that the oil or diesel fuel smelled by the warden came from a passing ship offshore, a problem

the official said, was "chronic." Insofar as the dumping of sewage into the ocean this official admitted that the Light Stations do dump sewage into the ocean, but in defense pointed out that Victoria does the same thing on a much larger scale.

The Coast Guard official went on to say that it was "a sad lack of communication which caused this misunderstanding" and that "I wish he [the warden] had spoken to me about his concerns." The official then went on to list a number of circumstances where the Coast Guard helps out the park and has nothing but respect for Pacific Rim Park.

This interview revealed again the lack of communication between the park and an adjacent agency, in this case the Canadian Coast Guard. Given the large amount of praise and respect the Coast Guard appears to have for the park, it would seem the park only has to communicate more often and more directly with the Coast Guard to improve working relations with them.

5.1.6 Mining

Park staff mentioned one threat under this category and that was a suspicion that tailings from an abandoned magnetite mine in Toquart Bay may be causing unknown pollution to the waters of Barkley Sound, thus affecting the Broken Group Islands unit. Wardens also reported that their compasses "went haywire" whenever they were in this area.

The British Columbia Ministry of Energy, Mines and Petroleum Resources was contacted concerning the mine and their information revealed that the tailings were from the old Brynnor Mine (Noranda Corporation) which shut down approximately 30 years ago. The tailings dumped into the ocean are crushed magnetite, limestone and inert silicates according to the ministry. It was emphasized that acid rock drainage was not a problem because the rock

dumped was not sulphide-bearing. The ministry stated that within the silicate matrix there could be trace amounts of copper, bismuth and arsenic but suggested the amounts would be so slight that no problem would be created.

A potential problem to the park raised by the ministry which was not mentioned by the park, are the large number of very small gold operations located along the Kennedy River. These operations result in holes in the sulphide bedrock which are "hand cobbed." The holes can then produce acid rock drainage which enters the Kennedy River above Kennedy Lake. Presumably the acid rock drainage could then enter the lower Kennedy River which flows into Tofino Inlet a few kilometres north of the park boundary in Grice Bay.

Interviews with the Ministry of Energy, Mines and Petroleum Resources suggest there is little or no communication between them and the park. The Ministry's information concerning potential acid rock drainage in the area points out the value of the park liaising more closely with this agency.

5.1.7 Other Terrestrial Threats

There are several varied concerns the park has under this heading which can be categorized generally as:

1. the illegal removal (poaching) of various fauna on land just outside the park boundary;
2. the on-going fertilization of Hobiton Lake by DFO;
3. the introduction of various flora and fauna into the park;
4. guidebooks which do not have park endorsement.

Under the first category (poaching) park staff suspect large mammals such as deer and black bear are being illegally killed just outside park boundaries.

This type of poaching could result in the reduction of the population of these species in the park (see e.g. Buechner 1987).

Several officials with the British Columbia Ministry of Environment - Wildlife Branch were interviewed regarding this problem. Four of these officials had no specific knowledge of poaching near the Pacific Rim Park boundary but did raise some interesting points regarding poaching in general on Vancouver Island. Generally these four officials felt there was "little or no problem to the park" regarding poaching and suggested that deer poaching, for example, "needs to be intensive to do damage." Similarly for black bears it was said that "even 20 animals taken in one area is insignificant." It was also stated that "the people of Tofino have heightened the awareness of poaching and this has had positive effects." It was also suggested that "wherever there is a logging road you will have poaching."

There is one Conservation Officer with the Ministry of Environment - Wildlife Branch who is responsible for the entire area surrounding all three units of Pacific Rim Park. According to this officer "the management area is large and there is no way to keep all records." This officer had specific knowledge of poaching within the management area and stated that "the poaching of Columbia Black-Tailed deer is a major problem on Vancouver Island." He went on to point out two locations where he knows poaching is going on close to the park boundary: the logging road located in TFL 44 (MacMillan Bloedel Ltd.) along the Darling River in the West Coast Trail unit and the golf course located on airport land in the Long Beach unit.

According to the Conservation Officer, the majority of deer are shot at night while being "pit-lamped." This technique trains a bright light on the eyes of the

deer which momentarily freezes the animal and provides sufficient illumination for the poacher to deliver a fatal gun shot. The officer has on several occasions laid in wait for the poachers along the Darling River but has not yet succeeded in apprehending anyone. He claims the poachers at the Tofino golf course are very difficult to apprehend because "they park their vehicles and walk in along the fairways."

While all the officials interviewed concerning poaching expressed a measure of concern for the park regarding this problem, it was clear there is an insufficient amount of data to make a proper judgement concerning the severity of the problem. No studies dealing with mammal populations are currently being done on the west side of Vancouver Island, though several are being conducted on the east side of Vancouver Island. To increase our knowledge of poaching and its effects on Pacific Rim Park studies of animal populations need to be conducted on the west coast of Vancouver Island. An additional measure to help mitigate the problem would be to increase the number of conservation officers in the management area to at least two or more.

Under the second category of "other terrestrial threats" is the on-going fertilization program being conducted by DFO in Hobiton Lake, which is located in the Nitinat triangle area of the West Coast Trail unit (see section 4.2.1.8). The end result of this fertilization program is that there has been a "two-fold increase" in the number of sockeye salmon returning to Hobiton Lake. The increase in sockeye salmon directly benefits the Ditidaht Band who have a food fishery located at Indian Reserve 9 at the mouth of Hobiton Creek.

The official with DFO responsible for managing the fertilization program at Hobiton Lake describes the DFO's relationship with the Ditidaht Band as

"unusually sunny" and indicated it was through hard work and perseverance that has come about: "it has taken over a decade of time to build a modicum of trust with the Ditidaht." In addition the official noted that "the DFO has never enforced a regulation under the Fisheries Act with the Ditidaht." The long-term relationship between the DFO and Ditidaht Band has culminated in the first-ever joint operation - a program to tag wild sockeye salmon to determine marine survival rates.

The DFO is proud of the good working relationship it has with the Ditidaht Band and when questioned about the park's concern over possible negative effects from the fertilization program the DFO responded "the park doesn't know much about fish. If the park characterizes fertilization as a threat then it is due to their ignorance." The DFO had other warnings for the park regarding their suspicion concerning the fertilization program:

> The CPS has a lot of homework to do and should be prudent and gentle in their administrative power with the Natives. They will not be able to legislate people to do their bidding. The park better find things for them [Natives]. One of the greatest threats to the park is cultural misunderstanding - hamhanding that breeds mistrust. It will not be easy for the park to develop good relations with the Natives. There is nothing the park can do to avoid some unworkable conditions.

The manager of DFO's program to fertilize Hobiton Lake described his communication with Pacific Rim Park as "limited." He reports three phone calls in 14 years between himself and the park with the last contact being "five or six years ago when the Nitinat triangle became part of the park." However, this official was happy to report that only one week before this interview, he was visited by the Chief Park Warden from Pacific Rim Park and a CPS official from

Vancouver prompting him to reply: "It's good to see the park casting a wider net."

More communication between Pacific Rim Park and DFO certainly seems appropriate. The DFO is doing sockeye salmon studies not only at Hobiton Lake but also at Cheewat Lake which could help the park develop baseline studies on this species - data which is lacking at the present time. The park's concerns over the fertilization program at Hobiton Lake are once again a concern over an inherited problem - according to the manager of the fertilization program at Hobiton Lake, the program was underway in Hobiton Lake when it became part of the park. The DFO has indicated that it would abandon the program if asked to by the park but warned of "dire consequences" to the park from the Ditidaht Band if the park so requested. Considering the overall poor relations the park has with the Native Bands in the park area (see Berg 1990), it appears that it may benefit the park more in the long-run to allow the fertilization program to continue.

Under the third category of "other" terrestrial threats is the problem of the proliferation of exotic vegetation into the park. Park interpreters have compiled a list of 60 species of plants which they claim are not native to the park. One of the more visible of the non-native species is *Cytisus scoparius* (broom) which can be seen growing in profusion around the park headquarters. This is a plant which spreads into "disturbed" areas and is generally found in areas of the park that have been cleared of forest cover for construction of buildings. Because broom is not making headway into stands of native vegetation in the park, park staff is not too concerned about its presence.

Park staff feel the biggest problem from the proliferation of non-native species in the park could be the loss (displacement) of native species. It is already suspected that the park has lost two rare plants: a *Botyrichrium* species (a grape fern) and a *Lloydia* species. Park staff cannot prove that the cause of this disappearance is the result of displacement by non-native species, and cite the possibility that these two species may simply be "at the edge of their range." The loss of these species could, in fact, be a reflection of the inadequate representation of the coast protected in Pacific Rim Park's boundaries. As one park manager stated: "The park really isn't a good representation of the coast here. To say we are protecting species isn't so. We do not have adequate protection."

Mitigation of this problem will be extremely difficult, if not impossible. Even if park staff could track down and eradicate every one of the 60 known non-native plant species (which is most likely impossible) there is little if anything the park could do to prevent more non-native species from entering the park. The best the park can do is attempt to educate park visitors of the seriousness of bringing in non-native plant species and working with adjacent agencies (such as the golf course) to minimize their use of non-native species which could find their way into the park.

The final category under "other" terrestrial threats is the publishing of guidebooks which do not have park endorsement. According to park staff this has led to some guidebooks publishing information regarding the location of various sensitive park resources resulting in the abuse of some of these resources.

According to several publishing companies contacted there is no legal onus upon the publisher to withhold information regarding Pacific Rim Park because "it would be censorship." However, one publisher contacted (who was also the author of a guidebook which included a section on Pacific Rim Park) said she did consult with the park concerning sensitive areas before publishing the book. She also pointed out that her motivation for writing the guidebook was to educate people concerning national parks and "not simply to make money." Unfortunately, she also believes that most publishers are "out to make money and do not necessarily care what the national park thinks."

From the interviews with publishers and others in the book business are the following recommendations for Pacific Rim Park regarding guidebooks:

1. seek out the publishers of guidebooks and send them a letter requesting a review of all manuscripts that relate to the park;

2. send a letter to all publishers of guidebooks outlining the park's position concerning sensitive locations in the park;

3. step up education of the public concerning sensitive areas through written material, interpretive programs and more signage at the location of sensitive areas.

Another culprit mentioned concerning the problem of some tourists damaging sensitive areas of the park was the British Columbia Ministry of Tourism for "issuing glossy, glowing, bullshit pamphlets about the area that do not at all educate the public about national parks." It would certainly seem prudent, therefore, for Pacific Rim Park to liaise more closely with the provincial ministry of tourism in order to provide input on information concerning the national parks.

5.2 Agencies Responsible for Marine External Threats To Pacific Rim National Park Reserve

The five categories of sources responsible for external threats to the marine resources of Pacific Rim Park are: marine transportation, commercial fishing, sport fishing, fish farms and other marine threats. These five categories will be discussed in turn.

5.2.1 Marine Transportation

A major North American shipping lane exists off the west coast of Vancouver Island which includes tankers carrying oil, chemicals or fuel oil, bulk carriers, log barges and foreign factory vessels. Park staff believe that tanker vessel oil transport is the number one threat to the park's marine environment. In 1989, 1379 tankers passed offshore of the park (an average of three - four per day). Park staff report three major spills have affected the park in the last 10 years.

All ships over 15 tons are subject to the Canadian Shipping Act, a federal Act which prohibits such practices as bilge cleaning at sea. Bilge cleaning flushes small amounts of oil into the ocean which can subsequently wash up on the shores of Pacific Rim Park. The Canadian Coast Guard confirmed this is a problem off the west coast and admitted it is difficult to track down and successfully prosecute those responsible. The legal technique of bilge cleaning requires ships to have their bilges pumped out in port with the effluent trucked to a proper disposal site - this technique, however costs the ship money, whereas, undetected bilge cleaning at sea is free.

The Canadian Coast Guard believes there is little the park can do to prevent illegal bilge cleaning off the west coast: "It is a matter of convincing the

public not to do it. You have to make the public aware of the potential damage." The Coast Guard believes the main culprits involved in illegal bilge cleaning and illegal dumping of litter and garbage are foreign vessels whose crews "are unaware and unconcerned about pollution of foreign countries." When asked if they thought the establishment of a biosphere reserve in the area of Pacific Rim Park would help mitigate these problems the Coast Guard said no.

Most tanker traffic moving south along the coast enters the Juan De Fuca Strait and must stay seaward of the West Coast Tanker Exclusion Zone which keeps tankers 45 miles offshore of the Long Beach unit but closer in to the other two units of the park to allow passage into the Juan De Fuca Strait. The West Coast Tanker Exclusion Zone is designed to make sure that a fully laden tanker is far enough offshore that if disabled, it would not drift onto shore before a tug from either Prince William Sound, Alaska or Anacortes, Washington is able to come to its assistance (Anderson 1989).

While the West Coast Tanker Exclusion Zone provides the park some measure of safety for southbound tankers, northbound tankers carrying heavy crude oil from Alberta are not under its jurisdiction and may travel inside its limits. This aberration was pointed out by David Anderson when making recommendations to the British Columbia government following the Nestucca oil spill:

> For reasons I have yet to discover, these vessels [northbound tankers] have not been subjected to the requirement of remaining outside the West Coast Tanker Exclusion Zone. This is but another example of how the rapid and unpublicized growth of this traffic has resulted in a failure to properly analyze the risk and safety factors associated with it (Anderson 1989: 50).

In addition to the risks inherent in large numbers of vessels operating just off the west coast of Vancouver Island there are other safety factors to be considered in regards to tankers. One such factor explored in depth by Anderson (1989) is whether tankers plying the west coast should be fitted with double hulls. In his final recommendations regarding tanker safety and the prevention of oil spills, Anderson (1989) suggests that Canada await the outcome of a U.S. Congressional Committee before making a decision on the matter of double hulls. The point of this discussion is that Pacific Rim Park has little expertise in this area (i.e. technical knowledge of marine engineering) and can add little to the on-going debate regarding such esoteric matters. The area in which the park can contribute expertise is in matters of oil spill clean-up and the documentation of linkages between spilled oil and damage to various biophysical elements (e.g. body counts of dead birds).

In regards to spills of oil, the Canadian Coast Guard stated "there is little anyone can do about an oil spill until the oil arrives at the beach." This is because open sea skimming of oil "can only retrieve a small percentage of the spilled oil." The system in place for cleaning up an oil spill requires the Canadian Coast Guard to provide an on-scene commander, who is sometimes paired with a co-representative from Environment Canada. Environment Canada utilizes the Branches under its control (e.g. Canadian Wildlife Service, Atmospheric Environment Service, Department of Fisheries and Oceans) to determine the areas requiring attention and the Coast Guard is then responsible for directing and mobilizing the actual clean-up. The Coast Guard had high praise for Pacific Rim Park during the clean-up of the Nestucca oil spill and said "the park was the most cooperative agency during the clean-up."

Another problem incurred during the Nestucca oil spill and one the Coast Guard confirmed as happening before, is that "the oil spill provides cover for ships to clean their bilges, knowing it will be impossible to trace back to their ship." The Canadian Coast Guard cite this as a possible explanation for the continual re-oiling of Pacific Rim Park beaches for the several weeks following the Nestucca oil spill.

While single large spills of oil tend to attract a great deal of media attention and have certainly resulted in damage to Pacific Rim Park, the effects of chronic, long-term small spills of oil, a large portion of which is a result of illegal bilge cleaning at sea, may also be causing significant damage to the park's resources. The Canadian Coast Guard has recently had limited success in apprehending ships illegally cleaning their bilges off the west coast through a partnership with the Department of National Defense (DND). The DND fly aircraft patrols over the waters off the west coast and when they spot a vessel trailing an oil slick they notify the Coast Guard, The Coast Guard then fly their own aircraft (capable of making water landings) out to the ship and lay charges. The Coast Guard points out, however, that they have "only caught the tip of the iceberg in terms of the number of violators."

The park's relationship with the Canadian Coast Guard in matters of marine transportation appear good. There is a good deal of communication between the agencies and they both appear to have a large measure of respect for one another. The best contribution the park can make in terms of mitigating the effects of oil spills from marine transportation is the documentation of damage to biophysical resources. The park is participating, for example, in a long term study conducted by Dr. Allen Berger of the University of Victoria's

Department of Biology which is gathering information on the cause of death of sea birds along the west coast. Results of the study may enhance the ability to more accurately predict the number of sea birds killed by oil spills. If direct linkages between oil spills and sea bird deaths can show higher numbers of birds killed than has previously been cited, then more pressure could perhaps be brought to bear on the federal government to enforce new regulations such as double hulls for tankers.

5.2.2 Commercial Fishing

In addition to the presence of a large commercial fishery of finfish and shellfish just outside the park boundaries, certain commercial fishery operations are allowed inside the park. At park inception in 1971 an agreement was made between the CPS and Environment Canada (DFO) to allow the continuance of three commercial fisheries: the Long Beach crab fishery, the salmon troll fishery and the Indian food fishery. A major problem which has resulted from this agreement is that commercial fishing has expanded considerably in the park since 1971.

The commercial crab fishery was initially permitted in 1971 to "continue within the park at its present level, which at that time consisted of only two fishermen with no winter operations." Now, however, the crab fishery continues year round with approximately 300 traps off Long Beach and 500 traps in Grice Bay.

Today, five other commercial fisheries operate at least partially in the park: a herring roe net fishery, the Barkley Sound sockeye salmon net fishery, the salmon troll fishery, the Nitinat chum salmon net fishery and the Juan De Fuca salmon net fishery. The park has no data available as to the nature, relative

size and value of the in-park component of the above mentioned commercial fisheries.

Because the park is not yet gazetted, fishing regulations in the park's tidal waters are managed under the Fisheries Act. The DFO is responsible for enforcing the Act but has worked closely with the park to prohibit certain fisheries in the park that are not normally excluded. One such example is the prohibiting of commercial shellfish harvesting within the park (except for the crab fishery previously mentioned). Until the park is gazetted as a national park reserve, the park plans to continue working with the DFO to either eliminate or further limit existing commercial fisheries in the park through amendments to the Fisheries Act.

It is unknown at this time whether the marine portion of Pacific Rim Park will eventually be managed as a marine national park or a national park. According to the CPS, in order to manage the marine portion of the park as a marine national park it will have to satisfy the criteria under systems planning for proper representation of the west coast marine environment. To meet these requirements the boundaries of the marine component of the park "may have to be considerably expanded." The CPS did not reveal the location of the possible boundary extensions but did say "it could have a significant effect on the current structure of commercial fishing off the west coast of Vancouver Island." This means that the boundary extensions could be large and it may be recommended by the CPS that no commercial fishing be allowed inside the boundary. While a boundary extension of this magnitude will certainly not be endorsed by the commercial fishing industry, the CPS believes it may be necessary to preserve stocks of several fish species.

5.2.3 Sport Fishing

The sport fishery in Pacific Rim Park can be characterized by the following quotes from park staff:

> The existing fishery poses a threat to park resources most especially the territorial fin fish in the Broken Group Islands and around Box Island.
>
> The nature of the existing fishery is not appropriate for a national park; most of the present angling in the park waters does not occur as part of an overall Aquatic Resource Program involving public education, recreation and resource protection.

The freshwater fishery in the park is reported as quite small. Under present management arrangements, the B.C. Ministry of Environment (MOE) is responsible for the licensing and managing of the park's freshwater fishery. Generally, the amount of angling pressure on the park's freshwater locales is unknown as no surveys specifically designed to yield this knowledge have been undertaken. The MOE does, however, conduct a survey every three years of anglers who have purchased a license on Vancouver Island. This survey is sent to approximately one-third of the anglers (estimated at 30,000 in 1989) and obtains information regarding the amount of angling, the locations being fished, the preferred species and angler success. Though survey results have not yet been reviewed by park staff, they could provide useful information regarding the freshwater fishery in the park.

The tidal water sport fishery in the park is reported as "large" and is managed by the Department of Fisheries and Oceans. The most popular species sought are salmon, rockfish and bottom fish. The following is summary of important locations for various species in the tidal water sport fishery in the park (see Figure 8):

Long Beach unit - Grice Bay, Portland Point, Florencia Island and Wya Point for salmon. Grice Bay for sea-run cutthroat trout.

Broken Group Islands unit - The perimeter of the unit for salmon, with rockfish and bottom fish taken in the sheltered inside waters.

West Coast Trail unit - Whittlestone Point, Cape Beale, the Nitinat Narrows, the area seaward of the narrows and Owen Point for salmon.

A creel survey conducted in Barkley Sound in 1989 provides some insight into the size of this fishery: from July 17 to September 30, 1989 there were an estimated 42,192 boat trips in the Barkley Sound with anglers on those trips catching an estimated 77, 838 salmon, 8, 594 ling cod and 22, 675 rockfish.

As previously mentioned, the tidal water sport fishery is large in the park and is characterized by a number of commercial guided angling companies, some large private fishing camps and the collection of a wide variety of edible invertebrates.The largest guided angling operation in Canada operates in Barkley Sound: the Canadian Princess Resort in Ucluelet. Several other smaller operators exist in the area based in Ucluelet, Tofino, Port Alberni and Bamfield. Because Pacific Rim Park is not yet gazetted and not proclaimed as a national park, these operators are not required to acquire a business license nor the CPS fishing guide certification. There has been little communication between the park and these operators.

Recently, the park experienced a new type of large private fishing camp:

> A large, privately-owned, converted ocean-going tug anchored for an extended period in the Broken Group Islands. The Seaspan Chinook, owned by a Vancouver shipping company, is used as a floating fishing camp for employees and invited guests. The ship is approximately 200 feet in length. It is fitted out with about 17 outboard motor-powered runabouts. It can accommodate over 20 guests and staff at a time.

Park staff do not believe this type of activity is compatible with national park objectives. It is the stated intent of the CPS to phase out large private operations and commercially guided sport fishing in the park over a five year period once the park is gazetted. The CPS understands that this will be an unpopular decision to the many users of these operations, but CPS firmly believes that "the pursuit of 'trophy' fish or the catching of one's limit are activities best provided for outside of the national park."

The collection of bivalve molluscs in the park (e.g. clams, mussels and oysters) has been restricted in recent years due to the prevalence of red tide or paralytic shellfish poisoning (PSP). However, the recent introduction of a quick and inexpensive PSP testing procedure has allowed the DFO to lift the general harvesting closure for the park area. This means that shellfish can now be legally harvested in the park. The park, however, believes this is not compatible with the purpose of a national park and has, therefore, informed DFO of its intention to prohibit all recreational harvesting of invertebrates within the national park. The park has proposed an amendment to the British Columbia Sport Fishing Regulations of the federal Fisheries Act which would extend the existing closure of commercial harvesting of shellfish to a total closure. Once the park is gazetted, the National Parks Act and Regulations will be used to accomplish the same purpose.

The park's overall attitude toward sport fishing as it currently exists in the tidal waters of the park is that it is out of control and is not compatible with the purpose of a national park. The park will have the authority (once gazetted) under the Park Act to restrict current sport fishing activities. While this action could put more pressure on waters just outside the park boundary, the park is

hopeful that as long as DFO properly manages these adjacent waters there will be no problem.

5.2.4 Fish Farms

Park staff reported three threats from this source and were concerned, in general, regarding the proliferation of fish farms along the west coast of Vancouver Island (see section 4.2.2.4). Two agencies are responsible for the licensing of fish in British Columbia: Ministry of Crown Lands (MCL) and the Ministry of Agriculture and Fisheries (MAF). Applications to develop fish farms start with the MCL which are then sent to the MAF for approval of the applicant's Marine Fish Farm Development Plan. Both of these agencies were interviewed to determine their relationship with Pacific Rim Park.

The MCL is the lead agency in licensing Fish Farms and refers the initial application to the MAF, Canadian Coast Guard, Ministry of Environment, DFO, local regional districts and "local relevant interest groups." When queried as to why Pacific Rim Park was not on the referral list an official with MCL replied, "because none of the applications have been less than one kilometre from the park boundary." The stated policy of the MCL is not to notify the park (or Native Reservation, Marine Park or Ecological Reserve) unless the application is within one kilometre of the boundary. Pacific Rim Park staff have specifically cited the fish farm located in Indian Bay as having possible adverse effects on water quality in the park as well as providing a sink for resident seals due to the shooting of these marine mammals by fish farmers. The fish farm in Indian Bay is located approximately two kilometres from the park boundary.

The MAF was contacted regarding this matter and it was their belief that the MCL "probably referred to the park" regarding fish farms in the area. However,

as previously indicated this was not the case. When asked about the park's concerns regarding the possibility of disease transference from farmed salmon to wild salmon an MAF official said: "that is just rhetoric, they do not have all the answers." The MAF admitted that they also did not have all the answers, but they do pride themselves on having come a long way since the inception of fish farms in British Columbia:

> Most concerns about fish farming were raised at time when little was known about how fish farming would affect our coastal waters. Now, after five years of study and action, many of these concerns have been laid to rest. Both government and the fish farming industry were able to preclude or minimize problems before they occurred (Ministry of Agriculture and Fisheries 1990a: 6).

The ministry identifies 32 studies that have either been completed or in progress which examine many aspects of aquaculture-environment interactions. Funding sources for the studies come from the federal government, provincial government, industry and B.C. Universities. Areas of research include: disease, genetic interactions, plankton impacts, benthic impacts and water quality (see Ministry of Agriculture and Fisheries 1990b:2-12).

Discussions with the MCL and MAF indicate there is no contact between them and Pacific Rim Park and that any concerns the park have regarding fish farms are due to their own ignorance. These characteristics are not the basis for a good working relationship between the agencies. MCL and MAF take a rather indifferent and defensive attitude regarding the park, the reasons for which are unknown. Improvements to this condition could be implemented by 1) putting the park on the referral list for new fish farm applications located outside the current one kilometre zone, 2) developing a joint research project

between the park and MAF to examine possible impacts of fish farms on the park and 3) other initiatives to simply open the channels of communication between the park and MCL and MAF.

5.3 Agencies Responsible for Terrestrial and Marine External Threats To Pacific Rim National Park Reserve

There are two categories of external threats under this heading: the Canadian Parks Service (CPS) and natural.

5.3.1 Canadian Parks Service.

Park staff mentioned six threats in this category and they fall under two general categories:

1. lack of funding;
2. failure to have the park gazetted.

In regards to the first category, one threat mentioned was insufficient funding for research. One park manager complained that "96 percent of our budget goes to paving over areas for campgrounds." The former park superintendent cited 70 rescues along the west coast trail in 1990 detracted from wardens time to do any research. He felt that if proper research were to be conducted in the park, there would have to be an increase in either the amount of money allocated or an increase in the number of park staff.

The Canadian Parks Service (CPS) is aware of the lack of scientific research in the parks and has recently addressed the issue in its Report of the Science and Protection Task Force:

> outside agencies and stakeholders do not perceive the CPS Western Region as having credibility in the scientific management of park resources. This lack of credibility is a result of many factors including: failure to apply scientific methods to resolving management problems; existing scientific knowledge not being

> integrated into all aspects of park operation and management.....and lack of published information on park resources (Zinkan, et. al. 1990: 34).

To mitigate the problem of the lack of scientific research in national parks in the western region, the CPS Task Force Report put forward 15 recommendations. None of these recommendations called for funding any additional staff. Several of the recommendations, however, were concerned with the development of closer ties to universities and one recommendation specifically called for "an effective funding program for a minimum of $25, 000 for research by graduate students." The rationale for this recommendation was explained:

> Many opportunities for mutual benefits can be realized from liaisons with universities and other governmental departments in developing joint programs for research. The CPS lags far behind the United States National Park Service and other agencies in establishing such programs (Zinkan, et. al. 1990:36)

When interviewed concerning the lack of money for research in the parks, a CPS official said in large part the problem is due to the "drastic cuts" made by the federal government to the Canadian Wildlife Service (CWS) in 1984." The CWS conducted a large portion of their research projects jointly with the CPS. According to the CPS "we have never recovered from the blow."

Interviews with CPS staff in Vancouver and Calgary revealed no plans to increase personnel at Pacific Rim Park and that, in fact, it is the CPS's belief that the federal government wants to cut funding for the national parks in Canada. The CPS used the example of recent cuts to national park interpretive programs as evidence of the federal government's intent.

Another threat to Pacific Rim Park which was blamed on the CPS is the delay in the gazetting of the park. The fact that the park is not gazetted means

the Park Act cannot be applied and park staff feel this allows for inadequate protection of all park resources. When interviewed regarding this, the CPS expressed its own frustration at what it called "bureaucratic feet-dragging in Ottawa" which is responsible for the delay in gazetting. The CPS claim that the gazetting process is being held up by the Department of Justice over an incorrect survey along one of the park's boundaries. The CPS expects gazetting will be completed sometime during 1991 after which time the park will attain national park reserve status. The designation 'reserve' will not be dropped until the Nuu-chah-nulth comprehensive land claim has been settled. However, according to the CPS 'national park reserve' status carries the same legal designation as 'national park' status and the full measure of the National Park Act will apply to Pacific Rim Park. The reserve status simply indicates that in the future, pending the outcome of the Nuu-chah-nulth land claim, the boundaries of the park may be changed.

The CPS admits there are a number of threats to Pacific Rim Park from sources outside the park's boundary. One official commented that the biggest single problem to the park is the extensive clear-cut logging that has taken place and is planned for the numerous "small watersheds which drain into the West Coast Trail unit." Of particular concern to the CPS is the planned cutting in the Carmanah and Walbran Creek watersheds. As one CPS official put it: "this is our last chance to do something we should have done 20 years ago [i.e. adding both the Walbran and Carmanah watersheds to Pacific Rim Park]." When probed as to why these two watersheds in particular were so important, the CPS official replied: "these are the last pristine watersheds in the area."

The CPS initiated a study at Pacific Rim Park in March, 1991 to determine the viability of applying to Canada Man and Biosphere for biosphere reserve status for the park. The CPS concluded the park would be a good candidate for biosphere reserve status and it is expected this will become a recommendation of the park's management plan which is due out in early 1992. However, one official with the CPS confided that the biosphere reserve proposal "will probably get nowhere because CPS Western Region does not have innovative thinking." Interestingly, most of the park staff interviewed did not see much value in the biosphere reserve either. Their reasons, however were due primarily to the additional amount of uncompensated work it would require park staff to make the biosphere reserve successful. As one park manager put it: "how can we be expected to pull off a biosphere reserve when we don't even have enough staff to accomplish the most basic functions of a national park?"

5.3.2 Natural

External threats to the park from natural sources are described in section 4.2.3.2. The primary thrust of the park's efforts to mitigate natural external threats has been the buttressing of the cliffs along Florencia Bay to prevent erosion from wind, waves and precipitation. Park staff suggest this effort has cost the park a considerable portion of its budget and several staff question the rationale behind the project. Some staff say that this type of erosion is a natural process and national parks should not just protect static landscapes, but rather should protect natural processes.

The possibility of moderate to severe earthquakes was frequently mentioned by park staff and there is a fear that a strong earthquake could collapse built structures located along the top of the cliffs in the Long Beach unit

(e.g. park headquarters building). One staff member explained that the geology of the escarpments along the beach in the Long Beach unit features a thin layer of clay at the surface which overlays a thicker layer of unsorted, unconsolidated conglomerant - a situation that is very unstable and in the event of an earthquake could result in the complete collapse of the escarpment. Not surprisingly, the same park staff member questioned the wisdom of the decision to place the majority of the park's structures on top of this unstable unit.

One other threat mentioned in this category was global warming and the implications for the park. This threat is addressed in The Report of the Science and Protection Task Force (1990):

> Significant changes in water, vegetation and wildlife components will likely occur faster than species can adapt. Sudden loss of native species, increases in exotic plant species, outbreaks of forest insects and disease and modified watershed and fire regimes are problems that will challenge managers.....Predictions are that Western Region parks will experience a 2 to 4 degree Celsius increase over the next five decades. Prediction for changes in precipitation are less precise but a decrease in summer precipitation and an increase in winter precipitation is anticipated. Changes will not occur gradually but will result in drought and flood peaks (Zinkan 1990:14)

The CPS understands that the sources of global warming are beyond the direct control of the parks. However, the CPS believes that the parks can set an example for the world by demonstrating "leadership in the reduction of internal and external sources of pollution." To this end the CPS has applied the federal "Green Plan" to the parks and has initiated environmentally sensitive practices and recycling to the Western Region parks including Pacific Rim Park. Initiatives at Pacific Rim Park include the "green team" which is made up of staff members who decide what environmentally sensitive practices the park can

undertake. To date, the park has begun recycling oil and paper and uses recycled paper.

The efforts begun at Pacific Rim Park by its "green team" are laudable as are the two specific recommendations regarding global change put forward by the Report of the Science and Protection Task Force which urge greater linkage with agencies monitoring global change (e.g. Forestry Canada) and to incorporate up-to-date information on global change into the Western Region parks' management of park resources. However, like the park staff members who questioned the viability of a biosphere reserve at Pacific Rim Park due to lack of staff, one wonders how park staff will be able to implement these two recommendations given the present staffing and funding levels at the park.

5.4 Summary: Agencies Responsible For Threats To Pacific Rim National Park Reserve, British Columbia

The research conducted in Chapter five generally concludes the following:

1) a low level of knowledge of external threats possessed by agencies responsible for those threats;

2) a low level of communication between Pacific Rim Park staff and agencies responsible for external threats;

3) several opportunities for mitigation of some external threats through *ad hoc* arrangements between the park and outside agencies.

The low level of knowledge concerning external threats to Pacific Rim Park is exemplified by forestry operations adjacent to the park boundaries. The two major operators, MacMillan Bloedel Limited and Fletcher Challenge Canada, claim they have knowledge of only four of 19 external threats park staff say are being caused by the two operators (see section 5.1.1).

The problem of low levels of knowledge of external threats by agencies such as MacMillan Bloedel and Fletcher Challenge is unlikely to significantly improve unless there are increased levels of communication between them and Pacific Rim Park staff. An example of this is the complete lack of contact between the two provincial government agencies responsible for the licensing of fish farms and Pacific Rim Park. This seems inappropriate due to the park's concerns over the proliferation of fish farms in Tofino Inlet (see section 5.2.4).

Mitigation of some external threats described in Chapter five would be possible, and this has been discussed in some detail. However, there are complications involved if staff at Pacific Rim Park attempt to carry out mitigative measures on a threat-by-threat, agency-by-agency basis. First, there is a lack of staff qualified to do so. Even if the park possessed staff with adequate knowledge of both the specific threat and agency responsible, it is unlikely the park would be able to divert staff from other park duties to liaise with outside agencies. Second, there are many agencies the park would have to liaise with, which be a time consuming proposition.

Mitigation of external threats not only depends on Pacific Rim Park, however, it also depends on the outside agencies. Another possible impediment to the mitigation of some external threats is the attitude some agencies have toward the park. Several agencies appear to feel the park is a "newcomer" in the area and as such, apparently occupies a more lowly position when compared to traditional resource industries such as timber harvesting and commercial fishing. Phrases such as "Johnny come lately" and "the new kid on the block" were used to describe the park by some agencies. The park is sensitive to this perception and for this reason, does not want to further alienate

some of these outside agencies. Some park staff suggested they have "more softball games and barbeques" with various agencies to improve relations.

It would seem unlikely that "more softball games and barbeques" is the answer to mitigating external threats to Pacific Rim Park. Many of the land use decisions regarding areas near the park boundaries are made far away from the park and outside the influence of any "down home hospitality" the park may be able to generate. It would appear, therefore, that any comprehensive attempt at mitigation must involve a broader vision of land use (and marine use) in areas adjacent to the park.

CHAPTER SIX - CONCLUSION

The purpose of this thesis is to describe external threats to Pacific Rim Park Reserve as perceived by the park managers and to assess the level of knowledge concerning the external threats of those agencies identified as the source(s) of the external threat(s), and to assess the level of communication between park staff and the agencies identified as the source of the threat(s). Finally, recommendations for mitigation of external threats have been provided where possible. However, as alluded to at the conclusion of Chapter five, current opportunities for mitigation are only *ad hoc* arrangements between the park and individual agencies. There is no broad, comprehensive strategy for dealing with the problems of external threats to the park. The following discussion examines a broader based solution to the external threats problem at Pacific Rim Park.

The research conducted for this thesis shows that a major impediment to mitigating external threats to Pacific Rim Park is the fact that the park has little influence beyond its administrative boundaries. The primary reason the park has little influence beyond its administrative boundaries appears to be institutional arrangements (e.g. see section 5.1.1 regarding forestry operations), whereby established patterns of resource development and resource management decision-making evolved and became established in the region before the park existed. It has been difficult for the park to "break into" this established pattern. A good example is the failure of the Ministry of Crown Lands and the Ministry of Agriculture and Fisheries to place the park on its referral list for fish farm applications which are located more than one kilometre

from the park boundaries (see section 5.2.4). Several times, as mentioned previously in the thesis, the park has been referred to as "the new kid on the block", thus reinforcing the notion that simply because the park has only existed since 1971 it should have little say in resource development and management in the region.

Compounding the problem of being identified as "the new kid on the block", is the failure of some agencies to appreciate and understand the purpose of a national park such as Pacific Rim Park. An example is the Alberni-Clayoquot Sound Regional District (ACSRD) which has planning jurisdiction in the region. The ACSRD believes that the park is so large that it "provide[s] it own buffer" (see section 5.1.2). When probed on this, the ACSRD believed that the Long Beach recreational area was far enough away from the northern boundary of the park that visitors would not be affected by development near the northern boundary. The only national park value this view takes account of is the recreational value of the park, and does not reflect the many other values national parks are legislated to protect. Canada's *National Parks Act* (R.S., c. 189, s. 1) regulations, and policy specifically identifies the biophysical resources of air, water, flora, fauna and soil to be protected, and the *National Parks Act* (R.S., c. 189, s. 4) states that parks are:

> dedicated to the people of Canada for their benefit, education and enjoyment, subject to this Act and the regulations, and the national parks shall be maintained and made use of so as to leave them unimpaired for the use of future generations.

The International Union for Conservation of Nature (IUCN) defines additional values to be protected in national parks. The IUCN states that national parks should:

> protect natural and scenic areas of national or international significance for scientific, educational, and recreational use. [They] should perpetuate in a natural state representative samples of physiographic regions, biotic communities and genetic resources, and species in danger of extinction to provide ecological stability and diversity (IUCN 1984: 49).

Clearly, there are values to be protected in a national park other than recreational values. In fact, it has been Canadian Parks Service policy since 1979 to give preservation of resources precedence over recreation in its management strategy for national parks. It is obvious from the research that this message is not getting out to agencies outside the boundaries of Pacific Rim Park. This raises the question: how can Pacific Rim Park articulate its purpose and the values it is legislated to protect?

6.1 Beyond Park Boundaries: The Possible Long-Term Mitigation and Prevention Of External Threats To Pacific Rim National Park Reserve

The literature reviewed for this thesis has shown that external threats are penetrating national park boundaries worldwide and causing damage to park resources inside those boundaries. The research for this thesis has shown a similar pattern at Pacific Rim National Park Reserve. The growing awareness of the external threats phenomenon has sparked research into ways of not only mitigating the effects of external threats, but of ways of preventing them (see section 2.6.4). This section suggests a possible long-term solution to external threats at Pacific Rim Park.

The Boundary Model theory (BM) identifies the legal boundary of a protected area as the "administrative boundary." Further, the BM identifies a natural ecological boundary as the "ecological edge" (Schonewald-Cox and

Bayless 1986).[36] The ideal situation, in terms of maximizing protection, occurs when the administrative boundary coincides with the ecological edge. Rarely, however, does the ideal situation occur. Most national parks do not have administrative boundaries that coincide with natural ecological edges (see e.g. Newmark 1985) which has resulted in the penetration of adverse external threats across park boundaries. As a result of this penetration, Schonewald-Cox and Bayless (1986) suggest a "generated edge" is established which forms a new human-induced ecological edge inside the park boundary. An example of a generated edge inside a park boundary would be clear-cut forests visible inside Pacific Rim National Park in the vicinity of Wickaninnish Centre.[37]

Boundary Model research also suggests that a protected area's area-to-perimeter (a/p) ratio is important regarding the degree of protection afforded of particular reserves (see section 2.6.4). In the case of Pacific Rim Park, the area-to-perimeter ratio is 500 square kilometres/240 kilometres, for a ratio of 2.08:1. For a protected area the size of Pacific Rim Park to have the maximum amount of protection using the area-to-perimeter rule (which would have to be a circular shape), the a/p ratio would be 500 square kilometres/79 kilometres, for a ratio of

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36 The term "ecological edge" as used by Schonewald-Cox and Bayless (1986) is similar to the term "biotic boundary" used by Newmark (1985). Newmark (1985), however, was using the term to describe the amount of land necessary to maintain a "minimum viable population" of some fauna - generally large mammals such as grizzly bears. The point is, both Schonewald-Cox (1986) and Newmark (1985) have underlined the importance of identifying some form of ecological boundary in order to understand how to best preserve and maintain protected species.

37 Large clear-cut areas of forest on Salmonberry Mountain and Mounts Frederick and Ozzard are visible east from Pacific Rim National Park Reserve Headquarters, near Wickaninnish Centre. Several park staff mentioned negative comments regarding the clear-cuts from visitors to the park. This constitutes a threat to aesthetic values in the park (see also Dearden 1988).

6.33:1. The low a/p ratio for Pacific Rim Park is further evidence of its vulnerability to external threats.

Boundary Model research is still in its infancy and although most of its research is devoted to describing locations of breakdowns in park boundaries and the identification of generated edges, it does have something to say concerning prevention of damage to protected areas such as national parks from external threats. BM research suggests that management techniques which succeed in moving the generated edge back to or beyond the administrative boundary of a park, will maximize protection of resources inside the boundary. BM research recommmends, in most cases, a management technique that creates and maintains a buffer zone surrounding the park boundaries as the best method to maximize park protection. Once the need for creating a buffer zone around a national park is established, two questions arise:

1. What area around the national park should serve as the buffer zone? (Specifically, how much area and how should the buffer zone boundaries be established?);

2. How should the buffer zone be managed? (i.e. Is there a marine and/or land use designation currently available that could be applied?).

To answer the first question, the literature shows there has been some research into how to establish buffer zone boundaries. One concept, recently developed by the United States National Park Service (USNPS), is known as the Watershed Approach (WA). While not specifically developed to determine buffer zone boundaries, the WA is a technique designed to assess and monitor the long-term effects of both natural and anthropogenic changes that occur

inside and outside a national park's boundaries. Furthermore, the WA recognizes that administrative boundaries of national parks do not necessarily protect resources inside the park, particularly if the park happens to occupy only a part of a watershed. The USNPS states that the WA is:

> a program [that] has been developed that recognizes water, as an integrator, transporter, solvent and as an organically and inorganically active substance, common to all ecological systems and common to many resource problems (Herrmann and Stottlemyer 1990: 20).

Establishing the rationale above, the USNPS then explains how it delineates the study area;

> NPS is faced with a number of park-specific issues of both internal and external origin and a number of general problems of a regional or global nature. These issues have immediate and long-term potential to affect integrity and management of park watersheds. Water and many ecological issues are most conveniently studied and best managed within the theoretically confined system -- the watershed. This unit is more easily comprehended than the generic term "ecosystem" (Herrmann and Stottlemyer 1990: 20).

Other researchers have used the watershed to determine ecosystem boundaries. Newmark (1985), for example states: "Practically, the biotic boundaries [of a national park] are defined as those hypothetical boundaries encompassing the entire watershed of a park..." (p. 197 - for more details on Newmark's research see section 2.4). Bormann and Likens (in Cooke and Doornkamp 1974) utilized the drainage basin as a suitable evaluation unit for assessing ecosystem processes and sucessfully quantified input-output relationships within and ecosystem in the White Mountains of central New Hampshire.

Figure 9 shows the approximate boundaries of a buffer zone around Pacific Rim Park based on a watershed approach. In attempting to apply buffer zone boundaries to Pacific Rim Park based on a watershed approach, it must be kept in mind that Pacific Rim Park has not only a terrestrial component, but also a marine component. The watershed is obviously not applicable to the marine environment, therefore, no attempt is made to determine buffer zone boundaries for the marine portion of Pacific Rim Park. The map (figure 9) illustrates the finite boundaries (divides or watersheds) of all the catchment areas (drainage basins) that have a channelway or valley floor[38] (e.g. river, stream, creek) that enter Pacific Rim National Park. The approximate area contained within the watershed boundary of the park is 6,920 square kilometres, or approximately 14 times the size of Pacific Rim Park.

Once the boundary lines of a buffer zone are established, the next question becomes: How the can the buffer zone be managed? One such method, reviewed in section 2.6.3 of the thesis, is the Biosphere Reserve designation. There are several positive reasons for selecting this designation for a buffer zone around Pacific Rim Park:

1. There already exist 283 Biosphere Reserves worldwide, six of which are in Canada. The designation is recognized by 72 member states of UNESCO and has had some success in managing lands about a preserved "core area" (Canadian Commission for UNESCO 1990).

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[38] This description of watershed units is based on Hack and Goodlet (in Cooke and Doornkamp 1974) who divide the components of a drainage basin into five components: nose, side slope, hollow, foot slope and channelway or valley floor.

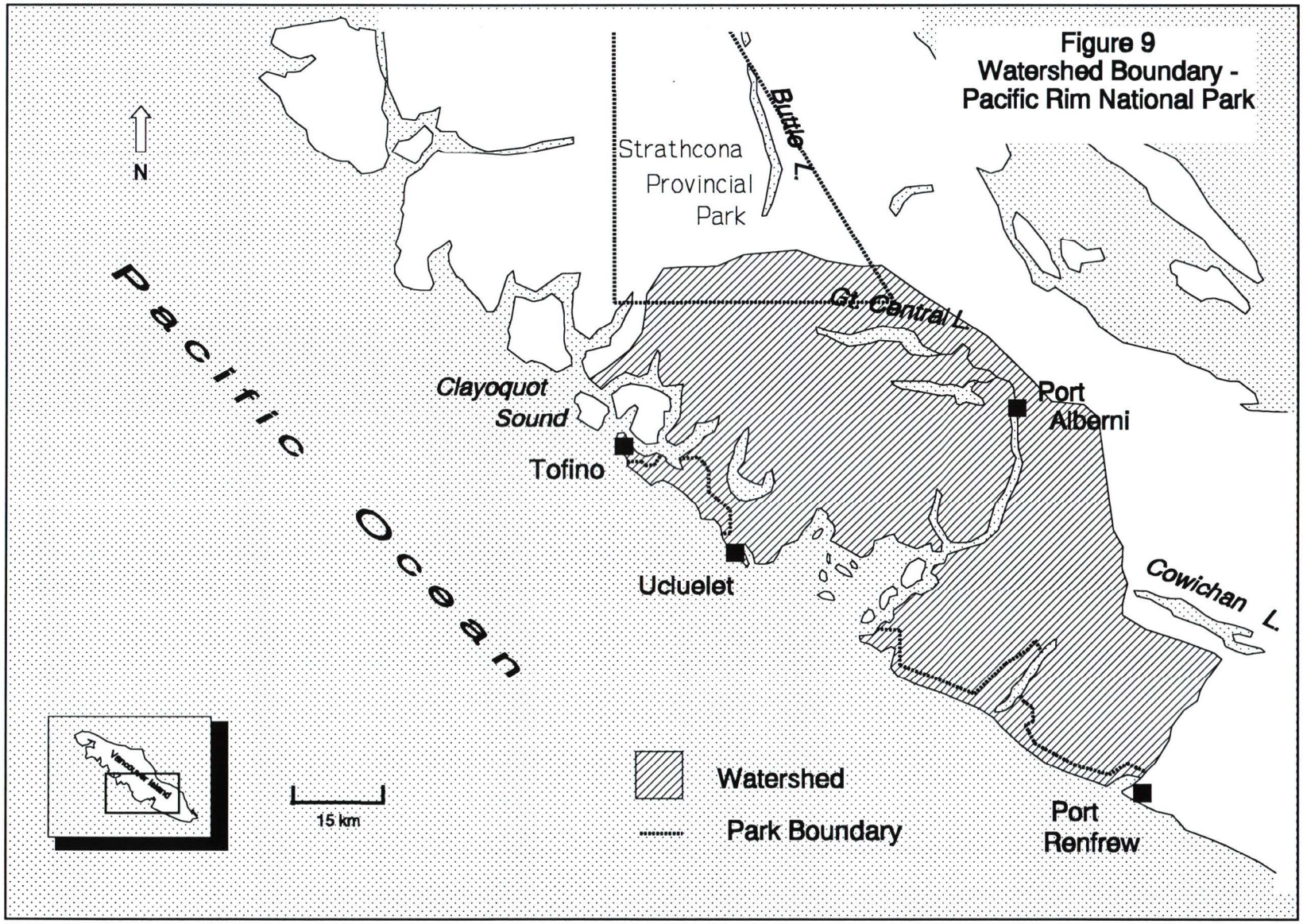
Figure 9
Watershed Boundary -
Pacific Rim National Park
N
Strathcona
Provincial
Park
Buttle L.
Gt. Central L.
Pacific Ocean
Clayoquot
Sound
Tofino
Ucluelet
Port
Alberni
Cowichan L.
Port
Renfrew
15 km
Watershed
Park Boundary

2. Biosphere Reserve status is a United Nations designation and therefore is not "controlled" by an agency that has a current resource interest in the area - it can be seen as a "neutral broker" in a cooperative management arrangement.

3. Biosphere Reserve status costs little money because it is operated primarily by volunteers.

4. Biosphere Reserves tend to attract more research interest than national parks - in a study of research being conducted at U.S. national parks by Mack, et. al. (1983), it was found that a significantly higher number of research projects were located at U.S. national parks that were designated Biosphere Reserves. This could certainly be of benefit to Pacific Rim Park because of the extreme lack of scientific research completed in the park.

5. Biosphere Reserve designation for Pacific Rim Park could also aid park staff in articulating the purpose and the values the park seeks to protect to neighboring agencies because of the world recognized stature of the program (see e.g. Dearden 1988).

The Biosphere Reserve designation may not be a panacea for the external threats problem at Pacific Rim Park, but it could lead to some positive changes in the way land use issues are handled in the region. The success of the Waterton Lakes Biosphere Reserve, which designates Waterton Lakes National Park, Alberta as its core area is evident in the following:

> The Waterton experience has shown that the biosphere reserve designation can be very useful to a National Park setting by strengthening its conservation mandate. The emphasis placed on cooperation has at the local and provincial levels begun to break down the "we-they" attitude which existed between the Park and its neighbours. The Park is in fact being reintegrated into its surroundings and this process ccan only serve to

> increase its long-term viability by building up a stronger base of support (Lieff 1985a: 43).

In summary, the benefits of a Biosphere Reserve designation for Pacific Rim National Park Reserve and the area indicated in figure 10 are:

1. Land use decisions made in the Biosphere Reserve would take into account any possible adverse effects on the park.

2. There would most likely be an increase in the amount of scientific research done in both the park and in buffer zone area.

3. An increase in the stature of the park and, therefore, a greater opportunity to educate neighboring agencies of the important functions (values) fulfilled by national parks.

6.2 The Future of Pacific Rim National Park Reserve

Several staff interviewed at Pacific Rim Park feared the intensity of external threats to the park would increase in the future. Reasons for this include:

1. Increasing population levels on Vancouver Island and the lower mainland of British Columbia will result in increasing pressure for recreation property adjacent to the park;

2. While there is hope that scientific and technological advances may lessen the threat of offshore oil spills and degradation from logging, it is feared that the chronic, long-term effects of past, current and future practices could have severe deleterious effects on park resources;

3. The lack of scientific data concerning such things as fish populations (and sound knowledge of other biota) will continue to make it difficult for park staff to properly manage the resources the park should protect;

4. The continued low profile of the park in terms of its relations with surrounding agencies will relegate the park to "second-class citizen" status, resulting in the park having little say in matters beyond it boundaries.

5. The possibility of devastating losses to the park's land area (e.g. beaches and escarpments) if global warming causes a significant rise in sea level.

In other words, the future prospects for Pacific Rim National Park Reserve, at least in the minds of most of the staff, are not particularly optimistic ones. Some staff even suggest that designating Pacific Rim as a national park is a mistake because there is no way it can ever fulfill its mandate due to its small size, and therefore is not truly representative of the biome it has been selected to protect. Regardless of whether this last suggestion is accurate, external pressures on the park are most likely to increase in the future. Without a buffer zone of some type to shield the park from these increasing pressures, Pacific Rim National Park Reserve probably will not be able to adequately protect the resources inside its boundaries "unimpaired for the use of future generations" (*National Parks Act* - R.S., c. 189, s. 4).

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APPENDIX I

SOURCE	THREAT	SUB-SYSTEM THREATENED	TEMPORAL	SPATIAL
		MARINE THREATS		
MARINE TRANSPORT:				
1. Nestucca oil spill	chemical pollution	water (documented)	?	All 3 units
		vegetation (documented)	?	All 3 units
		fauna (documented)	?	All 3 units
		soil (documented)	?	All 3 units
		aesthetic (suspected)	?	All 3 units
2. Containers of unknown toxic chemicals washed up onshore	chemical pollution	water (suspected)	?	All 3 units
		vegetation (suspected)	?	All 3 units
		fauna (suspected)	?	All 3 units
		soil (suspected)	?	All 3 units

SOURCE	THREAT	SUB-SYSTEM THREATENED	TEMPORAL	SPATIAL
3. Treated logs washing up onshore	chemical pollution	water (suspected)	?	All 3 units
		vegetation (suspected)	?	All 3 units
		fauna (suspected)	?	All 3 units
		soil (suspected)	?	All 3 units
4. Oil leakage from old shipwreck (Vanlene)	chemical pollution	water (suspected)	?	Austin I., BGI
5. discharge of oil and gasoline	chemical pollution	water (suspected)	slightly	All 3 units
		aesthetic (suspected)	slightly	All 3 units
6. All offshore traffic (shoreline)	litter	aesthetic (documented)	?	All 3 units
7. Tour boats	harassament of fauna	fauna (suspected)	?	All 3 units

SOURCE	THREAT	SUB-SYSTEM THREATENED	TEMPORAL	SPATIAL
8. Bulk freighters	styrofoam beads blow onshore in large quantities	aesthetic (documented)	?	LBU (suspected in all 3 units)
		fauna (suspected)		
9. Bulk log carriers	clean up of loss of cargo onshore	aesthetic (documented)	?	Long Beach, LBU
		soil (documented)	?	Long Beach, LBU
10. Large amount of offshore traffic	threat of future spills of oil, chemicals, fuel	water (suspected)	?	All 3 units
		fauna (suspected)	?	All 3 units
COMMERCIAL FISHING:				
1. Overfishing of Dungeness crab	legal removal	fauna (suspected)	?	All 3 units
2. Redsnapper dragnet fishery	legal removal	fauna (suspected)	?	All 3 units

SOURCE	THREAT	SUB-SYSTEM THREATENED	TEMPORAL	SPATIAL
3. "New fisheries" (herring roe net, Nitinat chum, sockeye salmon net, Juan de Fuca pink, turban snails, hagfish, butterclams, geoducks, gooseneck barnacles, horse clams, scallops, sea cucumbers, sea urchins)	legal removal	fauna (suspected)	?	All 3 units
4. Seaweeds, kelps	legal removal	vegetation (suspected)	?	All 3 units
		fauna (suspected)	?	All 3 units
5. Some offshore traffic	shooting sea lions noise pollution	fauna (documented)	?	All 3 units
		aesthetic (suspected)	?	All 3 units
SPORT FISHING:				
1. Area promoted as world class sport-fishing destination [Hot spots: Owen Island, Cape Beale, Nitinat, area north of Tofino]	legal removal	fauna (suspected)	?	All 3 units

SOURCE	THREAT	SUB-SYSTEM THREATENED	TEMPORAL	SPATIAL
2. Fishing camps: Owen Island, Effingham Inlet, Tzartus Island	legal removal	fauna (suspected)	?	All 3 units
	organic/inorganic pollution	water (suspected)	?	All 3 units
3. Over-fishing of rockfish and bottomfish	legal removal	fauna (suspected)	?	BGI, Box Island (LBU)
4. Overfishing of sport crab fishery	legal removal	fauna (suspected)	?	Grice Bay, Nitinat L. Long Beach
5. Fishing boats	litter	fauna (suspected)	?	All 3 units
		aesthetic (suspected)	slightly	All 3 units
FISH FARMS:				
1. Accumulation of feces and feed under pens	organic pollution	water (suspected)	?	All 3 units (marine)
		vegetation (suspected)		
		fauna (suspected)		
2. Transference of disease from farmed fish to native stocks	disease	fauna (suspected)	?	All 3 units (marine)

SOURCE	THREAT	SUB-SYSTEM THREATENED	TEMPORAL	SPATIAL
3. Fish farmers shooting predators near pens	illegal removal	fauna (suspected)	?	All 3 units
OTHER:				
1. Disease (Leptospirosis) to sealions contracted from sealions from California	disease	fauna (documented)	?	All 3 units
2. Poaching of shellfish	poaching	fauna (suspected)	?	LBU
3. General over-harvesting of flora and fauna in the ocean just offshore	Damage to ecosystem	fauna (suspected)	?	All 3 units
	[Loss of diversity]	vegetation (suspected)	very serious	All 3 units

TERRESTRIAL THREATS

FORESTRY OPERATIONS:				
1. Slash burning	smoke	air (documented)	10 days/yr	All 3 units
		aesthetic (suspected)	?	All 3 units

SOURCE	THREAT	SUB-SYSTEM THREATENED	TEMPORAL	SPATIAL
2. Pulp mill-Port Alberni	odor	air (suspected)	?	?
		aesthetics (suspected)	?	?
	chemical pollution	water (suspected)	?	BGI
3. Adjacent logging	debris in streams (including log jams)	water (suspected)	?	WCT, LBU
		fauna (suspected)	?	WCT, LBU
	silt/sediment in streams	water (suspected)	?	WCT, LBU
		fauna (suspected)	?	WCT, LBU
	stream temp. changes	water (suspected)	?	WCT,LBU
		fauna (suspected)	?	WCT, LBU
	changes in stream morphology	water (suspected)	?	Sandhill Cr.
		soil (suspected)	?	Sandhill Cr.

SOURCE	THREAT	SUB-SYSTEM THREATENED	TEMPORAL	SPATIAL
	flooding	vegetation (suspected)	?	WCT,LBU
	herbicide use	water (documented)	?	WCT,LBU (streams)
		vegetation (suspected)	?	WCT,LBU (streams)
		soil (suspected)	?	WCT,LBU (streams)
	reduced biodiversity	vegetation (suspected)	very serious	WCT,LBU
		fauna (suspected)	?	All 3 units
	loss of habitat	fauna (suspected)	very serious	All 3units
	damage to habitat	fauna (suspected)	?	?
	degradation of scenic	aesthetic (documented)	very serious	All 3 units

SOURCE	THREAT	SUB-SYSTEM THREATENED	TEMPORAL	SPATIAL
	views			
	logging roads close to park (uncontrolled access)	fauna (suspected) aesthetic (suspected)	very serious	WCT,LBU
	noise from logging	aesthetic (suspected)	?	WCT (near P. Renfrew)
	noise from booming grounds	aesthetic (suspected)	?	LBU, WCT
	drift logs on shore	soil (suspected)	?	All 3 units
		vegetation (suspected)		
	illegal removal of trees	vegetation (documented)	very serious	WCT
	decreased levels of water in streams in summer	administration (suspected)	?	LBU
LIGHT STATIONS:				
1. Dumping of oil or fuel into ocean	odor	air (suspected)	?	WCT
	chemical pollution	water (suspected)	?	WCT
2. Seepage of sewage into ocea	odor	air (suspected)	?	WCT
		aesthetic (suspected)	?	WCT

SOURCE	THREAT	SUB-SYSTEM THREATENED	TEMPORAL	SPATIAL
	organic pollution	water (suspected)	?	WCT
RESIDENTIAL/URBAN				
1. Wood burning stoves in Tofino and Ucluelet	smoke	air (suspected) aesthetic (suspected)	?	?
2. Land clearing near Tofino Airport	smoke	air (suspected) aesthetic (suspected)	?	?
3. Runoff from Tofino A.	chemical pollution	water (suspected)	?	Esowista Cr., LBU
4. Emmissions from large urban centres (Seattle, Vancouver, Victoria)	air pollution (acidic precipitation)	air (suspected) water (suspected)	?	All 3 units
5. Effluent from Ucluelet Inlet and Tofino	organic/inorganic pollution	water (suspected)	?	BGI, LBU

SOURCE	THREAT	SUB-SYSTEM THREATENED	TEMPORAL	SPATIAL
		fauna (suspected)	?	BGI, LBU
		aesthetic (suspected)	?	BGI, LBU
6. Use of fertilizers and pesticides at Tofino golf course	chemical pollution (Esowista Creek)	water (suspected)	?	Esowista Cr., LBU
7. Golf course construction and possible future expansion to 18 holes	sediment in water	water (suspected)	?	Esowista Cr., LBU
	exotics	vegetation (suspected)	?	" "
8. Development of residential homes in Toquart Bay	sediment in water	water (suspected)	?	BGI
9. Poaching of X-mas trees by local residents	illegal removal	vegetation (suspected)	slightly	LBU

SOURCE	THREAT	SUB-SYSTEM THREATENED	TEMPORAL	SPATIAL
10. Release of domestic cats and dogs in park	exotic fauna	fauna (suspected)	?	LBU
11. Pressure on park from growth of Tofino, Ucluelet, Chesterman Beach	residential encroachment	aesthetic (suspected)	?	All 3 units
12. Landfill fires	smoke	air (documented)	?	LBU
		aesthetic (suspected)	?	LBU
13. Leachate from landfill	chemical pollution	water (documented)	?	Sandhill Cr., LBU
		vegetation (documented)	?	Sandhill Cr., LBU
		fauna (suspected)	?	LBU
		soil (suspected)	?	Sandhill Cr., LBU
14. Garbage at landfill	poaching	fauna (documented)	?	LBU

SOURCE	THREAT	SUB-SYSTEM THREATENED	TEMPORAL	SPATIAL
INDIAN RESERVES:				
1. Dumping of sewage near airport from Esowista IR 3	organic pollution	water (suspected)	?	Esowista Cr., LBU
2. Indians intent to log reserve on WCT	legal removal	vegetation (suspected)	very serious	WCT
		fauna (suspected)	?	WCT
		aesthetic (suspected)	?	WCT
		soil (suspected)	?	WCT
3. Native land claim	alteration of park boundary and/or management arrangement	administration (suspected)	?	All 3 units
4. Location of Esowista Reserve (IR 3)	noise	aesthetic (documented)	?	Schooner Cove
	harassment of fauna	fauna (documented)	?	" "

SOURCE	THREAT	SUB-SYSTEM THREATENED	TEMPORAL	SPATIAL
5. Possibility of development at all reserves	noise	aesthetic (suspected)	?	All 3 units
	pollution	water (suspected)	?	All 3 units
6. Threat to block WCT	disruption of hiking trail	administration (suspected)	?	WCT
7. Possibility of court order to prevent gazetting if Natives not allowed to develop reserves	prevention of gazetting	administration (suspected)	?	All 3 units
OUTSIDE AGENCIES:				
1. Fertilization of Hobitan and Kennedy Lakes (WCT,LBU) by DFO	organic pollution	water (documented)	?	Hobitan, Kennedy Lks.
		fauna (suspected)	?	WCT,LBU
		vegetation (suspected)	?	WCT,LBU

SOURCE	THREAT	SUB-SYSTEM THREATENED	TEMPORAL	SPATIAL
2. Placing and removal of underground gasoline storage tanks by DND	chemical pollution	soil (suspected)	?	LBU
		water (suspected)	?	LBU
3. Blasting by DND gunnery practise offshore	noise pollution	aesthetic (suspected)	?	All 3 units
MINING:				
1. Tailings in ocean from abandoned magnetite mine in Toquart Bay	chemical pollution	water (suspected)	?	BGI
		fauna (suspected)	?	BGI
CANADIAN PARKS SERVICE POLICY:				
1. Allowance of some fisheries in the park which predate park establishment	legal removal	fauna (suspected)	?	All 3 units

SOURCE	THREAT	SUB-SYSTEM THREATENED	TEMPORAL	SPATIAL
2. Lack of national park status because not gazetted	lack of clearly defined boundaries	All subsystems (suspected)	?	All 3 units
	lack of enforcement authority	All sub-systems (suspected)	?	All 3 units
3. Insufficient funding for research	Lack of research information	All sub-systems (suspected)	?	All 3 units
4. Insufficient funding for enough personnel	Not enough personnel	All sub-systems (suspected)	?	All 3 units
5. Insufficient funding for staff training	Inadequate training	All sub-systems (suspected)	?	All 3 units

RECREATION:

SOURCE	THREAT	SUB-SYSTEM THREATENED	TEMPORAL	SPATIAL
1. Over-use of one area ("Toquart City")	noise	aesthetic (suspected)	?	BGI
	organic pollution	water (suspected)	?	BGI
2. Low flying aircraft (sightseeing)	harassment of fauna	fauna (suspected)	?	All 3 units
	noise	aesthetic (suspected)	?	All 3 units
3. Development of recreation facility in Effingham Bay	Over-use in one area of park	water (suspected)	?	BGI
		fauna (suspected)	?	BGI
OTHER:				
1. General over-harvesting of flora and fauna in the adjacent terrestrial areas	Damage to ecosystem [Loss of diversity]	fauna (suspected)	?	All 3 units
		vegetation (suspected)	very serious	All 3 units
2. Highway noise along Pacific Rim Highway	Noise pollution	aesthetic (suspected)	?	LBU

SOURCE	THREAT	SUB-SYSTEM THREATENED	TEMPORAL	SPATIAL
3. Disease survey of forests in park (John McIntosh CFS)	disease	vegetation (??????)	?	?
4. Poaching of deer near park boundary	poaching	fauna (suspected)	?	WCT,LBU
5. Introduction of field mice into BGI (Cowan Gulguett)	exotics	fauna (suspected)	?	BGI
		vegetation(suspected)	?	BGI
6. Introduction of various faunas and vegetation into park	exotics	fauna (suspected)	?	All 3 units
		vegetation (suspected)	?	All 3 units
7. Guidebooks which do not have park endorsement	harrassment of fauna	fauna (suspected)	?	BGI
	illegal removal (middens)	cultural (suspected)	very serious	All 3 units

SOURCE	THREAT	SUB-SYSTEM THREATENED	TEMPORAL	SPATIAL
NATURAL:				
1. Red tide	organic pollution	water (suspected)	?	All 3 units (marine)
2. Animal feces in fresh water	organic pollution	water (suspected)	?	WCT,BGI
3. Harsh natural environment (high winds and precip. and salt spray)	----------	vegetation (suspected)	?	All 3 units
4. Tsunamis	erosion	soil (suspected)	?	All 3 units
		fauna (suspected)	?	All 3 units
		vegetation (suspected)	?	All 3 units
5. Earthquakes	?	?	?	All 3 units
6. Climate change	rise in sea level, ocean warming, change in ocean currents	?	?	All 3 units

APPENDIX II

DEFINITIONS OF THREAT CATEGORIES

Threats to Air:

1. Smoke - volatilized products of burning substances such as wood, coal or other substances visible in the air.

2. Dust - matter reduced to particles so fine as to be easily borne and visible in the air.

3. Chemical pollution - contamination of the air by chemicals.

4. Reduction of visibility - reduction in the clarity of unaided vision as affected by atmospheric conditions (cause may be either natural or human-produced.

5. Odors - a substance that renders itself perceptible to the sense of smell. [Note: for purposes of classification this was also considered a threat to the aesthetic resources of the park].

6. Other - anything not included in the above.

Threats to Water:

1. Organic or inorganic pollution - contamination of water by compounds derived from plants or animals, or by compounds containing carbon (organic), or contamination of water by compounds not containing carbon except those of carbonates, carbides and most cyanides (inorganic).

2. Blocking of river or streamflow - organic debris or other material in a water course which affects the flow of water.

3. Silt or sediment in water - abnormal amount of this material in water.

4. Water temperature changes - abnormal increases and/or decreases in water temperatures.

5. Acidic precipitation - evidence of increased acidity in water due to acidic precipitation.

6. Other - anything not included in the above.

Threats to Vegetation:

1. Loss of vegetation - loss of vegetation from explained or unexplained circumstances.

2. Inadequate supply of water - resulting in problems for vegetation and animals (including humans).

3. Fire - problems resulting from both human-caused and naturally occurring fires.

4. Fire suppression - has this activity caused problems in the park? (e.g. build-up of organic debris).

5. Flooding - damage to vegetation caused by flooding.

6. Chemical pollution - contamination of vegetation by chemicals (could be either air or waterborne or both).

7. Non-native plants (exotics) - do non-native plant species exist and are they causing problems for native plants in the park?

8. Illegal removal of vegetation (poaching) - is this occurring and is it a problem?

9. Disease - plant diseases affecting the health of plants in the park.

10. Insect pests - insect pests which may affect the health of plants in the park.

11. Other - anything not included in the above.

Threats to Fauna:

1. Loss of habitat - loss of habitat through natural or human-caused processes which may adversely affect fauna.

2. Legal removal (hunting or fishing) - endangering fauna by legal removal of some species (e.g. are some catch limits set too high?).

3. Illegal removal (poaching) - are some species being illegally removed and endangering their existence in the park?

4. Inadequate supply of water - is this causing problems for fauna?

5. Impacts of animals not native to the park (exotics) - damage to park resources by non-native animals which may adversely affect protected park fauna.

6. Fire - is this a threat to fauna in the park?

7. Disease - is disease a threat to fauna in the park?

8. Inadequate supply of food - is this a problem for fauna in the park?

9. Overpopulation of a species - is there evidence that one or more species of fauna in the park is overpopulated in terms of the park's carrying capacity for that particular species?

10. Underpopulation of a species - is there evidence that one or more species of fauna in the park is underpopulated for any reason?

11. Habitat change - a change in the habitat which has caused or may have adverse effects on fauna in the park.

12. Chemical pollution of habitat - contamination of habitat by chemicals, resulting in adverse effects on fauna in the park.

13. Other - anything not included in the above.

Threats to Soil:

1. Organic or inorganic pollution - contamination of soil by compounds derived from plants or animals, or by compounds containing carbon (organic), or contamination of soil by compounds not containing carbon except those of carbonates, carbides and most cyanides (inorganic). Pollutants may be either air or water borne.

2. Compaction of soil - is soil being compacted?

3. Erosion - is soil being eroded?

4. Inadequate cover of vegetation - is this resulting in losses of soil or having other adverse effects on soil in the park?

5. Loss of soil nutrients - is this occurring in the park? (e.g. leaching).

6. Other - anything not included in the above.

Threats to Cultural Resources:

1. Climate - is the climate damaging cultural resources in the park? (e.g. erosion of petroglyphs).

2. Damage by plants - are cultural resources being damaged by plants? (e.g. exotic plants over-running midden sites).

3. Damage by animals or insects - is this occurring in the park? (e.g. exotic animals digging up midden sites).

4. Vandalism - is this occurring in the park? (e.g. uncontrolled entry of humans into sensitive areas).

5. Damage by acidic precipitation - is this occurring in the park? (e.g. park buldings being eroded).

6. Inadequate security - has the lack of security led to damage of cultural resources?

7. Flooding - has flooding caused damage to cultural resources?

8. Other - anything not included in the above.

Threats to Management and Administration:

1. Lack of clearly defined park boundaries - has this resulted in damage to park resources? (e.g. illegal entry of hunters).

2. Not enough personnel - is a lack of park personnel having adverse effects on park resources? (e.g. inability to prevent illegal hunting).

3. Too many visitors - is this a problem in the park? [Note: this is primarily considered an internal threat but is included to determine if there are external forces which affect the number of visitors].

4. Unlawful visitor behaviour - is this a problem in the park? [Note: this is generally an internal threat but was included as a probe to determine whether there could be an external component].

5. Conflicting resource uses - resource uses outside the park boundary which may have adverse effects on park resources (e.g. clear-cut logging up to the park boundary).

6. Lack of enforcement authority - has this resulted in problems in the park? [Note: this was included to determine whether the park's lack of gazetting

has resulted in problems of enforcement , i.e. technically, the park cannot use the Park Act to protect its resources].

7. Lack of research information - has this led to problems in the park?

8. Inadequate training [of park personnel] - is this a problem in the park?

9. Other - anything not included in the above.

Other Threats [Note: this category is termed *aesthetic* in the thesis, where aesthetic is defined as: beauty in art and nature]:

1. Litter - is this a problem in the park?

2. Noise pollution - is noise intruding into the park? (e.g. the sound of chainsaws from nearby adjacent logging operations).

3. Degradation of scenic views - scenic views located outside park boundaries, visible from inside park boundaries being degraded. (e.g. areas of clear-cut logging visible to visitors inside the park).

4. Residential or industrial encroachment - are there problems to the park stemming from this type of development? (e.g. the sound of barking dogs).

5. Other - anything not included in the above.

APPENDIX III

THREATS TO PACIFIC RIM NATIONAL PARK RESERVE

Description	Number of Times Reported
Chemical pollution	14
Organic pollution	10
Legal removal	10
Noise	9
Illegal removal	8
Harassment of fauna	4
Smoke	4
Exotics	4
Erosion	3
Sediment in water	3
Odor	3
Reduction of biodiversity	3
Disease	3
Litter	3
Clean-up of lost cargo	1
Debris in streams	1
Stream temperature changes	1
Flooding	1
Loss of habitat	1
Damage to habitat	1
Degradation of scenic views	1
Uncontrolled access	1
Drift logs on shore	1
Decreased stream levels	1
Air pollution	1
Residential encroachment	1
Alteration of park boundary	1
Blockade of hiking trail	1
Prevention of gazetting	1
Lack of clearly defined boundaries	1
Lack of enforcement authority	1
Lack of research information	1
Not enough personnel	1
Inadequate training of personnel	1
Over-use in an area near park	1
Harsh natural environment	1
Rise in sea level	1
Total	104

APPENDIX IV

INTERVIEW FORMAT

This interview seeks to ascertain whether or not, or to what degree the protected park resources of Pacific Rim National Park are threatened by activities outside its boundaries (external threats). Threats are defined as:

> those conditions of either human or natural origin that cause significant damage to park resources, or are in serious conflict with the objectives of park administration and management.

In this interview, park resources are grouped into the following categories:

1. air
2. water
3. vegetation
4. fauna
5. soil
6. cultural resources
7. management and administration
8. other

[Note: The justification for the above categories (with the exception of #8) comes from national park legislation which specifically protects the above-mentioned park resources.]

1. AIR

[Air refers to the particles and layers of gases which surround the earth and make up its atmosphere. Examples of threats to air include smoke, dust and chemical pollution.]

- Are there threats to air in the park? (if not, go to next section - if yes, continue)

The following is a list of threats to air. Please indicate the following: a) **current status** (absent, suspected, documented, unknown); b) if the problem is suspected or documented, **where does it originate?** (inside park, outside park, both, unknown, if known, what is the specific source?); c) if the problem is suspected or documented **how serious is it** to air? (very serious, moderately serious, slightly serious, unknown*).

Threat	Current Status?	Origin?	Seriousness?
1 Smoke			
2 Dust			
3 Chemical pollution			
4 Reduction of visibility			
5 Odors			
6 Other			

- If any of the above threats are suspected or documented, do you have or are you aware of any study or other documentation concerning it?

- If any of the above threats are suspected or documented, are there any efforts at mitigation of it? If so, what are they? If not, do you have any suggestions for mitigation?

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* VERY SERIOUS - those threats which may cause damage to park ecosystems that might not be corrected within a human lifetime. MODERATELY SERIOUS - those threats whose effects may last a decade or more. SLIGHTLY SERIOUS - threats whose effects may last a period of a few years.

2. WATER

[Water is found in different natural forms such as lakes, rivers and oceans. The concern of this research are the effects of external threats upon ground and surface water found within the park boundary. Examples of this problem include organic or inorganic pollution, blocking of river or stream flow, increased sediment in water.]

- Are there threats to ground and/or surface water in the park? (if not, go on to next section - if yes, continue.)

The following is a list of threats to water. Please indicate the following: a) **current status** (absent, suspected, documented, unknown); b) if the problem is suspected or documented, **where does it originate**? (inside park, outside park, both, unknown, if known, what is the specific source?); c) if the problem is suspected or documented **how serious is it** to air? (very serious, moderately serious, slightly serious, unknown).

Threat	Current Status?	Origin?	Seriousness?
1 Organic or inorganic pollution			
2 Blocking of river or streamflow			
3 Silt or sediment in water			
4 Water temperature changes			
5 Acidic precipitation			
6 Other			

- If any of the above threats are suspected or documented, do you have or are you aware of any study or other documentation concerning it?

- If any of the above threats are suspected or documented, are there any efforts at mitigation of it? If so, what are they? If not, do you have any suggestions for mitigation?

3. VEGETATION

[Vegetation refers to living photosynthetic organisms (plants) such as trees and grasses, which can manufacture their own food from inorganic substances. Examples of threats to vegetation include loss of vegetation, inadequate water, fire, floods, chemical pollution, invasion of non-native (exotic) plants.]

- Are there threats to vegetation in the park? (if not, go on to next section - if yes, continue.)

The following is a list of threats to vegetation. Please indicate the following: a) **current status** (absent, suspected, documented, unknown); b) if the problem is suspected or documented, **where does it originate?** (inside park, outside park, both, unknown, if known, what is the specific source?); c) if the problem is suspected or documented **how serious is it** to air? (very serious, moderately serious, slightly serious, unknown).

Threat	Current Status?	Origin?	Seriousness?
1 Loss of vegetation			
2 Inadequate supply of water			
3 Fire			
4 Fire suppression			
5 Flooding			
6 Chemical pollution			
7 Non-native plants (exotics)			
8 Illegal removal of vegetation			
9 Disease			
10 Insect pests			
11 Other			

- If any of the above threats are suspected or documented, do you have or are you aware of any study or other documentation concerning it?

- If any of the above threats are suspected or documented, are there any efforts at mitigation of it? If so, what are they? If not, do you have any suggestions for mitigation?

4. FAUNA

[Fauna includes living non-photosynthetic organisms such as birds, mammals and fish which are unable to manufacture their own food from inorganic substances. Examples of threats to fauna include loss of habitat, hunting, poaching, inadequate water supply, disease, fire and inadequate food supply.]

- Are there threats to fauna in the park? (if not, go to next section - if yes, continue)

The following is a list of threats to fauna. Please indicate the following: a) **current status** (absent, suspected, documented, unknown); b) if the problem is suspected or documented, **where does it originate**? (inside park, outside park, both, unknown, if known, what is the specific source?); c) if the problem is suspected or documented **how serious is it** to air? (very serious, moderately serious, slightly serious, unknown).

Threat	Current Status?	Origin?	Seriousness?
1 Loss of habitat			
2 Legal removal (hunting or fishing)			
3 Illegal removal (poaching)			
4 Inadequate supply of water			
5 Impacts of animals not native to the park			
6 Fire			
7 Disease			
8 Inadequate supply of food			
9 Overpopulation of a species			
10 Underpopulation of a species			
11 Habitat change			
12 Chemical pollution of habitat			
13 Other			

- If any of the above threats are suspected or documented, do you have or are you aware of any study or other documentation concerning it?

- If any of the above threats are suspected or documented, are there any efforts at mitigation of it? If so, what are they? If not, do you have any suggestions for mitigation?

5. SOIL

[Soil refers to the loose mineral and organic material on the surface of the earth in which plants grow. Some examples of critical resource problems related to soil include erosion, compaction of soil, chemical pollutants, inadequate cover of vegetation and loss of nutrients.}

- Are there threats to soil in the park? (if not, go on to next section - if yes, continue.)

The following is a list of threats to soil. Please indicate the following: a) **current status** (absent, suspected, documented, unknown); b) if the problem is suspected or documented, **where does it originate?** (inside park, outside park, both, unknown, if known, what is the specific source?); c) if the problem is suspected or documented **how serious is it** to air? (very serious, moderately serious, slightly serious, unknown).

Threat	Current Status?	Origin?	Seriousness?
1 Organic or inorganic pollution			
2 Compaction of soil			
3 Erosion			
4 Inadequate cover of vegetation			
5 Loss of soil nutrients			
6 Other			

- If any of the above threats are suspected or documented, do you have or are you aware of any study or other documentation concerning it?

- If any of the above threats are suspected or documented, are there any efforts at mitigation of it? If so, what are they? If not, do you have any suggestions for mitigation?

6. CULTURAL RESOURCES

[Cultural resources refer to structures, buildings, sites and objects which are protected and maintained in the park because they have cultural or historical significance. Examples of threats to cultural resources include vandalism, theft, damage from natural forces, acidic precipitation.]

- Are there threats to cultural resources in the park? (if not, go on to next section - if yes, continue.)

The following is a list of threats to cultural resources. Please indicate the following: a) **current status** (absent, suspected, documented, unknown); b) if the problem is suspected or documented, **where does it originate?** (inside park, outside park, both, unknown, if known, what is the specific source?); c) if the problem is suspected or documented **how serious is it** to air? (very serious, moderately serious, slightly serious, unknown).

Threat	Current Status?	Origin?	Seriousness?
1 Climate			
2 Damage by plants			
3 Damage by animals or insects			
4 Vandalism			
5 Damage by acidic precipitation			
6 Inadequate security			
7 Flooding			
8 Other			

- If any of the above threats are suspected or documented, do you have or are you aware of any study or other documentation concerning it?

- If any of the above threats are suspected or documented, are there any efforts at mitigation of it? If so, what are they? If not, do you have any suggestions for mitigation?

7. MANAGEMENT AND ADMINISTRATION

[This category refers to services which are required to manage and administer all park resources. Examples of threats in this category include lack of clearly defined park boundaries, not enough personnel, too many visitors, unlawful entry of visitors.]

- Are there threats to management and administration in the park? (if not, go on to next section - if yes, continue.)

The following is a list of threats to management and administration. Please indicate the following: a) **current status** (absent, suspected, documented, unknown); b) if the problem is suspected or documented, **where does it originate**? (inside park, outside park, both, unknown, if known, what is the specific source?); c) if the problem is suspected or documented **how serious is it** to air? (very serious, moderately serious, slightly serious, unknown).

Threat	Current Status?	Origin?	Seriousness?
1 Lack of clearly defined park boundaries			
2 Not enough personnel			
3 Too many vistors			
4 Unlawful visitor behaviour			
5 Conflicting resource uses			
6 Lack of enforcement authority			
7 Lack of research information			
8 Inadequate training			
9 Other			

- If any of the above threats are suspected or documented, do you have or are you aware of any study or other documentation concerning it?

- If any of the above threats are suspected or documented, are there any efforts at mitigation of it? If so, what are they? If not, do you have any suggestions for mitigation?

8. OTHER

[These are current problems which are not specific to any of the resource categories previously mentioned. Examples of "other" threats include litter, noise, odors, degradation of scenic views.]

- Are there other threats in the park? (if not, go on to next section - if yes, continue.)

The following is a list of other threats. Please indicate the following: a) **current status** (absent, suspected, documented, unknown); b) if the problem is suspected or documented, **where does it originate?** (inside park, outside park, both, unknown, if known, what is the specific source?); c) if the problem is suspected or documented **how serious is it** to air? (very serious, moderately serious, slightly serious, unknown).

Threat	Current Status?	Origin?	Seriousness?
1 Litter			
2 Noise pollution			
3 Degradation of scenic views			
4 Residential or industrial encroachment			
5 Other			

- If any of the above threats are suspected or documented, do you have or are you aware of any study or other documentation concerning it?

- If any of the above threats are suspected or documented, are there any efforts at mitigation of it? If so, what are they? If not, do you have any suggestions for mitigation?

THE FUTURE

[You have just reported on the threats currently affecting Pacific Rim National Park. What is your opinion regarding future threats?]

- Are there threats not currently affecting the park that are likely to in the future?

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Doyle, Stephen. 1988. "The Seven Sisters Mountain Range: A Case Study of a Conflict in Resource Management." *Environmental Essence.* Spring, 1988.

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February 20, 1992