THE DECLINING ROLE OF THE EARTH SCIENCES IN THE PLANNING, MANAGEMENT AND INTERPRETATION OF CANADA'S NATIONAL PARKS: IDENTIFICATION, DOCUMENTATION, POSSIBLE CAUSES, AND MEANS OF REVERSAL

by

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Abstract

This dissertation identifies a reduction which is currently occurring in the role of the earth sciences in the planning, management and interpretation of the national parks of Canada. Through the analysis of the Canadian National Parks Act, National Park Policies, Systems Plan and the Natural Resource and Visitor Activity Management Processes, as well as information on experience in the United States, New Zealand and other countries, it is shown that there is and has been a role for the earth sciences in the planning, management and interpretation of the parks. Case studies of ten management plans from nine parks indicated that the natural resource management functions at individual national parks rarely identified the earth sciences as high priority management concerns. Detailed case studies of Banff and the associated mountain parks (Yoho, Kootenay, Jasper), and Point Pelee National Park, along with interviews of park personnel, confirmed the findings that the earth sciences have never been afforded the same degree of management concern in the sample parks as have the biotic resources. The development of ecosystem-based management in response to the 1988 amendments to the National Parks Act has further reduced the role of the earth sciences, due largely, to the definition of ecological integrity as a biological concept. In contrast, interpretation messages developed in the 1970's included the earth science messages to the same degree as biotic messages. However, the increasing focus of interpretation on the communication of resource management goals has resulted in significant reduction of earth science messages. Indeed, in Point Pelee the earth sciences have been completely omitted from the message framework, while in Banff the 1993 ecosystem plan makes no reference to the earth sciences resources of the park. A number of explanations are suggested for this reduction, including the definition of ecological integrity as a biological concept, the lack of earth science expertise within the park system's staff, the engineering focus of earth science management, and the failure of academic geomorphologists to become involved in the identification of earth science measures of ecological integrity. The dissertation concludes with a number of recommendations aimed at reversing the decline of the earth sciences in the planning, management and interpretation of the national parks. Recommendations directed towards Parks Canada include developing a balance in the park staff and staffing structure through the identification of some positions as earth science specialists. This could be accomplished as part of the redefinition of the roles of wardens. Research and training partnerships were identified as other means of beginning to address the reduction. It is recommended that earth scientists take advantage of the opportunities in the developing field of natural areas management, and that they seek to identify meaningful earth science measures of ecological integrity. It is also recommended that earth scientists conducting research in the parks be encouraged to become involved in the management and planning process. The study develops and presents an interpretation program for Banff National Park which links some of the features and processes of the park to ecosystem-based management and education. Finally, the study identifies a significant new area for research and application of the earth sciences within the evolving field of parks and protected areas planning and management.

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CHAPTER 1

Introduction: The Problem and the Approach

The Problem

Parks and protected areas in Canada are currently undergoing significant changes in the manner in which they are managed (Dearden, 1991, Dearden and Rollins, 1994). Among the more prominent of these changes are: 1) newly defined roles for interpretation (Butler, 1994); 2) the evolution of resource management from preservation through protection and management to integrated management (Eidsvik, 1985, Dearden, 1991) and; 3) the changing role of science and research in the parks (Theberge, 1994). These changes are reflected in the 1988 amendments to the National Parks Act (Government of Canada, 1988) and in the revised Parks Canada Policy (Parks Canada, 1994).

National Parks represent the highest level of legislative protection afforded the natural environment in Canada and around the world. As such, national parks provide unique opportunities to manage, interpret, and study natural processes in relatively pristine conditions. Furthermore, national parks should serve as examples of the scientific management of natural resources, whenever such management is warranted. Indeed, if holistic science-based management is not done in national parks, it is highly unlikely it will be done in more developed areas. Thus national parks are models for the incorporation of earth science processes into ecologically sustainable parks, protected areas, and multiple use regions.

Management, interpretation and research also serve to conserve and communicate the core values or functions of national parks, and changes in these functions have the potential to affect significantly the very values they are intended to protect. Historically, there has been a well defined role for the interpretation of biological, geological, archeological, and historical features and processes in Canadian and other national parks. In keeping with this, research was often encouraged to support the interpretation and management of park resources in order to maintain natural processes. However, as will be shown in this dissertation, recent changes to the manner national parks are managed in

Canada have altered these relationships. And these changes have profound implications for the role of the earth sciences in park planning and management.

Indeed, the review of the literature indicates that the national parks of a number of nations recognize the important role the earth sciences play in the management, interpretation and research of national parks. These park systems, like Canada, identify the significance of the earth sciences in their broad mission statements. However, in some cases, Canada in particular, the role of the earth sciences is reduced in the actual interpretation and management of individual park resources. Furthermore, in Canada this reduction appears to be increasing as a result of a number of institutional changes affecting the park system. This reduced emphasis on the earth sciences is important because the national parks are the primary communicators of our nation's heritage and this heritage is, in part, the result of earth science processes. In addition, the earth sciences not only inform us about the past evolution of the landscape and biota, but are also a significant factor in contemporary evolution and development of biotic, abiotic and human landscapes.

The argument presented in this dissertation is that as a result of changes in Parks Canada legislation, policy, and perception, the earth sciences have begun to be reduced in significance in the various strategies of Parks Canada. This represents a serious concern as the earth sciences can and should play a significant role in understanding a variety of ecosystem functions, as well as in their management, planning and interpretation. In addition, earth science resources represent a number of the values that parks protect and communicate. Furthermore, given the leading role national parks play in the communication of park values and the scientific management of natural areas, any reduction in the role of the earth sciences in national parks could lead to the diminishment of the role of the earth sciences in other jurisdictions.

This argument can be developed in a number of ways. It is done here by addressing four objectives. The first objective is the identification or recognition of a role for the earth sciences in the various management strategies of Canada's National Parks. The second objective is to establish that the role of the earth sciences has been and is being reduced within the evolving management strategies. The third objective is to identify and assess possible reasons for the reduction. The fourth and final objective is presenting means of reversing the identified changes.

The Approach

1.1 Identification of a Role for Earth Sciences

To address the first objective, this dissertation undertakes an analysis of the role of earth science conservation in the planning and management of the national parks of Canada. Three broad literature sources are reviewed to do this (e.g. Nelson, 1968, 1978, Dearden and Rollins, 1994). Parks planning literature in general is reviewed to identify what role, if any, the earth sciences should play in park management (e.g.. Nelson, 1978). A second source of information is the roles that earth sciences play in national park systems outside of Canada. Parks Canada planning and policy literature is also reviewed to identify the role of the earth sciences in Canada's national parks.

1.2 Reduction of the Role of the Earth Sciences

The second objective is addressed through case studies. Initially, management plans for ten parks were reviewed to identify how the earth sciences are dealt with in each of the parks' primary planning document. From these ten, two parks, Banff (supplemented with information from the three other mountain parks; Jasper, Yoho and Kootenay) and Point Pelee, were chosen for a more detailed assessment based on a variety of park management and planning documents. These cases provided the basis for the development of an interview guide procedure which was applied in Banff, Yoho, Kootenay, Jasper and Point Pelee. It is difficult to generalize about the system from these cases. However, the results are very clear as to what is happening in these parks, and the suggestion that similar events are unfolding in other parks is advanced with caution.

Furthermore, it is possible that a similar reduction may be occurring in other park systems.

1.3 Reasons for the Reduction

Interview responses, the literature review, and an evaluation of the changing legislative and policy environment of Parks Canada, provide evidence to suggest reasons why the reduction is occurring. The results of the interviews identify reasons arising from within the parks service. The literature review points to the ideas and role of earth scientists as another reason for the reduction. The legislative and policy review identifies both these sources as contributing to the reduction.

1.4 Identifying Means of Reversing the Reduction

The fourth objective, the identification of means of reversing the problem, is met largely through the suggestions provided by parks personnel in interviews. The BEAT (Balance, Ecosystem, Adaptive, Teamwork) framework (Mitchell, 1991) provides a framework for organizing these suggestions. In addition, the operational or functional framework of the Canadian park service provides a conceptual basis for considering past, current, and possible future roles of the earth sciences in the planning and management of the parks. Within this framework, education or interpretation is identified as the most important function of the parks and the most effective way of overcoming the reduction in the role of earth sciences in the parks.

The research follows the interactive adaptive approach (Nelson, 1991). It moves from a general consideration of the potential role of the earth sciences in the management, planning and interpretation of parks and protected areas through the policy directives of the Canadian National Parks System, to case studies incorporating individual park management plans and activities, and to an investigation of the perceptions of park managers. The interactive adaptive approach is a research framework which recognizes that the changing context often requires adaptations in approach. This was certainly the case in this study in which the research methods tend to evolve as the study proceeded.

1.5 Structure and Contents of this Dissertation

The dissertation begins with a discussion of the limited literature relating the earth sciences to the planning and management of national parks and protected areas. A framework for the discussion of the problem was developed through identifying a context for the earth sciences in the general literature and international conventions on national parks, the literature on national parks and protected areas in other countries, the literature explicitly linking the earth sciences to national parks and protected areas, and the system model of the Canadian National Park System.

The case study methodology of the study is outlined in the third chapter. The justification is also presented for the focus on national parks. Additionally, other institutional arrangements for the practice of natural areas protection are identified and briefly discussed in relation to geomorphologic concerns. This chapter is, in essence, a discussion of the numerous false starts and dead ends encountered in the initial stages of defining the limits of the study. It documents the interactive adaptive methodology as employed in this study and identifies the strengths and limitations of the methods employed. The chapter identifies some alternative methodologies that might have been employed, given more time and financial resources.

The fourth chapter presents and discusses the systems plan of Parks Canada and outlines the manner in which it serves as a conceptual framework for subsequent discussion. In this chapter, the significance of the National Parks Act as well as the National Parks Policy is also discussed, focusing largely upon the evolution of these documents to the present, notably in regard to the role of the earth sciences in national parks.

The fifth chapter presents case studies of several national parks. It focuses upon the information contained within the individual park management plans and relates this to what is known about the specific earth science resources of the region represented by the Park, as well as what is known about these resources in a more general sense. In this chapter, ten management plans representing nine different national parks were reviewed.

Chapter 6 presents detailed case studies of two parks, Banff and Point Pelee. Park documents pertaining to all levels of management and planning are screened for information relating earth science features and processes to management and planning decisions concerned with resource conservation (management), interpretation, and research. In addition, site visits and interviews were conducted with park personnel to further estimate the level of importance ascribed to earth science resources. This chapter focuses upon specific site plans, rehabilitation priorities, the environmental assessment and review process, zoning priorities, and environmentally sensitive site identification and protection.

Chapter 7 presents the results of the interviews conducted in Banff, Jasper, Yoho, Kootenay, and Point Pelee. These results provide evidence to support the findings of the analysis of the various management plans. In addition, the results of the interviews identify reasons for the reduction in earth science and suggest means of reversing this trend.

Chapter 8 discusses the results of the preceding chapters and presents the argument that recent changes to the National Parks Act appear to have begun the process of reducing the role of the earth sciences in the management, interpretation and research of the national parks. It is recognized that earth science is still considered in broad generalized statements in the Systems Plan, as well as in the goals and objectives of the management plans of the national parks. However, at the level of management and most importantly of interpretation, the majority of plans do not provide for the earth sciences. Most resource managers (wardens) within the parks service indicate that earth science features and processes have never been a major management concern. Interpreters indicate that the earth sciences do not fit the new message framework which seeks to identify ecological integrity as the major theme. This final Chapter summarizes the conclusions of the previous chapter and presents recommendations arising largely from the interviews of park employees.

In summary, this dissertation undertakes an investigation into the nature of the role of the earth sciences in Canada's national parks. It identifies what has been done, what is being done elsewhere, what is currently happening in Canada (reduction), why the reduction is occurring and what can be done about it. The study does not identify if similar reductions are taking place in other national and provincial park systems. However, the changes that are occurring in Canada' s national parks and the inferred reasons for this occurrence suggest that similar reductions may be occurring elsewhere.

CHAPTER 2
Literature review

The first objective in this dissertation is to establish that there is a role for the earth sciences in the planning and management of Canada's national parks. The following discussion will identify some of the roles of the earth sciences in national parks through a review of related park literature. The literature is discussed in four separate sections corresponding to: international conventions on national parks; the specific experience of a number of countries with national parks; the literature explicitly linking the earth sciences to national parks; and finally, Canada's national parks. This review is presented largely in order to develop a conceptual framework from which to discuss the role of the earth sciences in national parks.

Arising from the identification of the internationally recognized values and purposes of national parks, three specific functions of the Canadian park system are identified as areas in which the earth sciences have an important role. These three functions are management and conservation, interpretation, and research. These three functions are identified in the Parks Canada policies of 1979 and 1994 (Parks Canada, 1979, 1994). The functions should not be interpreted as being separate from one another but as integrated.

Indeed, the lines between these functions often blur and overlap. Preservation and conservation require natural resource management, and interpretation relates to education, tourism and recreation. Research informs us about park resources and provides the data upon which resource management and interpretation are based. Interpretation in turn educates the public not only about the resources of the parks but also about threats to these resources and the management practices of the park. Thus, interpretation and research are management tools. While the National Park Policies (Parks Canada, 1964, 1979, 1994) and the Act and its amendments (Government of Canada, 1934, 1974, 1988) recognize research along with resource management and education as functions of the national parks, there is no planning document for research equivalent to the Natural Resource Management Policy Parks Canada, 1979) or Visitor Activity Management Policy (Parks Canada, 1986) with respect to research.

2.1 International Context and the Value of Parks

In response to increasing destruction of wilderness and natural habitats across the globe, many countries are developing environmental conservation and protection strategies (Nelson, 1985, McCloskey and Spalding, 1989, Trudgill, 1992). The various categories of protected areas (e.g. national park, wildlife refuge, game preserve, provincial park, wildlife management area, ecological reserve) allow for a wide variety of different uses. Among the different categories, national parks are recognized as providing the highest level of protection (CNPPA, 1969). In 1969 the International Union for the Conservation of Nature recommended that the term national park be reserved for sites which meet specific criteria; i.e. "a national park is a relatively large area

1. where one or several ecosystems are not materially altered by human exploitation and occupation, where plant and animal species, geomorphological sites and habitats are of special scientific interest, educative and recreative interest or which contains a natural landscape of great beauty and

2. where the highest competent authority of the country has taken steps to prevent or to eliminate as soon as possible exploitation or occupation in the whole area and to enforce effectively the respect of ecological, geomorphological or aesthetic features which have led to its establishment and

3. where visitors are allowed to enter, under special conditions, for inspirational, educative, cultural and recreative purposes."

In addition, the I.U.C.N. requests that nations not designate as national parks, areas which are strict scientific reserves, special reserves (fauna or flora reserves, geological or forest reserve etc.), managed by private institutions or lower authorities, or inhabited or exploited landscapes and areas where outdoor recreation takes precedence over conservation.

The I.U.C.N. resolution identifies a number of the values associated with national parks and explicitly identifies habitat conservation; scientific, recreative and educational interest; ecological, geomorphological and aesthetic values; and cultural and inspirational values. It is clear from the I.U.C.N. resolution that geomorphic features and processes are viewed as significant elements of the values of national parks.

2.2 Conceptual Framework

2.2.1 International Convention

In the hundred plus years since the 1872 establishment of Yellowstone as the world's first national park, attitudes about the role of the parks have evolved and changed in response to the values of the larger society (Hummel, 1989). In spite of this evolution, the historical paradox of the parks reflecting the tension between use and preservation and the diverging views of nature that this reflects, continues to hinder park managers (Henderson, 1968, Cawley and Freemuth, 1993). Darling and Eichorn (1969) suggested that the paradox lay within the idea's origin in the Romantic movement, and represents a "reawakening of the awareness of nature that is so evident in the writing of Rousseau and in the poems of Wordsworth and Coleridge" as expressed for Americans by Emerson, Thoreau and Bryant.[2]

These divergent views of nature are reflected in the values of national parks as identified in the international literature. As can be seen in Table 2.1, a number of "values" or benefits of the national parks have been identified and these range from the very practical such as the economic benefits associated with recreation to less concrete values such as cultural and spiritual benefits (Harroy, 1972, Standish, 1972, Taschereau, 1978, Hummel, 1989, Eidsvik, 1989, C.E.A.C., 1991, Prosser, 1976). As can be seen from

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[2] Significantly, the Romantic Movement developed in response, and opposition, to the rise of the Newtonian world view and the identification of science and the scientific method for understanding the world. It is somewhat ironic that National Park ideal which has its roots in opposition to the scientific world view, should now be turning to science as a primary means of managing the parks. Though not explicitly stated, this irony is not lost on many who advocate for a less reductionist scientific approach (e.g.. Theberge, 1994)

Table 2.1 Values, Purposes and Functional Divisions of National Parks

Values		
Ethical	**Environmental**	**Economic**
Intrinsic Reasons (All life has a right to exist)	Research (Monitoring, Knowledge and Understanding)	Agriculture (Gene Bank)
Heritage Reasons (Ability to understand our past)	Scientific Reasons (Biological Diversity and Physical Processes)(Natural Laboratories Benchmarks)	Habitat for Harvested Species (e.g. fish stocks, migratory birds)
Spiritual Reasons (Protection of Sacred Places)	Health and Recreation (Respite and Stress reduction)	Medicine
Cultural Reasons (Promote Cultural Identity, Foster National Unity)	Promote Public Support for Habitat Protection and Sustainable Lifestyles	Watershed Protection
Aesthetic Reasons (Provide Inspiration)	Maintain Ecological Processes	Soil Protection
	Permit Continued Evolution	Tourism (Regional Economic Development)
	Preserve Range of Ecological Options	Public Ownership
	Purposes of National Parks	
Education and Enjoyment	Resource Protection	Benchmarks and Research
	Parks Canada's Functional Framework	
Natural Resource Management	Interpretation and Visitor Services	Research

(Sources: C.E.A.C., 1991, Eidsvik, 1989, Harroy, 1972, Hummel, 1989, Prosser, 1976).

Table 2.1, many of these values such as education, conservation and preservation, and research also reflect the purposes of the parks as identified in national parks mission statements. Indeed, from these purposes three basic functions of parks can be identified. These functions are interpretation, resource management, and research. The following text will discuss the expressed purposes of the Australian, New Zealand, American, British and Canadian National Park systems in order to identify how these three functions are managed in these parks systems and to develop a framework for the discussion of the changes occurring in the Canadian system, and the role of the earth sciences within these changes.

2.3 The Parks

2.3.1 United States

As noted above, the World's first national park was proclaimed in the United States in 1872. The fundamental purpose of the national parks of the United States is

> '...to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such a manner and by such means as to leave them unimpaired for the enjoyment of future generations.'
> (Darling and Eichorn, 1969)

Traditionally, this mandate has been interpreted to mean that the parks are to be managed for two conflicting purposes (Lemons, 1987). Within this mission statement is also the identification of a root to the parks system which is inclusive of geological features. In addition, the United States system provides for the recognition of National Landmarks for sites of specifically geological and biological interest (Dilsaver, 1995). Indeed, there has been concern raised that in identifying potential national parks, not enough attention has been paid to biological concerns (Wright, 1994).

Historically, American national parks have been developed with a focus upon the protection of primeval landscapes, but they have not usually been identified due to biological uniqueness (Kaye, 1991). Indeed, many early American national parks were identified based on unique landforms or geological features (Rowntree et al, 1978). As the system developed, Leopold's (1949) view of the parks as serving to preserve a "vignette of primitive America" became a guiding principle of the 1964 Wilderness Preservation Act. This concept of wilderness in the parks was expanded to include the rehabilitation of previously disturbed sites (Allin, 1982). However, the major focus of this restoration work, and the criteria used to identify disturbance, focused upon biological considerations. These changes, and the growth and development of the sciences of ecology and conservation biology, have led to a greater emphasis being placed upon biological aspects of the system.

This is not meant to suggest that the earth sciences have been overlooked. On balance, however, the literature indicates a focus directed toward biological considerations (Lemons, 1987). Yet in spite of the recent increased emphasis on biological concerns, there remains a commitment to the consideration of the earth sciences in the American national parks. The American parks system has shifted management emphasis away from the maintenance of steady state and toward the recognition of significant erosional events (Hayden and Dolan, 1974) and there has been some research linking geomorphological processes to human impacts (Madej et al, 1994), climate change (Parsons, 1991) and the increased potential for natural hazards (Butler, 1986, 1989, O'Connor and Costa, 1993). In spite of this, it has been suggested that research is the weakest link in the American national park drive toward scientific management of resource and interpretation (Pritchard, 1990).

Finally the 1990 N.P.C.A. report on research and resource management in the U.S. National Park System identified four key areas of focus: education, ecosystem management, research and professionalization (Pritchard, 1990). The most significant conclusion of the report was that if research and resource management programs were to survive, an enhanced commitment to interpretation was essential. Furthermore, it was recognized that research required a legislative mandate. The report made no explicit reference to the role of the earth sciences in research and resource management in the parks.

2.3.2 Australia

Australia was the second country in the world to establish a national park with the identification of Royal National Park in New South Wales in 1879. However, unlike the other countries considered in this review, Australia's national parks are under the control of the individual states in which the parks are located (Davis, 1989). Indeed, as recently as 1993, the articles of the World Heritage Convention (1972) were being proposed as a guide to the development of a representative system of national parks (Bridgewater, 1993). In spite of this, the national parks of Australia contain and preserve a number of significant geological features and processes (Harris, 1992). As in Canada, and to some degree the United States, the national parks of Australia were initially established in order to provide tourism and recreation opportunities, no doubt reflecting the utilitarian views of the time. As a result, Australia's parks are also faced with the conflicting mandates of preservation and use (McKercher, 1993). Like North American parks, these conflicts center around appropriate use and the level of acceptable tourism (Wearing and Brock, 1991).

Australia's system is biased towards the conservation of biological features and processes due in part to its unique flora and fauna (Lucas, 1972). The general policy with flora and fauna is to replicate, as closely as possible, the conditions which existed prior to the influence of Europeans (Lucas,1972). This policy parallels an early policy of the U.S. Parks Service which sought to establish " a vignette of primitive America ...recreated as nearly as possible in the condition that prevailed when the area was first visited by white man" (Leopold, 1963).

Many states have developed extensive interpretation programs, although still without the centralized control and direction evident in other park systems. As a result, it is difficult to assess the overall consideration given to the earth sciences in the interpretation of Australia's national parks. Where earth science heritage features are interpreted, they are often done so with reference to the spiritual significance of specific features to the aboriginal peoples (Bridgewater, 1993). The lack of centralized planning for research, interpretation and resource management makes comparison with other jurisdictions difficult.

2.3.3 New Zealand

The current National Park System in New Zealand had its beginnings in 1887 when Maori chiefs asked that three volcanic mountains in the center of the North Island be awarded to the crown for the purpose of establishing a national park (Lucas, 1972). Tongariro National Park was formally proclaimed in 1894 and over the next 50 years 4 other parks were proclaimed.

The National Park Act followed much later in 1952 and was enacted "for the purpose of preserving in perpetuity....areas of New Zealand that contain scenery of such distinctive quality or natural features so beautiful or unique that their preservation is in the national interest"(1952). In many ways the sentiments expressed in this purpose statement echo the American and Canadian Parks Systems mission statements, in spite of the Act being written much later.

There is in the 1952 Act, provision for a wide representation of natural ecosystems incorporating outstanding scenery (Lucas, 1972), and many New Zealand national parks were recognized on the basis of the spectacular geological features associated with them. In keeping with the significant role that the earth science environment has played in the national parks of New Zealand, many parks emphasize this in marketing, tourism (Budowski, 1978) and interpretation(McSweeney, 1985). In addition, the high energy, alpine environment (Johnson, 1986, Thorsell and Hutchinson, 1992) creates significant natural hazards related to a variety of mass wasting processes (Dingwall et al, 1986). While there has been some research relating mass wasting to anthropogenic causes (Brown, 1990), there is yet little information relating high energy events to ecological processes or climate change in parks in New Zealand. The literature suggests that in New Zealand the earth science have not been diminished in their role in the National Parks. However, there is little indication in the literature that the concept of ecological integrity has assumed preeminence in the national parks of New Zealand.

2.3.4 Great Britain

The national parks of Great Britain do not conform to the I.U.C.N designation of national parks and are of the category described as special reserves (Simmons, 1978). This is not necessarily surprising given that England entered into the national parks arena nearly 50 years after the United States. Furthermore, it is reflective of a country whose landscape has been greatly modified by human activity. This, alone distinguishes the British park system from the others discussed here. In fact, a major goal of the British system is to protect the integrity of the countryside and landscapes (Simmons, 1978, Willis and Garrod, 1992). Indeed, the idea of wilderness is rejected in British Park management (Henderson, 1992). To this end, the British are much more accepting of physical interference in order to maintain preferred landscapes (Henderson, 1992, O'Riordan et al, 1993, Willis and Garrod, 1992).

Finally, and perhaps most significant, in spite of the great differences between British parks and the others discussed here, the British parks also are faced with the contradictory purposes of use and preservation (Simmons, 1972). What differs, are the values that are to be conserved, these being cherished landscapes and countryside as opposed to wilderness or ecosystems. It has been suggested that this reflects a comfort with those modified landscapes, while the North American obsession with the preservation of wilderness reflects concern over the rapid disappearance of previously untrammeled wilderness (Henderson, 1992).

With the possible exception of the national parks of Great Britain, the park systems examined above all implicitly recognize a role in the conservation of geological as well as biological resources. In some cases, the park systems emphasize biological features and processes at the expense of geological ones. The literature indicates that in New Zealand and the United States, the importance of the geological component of the environment is generally well represented and incorporated in interpretation and resource management. However, the changing role of national park systems in public consciousness and in national sustainable development strategies has begun to shift the focus in some park systems to the biological importance of these areas. This has been paralleled with a rapid reduction in financial resources. As a result, the limited resources of park managers are often focused upon the what is currently perceived to be the problem.

2.3.5 Canada's National Parks

Over one hundred years ago, Canada's first national park was established in an area that is now encompassed by Banff National Park in order to protect several hot mineral springs and the surrounding lands from sale, settlement and squatting (Nicol, 1968). The original reserve covered just 26 square kilometers, was expanded to 673 square kilometers with the establishment of the Rocky Mountains Park of Canada and the Rocky Mountain Parks Act of 1887, and currently encompasses 6641 square kilometers adjoining three other national parks in the 20,160 square kilometer Four Mountain Park Block (Lothian, 1987). During the ensuing one hundred and ten years, Canada's national parks have developed into a system encompassing 42 national parks representing 32 of 39 terrestrial natural regions (see Fig. 4.2) and 4 of 29 marine regions (Rollins, 1994).

Throughout this early period of development, the preservation of the landscape for purposes of public use and enjoyment has been one constant, if seemingly paradoxical, goal of the national parks (Henderson, 1968, McNamee, 1994). This paradox was one of the major themes raised at the 1968 conference on Canada's national parks (Nelson et. al., 1968).

2.3.6 Geomorphology and Canada's National Parks

In discussing the nature of the role of the earth sciences in the planning and management of Canada's National Parks, it is useful to consider the role within the functional framework of the Park System. This framework has developed from the values of National Parks identified in Table 2.1 (Intrinsic reasons, Heritage, Scientific, Aesthetic, Research, Ecological processes, Physical processes, Recreation, Promote support for parks). Indeed these functions were developed in order to protect and communicate these values and have been recognized in parks systems around the world. Thus, earth sciences relate to parks goals and objectives through the functions of interpretation and natural resource conservation and research. Although not currently an explicitly defined function within the parks system bureaucracy, research represents another important role of parks and is recognized as such in the Act (1930, 1988) and Policy (1978, 1994). A review of the academic earth science literature dealing with interpretation and resource conservation functions of park management provided little information. In contrast, much pure earth science research takes place within the national parks (i.e. Banff Resource Description and Analysis). Yet this research is rarely directly related to park values, beyond the recognition that the park has provided a relatively undisturbed site for the study of certain natural processes.

2.4 The Role of Management

Management of national parks is necessary because few parks are sufficiently large or undisturbed by human activity (Curry-Lindahl, 1972). As a result, in order to protect the values for which the parks were recognized, active manipulation is often required. In addition, the management of the parks' natural resources is sometimes necessary for the protection of the public and of park facilities.

However, in general, the use of earth science information in planning and management has been limited to its role in identifying "natural regions" (Bostock, 1970, Parks Canada, 1972). This information is presented as descriptive and does not deal with process or change. In contrast there are many ecological land classification systems in which process in general is recognized as a constraint to particular activities (Bastedo, Nelson, Theberge, 1986). Even in the latter instance, earth science features and processes tend to receive relatively little stress in planning and management in comparison with biotic features and processes. Often, management entails the management of human access to particularly sensitive sites. In this case recognition of the significance and sensitivity of the site is an important factor in management.

Much information exists in the published literature regarding the earth science features and processes in the Canadian national parks. Much of this information is catalogued in various Resource Description and Analysis documents for national parks (e.g. see Parks Canada, 1987, 1985). This information is intended to guide the natural resource management process and the visitor activity management process in conjunction with the park management plan.

The management of earth science resources in Canada's national parks has been dominated by an engineering approach (Haney, 1993, pers. comm., Syme, 1994, pers. comm., White, 1994, pers. comm.). As noted by Gardner (1978), knowledge and science are not static and the value of information changes in response to both changing theory and the changing requirements of society. Changes to resource management practice in Canada's parks reflective of an ecological approach should therefore engender changes to the engineering approach previously taken with earth science resources. Therefore, in order for information to be useful to the parks, someone must be available to collect and interpret the information in light of changing park requirements and earth science theory.

2.5 The Role of Interpretation

Interpretation is a key element of the Visitor Activity Management Process (VAMP)(Parks Canada, 1978). Interpretation is increasingly being viewed as a fundamental part of park management activities (Butler, 1994, Watson, 1990). In many ways interpreters are the front line staff of the parks and represent the only contact many parks visitors have with park staff (Wright, 1990). As such, interpretation and interpreters are essential in communicating the values of parks and in educating the public about the park and its resources. Traditionally, interpretation focused upon educating the public about the resources of the park. Programs and media focused upon the wildlife, the landforms and the history of the parks. More recently, however, park managers are using interpretation as a means to communicate the management messages of the parks as a means of engendering support for management activities. Thus, as management activities focus upon ecosystem management, so to will interpretive messages. It is this change of emphasis in interpretation and management that can potentially reduce the role of the earth science resources. This is one of the main questions addressed in the case studies.

As noted earlier, much of the early (late 1800's early 1900's) research in the national parks was of a variety that Gardner (1978) characterized as interpretive, meaning descriptive or exploratory in nature. Most recently, in part as a result of the development of the National Park Systems Plan, there has been the growth in interpretive research related specifically to park values. Much of this was done in the early and mid 1970's and can be seen to be a result of increasing interest in the scientific management of Canadian parks and protected areas.

Much of this "markedly interpretive" work used systematic research results to highlight the significance and uniqueness of many aspects of the regions' earth science form and process, and to communicate this significance to a broader audience of park visitors (e.g. Bellyea, 1967, Baird, 1967, 1968, 1972, 1975, Muir and Ford, 1985). In addition, many interpretive works are not academic in nature and are produced as guides and souvenirs for park visitors (e.g. Gadd, 1986, Muir and Ford, 1985, Gadd and Yorath, 1995). This interpretive work does not link the earth sciences to the new ecosystem messages of interpretation and continues to follow the pattern of interpretation established in the 1970's. Nor is there at present any effort to make this link.

2.6 Role of Research

It is useful to consider the role of research because research ideally provides the basic information upon which resource management and interpretation decisions should be based. In addition, research provides one of the few areas in which literature exists relating to the earth sciences in national parks as well as to their associated values.

The values of uniqueness and representativeness so central to national parks are also of major significance in research sites. Many of these locations provided research opportunities well in advance of park establishment (Gardner, 1977). Often the information collected as a result of such research was important in park establishment. This was most often the case when such research was of the type that Gardner (1968) characterized as interpretive, that is, research focused upon the uniqueness of the region. This contrasts with research Gardner identified as systematic. Systematic studies are those which are concerned primarily with the description and understanding of the feature or process. Many interpretive studies rely upon systematic studies for primary information. Paralleling the development of systematic studies in the sciences was an increase in the use of the national parks as sites for systematic studies throughout the most recent half century.

In spite of an increase in interpretive research during the late 1960's and early 1970's, and the publication of a number of books and articles concerning the geology and geomorphology of the parks, there was little direct applied research relating to management of the resources. It has been suggested that this could be due to the fact that engineering approaches were most commonly employed where earth science "problems" were encountered (Haney, 1993, pers.comm.). In addition, Durrant (1986) noted that applied work by geomorphologists has commonly not been published in the academic literature, in spite of the fact that application has been stated as a significant goal of geomorphological research (McLellan, 1988, 1995).

The significance of physiography in determining the natural regions which formed the basis or framework for establishing a Canadian System of National Parks

(Rollins, 1994) is noted in Dearden and Rollins' book, along with some of the provisions for paleontological resources (Eagles, 1994). In addition, Eagles noted the importance of identifying abiotic reasons why protected areas exist, and used the example of Dinosaur Provincial Park in Alberta as one of a park being established to protect paleontological resources.

A decade after the benchmark 1969 meeting, the 1978 Banff conference reexamined the issues identified in the previous conference and identified several emerging issues (Nelson et al, 1978). The conflict between recreational and conservational uses of parks was a continuing and expanding problem (Nelson, 1978, Marsh, 1978). In addition, the conference identified the need for a much increased role for research during the intervening period (Gardner, 1978, Herrero, 1978, Theberge, 1978). While Gardner identified the earth sciences in his consideration of research, both Theberge and Herrero focused upon the significance of biological research .

In both the 1969 and 1978 conferences, the only specific references to geology and geomorphology are contained in Gardner's papers on research in the national parks. Indeed, these were also the only research papers presented. In both of these papers, the references to geology and geomorphology were used to highlight the significance of research in the parks rather than to identify a particular role for geology and geomorphology.

Dearden and Rollins (1994) present a recent account of the status of planning and management of parks and protected areas in Canada. Here again research is recognized as the key element in the scientific management of the parks. This is also recognized by Parks Canada (Parks Canada, 1993). Again the role of the earth sciences in the planning and management of the national parks is minimally identified, reflecting the biological bias seen in earlier work.

2.7 The Changing Roles of Parks

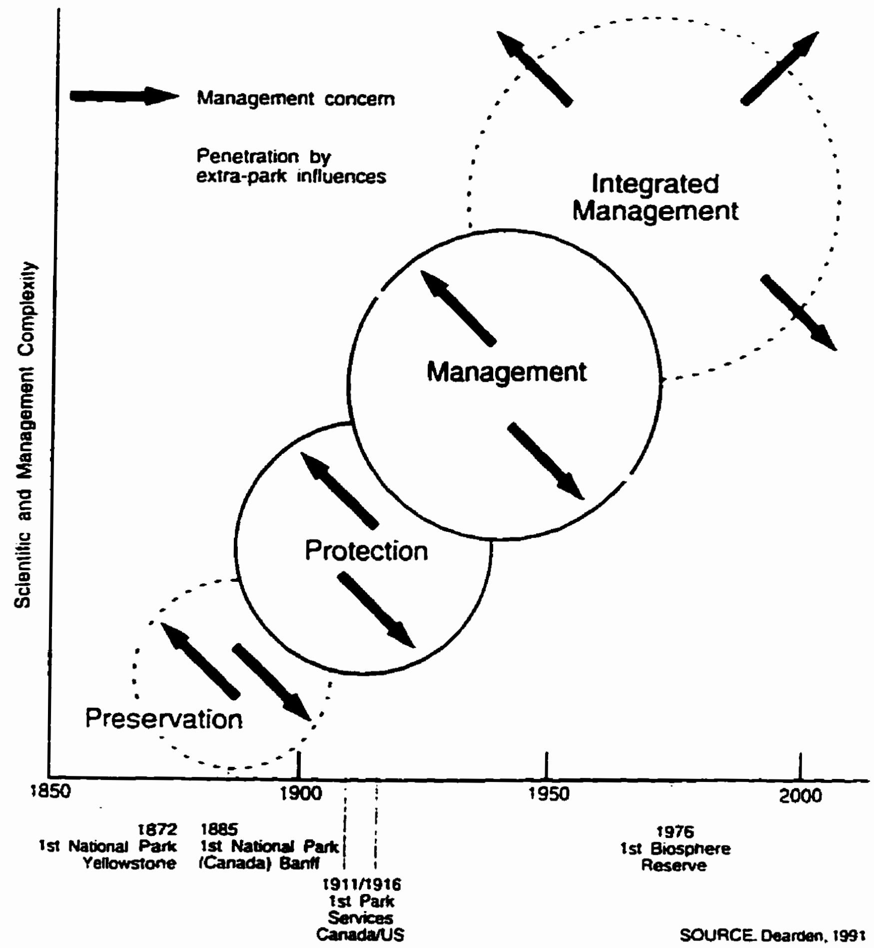
The preceding sections have identified how the three functions of parks have been in employed in a variety of park systems. While these functions remain fundamental elements in parks management, the conceptual or philosophical basis of parks and protected areas planning and management is undergoing a significant evolution. And this has implications for how the functions will be performed and how the earth sciences will fit within the functions in the future.

The past three decades have witnessed an ever increasing interest in the preservation of nature and the natural environment. While the United States Park System has experienced at least two major episodes of this, this is a relatively new movement in Canada (Nash, 1968). A brief period of citizen interest and activity developed through a newly formed National Parks Association as a result of a proposal for a dam on the Spray River in Alberta in the 1930's. The reaction was similar to the American reaction to the Hetch Hetchy Valley in California about the turn of the 20th century. However, unlike the American movement, the Canadian one engendered no base of strong public support and the National Parks Association disappeared (McNamee, 1994).

The resurgence of interest in Canada since the 1960's is strongly associated with the science of ecology in contrast to the earlier more spiritual American movement characterized by such individuals as Muir, Abbey and Leopold (Nash, 1968). The emerging profession of natural area planning and management is also strongly rooted in the biological and ecological sciences and, as a result, its associated literature is dominated by an ecological focus (Spicer, 1987). Indeed, Spicer (1987) and Juday (1987) both note that only rarely is the rationale and significance of earth science representation, conservation , and management discussed in the literature. This view was confirmed by the review conducted for this thesis.

Eidsvik (1985) and Dearden (1991) identify the evolution of four levels of management concern for parks and protected areas over time. In this framework (Fig 2.1),

Figure 2.1 Evolution of Scientific and Management Complexity in Park Management



early management is characterized as being concerned with preservation, that is the legislated protection of the land from development. With increased resource development, it was the recognized that national parks required boundary protection and the prevention of trespass. Increased recreational pressure in the 1960's brought about the awareness that such protection and associated passive management were unable to cope with the stress of increased use, and active management techniques have begun to be employed, for example controlled burning. Most recently, (1980's) it has been recognized that many problems facing protected areas originate beyond their boundaries. For this reason, integrative or ecosystem-based management is advocated. Furthermore, it was recognized that management of individual species often had unforeseen impacts on other species and their habitats.

In association with these changes, there has been an increasing recognition of the importance of science in the management of parks and protected areas (Eidsvik, 1991, Willison et al, 1992). However, as recently as 1991, the Acadia Conference on Science and the Management of Protected Areas did not identify a role for the earth sciences in the scientific management of parks and protected areas(Willison et al, 1992).

Given these changes in the conceptual framework within which the three functions of parks operate, the role that the earth sciences will or should play in the future deserves to be examined.

2.8 The Earth Sciences and Natural Areas

A number of literature sources were consulted in order to establish the roles the earth sciences have had and could have in the management of parks and protected areas. Individual national park systems were reviewed to establish the role the earth sciences have had. The general natural areas management and earth science literature was reviewed to determine the role the earth sciences should have. Much of the literature was originally identified through Geo Abstracts. Major journals included, but were not limited to: *Natural Areas Journal, Environmental Management, Ambio, Natural Resource Journal, Parks, Australian Parks and Recreation, Applied Geomorphology, Physical Geography, Canadian Journal of the Earth Sciences, GeoJournal, National Parks Magazine, New Zealand Geographer.*

The most significant contribution to the literature dealing with the relationship between the earth sciences and natural area preservation and management is contained in the 1987 geological heritage special issue of Natural Areas Journal (Spicer, 1987, Juday, 1987). In that issue, the lack of literature relating the earth sciences to natural areas preservation is noted as a significant gap, one which the special issue begins to address.

Juday (1987) identified three reasons why natural area professionals should consider earth science along with biotic features and processes. First, it is often difficult to separate biological from earth science features and processes in any ecosystem. Second, geomorphologic features can often serve as surrogates for natural diversity description. Finally, geomorphologic - landform factors are often decisive in ecosystem support and evolution. These reasons do not address the significance of earth science/geomorphologic features and processes in and of themselves. In addition, they do not refer to the variety of reasons that have often been forwarded for the protection of natural areas generally, for example ecological benchmarks, scientific value, and education (Table 2.1).

Many of the principles that justify concern for the biotic component of the environment can be applied equally to the abiotic or earth science component. Earth science components provide life support functions as well as the basic elements of elevation, slope, aspect, drainage, and denudation which in combination with climate, soils, and parent materials form the very foundation of many distinct environments and their associated biotic communities. Additionally, geological and geomorphologic forces play a significant role in the evolution of new species. Physical isolation accomplished through geological and geomorphologic processes is often responsible for the evolution of new species through island specialization, ecotype differentiation, and niche specialization (Juday, 1987). Many of these processes are evident in the National Parks of Canada, although not often is the significance explicitly recognized.

Earth science features and processes are not subject to extinction in the same manner that plants and animals are. However, some of the processes that produced many of the earth's surface features are no longer active. In this sense the removal of such features through aggregate mining of eskers and other glacial deposits is effectively a permanent loss. Many of these features provide information regarding past environments and subsequent environmental change and their loss therefore, represents a significant information loss. Furthermore, knowledge of past environmental change is critical in identifying future global changes.

The composition of current national parks and other protected areas is contingent upon the interplay among climate, geological and geomorphologic features and processes, time, and the niche adaptations of the component organisms. In Canada many current landscapes are the legacy of Pleistocene glaciations (Prest, 1972), which over time will be modified by contemporary geomorphologic processes into new landscapes and different environments. Therefore, a thorough understanding of the features, the processes that created them, and the current processes that are altering them is essential to an understanding of any ecosystem.

Physical landscapes and their biotic communities are not static. The management of our natural areas requires an understanding of not only the biotic assemblage, but also of the abiotic as they " are inextricably linked to the past evolutionary development of biota, to contemporary ecosystem support functions, and to the future physical and biotic character of natural areas" (Juday, 1987, p. 138.). To this we should add, the significant role that geomorphologic processes have on the current physical characteristics of the area, a role that is often not well understood.

Thus, it can be seen that management of abiotic form and process is necessary for the protection of the physical component of our natural heritage, for public knowledge and the associated educational value, as well as for research and further study in order that we can better understand the whole of our natural environment. Indeed, the past can provide clues to the future. Thus, an understanding of the processes which resulted in the current landscape can help with future resource management concerns, for example the occurrence of avalanches, slides, floods and other hazards to the park user (Gardner, 1986, Butler, 1988, Dingwall, 1988). In addition, there are intrinsic reasons for interpreting, managing and researching the abiotic component of the environment.

2.9 Summary

The central concern of this dissertation is that there are opportunities for earth science theory and knowledge to contribute to the management of the national parks and that this contribution goes beyond basic interpretation and physiographic identification. These opportunities have not been identified well in the literature. However, the opportunities identified for biotic resources are suggestive of the tremendous potential that exists. Furthermore, it is necessary that the earth sciences be considered along with the biological sciences in order to achieve the parks legislated mandate of maintaining ecological integrity. Holistic ecosystem-based management requires that the entire system be considered.

It has been suggested that much of our understanding of biotic evolution is too reductionist (Theberge, 1994). Earth science research in Canada's national parks has already provided a significant expansion of evolutionary understanding through the reinterpretation of the significance of the Burgess Shales (Gould, 1989). Other important relationships have been identified by Juday (1987). This thesis suggests that there may be many other ways in which the earth sciences can contribute to our understanding of the ecosystem at a variety of temporal and spatial scales, but their relevance must first be recognized. That is, the earth sciences offer tremendous promise in contributing to the ecosystem based management of our natural environment. In addition, significant discoveries or ecological links derived in national parks and other protected areas can ensure better management of resources in more developed areas. In addition to the roles identified above, the implications of global change and climate change hold enormous potential for earth science research, particularly in respect to identifying and monitoring key indicators of change. Furthermore, global and climate change have serious implications for process operation rates and natural hazard return intervals in the highly dynamic environments of national parks. These, in turn, provide opportunities for the interpretation of the earth sciences as an active part of the ecosystem.

This chapter has identified a number of roles the earth sciences can and should play in the management of parks and other protected areas. However, it has also been shown that rarely are these roles explicitly recognized in the literature associated with the planning and management of natural areas. In terms of what role the earth sciences play, most of the park systems reviewed recognize the physical landscape as an important component of the nation's heritage. However, based upon the literature available it is difficult to determine if the role is decreasing, remaining the same, or increasing. Indeed, this was one of the motivations for the study.

In terms of the roles the earth sciences should play, there is clearly a need for a stronger link between earth science processes and other ecosystem processes. This view is echoed for the role of the earth sciences in environmental impact statements (Lewin, 1975). This, too, was a motivating factor for the study. Because, if the earth sciences have important roles to play in the management of natural areas, why isn't it happening. And in particular, why isn't it happening in national parks.

The international literature on parks and protected areas identifies a number of values of parks and these values are often reflected in the earth science heritage of the parks. Within the national parks of Canada and indeed a number of other national park systems, we can identify three broad functions which serve to protect and communicate these values. These functions are natural resource management (ecosystem management), education (interpretation), and research. The international experience, and indeed Canada's experience, with national parks suggests that there are roles for the earth sciences in the administration of these functions, and that there are reasons to expand these roles. However, changes to the philosophical framework of park management suggests that the role of the earth sciences might be changing with respect to these functions.

These three functions form the basis of the conceptual framework within which the changing role of the earth sciences will be discussed in subsequent chapters.

CHAPTER 3

Methods

3.1 The Case Study Approach

The case study approach was selected because it allows for a very detailed evaluation of how programs and individual parks manage and interpret the earth science resources (e.g.. Lowry, 1994, Prosser, 1978). In addition, the case study allows for the consideration of both documentary (historical and current), interview, and anecdotal information (Miles, 1995). The case study allows for the simultaneous study of a large number of attributes, the consideration of changes over time, the inclusion of anecdotal information, and the identification of causation as developing from a variety of sources (Miller, 1983). Finally, the case study approach is a comprehensive approach that allows for the incorporation of a variety of techniques (Babbie, 1973, 1992). Because this study was focusing upon the national parks of Canada and the various bureaucratic levels of planning and management, a variety of documentary and field evidence was available for the study. Each information source provided insight into different aspects of the role of the earth sciences in the planning and management of the national parks. Table 3.1 identifies how the methods and information sources relate to each of the four objectives identified in Chapter 1.

The case study approach is not without its shortcomings. Perhaps the most significant criticism concerns the degree to which the case study results can be generalized (Babbie, 1992). To some degree this was accommodated in this study through the inclusion of a number of cases. In addition, the study looked at system and higher level planning policies in response to concerns about generalization.

3.2 Development of the Research

As originally envisaged, the research was to compare the preservation and management of geomorphologic processes and forms under a variety of protected area designations. It rapidly became apparent, however, that this would be unworkable. First, as identified in Chapter 2, many of the various institutional arrangements dedicated to the protection of parks and protected areas do not specifically refer to earth science features or processes as a part of their mandate. For example, many wilderness areas and ecological reserves are dedicated exclusively to the preservation and management of wildlife and other biological resources (Taschereau, 1988). Even where there is the recognition in principle of the importance of geological and geomorphologic resources within the definition of the natural area, this is usually limited to protection of specific features. Perhaps more significant, however, is the fact that many of these other designations provide no defined legislative basis or policy for the role of geological and geomorphological features and processes.

Table 3.1 Relation of Methods to Objectives

Objective	Method
1. Identify the role of the Earth Sciences	International Experience Literature review Content analysis of Act and Policy
2. Document Reduction	Case studies Content analysis of Management Plans Content analysis of supplementary plans Interview guide
3. Reasons for Reduction	Content analysis of Act and Policy Content analysis of Management Plans Case studies Interview guide
4. Addressing the Reduction	Case studies Interview guide

During the early stage of the research design, contacts were made with various provincial park systems along with the National Park System. It became evident that few provincial park systems had developed systems plans that identified regional preservation priorities, and of those that had, only one, Ontario, included provisions for the preservation of geological and geomorphologic features (O.M.N.R., 1980). In addition, the Ontario System provided some direction to the research through the identification that the focus of the system was exclusively on features. Other jurisdictions, notably Alberta, Saskatchewan and British Columbia, were in the process of developing systems plans and used geological and geomorphologic or physiographic regions in the identification and preparation land classifications(Achuff et al, 1988, 1993, B.C. M.E. L. P., 1994). Manitoba was developing a system plan for its provincial parks (M.D.N.R., 1985), however, the draft document and subsequent revisions provided little emphasis upon geological and geomorphologic features and processes. The draft document identified only 27 "significant " physical features in the province.

It became evident that the goals of many provincial park systems were quite disparate. For example in 1990, Nova Scotia, New Brunswick and P.E.I. were predominantly interested in providing a marketable tourist experience through their respective park systems and did not recognize natural area preservation as a major goal The wide variety of goals expressed by the various provincial parks systems along with the general lack of systems plan development suggested that a comparison between various systems would not be a productive approach.

The status of the various provincial systems was re-examined following the conclusion of the data collection. This follow-up has also confirmed that earth science is neglected and, strengthened the impression that there is an increasing emphasis on biological criteria in the identification of candidate natural areas. From a truly holistic perspective, this approach fails to consider most important aspects of the physical environment, the processes that created the features and the interaction of these processes with other components of the system.

Previous work by the author had established that the Act and Policies of the Canadian National Park System provided explicit direction for the incorporation of geological and geomorphologic features and processes in the planning and management of the parks. As a result, the focus of the research was redirected exclusively toward the national parks.

Case studies of national parks were used for a several important reasons. First, it would be impossible to assess the status of the earth sciences in all of the national parks of Canada given the number of parks, financial constraints, and logistical problems of data collection. Second, the case study would allow for an in-depth analysis of a few parks, and thus permit assessment at a more detailed level. Third, the set of laws, policies and regulations governing the management and planning of the national parks provided excellent background information on the role of geology and geomorphology in the national park system generally. Fourth, the case study approach allows for a more comprehensive assortment of techniques, as differing data sets (documents, interview responses) are collected.

As the research continued, the context in which the research was being conducted evolved in response to changing institutional arrangements and other conditions (Nelson, 1991). The amendments to the National Parks Act in 1988 provided the basis for the most significant of these changes as individual parks began to adjust their management priorities to reflect the changes in the Act. In addition, a new parks policy was released in 1994, reflecting changes to the Act. Commensurate with these changes, many parks were also completing various aspects of their individual park planning processes. The provisions required of the System Plan of 1972, Natural Resource Management Planning guide of 1982, and the Visitor Activity Management Planning guide of 1986 were all in various stages of completion in various parks. Given the changes to the Act and Policy, many of these management plans are now in need of revision. Indeed, many of the parks considered in Chapter 5 of this study are in the process of revising their various management plans to reflect these changes.

These changes engendered an additional focus to the research (Nelson, 1991). Where the previous Act and Policy provided for the equal weighting of geological and geomorphologic resources in decision making, the new act and policy identified ecological integrity as the primary focus in acquiring, managing and administering heritage sites. This is not necessarily a problem. However, the definition of ecological integrity does not explicitly identify a role for the earth sciences (Serafin et al, 1990). Furthermore, the definition of ecological integrity itself is elusive. Thus, the relationship of the earth science component of the ecosystem to the remainder of the system emerged as a point for attention. The significance of this point will be elaborated upon in subsequent discussion.

3.3 Case Study Methodology

The primary method of the case studies was the analysis of park documents (historical and current). The park documents form a series of increasingly specific recommendations and guidelines as to the appropriate activities of the parks and the purpose of the parks within the system. Furthermore each set of documents is guided by the previous document set. Thus, the documents provide a clear and direct record of the manner in which management should be practiced in the parks (Dilsaver, 1994). Each document was systematically evaluated for references to earth science heritage. The functional framework encompassing resource management, interpretation, and research formed the basis of the document search. That is, each document was initially scanned to identify the sections that dealt with these functions and then each of these sections was systematically assessed for references to earth science features, processes and effects.

Earth sciences were interpreted very broadly, and included references to all physical earth surface features and processes but excluded direct references to pedology, hydrology and glaciology. For example, in the Banff Park Management Plan there are references to the removal of old dams on the Spray River. This was interpreted as a reference to earth science process. Similarly the reconstruction of the dam on Johnson Lake was considered a reference to geomorphological processes, as were erosion control mechanisms on HooDoo Creek in Yoho. This process is described in greater detail in each of the following three chapters in which the various documents are analyzed.

Formal content analysis was not employed in this study, although many characteristics of the method were employed. Content analysis is often employed in the analysis of historical documentary data (e.g.. Faurer, 1994, Nelson and Kreutzweiser, 1988) where there is a large amount of information to be considered (Carney, 1972). In addition, content analysis is often used and is aptly suited to assessing change over time and is particularly appropriate for analyses of events in the news. (Carney, 1972). Generally, only a sample of the documents under consideration is selected. In content analysis, references to events, ideas or processes contained in the documents under consideration are counted and scored to identify their strength or weakness, or the positive or negative sense conveyed. Changes in these characteristics over time and between document sets are compared.

The strength of content analysis is in its systematic treatment of materials. In spite of this systematic treatment, content analysis still cannot eliminate judgment errors on the part of the scorer, nor does it negate the effects of inappropriate categories. In addition, the effectiveness of content analysis is determined to a large degree by the nature of the documents being considered (Carney, 1972). Ideally, content analysis is employed on documents with a continuous and lengthy record (Carney, 1972). In spite of the fact that the documents considered in this analysis do not meet such criteria for an effective content analysis, the general approach for a largely theoretically oriented content analysis (Carney, 1972) was employed in the systematic and objective retrieval of information from the documents (Table 3.2). Additionally, the categories employed (earth science features and processes) were clearly laid out to avoid losing information. As such the consideration of what constituted an earth science theme was necessarily broad. The conceptual framework based upon the functional attributes of the National Park System provides the basis for the systematic consideration of the park documents. By combining the systematic analyses of the documents collected for this study with the results of the field research and interview guide, the study was both longitudinal and

Table 3.2 Content Analysis Infrastructures
(After Carney, 1972)

Details of Infrastructure	Type of Content Analysis	
	CLASSICAL	THEORETICAL
Recording Unit	word	theme
Context Unit	sentence	chapter
Counting via	frequency, on computer	nonfrequency, manual content analysis
Text	ample	meager
Sample	multistage	purposive
Aim	description of manifest content	inference from latent content
Form of Comparison used to assess data	direct	indirect
Criteria for norms	inductive, from outside data	theoretical

cross- sectional (Babbie, 1989). The study incorporates elements of a variety of research techniques (case study, documentary analyses, modified content analysis, field research, interview guide) and focuses them within a case study approach. This approach utilizes the strengths of various techniques while accommodating for their weaknesses.

3.4 Study Site Selection : The National Parks

Having determined that the study would focus upon the national parks of Canada and the role of geology and geomorphology in their management and planning, it became necessary to identify individual parks for the case studies.

The existence of the National Parks Act, Policy, Systems Plan and the various resource management planning processes negates the need for random sampling. As all parks within the system are governed by the same laws, regulations, policies, and underlying principles, there is no logical reason to expect that any one park should markedly differ from another in its manner of resource conservation, research administration, and provision of visitor services and information. The System Planning framework provides for consistent application of resource surveys, inclusive of geology and geomorphology, in the identification of Natural Areas of Canadian Significance.

The parks that formed the basis of this study were selected for a variety of reasons, many of which reflect the wishes of interested and affected parties. Thus, the selection of the study sites was very much part of an interactive and adaptive process (Nelson, 1991).

Case study selection began in consultation with personnel at the headquarters for the Prairie and Northern Region of Parks Canada in Winnipeg. This initial point of contact was, in large part, because the researcher was located in Winnipeg and access to information and key personnel there was possible. Initial contact was provided through Stephen Woodley of Parks Canada, who was then coordinator of the Heritage Resources Centre at the University of Waterloo.

The contact person at the Prairie Region office had previously been Superintendent of a number of national parks, as well as being instrumental in the development of the Natural Resource Management Planning process of Parks Canada. In addition, the contact was trained as a geomorphologist and had significant interest in the research being undertaken.

At the suggestion of the contact person from Parks Canada, four parks were initially identified as potential case studies. These were Banff, Point Pelee, Wood Buffalo and Prince Edward Island. Banff was suggested due to its original identification and designation as a national park on the basis of its geological and geomorphologic resources, notably its hot springs. In addition, as Canada's first and most well known park, Banff would provide a long and well documented history. Banff is also the site of a significant amount of research into the highly dynamic alpine geomorphic environment.

Point Pelee was suggested in part as a result of the contact's previous work in the park. More significantly, the park provides a valuable counterpoint to Banff, as it was originally identified and declared a national park solely on the basis of its biological resources. In spite of this, Point Pelee easily fulfills the requirements of a Natural Area of Canadian Significance with respect to its beaches, sand dunes and other geomorphologic resources. Prince Edward Island was suggested on the basis of its significant and highly dynamic geomorphic environment along with the contact's familiarity with the park.

Wood Buffalo was suggested due, in large part, to its unique history of altering and modifying river channels in an attempt to address changes to the Peace River Delta.

Letters of introduction were sent by the Prairie Region Official to the Superintendents of the four parks and copied to the Chief Park Wardens and Chief Park Interpreters, requesting that they provide assistance to the researcher. Of the four parks, only Wood Buffalo did not respond to the requests for information. The remaining three parks gave the researcher access to all aspects of planning and management documents.

In subsequent meetings with the researcher's Ph.D. committee, concerns were raised about the selection of some parks and the level of detail that could be achieved with such a large sample. It was also suggested that if Banff were to be the main case study, the remaining three parks of the Four Mountain Park Block could provide valuable supplementary information. Furthermore, financial constraints precluded site visits to Wood Buffalo and Prince Edward Island. For these reasons, the Banff case was expanded to include Yoho, Kootenay, and Jasper National Parks as sources of supporting information. Prince Edward Island and Wood Buffalo were dropped.

It was also suggested that, in addition to the major case studies, a number of park management plans be compared and that these should be representative of similar environments. For this reason the park management plans of Waterton Lakes and Kluane National Parks were also analyzed for their incorporation of geological and geomorphologic information. Kluane Park and the Yukon Archives were visited during the field season of 1991 in order to gather documents related to geology and geomorphology and its role in the management and planning of Kluane National Park. The management plans used in the study were obtained from Banff, Jasper, Kootenay, Yoho, Waterton Lakes, Kluane (2), Point Pelee, Riding Mountain, and Wood Buffalo National Parks.

A new set of introductory letters was produced by the Prairie Region office in 1993, forming the initial contact with key personnel in the three mountain parks of

Kootenay, Yoho and Jasper. In summary, the major cases were the Point Pelee and Banff National Park with supplementary information obtained from Yoho, Kootenay and Jasper National Parks.

3.5 Field Seasons

Field work was conducted during May and September of 1993 and 1994. The spring and fall field seasons were selected in consultation with the previously identified contacts at the individual parks. May and September were identified as times during which most park employees would be both available in the parks and not be as busy as they would be during the peak summer months.

The first two site visits to Banff National Park in September 1993, and to Point Pelee National Park in May 1994, were undertaken in an effort to collect documentary information. However, it became apparent through these visits that much more information was available through discussion with park employees. As a result, an interview guide was developed in order to ensure consistency in the collection of this type of information from park personnel (see table 8.1).

In the first two site visits, Banff in September 1993 and Point Pelee in May 1994, the questions asked of park employees were not consistent in form or in application. Therefore, the interview process was begun anew in 1994 using a "modified snowball" sampling technique (Babbie, 1989) to identify appropriate respondents.

The snowball sampling method is a purposive sampling technique, in many ways exemplary of the interactive adaptive approach. In the snowball technique the intent is to identify and interview all those involved in or affected by an event or process. In this case, this meant affecting or being affected by the planning and management provisions of the various park management plans and being involved in the interpretation and management of the parks resources.

In the snowball method, a key individual is identified in each of the study sites. In this case, the individuals were identified by informed personnel within the Park Service.

The process begins with the interview of the identified individual who, in turn identifies others within the system who can provide further information or another perspective. The process ideally continues in this manner until all identified individuals have been interviewed and the same names keep arising. In actual practice, the process is occasionally interrupted when some identified individuals are unavailable and time constraints do not permit closing the process. During this study, most identified individuals within each of the surveyed parks were interviewed. Where modifications were necessary, all attempts were made to follow-up with those individuals not interviewed at the site. In contrast, a purely random sample could result in the selection of a sample that might not be able to answer the questions as well.

The interview guide itself was developed in cooperation with park staff at the Prairie Regional Office and members of the Ph. D. committee. As noted previously, the guide was developed in an attempt to ensure that personnel at all the sample parks were asked the same questions. It was not originally considered as part of the research design and evolved as a result of the field visits. The lack of time was a significant factor in the decision to use an open-ended qualitative interview guide as opposed to a quantitative questionnaire format. As with any methodology, the qualitative interview guide has its strengths and weaknesses, which can affect the outcome of the research.

The open-ended interview guide allows for a much broader and qualitative assessment of the conditions of the park over a period of time. Perhaps the greatest strength of an open-ended guide is that respondents are allowed to provide their own answers and are not required to respond in the limited number of ways offered by the researcher (Babbie, 1992). Indeed, this is a major criticism of the questionnaire survey, the fact that respondents may be led to answer in a specific way about a problem or issue they have not considered. Indeed, the responses to the open-ended interview guide used in this study indicate this very fact, as many respondents indicated that they had not considered the implications of the items raised during the interviews. However, in gaining a more accurate representation of the thoughts of park personnel with regard to the earth sciences, the ability to analyze the information quantitatively was reduced. Using a fixed-response questionnaire would have allowed for a more quantitative analysis of the results. In the early stages of the research a tape recorder was used to record responses. However, this proved to be a distraction to the respondents. Therefore, during the site visits, responses were recorded manually.

During the final field seasons, site visits were made to four of the major case parks, Banff, Jasper, Kootenay and Yoho, and key park personnel were interviewed using a modified snowball sampling technique. The interview questionnaire consisted of sixteen open-ended questions and these are presented in Table 8.1. It was not possible to return to Point Pelee National Park. However, two of the three personnel identified through the snowball sampling technique were interviewed over the telephone.

The September 1994 site visit to the mountain parks began in Yoho where three wardens and two interpreters were interviewed. One other interpreter was identified through the sampling process but was unavailable. Follow-up telephone calls were unsuccessful.

The second park visited in 1994 was Kootenay National Park. In this park three wardens and three interpreters were interviewed. All personnel who were identified through the sampling process were interviewed.

The third park visited in 1994 was Banff National Park. In this park, three wardens were interviewed during the field visit. Three interpreters were contacted through follow-up telephone interviews. The researcher was unable to arrange for the interview of one warden and one interpreter, identified through the sampling method in Banff.

The final park visited in 1994 was Jasper. In this park, only two interpreters were available to be interviewed during the site visit. Two wardens, one interpreter, and one private interpreter identified through the sampling process were not available. However, follow-up telephone calls resulted in the interview of the park interpreter, the private interpreter and one of the two identified wardens.

Finally, two independent researchers were identified through the snowball technique and both of these were interviewed. The interview schedule is summarized in Table 3.3.

Table 3.3 Wardens, Interpreters and Researchers Interviewed in the Study versus Number Identified in the Snowball Sampling Technique
(i.e. # interviewed of the # identified through the sampling process)

	[illegible]	[illegible]	[illegible]
[illegible]	3 of 4 identified	3 of 4 identified	1 of 1 identified
[illegible]	1 of 2 identified	4 of 4 identified[3]	1 of 1 identified
[illegible]	3 of 3 identified	2 of 2 identified	none identified
[illegible]	3 of 3 identified	3 of 3 identified	none identified
[illegible]	1 of 1 identified	1 of 1 identified	none identified
[illegible]	11 of 13 identified	13 of 14 identified	2 of 2 identified

In total 26 individuals were interviewed out of the 29 identified through the sampling technique. These represent 11 wardens, 13, interpreters and 2 researchers.

In summary, the case study approach resulted in a research project that employed a variety of research methods in the spirit of the interactive adaptive approach described by Nelson (1991). These methods included the historical documentary analysis, aspects of content analysis, and the interview guide. The approach was a qualitative one, focussed upon the thorough depiction and assessment of the conditions in the case parks over a limited period of time. As a result, there are some questions concerning the ability to generalize from the results. In retrospect, alternative approaches may have resulted in differing results. However, these would also have engendered a significant change in the research focus and still may not have ensured the ability to generalize the results. For

[3] One former interpreter now a private interpreter, guide and writer.

example, a questionnaire survey of geomorphologists and other earth science professionals would have provided valuable information regarding the attitudes of earth scientists towards the roles of the earth sciences in parks and protected areas; however it might not have provided a detached picture of what is actually happening in the park. Nor, could it provide any information regarding the direction that the management of the parks may be heading. Nevertheless, such a survey of earth scientists is considered to be a high priority for future research.

Chapter 4

The Role of the Earth Sciences in the Canadian National Parks System

4.1 Introduction

In this chapter, the current role of earth science in the planning and management of National Parks in Canada will be discussed in a general sense. As this discussion will focus upon Canada's National Park System, it is appropriate to outline briefly the organization of the National Park System and identify the relevant body of associated legislation, policies, and guidelines. This will form the basic outline of the chapter. Subsequent chapters will deal with explicit case studies of individual parks.

The Canadian National Parks System represents the highest degree of protection of natural features available in Canada (Nelson, 1978). The National Parks Act (1930, 1974 and 1988) and associated policies and regulations provide the guiding principles for all levels of planning within national parks. In the following discussion, the relevance of the various levels of institutional structures that guide National Park management and planning as they relate to earth sciences resources are identified, described and analyzed. This discussion begins with an examination of the Act of 1930 and subsequent amendments (1974, 1988). This is followed by a discussion of the Policy documents of 1979 and 1994, and the significance of the changes therein to the prospects for earth science. Following this, the Systems Planning process (1972) will be described and discussed, again in relation to its relationship to earth science conservation and management.

4.2 The National Parks Act

> "The national parks of Canada are hereby 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 enjoyment of future generations" (Parks Canada, 1974).

The Act in respect to the national parks of Canada has undergone revision since its earliest incarnation. The majority of these revisions have been incorporated to strengthen the provision for the protection of park natural resources. Clause 4 of the Act quoted above, is from the original act and carries a clear conservation and preservation message. However, there is in this clause the seeds of a paradox. The issue of preservation versus use was one of the focal points in the first National Parks Conferences of 1968 and 1978. Partly in response to these apparently contradictory purposes, Parks Canada Policy was drafted to strengthen the provisions for the protection of resources.

In recognition of the many changes that had occurred in Canada and questions about the operational value of the guiding concept of wilderness, the Act was amended in 1988. Significant changes to the Act included stronger provisions for the protection of natural resources and the recognition of the maintenance and restoration of ecological integrity as the primary goal of the park system. These changes are seen by many within the parks system as putting an end to the arguments concerning the dual purposes of the parks (Anderson, 1994, pers. comm.)

In addition, the provision for the designation of wilderness zones within parks was strengthened with the requirement that any changes to the borders of such zones required the approval of the government by order-in-council. The amendments also required the tabling of reviews of all management plans every five years in order to evaluate progress towards reaching the goal of attaining and maintaining ecological integrity

4.3 National Park Policy

The next level of organization is the Parks Canada Policy (1979 and 1994). The main purpose of the policy is to interpret the Act and provide an "integrated and comprehensive statement of broad principles to serve as a guide for more detailed policy statements on specific areas."

In this study, the policy documents of 1979 and 1994 were available for analysis. Each of these documents reflects the requirements of the Act at the time of policy formulation. In turn each of the policies impacted upon the development of various park management documents formulated during their period of application. Most of the management plans consulted in this research project were guided by the provisions of the policy of 1979. However, a series of draft policies were produced after the amendments to the Act in 1988, leading to the development of the policy document of 1994. While not formally accepted, these drafts provided some direction in keeping with the amendments.

The following discussion will address each of these policy documents separately as they relate to geology and geomorphology. The discussion will begin with a consideration of the policy of 1979.

4.3.1 Parks Policy 1979

The National Park Policy of 1979 was intended to provide a broad and comprehensive statement of principles and to serve as a guide for future initiatives. It replaced the policy of 1964. The document has three parts. The first section provides overall policies for all Parks Canada initiatives. The second section provides policies for current activities and third section provides direction for the new directives of heritage rivers, Canadian landmarks and heritage buildings. The program policies are general policies which are expanded upon in the national park policies.

The Parks Canada objective for national parks (1979) is :

> "to protect for all time representative natural areas of Canadian significance in a system of national parks, and to encourage public understanding, appreciation and appreciation so as to leave them unimpaired for future generations"
> (Parks Canada, 1979).

The policy provides direction for the National Park System, including policies which guide the identification (1.1), selection (1.2) and establishment of new national parks. Within these policy provisions are specific requirements that the area contain the greatest diversity of natural area themes, including geological, geographic and physiographic elements.

The policy (2.4.1) also guides the zoning process and notes that zone 1 (special preservation areas) will be so designated to protect rare, unique or endangered natural features.

The protection of natural resources is the primary objective of the parks. In the policy provisions for natural resource management, there is the clear direction that natural processes are to be minimally interfered with in order that the natural evolution of land and water environments can occur(3.2.1). In addition, the policy requires the development of an integrated resource data base. Active resource management is to model natural process (3.2.4) and only to occur under certain conditions (3.2.3)

Visitor use is also clearly delineated in the policy (4.0) and a major goal is the fostering of public understanding of park objectives and issues and the promotion of wise visitor use through interpretation.

The policy also provides direction for the conduct of research in the national parks. The policy recognizes the importance of research to the park system in identifying, developing, interpreting and managing the parks. In addition, the policy recognizes the significant opportunities that the parks provide for basic scientific research. The policy directs the parks to encourage and conduct research into natural phenomena, public needs, visitor use and impact that can assist in the identification, selection, establishment, protection, development, interpretation, planning and management of the parks(5.1).

The 1979 policy also provides direction for the development of the park management plan. The management plan of each park is an expression of the policies as they relate to specific resources of an individual park.

The 1979 policy identifies policies for the three key functions of resource protection and management, visitor appreciation , and research. Furthermore, the policy recognizes the significant relationship which each of these functions has with the others. In the various provisions for these activities, no distinction is made to suggest that one natural feature or process should be afforded differing status, except where such a feature or process is unique, rare or endangered. It is important to note that the 1979 plan speaks of features and processes, however, and not of species or gene pools.

4.3.2 1994 Policy

The 1994 policy was developed in response to a variety of pressures on the park system and the 1988 amendments to the Parks Act. As with the 1979 policy, the 1994 policy provides for the identification, selection, establishment and management of national parks. Throughout these provisions, the 1994 policy also stipulates that ecological integrity is the major consideration in conducting these tasks.

As with the 1979 policy, the new policy relies in part upon geological criteria for the identification, selection, and establishment of national parks.

The emphasis on the maintenance and protection of ecological integrity is the most significant change in the 1994 policy. Provisions for the maintenance of ecological integrity are contained in nearly all subsections of the new policy. As a component of management planning, what was formerly identified as the park conservation plan is now titled the ecosystem management plan.

In all aspects of resource management, ecosystem integrity is a prime consideration and Section 3.2 outlines how ecosystem-based management is to be implemented in the management of park natural resources. Included within this recognition of ecosystems and ecological integrity is the clearly stated goal that all management decisions should be based upon scientific principles. In fact, the policy explicitly identifies the science of conservation biology (3.2.2, 3.2.7)(Soule, 1986, Woodley and Theberge, 1992).

In addition, the policy provisions for visitor understanding and appreciation (interpretation) also identify ecological integrity as the prime consideration in the management of visitor activities and the provision of information. A significant change in the policy dealing with the provision of interpretation activities is the relation of park themes to broader environmental issues (4.2.5) and the relation of ecosystem integrity and the role of protected areas to a healthy environment (4.2.6).

The major changes associated with the new policy relate to the identification of ecological integrity as the prime consideration in all decisions affecting national parks. This change in emphasis from the protection of natural features and processes to the maintenance and protection of ecological integrity indicates an attempt to move towards a more scientific approach to the management of the parks. Indeed, the policy identifies the need for applied scientific research in all aspects of ecosystem management. This can be viewed as a positive change in the policy. However, much depends on the way it is interpreted, for example in respect of geological and geomorphologic resources of the parks.

While the previous policy identified the importance and significance of geological and geomorphologic features and processes in the national parks, the new policy potentially obscures this significance by assigning priority to ecosystems and ecological integrity. If the previous question was "what is the role of geology and geomorphology in national parks?", the new question is "what is the role of geology and geomorphology in ecological integrity and ecosystem-based management?"

According to the definition provided in the 1994 policy (p. 119), ecological integrity is:

> "A condition where the structure and function of an ecosystem are unimpaired by stresses induced by human activity and likely to persist."

The maintenance of ecological integrity is defined (p. 119) as :

> Managing ecosystems in such a way that ecological processes are maintained and, genetic, species and ecosystem diversity are assured for the future."

The policies of 1979 and 1994 do not define ecosystems or ecological processes. However, the message implied in the definitions, as well as in the discussion of the importance of science in ecosystem monitoring and management, implies that ecosystems and ecological processes are primarily biological functions. This suggests, at least at the level of the policy, a reduction in the importance of the earth sciences in the management and planning of national parks.

As noted earlier, this apparent reduction in the importance of geology and geomorphology at the policy level is related to how ecosystems and ecological integrity are defined. The management plans of the Four Mountain Parks define ecosystems as "a community of organisms, interacting with one another, plus the environment in which they live and with which they also interact" (Parks Canada, 1988b, p. 168). While not specifically mentioned, geology and geomorphology could be interpreted to be a part of 'the environment'. Unfortunately, this definition is not specific enough and the degree to which the earth sciences are included in such a definition rests entirely upon the individual park manager. As pointed out in the discussion in Chapter 3, many of the definitions of ecosystems and ecological integrity have this problem. In addition, many discussions of ecosystems and ecological reserves that do refer to the significance of the abiotic environment do so only in broad introductory statements, and rapidly focus the discussion solely upon the biotic processes and organisms (e.g. Taschereau, 1978). As a result , the academic background and the personal interests of individual managers will in large part determine if geological and geomorphologic features and processes are adequately represented in ecological integrity measurements and ecosystem management of the park. This point will be addressed in much greater detail in Chapter 7 where the results of the case studies are presented.

In spite of the problems identified in the preceding discussion, the concept of ecological integrity need not preclude the earth sciences in the management of the park ecosystems. In fact, the concept of ecological integrity and the policy directive requiring ecosystem-based management provide for the rigorous application of science in the management of the national parks. Furthermore, ecosystem-based management can be far more holistic than the earlier species and problem-based approach. Many park managers view the approach of studying and managing resources according to disciplinary lines as part of the problem (Zinkan, 1993).

Viewed in a holistic manner, the new policy can provide the opportunity for increased integration of disciplinary understanding of park resources and, as such, provide opportunities for geology and geomorphology to contribute to the ecosystem-based management of the parks. It remains, however, for geologists and geomorphologists to communicate the importance of this relationship, and to undertake research that integrates the abiotic with the biotic.

The preceding discussion has identified some major changes in Parks Canada Policy between 1979 and 1994, with particular reference to how they might impact on the role of geology and geomorphology in the planning and management of the national parks.

The new policy is ambiguous in terms of directions for the role of geology and geomorphology in the planning and management of the parks. At the same time, the new policy provides a tremendous opportunity for the scientific application of geological and geomorphologic principles in the preservation and maintenance of ecological integrity.

4.4 Systems Plan

The Canadian Park Service System Plan was developed in order to identify, establish, protect, and present those natural areas which are of Canadian significance and to implement Parks Canada Policy into the planning process. At the simplest level, one can recognize three main levels of organization: The Systems Plan, the Park Management Plan, and the Site Plan.

The Systems Plan is the overriding framework which guides the process of new park establishment in order to complete the Canadian National Park system, as well as providing guidance in the planning and review of existing parks. Two of the three identified functions of the national parks (resource protection and management, and interpretation) are guided by formal planning manuals. These documents, the Natural

Resource Management Plan (NRMP) and the Visitor Activities Management Plan (VAMP), are companion documents to the Park Management Plan (PMP), and provide input during all phases of the planning process. They are parallel planning structures. Significantly, there is no specific document which performs this function with respect to research.

The following discussion will examine the role of geomorphology in the Canadian National Park System Plan, Park Management Plan, Natural Resource Management Plan, and Visitor Activities Management Plan. Each of these planning structures can be seen to have applications to individual national parks.

The System Plan development project was initiated in May 1970 with the goal of identifying:

> "1. those Natural Regions and Natural History Themes deemed worthy of representation in the National Parks System of Canada;
> 2. those Natural Regions and Natural History Themes that already have representation within National Parks;
> 3. known features or areas having National Park potential, and provide a basis for examining the balance of the country for future National Park Areas."
> (Parks Canada, 1971).

The Natural Regions of the System Plan are based upon Bostock's (1970) *Physiographic Regions of Canada* coupled with ecological, geographical and geological considerations. Bostock's physiographic classification is based upon observable differences, that is, distinctive changes in topography and geology. The result of this melding of physiography with ecological and geographic variables are 39 National Park Natural Regions(see Figure 4.1)

The next level of organization is represented in the Natural History Themes. Natural History Themes bring out the essence of the Natural Region. Two categories, ecological and geological, are seen to account for most of the natural phenomena in Canada. In combination, these two categories produce the three major themes recognized by the Canadian Parks Service.

1. Land Forms
2. Geological History
3. Land Ecosystems.

The Canadian Parks Service considers the scenic and/or scientific interest of these themes to be a product of the human mind and as result, of different value to different individuals (Mondor, 1993). Assessments of the quality or value of any particular combination of the ecological and geological categories are undertaken at the next two levels - the Natural Region Study and the Natural Theme Analysis of Candidate Natural Areas of Canadian Significance (NACS)

4.4.1 Natural Region Study

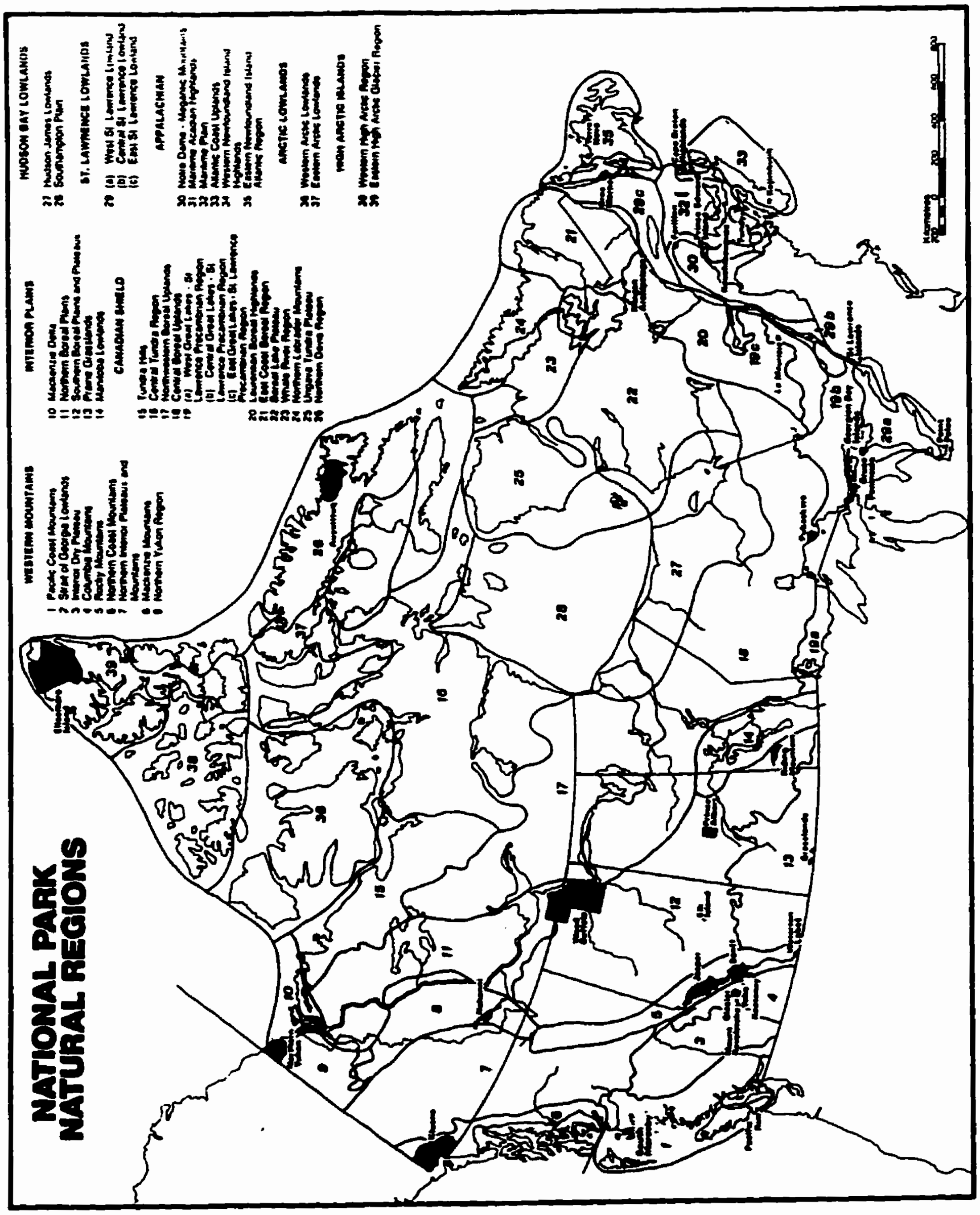
The purpose of the Natural Region Study is to analyze the entire Natural Region in order to identify potential natural areas of Canadian significance (N.A.C.S.) based upon the following criteria;

> 1. the area must portray the diverse geological, physiographic, oceanographic and biological themes of a natural region; and
>
> 2. the area must have experienced minimum modification by man or, if significant modification has occurred, must have potential for restoration to a natural state.
> (Parks Canada Policy, 1979).

N.A.C.S. identification is the first phase in the National Parks Systems planning process. It is a scientific process based upon natural resource values. However, professional judgment still plays a part (Parks Canada, 1982). With respect to geomorphologic features and processes, the inventories are generally based upon pre-existing work as accessed through the literature. Thus, areas which have received little attention from geomorphologists will be poorly represented.

Natural Region Studies have not been conducted for all of the 39 Natural Regions. This is because some Natural Regions were already well represented within the National Park System when the System Plan was introduced. Furthermore, it was determined that it was more important to develop and implement Park Conservation Plans and Park Management Plans for existing parks. The case studies being

Figure 4.1 Natural Regions of Canada



Source Parks Canada 1976.

investigated here have not been the subject of Natural Region Studies. Furthermore, those areas for which Natural Region Studies were available have yet to be proclaimed as national parks and as such Management Plans and other planning documents are not yet developed.

Two Regions for which Natural Region Studies were available and were reviewed during the early stages of this study, Natural Regions 21 and 24, the east coast boreal region and the northern Labrador Mountains, respectively, incorporate inventories of geology, physiography and land forms based upon representativeness (see Fig. 4.1). The system used to score N.A.C.S. is based upon both biotic and abiotic themes and attach value to both significance and "commonness". Significance is determined according to the following definition.

> "Prime Significance": a natural theme was considered of "Prime Significance" if its natural range or distribution covers an areal extent of at least 30% of the study area. A theme was also considered to be of "Prime Significance" if greater than 50% of its natural range in Canada falls within the natural region, regardless of its presence or absence in each sub-region.
>
> "Some Significance": a natural theme was considered to be of "Some Significance "if its natural range or distribution covers 10-30% of the study area or from 10-50% of its natural range in Canada is contained within the study area.
>
> "No Significance": is assigned to a theme which comprises less than 10% of the natural region or less than 10% of its range in Canada
> (Parks Canada, 1982 a & b).

Weightings of "representativeness" value are based upon the product of the values assigned to a theme for significance (maximum 3) and commonness within the Natural Area (maximum 3). The maximum representativeness value of a Natural Theme therefore is nine. Aggregate scores are then tabulated for both biological and geological themes and Natural Areas of Canadian Significance (N.A.C.S.) are identified based upon the results. From the N.A.C.S. identified in the Natural Region Study, potential national parks are suggested.

In two Natural Region Studies examined for this paper, geomorphologic information was severely limited. Only minimal field work was undertaken and most information was derived from geological reports and topographic maps (Parks Canada, 1982 a & b), i.e., the documents identified literature reviews as the source of the geological and geomorphological information. These regions have not been the sites of much earth science research; this is particularly the case where geomorphology is concerned.

As well, the method employed to determine significance raises a number of questions. Sampling methods represent an obvious problem, particularly because biotic and abiotic features are not randomly distributed. Most vexing perhaps is that there is little to distinguish between "significance", as defined in the method, and "commonness". By virtue of the weighting system, extremely common themes will score highly while unique themes may score very low. Furthermore, lack of adequate inventories and questionable assumptions (for example the lack of fieldwork) concerning methodological rigor in those inventories that do exist bring this system of significance determination into question.

4.4.2 National Park Establishment

The process of establishing a national park is a complex political procedure. In Canada, provincial governments have jurisdiction over natural resources and as such much negotiation must take place before provincial governments are willing to cede potential future resource development in what is proposed as a national park. In some cases mining interests may cause alternate N.A.C.S. to be considered. In many cases, mining claims and mineral deposits have a direct impact on park extent and the location of its borders. This occurred in Kluane National Park where 4, 221 sq. km. were excised from the original 1942 park reserve due to mining interests (Theberge, n.d.). For 30 years, mining interests blocked attempts to establish the park (Gray, 1987). Similarly, many spectacular areas were omitted from Nahanni National Park due to mining interests (Stene, pers. comm.). This is also the case with the candidate site in the Manitoba Lowlands for which the provincial government has objected to the Little Limestone Long

Point site on the basis of potential mineral development in the area. Selection of the candidate site is still unresolved and the Manitoba Lowlands is still not represented in the National Park System.

It is at this level in the Canadian park planning system that the role of the earth sciences and geomorphology begins to become somewhat ambiguous, if not in some cases contradictory (Woodley, pers. comm.). Indeed, often at this point some geologists along with foresters may be totally opposed to park establishment. Much of the utilitarian work identified by McLellan (1988) has been directed to resource extraction. In some cases, biologists, too, are opposed to park establishment due to the high degree of visitation that park establishment often causes, as well as the added constraints that are often placed upon research (Riewe, 1994, pers. comm.) It is also at this point where (theoretically) the three parallel planning structures of Natural Resource Management Planning, Visitor Activity Management Planning and Park Management Planning begin to guide and be guided by one another.

4.4.3 Natural Resource Management Planning

Parks Canada policy with respect to natural resources provides for the conservation and management of earth science components of the environment. The policy states:

> Natural resources within the National Parks will be given the highest degree of protection to ensure the perpetuation of a natural environment essentially unaltered by human activity (Section 3.1)
>
> Natural resources within National Parks will be protected and managed with minimal interference to natural processes to ensure the perpetuation of naturally evolving land and water environments and their associated species (Section 3.2.1).

The management planning for natural resources within a park begins with park establishment. Once a park reserve is established, a detailed inventory is conducted on both life science and earth science features. The inventory is based upon base maps, air photo interpretation, and field verification (Parks Canada, 1978). Results of the inventory are incorporated into the Parks Resource Description and Analysis (R.D.A.) which in turn helps guide the Park Management Plan or Conservation Plan (Parks Canada, 1986a, 1986b). The Park Conservation Plan identifies and priorizes resource management problems, concerns and objectives, and in turn is incorporated into the Park Management Plan.

As all the various management plans to this point rely upon inventories for basic data, the nature of these inventories is significant. Guidelines for geomorphological inventories suggested by Wickware (1973) incorporate both form and process. Yet throughout all the inventories conducted in the planning system of Parks Canada the emphasis has been almost entirely upon features as opposed to processes. This is particularly evident in the identification of Parks Canada Natural Regions and in the development of Natural History Themes, both of which focus exclusively upon features, through the use of physiography, landforms and geological history as key identifiers in the processes.

Neither does the Resource Description and Analysis specifically provide for the inclusion of process as well as form.

> "a) to consolidate the Park resource information base and to provide a description of the natural resources of the Park as a major step in the Natural Resource Management Process;
> b) to provide an evaluation of the Parks natural resources in terms of their limitations and opportunities for use, scientific importance, and ecological interrelationships;
> c) to identify basic information gaps in the inventory of the Park;
> d) to identify resource management objectives for the Park;
> e) to identify park conservation requirements to mitigate identified resource management issues, concerns or problems; and
> f) to serve as a public information document to assist in the presentation and subsequent understanding of the Park and its resources." (Parks Canada, 1987)

Prior to 1972, collection of natural resource information (inventories) was conducted by individuals and agencies interested in the particular region. In 1973 Parks Canada initiated inventories in a number of parks to acquire baseline data. These studies were undertaken by outside contractors, other government departments and Parks Canada staff (Park Canada 1987). While this would appear to suggest a more rigorous approach to the collection of natural resource data, in reality most inventories rely almost exclusively on previous research.

4.4.4 Park Management Planning

The Natural Resource Management Process (NRMP) is intended to guide the individual Park Management Plan in the conservation and management of both biotic and abiotic components of the park resource base. However, in practice the individual park management plans often do not provide for the management of geomorphological features and processes. This can, in part, be attributed to the fact that Natural Resource Management Process and the Planning Process for National Parks frequently do not occur concurrently. Ideally, the two processes should progress in an integrated fashion, each building on the development of the other (Parks Canada 1979b).

For example, both the Conservation Plan and Park Management Plan for Pukaskwa National Park provide explicit management guidelines for the management of flora and fauna (Parks Canada, 1986) but do not mention the earth science or geomorphological component. Furthermore, in the problem statement of the Natural Resource Management process for Pukaskwa National Park, it is noted that the natural resource inventory is incomplete as "the initial inventory program concentrated on describing fish, birds, large mammals, and tree species, and to a lesser degree, geology and geomorphology" (Parks Canada, 1986a). While the Park acknowledges these shortcomings and notes that studies will continue to identify rare and endangered species and their associated habitats, the remaining information gaps are perceived to be "relatively unimportant" by Park managers. Here it is evident that the earth science component has become a second priority (Parks Canada, 1986).

Similarly the Park Conservation Plan for Prince Edward Island National (1985) identifies a number of concerns related to coastal management which had been ignored repeatedly in the Park Management Plan. Significantly, active management suggestions consist of engineering and structural solutions rather than an applied geomorphological approach. In the Resource Description and Analyses and Conservation Plan for Kluane National Park (1987) extensive reviews are presented of all geomorphological research in the park. The youthful alpine landscape and ubiquitous geomorphic processes make Kluane an ideal area for geomorphological research. Indeed, geomorphological research has been ongoing in the area since the 1930's. However, at the Park Management Plan level the information on geomorphology is largely of a descriptive type and active management is directed towards the biotic component of the resource base.

4.4.5 Visitor Activities

The Visitor Activity Management Process (VAMP) can be seen as a companion process to the Natural Resource Management Process. Both management processes provide input to individual national parks at all levels of planning. As with the Resource Management Plan, VAMP also reflects parks policy with respect to what is determined to be appropriate visitor activity. The VAMP process attempts to reduce or nullify the conflict inherent in the dual mandate of the park system, through coordinated planning with resource management. The main planning component of the VAMP is the establishment of the Park Service Plan. Service plans may be produced as a single service plan or as three coordinated sub-activity service plans. These are the Park Interpretation Service Plan, the Park Visitor Service Plan, and the Public Safety Plan (Parks Canada 1987).

The purpose of the Interpretation Service Plan is to provide direction for services and to help visitors understand and appreciate both the park's purpose, as well as the natural and cultural heritage of the park. The plan seeks to determine priorities for presentation of the park's natural and cultural heritage based upon available information and the park's stated objectives.

The Visitor Service Plan directs the supply of visitor services and facilities in order to assist visitors to enjoy the park's significant natural and cultural heritage. This component of the plan is concerned with the determination of priorities in recreational opportunities offered, and their subsequent design and development.

The Public Safety Plan provides for a documented approach to planning for the provision of visitor accident prevention and search and rescue services in national parks. As such, the Safety Plan is very much concerned with the identification and assessment with natural hazards within the park.

Data for the development of the VAMP and service plans derive from the Resource Description and Analysis as well as market research aimed at determining the park's potential in terms of visitor understanding, appreciation and enjoyment. The VAMP manual provides for no explicit guidance on the manner in which the various heritage values, including geomorphology, are to be incorporated into the various service plans. As such, they are generally limited to information made available through the Resource Description and Analysis and Conservation Plans. Furthermore, availability of information does not ensure that it will be incorporated into the interpretation plan or service plan.

Cotton (1986) found that the incorporation of earth sciences in the interpretation programs of a number of parks in Ontario was highly variable and appeared to be related to personnel in individual parks. Corbus (1990) and Falk (1990) concur with this assessment and suggest that the perception of some geomorphic features or processes as being mundane prevents their incorporation into interpretation programs. Furthermore, there is a tendency among park managers not to consider the land base itself (and therefore geomorphology), but rather to deal with that which lives on the land base.

The provision of visitor services should provide for the opportunity to incorporate earth sciences into facility siting and other related matters, however, this is not always so (Zellermayer, 1990). As in the case with interpretation, the geomorphological information used to guide facilities provision are derived from previous resource inventories and the RDA. Furthermore, while park's policy provides for Environmental Assessment and

Review in facility siting, this is not carried out for many small operations, such as campgrounds (Zellermeyer, 1990). Given Parks Canada's mandate, and the fact that some site and facility development is required, and in light of a Resource Management Policy which states:

> "Where active resource management is necessary, techniques will duplicate natural processes as closely as possible " (Parks Canada, 1979),

it would appear that the incorporation of what Brunsden et al (1978) term "engineering geomorphology" is particularly appropriate.

The VAMP approach to natural hazards within the park is again based upon previous inventories and the R.D.A. Hence, hazard assessment reflects previous and ongoing research within the national park. Recently, research has proceeded in the U.S.. and New Zealand on natural hazards in national parks (Butler, 1986, 1989, Dingwall et al, 1989), pointing out quite clearly an important role for geomorphology within this component of the VAMP.

A role exists for the incorporation of geomorphology in all levels of the VAMP process. In the interpretation plan, both geomorphological form and process are important components in visitor understanding and appreciation of the park's natural heritage. Incorporation of geomorphology into the interpretation Service Plan, and indeed the Visitor Service Plan and Public Safety Plan, depends almost entirely upon the existence of prior geomorphological research and inventories, and the interest and ability of the individual park manager to integrate the information into the Park Service Plan.

4.4.6 Research

Parks Canada Policy recognizes the need for research at all stages of the establishment, development, and management of the national park system. This is in part seen to be necessary so that parks can be identified, protected, and interpreted to the public. The Policy states that

> Parks Canada will encourage and conduct research into natural phenomena, public needs, visitor use and impacts so as to contribute directly to the

identification, selection, establishment, protection, development, interpretation, planning and management of national parks.

Other research in national parks which will enhance understanding of natural processes and/or enjoyment of natural areas will be authorized:
i) when use of a national park environment is essential; and
ii) when such research is undertaken or sponsored by a qualified individual or organization.

Research activities and facilities within national parks will be controlled by Parks Canada to protect natural resources. (Parks Canada, 1979)

Here it is evident that research is intimately linked to resource management and visitor appreciation. Gardner (1978) reviewed the changing attitude towards research in Canadian national parks, noting that prior to the development of a new park's policy on research, there was an increasingly restrictive attitude towards research. The development of a new policy clearly recognizes the need for research. However, as Gardner (1978) noted, in practice research permits are often withheld. Furthermore, "ignorance of, or non-attention to prior research results, suggest that policy does not reflect practice" (Gardner, 1978).

4.5 Assessment

The preceding discussion has briefly outlined the planning process employed by the Canadian Parks Service and identifies a number of areas in which geomorphology can be of use in the planning and management of Canada's national parks with respect to the three main functions served by the national parks: resource protection, visitor appreciation and understanding, and research. From the Systems Plan through to the identification of N.A.C.S., geomorphological themes are or should be a significant factor in the planning process. However, at the level of the individual national park, practice, unfortunately, often does not follow policy and the role of geomorphology is often significantly diminished (Woodley, 1990, pers. comm, Falk, 1990, pers.comm.). In the preceding discussion, the Management Plans of only three parks (Pukaskwa, Kluane and P.E.I.) were available for examination. Therefore, the suggestion that management for geomorphology is generally ignored at the individual park level is advanced with caution. Chapter 5 follows up on this with the analysis of ten management plans from nine different parks.

The question nevertheless can be asked as to why the role of geomorphology might have diminished? A number of reasons can be suggested. First, there is a perception among park managers that geomorphological and other earth science features and processes are not as important as biological features and processes (Woodley, 1990 pers. comm., Falk, 1990, pers. comm.). This can, in large part, be attributed to the limited number of geomorphologists and other earth scientists employed in parks (Spicer, 1987, Woodley, 1990, Falk, 1990). Furthermore, the sense that geomorphological components "aren't as important" may not reflect professional orientations, but rather reflect unfamiliarity of the significance of earth science components in the system.

The overwhelming focus upon "features" in the Canadian Parks System plan may place limits on the perceived need to manage geomorphological processes. This is particularly the case where managers are not trained earth scientists and geomorphologists. This concern regarding the background of park managers will be addressed in greater detail in chapter 7 as part of the interview questionnaire. Also, each successive stage of the planning process depends upon the accuracy and comprehensiveness of the information available to it. Thus, the level of detail of geomorphological information is determined by the research which has preceded the resource inventories. Thus, research is fundamental to successful incorporation of geomorphological form and process into national parks management and planning. Finally, earth scientists may often be perceived as enemies to the parks, interested solely in mineral exploitation.

CHAPTER 5

Review of the Management Plans

In this chapter, ten management plans of nine national parks (Table 5.1) will be analyzed for earth science representation. These parks were selected as a result of the input of contact personnel at Parks Canada. While it was felt that these parks represented a fairly representative sample of the wide variety of parks within the National Park System, it was also not considered important that they be so. It is suggested that the Act, policies, systems plan, and management planning processes of Parks Canada should ensure that all parks are managed in a consistent manner. Therefore, the nature of the earth science resources managed in a given park may vary with geography, but the manner of their management should not. The sample includes Banff, Yoho, Jasper, Kootenay, Riding Mountain, Wood Buffalo, Kluane, Waterton Lakes, and Point Pelee National Parks.

It has already been established that geological features and processes are supposed to be considered at all phases of management and planning of the national parks (Parks Canada, 1984, 1979, 1994). However, the Policy and the Act have both changed as noted in the previous chapter. Therefore, the management plans discussed below will be considered in light of the policy document and Act effective at the time the plan was produced.

The management planning process for the National Parks has been described in Chapter 4 and will not be outlined again here. However, key functions corresponding to the three functions identified in Chapter 2 are contained in all management plans and this allows for a consistent assessment of the degree of geological inclusion in any given management plan. The basic outline of most management plans includes: Introduction and Objectives, Park Concept, Protection and Management of Park Resources, Visitor Understanding and Enjoyment, Communication Services, Support Facilities, Regional

Integration, Environmental and Social Impact Assessment, and finally, Implementation Strategy or Priority. These sections are further subdivided allowing for ease in comparison from one park to another. Some management plans also include sections

Table 5.1 Park Management Plans Consulted in the Analysis

Banff National Park Management Plan	1988
Point Pelee National Park Management Plan	1993
Jasper National Park Management Plan	1988
Yoho National Park Management Plan	1988
Kootenay National Park Management Plan	1988
Waterton Lakes National Park Management Plan	1992
Riding Mountain National Park Management Plan	1987
Wood Buffalo National Park Management Plan	1984
Kluane National Park Management Plan	1980
Kluane National Park Management Plan	1990

dealing with future directions , or separate the goals and objectives from the introduction and or park concept. These, however, are only minor editorial differences and generally there is a high degree of organizational consistency among park management plans. This is particularly evident in the management plans of the four parks of mountain block. In general, plans do not explicitly identify research.

While not all of these sections will contain information associated with earth science, those in which the policy and act specify concern for the abiotic environment will be analyzed for such information. Table 5.2 outlines these sections of the plans and identifies whether or not an assessment was possible for each of the management plans. From this we can see that the plan can and should provide for earth science consideration in the park objectives, the park concept, zoning, environmentally sensitive sites, protection and management of heritage resources, visitor activity management, interpretation, environmental assessment and review, and implementation priority. Furthermore, it can be determined whether the individual plans provide for features, processes, or both features and processes.

This assessment is not a formal content analysis in which numbers of citations are counted and compared to some "expected outcome". Instead, the plans will be reviewed to identify all references to earth science resources and these will be discussed in terms of management complexity as described by Dearden and Rollins (1994).

Table 5.2 Plan Functions Assessed for Earth Science Heritage

Management Item	Jasp.	Ban.	Koot.	Yoho	Kl.80	Kl.90	Wat.	PPN	RMN	WBN
Park Objectives	A	A	A	A	A	A	A	A	A	A
Concept (themes)	A	A	A	A	n/a	A	A	A	n/a	n/a
Zoning	A	A	A	A	A	A		A	A	A
Environmentally S.S	A	A	n/a	n/a	n/a	n/a		A	n/a	n/a
Protection and Mgt.	A	A	A	A	A	A	A	A	A	A
Visitor Management	A	A	A	A	A	A	A	A	A	A
Interpretation	A	A	A	A	A	A	A	A	A	A
Environmental Assessment and Review Process	A	A	A	A	A	n/a	n/a	n/a	n/a	A
Priority	A	A	A	A	n/a	A	A	n/a	A	A

A- Management item included in park plan
n/a- Management item not included in plan

The following discussion will present the nature and degree of concern for geological components of the natural environment as exhibited in the Parks Management

Plans in the categories identified in Table 5.2. Previous discussions have shown that the Act and Policy clearly identify all components of the natural environment as significant management concerns. In spite of changes to the Act which hold that ecological integrity is to be the key goal in management and interpretation, there is no reason at this point in the analysis to suggest that this might necessarily have a negative impact on the degree of earth science incorporation in future plans.

It will be shown in the following discussion that it is at the level of the management plan that the earth sciences begin to assume a lower priority in the Park System and that this reduction in emphasis has a time element. From the parks discussed below, two major cases have been selected for in depth follow-up. These are Banff and Point Pelee National Parks.

The chapter begins with a summary of the results of the analysis of the management plans for the nine parks. This summary follows the organization of the plans, beginning with the park objectives and concluding with implementation priorities. The summary presents management strategies of the individual plans which hold in common their organization and treatment of earth science resources and identifies how the management strategies match the framework identified by Dearden (1991)(see Figure 2.1). It is shown through the review of management plan items that earth science heritage resources are managed entirely within the preservation and protection typologies of management complexity, and as such, reflect neither current protected areas management practice or the possibilities of applied geomorphology (see Table 5.3).

The summary is followed with a brief description of the ten parks chosen for this study and, an identification of where the plans for these parks differ from the general summary presented previously. As has been noted, there is a high degree of organizational consistency among the plans, and in general this consistency extends to contents as well.

Table 5.3 Inclusion of Earth Science Features and Processes in Management Plan by Management Item and Park Plan

Management Item	Jasp.	Ban.	Koot.	Yoho	Kl.80	Kl.90	Wat.	PPN	RMN	WBN
Park Objectives	F+P	F+P	F+P	F+P	F+P	F+P	F+P	F+P	F+P	F+P
Concept (themes)	F	F+P	F+P	F+P	XXX	XXX	F+P	XXX	XXX	F+P
Zoning	F	F	F	F+(P)	F+P	F+P	F	n/a	F	F+P
Environmentally S.S	n/a	n/a	XXX	XXX	XXX	XXX	n/a	n/a	XXX	XXX
Protection and Mgt.	F	F	F+(P)	F+(P)	n/a	n/a	F	F+P	F+P	F
Visitor Management	n/a	Conf.	n/a	Conf.	F+P	n/a	n/a	n/a	F+P	n/a
Interpretation	F	F	Inc.	F	F+P	F+P	n/a	n/a	F+P	F+P
EARP	n/a	n/a	Insig.	F/n/a	P	XXX	P	XXX	n/a	n/a
Priority(Hi,Med,Lo)	n/a	n/a	Lo	n/a	XXX	n/a	Med	Lo	Lo	Med

F/P-plan provides for both feature and process in the goals of the management item
F-plan provides for feature in goals of management item
P-plan provides for process in the goals of management item
n/a-no provision for either feature or process in the goals of the management item
Conf.-conflict identified between provision of visitor service and earth science resource.
XXX- no data presented

5.1 Management Plan Functions

5.1.1 Park Objectives

The objective statements of the management plans for each of the parks consulted in this study were consistent. The statements were general in nature and are reflective of Parks Canada Policy in respect to the purpose of the national parks (Parks Canada, 1979, p. 28).

Objectives for individual parks were general statements of the intent to protect and preserve resources, and this lack of specificity applied equally to the biotic and abiotic resources. For example, the objective statements for the four mountain parks are identical, and do not identify any specific features or processes (Parks Canada, 1988a, b, c, and d). In terms of the framework identified by Dearden (1992), the objective statements for all the parks considered in this study refer to preservation and protection only (see Table 5.4). There are no references to management of integrated management with respect to park objectives.

Table 5.4 Specific Park Activities Identified in the Management Plans and Level of Management Complexity (after Dearden, 1991)

Preservation	Protection	Management	Integrated Management
Preserve Features and Processes	Protect Features and Processes Public Safety Zoning ESS Erosion Control Remove Freshfield Hut Remove Bow Hut	Public Safety Zoning ESS Erosion Control Remove Freshfield Hut Remove Bow Hut Reduce Road Blakiston Fan Redam Johnson Lake Cease Gravel Extraction Rehabilitate Disturbed Sites	

5.1.2 Park Concept

Park concept statements were not produced for each of the management plans consulted in the study and, as such, it is difficult to make conclusions regarding the significance of the concept statements. Those concept statements that were provided in the plans were elaboration's of the park objective statements, and identified the significant park themes that the individual parks were to represent. As such, they were reflections of the Natural History Themes identified through the N.A.C.S. process as directed by the 1972 Systems Plan (Parks Canada, 1972). Park concept statements are presented in Appendix 1.

5.1.3 Zoning

Zoning represents a management strategy designed to establish the relative emphasis to be placed upon protection versus use for specific park lands. Zoning is based upon established park objectives, resource description and the potential uses of the park. As such, Zoning represents the application of Parks Canada Policy and park specific knowledge (Parks Canada, 1988a).

The identification of specific park lands as Zone 1 (Special Preservation) identifies these lands as supporting or containing rare, unique or endangered features, or the best examples of certain natural features. Access and use of Zone 1 sites is strictly controlled. As such, zoning decisions reflect the third level of scientific and management complexity identified in Dearden's (1991) typology. Zoning represents protection of the resource from internal threats arising from increased recreational use of the resource.

All but two of the plans included in the study, those of Point Pelee and Waterton Lakes, identified at least one Zone 1 Special Preservation site on the basis of significant earth science feature(s). In the case of Point Pelee this is not surprising, as the park itself was initially established solely on the basis of biological criteria. In addition, much of the shoreline of Point Pelee National Park is designated as a hazard zone due to concerns relating to flooding and shoreline erosion.

All Zone 1 sites identified in the management plans were focused upon the protection of features as opposed to processes (Parks Canada, 1980, 1984, 1987, 1988a, 1988b, 1988c, 1988d, 1990). However, some of these features (e.g. Manitoba Escarpment), were selected as features which represented the results of processes.

In general, it is difficult to form any firm conclusions based upon the manner in which the earth sciences are presented in the zoning strategies of the park. However, it is possible to state that zoning reflects the provisions of the Systems Plan (1972), Parks Canada Policy (1979), Natural Resource Management Process (Parks Canada 1986), and management knowledge of the earth science resources of the individual park.

5.1.4 Environmentally Sensitive Sites.

There is not enough information on environmentally sensitive sites (ESS) in the sample to reach any conclusions. No plans consulted in this study identified ESS's on the basis of earth science resources.

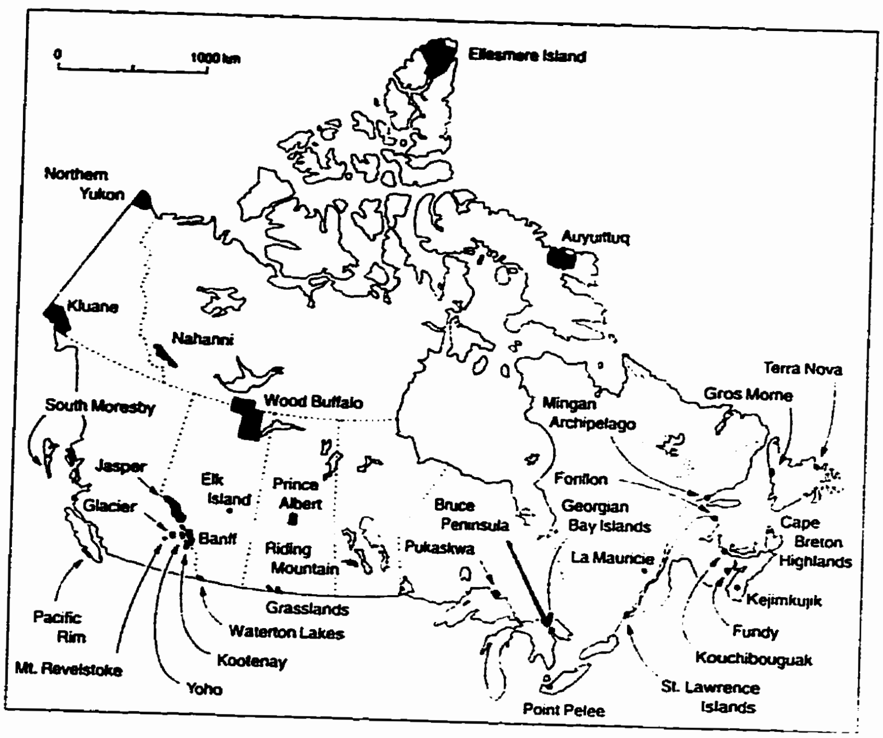
Environmentally sensitive sites protect resources which are identified as either unique or sensitive, and which can withstand higher levels of controlled visitor activity than areas identified as Zone 1. As such, ESS's are similar to Canadian Landmarks (Parks Canada, 1979, p.43) and the National Landmarks of the United States (Spicer, 1988). While the Landmark system in the United States is quite well developed and highly representative of geological resources, in Canada only one Landmark, Tuktoyuktuk Pingoes, has been established.

The park objectives, concepts, and zoning sections of the management plans assessed in this study were all consistent in following Parks Canada Policy. The following five management plan sections (resource protection and management, visitor management, interpretation, environmental impact assessment, and implementation priority) are much more closely focused upon specific management concerns of the individual parks. However, these management strategies also exhibit similarities among the parks.

5.1.5 Resource Management and Protection

A number of significant trends begin to establish themselves in this section of the management plans. First, it is at this stage that some plans do not identify management of the earth sciences as a concern. Second, it is the stage at which a number of plans do not include earth science processes in their plan objectives. Third, it is at this stage that the broad unfocused guiding objectives do not translate into specific management guidelines for earth science resources. Finally, and most importantly, it is in this item of the

Figure 5.1 National Parks of Canada



Source Eagles, 1994

management plans that all but one (Wood Buffalo National Park) of park plans, that the provisions for biotic resources greatly outweigh those of the abiotic.

This general trend refers only to references to the earth sciences and does not imply that the plan item makes any significant statements with regard to the import of the earth sciences in that plan item. This is particularly true with reference to the management items relating to resource protection and management, and visitor management.

Resource protection and management items relating to earth sciences in the various plans are generally stated as broad objective statements that do not refer to specific management actions relating to specific earth science concerns. In addition, most of the plans further elaborate through guideline statements that identify the manner in which the objectives are to be achieved.

When compared to the management provisions for the biotic resources of the park, there are distinct differences in the manner that the earth science resources are dealt with in almost all the plans. This difference begins with the nature of the individual sub-headings under resource management. Every plan in this study identifies earth science concerns under the single sub-heading of "resources", while all biotic concerns are further sub-divided and discussed under the sub-heading of management. For example, in each of the four mountain parks, earth science heritage is considered under the sub-heading "Geological and Physiographic Resources", while biotic heritage is sub-divided into "Vegetation Management", "Wildlife Management", and Fisheries Management" (Parks Canada, 1988a, b, c, d.).

In addition to allowing for a more detailed discussion of biotic resources, the use of the word management implies that there is a difference in the manner in which these resources are perceived. This is not a statement that can be made with certainty, and, the management plans themselves do not provide incontrovertible proof. Indeed, a major problem with the management plans is that there is so little specific information which relates directly to earth science management issues (the exceptions being Point Pelee and, to some extent, Yoho (Parks Canada, 1993, 1988b).

Two problems identified in a number of the management plans, gravel extraction and disturbed site rehabilitation, can be characterized as earth science concerns. However, while the plans recognized that gravel extraction is inconsistent with the goals of the National Parks, they did not identify the significance of the deposits in terms of earth science heritage, nor did they identify a role for applied geomorphology in reclamation. Indeed, reclamation concerns centered upon aesthetics and biotic concerns, for example concern over sightlines due to pits along the Icefields Parkway.

In contrast, the provisions for biotic management often clearly identify management interventions, for example fire in the four mountain parks, non-native plant control in a number of parks, marten and fisher re-introduction in Riding Mountain to name a few. Characterizing these management strategies, according to the framework identified by Dearden (1992), results in the identification of earth science management strategies as being dominated by preservation and protection typologies, while the biotic management strategies fall within the management -integrated management typology.

5.1.5 Visitor Activity Management

As with other management strategies in the various park plans, the provisions for visitor activities provided little direct reference to the earth sciences. This limits the argument to the suggestion that the lack of identification of earth sciences features and processes as management concerns reflects that these are not viewed as management problems.

In spite of these problems, those management items that do address the earth sciences appear to provide evidence of a decline in the significance afforded to earth science resources in nearly all of the management plans considered. There is very little reference to the earth sciences in the text of the documents, and where there are references, they often identify conflict between the provision of visitor services and earth science heritage resource values.

Perhaps most significant were the number of conflicts between resource values associated with the earth science heritage of the mountain parks and the provision of visitor activities and/or services. In three of the four mountain parks, there was such a conflict.

A significant one was the decision to rebuild the dam at Johnson Lake in Banff National Park. This decision is in direct contravention of the Act and Policy of Parks Canada. In the justification for this action, the management plan identified the rarity of such features as low elevation lakes in the montane region of the park and the fact that the lake has provided fish and waterfowl habitat during its 50 years of existence (Parks Canada, 1988d, sec. 4.2)

Thinking about the first of these reasons, it is the very nature of the lower elevation montane region to be well drained and consequently depauperate of standing bodies of water. Thus, low elevation montane lakes are not representative features of the region, and therefore their rarity need not be an excuse to create artificial ones.

The second argument states that the lake provides habitat for fish and waterfowl. This implies that the preexisting conditions provided no habitat, an unlikely situation. While the original environment likely did not provide habitat for fish and waterfowl, it undoubtedly provided habitat for some other organisms. In addition, the fish for which the lake provides habitat are non-native stocked trout (Brook-*Salvelinus fontinalis*, and Brown-*Salmo trutta*). The preceding provides some evidence of the bias towards the biotic resources in the management plan of the park.

While the true reason for the damming of Johnson Lake appears to be significant public support for "raising water levels", the identification of habitat provides a more acceptable reason for interfering with natural processes in the minds of the writers of the plan. This bias is so strong that even non- native species are considered to be more valuable than the naturally though unspectacularly occurring abiotic processes.

Other conflicts in Banff were related to the siting of backcountry huts in locations extremely hazardous or inaccessible due to the active geomorphological processes of the area. These conflicts pointed to a lack of understanding of earth science processes on the part of park managers. In addition, it indicated that geomorphologists were not consulted about potential siting problems. In the following text this will be shown to be a recurring problem.

Similar, although less stunning, examples of the general lack of concern given to earth science process in visitor management provisions occur in other mountain parks In Yoho National Park, the siting of the visitor centre and at least one campground conflicted with both earth science resources and processes (Parks Canada, 1988b). In spite of the recognition that these conflicts existed, the sites were developed and maintained. However, Yoho remains the mountain park that is most oriented to the earth sciences in its management plan and consideration is given to some of the more spectacular processes such debris slides and avalanches in hazard assessment and public safety (Parks Canada, 1988b).

In addition to the conflicts between visitor use and resource protection, there is a general trend in the plans towards a reduction of emphasis on earth science resources in the management items in each of the plans. That is, it appears that as the plans move from general objectives to actual management, the earth sciences are considered less and less.

5.1.6 Interpretation

Management items relating to the interpretation of park heritage resources consistently centered around the themes to be presented, and the various methods of delivering these messages to the public. In general, most of the plans recognized at least one theme relating to the earth science heritage of the park. However, the focus was largely upon features as opposed to process. For example, the interpretation program in

Yoho National Park, which is dominated by an earth science focus, focuses upon the features of glacial and fluvial erosion. While these are representative of processes, the focus is on the features produced, and there is no consideration of contemporary processes, such as the debris flows of Cathedral Mountain.

In addition, there appears to be a general trend towards a reduction of emphasis in the earth science interpretation in the more recent plans. The lone exception to this is the Kluane 1990 plan which identifies the significance of both features and processes in the identification of park themes. However, the interpretation section of this plan is essentially unchanged from the 1980 plan.

The earliest plans, those of Kluane(1980), Riding Mountain(1987), and Wood Buffalo(1984), all incorporate both form and process in the messages being delivered to the public. These messages are reflective of the Act, (1930), Policy (1979) and Systems Plan (1972) in effect at the time. This is in spite of the fact that two (Riding Mountain and Wood Buffalo) of the three parks are not particularly dynamic in terms of geomorphological processes.

The plans of the four mountain parks, all produced in 1988, identify the interpretation of features as the main focus in their interpretation themes. Similarly, the management plan of Waterton Lakes (1992) identifies features of the park as the significant themes in the interpretation of earth science heritage.

The greatest departure in theme development is contained in the management plan for Point Pelee National Park (1992). The themes for Point Pelee do not include any specific reference to the earth science heritage resources of the park. The interpretation of the park resources is directed to focus upon biological resources and a number of messages relating to environmental citizenship and ecological integrity.

This is suggestive of a significant change in the interpretation of the National Park Act with respect to interpretation of park resources and the significance of the themes identified through the Systems Planning process. It is, however, only suggestive of a change as it represents only one case.

In general, there is a better representation of earth science in the theme identification for interpretive messages than in natural resource management items of the plans. To a large degree this can be explained by the fact that the source of the themes for interpretation lies in the Systems Plan (Parks Canada, 1972) process for identifying Natural Areas of Canadian Significance. Through this process the significant and representative natural resources responsible for park establishment are identified as Natural History Themes and incorporated into interpretation messages.

However, with the amendments to the National Park Act in 1988, the protection of natural resources (both biotic and abiotic) is no longer the ultimate consideration in management and interpretation in the national parks. Instead, the maintenance of ecological integrity is to be the ultimate goal of management and interpretation.

Furthermore, there is no way of knowing, using only the Management Plan of 1992, whether earth science resources were previously interpreted at Point Pelee. This will be discussed in the next chapter, which presents the more detailed case studies of Banff and Point Pelee National Parks.

In addition, the 1994 review of the Management Plan of Banff, as well as the interviews of park personnel, should provide clarification as to whether the interpretation of earth science resources is in fact being reduced in the mountain parks in response to changes to the Act.

5.1.7 Environmental and Social Impact Assessment

The environmental impact assessment statements of the management plans continue the trend of diminished attention to earth science. Here only one plan, that of Kluane (1980), identifies a concern related to the earth sciences in the Environmental Assessment and Review Process section. This was the earliest plan that was considered in the study.

In spite of the fact that a variety of other management items in the plan clearly identified significant impacts to earth science resources in the parks as a result of some plan provisions, the Environmental Assessment and Review Process section of the plan does not identify these as concerns(for example the Visitor Centre in Yoho and the rebuilding of the dam at Johnson Lake). Given that there were few clear and specific guidelines relating to earth science resource management in the plans of the parks, it is not surprising that the Environmental Assessment and Review Process section is void of implications. That is, where management objectives consist solely of general statements regarding the protection and preservation of resources, specific impacts are unlikely to be identified.

The requirements for Environmental Assessment and Review Process in the National Parks are such that all proposed activities to take place in the park must be reviewed. Therefore, the expanded case studies to follow will allow for further assessment of these findings.

5.1.8 Implementation Priorities

The level of priority that the park management plan ascribes to a particular management activity is measure of the item's perceived importance in park management. In the review of this item in all of the plans consulted in this study, strategies related to the management of the earth sciences were identified as a high priority item in only two park management plan (Parks Canada, 1988b, 1992).

In fact, the listing of implementation priorities for many parks identifies projects not referred to at any other point in the management plan, while at the same time ignoring items related to the earth sciences identified in the plan. For example, nowhere in the text of the Jasper Management Plan (Parks Canada, 1988a) is there reference to either coyotes or beavers as a management concern. However, both of these items are identified as high priority items in the implementation strategy. This is perhaps the most important aspect of the management plans in terms of identifying the low level of significance afforded earth science concerns within the management plans consulted in this study. Table 5.5 below summarizes these implementation priorities.

Table 5.5 Implementation Priority Identified in Park Plans
(Priority of proposed activity)

Park	Implementation	Priority	
	High	Medium	Low
Jasper Park Plan	0 Earth Science 14 Biological	1 Earth Science 11 Biological	
Yoho Park Plan	0 Earth Science 7 Biological	1 Earth Science 0 Biological	
Kootenay Park Plan	2 Earth Science 10 Biological	0 Earth Science 2 Biological	
Banff Park Plan	0 Earth Science	0 Earth Science	
Kluane Park Plan 1980	No implementation Priority given		
Kluane Park Plan 1990			
Waterton Lakes Park Plan	2 Earth Science 5 Biological	0 Earth Science 2 Biological	3 Earth Science 0 Biological
Riding Mountain Park Plan	0 Earth Science 7 Biological	1 Earth Science 0 biological	1 Earth Science 1 Biological
Wood Buffalo Park Plan	0 Earth Science 3 Biological 1 Biological and Earth Science	0 Earth Sciences 0 Biological	0 Earth Sciences 1 Biological
Point Pelee Park Plan	No Implementation Priority Given		

The individual management plans do not provide the means by which the priorities are established, nor do they identify ranking of proposed projects within a priority. In addition, there is no means of identifying which strategies actually are implemented. For example, the second highest priority earth science items identified in the Kootenay management plan were the development of a geological and a hydrological resource management plan. In spite of the fact that these plans were produced in 1988, neither of these strategies have, as yet, been implemented (Halverson, 1994, pers. comm.). In addition, as new priorities emerge through the review of the management plan (1994), some of these strategies are accorded lower priority.

Overall, the preceding assessment and discussion have identified a significant reduction in emphasis placed upon the earth science resources of the national parks in the management plans of nine parks. This reduction proceeds as the management item become more focused and activity driven within the planning framework. That is, in the general statements of the park objectives and management objectives of the plan for the earth sciences resources are generally considered equally with the biotic resources of the park. However, as the plan moves to more specific guidelines, actions, and implementation priorities, the earth science resources are less and less important.

In general, interpretation has been an exception to this general pattern. The earth sciences have formed important themes in the interpretive messages of the national parks. However, here too there are limitations. Generally, interpretive messages focus upon features as opposed to processes and as in other plan items features and processes are often confused.

The following ten subsections of this chapter will focus upon the elements of the individual park plans which do not conform to the discussion presented above. In these discussions, only those plan provisions which are distinctly different from the summary above will be discussed.

5.2 The Management Plans

5.2.1 Jasper National Park

The management plan for Jasper National Park was, like those for all the national parks in the four mountain parks block, approved and put in place in 1988 and was updated (1994). This is particularly fortuitous in that it allows for an assessment of how the amendments to the Act are seen to affect the management plan review.

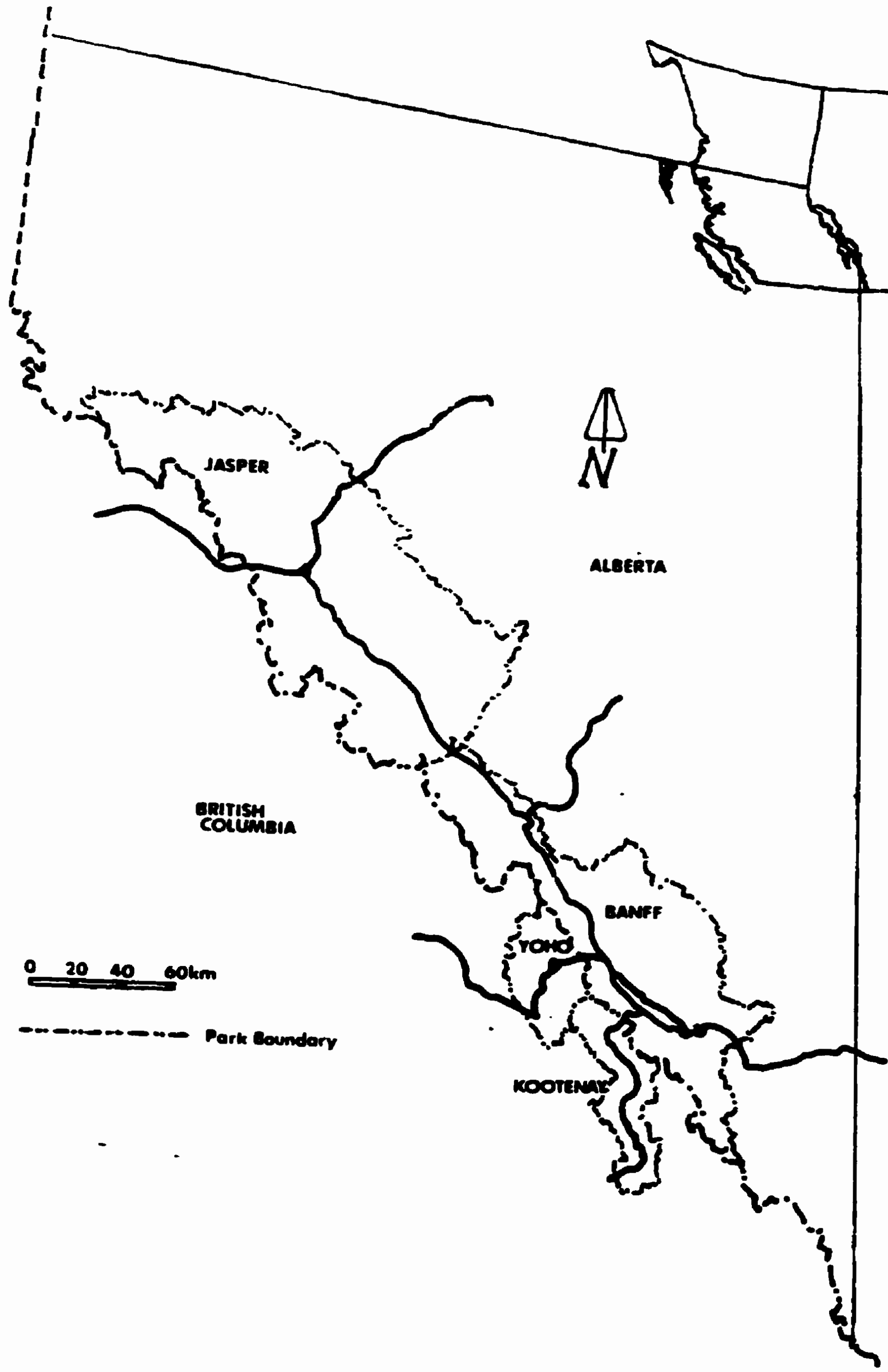
Jasper National Park is the largest of the four mountain block parks (Fig 5.2) and covers an area of 10, 878 sq. km. (see Fig. 5.3) In 1984, these four parks, encompassing a total area of 20,160 sq. km., were designated as a world heritage site in recognition of "their outstanding beauty, the diversity of vegetation and wildlife, and the exceptional examples of glaciation, canyon and karst features" (Parks Canada, 1988, p.11).

Each of the four mountain parks shares the same objectives. These are:

> " Protection and Preservation of Resources,
> Natural Resources and Processes
> a) To protect and preserve the natural resources and Processes occurring within Banff, Jasper, Kootenay, and Yoho;
>
> b) To provide the highest level of protection or, where appropriate, preservation of resources and processes that are:
>
> i) nationally or internationally significant;
> ii) unique rare or endangered;
> iii) good examples of the natural resources and processes occurring in the Canadian Rocky Mountains; and
> iv) important in retaining the parks wilderness character."

The preceding outlines that the objectives of the four mountain parks are concerned with the preservation and maintenance of all "significant" natural resources and processes within the parks. There is no distinction drawn between the living and non-living resources and processes. However, neither is there a connection made between these. This set of objectives is common to all national parks and is outlined in the Park Management Guidelines (Parks Canada, 1982).

Figure 5.2 The Four Mountain Parks



Source: Parks Canada, 1994

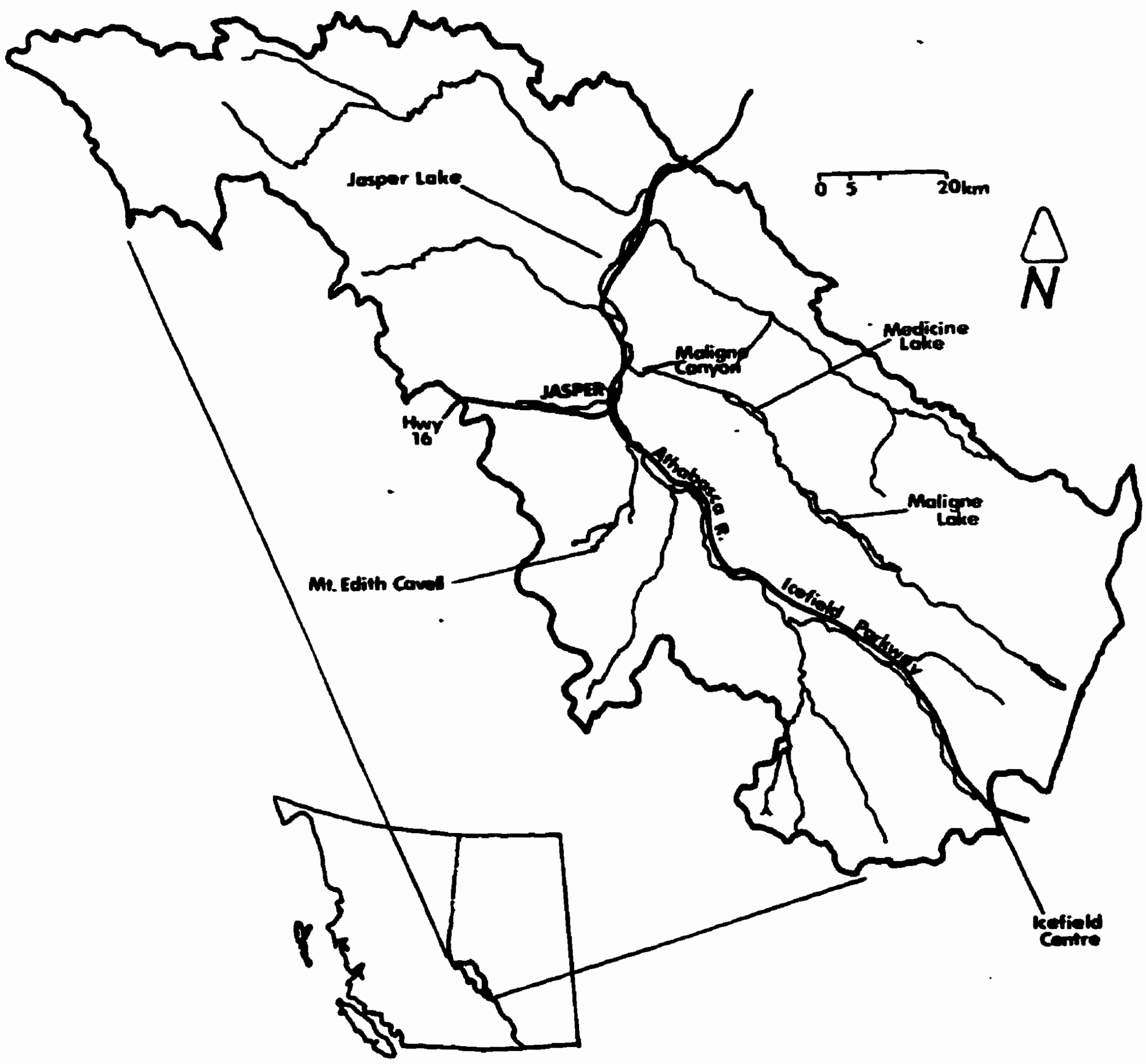
The park concept for Jasper National Park, like those for the other national parks is focused upon the natural history themes of the park. As these themes are focused upon the most significant features and processes of the park, it seems reasonable that these themes will form the focus of management, interpretation and research initiatives.

The plan indicates that one of four Zone 1 sites (Fig. 5.3), was designated as a result of the recognition of its geological significance. The significance of this site, like many karst sites in the Canadian Rockies, is largely the result of the work of Ford (1973, 1972) pointing to the importance of interest on the part of the scientific community in the establishing the role of the earth sciences in the national parks.

The management plan of Jasper National Park notes that a number of features have been identified within the park as significant on both a national and international basis. Included among these are the Maligne River Karst System, the sand dunes of the Jasper Lake area, as well as (unnamed) canyons, natural bridges, fluvial features, and glacial landscapes (see Figure 5.3). The plan goes on to point out that while many of features have been identified and studied, a number of others, including fossil beds, karst systems and permafrost areas, require further study in order to determine their significance as well as to define management strategies for their protection.

In the Park Management Plan discussion of these management guidelines, it is noted that systematic study is required in order to develop management strategies for the protection of significant features. The discussion notes that such information will be invaluable in the preparation of interpretation material explaining the parks heritage resources and identifies the Snaring River Karst System as a resource with potential significance requiring further study. In addition, the significance of the Maligne Karst System, the Surprise Valley, the Jasper Lake Dunes, and the Miette Hotsprings are all singled out for special attention in terms of management. However, no management directives arise from this recognition.

Figure 5.3 Jasper National Park



Source: Parks Canada, 1994

Finally, the discussion notes that gravel extraction affects vegetation and geological resources as well as the visual integrity of the park, so that in the future all attempts will be made to acquire gravel resources from outside the park. This particular concern is common to all the mountain block parks as well as to many other parks within the system and results in numerous borrow pits throughout the park in various stages of reclamation. The plan calls for a systematic approach to the priorization of disturbed site rehabilitation, focusing upon such factors as visible degree of impairment, extent of damage to natural habitat, disruption of watershed, and potential for continued terrain damage. In addition, the plan calls for the development of approved rehabilitation plans in the case of all future site disturbances. This latter point is in direct contradiction of the discussion in the geological resources section which calls for the cessation of gravel extraction in the park. This suggests that there is a conflict within the document with respect to the provisions outlined in different sections of the plan. This type of conflict occured in a number of the plans, and the follow-up questions asked of park managers during the survey provide further evidence of this (see chapter 8).

It is clearly stated in the objectives of the park management plan that resource protection will take precedence whenever there may a conflict between visitor use and facility development, and the potential for adverse impact of park resources. Nevertheless, the high degree of emphasis placed upon biotic resources in the resource management guidelines is reiterated in the various visitor management guidelines.

Significant implications for the management of day use areas as they relate to geological and geomorphological resources are identified in the recognition of the need for an area plan for the Columbia Icefields. The discussion notes:

> 'The Columbia Icefields is one of the best known and most popular visitor destinations in the Canadian National Park system, due to its spectacular natural resources and the easy access to a glacial environment. Facility development in the area has occurred haphazardly. The need to closely integrate visitor facilities to improve visitor experience and safety, to improve the area's aesthetics and to mitigate environmental concerns has been noted for some time. The area plan will address these concerns. It will provide long term-development alternatives,

> recommend short-term design actions, and set the direction for the required site improvements."
>
> (Parks Canada, 1988, p. 70)

While the reference to specific geological and geomorphological resources is lacking, it is clear that the emphasis here is upon the significance of the unique opportunities provided by this glacial environment. It is curious that this significant resource was overlooked in the resource management objectives and guidelines of the park. Further implications arising from the development of this area are addressed in chapter 8.

The shared messages of the Four Mountain parks were, in large part, guided by the "Interpretive Plan for the Seven National Parks of the Canadian Cordillera" (Parks Canada 1975). The intention of this document was to coordinate message presentation among the parks so that duplication could be avoided. However, the discussion of the management guidelines of 1988 indicates that a number of additional heritage themes have gained prominence since this time, including Heritage Rivers and World Heritage Sites. In addition, the role of interpretation had expanded to include such messages as park management goals and to use interpretation itself as a management tool through fostering environmental awareness and the development of appropriate behavior (Butler, 1994). Given that park resource management guidelines do not include geology and geomorphology to any appreciable degree, it becomes evident that the management plan of 1988 will also engender a reduction of the significance of geology and geomorphology in park interpretation.

A number of information gaps are identified throughout the management plan and many of these have been presented above. In addition, the Environmental Assessment and Review Process of the plan identifies some specific issues related to facility development in the park and includes in this the need for further study of the Jasper Lake dune complex as the only additional significant geomorphological information gap. It is noteworthy that neither the Columbia Icefield nor the Maligne canyon were identified as EARP concerns.

5.2.2 Yoho National Park

Yoho National Park comprises 1,313 km. sq. of the 20,160 sq. km. Four Mountain Park block, and protects a representative portion of the Rocky Mountains west of the Continental Divide (See Fig. 5.4). The Yoho National Park Reserve was initially established in December, 1901, largely as a result of the explorations Dr. Jean Habel in 1899 (Lothian, 1987).

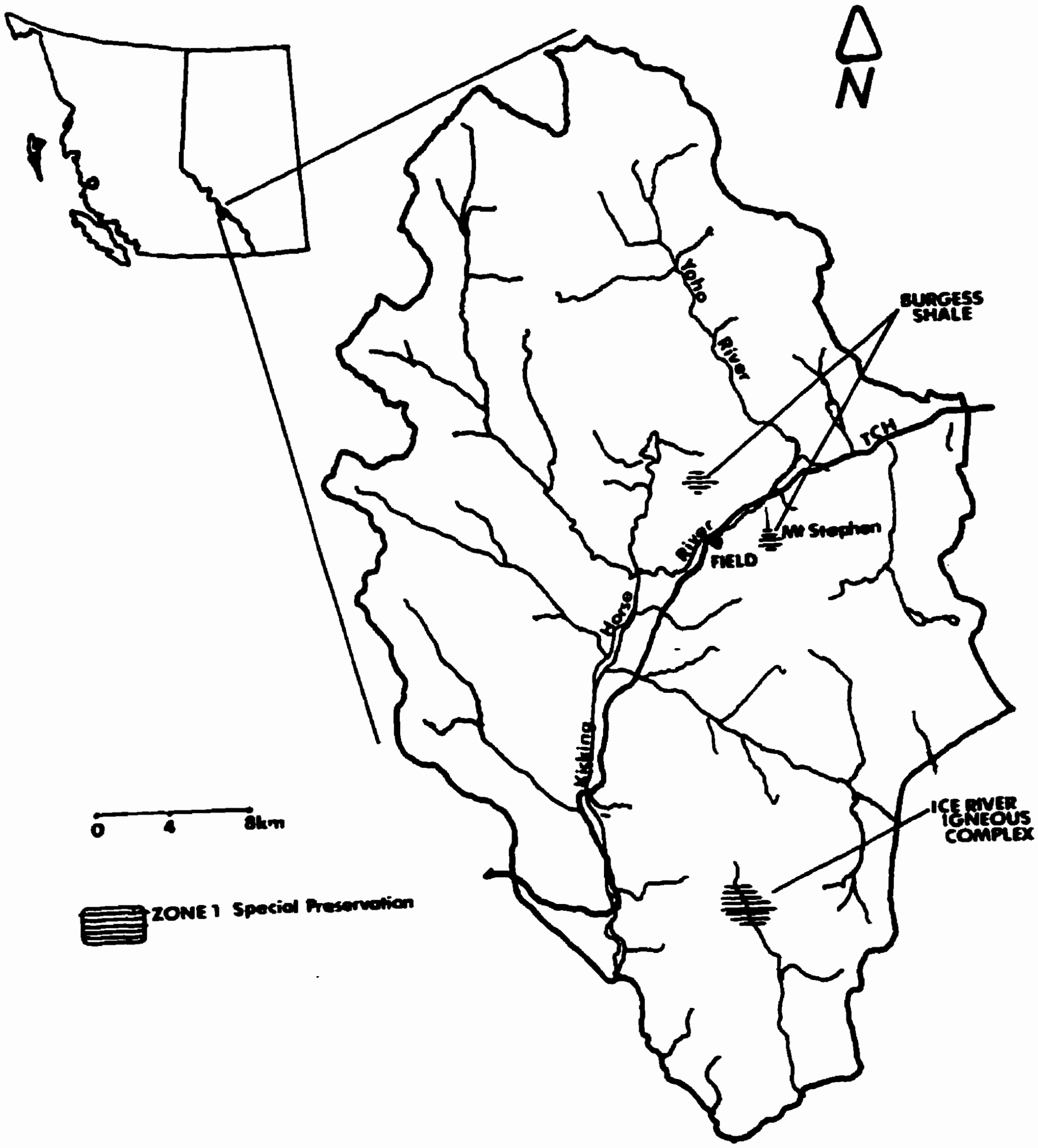
The park theme, Rockwalls and Waterfalls, as well as the emphasis placed on natural history themes associated with the geological and geomorphological resources of the park, point to the high degree of significance of these resources to the park. This significance is further highlighted by the designation of both the Burgess Shale fossil beds and the Ice River igneous complex as Zone 1 Special Preservation areas. In the 1988 plan no other Zone 1 sites had been identified. However, it is noted that section 3 of the plan (Resource Management) directs further research and the development of an ecologically-based management strategy. It is anticipated that new potential Zone 1 sites may be identified through this process.

In recognition of the highly dynamic geomorphic environment of the park, the park concept also recognizes the need for natural hazard evaluation and control.

"In the interest of public safety along the Trans-Canada Highway and park roads, the monitoring and control of avalanches, debris flows, mudslides and other natural hazards will remain an administrative priority. Such activities, involving the use of helicopters and oversnow vehicles as well as explosives are necessary and acceptable."

It is evident that the park concept clearly recognizes the significance of the dynamic contemporary geologic processes as well as the international and national significance of relict features within the park.

Figure 5.4 Yoho National Park



Source: Parks Canada, 1988.

The earlier guidelines discussion noted that the management of the park's geological resources is guided by an ongoing geological resource management plan that is intended to identify measures required to protect significant park resources. The major problems associated with the Burgess Shales and the semi precious minerals of the Ice River complex stem from their collection by park visitors. As a result, access to both these areas is restricted. The Burgess Shales can only be visited by guided walks, while access to the Ice River complex is to be controlled by backcountry permit. Trails are to be minimal or non- existent. In fact there is no interpretation of the Ice River Complex and very few visitors are even aware of its existence. Furthermore, due to the region's significance, the management plan does not even provide a map identifying its location.

As noted in the guideline rock and mud slides, and debris flows are major management concerns in Yoho, particularly in the Cathedral Mountain, Mt. Hurd, Mt. Stephen and Mt. Field areas. The active mass wasting processes have had significant impacts upon the Trans-Canada highway and the CPR. Jackson (1978) identifies a Jokullhaup as the causal agent in the debris slides of Cathedral Mountain. Active management of the subglacial lake has been taking place since the late 1980's. The management plan makes no reference to this but notes that "actions are being taken to gain a better understanding of these geomorphological problems" and that "steps will be taken to control slides threatening facilities and to improve general public safety measures".[4] Also, the plan calls for all future facility siting to be planned in a manner that ensures active manipulation is not required.

Related to this are a number of resource conflicts associated with the provision of front country accommodations. The campgrounds at Hoodoo Creek and Chancellor Peak both require the manipulation of geomorphic processes. In addition, both of these sites are, in terms of earth science processes, disturbed sites.

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[4]Significantly, there is no evidence of this in either the research permit log for the park or in references to EARP.

The plan notes that the Kicking Horse Campground is located in a constricted valley bottom which is prone to avalanches and as such there are no plans for its expansion in spite of high demand by visitors. Interestingly, the plan does not identify any concerns related to the upgrading of the Kicking Horse overflow relating to its location in a geomorphically active zone. In fact, in 1994 the entire overflow campground was seriously damaged by the debris flow (Fig.5.5).

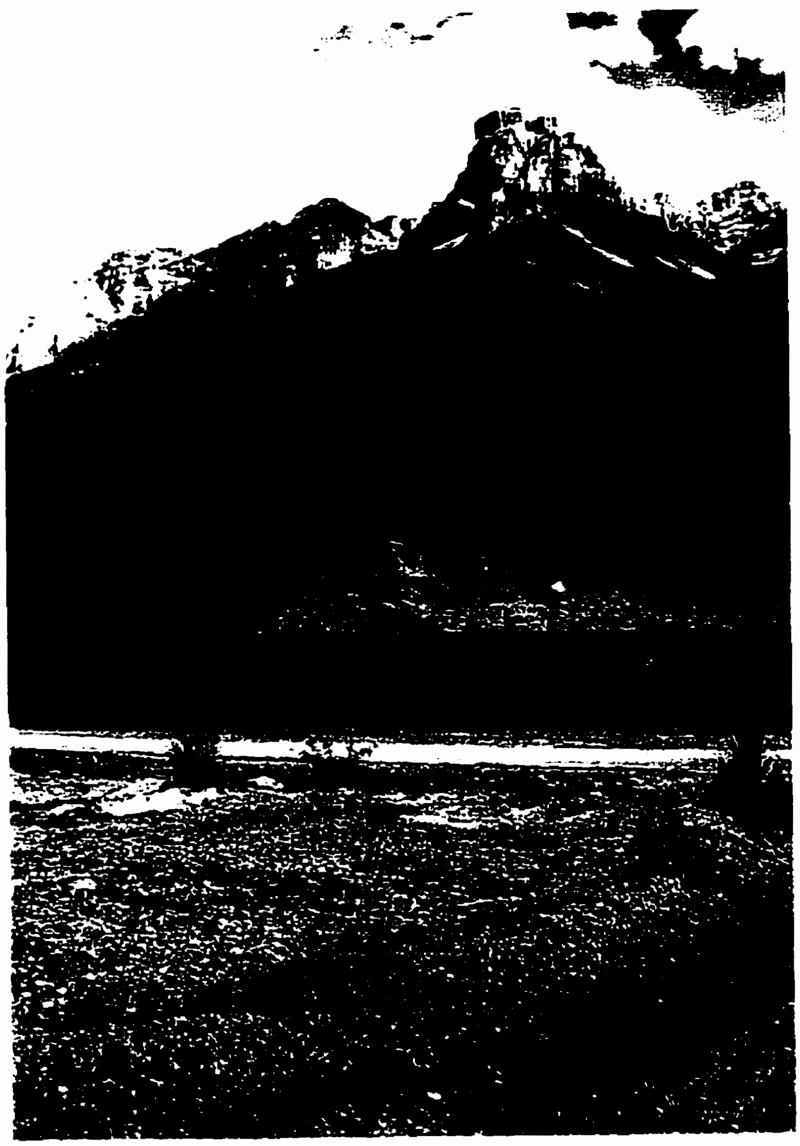
In most other national parks, the environmental impacts relating to visitor access are focused largely on highway wildlife mortality. While this is also a concern in Yoho National Park, the extreme local relief along the transportation corridors of Yoho National Park results in a very active geomorphic environment. The Plan guidelines explicitly acknowledge this fact.

> D. In attempting to control mass wasting, glacial outburst floods, snow and rock slides, an emphasis will be placed on minimizing the amount of manipulation of natural features that is required. New facilities will be carefully sited to avoid potential conflicts with natural processes.
>
> Discussion:
>
> Due to the extreme nature of Yoho's topography, many facilities must necessarily be located in areas which are subject to natural phenomena such as mass wasting and snow slides. This manipulation has taken place to reduce hazards from these processes. This manipulation of natural features will be minimized in the future.
>
> (Parks Canada, 1988b, pp. 116-117)

The management plan of Yoho National Park recognizes the significance of the geomorphic processes in the park from the perspective of hazards mitigation. Yet the plan confuses features and processes in both the guideline and the subsequent discussion. As well this is the first and only reference to the unusual process of glacial outburst flooding or "jokullhaup". Curiously, the plan does not refer to these events in the environmental assessment.

In the development of communications for the Park Management Plan, Yoho again distinguishes itself from the other mountain parks in the degree to which the

Figure 5.5 Stephen Slide Area, Kicking Horse Pass September, 1994.
(Note debris in foreground and engineered channel in background at right)



(Campbell, 09/94)

management plan makes specific reference to geological and geomorphological resources. The plan further guides the provision of interpretation programming and outlines the significance of themes associated with "geology of the western and main ranges of the Rockies, the Burgess Shale fossils, the sculpturing of the landscape by water, glacial ice and wind, as well as the ecology of the Montane, Subalpine and Alpine life zones" (Parks Canada, 1988b, p. 144). This particular section of the plan highlights two significant problems hypothesized in this study. First, is the general lack of emphasis in interpretation placed upon contemporary geomorphic processes, and second, the apparent disconnection between these abiotic processes and ecology.

It is apparent that the main focus in the guidelines relating to interpretation of the park's heritage resources is upon features. Considering the highly dynamic nature of the geomorphic processes in the park, a unique opportunity exists to interpret these to the public.

The plan guidelines outline the location of the new visitor facility to be built near the town of Field. In the subsequent discussion, it is noted that the construction of the facility will result in the disturbance of a relatively rare floodplain feature. This feature is not identified, nor is it noted whether the feature is the result of contemporary processes or whether it is a relict feature. Observations of the site of the new visitor centre during the 1994 field season indicate the rare floodplain feature is in fact simply a floodplain (or portion thereof), and that the visitor centre and gas station have been constructed in this location.

The discussion of the Environmental Assessment and Review Process tends to ignore the negative impacts of plan guidelines, such as the destruction of "a rare floodplain feature" associated with the construction of the new visitor centre.

The plan also recognizes the knowledge gaps associated with the extent of both the Burgess Shale and the Ice River Complex, but does not suggest any avenues to address this shortcoming. As noted previously, the plan does not identify any concerns in the E.A. section dealing with the mass wasting processes of the park.

The priorization of plan guidelines is not reflective of the stated goals of the park, nor does it reflect the importance of geological and geomorphological features and process in Yoho National Park. While the plan itself identifies a variety of management concerns related to the parks' significant geological and geomorphological features and processes, the priorization of plan guidelines clearly emphasizes the biological over the abiotic component of the parks "ecosystem".

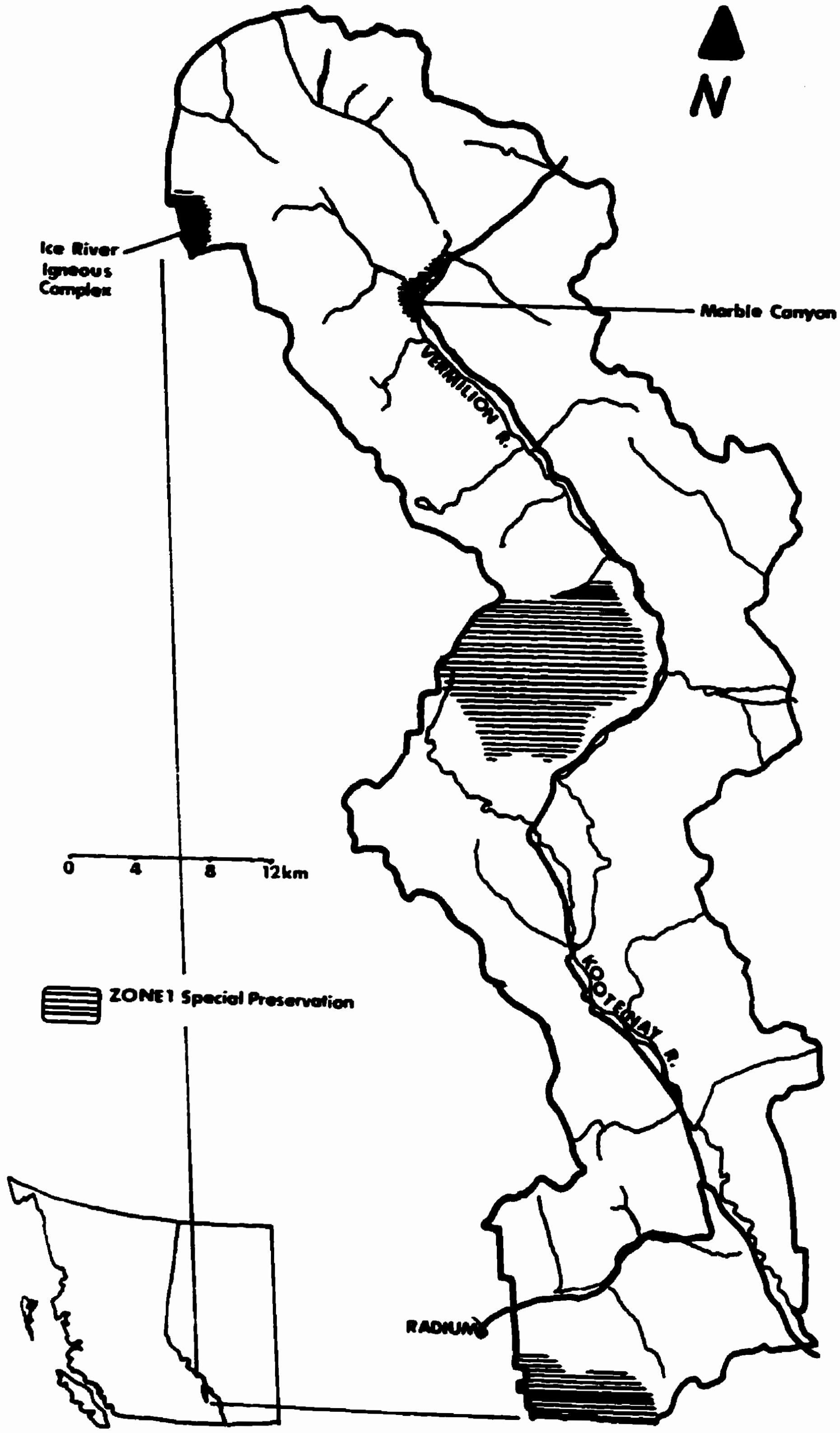
5.2.3 Kootenay National Park

Kootenay National Park was established as Canada's tenth national park in 1920. The park encompasses 1406 sq. km and is part of the 20, 160 km. sq. four mountain park block (see Fig. 5.6). Kootenay contains representative features of the Western and Western Main ranges, extending from the continental divide to the edge of the Rocky Mountain Trench. The park was created in part as a result of the construction of the Banff-Windermere highway.

The designation of both the Cathedral Escarpment and the Ice River Complex as Zone 1 Special Preservation identifies these resources as significant resources of Kootenay National Park. This designation is also somewhat problematic. The value of these resources lays largely in their uniqueness, and therefore in their exceptional scientific value and what we can learn about past environments from them. The restrictions placed upon such sites by Zone 1 designation can inhibit or in some cases altogether prevent further study. It should also be noted that both the geological Zone 1 sites are not as well understood as the Zone 1 biological sites in Kootenay National Park. In addition, the extent to which these areas exist within the park is not known and, therefore zoning is only guessed at.

The plan identifies fourteen first priority management concerns related to the protection and management of natural resources. However, the plan identifies the

Figure 5.6 Kootenay National Park



(Source: Parks Canada, 1988c).

development of a geological resource management plan as a priority. The remaining implementation strategies focus largely upon biotic resources. The lack of a geological resource management plan could explain the relative lack of significance attached to the earth science resources in the Kootenay management plan. This is highlighted by the fact that the existence of significant fossils of the Burgess Shales is only guessed at in the plan. Similarly, the extent and boundaries of the Ice River Igneous Complex within Kootenay is unknown. Such internationally and nationally significant features require further study. These are, however, features and, as such, represent a different type of management concern than processes might.

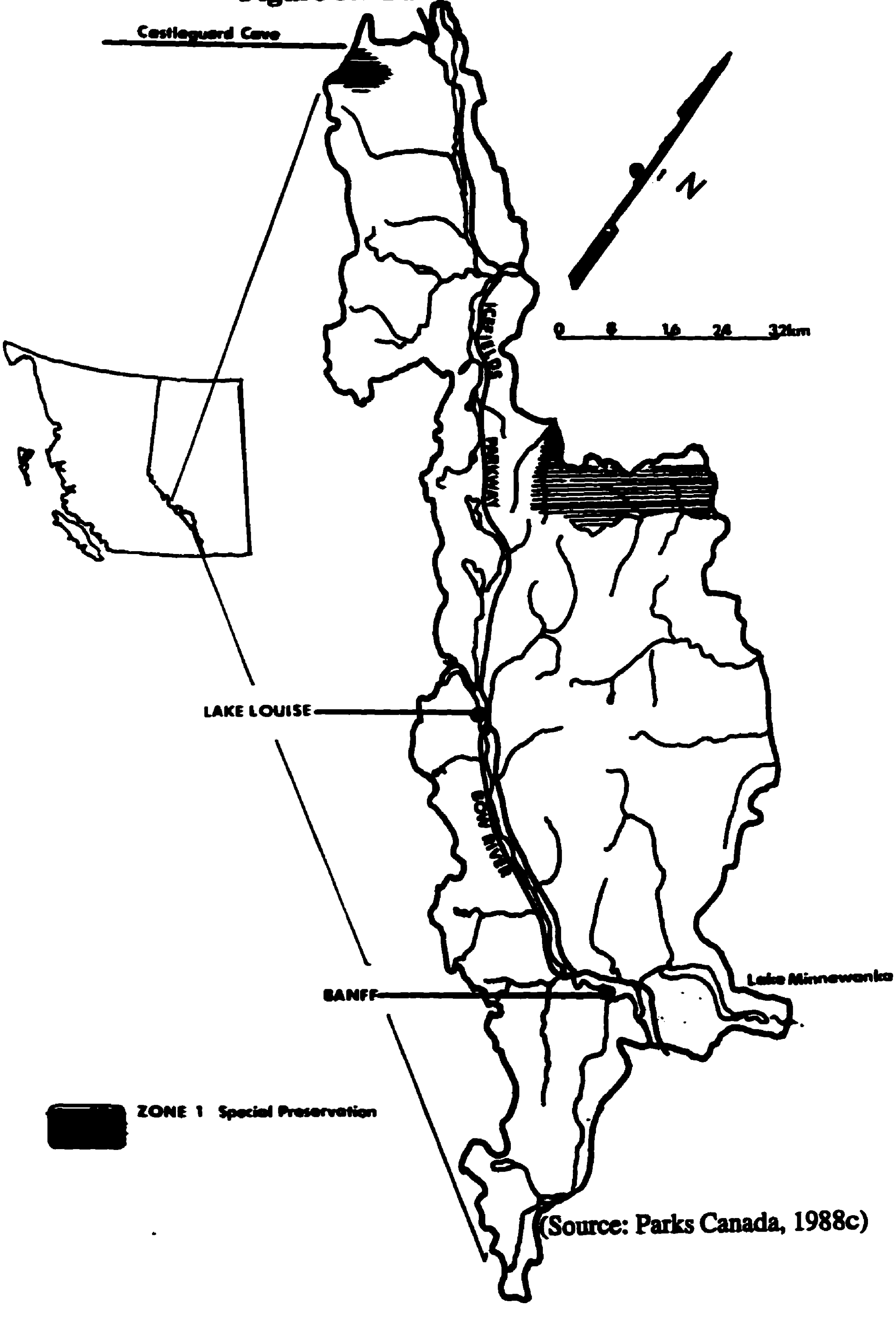
5.2.4 Banff National Park

Banff is Canada's first national park and this role is highlighted in the management plan of the park. Banff has grown from the original reserve of 26 sq. km. to its current size of 6, 641 sq. km. and shares its borders with Jasper, Yoho and Kootenay National Parks (see Fig. 5.7). The thermal springs at Sulphur Mountain were very important in the early establishment of the park. While the original reasons for park establishment were based upon the geological resources of the springs, it was largely the economic benefits to be derived from these resources that led to park establishment (Brown, 1968, Parks Canada, 1994). This set of circumstances led to the paradox of preservation versus use, and has been the source of ongoing debate and conflict concerning the role of parks.

Much of the history of the national parks in Canada is evident in the history of Banff National Park and a number of studies have focused upon this (Nelson, 1968, Nicol, 1968, Brown , 1968, Scace, 1972).

Banff is one of the most recognized and most visited of Canada's national parks ,and as a result experiences a wider variety of management problems than many less popular national parks. As a result of the management concerns associated with the townsite of Banff itself, as well as the pressure associated with the large numbers of

Figure 5.7 Banff National Park



(Source: Parks Canada, 1988c)

visitors (visitor safety, resource conflict, inappropriate activity, facility development etc.), the pressure placed upon the natural resources of the park is often much greater than in other national parks. Therefore, resource protection and management are of utmost importance in the management plan of Banff National Park.

The plan also notes the significant hazards associated with visitor activity in areas of active geomorphic processes such as avalanches and glacial ablation zones.

The management plan of Banff National Park recognizes four Zone 1 Special Preservation areas in the park. One of these, the Castleguard caves, is directly related to the geological and geomorphological resources associated with this unique and internationally significant karst system. The cave system has been mapped for a length of 18 km., but is thought to be over twice that length. It has been described as among the finest examples of alpine karst anywhere in the world (Ford, 1973). In addition to the rare and unique geological features such as calcite pisoletes, the cave system also provides habitat for rare and unique fauna, providing a clear link between the abiotic and biotic systems of the environment.

The discussion of the management guidelines states that, while a number of significant geological and physiographic features have been identified, there is a need to undertake a systematic study to enable the development of management strategies for their protection.

The Banff Management Plan identifies a number of geological and geomorphological resource conflicts in the provision of visitor opportunities. Again, many of these issues are common to all the parks in the four mountain park block. Trail braiding and soil erosion are serious concerns in a number of backcountry areas. In addition, it is noted that many trails follow historic routes and do not provide for an aesthetically pleasing experience. It is suggested that some trails be rerouted in order to provide more scenic vistas along the route.

The plan guidelines identify significant safety concerns related to the location of certain alpine huts located in the backcountry. In the case of the Bow hut, the plan discussion notes that redevelopment or relocation of the hut would reduce public safety concerns as hikers would not be encouraged to cross the toe of the glacier during the summer season.

In addition, the newly developed Freshfield hut is no longer accessible, due to the formation of a large lake at the toe of the glacier and the subsequent "calving" of an ice cored moraine along its margin. The moraine was to provide access to the hut. The plan calls for the removal of the hut. No mention is made in the plan as to whether geomorphologists were consulted about the potential for these siting problems to occurs (i.e.. EARP identification). This provides an example for which such information would have been useful. Furthermore, it points to potential future problems associated with glacial response to global warming and the role of the earth sciences in global change studies. Neither of these geological resource issues was identified in the resource management section of the plan.

The plan identifies a case where the provision of visitor activity will take precedence over allowing natural processes to operate without interference:

> THE WATER AT JOHNSON LAKE WILL BE RESTORED TO ITS LEVEL PRIOR TO THE FAILURE OF THE DAM IN 1986
>
> i) Heritage Resources
>
> Johnson Lake was originally created in 1930 by damming both ends of the erosional trough which contained an unnamed creek emanating from beaver swamps at the base of Mount Inglismaldie. It is one of only eight low elevation montane water bodies in the park. Although not a natural waterbody, Johnson Lake has provided fish and waterfowl habitat during the 50 years of its existence.
>
> ii) Visitor Opportunities
>
> The lowered lake levels reduced the quality of recreational opportunities. A petition signed by over 1,600 individuals was forwarded to the Canadian Parks Service in support of restoring the higher lake levels. Residents of Banff townsite valued the lake, prior to the failure of the dam,

> as a local swimming spot. Restoration of the water level will satisfy the demand for recreational opportunities. The provision of these opportunities will take precedence, in this particular case, over the principle of permitting natural processes to operate without human interference.
>
> (Parks Canada, 1988d, p. 83)

While this is a case of a visitor opportunity being given precedence over an abiotic resource, the reasoning for allowing this to occur is in part based upon the biological resources that have come to occupy the artificial habitat. This particular guideline contradicts the stated management objectives, the Parks Policy and the Act, and provides a dramatic example of the higher priority placed upon biotic resources when they conflict with abiotic. This is shown here to be the case even when the biotic resources were not originally in existence in a location.

The messages of the communication services will focus on the nationally and internationally significant heritage resources of Banff National Park, the park's role as Canada's first national park, and the block's designation as a world heritage site. The plan guidelines provide for the type of message consistent with the park's objectives as well as the location of visitor information centres. Lake Louise is identified as the site at which geology will be interpreted in the park.

> " The Lake Louise Visitor Reception Centrewill provide information about oportunities and services available in thr local area, in the park and in the four mountain parks. The centre will be a major facility for interpreting the geologyof the Rocky Mountains and orienting visitors to interpretive opportunities in all four parks. Basic and emergency information will be available year round and 24 hours a day.
>
> Lake Louise is a major visitor centre and a popular Rocky Mountain destination which is internationally known. Many visitors travel to Lake Louise from other areas in the Four Mountain Parks. A new visitor reception centre is scheduled for completion in 1990 which will serve the 800,000 people who visit Lake Louise each year. Its central location in the heart of the Main Ranges of the Rocky Mountains makes it an ideal location for interpreting the geology of the Rocky Mountains. "
>
> (Parks Canada, 1988d, p. 157)

The interpretation of park heritage resources occurs throughout the park. The plan identifies the natural history themes previously identified in the park concept as significant portions of the interpretation program. Plan guidelines (p.167) identify the geological story of the Rocky Mountains as the emphasis of the Lake Louise centre. In addition, the shared messages of the mountain block parks were coordinated in the past by the "Interpretive Plan for the Seven Parks of the Canadian Cordillera" (1977). However, the discussion of the 1988 plan notes that a number of messages have changed in significance (e.g. archeology) and that new messages have emerged (e.g. World Heritage Site, Canadian Heritage Rivers). Furthermore, interpretation is viewed as a management tool and the messages relating to management issues such as bear management and fire management have increased in importance.

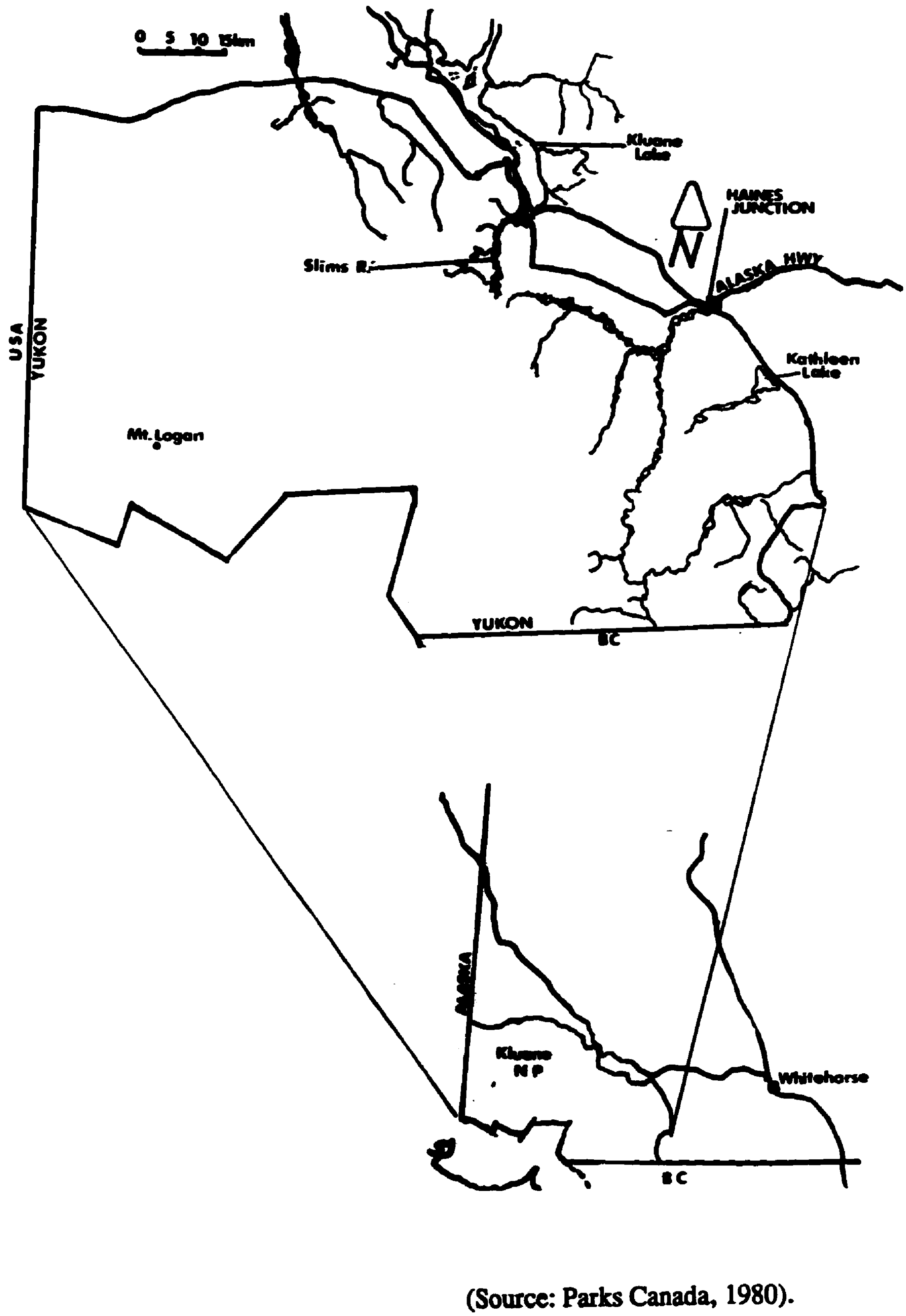
5.2.5 Kluane National Park

Two management plans were available for Kluane National Park. The first, produced in 1980, was developed prior to the Resource Description and Analysis (1987), while the second plan was completed in 1990 in response to fiscal restraint and changes to the National Parks Act.

Kluane National Park is representative of the Northern Coast Mountains Natural Region and encompasses an area over 22, 000 sq. km. in the southwest Yukon Territories (Fig. 5.8). The management plan (1980) recognizes that the park is focused on the high peaks and icefields of the region . The plan notes that a major agent of landscape formation is glaciation and that the park is significant for its alpine glaciers as well as its preponderance of rock glaciers and surging glaciers. In addition, the park's human history is only beginning to be understood. However, it is the critical wildlife habitat that the plan identifies as requiring special attention for protection.

The construction of the Alcan Highway was a major agent in the events leading to the development of Kluane National Park. "Recognizing the potential impact of the new route, army officials suggested to the Canadian Government the possibility of a park. As

Figure 5.8 Kluane National Park



(Source: Parks Canada, 1980).

a result, in 1942 a Privy Council order was passed on the recommendation of the Controller of the Yukon and the Advisory Board on Wildlife Protection establishing a National Park Reserve of over 25,000 square km. In the following year, the area was designated as the Kluane Game Sanctuary until such time as the National Parks Act was amended to include and establish Kluane National Park"(Parks Canada, 1980, p. 9). Between that time and the proclamation of the Park Reserve in 1976, numerous attempts were made to establish a park. None was successful due to the presence of mining interests.

5.2.5.b 1990 Kluane Management Plan

In 1990, the Kluane National Park Management plan was developed largely as a result of the failure to implement the access provisions of the 1980 plan due to fiscal restraint and the inability to attract private funding, as well as the amendments to the National Parks Act. The new plan continues to recognize the maintenance of the park's wilderness character as the park's primary objective.

The structure of the plan initially separates the physical description of the park from the section dealing with heritage resources and processes. This is a rather unusual format when considered in light of other management plans. The description of the physical environment focuses upon the significance of the St. Elias mountains in terms of the regional climate and the resulting icefields. The dynamic nature of the physical system is identified as hampering penetration of the park's front range barrier and therefore, resulting in the protection of the mountain wilderness and its wildlife population. The plan does not, however, highlight the significance of these resources by themselves. In addition, the discussion of the natural heritage resources of the park focuses exclusively upon vegetation and wildlife resources. In some cases these resources are identified as resulting from geomorphological process, for example the land-locked salmon of Sockeye Lake. As well, the vegetation complex is recognized as being a reflection of a landscape in constant change due to the active geomorphological processes in the park. Geomorphological processes thus are a very significant aspect of the park. They are, however, only viewed as significant in association with biotic resources. This points to a recognition of the earth science connection to the ecosystem, and hence a potential role for applied geomorphology.

5.2.6 Waterton Lakes National Park

Waterton Lakes was established during the period in which control of natural resources in western Canada rested with the federal government. A partial result of the near unilateral withdrawal of these land as parks was a frequent rearrangement of park boundaries. Waterton Lakes National Park was established as the Waterton Lakes Dominion Park in 1911, through a reduction of the previously established Kootenay Lakes or Waterton Lakes Forest reserve to a 36 sq. km. area (Fig. 5.9). In 1914 the park area was enlarged to 1096 sq. km. However, this proved to be unsatisfactory to the Forestry Branch and the park area was subsequently reduced to 570 sq. km.. In 1955 a further 350 hectares were withdrawn (Lothian, 1987).

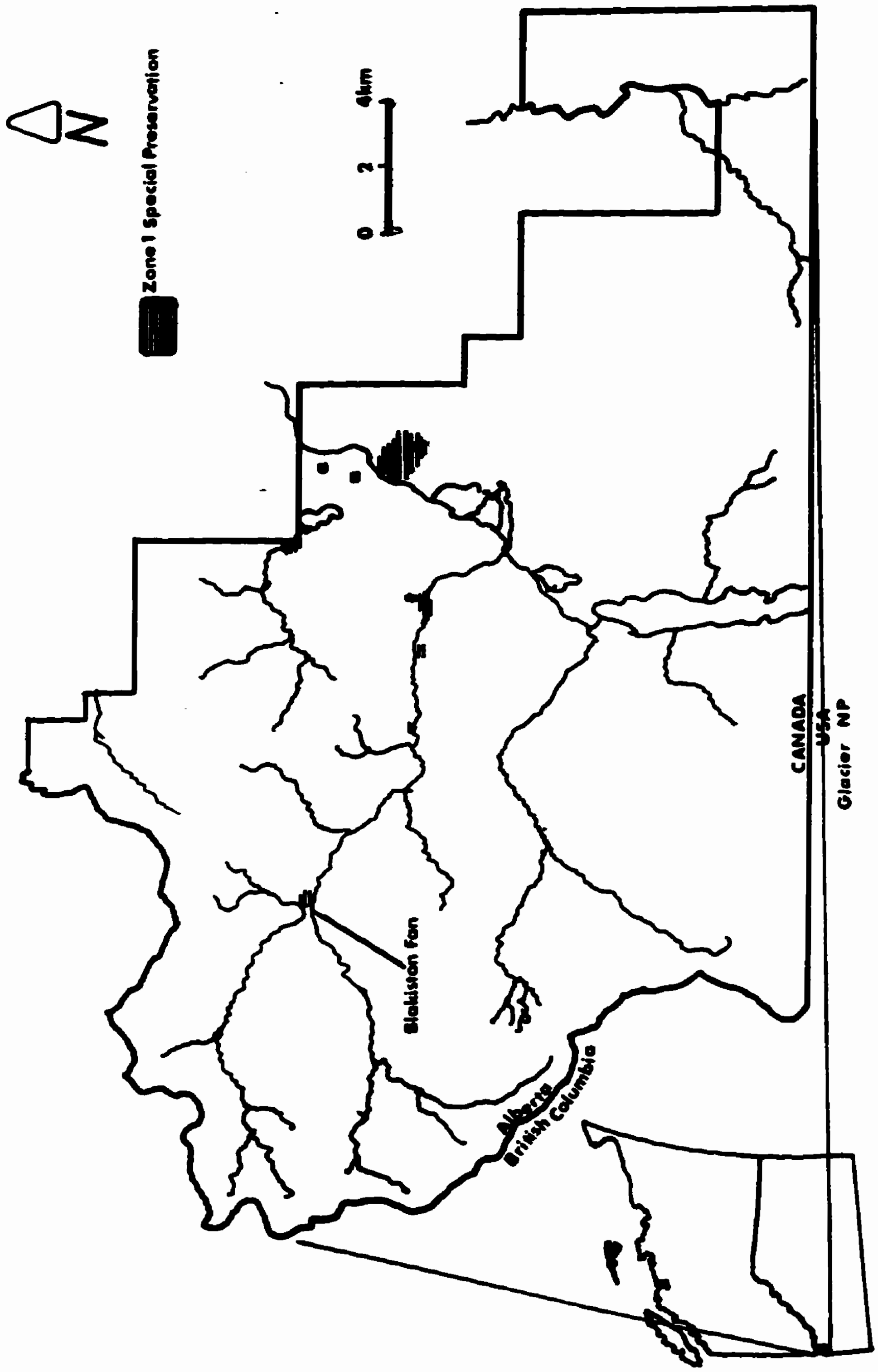
The management plan of Waterton Lakes available for this study was put forth in 1992. It therefore is guided by the amendments to the National Parks Act of 1988 and incorporates provisions relating to ecological integrity. While the new policy (1994) was not available at the time of the development of the management plan, draft policies reflecting changes to the act were available to guide the 1992 management plan.

In spite of the very significant changes to the Park's Act enacted in 1988 and the development of new policies during this period, the Waterton management plan of 1992 is remarkably similar in its layout to those of the Four Mountain Park Block.

Unlike the plan provisions for other parks, however, the provisions of the Waterton Lakes Plan identify sustainable use and ecological integrity as significant principles to be developed in the plan.

The objectives do not explicitly refer to geological or geomorphological features and process. However, they provide general direction for their inclusion into the resource

Figure 5.9 Waterton Lakes National Park



(Source: Parks Canada, 1992)

management provisions of the plan. The references to natural resources, natural processes and resources in the objective statements of the plan include geological considerations. A case can also be easily made to acknowledge the inclusion of geology and geomorphology in the objective statement referring to scientific information. In fact the subsequent section of the plan which deals with geological, physiographic and paleontological resources illustrates these connections in reference to the scientific significance of a number of unique geological features in the park. Here again, however , the emphasis is placed upon the feature rather than the processes.

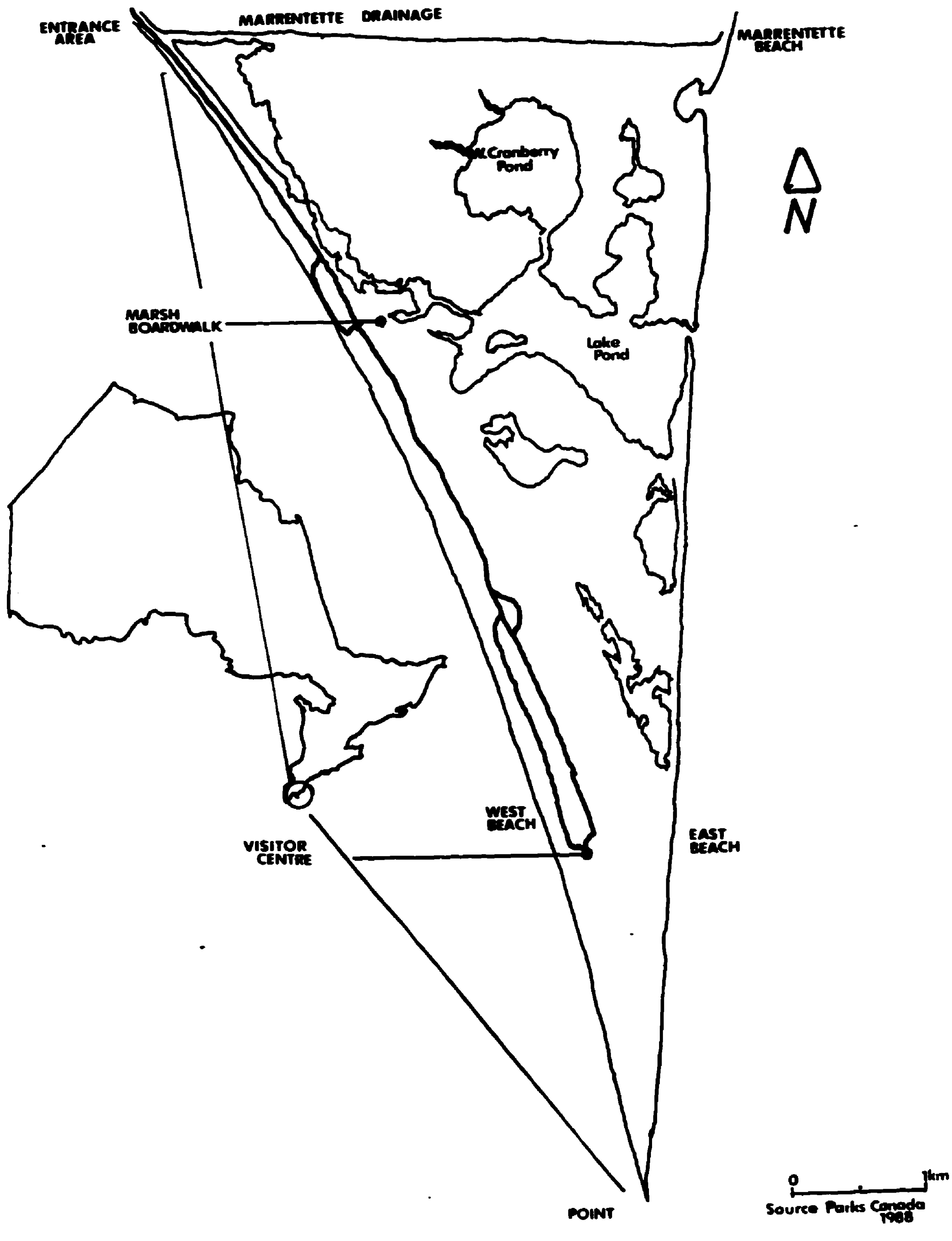
5.2.7 Point Pelee National Park

Point Pelee National Park occupies a spit extending into the western basin of Lake Erie and was first confirmed as a national park by Order in Council on May 29, 1918 (Lothian, 1987). Point Pelee is one of the smallest of Canada's national parks, encompassing an area of only 15.5 sq. km., of which less than a third is dry land. The park is essentially an elongated triangular spit ten km. long and five kilometers wide at its base, occupying the most southerly contiguous point of land in Canada (Fig. 5.10).

Of the parks considered in this study, Point Pelee is unique in two significant ways. First, Point Pelee is the only national park considered in this study to be declared a national park solely on the basis of its biological significance (Lothian, 1987). Second, Point Pelee is the result of the highly dynamic and contemporary processes of longshore drift and beach erosion and deposition. This unique combination of circumstances, in which the "habitat" is in a state of perpetual change, creates some unique management problems for a park whose primary reason for existing is the flora and fauna that exist on the "habitat".

Indeed, Point Pelee National Park officials have a long and checkered history of managing the processes of coastal erosion. One of the earliest references to erosion of the point is contained in Taverner's (1915) report in which he suggested offshore dredging as

Figure 5.10 Point Pelee National Park



a possible cause of the erosion at the tip of the point. Since that time, various beach erosion control measures have been introduced and, subsequently removed, in response to changing shoreline conditions (East, 1976). This will be discussed in greater detail in a following chapter.

Objectives for visitor appreciation and understanding, however, include an expanded role for interpretation that includes the "aim of fostering environmental awareness among members of the public, and achieving the Green Plan goal of assisting Canadians to make sound environmental choices" (Parks Canada, 1992, p.8). This expanded role for interpretation should not be perceived as negatively affecting the more traditional interpretation efforts. However, the following section of the plan notes a growing number of significant factors affecting the park. These factors include the increasing islandisation of parks, the requirement for the maintenance and restoration of ecological integrity, the invasion of non-native species, the development of the disciplines of conservation biology and restoration ecology, the growing level of public environmental awareness, economic restraint and restricted budgets, and the need to direct funds to those programs most closely reflecting the national park mandate.

These factors, when taken together, point strongly towards the diminution of the earth sciences in the management, planning, and interpretation of Point Pelee National Park. They show a strong bias towards the biotic and suggest that some areas of park programming will be dropped.

The park concept for Point Pelee National Park makes a clear departure from the objectives of the park and focuses exclusively upon the biotic component of the environment in identifying the enhancement of the Carolinian character as the major proposal of the plan. The plan identifies the valued natural resources of Point Pelee's revised zone 1 areas as exclusively biological. In addition, the plan concept also identifies that the significance of regional integration is a biological one and that restoration of the park is to be guided by the "new scientific disciplines of conservation biology, restoration ecology and the study of stressed ecosystems"(Parks Canada, 1992, p. 12)

The management plan provisions of Point Pelee National Park reflect the 1988 amendment to the National Parks Act and, therefore, identify ecological integrity as the first priority in considering how the park will be managed.

However, unlike other plans, the Point Pelee National Park Management Plan does provide for the potential of managing the earth science resources of the park.

> i) Parks Canada recognizes that shoreline erosion, recession and deposition are essentially natural processes. Therefore, they will be allowed to proceed unimpeded except where monitoring has shown that without limited intervention, public health, or safety or major park facilities are threatened; or there may be serious adverse impacts on neighboring lands; or the objectives of the park management plan relating to the maintenance of natural and cultural features cannot be maintained.
> ii) Parks Canada will continue to encourage the support and the development of an integrated regional shoreline management program......will strive to manage the use and development of the shoreline to minimize the conflict between natural systems and human activities.
>
> iii) Parks Canada supports the recommendation ....that the south portion of the Marentette drainage scheme be converted back to wetlands....based on the fact that shoreline hardening north of the park caused accelerated rates of erosion at the park's northeast corner during periods of high water level in Lake Erie and created a breach in the barrier beach which protects the marsh and agricultural fields.
>
> iv) Parks Canada will continue to remove the remains of erosion control structures which will not naturally or quickly deteriorate. Such structures will be removed following an assessment of the environmental, especially geomorphological, implications.
>
> v) Shoreline monitoring for the park will continue, in order to contribute to the shoreline management program and to assess erosion at the northeast corner of the marsh. (Parks Canada, 1992.p.25)

The preceding generally outlines a program of allowing natural processes to operate and includes the removal (where appropriate) of existing erosion control measures. Yet, at the same time the plan prescribes allowing natural processes to operate, the plan acknowledges that the natural system has been disrupted due to shoreline hardening updrift of the park.

There is a significant degree of confusion in this section of the plan as to the natural state of the physical processes of erosion, deposition and shoreline recession, and therefore, about the significance of active management of these processes in the maintenance of ecological integrity.

This contrasts markedly with the provisions for both vegetation and wildlife management presented in the plan. These provisions provide relatively clear goals in terms of the desired species assemblage and the high degree of active management prescribed to attain these goals.

The provisions of the Point Pelee National Park Management Plan for visitor services follow those of other plans in the identification of the role of encouraging visitor understanding, appreciation, and enjoyment of the park. It departs from these other plans, however, with the addition and identification of a number of messages related to environmental citizenship and stewardship as important roles for the park.

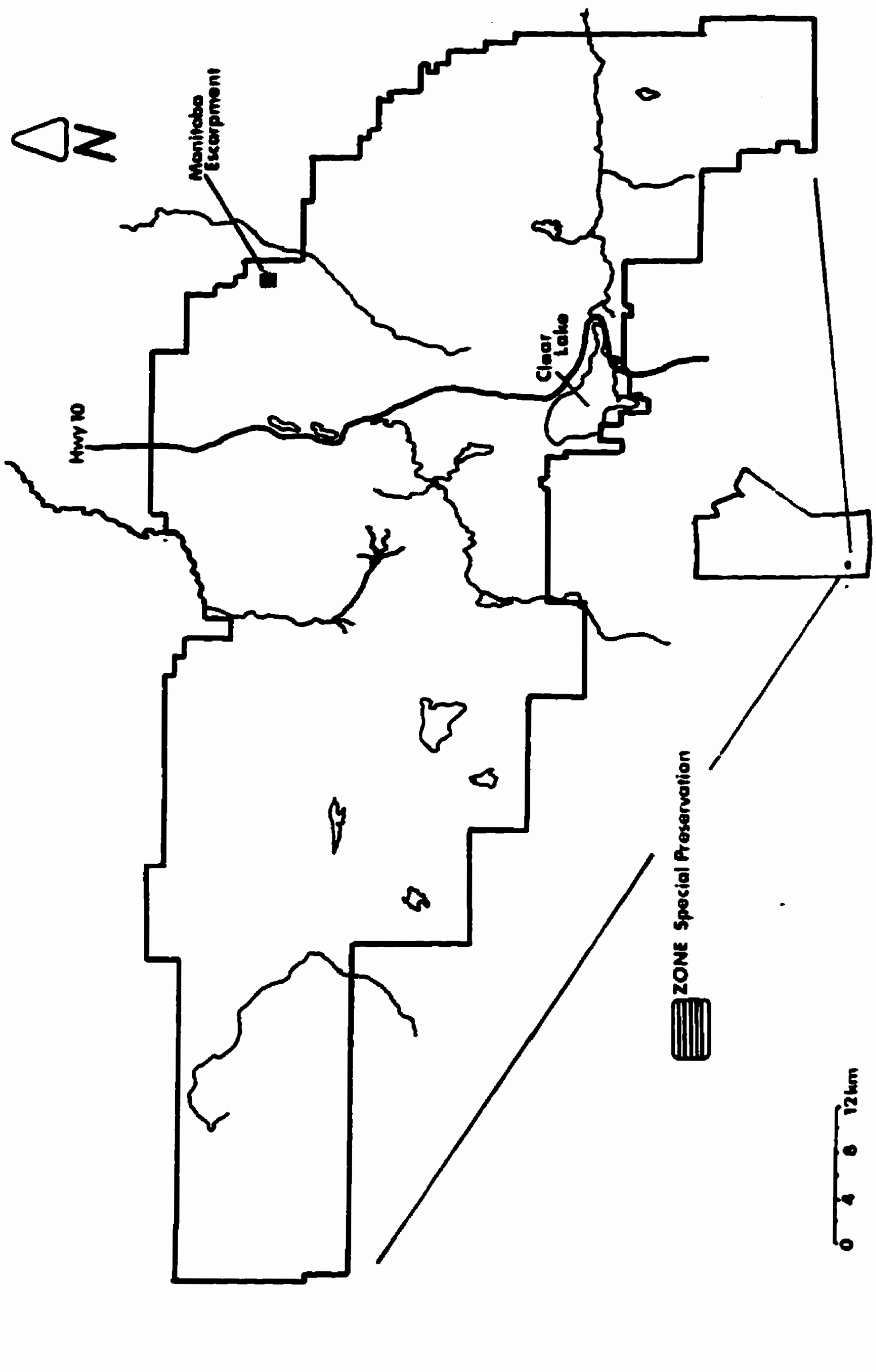
In addition, the ecosystem restoration and management concept is seen not only as enhancing the visitor experience but also as providing a new direction in the communication program. The plan identifies 5 themes as the interpretive messages to be presented under the park concept of "Partner's in Preservation" and not one of these relates the important role of geology or geomorphology in the forming the parks ecosystem.

These five themes relate to sustainable living, the regional ecosystem, the Pelee story, preserving the environment, and global issues. It is apparent that the role of the earth sciences could be incorporated in any of these issues, but they have not been. This is discussed in greater detail in the next chapter.

5.2.8 Riding Mountain National Park

Riding Mountain National Park was the last park established from unalienated public lands by the government of Canada (Lothian, 1987). Original proposals called for a park to be established in eastern Manitoba south of the Winnipeg River in a region now

Figure 5.11 Riding Mountain National Park



(Source: Parks Canada, 1987)

occupied by the Whiteshell Provincial Park. However, public opinion favored the establishment of the park in the region of the Riding Mountain Forest Reserve and it was that option that was eventually chosen, largely to fulfill the role of summer playground for Canadians (Lothian, 1987), although it does also fill the role of a vast wildlife reserve in what is essentially a biological island surrounded by wheat fields and pasture (Parks Canada, 1987).

Riding Mountain National Park covers an area of 2, 976 sq. km in western Manitoba. The park marks the transition from the first prairie level (the Manitoba Lowland) to the second prairie level, and preserves a representative example of the Manitoba Escarpment (Fig. 5.11). The Manitoba Escarpment is the most significant regional topographic feature, creating a park that is a prairie mountain with a rich biological mosaic. Three life zones -grassland, aspen/oak, and mixed wood ecosystems- overlap in the park, producing a diverse assemblage of plants and animals. In addition, features such as strandlines, melt water channels, moraines and potholes are illustrative of the role ofquaternary glaciers and fluvial processes in sculpting the landscape (Parks Canada, 1987).

The management Plan for Riding Mountain National Park is consistent in all plan sections with the summary presented earlier. In general, the plan identifies the protection of features that represent the impact of long dormant processes.

5.2.9 Wood Buffalo National Park

Wood Buffalo National Park was created by Order in Council on Dec. 22, 1922 in order to protect the last remaining wild herd of buffalo in Canada. From an original reserve of 27, 195 sq. km., the park has been enlarged to its current size of 44, 807 sq. km., the largest of Canada's national parks (Lothian, 1987) (Fig. 5.12).The park's size and isolation have contributed to the survival of several rare and endangered species, including the whooping crane, wood bison and the peregrine falcon (Parks Canada, 1984).

The park protects a representative example of the Northern Boreal Plains' natural region, and small portions of the Southern Boreal Plains and Northern Boreal Uplands natural regions. The collection of natural systems within the park is unique in Canada in their number, extent, and the degree to which they are self regulating and self perpetuating (Parks Canada, 1984).

A number of significant earth science features and processes are protected by the park, including the most extensive gypsum karstland in the world, salt plains unique in Canada, and the delta of the Peace-Athabasca Rivers, one of the largest fresh water deltas in the world(Parks Canada, 1984).

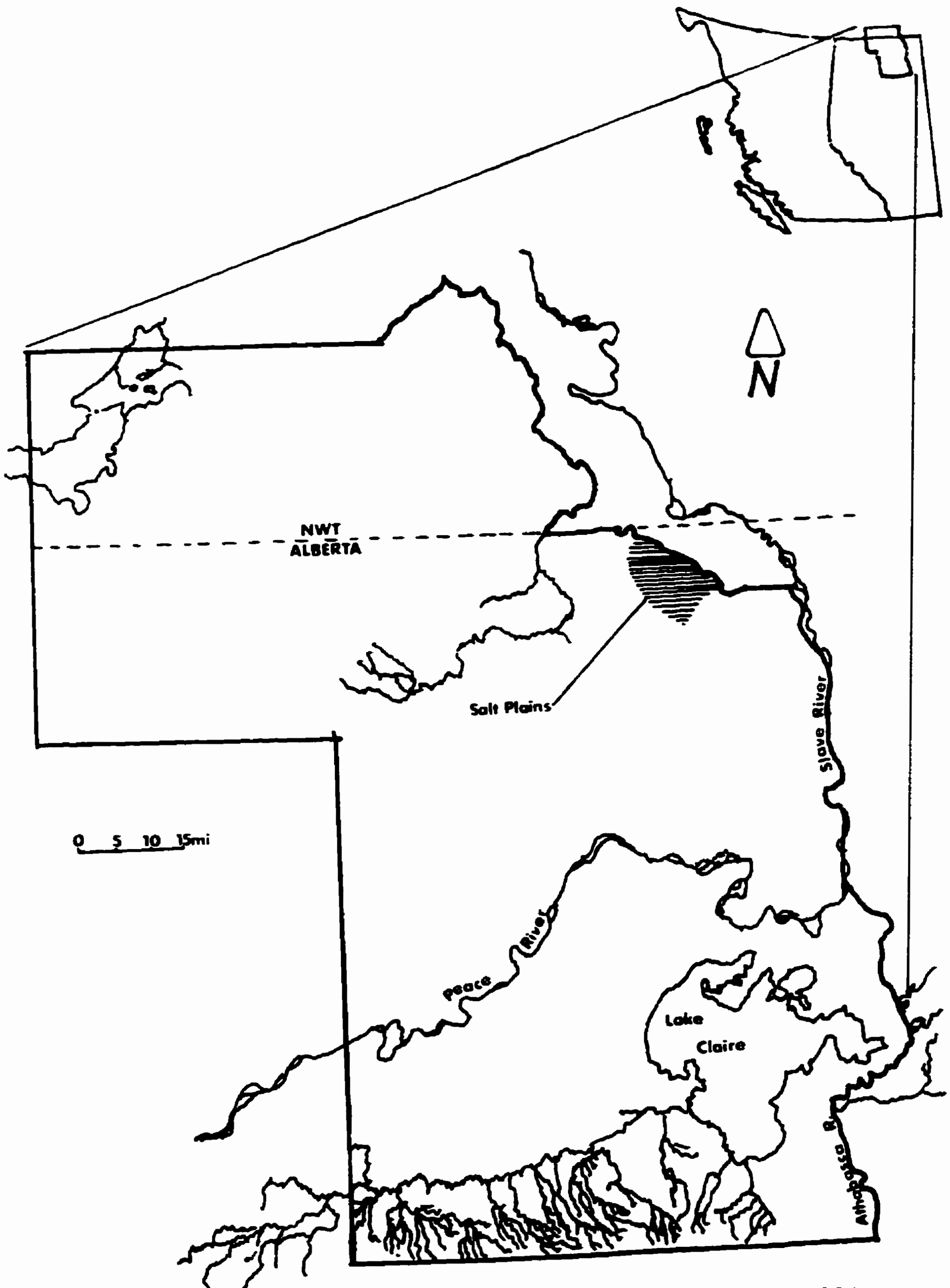
Park objectives statements for Wood Buffalo National Park are clear in their direction to earth science form and process and point to the relationship between these two concerns.

> Parks Canada will ensure that the underlying landform processes of the park continue to function and create the landforms that characterize the park such as karst features, saline flats and erosional features of the Cretaceous highlands of the park. Special protection will be provided to particularly significant landform features such as sulphur springs, salt deposits and gypsum caves to ensure that they do not deteriorate due to the influence of man.
>
> (Parks Canada, 1984, p. 3)

Resource management in the park with respect to geology and geomorphology is directed to focus upon those features previously identified as significant, including the Peace Athabasca delta, the dune formations, and the gypsum karst. Most management will take the form of monitoring and restricting access. There is no mention of applying earth science theory to the management of processes.

In contrast, there is a significant amount of active manipulation of biotic resources in the park. This is not surprising, considering the nature of the biotic management concerns facing the park. These concerns include, but are not limited to, the endangered whooping cranes and peregrine falcons, the threat of disease to the bison herd (the very reason the park exists and a significant reason for its international significance), the

Figure 5.12 Wood Buffalo National Park



(Source: Parks Canada, 1984)

impact of the Bennett Dam on the delta and its ecosystem[5], and the nonconforming practices of lumbering, trapping and hunting which occur in the park.

It could be argued that there is a role for applied fluvial geomorphology in attempting to overcome the problems associated with the Bennett Dam, although to date no such work has been attempted.

As is the case with the other management plans which predate the amendment to the National Park Act, a significant degree of earth science heritage is incorporated into the themes of the interpretation program.

5.3 Summary

In this chapter, the review of park management plans has identified the limited degree to which management of the earth sciences is referred in park management plans. Where there is reference to the earth sciences, the reference generally relates to features as opposed to processes. Furthermore, the processes referred to are in many cases no longer active. Where the plans refer to the management of the earth sciences, two general categories of management can be identified:

1. Management to protect the resource from adverse impact due to human use.
2. Management to protect human safety and park facilities from the impact of potential hazards.

The management of both these categories of concern is largely conducted through zoning. For example, Zone 1 Special Preservation areas such as the Burgess Shales in Yoho or Castleguard Cave in Banff, and Natural Hazard zones in Point Pelee. The second category of management, however, often requires active interference with natural processes. For example, the scaling of the canyon walls (Fig. 5.13) in Johnson and

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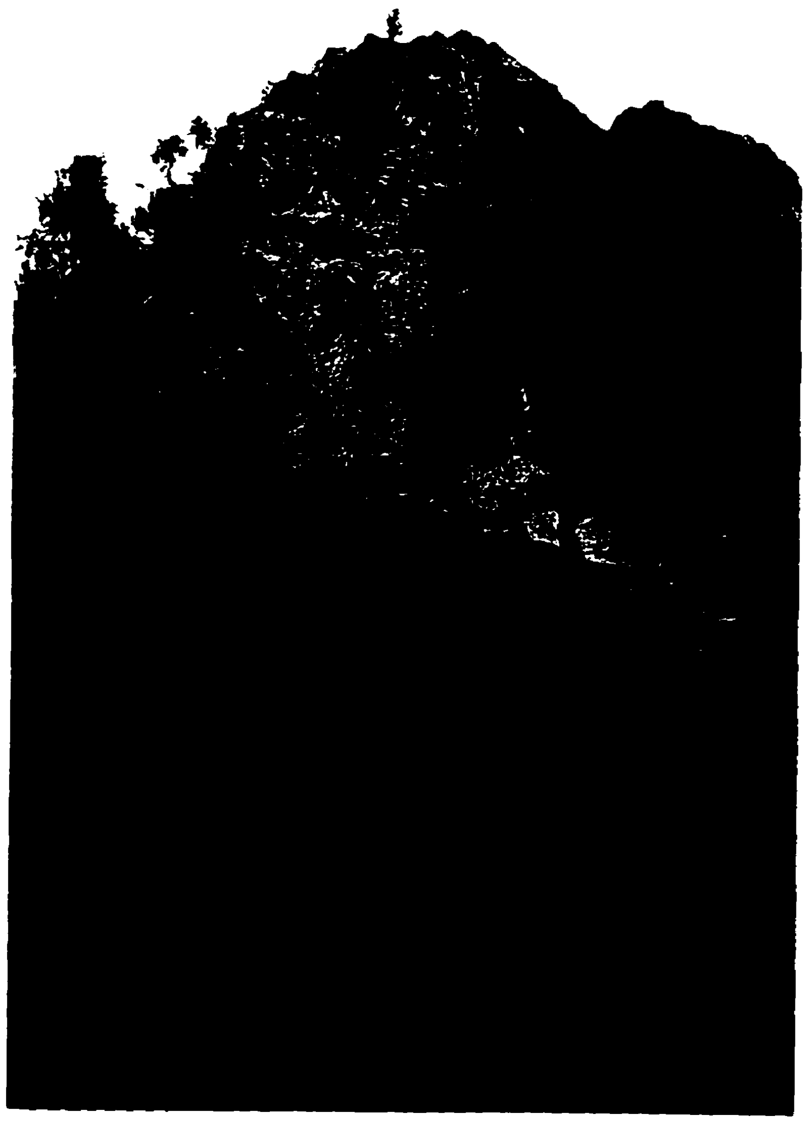
[5]Not only has the dam significantly altered the hydrology, sedimentation and ecology of the delta downstream, but it has also flooded a valuable paleontological resource (dinosaur trackway) upstream. A number of efforts have been made to overcome to problems associated with the dam, including the construction of weirs on the Riviere des Rochers and the Revillion Coupe. However, these were unsuccessful in replicating the natural hydrological regime of the delta.

Figure 5.13 Rock Scaling and Cementing Canyon Walls
Sinclair Canyon, Kooyenay National Park



(Campbell, 09/94)

Sinclair Canyon or the installation of erosion control devices along the shoreline of Hoodoo Creek or the Northeast Beach at Point Pelee.

These active manipulations are only referred to in the management plan of Point Pelee National Park, and no reference is made of them in the other plans. Furthermore, these manipulations generally do not emulate natural processes, nor do those conducting them seek to determine how these processes integrate with the remainder of the ecosystem. Indeed, more often than not in the cases identified in this study, this type of management attempts to prevent the natural process from operating.

Furthermore, while there is a high degree of consistency between the management plans of the various parks considered in this study, within individual management plans there are numerous oversights. This is particularly evident in terms of the identified earth science resource management sections. On many occasions, concerns raised in regard to visitor activity were not identified as either resource, E.A., or implementation concerns. Perhaps most significant among these is the failure of such concerns to appear in the implementation priorities.

The next two chapters provide a more detailed assessment of a variety of park management plans from two study areas (Banff and Point Pelee), and follow up on the findings of this chapter.

CHAPTER 6

Case Studies: Banff

This and the next chapter present detailed case studies from parks of two different Natural Regions (Fig. 6.1). The parks are Point Pelee National Park and Banff National Park. The main focus of this chapter will be upon Banff National Park; however, the block management planning for the four parks necessitates the inclusion of the remaining three mountain parks in the overall case study. Thus, the main cases are those of Banff and Point Pelee, while Jasper, Yoho, and Kootenay provide for a broader picture of earth science in the management of the mountain parks and for a larger sample of park personnel for the interview process.

The cases were developed through the collection of documentary evidence in the form of a variety of park management plans. These documents include, but are not limited to, Park Conservation Plans, Park Service Plans, Natural Resource Management Plans, Interpretation Plans, Natural Resource Conservation Plans and individual Site Plans. In a number of cases, other supporting documents were also made available by park personnel. A complete list of documents for Banff and Point Pelee National Parks is given in Tables 6.1 and 7.1.

During data collection, it became evident that documentary evidence alone would not be sufficient to identify the nature of planning for earth science in the parks. Park personnel frequently identified gaps in knowledge not identified in the plans as well as frequent failures to implement plan guidelines relating to geological and geomorphological resource concerns. Indeed, in most cases the plans appeared to be little more that restatements of points of view expressed in other plans.

In order to ensure that the information supplied by parks personnel was gathered in a consistent manner, a series of questions were developed to be employed during interviews with parks personnel. The method has been described, and the interviewees identified by type (i.e. warden, interpreter, researcher) in Chapter 3.

Table 6.1 Documents of Banff National Park

Park Documents	Document Type
Park Conservation Plan 1983	Resource Management
Park Conservation Plan 1990	Resource Management
Ecosystem Conservation Plan 1993-1998	Resource Management
Backcountry Management Plan 1990	Resource Management
Draft Plan Minnewanka Area 1993	Site Plan (Resource, Interpretation)
Vermillion Lakes Draft Area Plan 1994	Site Plan (Resource, Interpretation)
Resource Description and Analysis 1988	Resource Management
Park Management Plan 1988	Integrated
Research Summary Western Region 1977-1993	Research
Geological Resources of Yoho National Park 1994	Research, Resource
The Mountain Guide 1993, 1994(Banff)	Interpretive
Jasper National Park Visitor Guide 1994	Interpretive
Resource Management Plan 1977	Resource management
Yoho National Park Visitor Guide 1994	Interpretive

At the outset, it is helpful to recall a number of significant changes which have affected the institutional arrangements of the Canadian Parks System over its history. Many of these have been identified in Chapter 4. During the most recent period, the period for which management plans are available, notable changes include: amendments to the National Parks Act in 1988; the transfer of Parks Canada from Indian and Northern

Affairs to Environment Canada and the subsequent development of the Green Plan; the development of a new Parks Canada policy document in 1994; and, the most recent movement of Parks Canada to the Department of Heritage. Each of these changes can be expected to influence the development of planning documents. In addition, declining financial resources have led to significant changes within the Parks System bureaucracy and the provision of services.

Put simply, planning documents tend to reflect the predominant influences of the time of their production. As the planning documents used in this study were developed at different times, they must be assessed in light of the Act and policies. In this regard, a major distinction reflects the inclusion of ecological integrity into the amendments to the Act, and the recognition of the applicability of the sciences of conservation biology and ecosystem restoration.

The documentary evidence follows the three previously identified functions of parks: resource management, interpretation, and research. The results are therefore presented in this order. This Chapter and Chapter 7 present the data collected during the study.

6.1 Banff National Park

As can be seen from Table 6.1, with the exception of the 1983 Park Conservation Plan, all the park documents available for this study postdate the amendments to the National Park Act in 1988.

Many of the documents are lengthy discussions of the various resources of the parks. It would be impossible to completely summarize them, given the limitations of space. Therefore, the following discussion will briefly review each of the documents and comment only upon the provisions that specifically relate to earth science resources. In addition, the documents will be examined for references to the conflicts and trends identified in the previous chapter. The discussion will begin with the documents dealing specifically with resource management. This will be followed by those dealing with interpretation and finally with those of research.

6.1.1 Resource Management

6.1.1.1 Banff Resource Management Plan 1977

The 1977 Resource Management Plan can be considered as the first of a series of documents describing the primary resource inventory information and the resulting management considerations for Banff National Park (Parks Canada, 1977). The plan is a systematic analysis of resource data relating to geological and geomorphological characteristics. These characteristics include materials, slope, and to a certain degree the features and processes.

The plan provides an assessment of the limitations and capabilities presented by the site, material, terrain and related influences, and suggests a number of management options ranging from no management of any kind to active engineering. The plan does not refer to the application of geomorphology in any management context.

Provisions of the plan for biotic resources greatly outweigh those for the abiotic. In addition, when management of biotic resources is required biological science input is sought, whereas abiotic management is explicitly identified in the plan as engineering.

6.1.1.2 Banff Park Conservation Plan 1983

The Park Conservation Plan reflects the direction received from the park management plan, the Management Framework for the Four Mountain Parks (1978), and is dependent upon the information contained in the Resource Description and Analysis. It is further guided by the 1979 Parks Canada Policy .

The 1983 Park Conservation Plan (PCP) identifies a number of management problems which are categorized as vegetation management problems, wildlife management problems, aquatic management, land management, and administrative issues. Within this categorization, water management and land management problems most directly relate to earth science resources.

Figure 6.1 Disturbed Site Hidden Behind Berm
Lake Minnewanka Area, Banff

(Campbell, 1993)

The objectives of the PCP are identical to those of the Park Management Plan presented in the last chapter. Problems for the PCP are defined in the plan as deviations from the norm, where the norm is related to known resource management objectives, national park policies and other management guidelines (Parks Canada, 1983). In the 1983 PCP, no water resource problems are identified which relate in any way to the earth science resources of the park.

The land resources section identifies the protection of unique, rare and fragile resources as a problem identified through the biophysical inventory. The preferred course of action identified in the plan is the preparation of a comprehensive management plan that provides for the various types of resource protection required. However, the PCP makes no direct reference to earth science resources, nor does it identify biological resources. In this sense, and in light of the nature of the policy of 1979, it can be seen as exclusive of earth science resources. The rehabilitation of borrow pits and the preparation of the Resource Description and Analysis are also identified as problems to be resolved by the PCP.

The plan priorizes the problems identified, and the highest priority is given to the protection of unique, rare and fragile resources. Rehabilitation of borrow pits and preparation of the resource description and analysis are ranked 21 and 25 respectively out of a total of 25 identified problems. Seventeen of the remaining items reflect biological resources. Of the three problems presented here, only the rehabilitation of borrow pits deals specifically with earth science resources.

6.1.1.3 Banff Park Conservation Plan 1990

The 1990 Park Conservation Plan is organized in a similar fashion to the 1983 plan. In addition to the categories of problems identified in the 1983 plan, the 1990 plan identifies the goal of integrated ecosystem management. The preferred course of action to achieve this goal is identified as a biological learning process (Parks Canada, 1990) known as the Adaptive Environmental Assessment and Management.

Within the categories of aquatic management and land management, no problems are identified that specifically refer to earth science resources. However, the problems of hydro-electric impact mitigation, Zone 1 guidelines, rehabilitation of human disturbed sites and the need for site plans at The Plain of Six and Lake Agnes Teahouses are, all at least peripherally, related to earth science resources.

Priorization of the problems in the 1990 PCP identifies Integrated Resource Management as the highest priority item in the plan. Integrated Management represents the highest level of management and scientific complexity in Dearden's (1991) typology. Yet the 1990 PCP does not refer, in any way, to earth science in its consideration of integrated management. Zone 1 site plans are identified as fifth priority, hydro-electric impact mitigation is eleventh, Plain of Six/ Lake Agnes is thirty-second and disturbed site reclamation is thirty-sixth of a total of thirty-seven identified problems. The public safety plan is the twenty first priority of the plan.

The 1990 plan does not identify the reclamation of borrow pits as a problem in spite of their identification in both the 1983 PCP and the 1988 Park Management Plan. Where borrow pits are discussed in the plan of 1983 and 1988, the focus of the concern is largely related to vegetation effects. The significance of the deposit in terms of the information it contains regarding past environments , and therefore its value in prediction, is never addressed.

While the Park Conservation plans of 1988 and 1990 do not make reference to the conflicts identified in the management plan of 1988, a significant problem isidentified in the 1990 plan which potentially relates to the re-damming of Johnson Lake.

The 1990 PCP notes that the document entitled the Special Resources Study of Banff National Park identifies three herptiles as rare or uncommon near the boundaries of their range within the park. One of these, the eastern long toed salamander (*ambystoma macrodactylum*) has been eliminated by stocked trout in parts of their range.

The habitat of the eastern long toed salamander is moist montane forest near small ponds and marshes. This is the type of habitat that existed in the area that is now Johnson Lake prior to damming. It is highly possible that the damming of the area and subsequent stocking with non-native trout have eradicated this rare species from this particular area.

It is somewhat ironic that, in defense of reconstructing the dam at Johnson Lake, the 1988 management plan argued that it provided valuable habitat for non-native fish and waterfowl, while in fact it may have destroyed the habitat of a rare amphibian.

That there is no mention of the rare herptiles in the 1983 PCP or the 1988 Park Management Plan indicates that the problem was unknown at the time. However, had the plan not placed biological considerations above earth science/hydrological ones the problem likely would not have occurred. Even if seemingly insignificant earth science processes are not valued in and of themselves, they may provide important habitat requirements of which we are not . This exemplifies the importance of carefully assessing any proposals which disturb natural processes.

6.1.1.4 Banff Ecosystem Conservation Plan 1993-1998

The 1993 Ecosystem Conservation Plan is the most recent resource management document reviewed for Banff National Park and is guided by the amendments to the Act of 1988, the policy of 1979 (draft of 1994), Natural Resource Management Process of 1992, and the management plan of 1988.

The plan notes that updates to the Natural Resource Management Process (1992) identify the Ecosystem Conservation Plan as the major planning document of the park, whereas the earlier NRMP(1976) identified the Park Conservation Plan as such. The significance of this change in relation to the earth sciences is in the manner in which an ecosystem is defined and, therefore, the manner in which indicators of ecosystem health are identified.

The Ecosystem Conservation Plan of 1993 contains no reference to any earth science feature or process. The entire focus of the document is biological and all indicators are also biological.

6.1.1.5 Yoho Geological Resources Management Strategy

Only Yoho National Park among the four mountain parks had a Geological Resource Management Strategy. The Yoho National Park Geological Resources Management Strategy (Guduraj, 1994) is, in fact, no more than an annotated bibliography which identifies the research and subsequent publications which have focused on the park. The strategy makes no recommendations and does not identify any gaps in knowledge.

6.1.1.6 Summary

While the earth sciences never figured prominently in all the Banff National Park plans, the earlier plans (i.e 1977, 1983) provided the identification of some management concerns related to earth science features and processes. The earliest plan (Parks Canada, 1977) referred to the management of the earth science resources in terms of engineering and not of applied geomorphology. In terms of the framework identified earlier, this would suggest that the earth sciences are managed at a complexity level no higher than that of management, and in most cases are reflective of the preservation, protection management typology.

In general, it can be concluded that the earth science resources of Banff National Park were never a high priority management item, despite a number of concerns identified in both in the 1988 plan and in this discussion. The interpretation of the ecological integrity amendments of the Act of 1988 in the Ecosystem Plan of 1993 as a biological condition has resulted in the earth sciences being removed entirely.

6.1.2 Interpretation

Interpretation is a major component of the provision of visitor services and as such many visitor services documents contain significant references to interpretation. The following discussion will examine a variety of interpretation and visitor activity documents collected from Banff National Park. In addition, the Visitor's Guides for Yoho and Jasper National Parks provided reference to some earth science features. The Kootenay National Park Visitor's Guide was unavailable for consideration. These will be assessed for earth science content in light of the relevant governing principles at their time of production.

6.1.2.1 Banff Backcountry Management Plan

The Backcountry Management Plan is a Visitor Services document and, like most other documents relating to park management, refers to the objectives of the park as identified in the 1988 management plan. Here again, as noted by White (1993), most of these statements are broad qualitative statements that do not provide measurable goals.

In spite of these shortcomings, the plan notes a number of significant potential impacts to earth science resulting from a variety of visitor activities. The plan identifies concern over those areas designated Zone 1, specifically Castleguard Cave, and notes that visitor access is to be strictly controlled and open only to recognized speleological groups with research permits.

The plan identifies the amendment to the Act, recognizing that preservation will take precedence over use, and that wilderness zones would be legislated as the most significant changes with respect to visitor use of the backcountry.

Visitor use of the backcountry is to take place in such a way that allows for the "perpetuation of naturally evolving land and water environments and their associated soils and landforms." (Parks Canada, 1990, p. 11). In addition, the plan identifies that monitoring for changes and mitigation of effects will be undertaken where human activities have the potential to affect soils and landforms. E.A.R.P. will take place where new facilities are constructed.

In contrast to resource management documents produced after the Amendments to the National Park Act (Parks Canada, 1988), the Backcountry Management Plan, which is an exercise in visitor management, provides for earth science resources at least in principle.

However, the plan does not specifically refer to a number of the issues raised in the Management Plan of 1988. Specifically, the 1990 plan does not address the locations of the Bow and Freshfield Alpine huts and the public safety and access concerns associated with them.

6.2.2.2 Lake Minnewanka Area Plan (LMAP) 1993 Banff

In contrast to the Backcountry Management Plan (BMP), the Lake Minnewanka Plan deals with the semi-primitive or front country of Banff National Park. Most visitors to the area are day users and the vast majority (40 %) are engaged in sightseeing as the primary activity.

Also different from the BMP is the degree to which the LMAP focuses upon the ecosystem management strategies to be employed in managing visitor opportunities in the area. Ecosystem management, as identified in the area plan, will follow upon the recommendations of White(1992), and as such, there will be no role for the earth sciences in this aspect of the plan. As identified by White (1993), the simple (desired) ecosystem model for the montane ecoregion includes humans, wolves, elk and aspen as indicators of ecosystem health.

The plan does, however, identify a number of interpretive themes for the area. These themes identify the formation and evolution of the mountain landscape as a key theme to be interpreted in the area. In addition, wildlife, habitats, cultural resources, the history of the area (themes identified in the management plan of 1988), the management of the park, and environmental citizenship are identified as major themes of the interpretive program. The sub-themes which are identified as management oriented do not identify any earth science concerns.

In addition, the area plan notes the existence of a number of disturbed sites as a result of gravel extraction and landfill. This disturbance is identified as decreasing montane habitat, resulting in erosion, visual impacts and the colonization of non-native plants. There is no recognition of the potential impact or significance of the geomorphic features removed as a result of gravel extraction, nor is there any reference to the loss of information associated with gravel extraction.

The plan identifies three significant features, one of which (travertine drape along the Cascade Valley) is not identified in any previous documents relating to park management and interpretation. The other two features, the loess deposition at Devil's Gap, and the hoodoos near the Cascade Power Plant, are both earth science features as well. From this it would appear that even if management of park resources in Banff is not dealing with the earth sciences, interpretation and visitor services are.

Finally, Johnson Lake exists within the Minnewanka area, and although the plan notes that the wetlands at Johnson Lake are to be treated as a sensitive site, the plan does not identify the nature of the sensitivity or if it relates to the rare long-toed salamander.

6.1.2.3 The Banff Mountain Guide 1993

The 1993 Visitors Guide for Banff National Park reflects the significant changes made to the National Park Act in 1988. The main messages contained within the guide relate to the problems associated with managing the national park's natural resources and to how visitors to the park can be of assistance. While the guide does make limited reference to sites that incorporate the interpretation of earth science messages, the text of the guide itself concentrates upon the park's wildlife and the messages of Canada's Green Plan.

In addition, the guide outlines the schedule and locations of the parks' interpretive program. However it does not reflect the messages to be presented during these events. Therefore, it is impossible to make comments with respect to guided interpretation.

The guide also directs visitors to the various visitor centres of the park. The visitor centre at Lake Louise has been identified in the *Framework for the Interpretation of the Seven Mountain Parks* (Parks Canada, 1978)(Banff, Jasper, Yoho, Kootenay, Waterton, Glacier, Revelstoke) as the site at which the story of Mountain Building is to be interpreted. The centre was completed in 1992 and gives a excellent account of the mountain building process and the development of the contemporary landscape.

However, as will be shown in the next chapter, since the Centre was planned and constructed, the central messages of Parks Canada have changed and there is the suggestion that had the Lake Louise Visitor Centre been developed today the story of mountain building would not be a significant message at the site(Anderson, 1994, pers.comm.).

6.1.2.4 The Banff Mountain Guide 1994

The 1994 edition of the Banff National Park Visitor's Guide is presented in a different format than that of the previous year. In this edition a magazine format is used with longer articles dedicated to a few significant themes.

As with the 1993 edition of the guide, a dominant theme is ecological integrity and the goals of ecosystem-based management. The guide focusses upon ecosystem-based management of the Bow Valley and identifies this solely in terms of the interrelationships among wolves, elk, humans, and aspen. In addition, the guide presents articles on archeological heritage and public safety concerns in the park.

As with the 1993, guide there is no identification of the content of the various interpretive opportunities provided by park interpreters. However, one can conclude that the nature of any such presentation will be heavily influenced by the background of the individual interpreter and therefore his or her comfort level with the topic.

Visitor's Guides for other parks in the four mountain block show similar orientation. The 1994 Visitor's Guide for Jasper National Park is consistent with the visitor's guides of Banff National Park in that there is very little emphasis of the earth science heritage of Jasper National Park in the text of the guide. The format of the guide is similar to the 1993 Banff Guide and a number of sections relate to a variety of wildlife management concerns, and identification of wildlife.

The Jasper guide also lists the interpretive schedule for the park and in this section a number of interpretive events take place at significant earth science heritage sites such as Maligne Canyon and Wilcox Pass. While the guide does not identify the content of the interpretive events, their location is suggestive of at least some earth science content.

The 1994 Visitors Guide to Yoho National Park is unique among the mountain parks in the high degree of emphasis placed upon the earth science heritage of the park. Like the 1994 Banff Visitor's Guide, the Yoho guide is formatted like a magazine with a number of articles dealing with various park resources and concerns.

In the case of Yoho, the guide highlights the geomorphology of the Kicking Horse River, the proglacial environment along the Iceline trail in the Yoho Valley, and the significance of the Burgess Shale.

As with the guides of the other parks, the Yoho guide also identifies the theme of ecosystem-based management and environmental stewardship. However, unlike the guides for the other park's these two themes have not overshadowed the themes relating to the park's significant resources. Yet, the guide still fails to connect the earth science themes to the more recent themes of ecosystem-based management and ecological integrity.

The guide does not identify any interpretive programs being conducted in the park. It only identifies the privately guided hikes to the Burgess Shales and notes that for those unable to engage in the long and strenuous hike that interpretive displays are available at the Field Visitor Centre, the Kicking Horse overflow campground and the Lake Louise Visitor Centre.

During the 1994 field season, considerable concern arose in Yoho National Park due to the severity of the fiscal restraint being imposed upon the park. As a result of this restraint, interpretation was severely limited and left to the private sector. In addition, there were concerns about the relocation of the administrative staff from Yoho to Lake Louise in Banff National Park.

6.1.3 Summary

With the exception of the visitor guide to Yoho National Park, the visitors' guides available for this study do not reflect the significant earth science resources present in the parks. These guides reflect the current biological orientation toward ecological integrity arising after the amendments to the National Park Act (1988). This direction is further supported by the Green Plan and by the message theme developed to encourage environmental citizenship.

However, in spite of this, a fairly high degree of earth science interpretation occurs in the park, as evidenced by interpretive displays and roadside signposts such as those at Lake Louise Visitor Centre, Moraine Lake, the Field Visitor Centre, Maligne Canyon, the Columbia Icefields and numerous other locales throughout the Four Mountain Parks (Fig. 6.4). These exhibits are, however, the remains of an earlier agenda in Parks Canada interpretation scheme. That they exist now is largely due to the impact of the implementation of the systems planning process which focused upon significant natural resources of the Parks.

As expressed in the plan for the Lake Minnewanka area, the major focus of the visitor activity management and interpretation for the park is the ecosystem-based management of the park, and earth science resources are referred to nowhere in the ecosystem plan. In essence, the provision of interpretation opportunities related to the earth sciences is paralleling the natural resource management of the earth sciences of the park, with the significant difference that the earth sciences were at least interpreted in the past. Earth science were incorporated in the early stages of the natural resource management process through the biophysical surveys, ecological land classification, and the resource description and analysis. As the process of natural resource management incorporated this information, it has been reduced until in the management plans and park conservation plans, the earth sciences are treated only with broad sweeping statements that they will protected and processes allowed to operate without interference.

The resource management plans treat earth science resources of the park as static and unchanging. Indeed, this is the very nature of the ecological land classification. As a result, management plans do not, and cannot identify concerns related to the earth sciences. Indeed, this is something of a circular problem, in that if it is not recognized that earth science process is significant in an ecological sense, there will be no monitoring or search for connections and, related themes will remain unknown. Resource managers in the park seem to be operating in a framework which does not readily allow them to see the significance of the earth sciences. Conversely, earth scientists may not be active enough in pointing out the significance of the connections, and may continue to pursue research which does not relate to park goals.

In contrast, interpretation can, to some degree, deal with the perception of the apparently fixed nature of earth science features and process. Indeed, many of the features interpreted in the parks have taken millions of years to form. Therefore, some interpretive material will be timeless, assuming there is no significant change in theory. Thus, the earth science interpretation that exists in the park might remain for some time while new themes are developed. Or will it? There has been some suggestion that wardens would like to see a number of the roadside signposts removed and replaced with management issues and some interpreters note that the new messages should replace the old as "we don't want people to think of this as a special place"(Anderson, 1994, pers. comm., Harding, 1994, pers. comm.)

Interpretation of ecosystem-based management and ecological integrity attempts to explain the new management initiatives of Parks Canada to the general public, and to point out the connections between activities outside the parks and ecosystems within the parks. It is part of a more holistic and integrated approach to the management of the parks. However, for some reason, it has failed to consider the links between the abiotic and the biotic components of the ecosystem and, in so doing, has weakened the role of the earth sciences in all aspects of planning, management and interpretation of the parks, as well as the integrity of the management principle.

Given these momentous changes in the manner the parks are to be managed and interpreted, it might be useful to consider the role that research has played and could continue to play in park affairs.

6.1.4 Research

The earlier discussion of the role of research in the national parks has identified that research was not always welcome in the national parks (Gardner, 1968). Over time the perception of research in the parks has changed and now research is to a large degree welcome in the parks. Indeed, the parks are often undertaking research on their own and actively soliciting researchers where they do not have the in-house expertise. In spite of this, there has been no significant increase in earth science research within the Rocky Mountain National Parks. Table 6.2 presents the Summary of research permits issued for earth sciences from 1974 to 1993 for the Four Mountain Parks. In general, these permits are for university and other independent researchers and do not include inventories conducted by consultants and park staff. After 1988, all research, including that conducted by park staff for EARP, required permits. This places some limitations on the information. However, it does not detract from the clear reduction in permits issued.

As pointed out by Durrant (1986), there is some difficulty in identifying geomorphological research in the literature due to the fact that the categorization of research and the nature of the science often preclude this. This is the case with the summary data on research permits granted for the mountain parks. Separating types of earth science research based upon the summary statistics is impossible. Summary data for the Western region of Parks Canada identifies research as geology/geomorphology, pedology, hydrology/ice. In addition, actual research permits collected from the Regional Library in Banff National Park did not allow for accurate comparison or infilling of missing years due to inconsistencies in the data.

Table 6.2 Comparison of Earth Science Research from late 1970's, late 1980's and early 1990's, Four Mountain Parks

Type/Year	74	75	76	77	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	90	91	93
Geology	24	21	19	19	18	22	20	12	11	14	14	11	26	17	6
Pedology	10	2	4	3	1	0	2	1	0	0	0	0	0	2	0
Hydrology	10	3	7	3	3	2	4	3	3	0	5	3	4	4	1

note: Geology includes geomorphology, and Hydrology includes ice studies.

However, the data presented here show a general trend towards less geological and geomorphological research in the national parks towards the late 1980's, followed by a sharp rise in 1990 and 1991 and a drop again in 1993. This corresponds to Gardner's (1978) study which found a slight decrease in purely systematic earth science research and an increase in research in management-directed studies such as resource inventories.

Gardner (1968) noted that for the period between 1961 and 1967 research permits granted for the earth sciences remained relatively static. During this same period, biological research increased in the parks, largely due to the increased vigor of the interpretive program. From the 1970's to the present, research of all types has dropped significantly in the Western Region parks(Table 6.3 below).

This decline in research in the parks is due to a number of reasons. First, in the late 1960's much research related to the petroleum industry was being conducted within the parks (Gardner, 1968). This research had little connection to park purposes. In the 1970's much research was initiated in the parks as a result of the Systems Plan and the need for basic biophysical information. Much of this was earth science information and, as noted in Chapter 2, this information often contributed to interpretive documents and programming. The decline can also be attributed, in part, to the completion of the basic biophysical inventories. In addition, it has been suggested the overall reduction in funding for basic research in Canada in the late 1980's has also contributed to the decline in research (Catt, 1994, pers. comm.).

Recent changes to the Act and Policy of Parks Canada note the significance of research and point to the need for scientific information to aid in the management of the park natural resources. This research is to be directed towards ecosystem-based management and the maintenance of ecological integrity. As noted on numerous occasions in this dissertation, there is no indication that Parks Canada interprets these goals to be inclusive of the earth sciences.

Table 6.3 Research Permits Issued by Western Region 1974-1991 by Park

Park/Year	74	75	76	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Banff	65	45	52	34	28	31	34	25	27	19	22	16	34	30
Jasper	61	51	43	42	26	22	24	21	17	19	24	18	33	25
Kootenay	12	6	16	13	7	8	12	5	5	5	7	8	9	6
Yoho	39	33	15	15	13	14	8	19	8	5	8	10	16	13
Waterton	39	33	15	11	7	4	7	9	10	3	7	7	8	9

A major component of the Review of the Four Mountain Parks Management Plans involves the establishment of the recent Bow Valley Study on current land use stresses on park resources (White, 1984, pers. comm.) and the integration of ecological research and management of the four parks. In the review, concerns have been identified for each of the parks, however none of the concerns directly identifies the earth science as a concern. The steering committee charged with establishing ecosystem-based management does not include representatives of any aspect of the earth sciences (Pederson, 1994, pers. comm.)

Earth science research in the parks, as identified by the research permits, indicates a strong emphasis on systematic studies unrelated to park concerns. Where earth science research is commissioned by Parks Canada, it is largely of a descriptive inventory nature.

The foregoing discussion suggests that the future for applied earth science research in the parks could be seriously limited. While the Banff plan has identified research needs related to the biotic component of ecosystem-based management, there is no recognition, yet, of the role the abiotic systems can play. Conversely, it could be argued that there is indeed a very significant role for earth science research and applied earth science in the management of the parks. The role simply has not been recognized by the parks or by earth scientists. The discussion of this lack of awareness will form a significant part of the following chapter.

Chapter 7

Case Studies: Point Pelee National Park

Point Pelee National Park presents a radically different case than that of Banff National Park. First, it is much smaller, in fact one the smallest in the Canadian National Parks System. Second, while it can be argued that Banff was created on the basis of its spectacular geology, Point Pelee was established in 1918 solely on biological grounds (i.e.. the protection of migratory birds). Finally, while the mountain parks reflect a diverse array of earth science features and processes, Point Pelee is dominated by the single process of beach erosion and deposition.

Given the preceding, the remainder of this discussion will focus exclusively upon the processes of beach erosion and deposition as they are dealt with in the management, interpretation and research efforts of Point Pelee National Park. The documents consulted are identified in Table 7.1.

7.1 Natural Resource Management in Point Pelee National Park

This discussion will focus exclusively upon the provision of management guidelines as they relate to the management of shoreline erosion processes at Point Pelee National Park. Most of the documents available at Point Pelee National Park postdate the amendments to the National Parks Act and, therefore, reflect the changes associated with the provisions for ecological integrity. However, East (1976) provides an excellent review of the nature of shoreline management at Point Pelee throughout the park's history. In addition, numerous studies have focused upon issues related to shoreline management of the peninsulas along the north Lake Erie shore (Nelson et al, 1975, Battin, 1975).

7.1.1 Shoreline Erosion Point Pelee National Park 1976

Erosion of the Point Pelee National Park shoreline is a response to elevated water levels (East, 1976). East (1976) identified four periods of shoreline erosion associated with high lake levels. The first period for which information is available identifies the

Table 7.1 Documents of Point Pelee National Park

Park Documents	Document Type
Point Pelee Natural Resource Conservation 1991	Resource
Point Pelee National Park Interpretation Service Plan 1988	Interpretation
Point Pelee Visitor Guide 1994	Interpretation
Point Pelee Management Plan 1993 Draft	Integrated
Environmental Assessment of Point Pelee National Park Management Plan 1993	Resource
Ecosystem Management Program Vol. 1 and 2 1992	Resource

planting of willows around the tip to inhibit wind erosion. From 1910 to 1930, East notes that there was significant concern regarding erosion of the point. In 1931, 900 meters of shore protection was emplaced in the park and a further 900 meters emplaced to the north on Mersea township beaches. The protection took the form of mattresses of willow poles 10-12 meters across spaced 1,5 meters apart, wired together and buried 3 meters from the waterline. They were expected to take root and increase stabilization with time. In addition, wire mesh groins were placed at 100 meter intervals. East notes that the wire mesh was destroyed by ice action within a year and that most of the willow mattresses were undermined by erosion. The years directly following this were characterized by lower lake levels until 1937 when new beach protection measures were undertaken. One hundred and twelve wooden groins were erected over 1700 meters of the East Beach. It is not known where exactly they were placed as they were destroyed by wave action and no plans for the program were retained.

The second phase of beach protection occurred during the high water levels of 1948-1952. At this time the object was to evaluate the effectiveness of three different erosion control mechanisms, oak pilings (Figure 7.2), interlocking steel pilings, and reinforced concrete crosses. Initially the oak pilings were deemed to be effective, resulting in the installation of an additional 400 meters in 1950. The steel piles were found to increase erosion and were quickly removed, while the concrete crosses were usually displaced by storms (East, 1976). The study was apparently discontinued after lake levels declined in 1952. Thus, evaluations of the effectiveness of the crosses and oak piles are difficult, if not impossible, due to the lack of systematic monitoring.

The third episode identified by East occurred between 1953 and 1968. During low water in 1959 experiments conducted using concrete crosses along the West Beach resulted in some accumulation of sediment. However high water and severe storms in 1960 resulted in an estimated 1 to 6 meters of erosion along 400 meters of beach (East, 1976). Due to continued concern over erosion of the West Beach and road, a permanent rock wall was constructed along a 400 meter section of shoreline in 1962.

The period from 1968 to 1976 is the final episode of erosion management identified by East (1976). Severe storms and high water in 1968 caused washouts along the West Point Beach and erosion north of the wall (1962)(Fig 7.1). The construction of the Marrentette rock groin to the north of the East Barrier Beach was the cause of great concern to park managers and resulted in several contracts being awarded to investigate potential effects of the structure (East, 1976). The fears proved to be well founded and in 1972 the beach barrier south of the groin suffered severe erosion for

Figure 7.1 The Point Pelee Region

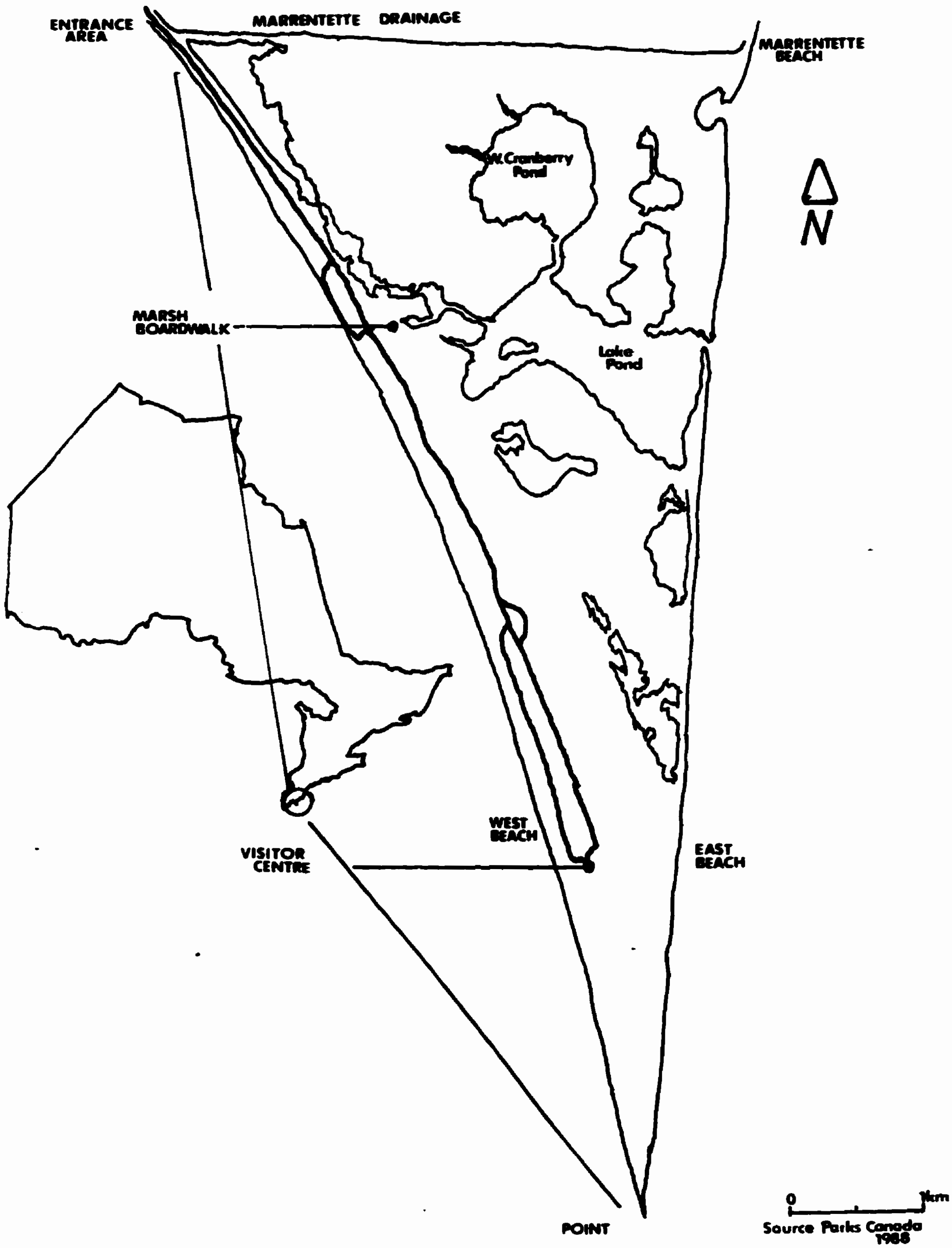


Figure 7.2 Oak Pilings East Beach Point Pelee
(Originally installed 20m onshore 1948-52, now 30 m offshore)

(Campbell, 05/94)

some 600 meters (East, 1976). Another breach occurred in 1973, prompting the suggestion that beach renourishment be investigated. The estimated costs for this were placed at $140,000. It was also suggested on numerous occasions that a hydrological model of the sediment system be constructed. However, as East points out, response to shoreline erosion in Point Pelee follows the pattern described by Nelson et. al (1975), where ill-conceived decisions are made under pressure of circumstances in a crisis atmosphere.

East concluded that erosion is essentially a natural process, altered by the impacts of humans. These impacts are most significant along the Marentette Beach where the introduction of structures has markedly increased erosion downdrift. East suggested that in time the Point would adjust to these new conditions.

East's work provides a valuable documentation of the history of erosion management efforts at Point Pelee until 1976. After 1976, the erosion problems in the northeast corner of the park continued to be the primary focus of erosion management. In 1978, the 1973 breach of the Northeast corner was closed with a sand berm. It was felt that the success of the breach closure depended upon improvements to the regional sand budget (Parks Canada, 1981). In an effort to improve the budget a stone groin at Marentette, north and upcurrent from the breach, was removed. This was followed with a shoreline renourishment project and a triple line of concrete tetrapods along the northernmost 260m. of the Northeast Beach (Lavalle, 1990). Lavalle (1990) noted that the breach at the Northeast Beach appeared to recover somewhat but the return of high water and the reconstruction of the stone groin at the southern tip of Marentette resulted in significant beach erosion. (Fig. 7.1)

In this period of time, another breach opened to the north of the park boundary as a result of spring storms in 1980. The breach was enlarged throughout the spring, exposing the dike surrounding the Marantette drainage to direct wave action. As a result, the park was forced to renourish the sediment in this area and close the breach with a sand berm.

High water in the 1980s and severe storms in 1986 reopened the breach at the Northeast corner and also opened a breach at Lake Pond midway down the east beach. Subsequent research at the Northeast Beach suggested that the concrete tetrapods were increasing the erosion at that site and therefore should be removed (Lavalle, 1991). In addition, it was noted that in light of the negative regional sand budget, the potential threat of erosion to the Marentette dike, and the continued threat of high water, renourishment to offset the losses was the most desirable action in terms of the geomorphic system and the maintenance of the point.

7.1.2 Park Conservation Plan 1991

The 1992 Park Conservation Plan identifies three areas of concern related to the earth sciences. These are the negative regional sand budget, shoreline processes, and the dune landforms. All three of these processes are interconnected, and shoreline processes and the negative regional sand budget actually refer to the same thing.

In terms of the negative regional sand budget, the plan states that attaining a neutral budget through removal of erosion control devices and spot renourishment could not be implemented, based upon the experience of the late 1970's. The 1982 management plan consequently identifies the acceptance of a slightly negative sand budget. Thus, the plan identifies a management approach of minimal interference.

In terms of shoreline processes, the park conservation plan identifies the Northeast Beach as the only point in the park where human manipulation of naturally occurring shoreline processes is to take place. In addition the plan notes that erosion control devices at a number of locations throughout the park are no longer compatible with park policy and should be removed. Finally, the plan calls for ongoing monitoring of erosion at the Northeast Beach in order that hazard maps are kept current.

In the 1992 Park Purpose Statement, the dunes are identified as a dynamic landform which forms the basis of the "park's nationally and internationally significant geomorphological resources. The dunes or dynamic landform are to be given the highest degree of protection to ensure continuation essentially unaltered by human activity."(Parks Canada, 1992, p. 44). It is curious that this statement is applied only in reference to the dune landforms and not to the very basis of those landforms, the shoreline processes. The shoreline processes and the negative regional (Point Pelee) sand budget are no longer unaltered by human activity, as years of research have shown (East, 1976, Shaw, 1988, Lavalle, 1990). Given this, Park Policy is clear in requiring that management be directed towards reestablishing natural process in respect of dunes. Yet in the 1991 Park Conservation Plan, this is not extended to the associated underlying process of shoreline processes. Perhaps this is the result of the parks long history of ill-advised responses to sudden erosional activity.

7.1.3 Draft Park Management Plan 1993

The 1993 Draft Management Plan of Point Pelee has already been discussed in the previous chapter,. However, it bears reconsideration at this point in light of the previous discussion, because it suggests that Parks Canada is now addressing the various processes in the coastal system in a more comprehensive manner.

The 1993 plan contains a number of provisions related to shoreline management which are subsequently reviewed in the 1993 Environmental Assessment of the Plan. These provisions suggest that the processes of erosion, deposition, and beach recession are natural processes and that they will be allowed to operate unimpeded except: where monitoring has indicated that public health and safety or major park facilities are threatened; where there may be serious impacts upon neighboring lands; or where objectives relating to the maintenance of natural and cultural features cannot be attained.

The plan also identifies the goal of developing a regional shoreline management policy to minimize conflict between natural systems and human activities. It is suggested that the south portion of the Marentette drainage scheme be converted back to wetlands. The plan identifies the need to continue to remove the remains of erosion control structures in the park and to continue the long-standing program of shoreline monitoring, especially in the Northeast Beach area. Finally, the plan identifies the susceptibility of the dunes along the western shore to impacts associated with visitor use and development, noting a number of strategies undertaken to offset these effects.

While the plan recognizes the significance of the shoreline processes, it fails to take into account that it is no longer an entirely natural process. Thus, the provision to allow the processes to proceed unimpeded is, to a certain degree, misguided as the negative sand budget on the East Beach, which appears to arise in part from diking, and other shoreline protection measures in shoreline areas north of the park boundary, will likely result in the continued erosion of the park.

7.1.4 1993 Environmental Assessment of the 1992 Park Management Plan for Point Pelee National Park

The environmental assessment of the Park Management Plan does not identify any concerns associated with the management provisions for shoreline management as presented in the 1992 Park Management Plan. Only one of the provisions was subjected to a level 2 screening and no conclusions were drawn about the possible consequences of removing erosion control structures, in spite of the available research. It was determined that monitoring of beach profiles be conducted to determine impacts.

Curiously, the environmental impact assessment does not identify shoreline management in the same category as other natural resource concerns, implying it is not a natural resource issue. In addition, in the comments regarding mitigation of potential shoreline problems due to the removal of erosion control structures, the assessment notes that an engineering evaluation is required prior to removal. This contradictsthe amendments to the Act which call for management to be based upon sound scientific understanding and the replication of natural processes. The assessment makes no mention of the need for coastal geomorphologists in the decision-making process and appears to ignore the results of years of study supported by Parks Canada.

7.1.5 Ecosystem Management Program Point Pelee National Park 1992

The ecosystems management document for Point Pelee National Park was produced for the park under contract by the consulting firm of Geomatics International. It is not considered by Parks Canada to be the final document in respect of ecosystem management at Point Pelee.

The ecosystem management plan notes that in order for the plan to achieve the stated goals of the amended National Parks Act regarding ecological integrity, three major adjustments must be made to the perceptions of park managers. First, there must be recognition that management must be focused on the level of the ecosystem as opposed to the species level. Second, there must be a shift from the hands-off approach which was predicated on the belief that nature could manage itself. It must be recognized that active management is often required to maintain the values that the parks were formed to protect. Third, there must be a move away from the perception that national parks are autonomous, and towards one that recognizes that they are part of larger systems and that influences from outside the park, both good and bad, must be addressed in park management (Geomantics, 1992).

The plan goes on to discuss the concept of ecological integrity as it relates to Point Pelee and identifies means of measuring integrity. All of these means are based upon biological factors. However, the plan explicitly recognizes the significant processes of shoreline erosion and the potential negative impact this could have on the ecological integrity of the park. The plan recognizes the maintenance of the physical processes as part of the park ecosystem and, unlike all the other plans considered to this point, notes that active management of shoreline erosion is essential, given the human disturbance to the natural process operating north of the park boundary along the East Beach.

Unfortunately, as noted above, the plan is not the product of Parks Canada or Point Pelee, and in a Parks Canada interoffice memorandum attached to the second volume of the Ecosystem Management Plan, it is noted that there are significant concerns with the provisions of the plan relating to the removal of erosion control devices at the northeast corner. This may be related, in large part, to the political pressure from owners in the area north of the East Beach.

In any event, no vestige of the suggestions for incorporating the scientific management of shoreline processes into the ecosystem management of the park can be found in the 1993 Management Plan.

7.1.6 Summary

Point Pelee National Park has a well documented history of attempting to manage the shoreline processes of erosion and deposition (Battin, 1975, East, 1976, Nelson et al, 1975, Shaw, 1988, Lavalle, 1990). East (1976) provided an excellent historical account of the variety of erosion control measures employed at Point Pelee. In general, he concluded that many of these measures were ill-conceived and improperly monitored following the abatement of the crisis atmosphere that surrounded their implementation. In part as a result of East's conclusions, and also in response to the development of the National Park Policy (1979), in recent years a general policy of inactive management has been employed by the park, and actively eroding areas have been classified as hazard zones. Throughout this period, studies continued to investigate the nature of the sediment transport process. It is generally accepted that the spit is in a negative sand budget, however management can still be characterized as hands off, except where facilities or neighboring lands are at risk. As pointed out in the Ecosystem Management Plan (1992), this perception that nature can manage itself must be changed if the park is to be managed in an ecologically sustainable manner. That is, erosion will continue with consequent effects on the marsh and as a result the park will not be ecologically sustainable in its current configuration. The Management Plan of 1993 makes this perceptual change with respect to the park's biotic resources but fails to do so where the abiotic resources are concerned.

7.2 Interpretation

As is evident from the preceding discussion, a wealth of information exists regarding the shoreline processes of Point Pelee National Park. The following discussion will focus upon how this information has been incorporated into the park's interpretive function, and assess the apparent reduction in earth sciences within interpretation identified the previous chapter.

Three documents were available for the assessment: the Park Interpretation Service Plan of 1988, the revised Draft Message Framework for the park of 1993, and the 1993 Visitors Guide.

7.2.1 Park Interpretation Service Plan 1988

The 1988 Interpretation Service Plan is identified as developing from the 1982 Park Management Plan and as such, is reflective of the 1979 Parks Canada Policy.

The objectives of the plan are broad statements which identify: 1)the importance of the recognition that Point Pelee is a National Park; 2) the provision of opportunities for visitors to come into contact with the eight themes identified for the park; 3) the needs and expectations of specific user groups and; 4) the need to increase awareness outside the park through interpretation and extension activities.

The eight themes identified in the plan and the locations at which they are interpreted in the Park are presented in Table 7.2. The 1988 plan identifies the landform itself as a significant theme in the interpretive message of the park. However, the text that identifies the significance of the landform and the processes that shape it focuses largely upon the shape of the tip. This is highlighted by the location at which the landform theme is interpreted. The Point changes its shape from year to year, while the triangular shape of the entire park can best be appreciated from a tower viewpoint located in the south central part of the park. (Fig. 7.3).

Table 7.2 Interpretation Themes Point Pelee National Park 1988

Theme	[illegible]
Migration	The Tip
Carolinian Flora and Fauna	Visitor Centre
Canada's Southernmost Mainland	The Tip, Entrance Area
Great Lakes marsh	Marsh and Boardwalk Tower
Landform Formation	The Tip, Marsh and Boardwalk Tower
Role as a National Park	Visitor Centre, Deslaurier House, Entrance
Human Activity	The Deslaurier House
Diversity of Habitat	Visitor Centre, Marsh and Boardwalk Tower

The plan presents a brief overview of the significant changes that have occurred at the Point and the fact that the entire Point is migrating to the west (Lavalle, 1986, 1990, Trenhaille, 1976). Indeed, the east shoreline may be migrating more rapidly than the west shoreline, resulting in a potentially continuous decrease in park area. This migration is not a significant feature of the interpretation of the park.

The plan notes that most visitors to the park are unaware of the significance of the shoreline processes, largely due to the time at which peak visitation occurs. Peak visitation occurs in the summer while the shoreline erosion processes are dominant during the spring and fall. As a result, the plan notes that effective communication of the message of landform change requires the use of photographs. An alternative site for the interpretation of Park Migration and shoreline recession would be the east beach where oak pilings, at one time on the beach , are now visible 20 m. offshore.

7.2.2 Draft Message Framework 1993

The draft message framework was developed in 1993 in response to the changes in the National Parks Act and its provisions for ecological integrity. In addition the draft message framework reflects the move of Parks Canada to Environment Canada and the joint vision of concern for the environment.

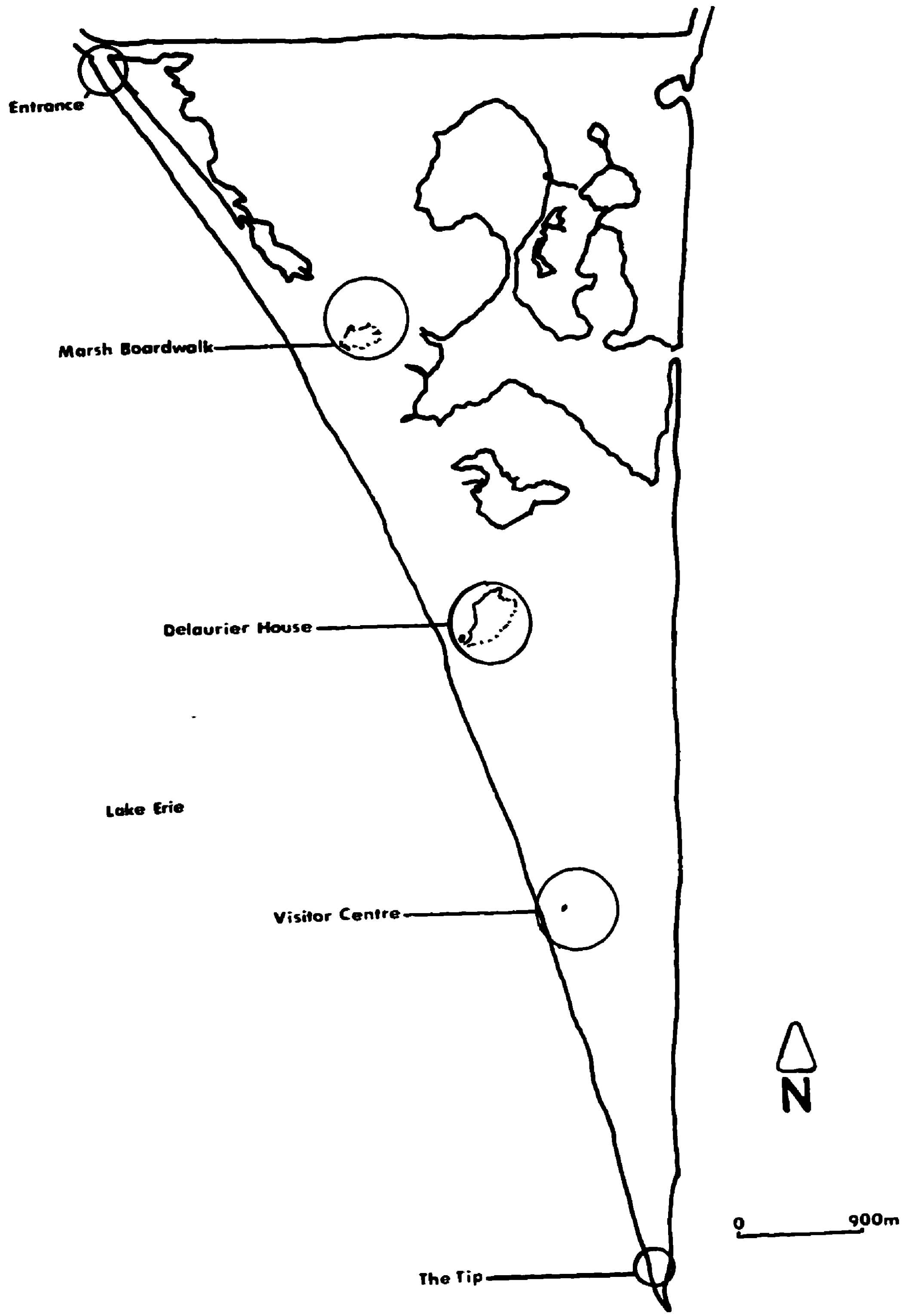
The framework notes that the original theme of *Canada's Deep South* is evocative of a very different image than the new overall theme *Partners in Preservation*. Within this overall theme are 5 sub themes (Table 7.3). Of these only the Pelee Story is reflective of the 1988 plan.

Furthermore, within the Pelee Story theme, the earth science component is reduced to that of an incidental theme. The themes within the Pelee Story deemed to be significant in the new framework are exclusively biological in nature. This provides evidence of clear reduction in the significance attached to the earth science resources of the park as a direct result of the interpretation of the Green Plan and the amendments to the National Parks Act. The new message framework makes no provision for the earth

Table 7.3 Draft Message Framework Point Pelee 1993

Theme	Sub Themes
Environment Canada	Vision Services Canadian Parks Service National Parks Point Pelee's Role
Regional Ecosystem	Habitat Loss 97% Gone, 12% Minimum The Value of Habitat Sustainable Living - Economy, Environment, Society Restoration and Preservation
The Pelee Story	Special Places-Carolinian forest, marsh, migration Special Species-Diversity, rare, threatened, and endangered species People and Point Pelee-Indigenous people, Europe and settlement Incidental Stories-Southernmost land, Nautical History, Landform
Preserving the Environment	Ecosystem Management Stewardship - in park practices Citizenship Opportunities for involvement
Global Issues	Acid rain, water quality, waste management Green Plan Great Lakes

Figure 7.3 Interpretation Sites Point Pelee



(Source: Parks Canada, 1988)

sciences in any of the newly identified themes, and such additions apparently are not being considered (Hince, 1994, pers. comm.).

7.2.3 Point Pelee Visitor Guide 1994

The 1994 Point Pelee Visitor Guide is reflective of the changes identified in the new 1993 Park Message Framework. The visitor guide makes no reference whatsoever to any earth science feature or process in the park. The guide discusses the regional issues, cooperative efforts, the role of volunteers, and ecosystem management. None of these discussions relates the earth sciences to these issues.

7.2.4 Summary

Interpretation of the earth sciences is no longer occurring at Point Pelee National Park. The development of the new message themes has reduced the significant earth science features and processes of the park to the status of incidental messages. Yet the problems associated with human modification of the shoreline of Lake Erie present an excellent opportunity to interpret how the park is affected by what happens outside its borders, and to develop this into the messages of environmental stewardship. However, the Park does not recognized these opportunities and reflects the relatively narrow biological bias evident in all other aspects of park management.

Finally, the physical systems will have to be considered in light of global change and particularly the potential impacts of global warming(Sanderson, 1987). While it has been suggested that Great Lakes levels may drop as a result of global warming, it is also likely that the ice barrier that protects the western shore of Point Pelee from erosion during late fall and early winter storms, will not form and increases in erosion can be expected if this occurs.

7.3 Research

Point Pelee National Park has been the site of extensive research related to the dynamic processes of shoreline erosion, point migration and beach recession. This research dates back to 1933 (Kindle, 1933) and continues today (Lavalle, 1994) under a continuing contract to monitor changes in beach profiles. Much of the geomorphological research is directed by park management concerns, and as such, Point Pelee is unique in terms of the parks considered in this study.

However, in spite of the ongoing research related to the shoreline processes of the park and the clear connection which these processes have to outside human activities, the park interpretation messages do not address this in terms of the new messages. In addition, the new messages do not refer to the management strategies for shoreline processes, and the significance of regional integration to this management. Research does indicate, however, that the park is the recipient of all updrift impacts to the sediment flow system and, as a result of shoreline hardening and sediment capture outside the park, is in a negative sand budget situation.

Research in Point Pelee provides a significant information base to guide resource management. However, the management decisions are often influenced by pressure to protect lands outside the park, and as such do not necessarily reflect the best use of the available information.

7.4 Overview

In summary, chapters 6 and 7 report on the analysis of documents relating to natural resource management, interpretation, and research in order to assess whether there has been a decline in the consideration of the earth science resources over the past 10-20 years. The analysis and assessment focused upon Banff, and associated parks such as Yoho, and on Point Pelee. It was not possible to survey all the relevant planning documents for the various parks, due to the limitations of time. Furthermore, many of these documents are no longer available. Even current management plans are in exceedingly short supply.

The results of this chapter show that the greatest change in earth science inclusion in planning and management is occurring in the interpretive functions of the parks. This is most clear at Point Pelee where the earth sciences have been reduced to incidental messages. In Banff and the associated parks, much interpretive material exists in the form of visitor centres and roadside exhibits. However, there is the sentiment that if the pre-existing interpretive displays were to be constructed under the present policy the earth sciences would be significantly reduced in message content. Thus, earth science interpretation in the mountain parks may be an artifact of the outpouring of interpretive work conducted during the 1970's.

In terms of resource management, Point Pelee has shown a significant decline in the degree of active management of the shoreline processes. In the past, many management practices were focused upon structural approaches to erosion control at specific locations without regard to the entire system. Recently, the policy has been one of inactive management or non-intervention, in spite of system knowledge that indicates that sediment augmentation and other manipulation seem necessary if ecological integrity is to be maintained. In contrast, active management or intervention is supported where biological systems have been negatively impacted by human activity.

In Banff and the associated parks, there is generally little evidence in the plans of active management of earth science resources, and there is certainly no indication of applied geomorphology. In most cases the priorization of resource concerns places biotic resources much higher than abiotic ones, regardless of the significance ascribed to them in the management plan. Indeed, in the most recent ecosystem management plan for Banff no consideration is given to the abiotic component of the ecosystem. As the parks develop ecosystem management strategies which reflect the new ecological integrity mandate, the earth sciences are no longer being considered in any significant way. These findings suggest that the earth sciences are not considered to be a component of an ecosystem within the context of the planning and management by Parks Canada. As a result, the increased emphasis on the communication of management messages in interpretation will further reduce the earth science content of earth science messages.

In terms of describing these management practices according to Dearden and Rollins' typology, it is useful first to consider why management of earth science resources might occur. The various planning documents consulted for this chapter identify two broad reasons why earth science resources might be managed.

1: To protect the resource from adverse impacts associated with human activities.

2: To protect park facilities and visitors from possible damage or harm associated with a particular earth science resource.

In regard to protection of resource from adverse impacts of human activities, management has generally taken the form of zoning. While Dearden and Rollins characterize zoning as being at the management level of complexity, it is also related to protection. Furthermore, it involves the management of people, not resources, and therefore may require little knowledge of the resource.

Management strategies to protect park facilities and visitors from earth science processes involve both zoning (e.g.. hazard zones), and active manipulation of the resource (e.g.. erosion control). Here, again, zoning can be characterized as the management of people. Where active manipulation of the resource is undertaken, the physical process is often interfered with in order to protect park resources. No examples have been found which take into account the role of the process in the physical system, or its integration into the ecosystem. In all cases where active management was undertaken it was of an engineering nature. The documents consulted in this chapter indicate that management and interpretation of the earth sciences have not paralleled the management of the biotic resources in their level of management sensitivity and complexity.

CHAPTER 8

Results of the Interview Questionnaire

The previous two chapters have shown a reduction in emphasis placed on the earth sciences in the planning, management and interpretation of the National Parks selected for this study. This chapter follows these findings through presenting results from interviews with resource managers (wardens) and interpreters working in the parks in question. It presents the results of the interviews of the park personnel. As noted previously, a modified snowball sampling method was employed.

The chapter begins with a statement of the purpose of the interviews , the method of delivery and an identification of how the questions arose from the previous research. This is followed with a general identification of the questions, outlining their intended purpose and identifying what worked and what did not. The third section presents the results of the interviews. The final section presents a summary and interpretation of the results.

8.1 Purpose and Method of Interviews

The major purpose of interviewing park personnel was to expand upon the information collected through the analysis of the park documents. A number of questions arose as a result of the findings of the previous chapters. Over the two field seasons (1993, 1994), each of the five parks (Banff, Yoho, Kootenay, Jasper and Point Pelee) from which the interviewees were drawn, were visited on at least one occasion, and several of the parks were visited two or three times. During the first field season, the initial contact was made and documentary evidence was collected. During this early research and document collection, it became apparent that the wardens and interpreters in the park were a valuable source of information, and had a knowledge of park operations that went far beyond what was contained in the various management plans. In order to access this information the interview guide presented in Table 8.1 was developed as described in Chapter 3.

A modified snowball sampling technique was employed to target knowledgeable persons. In this method, the initial contact in the park was provided through the park superintendent, who identified key people within the park interpretive and resource management staff. From these individuals the sample grew as each interviewee identified others in the park with expertise relating to various aspects of the questionnaire. Such a sample can ideally be considered complete when no new names are identified. This closure generally worked in this study, although not all identified interviewees could be consulted. Some interviewees identified individuals in neighboring parks and they were added to the sample. Table 3.4 identifies the sample by respondent type and park affiliation.

As illustrated in Table 3.4, only three of the experts, identified through the sampling technique, were unable to be included in the sample. Two of the persons identified were park employees (wardens) who were not in the park during the research visits. A number of attempts were made to contact these individuals, but were unsuccessful. The interpreter not contacted had retired from the park service a number of years prior to her identification in the sampling procedure and could not be traced.

8.2 Identification of the Questions

The questions are presented in Table 8.1 below and can be identified as falling into one of five general categories: 1) questions related to changes in interpretation, management and research, and their relationship to the earth sciences (questions 8.1 a, b, c, and 8.2); 2) questions related to the EARP process and the identification of earth science concerns by the process (questions 8.3 a, b, and 8.4); 3) questions related to specific earth science management activities (questions 8.5, 8.6, 8.7, 8.8, 8.9); 4) questions relating to the awareness of significance and nature of the earth sciences to the

Table 8.1 Interview Questions

8.1 a How has interpretation changed in the park over the past 10 to 20 years?
8.1 b How has resource management changed in the park over the past 10 to 20 years?
8.1 c How has research changed in the park over the past 10 to 20 years?
8.2 How has this changed with respect to geology/geomorphology; that is have you noticed a difference in the way that geological resources have been perceived, managed and presented?
8.3 a What has been the most significant issue identified through the Environmental Assessment and Review Process?
8.3 b Can you identify any specific issues relating to geology and geomorphology identified through the Environmental Assessment and Review Process? (e.g. Trans-Canada Highway twinning, Sunshine, Lake Louise)
8.4 Who conducts the Environmental Assessment and Review Process....What is their background?
8.5 What criteria are used for determining Zone 1 areas and what is the process? Can you describe it for specific zones e.g. Burgess Shale , Castleguard Caves?
8.6 How are Environmentally Sensitive Sites determined?
8.7 a What specific resource management activities are performed by the Warden's Service?
8.7 b What percentage of resource management activities are related to geological resources and concerns?
8.8 What type of rehabilitation work is being done? How are these prioritized?
8.9 Why restore disturbed sites for ungulates? i.e. is this the original habitat, form?
8.10 What is the significance of geology and geomorphology in ecosystem health or ecological integrity?
8.11 What is the influence of external special interest groups in management decisions?

8.12 When does geology/geomorphology (form/process, resource/hazard) become a matter of consciousness? i.e.. crisis response vs. ongoing process
8.13 What is the background of the Warden/interpreter and how long have they been with Parks?
8.14 What would you identify as the four most significant geological/geomorphological forms or processes within the park?
8.15 Do you perceive any shortcomings in the manner with which geological/geomorphological heritage resources are dealt with in the park, park system in management and interpretation etc.?
8.16 How would you address this shortfall, given budgetary and manpower constraints?

park and the park system (questions 8.10, 8.11, 8.12, 8.13, 8.14, 8.15); 5) and finally, a question relating to means of addressing the shortfall (question 8.16).

The purpose of the questions related to changes in interpretation, management and research was to assess the results of the previous chapters which indicated that the earth sciences were being reduced in importance in the management plans of a number of national parks. In general, these questions confirmed the results of the previous chapters.

The second category of questions, those related to the EARP process, developed directly from the analysis of the management plans, which identified no concerns or problems related to the earth sciences in spite of the fact that other sections of the plans identified a number of conflicts. It was anticipated that these questions would provide some insight into the shortcomings of the EARP process with respect to the earth sciences.

The purpose of the third category of questions was to identify specific resource management activities performed by the warden's service that related to the earth sciences. These questions began by asking the respondents to identify why certain areas were singled out for protection and how these decisions were made. This was followed with more general questions regarding the management of earth science resources. A number of the questions in this category proved to be difficult for the respondents to answer. This problem is expanded upon in the following section of this chapter.

The fourth category of questions was intended to identify possible reasons for the observed reduction in emphasis on the earth sciences in the parks. These questions focused upon the respondents' awareness of the role and significance of the earth sciences in terms of both ecological functions as well as in the management and interpretation of the park, the training and background of the respondent, and their knowledge of the significant earth science resources of the park. The responses to these questions supported the findings of chapters 5 and 6.

The final category of questions had the purpose of identifying means of reversing the reduction of the earth sciences as perceived by those responsible for the protection of the National Parks. This question is predicated on the assumption that the respondents, at the end of the interview, have identified a reduction in the role of the earth sciences in the planning, interpretation and management of the National Parks. Responses to this question were quite positive and supported the view that the earth sciences are often overlooked in management and planning.

The questions were always asked in the order presented in Table 8.1 and can be characterized as evolving from general to more specific and, finally prescriptive queries. The questions were asked of all Parks Personnel interviewed and as a result several questions were inappropriate for some categories of respondents (for e.g. EARP questions not relevant to interpreters). In spite of the questions being open ended, a number of the responses were "off target" and less useful than anticipated. In addition, several of the responses overlapped with those of other questions. These problems are addressed further in the presentation of the results.

8.3 Results of the Interview Questions

The following Tables (Tables 8.2 through 8.16) present the responses to the interview questions. In some cases, the responses were quite lengthy, andfor this reason are only summarized in this Chapter. Each Table is briefly described and data analyzed. As a general rule, the responses are presented by category of respondent, that is wardens/resource managers, interpreters, and researchers. The numbers of the latter category is limited as only those researchers identified through the snowball sampling technique were interviewed. In addition, only two individuals were interviewed in Point Pelee and as a result the responses often appear to relate only to Banff and the associated mountain parks. Where the responses from Point Pelee are different from Banff and the mountain parks, this is noted in the text. However, where there is no appreciable difference in responses, distinctions are not made between the parks in the interest of respondent confidentiality.

The responses are presented in the order that the questions were asked and are grouped by the categories identified above.

8.3.1 Identification of Change

Questions 8.1 and 8.2 were designed to provide information regarding changes to the management, interpretation and research of the National Parks. Question 8.1 is more general and was asked to determine if the respondents would recognize a reduction or change with respect to the earth sciences without prompting. This was followed with question 8.2 which directly asked the respondents to identify any changes in the way the earth sciences were treated.

8.3.1.1 Question : How has Interpretation Changed Over the Past Ten to Twenty Years?

The first question asked of the interviewees concerned their impression of general changes in the ways the parks have been managed, interpreted and studied (research) during their tenure with Parks. This question is presented in three separate tables (Tables 8.2a, 8.2b, 8.2c) thus allowing for separation of the three components of the question,

Table 8.2.a How has interpretation Changed over the past 10 to 20 years?

[illegible]	[illegible]
Warden/Resource Manager Four out of thirteen responding	Increasingly dealing with an educated clientele. Ecotourism
	Both Interpretation and management are more focused outwardly than in the past. Even communication attempts to reach external groups.
	Was natural history-1 species now ecosystem-# of species, global perspective rather than park.
	Increasing importance attached to cultural landscape, archaeological, built and mining history
Interpreters/communications -Thirteen of fourteen responding	There is less of it, shift away from interpretation which is now considered a luxury-sense that we are preaching to the converted. Now must be economically viable-hikes given over to private operators
	Whole structure has changed-amalgamation of interpretation and communications. In addition, the messages have changed, move toward broader environmental messages.
	Storylines have changed, increasing emphasis on broader environmental stewardship. Geology and geomorphology are included.
	Most significant change in the past 2-3 years in the message area and cost effectiveness.
	10 to 20 years ago interpretation regarded as a core service, now focused upon communicating management issues, and with the move to ecosystem management and ecological integrity and environmental stewardship the old messages are being lost.
	Revenue generation cost recovery
	Major shift away from what is in the park and towards a broader audience putting parks in a global perspective.
	Interpretation has mirrored the evolution of the parks has moved away from the feature specific. In the early years interpretation was feature specific, in the 70's we used an ecological approach within the park, now changing to ecosystem approach. Moving away from park values to ecosystem values. Biggest barrier to this is that we say parks are special places.
	Complete change in focus. Environmental citizenship is the new message. We have moved away from "this is what we are about message" In the 80's the emphasis was on that which was special, linked messages, and education.
	Refocusing of the message less on geology and geomorphology and more on environmental messages. Focusing on local audience.
	Wouldn't recognize what was. Emphasis on resources has dropped considerably and will continue to do so. Must impart a sense of environmental citizenship
	Becoming more imaginative and moving towards more partnerships where we are the knowledge experts.
	Interpretation has been practically killed. Earth science interpretation has always been a problem as it is not an intuitive thing
	Pretty clear that interpretation is dissipating- there is no support at the policy level. Move is to privatization - interpretation always seen as fluff.

Research, Management and Interpretation. This is important as the interviewees, while identified by function, also responded as to their perception of changes in other functions. All responses are presented as contractions of the actual response but reflect the actual words used by the respondents.

The preceding responses present a number of common themes relating to interpretation. The main concerns related to the process of interpretation itself and to the focus of the message.

Respondents were nearly unanimous in the identification of the changing message focus as a significant change to interpretation within the very recent past and within this is the recognition that the earth sciences have been impacted by these changes. Ten of thirteen interpreters and two of four wardens identified the change in interpretation messages. This change in message focus has two dimensions.

The first dimension is that of the message content or information. All respondents were in agreement that there has been a significant shift in message focus and that this change has been to move away from resources, species , feature interpretation to a system-oriented interpretation. One respondent identified a three-stage shift in the message content from the initial period of formal message delivery in the 1970's. This shift was from the specific feature or species in the 1970's, to a more holistic ecosystem message in the 1980's, to the current message focus of ecological integrity and management issues. In keeping with this theme of changing message content, one interpreter noted the change in emphasis away from parks as special places to parks as part of a larger ecosystem.

The second dimension of the changing message focus identified by the respondents is the audience. Several respondents identified the move to delivering information to an external audience. This change is related to the two changes already identified. First, the changing focus to an external audience accompanies the reduction in interpretation within the park. This is, in part, accomplished through partnership with external groups. Second, this change in message focus to external groups parallels the redevelopment of the message content to the relationship between the park and the region outside the park and the global ecosystem.

In terms of the role of interpretation itself, the responses point to the recognition that over the past few years interpretation has received much less emphasis within the parks than in the past. Indeed, a number of respondents expressed the concern that interpretation was on the verge of elimination. Expanding upon this theme were the responses that indicate that interpretation and many other services provided by the park are being driven towards a cost recovery model. These particular changes seriously threaten Parks Canada's control over the messages presented. During the field season there was a significant amount of tension in some of the parks due to concerns related to the consolidation of services within parks, the move to privatization of interpretation, and the impact of the change in department from Environment to Heritage.

8.3.1.1.b : How has Resource Management Changed Over the Past Ten to Twenty Years?

Table 8.2.b How has resource management changed in the past 10 to 20 years?

Respondent Function	Response
Warden/Resource Manager -Six of thirteen responding	More proactive less reactive
	20 years ago management of resources focused upon tourism development rather than protection and preservation this moved through the protection of specific features to the current focus ecological integrity of natural resources
	Was natural history- 1 Species. Today It is ecosystem level # of species over a landscape-global perspective rather than park.
	Change to whole ecosystem focus , now hopefully over dual mandate
	More outwardly focused than in the past. Spend more time with provincial colleagues than within the park.
	Previously emphasis placed unique features or single species
Interpreter - Four of fourteen responding	Block planning
	Formerly managed within park boundaries Now one piece of a regional puzzle. Ecosystem based management
	Ecological approach
	Focus change from the components to overall system

The responses to this question parallel those of the previous one. Again, there is near unanimity about a move away from feature and species specific management to an ecosystem approach. Indeed, all responses indicate this. This is stated in a number of ways, but the general message is that previously parks were reactive and focused upon individual or unique features and species. Not one response contradicts this perception. However, unlike the responses to the previous question no respondents connected the changes to the earth sciences.

As would be expected, a greater percentage of wardens were able to answer the question than interpreters and no researchers responded. All respondents viewed the changes in resource management as a positive one.

8.3.1.1.c: How has Research Changed in the Past Ten to Twenty Years?

Responses to this third component of question, once again, were nearly unanimous in identifying the change from species specific research to that of a broader ecological focus. As one warden responded, they "mirror" the changes to resource management. In addition, respondents identified two other common themes in their responses to this question. It should be noted that the non-responding wardens and interpreters were asked the questions. They simply could not provide a response. This holds true for all questions in the series.

The first theme is that research is now often actively sought by park managers, whereas in the past researchers were often discouraged. This latter point was confirmed by the impression of researchers themselves, one of whom has been denied permits in the past. Further illustration of this point are the comments of Riewe(1994) who does not pursue research in the National Parks due to the number of restrictions. In addition, many wardens within the park are unaware of the work being conducted by internationally respected researchers (Todgham, 1994).

Table 8.2.c How has research changed over the past 10 to 20 years?

[illegible]	[illegible]
Warden/Resource Manager - Seven of thirteen responding	20 years ago research was more species specific and each park was treated on its own, now system viewed as a block. Past focus on highly visible animals, now keying in on carnivores as indicators of ecosystem health. Also research on fire in the ecosystem. Research is identified as part of the mandate. There has been a management push for science, however science may tell us things we don't want to hear, therefore we need education within the ranks.
	Research done with external partners
	Research is now more collaborative than in the past, it transcends park boundaries and is multi party research
	Mirrors management need for global perspective.
	Mirrors management need for global perspective.
	Management and research more focused on ecological integrity.
	There is now a lot more applied research related to park service problems. More emphasis on issues park managers perceive to be important. Less money (%) spent on pure research. More parks money involved
Interpreter - Two of fourteen responding	In the 80's and prior research particularly research that manipulated resources was not encouraged. Today research is very much encouraged. Parks are natural laboratories. The governments slashing of CWS research component in 1985 contributed to the lack of research in the mid to late 80's.
	There was a time when academics from universities were unwelcome in the park. To some degree this has changed, but researchers must still be persistent. This is ironic as the results were wanting years ago. There is now a focus on research and it is focused on the ecosystem approach, but we still must understand the underlying part.
Researcher - Two out of two responding	Yes very definitely, my first application was refused (5 years ago) Now they are actively seeking researchers. Change in personnel from warden to resource management.
	Research increasingly being undertaken by the wardens service, largely related to wildlife

The second theme is that much of the research now undertaken in parks is collaborative. This includes park-initiated research conducted in cooperation with other National Parks as well as with Provincial agencies responsible for the management of the surrounding land. All four mountain parks have identified collaborative research projects either with one another or with external research partners. Included among these are the Tri-Council ecosystem monitoring program in Jasper, the Bow Valley study in Banff, and a number of cooperative wolf and grizzly studies in all four parks. In all cases, the collaborative research and park-initiated research is of a biological focus. No respondents from the parks identified changes in the type of earth science research being conducted in the parks, while one researcher noted that research conducted by park personnel is largely biological.

8.3.1.2 :How has this (interpretation, management, research) changed with respect to geology/geomorphology?

The preceding question asked the respondents to identify changes that they had perceived in the management, interpretation and research conducted within National Parks. The majority of respondents identified that changes had indeed taken place. The greatest changes identified by the respondents was a reduction in species and features specific focus in all facets of park administration. That is, individual species and features were now emphasized much less in management, interpretion and research. With the exception of the responses in connection to interpretation, few respondents identified any changes with respect to the earth sciences.. The following question was intended to identify changes in the way earth science features and processes specifically have been managed.

Table 8.2 How has this (interpretation, management, research) changed with respect to geology/geomorphology, that is have you noticed a difference in the manner that geological resources and processes have been perceived managed and presented?

Respondents' Type	Responses
Warden/Resource Manager - Nine out of nine responding	Yes in some place. Generally the immediate problems are with wildlife, geology is often perceived as unchanging.
	Public is much more sophisticated tired of information overload. Moving to the other side ecotourism, want to see solutions to larger issues, the exception are things like the Burgess Shales.
	Haven't noticed a lot of difference, sense a greater awareness that geomorphology need to be considered with other resources, though have no examples of where that has happened
	No change noted. Last review of Management Plan raised no concerns re geology and geomorphology and the 1999 review is to address ecosystem.
	Haven't noticed a change. Not dealt with, geology and geomorphology do not figure into the picture in any significant way.
	Not much change. With the new initiatives geology and geomorphology have taken a bit of a back seat in all parks.

Point Pelee	We have gone from active management and protection with mechanical means to a realization that we can't change what mother nature is going to do.
	Not a lot of change, benign neglect all the way. In Banff there has been a bit of a decrease in geological geomorphological research because people are not as active as in the past.
	.....unless something big happens geology and geomorphology aren't really considered. The change to linking the four mountain parks in ecosystem management doesn't provide for input from geologic or geomorphic in the steering committee.
Interpreter - Twelve of thirteen responding Includes private interpreter	There is some attention to it due to the Burgess Shales and this has increased since Gould's book[6]
	There is some presentation not a lot, will be even less with ecosystem focus.
	Not really. Geology is difficult to interpret.
	No big changes streamlining to avoid duplication. 4 Mt. block planning.
	Nobody has done an interpretation program on geology/geomorphology in the past 10 years - nobody has that background. It has been given a lower priority in the storyline.
	Geology and geomorphology were never really a consideration and I don't see a difference now.
	If presentation of geology and geomorphology has decreased then probably all presentation has decreased.
	Have had a real concern that the abiotic side is poorly by staff except where it connects with biota or causes trouble....no staff for geological or geomorphological resources. Staff for fish, forests, wildlife etc. There isn't the emphasis there should be considering it is the four *mountain* parks. The number of people who are competent to interpret park resources has deteriorated, here noone has the background to effectively interpret the earth sciences.
	Yes. Geology and geomorphology have a far lower priority in terms of messages. Lake Louise visitor centre provides the geological story of mountain building however if it were being built now geology would be a very minor focus, similarly the roadside exhibits etc. Warden service is pushing for the removal of signs which don't deal with park management issues.
	Geology and landscapes are significant which is odd because we tend to discount them
	Earth science interpretation has taken an even bigger plunge than other messages with restructuring.
Point Pelee	It is a lower priority in terms of the messages not being on the characteristics of the park, but on the broader context. We look on landform as an incidental story, yes we're on a sand peninsula but we could be somewhere else, our prime role is the Carolinian Ecosystem.
Researcher	Not much has changed in the past 10 years but in the past 20 or 30 years there is a much greater awareness in terms if some geological resources such as the Burgess Shale which is a World Heritage Site. Information about the Shales have been available through the park, R.O.M, the Smithsonian. There is a rich body of information which I attribute to 100 years of research on the Burgess Shales conducted by geologists.

[6]Gould. Stephen J.. 1989, Wonderful Life

The responses to this question confirm the view that geology and geomorphology are not accorded the same level of importance as biotic resources in management and interpretation within the National Parks. With few exceptions, respondents identify geology and geomorphology as being ignored or a lower priority resource within the park. Curiously, however, respondents were not unanimous in their perception of whether or not this is indicative of a change in the manner with which earth science resources are interpreted and managed. That is, there was the suggestion that earth science has never been an important consideration in the planning and management of the parks.

In both interpreters and wardens' responses, there was some disagreement as to whether the way geology and geomorphology was presented and managed, had changed. However, wardens tended to more consistently (6-2) hold the view that geology and geomorphology had never been important considerations in resource management. Comments such as "benign neglect", "taken a back seat", "really lax" are fairly indicative of the manner in which wardens perceive geology and geomorphology's role in past management practices. One warden noted that he sensed a change in awareness with respect to geology and geomorphology but could not identify any examples.

Interpreters, in contrast, were more evenly split in their response to the first component of this question with four seeing no change, three perceiving a change and five not directly answering the question. The general consensus among interpreters was that geology is difficult to interpret, a lower priority in the storyline, difficult to integrate into the new ecosystem message, and has never really been done[7]. There are a few exceptions to this view. One interpreter felt that all interpretation had declined and this view was shared by the private interpreter who also felt that geology and geomorphology had been reduced to an even greater extent.

[7]Note. In the context of this response it was intended to mean actual naturalist led interpretation and does not refer to exhibits and displays at visitor centre.

The one researcher who responded indicated that not much had changed in the past 10 years. However, he noted an increase in awareness during the period of 20 to 30 years ago.

In keeping with the general belief that the role of geology and geomorphology has declined, or was never very significant, one interpreter was very concerned that the abiotic side was poorly understood by park personnel and discussed at length his concerns. Another noted that geomorphology is significant but commented that this was odd because the parks tended to discount the earth sciences.

Finally, a warden suggested that people are tired of information overload and now wanted to see solutions to larger issues. These assertions directly contradict the observations and research of a number of other park personnel and could reflect the very senior position of the respondent and his distance from hands-on management and interpretation. Indeed it appears to be a justification for the continued erosion of interpretive services within the parks. Senior interpreters noted that an Angus Reid(1994) poll suggested that the number one reason people come to the park is to understand the landscape, and to learn and to explore, hardly an indication of information overload.

From the preceding discussion, it is clear that the majority of respondents perceive the earth sciences to be a lower priority in terms of their role in management and interpretation of park resources. This is not to suggest that they place a lower priority on the earth sciences, but that the earth sciences have received a lower priority.[8] As well, there is some disagreement as to whether this is a continuation of past trends or a relatively new development. Finally, there is some divergence in the opinions between the nature of the changes in interpretation versus those in resource management.

[8] Some respondents did feel that the earth sciences were not at all important and didn't quite understand why the researcher was pursuing this, they were however, by far in the minority.

8.3.2 Environmental Assessment and Review Process

These questions were originally presented in three parts. However, the results of the first two parts overlapped. Therefore, the results of these two questions are presented below separately, but are discussed together. The responses to the third question follow the discussion of the first two. These questions were intended to address the problems noted in the analysis of the management plans and related documents in Chapters 5, 6 and 7. That is, there appeared to be no consideration of earth sciences in the plan environmental impact statements.

8.3.2.1: What Has Been the Most Significant Issue Identified Through the Environmental Assessment and Review Process

8.3.2.2 : Can You Identify Some Specific Issues Relating to Geology Identified Through the Environmental Assessment and Review Process?

Table 8.3.a What has been the most significant issue identified through the Environmental Assessment and Review Process?

Respondents' Type	Response
Warden/Resource Manager - Ten of fourteen responded	Cumulative Effects
	Cumulative Effects
	Ice River Mineral Extraction in important Grizzly Habitat
	None. mostly in house maintenance
	Rock Scaling and Cement Sealing
	Gravel Extraction
	Landscape Connectivity/Habitat Fragmentation
	Public Safety-Avalanches-Ski Area Development
	Cumulative Impacts Icefields Centre
	Shoreline Erosion
Interpreter- Four of thirteen responded	Little done in Kootenay Only looked at due to Grizzly Habitat
	Geology not changing quick enough
	Cumulative Impacts
	Habitat Fragmentation

Upon initial examination of the responses to these questions, a number of items are immediately evident. First, very few interpreters and no researchers provided responses. While not immediately evident from this presentation, very few wardens were prepared to answer this question as well.

Table 8.3.b Can you identify some specific issues relating to geology identified through the Environmental Assessment and Review Process?

Respondents' Function	[illegible]
Warden/Resource Manager	Gravel pits-if aggregate is taken from the park perhaps we can do a better job of reclamation
	Slump in front of lodge

The responses present some problems as the respondents identified more impacts associated with the earth sciences to the first general question than to the second question which specifically asked about the earth sciences. Perhaps the most significant result of the questions was that few issues related to the earth sciences have been identified through the EARP process.

The results of these question were disappointing as a number of significant events should have been identified by the respondents of the mountain parks with regard to potential impacts. First, the proposed twinning of the Trans Canada Highway (TCH) has implications for both the biotic and abiotic resources of the parks. Second, during the field season of 1994, the TCH was closed due to the debris flow in the area of Mt. Stephen, yet this was not identified as an issue. Third, the privatization of interpretation hikes to the internationally significant Burgess Shales was not identified as an issue. Fourth, Environmental Assessment and Review Process specialists did not identify any concerns related to the redevelopment of the Icefields Centre. Finally, the drilling of the well at the Maligne Teahouse was not identified as an issue by the Environmental Assessment and Review Process specialist.

These represent some of the larger, more obvious contemporary concerns that were identified in response to other questions throughout the interview process. In addition to these are numerous minor issues related to geology and geomorphology. Yet, in spite of this, when the Environmental Assessment and Review Process is conducted, these issues do not appear to be recognized.

8.3.2.3 : Who Conducts the Environmental Assessment and Review Process and What is Their Background?

Question 8.4 was intended to see if the background of the EARP specialist might provide some reasons for the lack of identification of earth science implications in EARPs. The results of Table 8.4 show a strong bias towards a biological background among Environmental Assessment and Review Process specialists in the five parks examined for this study.

Table 8.4 Who conducts the Environmental Assessment and Review Process and what is their background?

Warden/Resource Manager	Background or Training
Five of five Environmental Assessment and Review Process specialists responding	Geography/Biology
	B.Sc. Biology
	B.Sc. Biology
	B.Sc. General Science
	Diploma Fisheries Management

The lack of a geological/geomorphological background on the part of the Environmental Assessment and Review Process specialist would hamper his or her ability to perceive the implications to geological and geomorphological resources and processes of many proposed activities and provides some explanation for the results of the two previous questions. In fact, Todgham (1994 pers. comm.) indicated serious oversights regarding the earth sciences in the E.A. of the proposed Columbia Icefields Centre relocation. These concerns were brought to light by individuals outside the process and were only recognized after significant effort was expended on the part of the intervenor. In another case, internationally renowned Karst experts expressed concern for geological resources as a result of the proposed well drilling in the Maligne Canyon (Gadd, 1994, Todgham, 1994, pers.comm.). These concerns were not addressed and the drilling exposed sulfur water which potentially contaminated the water supply, and disrupted subsurface hydrology.(Todgham, pers. comm., 1994).

8.3.3 Identification of Management Issues

Questions 8.5 through 8.9 are directed at identifying specific examples of how the earth sciences are included in the resource management activities conducted in the parks. Some of these questions arise directly from the management plans. Questions 8.5 and 8.6 are considered together as the responses overlap significantly. Both of these questions arose from the analysis of the management plans which identified a number of Zone 1 and Environmentally Sensitive Sites.

8.3.3.1: What Criteria Are Used for Determining Zone 1 Areas and What is the Process?

8.3.3.2 : How are Environmentally Sensitive Sites Determined

The purpose was to determine how earth science information was used in the identification of Zone 1 and Environmentally Sensitive Sites. These questions proved to be somewhat difficult for the respondents to answer and the most common response was that it was in the Natural Resource Management Process manual. Attempts to establish the means of attribution of value proved to be futile.

Table 8.5 What criteria are used for determining Zone 1 areas and what is the process?

Respondent Type	Responses
Warden/Resource Management Nine of ten responding (No interpreter or researcher responses)	Resource Description and Analysis
	Significance determined through management committees
	Method described in policy
	Policy
	Natural Resource Management Policy
	Natural Resource Management Policy
	Awareness of resources-research
	Done prior to wardens tenure
	Recognition that it is there- hence research

In addition to the references to policy, three wardens identified the significance of awareness of the resource in the designation of Special Preservation Zone 1 and in Environmentally Sensitive Sites.

Table 8.6 How are Environmentally Sensitive Sites Determined?

Respondents' Position	[illegible]
Warden/Resource Manager Two of ten responding (No interpreters or researchers responding)	Based on the Resource Description and Analysis and the Ecological Land Classification. This did not identify micro sites, largely based on literature review.
	The Recognition that it is there, hence record of research.

Both these question provided only limited responses. The designation of Zone 1 and ESS 's is perceived by many in the service to be a task that is complete and such designations are thought to be determined upon the basis of the Resource Description and Analysis. The "empty response" can be viewed as significant in terms of the gaps that they identify. In addition, one warden identified "recognition" that a site exists as means of determining ESS's.

Perhaps the most significant conclusion that can be drawn from the two preceding questions is that the majority of current park personnel have had little or no connection to the identification of Zone 1 areas and ESS's, and that, by and large, ESS designation is not viewed as an ongoing process.

The next question is again a two part query. In the first part the respondents are asked to identify the types of resource management programs that are currently underway in the park, and in the second segment the respondents are asked what percentage of this work is related to geology and geomorphology. This question is largely under the purview of Wardens, although interpreters were given the opportunity to respond.

8.3.3.3 : What specific resource management activities are performed by the Warden's Service?

Question 8.7.a was intended to provide some sense of the overall nature of resource management work conducted by the wardens' service. The responses to this question were anticipated to provide a point of comparison for the responses to question 8.7.b.

Table 8. 7. a What specific resource management activities are performed by the Warden's Service?

[illegible]	[illegible]
Warden/Resource Manager Six of ten responding	Environmental Assessment and Review Process, Preparation of Conservation Plan, Ecosystem Plan being developed with remaining Four Mountain Parks.
	Ecosystem program, coordination of science and research. Air quality, wildlife, forestry effects, forestry on landscape structure, hydrology- water quality, aquatics management-declining amphibians, pattern of protected areas, biodiversity
	Vegetation Management - non-native plant control, fire policy no prescribed burns, hazard control about facilities, monitoring for insects and disease, Vegetation Management Plan for the block. Wildlife management - wolf ecology, co-management of bighorn, highway mortality, annual survey-elk, sheep, Grizzly study. Aquatics - 4 Mt...... Block fisheries Mgt. Plan, N.H.R.I. .streamflows, water quality, snow courses, runoff forecasts. Environmental Assessment and Review Process - research and collecting permits - 20 per year - 2-3 geological. Abrasive pit, rock scaling in canyon.
	Major resource initiative in ecosystems. Hydrology, air quality, aspen study, ecohistory study, biodiversity study, wolf study, fishery mgt. discussion, bighorn mgt. plan, grizzly studies, wildlife monitoring program, noxious weed program, fire management program, vegetation history plan, highway mortality, boundary marker program, regular patrols, enforcement.
	Ecosystem management and ecological integrity
Point Pelee	Fisheries, aquatic, limnological and vegetation management, air and water quality
Interpreter	Development of ecosystem management plan, Integrated resource management plan.
	Really wide ranging - Wildlife management, elk/people conflict, bear management, ecosystem management
	Pulling dead animals off the road, Elk/human conflicts in spring and fall, remove NaCl from highways, recent ban of rafting on the Maligne to protect harlequin ducks.

The replies indicate that the main management function at the time the question was asked related to the development of ecosystem-based management of park resources. Within this new management focus, older functions have been subsumed. These include vegetation management, fire management, bear management, wolf management, elk management, and noxious weed control. Each of these management concerns was identified in earlier management plans but are now being addressed in an ecological manner. Park wardens were nearly unanimous in this interpretation. The lone private interpreter holds a cynical view of the management activities of the Warden's service.

8.3.3.4 : What percentage of resource management activities are related to geology and geomorphology?

The purpose of this question was to establish the amount of resource management work performed by the wardens that relates to the earth sciences. Responses to this part of question 8.7 b confirm the perception that the earth sciences are not considered to be significant management concerns.

Table 8.7.b What percentage of resource management activities are related to geology and geomorphology?

Respondents' Type	Response
Warden/Resource Manager Eight of thirteen responding	It is somewhat more significant in Yoho. However it hasn't been a high priority, more of the focus has been on flora and fauna. In spite of the 1988 Management Plan we still extract gravel in the park.
	Stephen slide, engineering solution. Don't know limits to the system.
	Less than 5% is relate to geology (low end)
	Less than 10%
	Very little 1 or 2%
	10 or 20%
	Not done
	Very small percentage, Geomorphology does not play a major role, Deal very little with rocks and soil, primarily with living things
Point Pelee	Time and money-wise very small less than 5 %
Interpreter Two of fourteen responding	None - Incredibly small amount
	Some groundwater abuses, mostly strictly E.A.R.P.. Earth science end shoddy, e.g.. the tea house at Maligne ignored advice not to drill struck sulfur water at 500 ft.. None of this in the initial Environmental Assessment and Review Process. Done in spite of the objections of Smart and Ford.

Respondents clearly identify the low percentage of time and money that the Warden's service commits to the management of geological and geomorphological resources. The respondents identify a range from 0 (none) to 10-20% of resource management duties as being related to the earth sciences. This is interpreted as not due to a lack of management issues to deal with (e.g. Stephen Slide, Johnson Lake, Maligne

Canyon, Northeast Beach to name a few), but to the relatively low priority assigned by the warden service to these issues and to the apparent difficulty of integrating these problems into an ecosystem management plan.

Finally, the response of one warden notes that in spite of it being in contravention of the Act (1930, 1988), the policy (1979, 1994) and the management plan(1988), gravel extraction still occurs within the park. In addition, at least one interpreter (in response to another question) used ecosystem management and ecological integrity as justification for the continuation and indeed the expansion of gravel extraction within the parks.

8.3.3.5 :What Types of Rehabilitation/Restoration Work is Being Done and How are These Prioritized? (Table 8.8)

As a follow-up to the preceding question, respondents were asked about the type of rehabilitation work currently underway in the parks. Again, the question was primarily directed to wardens, although some interpreters did respond. This question was asked in an attempt to identify awareness of concerns related to the earth sciences in the rehabilitation work performed in the park.

Table 8.8 What types of rehabilitation/restoration work are being done and how are these prioritized?

Respondents' Type	[illegible]
Warden/Resource Manager Six of ten responding	Not done , topsoil creation- stockpile - use of pit run as topdressing. Problem is budgets are 1 year. Closed one access road reclaimed one pit.
	Really, very little is done actively.
	Habitat, NW beach area parking lot- restoration of a very narrow strip of vegetation, we left too narrow of a buffer. Some dune restoration and stabilization.
	Some Priority or inventory of disturbed sites. Current pits have plans - some stock piling of soil and vegetation.
	Until the 1980's there were no standards or links with past works. Now conditions are put on contracts, for rehabilitation of cut slopes, fire roads, borrow pits, old dams have been removed from the Spray river, active slopes are prioritized.
Interpreter	Not sure how it is prioritized, probably by individual a managers. Borrow pits, fire roads, still gravel extraction in the park.
	None
	Not done
	They are supposed to be working on the borrow pits at Maligne Lake and the Icefields Centre.

The responses are somewhat varied in the identification of specific rehabilitation activities being conducted within the various parks. However, they generally outline an approach that indicates rehabilitation is a very low priority in most instances.

As one warden responded, budgets are on an annual basis and one result of this is that lower priority activities are often not done. As shown in Chapter 5, pit rehabilitation has repeatedly been identified as a lower priority management task. The management plans of the four mountain parks also identified ungulate habitat as a goal of the rehabilitation process and this led to the question regarding ungulate habitat.

8.3.3.6 : Why Restore for Ungulate Habitat?

Question 8.9 arose from the recommendations of the Banff and associated parks' management plans which identified ungulate habitat as a goal of gravel pit rehabilitation. The question was developed in order to identify if the original form was ungulate habitat. And if not, why is ungulate habitat, as opposed to original form (feature), not the desired goal of restoration? There were no responses to this question.

8.3.4 Awareness of the Earth Sciences

Questions 8.10. 8.11, 8.12, 8.13, and 8.14 all relate to the awareness the respondents have of the significance of the earth sciences to various aspects of the park and the park system.

8.3.4 .1: What is the Significance of Geology and Geomorphology in Ecosystem Health or Ecological Integrity?

Table 8.10 presents a summary of responses to question 10 which illustrates the manner in which the earth sciences are perceived by parks personnel to relate to ecological integrity.

The results indicate a variety of perceptions as to the significance of geology and geomorphology for ecological integrity. In general, there is the perception that geology and geomorphology are very significant and form the foundation upon which everything

Table 8.10 What is the significance of geology and geomorphology in ecosystem health or ecological integrity?

Respondent Type	[illegible]
Warden/Resource Manager Eight of Thirteen responding	Geology ultimately defines what grows. Critical but not addressed
	Geology and geomorphology are the source of the base material/base resources upon which biological resources live. However biological research does not reach that level of understanding therefore geology is generally ignored.
	Look at the landform and see the relationship with what lives on it - numerous ties with wildlife and vegetation. There is a lot to learn from the fossil record (palynology) vegetation change and potential response to climate change.
	In this park it is very significant. the ecology is largely alpine and subalpine, less montane. Most unique features are the alluvial fans, almost all are modified, tied to winter range. Avalanche scars are very significant in terms of habitat.
	As significant as all the other components of the ecosystem, landform and soil structure determine vegetational structure, vegetation determines ecological health.
	Foundation
	We are currently dealing with the development of a monitoring program to determine if we are moving away from or toward ecological integrity. This is being done through the Tri-Council, in our discussions to date geomorphology doesn't play in any way.
	It is the platform upon which everything exists. In public safety we are closer to bare geology than anything else. In management everything comes back to being measured against living things. From a management perspective we don't know about then so its not an issue
Interpreter Nine of fourteen responding	Evolution and the diversity of life, the geological story injects humility
	So intricately related- can get lost if you don't go back to the foundation (geology)Understanding of the base leads to an understanding of the whole.
	It is the foundation of the ecosystem - determines climate. Ultimately it is the reason the parks are here and the reason people come to the parks and therefore ultimately the reason the parks are in danger. Mountain form an artificial ecosystem boundary.
	Personally Hadn't made the connection. However considering avalanches, rivers etc. it has some impact.
	The notion is that you only achieve ecosystem health if you get to habitat, therefore geology/geomorphology is very important through drainage, soils, aspect.
	There has never been a parallel with wildlife in the manner of treatment of geology and geomorphology.
	It is the starting point. definition of landscape unit.
	Starts from the bottom up, relationship is absolutely integral
	Well, to me it is the foundation from which you build your stories.
Researcher Two of two responding	Highly important
	Geology, that is the rocks and surficial materials are the stage upon which the life systems operate.

else is based. Indeed, six of eight wardens, six of nine interpreters and one of two researchers identified the earth sciences as the foundation of the ecosystem. However, while the recognition of the significance of geology and geomorphology exists in the general sense, there is also the suggestion among park personnel that it does not receive much consideration in actual management and interpretation. Four of eight wardens suggested that in spite of its importance, the earth sciences are rarely considered.

As with the responses to other questions, some respondents felt that they were not able to connect that foundation with the processes of the ecosystem. In terms of the responses of the wardens, it is evident that geology and geomorphology are not being considered in the implementation of the ecosystem plan. This is also illustrated in the responses to other questions as well as in the ecosystem framework identified in Chapter 6.

Interpreters also found the incorporation of the earth sciences into ecosystem based messages somewhat problematic. In addition, interpreters identified the geological time frame as difficult to work with.

8.3.4.2 : What is the Influence of External Special Interest Groups on Management Decisions?

The question regarding special interest groups was intended to identify the existence or lack thereof, of groups advocating on behalf of the earth science resources of the park. As can be seen, (Table 8.11) the majority of the special interest group impact derives from conflicts over development versus preservation.

The results illustrate that special interest groups have a significant impact upon the decision-making process in the parks. However, beyond the Friends of the Burgess Shales, there have been no significant issues addressed by special interest groups. In general, special interest groups focus upon the biological aspects of park management.

Table 8.11 What is the influence of external special interest groups on management decisions?

Respondent Type	[illegible]
Warden/Resource Manager Six of ten responding	High to extreme
	In this park not a lot, most often within the framework of the four mountain block.
	Involved in everything- commercial, environmental, legal, political.
	They have become much more influential than in the past..
	Quite a bit of influence. Geological concerns only arise if they fit in the context of their own personal interest.
	They have become much more influential than in the past..
Interpreter Seven of thirteen responding	Environmental watchdogs, Trans - Canada highway, Lodges and guests, C.P.A.W.S..
	Yes Environmental sector, (Golden, Field)
	Public consultation is very important, we attempt to take concerns into consideration. issue determines location.
	It is getting to be more and more
	Right now its pretty strong, that is significant and increasing on both sides of the debate.
	First who is a special interest group. Environmentalists are not a special interest group. A.M.P.E. is and represents commercial vested interests, these are the single greatest impact.
	The park is well respected and involved in the community.

8.3.4.3 : When Does Geology/Geomorphology Become a Matter of Consciousness?

The purpose of question 8.12 is to attempt to identify how wardens and interpreters in the parks think about the earth sciences on a day-to-day basis. That is, do they think about the earth sciences on a regular basis or does it take an "event" to cause them to consider the earth sciences.

Table 8.12 When does geology/geomorphology become a matter of consciousness?

Respondent Type	
Warden/Resource Manager Ten of fourteen responding	When it falls on the road. During road construction we identify slope angles, and it is considered during the planning stages.
	When and "event" occurs, or if a monitoring program indicates action. In public safety- hazard assessment. In Banff and Elk Island Ecosystem models there is nothing done on geological or geomorphological concerns, we need such a model that includes geology and geomorphology. Consciousness will be raised when someone raises it for us.
	When we start realizing the significance of the linkages between it and other natural sciences, realize its effect on ecosystems and human activity.
	%0-100 year events. In most cases doesn't twig the interest of managers who are on average only here 5 years. For example alluvial fans don't enter our consciousness.
	When we want to build a road through it. In public safety- the #1 causal factor for visitor injury is gravity and the lifting mechanisms the terrain. Fair to say that geological features are the most interesting to people and therefore most attractive. Canyons enter our consciousness due to risk management. We tame the canyon for interpretation and put in catwalks and now rocks can fall on them, so we have to scale and cement the walls....this is the most futile thing in the world" yet it must be done because people are often getting hurt in them. Last 2 years 2 accidents in 1 canyon 1 fatal. The interesting thing is the inside of the canyon not the trees. We have to assume a wildland environment and we are not going to tame it.. Not all people want it tamed yet from a risk management perspective that's what's needed.
	When we start digging or when there is an event - public safety/ transportation.
	If there is a project in an area we will review information.
	Comes up more as crisis in terms of geomorphology. Icefields redevelopment geology was a big concern. Karst there have been a number of small disasters.
	In the past it has been as a result of crisis response, now we plan for some contingencies
	When Something is going to be altered- roads and infrastructure, rock scaling to prevent falls. slumps and terracing, safety information for climbers. We could be doing a lot more education of people with regard to geology and geomorphology.
Interpreter Nine of fourteen responding	When declared a World Heritage Site. In interpretation when people ask about braided streams, lake colors, and the Burgess Shales. Simply being a park in the Rockies.
	When an event occurs - such as flooding or avalanches. From an interpretation point of view people are interested in living things. New management plan does not identify any issues related to geology.
	When things slide on the road, when snow slides across the highway, when people fall into canyons.
	When you drive through it.

	Enters when the knowledge is there that shows it is a significant factor in decision making, therefore it needs a knowledgeable person
	Probably until we have a management issue that needs to be addressed it is "out of sight, out of mind" When I arrived in 1973 we began a study on the Maligne karst system which ended in 1979. Through the course of that decade we got a reasonably good understanding of what we had, yet a couple of years ago we allowed the lessee of the Tea house to drill for water until they hit a pocket of sulfur water. This is indicative of where we place the value of landscape features. If we had someone who had a geological or geomorphological background on staff it might not have happened.
	When its across your road. The #1 answer is when there is interference with manmade structures.
	It is highly variable. Dependent on knowledge base of staff, keys back to landscape.
	From the management perspective the physical environment is dangerous to the public and the public is dangerous to it. These are at odds (avoid/rescue).
	When it fall on the road or more likely when the road is lost due to erosion.
Researcher One of two responding	When there is an accident, i.e. debris flow etc. Crisis response, And when staff become aware they have a significant resource.

As can be seen from the responses to question 12 presented in Table 8.12, geology and geomorphology most often (12 of 21 responses, 6 of 10 wardens, 5 of 9 interpreters, and 1 of 1 researchers) enter the minds of park personnel when "it slides onto the road", that is when an event forces park managers to consider it. This particular answer cuts across warden, interpreter and researcher lines. This is very important in terms of the lack of attention and expertise in respect to geomorphology as it reduces the ability to deal with hazards and can result in plans and activities more dangerous to users.

The second most common response (4 of 21 responses, 1 of 10 wardens, 3 of 9 interpreters) suggested that geology and geomorphology entered the wardens' consciousness when the information base indicates that a management decision will have implications for earth science resources. Again the recognition factor is related to the occurrence of an event (in this case development.).

The third most common response (3 of 21, 3 of 10 wardens) can be summarized as "it doesn't", that is the earth sciences do not enter park managers' consciousness. This is reflected here in comments such as "doesn't twig the interest of managers who are only here 5 years. Consciousness will be raised when someone raises it for us, when we start realizing the significance".

The final category of response identifies the park staff's recognition (7 of 20, 2 of 10 wardens, 4 of 9 interpreters, 1 of 1 researchers) of the significance of the resource. Here it is evident that there may be a requirement for an external agent to develop the consciousness or to raise the awareness of the park personnel with respect to the significance of the earth science resources of the park. This can be seen to be particularly important in the case of processes.

In addition to the direct responses to the question, a number of respondents answered the question with respect to visitors to the park. This was most evident in the replies of the respondents from the Rocky Mountain parks. It was perceived that geology and geomorphology enter visitors consciousness much more frequently than they do for wardens and interpreters. The fact that "it is a park in the Rockies" and the scale of the "big rivers and big mountains" is seen as raising visitors' awareness of the earth sciences "when they drive through it". One Warden even went so far as to say that it is the geological features that are the most interesting to visitors "The interesting thing is the inside of the canyon, not the trees". Given park personnel's perception of the high degree of significance which visitors associate with the park's earth science resources, it is unusual at the very least, that park personnel themselves so seldom consider the earth sciences in the management of the park.

8.3.4.4: What is the Background of the Warden, Interpreter?

The preceding summary of the level of consciousness of the sample of park personnel identifies that earth sciences resources are rarely considered in the day-to-day operation of the park by park wardens and interpreter. Question 8.13, presented in Table 8.14 below was developed to provide one possible explanation for this. The question is intended to identify if any of the respondents has an academic background in the earth sciences.

Table 8.13 What is the background of the Warden, Interpreter?

Respondent Type	[illegible]
Warden/ Resource Manager Eleven of fourteen responding	B. Sc. Environmental Biology
	B. Sc. Geography/Biology
	B.Sc. Geography Technical Degree in Resource Management
	B.Sc. Earth Sciences, eclectic undergrad employed as a biologist in the system.
	B.Sc. General
	Dip. Fisheries and Wildlife
	B.Sc.(2) Forestry and Forest Ecology
	Mountaineer - Train others for travel in the park.
	Dip. Wildlife Management, coursework in conservation biology, restoration ecology, 20 years in parks.
	B.Sc., Forestry/Biology
	B.Sc., M.Sc. Environmental Design, 20 years in parks
Interpreter Eleven of fourteen responding	B.A.. Literature/Communications
	Hotel Management Naturalist
	B.Sc. Biology (22 years in park)
	B.Sc. Biology, M.Sc.. Plant Pathology, park naturalist since 1976.
	M.Sc. Wildlife Ecology. Dip. Fisheries Wildlife Management. 10 seasons as seasonal interpreter.
	B.Sc. Biology/Botany
	B.Sc. Biophysics, follow-up courses in Earth's sciences and 20 years of rubbing shoulders with the likes of Luckman and Kucera.
	B.Sc. Forestry -8 years in Banff, formerly in forest industry.
	B.Sc.(Hons..) Zoology
	B.Sc. Biology, 24 years in Parks
	B.Sc. Earth Sciences
Researcher Two of two responding	Ph.D. Ecology
	Ph.D. Geomorphology

Responses to question 8.13 indicate nine of eleven wardens and eight of thirteen interpreters were trained in biological science background. In fact, only one of the wardens included in the sample had a degree in the earth sciences and this individual was working in the system as a biologist not an earth scientist. Many of these wardens are also employed in the system as wildlife managers, forest ecologists etc. and as such there explicit recognition that a biological education is valued by Parks Canada. Among interpreters interviewed, one of thirteen was trained in the earth sciences, and this individual was a private interpreter and not employed by Parks Canada. In addition, there is a significant amount of continuing education of staff and, this too is focused upon the biological sciences.

In reviewing the responses to the previous question, one thing that is immediately apparent is the dearth of wardens and interpreters trained in earth sciences. It was pointed out on numerous occasions throughout the interview process, and in response to a variety of questions that the parks do not hire wardens as earth science specialists. There is simply no recognition within the system of the need for such expertise.

8.3.4.5 : What Would You Identify as the 4 Most Significant Geological or Geomorphological Features or Processes in the Park?

During the early stages of the research, it was apparent that in many instances the earth sciences were poorly understood and managed in the park system. Therefore, question 8.14 was developed with the purpose of identifying whether the respondents were aware of the significant resources of the parks in which they worked. Furthermore, it was anticipated that the responses might neglect process in favor of features. Table 8.14 indicates that there is fairly high degree of recognition of the significant earth science resources of the parks. The results for this question are displayed by park and respondent function in order to facilitate comparison within parks.

In general, Table 8.14 shows that personnel from the various parks respond in a relatively consistent manner with respect to the significant resources of their park. In most cases the respondents identified features noted as Zone 1 sites in the respective park plans. Most respondents identified features as opposed to processes in response to this question. This corresponds to the emphasis of the management plans of the parks identified in Chapter 5 which emphasize features as opposed to processes in all plan guidelines.

Table 8.14 What would you identify as the 4 most significant geological or geomorphological features or processes in the park?

Respondent Type	[illegible]
Yoho Warden/Resource Manager	Burgess Shales, Ice River Complex, Mt. Stephen Slide, Jökulhlaup.
	Burgess Shales, Ice River Complex, Mt. Stephen Slide, Jökulhlaup.
	Burgess Shale, Iceline Trail- moraines, glacial activity, Ice River Igneous Intrusion -(created headaches due to a variety of mineral claims in the area, again the concerns are biological). "Rockwalls and Waterfalls"
Interpreter	Burgess Shale, Stephen Slide, Emerald Lake.
	Burgess Shale, Ice River Igneous Complex, Glacial activity, Continental Divide, "Rockwalls and Waterfalls".
Kootenay Interpreter	Hot Springs-faulting, Western ranges, Glaciation (a little bit), Paint Pots, Rocky Mountain Trench, Headwaters of the Kootenay.
	Marble Canyon, Sinclair Canyon, Redwall fault, Paint Pots, western edge of the trench- Purcells.)
	Extension of the Burgess Shale, Marble Canyon, Paint Pots, Stanley Canyon.
Warden/Resource Manager	Burgess Shale, Cave Systems, Relations to scenic values e.g.. Redwall Fault, Hotsprings, Canyons.
	Ice River, Fossils-Burgess Shale, exposure of Gog Quartzite, Mt. Mazama Ash, Geothermal Springs, Paint Pots.
	Sinclair Canyon, Ice River Complex, Valleys
Banff Warden/Resource Manager	Alluvial Fans, Slide Paths, River Floodplains, Braided Stream Channels.
	The whole Park- it is Geology and geomorphology, Climbers get a map view, Outwash plains, where terranes meet, the whole picture of mountain valley history.
Interpreter	Mountain Building, and influences on weather and climate and landform evolution.
	Rocky Mountains, Mountain building story, Glaciation, Erosion Processes, Rivers- hydrology.
Researcher	Fluvial Processes, glaciers and glacial processes, general topography. land surface mobility, and the lithology.
Jasper Interpreter	Karst in Maligne, Columbia Icefields, Processes that are taking place.
	Geology: complete x-section of the bedrock lithology Precambrian to the present .Foothills, Front Ranges, Main Ranges, not restricted in access, story of sedimentation and uplift. Landscape sculpturing- glaciation, Pleistocene effects and contemporary, people can walk right to the features of retreat. Internationally significant Karst in Maligne, water as an agent of erosion and deposition. Jasper Lake sand dunes, regionally significant, Brule Lake, Disturbed by road, rail and human activity, date back 10,000 years to deglaciation.
Warden/Resource Manager	Karst at Maligne, Icefields, Beyond that I don't see anything of regional or National significance.

Private Interpreter	To the public I think it would be The Icefields and the Athabasca Glacier, The Maligne Valley (canyon and lake), Mount Edith Cavell, and the Athabasca River (falls). My personal list would include the Surprise Valley (rockslide area), Jasper Lake and the region including Rocky River, the dunes and Talbot Lake, The Columbia Icefields (classic example of bedrock control, and the Castleguard Cave.
Point Pelee Warden/Resource Manager	Shoreline of Point, East Barrier Ridge and the vegetated dunes on the west side of the park.
Interpreter	Deposition and erosion, Isostatic rebound, Glaciation.

A noteworthy exception to this general trend is the identification of the Stephen Slide by three of the five respondents in Yoho. It is likely that this was due to the closing of the Trans Canada Highway due to a debris flow just prior to the interview process.

8.3.4.6 : Do You Perceive Any Shortcomings in the Manner in Which Geological and Geomorphological Forms and Processes are Dealt With in the Park, Park System?

The purpose of question 8.15 was to determine whether the park staff thought the earth sciences were adequately considered in park management. Given the findings of previous chapters which suggested that the earth sciences were not considered to the same degree as biotic resources, it was determined that it would be useful to identify if park personnel saw this as a problem.

Table 8.15 Do you perceive any shortcomings in the manner in which geological and geomorphological forms and processes are dealt with in the Park, Park System, etc.?

Respondent Type	Response
Warden/Resource Manager	Yes, primarily with continued operation of gravel pits, though this is changing. Geological process and gravel are viewed in a completely different context than trees.
	Yes, Physical science is often ignored. If we are truly looking at turning to an ecosystem framework we have to include geological geomorphological specialists.
	Yes, we don't have a solid basis of expertise within the system. We may have geologists and geomorphologists within the system but they are not hired as such.
	Other than not being considered in the management plan, we are aware that they are there.
	Yes, There is not an awareness either within the park staff or park visitors. It is another important component of the park system.
	Yes, we could move into modeling/standards/inventory.
	yes, but people are trying to do what they can do, we need to throw water on the engineers.
	On a broader basis I think we have a long way to go with providing park users with the information they want We're in the business of education, to promote respect and understanding of the ecosystem. We haven't done a great job of that

Point Pelee	No, not at Point Pelee, we've managed geological resources a lot more than others have had to. A lot of landforms here have been altered.
Interpreter	Yes, giving up the Burgess Shale hike, not giving the Park perspective, we do nothing in Ice River, potential slate mine in prime grizzly habitat.
	Yes, need a better understanding, understand the base, leads to understanding the whole
	Biggest shortfall is getting the information into layman's terms, the information is too technical to use.
	Yes there is not a lot of emphasis.
	Training about what it is and its significance is definitely low, little knowledge of geomorphic system in ecology. Not really considered due the above.
	I think its the connection - what is the connection to ecosystem management - otherwise the focus is specifically on features, we must protect processes as opposed to features.
	Yes there just isn't the emphasis there should be especially considering its the Four Mountain Parks. We're definitely deficient in this park but to my knowledge there is nobody who has the background in the Earth Sciences. On the other hand we have done a good job on wildlife in part due to a different perspective. There has never been a parallel to wildlife in the manner of treatment of the earth science resources We protect bridges along fans with no real understanding beyond an engineering understanding, not a holistic approach. I feel we could do a better job with how we manage geomorphology and that we must do it. We are in a situation where the either doesn't know or can't respond. Even the Biophysical Inventory focuses upon soils, vegetation and wildlife with no real documentation on underlying geology and geomorphology, it is simply not considered.
	Yes, I think so, very little emphasis placed upon it.
	The greatest difficulty is that it is very difficult to get sound interpretations from researchers as to the defining concepts. Also there is the problem of conflicting views, problem with institutions and the academic community.
	Yes There is a lack of information and shoddy earth science related to environmental impact work. We need more baseline work.
	Yes, from this discussion its become apparent. In our haste to establish other messages, we have ignored geology and geomorphology. We don't have anybody on staff who has the background.
Researcher	No. Most are dealt with in a haphazard manner at the moment, most staff are poorly trained, they haven't recruited that type.

A total of 18 of 21 respondents gave a positive response to this question, only two respondents stated that they perceived no shortcomings in the manner in which the earth science resources were dealt with in the parks.

There is a very strong sense among the respondents, most of whom do not come from an earth science background, that the earth sciences are not managed or interpreted in the same way as are trees and wildlife. In addition, there is the suggestion that, as Parks Canada redirects its efforts in management and interpretation towards ecosystem-based management, there is a very real chance that the earth sciences will be completely excluded.

The two negative responses identified distinct concerns. The researcher's response indicated that he felt all resources in the park are dealt with in a haphazard manner and that the earth sciences were no different. The lone negative response from a park employee to this question came from the Warden at Point Pelee who noted the long history of management of the shoreline in the park. However, this respondent made no reference to the nature of the management practices or their connection to science.

Question 8.15 was effective in fulfilling its purpose and identified that the respondents generally felt that the earth sciences were not dealt with as well as they could, or should be.

8.3.5 Means of Reversing the Decline

8.3.5.1 : How Would You Address This Shortfall Given Budgetary and Manpower Constraints?

The final question was asked in an effort to identify means of reversing the decline in earth sciences in the management, planning and interpretation of the parks from the perspective of those in the system. It was felt that the respondents might best be able to identify measures that would be effective within the National Parks System.

The responses to this question are divided almost equally between three recognizable themes; education and training, partnership and sponsorship, and staffing. Six respondents identified education as one means of addressing the shortfall, while four identified staffing and five identified partnerships. In addition, several respondents identified two or more of these themes in their response.

Table 8.16 How would you address this shortfall given budgetary and manpower constraints?

Respondents' Type	[illegible]
Warden/ Resource Manager	Education, change from having engineers as solvers of problems, process hasn't taken a front seat. Science, partnership with the Burgess group
	Currently operational review in parks and there may be an opportunity to look at things like this, repriorizing may provide opportunities, in some parks they have people responsible for archaeology could do the same for geology and geomorphology. Here we consult the archaeologist for information about paleontology. Partnerships with research would help. We are not very proactive in getting research (geological/ geomorphological) that meets our needs.
	It is something we can't do ourselves unless a park warden comes in who has the background.
	Depends upon the individual in the park and their background for e.g.. a geological interpreter. Need more memos of understanding with universities, we can't do it on our own.
	It is useful to pick a problem that is illustrative of the connectivity. We need to move to the 1000 year return interval. Avalanching, alluvial fans. Were moving to the 500 year model. #1 problem alluvial fans, #2 avalanches, #3 flooding.
Interpreter	Corporate sponsorship
	First need to recognize importance of geomorphology to the whole system. Manual to relate geology to all facets of park management, training sessions. Bring in geologists to talk to staff. More communication or partnership. *Research Links*, media work on slide area, potential area of interpretation.
	Partnership
	More emphasis on relating geology and geomorphology to broader issues, currently it is at the far extreme and has drawn off, emphasize heritage value of geology within parks, hire people with geology/geomorphology backgrounds.
	Incorporate into staff training - increase awareness 1. there is a shortfall, 2. what does it mean.
	The research must make the connection, the community must demonstrate the connection with the ecosystem.
	Must have a more structured focus which could involve the academic community, there is a failure to recognize the importance of communicating with academics who can inform us. We are now on our way to formulating a science program based upon ecosystem approach and I fear that unless there is a change in the way we think there will remain a focus upon the biotic.
	Off the top of my head, not a clue. Message development has gotten away from the resource, however with the move to heritage there may be a shift in emphasis to Canadian identity. Step back and figure out ways of integrating, get expertise on staff, develop skills.
	Perhaps a conference or symposium focusing on the legacy of geology and geomorphology, profile what's being done relevant to Parks.

	Don't accept them (budgetary and manpower constraints). Parks are drastically underfunded. Proper research that meets park needs, can't depend upon Universities, must have longer term commitments. Could easily double the Park budget.
	First must be somewhat cognizant of the concern, we're now redeveloping the message for new visitor centre. Initially geology and geomorphology were presented well, this was reduced however, now since our discussion we will relook at it.

8.4 Summary

The results of the interview guide have been presented according to the five categories of questions. Overall, the responses support the findings of the previous chapters which suggest that the earth sciences are being reduced in the planning management and interpretation of Canada's National Parks. The results are summarized here according to these five categories of questions.

8.4.1 Identification of Change

Questions 8.1 a, b, c and 8.2 provide responses which indicate that a number of significant changes are occurring in the management, planning and interpretation function of the National Parks, both generally and with respect to the earth sciences in particular. In considering parks in general, the major themes identified through question 8.1 relate to the development of the ecosystem approach to management and its inclusion in interpretation and research initiatives. With respect to the earth sciences in particular, most respondents felt that the earth sciences have been a secondary concern in the management, planning and interpretation of the National Parks. However, there was some disagreement as to whether this constituted a reduction in emphasis, or had always been the case. Most wardens that responded (6 of 8) held the view that the earth sciences had never been considered to the same degree as biotic resources. Interpreters were split between those who saw no change from a previously low level of concern (4 of 8) to those that identified a reduction in emphasis (3 of 8). In general, the majority of respondents perceived the earth sciences to be a lower priority item in terms of how they are managed and interpreted in the parks.

8.4.2 Environmental Assessment and Review Questions

Initially, the results of the questions (8.3a, 8.3b, and 8.4) relating to the EARP process in the parks appear to be disappointing. Very few respondents were able to answer these questions. In spite of this, the results show that the earth sciences are rarely identified as significant concerns in the EARP process. The second component of this category of question identifies on possible reason for the low level of earth science recognition in EARP statements. The results indicate that no EARP specialists within the parks have earth science backgrounds.

8.4.3 Management Activities

Questions 8.5 through 8.9 were intended to identify how the earth sciences are managed, and where they fit in terms of management priorities. Responses to many of these questions, like those in the previous categories, appear on first examination to be disappointing. However, the responses to question 8.7 b show that only a very small percentage of time and money is devoted to management activities related to the earth sciences. As the other questions are simply more specific attempts to determine the level of management concern for the earth sciences, it is not surprising that the responses do not identify earth sciences in any significant way.

8.4.4 Awareness of the Significance of the Earth Sciences

Questions 8.10 through 8.15 were intended to identify the level of the respondents' knowledge with respect to the earth sciences in a variety of contexts. The responses to these questions indicate a number of things. First, there is a strong sense that the earth sciences form the foundation of the ecosystem. Second, in spite of this, a number of respondents indicated that the earth sciences were rarely considered. Third, few special interest groups raise awareness of the earth sciences in the parks. Fourth, the earth sciences are generally not considered until there is a crisis, or "something falls on the road". Fifth, very few respondents from the park system come from an earth science background (1 of 22), and no park staff are hired in the capacity of earth scientists. Sixth, most respondents were quite aware of the major earth science features in their respective parks, but very few of the processes. And finally, the great majority of respondents (18 of 21) perceived a shortfall in the manner in which the earth sciences are dealt with in the parks. This category of question was quite effective in identifying and documenting the reduction currently occurring with respect to earth sciences in the National Parks of Canada.

8.4.5 Addressing the Shortfall

The final question in the interview guide asked the respondents to identify means by which the reduction might be reversed, bearing in mind restrictions of budget and manpower. Respondents identified means of reversing the decline which fall into one of three themes; education and training, partnerships, staffing.

Education is perhaps the most significant of these suggestions as it is only through education that there can be recognition of the problem. In fact, many responses noted that only through education will the extent of the problem be realized by park personnel. Throughout the interview process, many respondents noted how they had not considered the role of the earth sciences until taking part in the interview process. Clearly, the first step to correcting any problem is recognizing one exists.

Once recognition is achieved, it is necessary that park personnel have knowledge and or ability to apply earth science theory in the management and interpretation of the parks resources. In order for this to happen, current staff must be trained. A number of respondents suggested that a conference or symposium, or publication of earth science information in the Parks Canada publication, "Research Links", might begin to address the education needs of Parks Canada in this regard. Many respondents identified training sessions and continuing education as a possible solution.

The second theme identified was that of partnerships. It was suggested by many respondents that partnerships with universities, researchers and business could help overcome the financial barriers associated with overcoming this shortcoming. Here again, it is clear that recognition is a priority.

The third theme related to staffing of the National Parks. It has been noted previously on numerous occasions, that Parks Canada does not hire many wardens and interpreters as earth scientists and when it does, they may be classed as biologists. As a result of this, the department does not have the expertise to deal with earth science issues in the same manner it deals with biotic concerns. Essentially, Parks Canada has taken an engineering approach to earth science problems. There has never been a parallel with biology in the way in which the earth science resources are dealt with in the parks. Earth scientists have not been recognized in the same way as foresters, wildlife biologists, fisheries managers, and others.

8.5 Discussion

This chapter has presented the results of the interview questionnaire applied in the five case study parks. A number of key issues can be identified.

First, the results support the findings of the previous chapter which indicate that in interpretation messages of the National Parks, the earth sciences are being reduced in significance and in some instances are being eliminated. A major reason appears to be a response to the revised National Park Act and the revised Policy, which identifies ecological integrity and ecosystem-based management as key elements in resource management and interpretation. While a number of respondents saw the earth sciences as significant elements in the ecosystem and in ecological integrity, they also note that the earth sciences are poorly understood by most park employees and, as such, are not easily incorporated into new messages and management practices.

Second, the results of the interview suggest that the earth sciences were never really a significant management concern in Banff and the associated mountain parks, and have been reduced to a non-managed resource in Point Pelee. Respondents from both Point Pelee and the mountain parks identify a crisis response pattern of managing earth science resources . In addition, the respondents note that when the resource is managed it is with an engineering approach. Essentially these managers did not see any change in how the earth sciences were being managed (out of sight out of mind) and this confirms the findings of Chapters 5, 6 and 7.

Overall, the results of the survey indicate a recognition that the earth sciences require better understanding and, in turn, management by park staff. However, it is also suggested that this requires; first, recognition that there is a problem; second, education of staff so that they can address the problem; and finally, partnership and cooperation with researchers that will allow earth science information to be more readily available to park employees

8.5.1 Resource Management

In general the responses to the questions about earth science management in the parks confirm the findings of the previous chapters which suggest that not only is the management of the earth science being reduced, it was never a high priority concern.

Point Pelee National Park has seen a steady decline in management plan references to active management of geomorphological processes. The plans recognize the active nature of the spit and consider erosion as a natural process. A number of documents reference the fact that the natural cycle is in disequilibrium as a result of activities outside the park (Lavalle, 1990) and the management plans call for cooperation with other regional resource managers.

The managers interviewed in Point Pelee were those who saw a decrease in the management of geological and geomorphological resources in the park, yet curiously did not refer to the extensive research that has been conducted as a result of the erosion concerns. Past efforts at managing the erosion at Point Pelee involved the application of engineering solutions at specific "problem" sites with little regard for the entire system. The ongoing research has provided significant insight into some of the limits to the sediment transport system of the park. This is a curious situation where knowledge of the system has increased while active management has decreased.

In Banff and the associated mountain parks, the findings of both the review of park documents and the interview of park staff indicated that geological and geomorphological features and processes receive little attention in terms of actual active physical management. Most management plans refer to earth science resources in very general terms and rarely identify specific concerns, even when they are very significant (e.g. Stephen Slide area). Generally, management is of a crisis/response type. This is confirmed by the results of the interviews which identify a very low percentage of resource management time and money directed towards earth science issues. In addition, the move to ecological integrity as a guiding principle in the management of park resources has not been one that is identified as including the earth sciences.

Banff and the associated mountain parks are taking part in the planning process for the incorporation of ecological integrity into their revised park management plans. The steering committee for the four mountain parks has representatives from each of the parks. These representatives provide expertise in a variety of areas relating to ecological integrity. There is no representation on the committee with expertise, or the expectation to provide expertise, on the relationship of geomorphology and geology to ecological integrity. Representatives provide information on wildlife, vegetation and aquatics.

The lack of concern for the management of the earth sciences in Banff and the associated mountain parks is highlighted by the failure to identify earth science concerns through the EARP process. This can, in part, be explained by the fact that the Environmental Assessment and Review Process specialist for each park may not have a good understanding of geological processes and features and, therefore, may not perceive any potential impacts arising from proposals. In fact, the Park Conservation Plan for Banff (1990) notes that much of the assessment of potential impacts and the identification of problems relates to the perceptions of the individual Environmental Assessment and

Review Process specialist. As has been noted in the responses to questions 1, 2, and 3 there is a strong perception among park managers that geological resources are constant and immutable. In addition, there is the matter of the researchers themselves and their contribution to the Environmental Assessment and Review Process. In general, geologists and geomorphologists are only involved in the process if the Environmental Assessment and Review Process specialist requests their advice, or if the scientist advances concerns of their own (Sheehan, Todgham, Niddrie 1994 pers. comm). In the first of these cases, the involvement then falls back upon the available information and ability of the Environmental Assessment and Review Process specialist to use such information. This point is addressed in the next question, the results of which are presented in Table 8.4.

In addition to these examples of geological resources being mostly ignored in the Environmental Assessment and Review Process, the preponderance of biological concerns clearly shows that familiarity and expertise of the Environmental Assessment and Review Process specialist is highly significant in the identification of significant implications.

8.5.2 Interpretation

The changes identified in response to the survey confirm the changes noted in the interpretation document in the preceding chapter. These changes are significant because they identify a move away from the idea of National Parks as special places. They are also very significant in the manner in which geology and geomorphology are presented and perceived, not only for park visitors but also to interpreters and managers.

In terms of their perception of these changes, most interpreters were pleased with the message content changes and felt that the resource and species information previously dealt with in interpretation easily integrated into the new messages. Geological and geomorphological information, however, was not perceived to fit with the new message content and, in fact, had been identified by at least two interpreters as being poorly done .

In contrast, most interpreters and indeed Wardens were quite alarmed at the concept of cost recovery and the move towards the privatization of interpretation. One private interpreter suggested that interpretation had been "killed'. These perceptions confirm the changes identified in the recent management plans and other park documents identified in the previous chapter. In addition, they reflect the changes to the Parks Act, 1988, and the new Park Canada Policy, 1994.

Interpretation in Point Pelee provides a clear example of how the earth science messages are being reduced as a result of the amendments to the National Parks Act. In Banff and the associated National Parks, many sites interpret the geology and geomorphology of the park. However, these are in large part the remains of past interpretive initiatives. It was suggested by a number of respondents that if these sites were to be built in respect to the current Act and policy, these sites would deal far less with the earth sciences. In addition, a number of respondents noted that the earth sciences were often poorly interpreted in any event (see Fig. 8.1). Given that interpretation is now viewed as a management tool, there is a significant and growing connection between the type of resource management conducted by the warden' service and the messages of interpretation. Therefore, if the earth sciences are not dealt with as management concerns, it is unlikely that they will be incorporated into future interpretive messages.

8.5.3 Research

It was suggested by respondents that the focus of research has moved from feature and species specific studies to whole ecosystems and does not reflect what is actually happening where geological and geomorphological research is concerned. As shown in Chapter 5 earth science research within the parks has shown considerable changes in volume over the years, however the basic type of research has not changed.

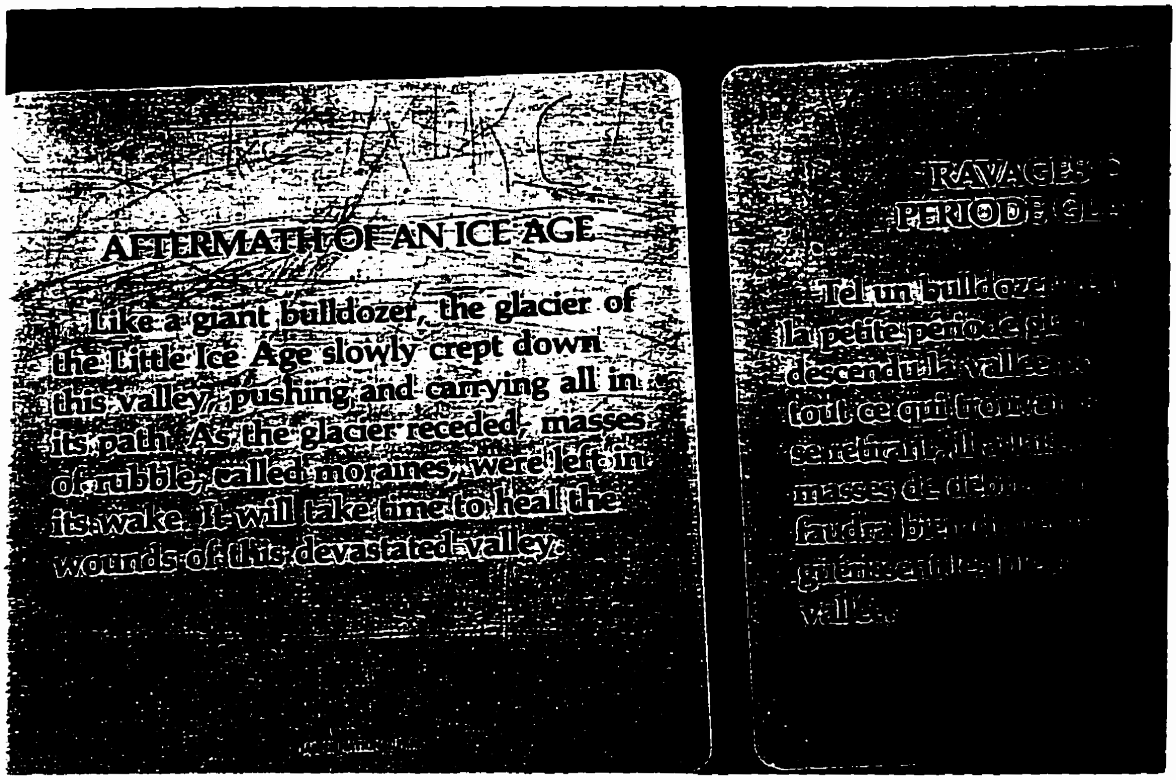
Geological and geomorphological research have a long history in Banff and the associated mountain parks, and have contributed a great deal to our understanding of the areas (e.g.. Mountjoy, 1958, Ford, 1978). However, little of this research has been of an applied nature. Perhaps more significantly, even less has been research actively solicited by the park. The management plans of the Banff and the associated mountain parks all identify knowledge gaps related to geological and geomorphological forms and processes. Some of these are related to highly significant landforms and processes within the Park (e.g. Jasper Lake Dunes) and yet, no cooperative research ventures are proposed. Why is this, particularly in light of the increasing level of interest in research and the increasing cooperation both financially and logistically from Parks (White, pers. comm. 1994)? Perhaps the most important reason has to do with the level of earth science understanding of Parks interpreters and wardens.

In contrast, in Point Pelee National Park there is an extensive record of research dealing with the shoreline processes in the park (Battin, 1975, East, 1976, Shaw, 1985, Lavalle, 1990), yet reference to this research in the interpretation and management of the park is limited. While collaborative research continues in Point Pelee the information derived is not put to use.

8.5.4 Reasons for the Reduction

Reasons for the reduction can be identified as originating in one of two audiences. The first of these is the park staff themselves. The second is earth scientists. The responses provided some support for the first reason in that many respondents identified that few park personnel (only one of twenty warden and interpreters interviewed) have strong backgrounds in the earth sciences and that the earth sciences are perceived to be difficult. This is further confirmed by the results of question 13 presented in Table 7.13. Of 10 wardens who responded to the question only one had a degree in earth science and he was employed as a biologist in the system. Another, trained in forestry, had a strong background and an interest in geology and geomorphology; the remainder had a biological background and as indicated in the responses to other questions only limited familiarity and comfort with earth science information.

Figure 8.1 Interpretive Plaque in Jasper National Park
(Note the Characterization of glacial activity as destructive)



(Campbell, 09/93).

Of 11 interpreters who responded to this question, not one had a background in the earth sciences, although one had taken an interest through his association with a number of earth science researchers in the park. Again the vast majority of the remaining interpreters came from a biological background.

This large imbalance towards the biological sciences within the park service represents a potentially significant reason that geology and geomorphology have, to date, not been incorporated within the ecological integrity plans for the park.

However, there is another significant reason that the earth sciences have been reduced in stature in the planning and management of the parks. It has been previously identified that both the focus and the means of research in the parks are perceived to have changed recently. Yet, this is not necessarily the case where the earth sciences are concerned. Not only is there little collaborative research, there is very little research within the Mountain Parks that relates the geology and geomorphology to the rest of the ecosystem. Nor have there been attempts to identify indicator processes or forms as there has been for the biotic component of the system. This suggests that earth science researchers are no longer providing the kind of information that park managers and interpreters want. Or more correctly, that the type of information required by park personnel has changed and earth science research has not. This is very significant, because in the first instance the information must be there in order for it to be used, while in the second instance the managers must have the education to be able to use it. Finally, the managers must have a deep enough understanding to recognize that there is an information gap.

8.5.5 Means of Reversing the Reduction

The results of the interview identify three themes related to the reversal of the observed reduction in the role of the earth sciences in the planning, management and interpretation of Canada's National parks. Respondents were nearly unanimous in their perception that the earth sciences had been reduced in importance and, identified education and training, partnerships and staffing as possible remedies to the reduction.

Pratt (1994) identifies geological knowledge deficiency as a significant problem in the Canadian Park Service, while members of the service note that most researchers make little or no effort to communicate their findings to park personnel. Gardner (1995, pers.comm.) concurs with this latter statement and identifies the annual report as the main means of communication with park staff. Here again is shown the importance of the ability of the parks staff to make use of the information received from researchers and the need for education.

These findings which showed that earth sciences were not being included in ecosystem and the new message themes is considered not to be due to a lack of information concerning geology and geomorphology, so much as to an inability of park managers to incorporate and recognize its' significance.

Several respondents noted this inability of park staff to deal with the earth sciences. Others suggested (question 8.10) that in order to have a complete ecosystem based management strategy the earth sciences must be included. However, it is also clear from the responses to this question and question 13 that there is no one within the Parks Service who is capable of addressing this problem, nor does the current staffing structure (i.e. bear ecologist, wolf ecologist, forest ecologist) and staff function, particularly in the mountain parks, allow for it. Given the changing emphasis in resource management in Parks Canada and the apparent inability of Parks Canada to address this problem it is incumbent upon academic geomorphologists to begin to address this concern.

Furthermore, there is the problem associated with the fact that the earth sciences have never been managed by earth scientists. They have, as indicated by several responses to this and other questions in this study and through the management plan analysis, been engineered (for example erosion control structures at Point Pelee and the draining of the subglacial lake in Yoho). Indeed, to a certain extent this is a problem identified in applied geomorphology in general. The idea that the approach taken in the parks, with respect to the earth surface, was dominated by an engineering focus was expressed by a number of park personnel on a number of occasions (Haney, 1993, Mouland, 1994, Woodley, 1990 pers. comm).

The various aspects of park management have undergone a transformation with the recognition of ecological integrity as the primary goal in park management. To this end, staff are now expected to fill such roles as ecosystem specialists, forest ecologist, aquatic ecosystems specialist. These changes in title reflect a significant change in the perception of the resource on the part of the system, and the individual managers.

It is not surprising then that a number of respondents identified the need to hire staff with a geological or geomorphological background to ensure that these resources are properly dealt with in the context of the changed Act and Policies of Parks Canada.

This latter point is particularly important in that the engineering approach previously taken with the earth sciences does not fit within the framework of an ecosystem model.

CHAPTER 9

Summary, Discussion, Impact and Recommendations

The preceding chapters have presented the results of an investigation into the role of the earth sciences in the planning, management and interpretation of Canada's national parks. In each chapter, specific attributes of the Canadian Park System were examined for the degree and nature of earth science representation. The analysis proceeded from the general topic and progressively narrowed through the park systems plan and associated documents, individual park management plans, and finally the specific management and interpretation actions as identified in the case park documents and through the interview process. The investigation focused upon case studies of Banff and the associated mountain parks and Point Pelee National Park.

9.1 Summary of Research

This research was motivated by the writer's observation that the growing body of literature dealing with the management of parks and protected areas rarely identified a role for the earth sciences. This suggested that there could be an opportunity to identify a broader role for the earth sciences in the planning and management of parks and protected areas. As the research developed, it became apparent that while a great deal of earth science research was being conducted in Canada's national parks, this information was rarely used in actual management decisions. Indeed, as the research progressed it became apparent that the role of the earth sciences was being reduced even further. The argument presented in this dissertation suggests that the recent amendments to the National Parks Act have engendered a reduction in the role of the earth sciences in the planning, management and interpretation of Canada's national parks. In order to address this question four objectives were identified.

1. Establish that there is and has been a role for the earth sciences in the planning and management of Canada's national parks.

2. Document that the role of the earth sciences is being reduced in the planning and management of Canada's national parks.
3. Suggest reasons why such a reduction may be occurring.
4. Develop means of reversing this trend.

These four objectives are discussed below, but first the method and results of the dissertation are described and summarized.

The second chapter of the dissertation reviewed the limited literature which explicitly linked the planning and management of parks and other protected areas to the earth sciences. In this chapter, it was identified that specific references linking the earth sciences to the planning and management of parks and other protected areas were minimal, despite of the increasing volume of research concerned with the scientific management of parks and protected areas in general. Even given the limitations of the literature and the relatively poor record of the application of geomorphology in planning and management of national parks and protected areas, a number of roles were identified for the earth sciences in these capacities. These roles are described in terms of three functions performed by parks and protected areas: resource management (ecosystem management), interpretation, and research. These functions form the conceptual framework within which the roles are discussed.

The third chapter described the methodology employed in the study and identified the selection of the study sites. The study focused upon national parks because provincial parks and other protected areas often have diverse goals and objectives, and as such comparison between systems would be impossible. The research progressed from an analysis of the Act, Policies, Systems Plan, Natural Resource Management Planning Process, through the analysis of 10 management plans for 9 national parks for earth science application.

Following upon this, a variety of management and interpretation documents from Banff and the associated mountain parks and Point Pelee National Park were analyzed to determine the level of earth science incorporation in the plans. Finally, interviews were conducted with park staff from Banff and the associated mountain parks and Point Pelee National Park. The interviews addressed a variety of issues in the parks as they related to the role of the earth sciences in the planning, management and interpretation of the national parks. Respondents were chosen for the interviews using a modified snowball sampling technique.

The fourth chapter presented the results of the analysis of the National Parks Act. National Parks Policy, Systems Plan, and the Natural Resource Management Process of Parks Canada. The results of this analysis indicate that there has been, and continues to be, a role for the earth sciences in the planning, management and interpretation of Canada's national parks. The chapter suggests, however, that the role is no longer explicit in the amended National Parks Act and National Parks Policy.

The fifth chapter presented the results of analyzing 10 management plans of 9 national parks. The results of this analysis suggest that the earth sciences have never been accorded the same degree of management concern within the parks system as have the biotic resources of the park in terms of resource management. The analysis of the plans provides numerous examples of earth science resources being mismanaged and earth science information being either misinterpreted or ignored. The plans display a consistent decline in reference to the earth sciences from the broad park objective statements to the identification of implementation priorities for specific management activities. In terms of interpretation the plans offer little information identifying the types of material interpreted.

In chapters 6 and 7, a variety of park documents from the two main case studies, Point Pelee and Banff, were analyzed in order to determine the level of earth science incorporation in management and interpretation. The analysis showed that the earth sciences have been significantly reduced in the most recent management and interpretive plans analyzed in the study. In fact, the most recent ecosystem management plan for

Banff and the new interpretive message framework for Point Pelee omitted the earth sciences entirely.

The results of the interviews presented in chapter 8 confirm the findings of the other chapters. The interview responses indicate that the role of the earth sciences is declining in the management, planning and interpretation of the sample national parks, largely as a result of the identification of ecological integrity as a biological concept. In addition, the responses to the interviews identify that while park staff recognize that there is a role for the earth sciences in the planning, management and interpretation of the parks, this does not translate into the daily management activities of the park. Respondents identified a low level of expertise within the staff of the system as one of the reasons that the earth sciences are poorly dealt with in park management. Finally, the respondents identified education and training, partnerships, and staffing priorities as means by which the reduction might begin to be reversed.

9.2 Discussion

In their 1994 book, *Parks and Protected Areas in Canada*, Dearden and Rollins state that "the times they are a changin'" in Canada's parks. The changes referred to largely reflect the different roles that the parks have been perceived as fulfilling, the changing pressures on the parks, and the parks management responses to these changing pressures.

As has been shown in this dissertation, parks are changing, but where the earth sciences are concerned it appears to be for the worse. Dearden (1991) identifies the evolving role of parks as one originating in isolation and moving towards integration. Between these two poles on the continuum are protection and management. This continuum can provide a useful vehicle for considering the role of the earth sciences in the National Parks System. When the role of geomorphology in national parks is considered in this context, it is apparent that the significant change at the moment is occurring without the earth sciences. The following discussion presents the interpretation of the results of the research in the context of the four objectives identified for the study.

9.2.1 The Role of the Earth Sciences in National Parks

International experience with national parks reflects a number of roles that the earth sciences have played and, can continue to play, in the planning and management of Canada's national parks. The earth sciences have provided means of identifying the park systems natural regions, as well as providing key elements in the identification of natural history themes. In addition to these descriptive functions, the earth sciences provide a variety of important ecological functions at a wide variety of scales (Juday, 1988). In spite of this recognition of the important role of the earth sciences in the management of parks and protected areas, and its potential role in defining ecological relationships, the geomorphological literature concerning this relationship is very limited.

In chapter 2 it was shown that the national parks considered in this study provide sites for much pure earth science research (e.g. Luckman, 1981, Ford, 1983, Gardner, 1984). This research has taken place since the earliest days of park establishment. During the earliest periods of research, most work was exploratory and therefore descriptive in nature, a type Gardner (1977) described as interpretive. Subsequently, earth science research in the parks became more systematic in nature and reflective of the dominance of process-oriented research typical of contemporary earth sciences. In a few cases "markedly interpretive" research has been conducted (e.g.. Baird, 1963a+b, 1964a+b, 1965, 1967, 1972, 1976, 1977, Bellyea, 1967, Kucera, 1974, Muir and Ford, 1985). However, such studies are, in general, the exception. One of the most striking aspects of these "markedly interpretive" works is that they were largely produced in the decade 1965-1975. It is during this period that Parks Canada developed and implemented its systems plan. In addition, a number of non-academic studies have been completed relating to the interpretive aspect of the parks (Gadd, 1987, Yorath and Gadd, 1995).

However, in order to implement the provisions of the systems plan it was necessary that research of a "markedly interpretive" type be available. More succinctly, it was necessary that highly technical information be produced though systematic research in a form easily accessible to park managers, interpreters and visitors, most of whom do not have earth science backgrounds.

Studies and documents directly linking earth science research and theory to the management, planning and interpretation of Canada's national parks are almost non-existent. This is important when one considers the significant role which the national parks have played as sites for earth science research, and when one recognizes the significance of the relationship among research, management, and education functions in the national parks. Furthermore, most park managers and interpreters are unable to access the systematic research that does exist. As a result, there is often a significant gap between what is known about the resource and the ability of parks personnel to use that information.

The regulatory and institutional structure of the National Park System has provided a convenient framework for the consideration of the role of the earth sciences in the management, planning and interpretation of Canada's national parks. At the highest level, the National Parks Act provides for a potentially significant role for the earth sciences in the planning and management of the parks. The 1930 National Park Act (Government of Canada, 1930) identified the protection of the parks' natural resources as the primary consideration in all aspects of the management and planning a national park. This statute did not distinguish between biological and abiotic resources. In the Act and in the relevant park policy eventually developed from this document (Parks Canada, 1964, 1979), the earth science features and processes are recognized as natural resources to be afforded the highest degree of protection. Indeed, the policies were developed in order to clarify the relationship between the preservation and use provisions of the Act and to ensure that preservation took precedence over use where conflicts occurred.

9.2.2 Reduction of the Role of the Earth Sciences

The assessment of the system plan, the park plan, the case studies and the interview responses indicates that the management of earth science resources are not paralleling that of biotic resources and provides possible reasons why this is occurring. Amendments to the Act in 1988 (National Parks Act, 1988) caused changes in the interpretation of the Act which ultimately led to the diminution of the significance of the earth sciences in the planning, management and interpretation of the national parks. As discussed in Chapter 4, it is most unlikely that the amendments were intended to have this result. However, the Act sets the stage for policy and all lower level regulations . As such, the 1988 amendment recognizing ecological integrity as the primary consideration in all aspects of park management significantly affected the role of the earth sciences in park management and interpretation, as a result of the manner in which ecological integrity came to be defined.

Furthermore, earth scientists are not conducting research that allows for easy integration of their results with the requirements of ecosystem-based management. Indeed, given the strong impetus to manage the national parks to maintain ecological integrity, the serious reduction in park operating budgets, and the decrease in wilderness elsewhere in the country, ecosystem-based management is becoming an even greater priority within the National Parks System. Management of earth science resources in the parks has never reflected the strong theoretical base of the earth sciences in general, and geomorphology in particular. Indeed, geomorphological processes have only been 'managed' in the sense that they have been modified. With the advent of ecosystem-based management in the national parks, this previous shortcoming in earth science management has been magnified.

The definition of ecological integrity and ecological processes has been a biological one. Thus, although the 1988 amendment to the Act did not specifically reduce the role of the earth sciences, the subsequent policy definitions of ecological integrity in policy reflected just such a change. In addition, the growing recognition of the role of interpretation as a management tool (Butler, 1994), in concert with fiscal restraint, exacerbated the diminishing role of the earth sciences as ecosystem-based management was interpreted as a biological concern.

This apparent reduction in the emphasis placed upon earth science resources has been, in part, a direct result of the manner in which ecological integrity is defined. This problem of definition is heightened as the focus narrows from the broad goals of policy to the more specific management plans. It is important to note that the definition of ecological integrity need not exclude the role of the abiotic features and processes and indeed, should not. However, many definitions of ecosystems and ecological integrity have this problem and, even where definitions provide for the earth sciences, the subsequent discussion too often quickly focuses upon biological considerations. It is therefore imperative that earth scientists involved in research in the national parks, as well as geomorphologists involved in research generally, identify this link between the earth sciences and ecological integrity. Furthermore, park personnel must be educated as to the significance of the earth sciences in ecosystem health and ecological integrity. These two actions must be linked and involve cooperation between parks personnel and academic geomorphologists and other earth scientists.

The next level of inquiry focused upon the systems plan of Parks Canada (Parks Canada, 1971) and various management plans such as the Natural Resource Management Plan (Parks Canada, 1979b), and Visitors Activity Management Plan (Parks Canada, 1987). As each of these documents predates the amendments of 1988, they reflect the earlier act and policies of Parks Canada.

The systems plan was developed to guide the process of new park establishment in order to complete the system, according to sound scientific principles, and to guide the planning and review of existing parks. In order to identify potential parks, information regarding the resources of potential parks and existing park resources was necessary. This information base was strengthened by the need for additional and accessible information for management and interpretation.

Analysis of the main functions of the systems plan has shown that the earth sciences are significant concerns in the identification, establishment and management of the national parks, and that geological and geomorphic features and processes should receive equal consideration to that afforded biological features and processes. Indeed, the Natural Regions of Canada (see Fig. 4.1) are based largely upon Bostock's (1970) *Natural Regions of Canada*. However, the systems plan and the management planning documents predate the 1988 amendments to the National Parks Act. The systems plan and these documents have not been amended to reflect the changes in the Act, the introduction of the concept of ecological integrity, and the apparent diminution of the earth sciences in the new policy of 1994.

The results of Chapter 5 indicate that earth sciences have little importance in the national parks at the level of the individual park management plan. In general, the management plans of all the 9 parks consistently provided for the earth sciences in their goals and objectives. However, these goals and objectives statements are little more than reiterations of the policy of 1979. In addition, the plans focused largely upon features as opposed to process and, where conflicts existed between resource values associated with the earth sciences and visitor use, the principles of the Act and policy often did not apply. That is, visitor use took precedence over earth science resource conservation. The nature of the plans and the slight emphasis placed upon the earth science indicates a view of the earth sciences as unchanging and static.

The implementation priorities of the individual plans provide a relatively simple and accurate means of assessing the perceived significance of various earth science resources in park management decisions. The implementation priorities of the management strategies identified in the plans examined in this study, consistently identified the earth sciences as among the lowest priority activities, and in many instances included strategies related to biotic resources not identified elsewhere in the plans. It is important to note that most of the 10 plans were prepared before the 1988 National Park Act amendments, so that neglect of the earth sciences preceded that Act. However, these plans are in the process of change, and new programs and policies are being adopted following the 1988 amendments to the Act.

Changes to the interpretive messages in the plans are among those being made in response to amendments to the Act. Some new messages relate to ecosystem management and ecological integrity. Along with this is a significant reduction in the messages relating to the natural resources of the parks. More significantly, biological resources have been incorporated into the new messages, while the earth sciences have not.

Chapters 6 and 7 presented a study of policy and management documents of Point Pelee and Banff supplemented with information from the associated mountain parks. This more detailed assessment revealed a continuation of the trends identified in the management plans in Chapter 5. Specifically, the recent changes to the Act and policy with respect to ecological integrity and ecosystem management are interpreted in the various Park Conservation Plans, and Ecosystem Management Plans, in purely biological terms. The lone exception among the parks studied for this research project is the unofficial ecosystem plan of Point Pelee National Park, which identified the significant role that the negative sand budget has on the park's ecological integrity. However, the official Park Conservation Management Plan explicitly excludes the shoreline processes as an element in measuring ecological integrity . Indeed, only biological factors are treated in an integrated manner. Building upon this omission is the integration of management principles into the new message framework of the park. In the new framework, the erosion processes and the natural hazard information associated with them are removed entirely. Overall, these changes have resulted in the elimination of the earth sciences as a significant element in the management and interpretation of the park.

This is a stunning oversight, considering the relevance of this one issue to both the ecological integrity of the park, and to its relationship to the remaining messages of the park interpretation plan. Sustainable living, links with the regional ecosystem, and partners in preservation are all messages that, in the Point Pelee Interpretation Program, could deal directly with the problem of the negative sand budget. Communicating such a message is an essential management action if the negative sand budget issue is ever to be resolved. The vast majority of park visitors are from the surrounding region and it is the regional shoreline management that is, in part, causing the problems at the Point. The shoreline problems of Point Pelee with its links to regional resource management and hazard management, and their role in the ecological integrity of the park provides an excellent opportunity to present a truly holistic interpretive program joining all messages of the park.

Chapter 8 focused upon the results of the interviews. The interviews indicated that the earth sciences are rarely consciously considered by the wardens and interpreters in the parks. This attitude parallels that exposed in the management plans. That is, "its there (in the biophysical inventory/subconscious), we just don't think about it." As a result of participating in the interview process, the consciousness of some wardens and interpreters was raised. The results of the interview process strongly support the hypothesis that the earth sciences are being reduced in significance in the management, planning and interpretation of Parks Canada.

This confirmed what was observed in the management plans and the related management documents. Furthermore, the respondents were nearly unanimous in their opinion that the manner in which the earth sciences are dealt with is a serious shortcoming. Responses to the interview suggest that overcoming this shortcoming might be accomplished in three ways. First, was the recognition that the earth sciences were being excluded from the management and interpretation of the parks. Second, was the need for staff training and development. Within this, was the recognition that Parks must employ earth scientists in the capacity of earth scientists and that these individuals should be involved in the development of the ecosystem management framework for the park. Third, was the recognition that in light of fiscal restraint, partnerships could provide a useful avenue for the resolution of the problem. Education, of park staff, the public, and earth scientists was seen to be the most important factor in overcoming the deficiency.

9.2.3 Reasons for the Reduction of the Role of the Earth Sciences

The preceding confirmation of the reduced emphasis placed upon the earth sciences in Canada's national parks suggests a number of reasons why the reduction is occurring. First, with the exception of the special issue of the *Natural Areas Journal* in 1988, earth scientists have failed to connect the processes and systems they study with the biotic component of the ecosystem. In fact, earth science research in the national parks has shown no major change in orientation over the past 20 years, while significant changes have occurred in biotic research. Second, during this same time period in which the biological researchers were directing their research towards ecosystem modeling, the National Park Act and the National Park Policy were amended to identify ecological integrity as the primary goal of management of the national parks. Finally, earlier attempts at managing earth science processes in the parks reflected a primarily engineering approach that was not only inconsistent with ecosystem-based management, but had also prevented geomorphologists from being actively involved in many earlier resource management efforts. Thus, there was little history of considering geomorphological systems in park management and planning.

In addition to the failure of geomorphologists to become involved in the developing ecosystem-based management of the parks, the staffing structure of the parks is in part responsible for the reduced emphasis on earth science resources. As was identified in the study, no interviewed park employees were employed in a capacity with responsibility for the earth sciences. In contrast, employees were identified as vegetation specialists, fisheries offices, wildlife ecologists and so on. In addition, only one of the park employees interviewed had received formal education in the earth sciences. When considered along with the gap identified in the earth science literature, these factors identify a potentially expanding chasm between the interests of earth scientists and the goals of the national parks with respect to resource management in the parks. In order to address this widening gap, a number of actions are needed to begin to reverse the situation.

9.2.4 Reversing the Trend

Suggestions for reversing the trend arising from the results of the interview fall into three basic categories; education and training, partnerships, and staffing. Education and training cover a broad spectrum of activities, ranging from the raising of staff awareness with respect to the earth sciences, to formal education programs aimed at increasing staff expertise. Indeed, education is seen as central to the role of the parks, and the acceptance of their mandate both within the system and outside it. To this end, it is essential that earth scientists communicate the significance of the earth sciences in all aspects of park management. In the following section, as an example of the type of education material that could be developed for parks, a simple interpretive plan is presented for Banff National Park, identifying a number of earth surface features and processes and their linkages to other components of the ecosystem.

Partnerships are a means of accessing expertise within universities, Geological Survey of Canada and other organizations. Staffing refers to the need to employ earth scientists in the capacity of earth scientists and that these individuals should be involved in the development management framework for the parks. These partnerships emphasize the significance of education as a key element in the resolution of the problem. Again, education should involve parks personnel, the general public, and earth scientists. These suggestions are discussed in greater detail in the recommendations section of this dissertation.

9.3 Impact on Identified Functions

Throughout this dissertation, the role of the earth sciences has been discussed in terms of their role within the conceptual and functional framework of resource management, interpretation, and research. This framework has been based upon what the roles of the earth science have been in the past, are at present, and can be in terms of the future. In simplest terms, the functions have been developed to protect and communicate the values of national parks. The following discussion briefly relates the conclusions of this dissertation to these functions

9.3.1 Resource Management

In terms of resource management, the park managers have never really gone beyond the role of protection of significant geological and geomorphological features in the parks' evolution. This has been identified in all the mountain parks and goes a long way to explaining the differences in presentation of the abiotic and biotic resources within the Park Management Plans (i.e. geological resources vs. wildlife management). Wardens in the parks also consider the management of earth science features and processes as a non-issue and indicate no need to understand the resource beyond an engineering level of knowledge. Given these conditions, it is understandable that the earth sciences have not been incorporated into the ecosystem management program. This approach is not, however, acceptable. Due to the lack of active management, and therefore the lack of park-directed applied earth science research in the park, no coherent body of information exists linking the earth sciences to ecosystem-based management.

Unique among the parks considered in this study, Point Pelee has a long history of management, and therefore of applied research. In spite of this, Point Pelee managers do not consider the physical processes of the park in the same sense that they consider the biological. The history of active management at Point Pelee is a story of ill-informed and reactive structural engineering solutions to crisis events. As a result, attitudes towards management of the resources in the park are understandably negative. Unfortunately, this has led to the failure to recognize the need to integrate the management of the abiotic component of the environment with the biotic. It was noted by one respondent that the notion of abiotic and biotic components of the ecosystem is not a useful distinction and that ultimately all things are linked to the biotic (Gadd, 1994, pers. comm.). Zinkan (1991) also suggests that disciplinary distinctions such as biologist and geologist prevent the useful application of ecosystem-based management.

These comments indicate the need for a holistic approach, one which includes all components of the ecosystem. However, it does not negate the fact that a significant component of the system is being ignored and as such, the ecosystem integrity is compromised. Furthermore, as was shown through the results of the interviews, few park employees have an earth science background, and none is employed in such a capacity. Therefore, given a situation in which ecological integrity is defined as exclusive of the earth sciences, and where geomorphologists and geologists are not involved in research, it is most unlikely that parks will be managed with a view to including the earth sciences in maintenance of ecological integrity.

An obvious problem associated with the linking of earth science research to ecological integrity is that such work is, by nature, at the borders of the disciplines and may or may not be of interest to traditional earth science or biological researchers.

9.3.2 Interpretation

Interpretation follows management in that a major thrust in modern interpretation is the communication of management issues. Interpretation is seen as a management tool for both communicating messages and educating the public in terms of appropriate activity (Butler, 1994).

As such, interpretation can be seen as evolving from messages of preservation through to protection, management, and culminating in integrated management. And, as management issues show a decline in earth science values, so will interpretation. This decline has been identified as occurring, and there is a strong indication that it will continue to occur. The fact that the earth sciences have not been incorporated into ecosystem management indicates that earth science will continue to decline as an interpretive message. Furthermore, education has been identified as perhaps the most important function of the National Parks and the most effective means of communicating the importance of the earth sciences in ecological integrity to parks employees. If park employees are unaware of the role of the earth sciences in ecological integrity, then it is unlikely that the message will be interpreted to the general public.

Table 9.1 and Figure 9.1 provide the basis for a model or illustrative interpretive program in Banff National Park which identifies numerous geomorphic features, the processes that created them, the national park values they reflect, their links to the ecosystem and possible monitoring implications. This is an example of a type of programming that relates earth science features and processes to other components of the ecosystem, while identifying their significance in terms of earth science heritage and the values of national parks. A program such as this could be developed and delivered at minimal cost to the parks. The program is envisaged as automobile accessible and incorporates some sites that are currently being interpreted.

In addition, a number of other sites could represent these features located throughout the park and surrounding region. Programs could easily be developed for a variety of backcountry areas of the mountain parks such as the Iceline Trail in Yoho, Bow Glacier in Banff, and the Maligne Valley Trail in Jasper. Similar programs could be developed for all National Parks. In the case of Point Pelee, the program should focus on the regional shoreline management strategies and the ecological impacts of the negative sand budget. This could be further linked to lake levels, climate change, and natural hazards.

9.3.3 Research

Finally, with respect to research, there is evidence that there has been little change where the earth sciences are concerned in the parks. In part this reflects the fact that much earth science research in parks is conducted by independent researchers and that the parks simply provide a suitable site or access to a particular formation or process for study. Rarely is the research related to park values, and just as rarely is the research directed by the park managers.

Table 9.1 Proposed Interpretive Program for Banff National Park

FEATURE	PROCESS	HUMAN IMPACT ROLE	ECOLOGICAL ROLE	VALUES	OTHER LINKS
1[9]. Avalanche path	Avalanche	Public Safety	Habitat Grizzly Bear Disturbance Nudation	Intrinsic Educational Ecological Scientific	Colluvial processes Climate change indicator
2. Alluvial Fan	Fluvial erosion and deposition	Highway safety, transport	Disturbance Habitat Aspen regeneration	Intrinsic Educational Ecological Scientific	unknown
3. Hoodoos	Erosion	Disturbance	Unknown	Intrinsic Educational Ecological Scientific	Colluvial processes Climate change indicator
4. Floodplains	Overbank flooding and deposition	Facility protection Public safety	Habitat	Intrinsic Educational Ecological Scientific	Fire Climate change
5. Moraines	Glacial deposition	Public safety	Habitat	Intrinsic Educational Ecological Scientific	Glacial advance and retreat Climate change
6. Slide Paths	Debris slides	Public safety Transport	Nudation Disturbance	Intrinsic Educational Ecological Scientific	Colluvial processes Climate change
7. Braided Streams	Alluvial erosion and deposition	Transport	Habitat	Intrinsic Educational Ecological Scientific	Glacial advance and retreat Climate change
8. Talus cones, Scree slopes	Rockfall	Public safety	Habitat	Intrinsic Educational Ecological Scientific	Climate change

[9] See map Figure 9.1 for location

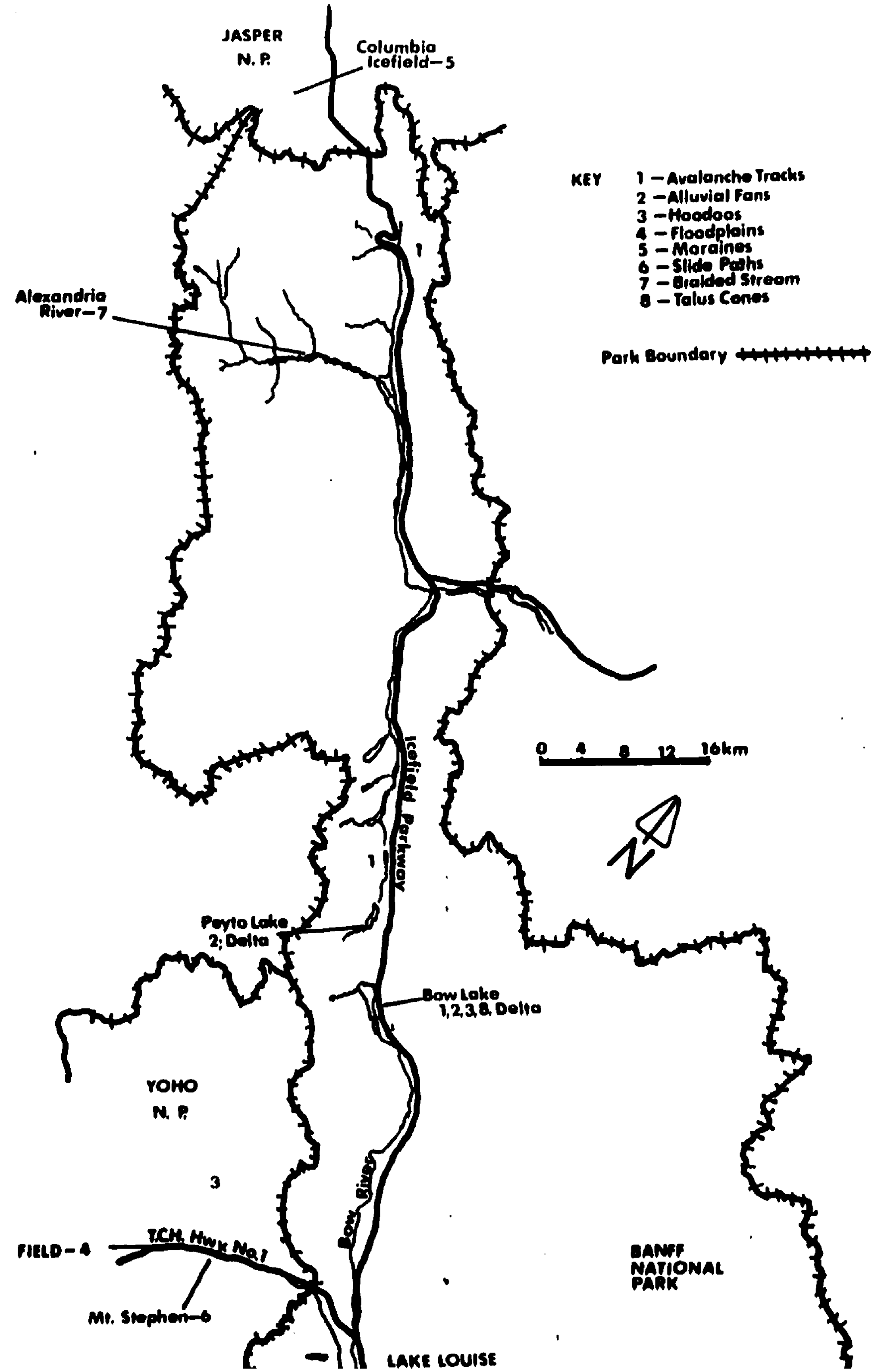

JASPER
N. P.
Columbia
Icefield—5
KEY
1 —Avalanche Tracks
2 —Alluvial Fans
3 —Hoodoos
4 —Floodplains
5 —Moraines
6 —Slide Paths
7 —Braided Stream
8 —Talus Cones
Park Boundary
Alexandria
River—7
1
0 4 8 12 16km
Icefield Parkway
N
1
Peyto Lake
2; Delta
Bow Lake
1,2,3,8, Delta
YOHO
N. P.
3
Bow River
FIELD – 4
T.C.H. Hwy No.1
Mt. Stephen—6
BANFF
NATIONAL
PARK
LAKE LOUISE

Figure 9.1 Locations of Proposed Interpret

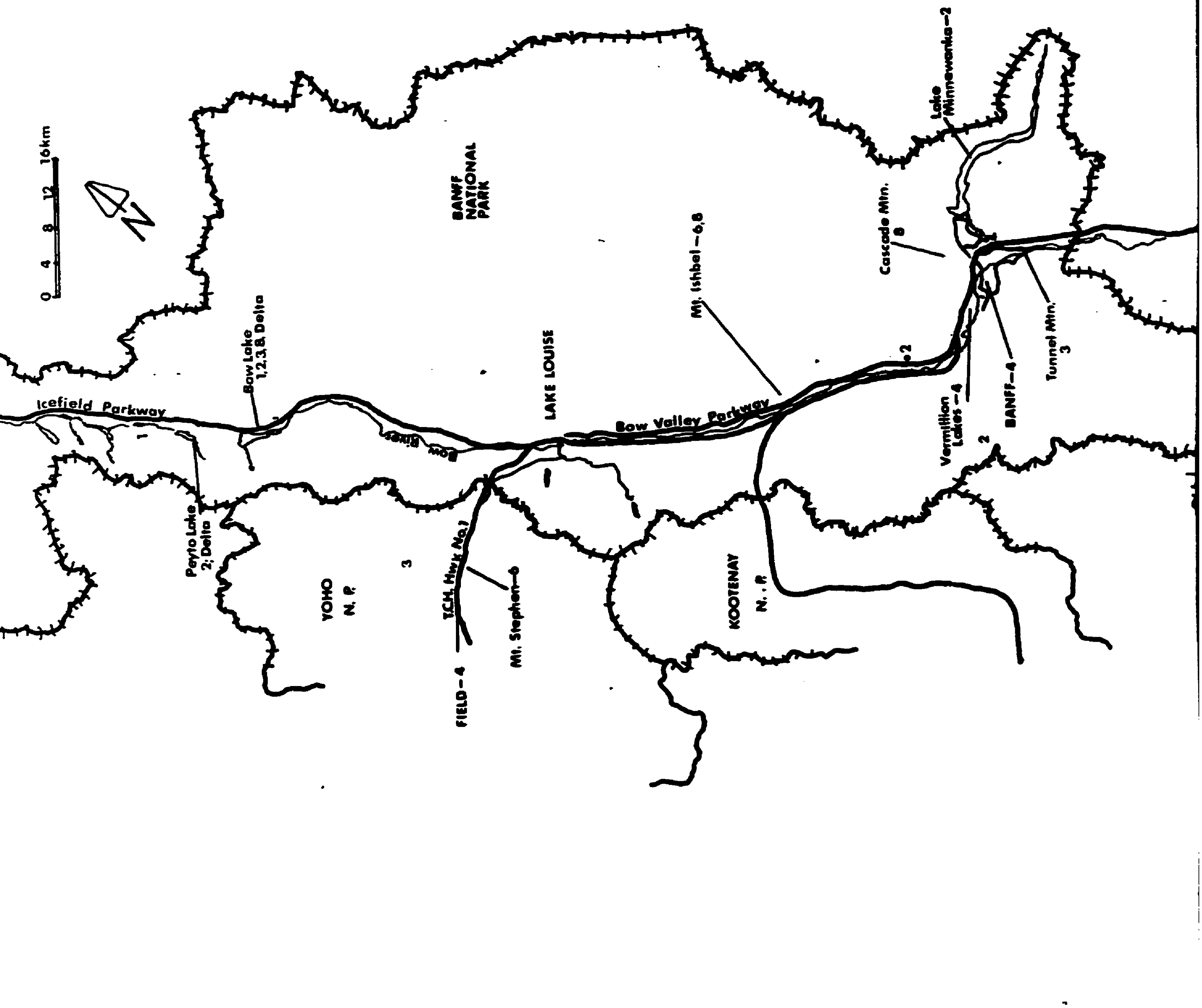
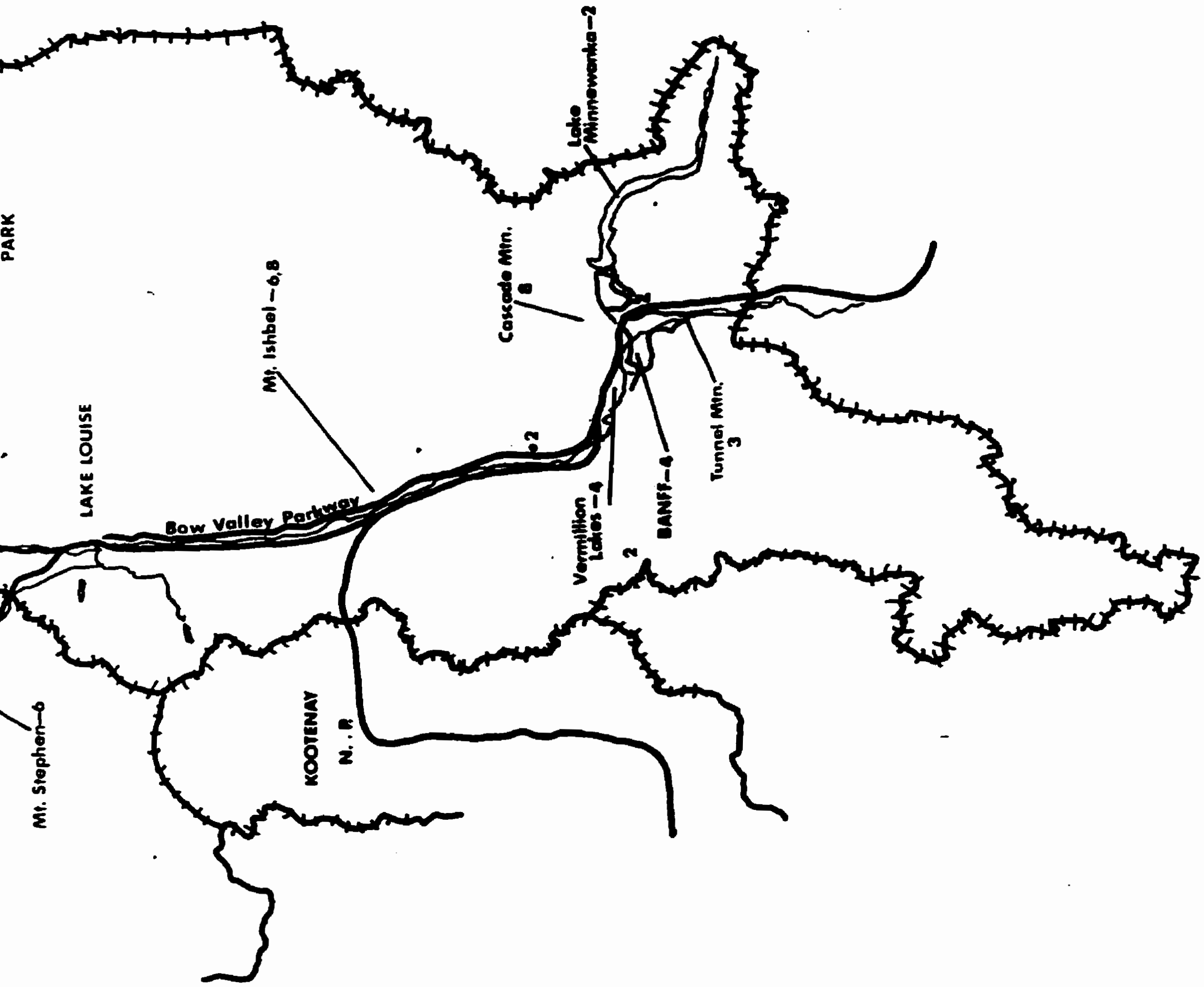


Figure 9.1 Locations of Proposed Interpretive Sites (Banff)



Park-directed research, however, has been increasing and much of the research currently conducted in parks can be characterized as "in house". Much of this is in response to the need to define measures of ecological integrity but, as established above, this is not defined to be inclusive of the abiotic processes and features of the park.

Thus, a condition exists in which earth science researchers are mostly unaware of what type of information and research the park managers might find useful, and park managers do not see that they might have a need for such information. This presents a real opportunity for earth scientists to contribute to the management and interpretation of the national parks. Ecological benchmarks need not be entirely biological. Indeed, geological features and processes formed the basis of the natural region description by acting as surrogates for species diversity and ecotype differentiation. Integrating into ecosystem-based management should allow the earth sciences to provide measures of ecological integrity and health. Point Pelee provides an excellent example of this, and others have been suggested in this study. Alluvial fans , channelization and their relationship to ungulate habitats, avalanche paths and avalanche control, flooding and flood control, fire suppression, runoff and floods all provide potentially significant links between the biotic and abiotic environments.

The 1988 changes to the National Parks Act and the 1994 changes to Parks Canada Policy were intended to strengthen the provisions for protection of the natural resources of the parks. In fact, the maintenance of ecological integrity will be the primary concern in all management activities in the parks. However, the antecedent conditions with respect to the manner in which resources were managed, the degree to which earth scientists were involved in management, and the staffing profile (job description and academic background) of the parks essentially eliminated any possibility of the earth sciences being properly incorporated into this new era of park management. This oversight was exacerbated by the independent nature of the earth science researchers working in the park, several of whom expressed surprise with the hypothesis advocated in this thesis.

9.4 Identifying a Context : addressing the problem

Several frameworks have been identified and applied in various sections of this dissertation. The interactive adaptive framework was identified as providing guidance in the development of the research and research method. The internationally recognized values and functions of national parks identify a number of roles for the earth sciences. The framework of the system plan and management planning process of Parks Canada, which has been developed to protect and communicate these values, provided an organizational framework for the discussion of the role of the earth sciences in the national parks of Canada. And, Dearden's typology (1991) provided a means of identifying the level of management complexity employed in decisions affecting earth science resources. However, none of these frameworks alone provides a means of addressing the reduced role of the earth sciences.

Mitchell (1991) provides a framework which incorporates a number of the elements of the frameworks identified above and shows promise in dealing with conflict and uncertainty in resource management. There are four BEAT elements; balance, ecosystem, adaptive and teamwork. These elements can provide a context for considering the declining role of the earth sciences in the national parks of Canada.

It is recognized in all resource decisions that a variety of dimensions must be considered. The first element of the BEAT framework is balance. Addressing the reduced role of the earth sciences has environmental, cultural and economic implications. Given the budgetary constraints faced by parks, the economic implications are significant. In addition, the administrative culture of parks has been dominated by a biological focus. Both of these issues place significant constraints upon the parks' ability to increase the role of the earth sciences in planning, management and interpretation. The element of balance identifies the need for trade-offs between the competing interests of biotic and abiotic sciences for limited funding. This need for balance was recognized by one warden who indicated that, if shown the need for earth science expertise in the park, he would adjust the staffing priorities in the park in order to obtain better balancing of viewpoints.

The ecosystem element is one that has been incorporated into the various activities of the national parks. The approach is integrated and holistic. However, as applied in the Canadian National Park System, little consideration is given to the earth sciences. This limitation can be related to the lack of balance identified above and the sectoral nature of individual disciplines (Zinkan, 1991). The strategic concern must maintain awareness of linkages but need not be comprehensive. This has implications for the nature of earth science research conducted in the parks. Current research does not meet the needs of park managers. Emphasis upon linkages and systems provides a more relevant approach in terms of applications in park management. Indeed, it is at the borders of disciplines that the ecosystem models hold the most promise. Education and understanding of these borders and linkages will be a key to the successful implementation of the new ecosystem based management.

Uncertainty and change in both the physical and human environment are addressed through an adaptive approach. An adaptive approach is flexible and provides a number of options to respond to changing conditions. The interactive adaptive approach employed in this dissertation provides an example of how research should be flexible in response to change. In a broader context, the exclusion of the earth sciences from the ecosystem planning framework of Parks Canada limits options and reduces flexibility in the face of change. As Parks Canada attempts to identify measurable indicators for environmental monitoring (East, 1994, pers. comm.), flexibility and options should be incorporated. In view of concerns over global change and climate change, the inclusion of relevant earth science indicators can increase options.

Teamwork or partnerships is an element identified on a number of occasions in this dissertation. Many respondents identified the need to develop partnerships with institutions in order to renew the role of the earth sciences in the National Parks. Teamwork ensures that interests with legitimate concerns have an opportunity to shape management decisions. Through teamwork, earth scientists from a variety of institutions can have input into the manner in which earth science concerns are dealt with in the parks. In addition, the parks can identify research needs that earth scientists may not have considered. In order for this to succeed both partners must be flexible and willing to consider different ways of doing things. This can be seen to provide enormous opportunities to both earth scientists and to Parks Canada.

The BEAT framework incorporates a number of elements which provide a useful context for identifying implication of the declining role the earth sciences in the planning, management and interpretation of Canada's National Parks. In addition, it provides some direction for the identification of means of reversing the decline.

9.5 Recommendations and Implications for Future Research

Recommendations arising from this study can be directed toward three distinct audiences; the National Parks of Canada, earth scientists, and citizens. In addition, the recommendations conform to the BEAT framework.

9.5.1 The National Parks

9.5.1.1 Balance and Ecosystem

1. The first recommendation directed towards national parks managers is the identification for the need to incorporate balance in the staffing structure of the parks. This is seen to be one of the most significant barriers to the renewal of the role of the earth sciences in the planning, management and interpretation of Canada's national parks. In addition to the changes which parks are undergoing as a result of the amendments to the National Parks Act, the national parks are redefining the roles of wardens (East, 1994, pers. comm.). This redefinition involves a shift in roles from enforcement and patrol to science and monitoring. This shift represents an opportunity to address the lack of earth science expertise within the service with minor cost implications as moneys are to a large

extent simply being redirected. That is, what is required is a redistribution of existing human resources. This may be accomplished through strategic staff replacement (i.e. filling vacancies with earth scientists), reorganizing and redefining the duties of existing staff, and education and retraining. This recommendation can be seen to incorporate several elements of the BEAT framework, notably balance, ecosystem and adaptation.

In the four mountain parks, a cost effective way by which this might be accomplished would be for the four parks to share the cost of one earth science specialist. This specialist would be responsible for coordinating earth science research in the parks, identifying needs and communicating these needs to other research institutions. Conversely, the specialist could communicate the significance of the research in the parks to other park ecosystem specialists. In addition, the specialist could serve as an advisor to the EARP specialists in each of the parks and direct them to appropriate experts when necessary. The specialist would provide input to the ecosystem management strategy for the four mountain parks, the Bow Valley Corridor Study and the Tri-Council study. A major focus for the specialist would be the identification and monitoring of linkages between abiotic and biotic systems. It is anticipated that such a position would, at most, cost .25 PY per annum per park, and could result in enough savings elsewhere within the parks, through reduction of duplication, to account for the entire amount. Given the increasing emphasis Parks Canada is placing upon science and the inclusion of highly trained individuals in the parks service, it would appear a very appropriate time to implement this proposition. Finally, the specialist could provide much in-house training for park staff.

Alternatively, interpretive programs such as the one developed in this dissertation could begin to point to the significance of the earth sciences in the overall ecological health and functioning of the park. This would result in the education of both parks staff as well as park visitors and could, at the same time, lead to the identification of new areas of research for geomorphologists and ecologists along with potential ecological benchmarks.

9.5.1.2 Education and Training

2. The second recommendation to the national parks develops from the preceding and identifies the need for the education and training of park personnel regarding the links between the abiotic and biotic components of the ecosystem. While the hiring of some staff as earth scientists in the system is identified as the number one priority, in reality this will not always be possible. As such, it will be necessary to ensure that wardens and interpreters in the parks are adequately trained with respect to both the biotic and abiotic components of the ecosystem. As noted above, some of this training could be accomplished in-house with minimal budget implications.

Training could be provided through partnership agreements between parks and Universities or other research institutions. Many models of these types of partnerships exists and this is an expanding area of University Continuing Education Divisions. The recent partnership agreement between The Centre for Indigenous Environmental Resources (CIER) and the Continuing Education Division at the University of Manitoba provides just one example of how these partnerships can be developed. Similarly, the work of the Heritage Resource Centre at the University of Waterloo provides another means of delivering education and training, and disseminating information between partners. In this type of partnership arrangement, it is the role of the National Parks to identify the type of information required. Cost implications are determined by the nature of the individual agreements and what each of the partners is able to provide.

9.5.1.3 Partnerships

3. The third and final recommendation for Parks Canada is that the parks enter into research partnerships with institutions conducting earth science research. Through such partnerships mutually acceptable goals and objectives can be identified. Parks provide important locations for basic research. However, in the past this research has not often

served the needs of park managers. Through strong links with researchers and research institutions, new opportunities for research can be identified. This will require flexibility and adaptiveness on the part of both the parks and on earth scientists as each adjusts its goals. In many instances, these partnerships need not have any cost implications. Indeed, by facilitating research through the identification of problems and potential study sites, and the provision of accommodation and logistical support, parks can reduce the expenses of the researcher. In exchange, the researcher could be expected to provide training or present reports relevant to park needs. These types of accommodations cost little and yet provide enormous benefits to both partners.

9.5.2 Earth Scientists

1. The primary recommendation to earth scientists is the suggestion that earth scientists must broaden the scope of their research and be open to discussing research needs and priorities of national parks if the earth sciences are to play a significant role in the planning, management and interpretation of Canada's national parks. The international and Canadian experience with national parks identifies a number of values associated with the earth science heritage of national parks. It has been shown that much systematic research takes place in national parks. However, earth scientists must begin to view the national parks as more than locations for research. Earth scientists must become actively involved in the planning and management process. Only through this activity will they be able to identify earth science research which provides the type of information parks requires. Given the implications of global change and climate warming, numerous opportunities exist for earth scientists, in cooperation with Parks Canada, to identify and monitor indicators of ecological integrity. As with other partnership agreements, there need be no financial costs associated with such an approach, and the approach may well provide savings for both the researcher and the parks.

9.5.3 Citizens

A third audience is the citizens of Canada. It has been shown through the responses to the interview that special interest groups have significant and growing impact on the management, planning and interpretation of the national parks considered in this study. However, with the exception of the Burgess Shale Foundation, these special interest groups focus upon the biological resources of the parks. These groups must be encouraged to advocate on behalf of the earth science resources of the parks to the same degree as they do the biological resources of the parks. Here again, there is a role for earth scientists to become involved in the various special interest groups and identify features and processes of special concern. The major way in which this can be accomplished is through education. The simple interpretive program presented in this chapter provides an example of how the earth sciences can be shown to be relevant to the ecological integrity of parks. In addition, such a program can also highlight other implications of earth science features and processes, such as public safety and global change. Educating the public as to the relevance of the earth sciences is, perhaps, the most important means of addressing the declining role of the earth sciences in the national parks of Canada.

9.5.3 Future Research Implications

Emerging directly from the findings of this dissertation are a number of questions that point to future research possibilities. The first is to identify more precisely the future role of the earth sciences in the national parks of Canada. Stronger links need to be identified between the earth and the biotic sciences. Research needs to focus upon identifying earth science measures of ecological integrity. In addition, there needs to be a greater emphasis placed upon the planning and management implications of earth science research in the context of the national parks.

Applied geomorphology must go beyond an engineering approach to problems. This has great implications for research in applied geomorphology, and suggests a whole new direction of study relating to emulating natural systems in the management of processes. This is in keeping with McLellan's criticism of geomorphologists retreat to the study unmodified systems (Durrant, 1986, McLellan, 1995).

It would be instructive to consider other national parks and protected areas systems to see if the findings of this study are consistent with what is occurring in other jurisdictions, and if so, to identify why the trend exists in these systems and when it began. This study's focus upon Point Pelee and Banff could limit the applicability of the results to other parks and protected areas. The findings which indicate the lack of earth science expertise might not hold true in other regions and this could impact on management and interpretation. Following from this, it would be informative to identify cases where the earth sciences have played a significant role in all aspects of parks and protected areas planning and management, as this might provide valuable information for addressing the problem in Canada's parks.

Other questions that emerge indirectly from the study are: What do earth scientists think of the declining role of the earth sciences in the parks? Are they aware that a reduction is taking place? Do they care? Or, do they see connecting the earth sciences to park management issues as important? Or are parks viewed simply as sites in which to conduct their research? Is there a need for more and better prepared earth science inventories in national parks? Would it be useful to develop a spectrum of applied geomorphology ranging from engineering approaches in urban environments to systems emulation in parks and protected areas? There is a need to identify the role of geomorphologists and other earth scientists in the declining role of the earth sciences in the national parks. This is a major limitation of this study and this role was not specifically addressed.

Finally, a number of questions emerge from the approach used in the study. One of the major problems encountered in this study was the need to identify that something was not occurring. That is, proving something is not there is a difficult task, and it occurs to the writer there must be other studies which have dealt with this problem and identified approaches other than the one employed in this study. Future studies could rely more heavily upon the interview or a questionnaire mailed to park employees, as it was the responses to the interviews that proved most illuminating.

In conclusion, this dissertation identified that in the parks considered in this study, the earth science resources were never accorded the same degree of attention as the biotic resources. In addition, this role is currently being further reduced as a result of the 1988 amendments to the National Park Act. This points to a vital area of research currently being overlooked by both earth scientists and the managers of Canada's National Parks. The application of geomorphology in ecosystem based management holds enormous potential at a variety of spatial and temporal scales. Failure to recognize the role of the earth sciences in ecosystem-based management of the parks threatens to compromise their ecological integrity. Application of the recommendations presented in this dissertation could begin to address this oversight and begin the development of an exciting and valuable new role for the earth sciences in the management of Canada's National Parks.

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