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An approach to defining greater park ecosystems and its application to Gros Morne National Park (Newfoundland)

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An Approach to Defining Greater Park Ecosystems and Its Application to Gros Morne National Park

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ABSTRACT

Ecosystem management is an integrative, cooperative, adaptive approach to resource management that has evolved in response to the growing number of environmental and resource problems over the past several decades. One such problem, the threat to the world's biodiversity, may be attributed to the the destruction, degradation, and fragmentation of habitat resulting from the expanding human population, and the inability to set aside in strict nature reserves, sufficient habitat for wide-ranging mammals and fully functioning ecosystems.

The Greater Park Ecosystem concept may be seen as the embodiment of ecosystem management in national parks and a response to the threat to biodiversity. A major challenge to effective implementation of such an idea is defining the boundaries of the management unit or ecosystem. Delineation of these boundaries may be guided by principles of protected area design, as well as by previous efforts to delineate ecosystem boundaries. However, any approach used to delineate the boundaries of a Greater Park Ecosystem should be consistent with the objectives and principles of ecosystem management, both its ecological (substantive) and sociopolitical (process) aspects.

In this study an evaluation of previous efforts to delineate ecosystem boundaries was carried out. It concluded, based on criteria drawn from the literature on ecosystem management, national parks management, and protected area design, that no single approach adequately addressed the problem of protecting native biological diversity in national parks, in the face of increasing pressures from beyond the park boundaries.

The approach suggested in this study addresses substantive ecological concerns as well as the process of boundary delineation itself. It considers abiotic, biotic, and cultural features and processes of the park region, particularly those that traverse official park boundaries. The location of significant and/or representative features and processes guides the preliminary placement of the Greater Park Ecosystem boundary, which will likely change with input from the various stakeholders. The suggested approach addresses the *process* of boundary delineation by encouraging participation of all stakeholders in the region, fostering a cooperative approach among competing resource users, and ensuring that institutional structures are appropriate. An overriding consideration is that the final boundaries encompass an area that is sufficiently large to support a minimum viable population of the most space-demanding species in the region.

The substantive aspects of this suggested approach were illustrated in this study with reference to Gros Morne National Park in western Newfoundland. The resulting Greater Gros Morne Ecosystem boundaries were compared to several other alternatives which were based on the boundaries of the region's ecoregions, physiographic regions, and the Western Newfoundland Model Forest. The suggested boundaries were shown to be superior to the other alternatives in terms of significant habitat characteristics, human landuse, watershed integrity as well as several other measures.

A preliminary assessment of the process components of the suggested approach, again with respect to Gros Morne National Park, revealed that the agencies responsible for resource management in Newfoundland appear to be moving toward an ecosystem management philosophy. The need for greater integration, cooperation, and adaptability has been widely acknowledged. From the general public, there appears to be more appreciation of the consequences of poor resource management, due primarily to the collapse of the Northern cod fishery, greater acceptance of new ideas, and a demand for more input from local groups and individuals. Despite this, the lack of alternative employment opportunities outside the extractive resource sector, and the long history of unrestricted local resource use remain barriers to widespread acceptance of the Greater Gros Morne Ecosystem concept.

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I. INTRODUCTION

Humans have long drawn artificial lines on the land to delineate political and administrative regions, resource management units, land uses, and a variety of other classifications. In recent years, however, it has become clear that as the impacts of human activities cross regional, national, and even continental borders, a new approach to defining boundaries, and to managing the resources within those boundaries, is needed. The recent dispute between Canada and Spain over fishing rights and quotas off the east coast of Newfoundland illustrates this problem. The dispute may be attributed in part to the use of an artificial 200 mile limit to establish national jurisdiction instead of the natural boundary formed by the edge of the Continental Shelf. Conflicts over air and water pollution that cross political or administrative boundaries highlight the shortcomings of using such boundaries to define management units. Administrators of national parks in North America have recently expressed concerns that activities such as forest clearcuts and other large-scale developments occurring beyond the "artificial" park boundary do not consider the impacts on the park's natural processes, and therefore threaten the very purpose for which the park was established. These few examples point to the need to reexamine the way resource management units are defined and the need to incorporate ecological processes as the very basis of a new definition. They also suggest that a whole new philosophy of resource management is required.

A new philosophy of resource management that has emerged and gained some acceptance in recent years is ecosystem management. It may be characterized by increased integration, interagency cooperation, local participation, adaptability, and by the use of naturally- and culturally-defined management units, or ecosystems. The significance of this ecosystem concept was highlighted by Eugene P. Odum (1992) when he called it the number one idea in ecology for the 1990's.

As noted above, resource management units are often defined by artificial boundaries. One of the major challenges to implementing ecosystem management is the delineation of natural ecosystem boundaries. Previous efforts to determine such boundaries include a variety of ecological land classification methods, the use of watersheds, and bioregionalism, among others.

The principles of ecosystem management have been embraced by national parks in Canada. The problem with artificial boundaries is particularly challenging in and around these protected areas. The often great disparity between the goals of national parks and those of other resource users may create a significant natural barrier between the park and surrounding lands. Because most parks are not sufficiently large, in isolation, to maintain viable populations of large mammals, disturbance regimes, and other ecological patterns and processes, such a barrier represents a significant threat to the integrity of natural processes within the park.

Administrators of many North American national parks have responded to this problem through the Greater Park Ecosystem concept. The most widely cited example is the Greater Yellowstone Ecosystem, but other parks including Jasper, Fundy, and Pukaskwa have been associated with the concept. The Greater Park Ecosystem is conceived to be a region of cooperative management, available to all resource users, with the maintenance of ecological integrity as its overriding objective. It is to be centred on the park, and defined on the basis of biophysical and cultural criteria. To delineate the actual boundaries of a Greater Park Ecosystem one of the approaches noted above for defining ecosystems generally (ecological land classification, watersheds, bioregionalism, etc.) may be used. Alternatively, some other abiotic, biotic, or cultural factors, or some combination of previous approaches and these factors may be used. Grumbine (1994a) sets as a fundamental criterion for defining greater ecosystems, provision of primary habitat necessary to sustain the largest carnivore in a region.

Despite the attention given to the Greater Park Ecosystem concept over the past several years, putting the concept into practice has been difficult. There remains no North American national park for which a well-defined greater ecosystem exists. Furthermore, there is no generally accepted methodology for delineating the boundaries of such a region. This study will present a viable Greater Park Ecosystem methodology and illustrate an application using Gros Morne National Park.

Research Problem and Objectives

In this study I will address the following research questions:

1. What approaches have been used to define ecosystems and what are the strengths and weaknesses of each in the context of the objectives and principles of ecosystem management and national park management?

2. What approach or combination of approaches is most appropriate for defining a Greater Park Ecosystem and how can this be applied to Gros Morne National Park and surrounding region?

3. What are some of the institutional and socioeconomic factors that may facilitate or constrain implementation of ecosystem management through a Greater Gros Morne Ecosystem?

This research is not being carried out with the intention that it be implemented as is for Gros Morne National Park, but to demonstrate a methodology for defining Greater Park Ecosystems and to illustrate this methodology by using the example of Gros Morne National Park. As such it is intended to serve as an example tool that might be a catalyst for further discussion among the many stakeholders in the region.

Methodology

The methodology for the study included library research, gathering of biophysical and cultural data from resource and mapping agencies, and personal interviews. Information regarding the biophysical and cultural features of the study area was obtained from a variety of published materials including maps of vegetation, topography, geology, etc. and through discussion with park, resource, municipal and other officials. The survey and evaluation of alternative ecosystem definition bases were based primarily on library research. Ecological data were obtained from recent research carried out jointly by Gros Morne National Park and the Newfoundland Wildlife Service, supplemented by library research. Information regarding institutional concerns was derived from material related to integrated resource management in Newfoundland, published by a variety of federal, provincial, or other agencies, as well as from personal interviews.

These personal interviews were designed to provide some understanding of the views of the various stakeholders toward ecosystem management and the need for some form of Greater Gros Morne Ecosystem. Many of those interviewed had participated in the Western Newfoundland Model Forest, another region of cooperative resource management in western Newfoundland, and so had definite opinions about the potential for a similar arrangement around Gros Morne National Park. This information assisted me in assessing whether a more cooperative approach involving local groups and resource interests might be acceptable in the region surrounding the park (See Appendix 1).

A detailed description of the methodology used in defining a Greater Gros Morne Ecosystem is provided in Chapter 5.

Overview

This overview presents a conceptual framework on which the remainder of the paper will be based. It introduces the concept of ecosystem management and discusses how it has evolved in response to societal changes. It illustrates how the evolution of ecosystem management is reflected in changes to national parks management in Canada, and ties this in with my major focus, defining a Greater Park Ecosystem. Finally, it provides an introduction to the Gros Morne National Park region of western Newfoundland.

Ecosystem Management: The New Paradigm

Until recently, the accepted paradigm for natural resource management was reductionist, anthropocentric, and competitive in nature. This reflected the general views of Western society that the natural world could be understood in terms of its component parts, that science and technology could provide such understanding and solve human problems, that human beings were separate from and stood above the natural world, and that the market, with its emphasis on individualism and competition would allocate resources efficiently and effectively (Milbrath, 1989; Capra, 1982; Galbraith, 1985). Milbrath (1989) called this the dominant social paradigm.

This traditional approach to resource management is no longer compatible with current realities. The rapid growth in the number and intractability of resource, environmental, and social problems over the past several decades suggests that society has failed to adjust its management approach to fit changing societal conditions. As Walter Rosenbaum (cited in Grumbine, 1994b:107) suggested, "[e]nvironmental degradation is a 20th century problem resolved according to 18th century rules." The world of the late 20th century differs significantly from that of the 18th century or even the mid-20th century. Human population and per capita resource use are much higher today and the power of technology is much greater. These changes have contributed to an increase in the number and severity of resource shortages and conflicts, an increase in the complexity of interrelationships within and between the human and natural world, and a growing acknowledgement of the uncertainty inherent in our biological, economic and other predictive models.

One possible response to some of these resource, environmental, and social problems is to reduce human population and per capita resource use, and to control the use of powerful new technologies (Ehrlich and Ehrlich, 1990; Milbrath, 1989; Grumbine, 1992). Even assuming that such actions are ethical and desirable, the momentum driving these societal changes is such that they might require 50-100 years or more to reverse, so another means by which the pressures from these changes might be eased in the short to intermediate term is necessary. This might be accomplished by attempting to more effectively manage increased complexity, resource conflict, and uncertainty -- the secondary effects of rising population, resource use, and technological advance.

The problems of the interrelationships of humans and their environment in the face of increasing complexity, conflict, and uncertainty have been discussed since the middle years of this century. Significant agreement is emerging regarding several features of a new approach to more effectively deal with them. These include (i) a more integrated, holistic approach to balance the traditional reductionist approach and provide an improved perspective on complex interdependencies (Udall, 1963; Caldwell, 1970; Burhoe, 1973; Holling, 1978; Grumbine, 1994a; Mitchell, 1995; Trist, 1980; Wiman, 1991; Cambel, 1993; Waldrop, 1992; Wilson, 1973; Rose, 1993; Kay and Schneider, 1994), (ii) greater cooperation among competing resource users, which recognizes the challenge of managing a finite resource supply in the presence of an expanding population base, and the ethical dilemma in allowing political/economic power to determine how resources are allocated (Leopold, 1949; Udall, 1963; Caldwell, 1970; Trist, 1980; Holling, 1978; Waldrop, 1992; Falk, 1973, Kennedy, 1993; Grumbine, 1994a; Mitchell, 1995), and (iii) developing adaptive capabilities, which acknowledge the limitations of our predictive models by assuming unexpected outcomes (Trist, 1980; Wiman, 1991; Holling, 1978; Waldrop, 1992; Nicolis and Prigogine, 1989; Kay and Schneider, 1994; Wynne, 1992; Grumbine, 1994a; Mitchell, 1995).

These ideas form the basis of a new philosophy of natural resource management often referred to as ecosystem management. A comprehensive definition was provided by Grumbine in "What is Ecosystem Management?"(1994a): "Ecosystem management integrates scientific knowledge of ecological relationships within a complex sociopolitical and values framework toward the general goal of protecting native ecosystem integrity over the long term." This definition reflects an ecocentric point of view -- it considers humans as only one element of the natural environment. Others support an anthropocentric focus (Kessler et. al., 1992; Wood, 1994) (quoted in Stanley, 1995). Table 1 summarizes how ecosystem management has developed and evolved in response to societal changes. The shaded portion might be thought of as being consistent with the ecocentric view of ecosystem management, but not with the anthropocentric view.
As difficult as it is to provide a generally accepted definition of a term such as ecosystem management, it is even more difficult to implement that which ecosystem management is conceived to be. The challenges to implementation include: (i) definition of the management unit or ecosystem itself, (ii) the need to change institutional structures, (iii) the need for improved understanding of ecological patterns and processes (Slocombe, 1993), and (iv) the need for changes in human attitudes and values (Grumbine, 1994a).

The first challenge, defining the management unit, provides the focus for this study.

Table 1: Evolution of a New Resource Management Paradigm

Societal Change	Traditional Resource Management Response	A New Approach
Increased population, per capita resource use, and technological advance	Current and future technology will solve human problems	**Population control** **Reduction in resource use** **Appropriate technology**
	Humans dominant species	**Attitudinal shift re: relationship between humans and nature**
Increased complexity	Increased effort to understand interactions using reductionist methods	Increased effort to understand interactions using holistic and reductionist methods Limits to understanding acknowledged Value of other ways of knowing acknowledged
Increased uncertainty	Certainty is achievable through science	Uncertainty explicitly acknowledged Adaptive management
Increased conflict	Competition	Increased cooperation
	Political and economic strength important ('survival of the fittest')	Maintenance of ecological integrity overrides other interests

This issue will be discussed in the context of Canadian national parks, particularly Gros Morne National Park in western Newfoundland. The institutional implications of this new approach to management unit definition will also be addressed.

National Parks in Canada

Management of national parks has evolved under the same conditions and has been subject to the same environmental changes as other areas of natural resource management. The response of Canadian national parks has been a change from a commercial focus to one based on human recreation, to one based on maintenance of ecological integrity; from a policy encouraging resource extraction to one prohibiting resource extraction to one which attempts to integrate small-scale resource extraction into local history and culture; from an emphasis on internal threats to a growing awareness of the significance of external threats (McNamee, 1993). This change in focus and in general philosophy mirrors, in some respects, the change from traditional natural resource management to ecosystem management. In particular, it highlights the importance of improved integration of the park's activities with those of the surrounding region. One step towards improved integration is to include the park in a larger management unit whose boundaries are based on biophysical and cultural features, rather than on artificial political considerations, that is to define a Greater Park Ecosystem.

Greater Park Ecosystems

In essence the Greater Park Ecosystem concept represents an attempt to implement ecosystem management for a national park. One of the earliest and most difficult steps in such a process is delineation of ecosystem boundaries. There is no generally accepted approach for delineating boundaries for a Greater Park Ecosystem. However, some guidance may be provided by approaches that have been used in the past to define ecosystems, ecoregions, bioregions, or other natural region.These include a variety of ecological land classification systems, the use of watershed boundaries, and bioregionalism. Also helpful may be the body of literature dealing with protected area design, which is derived primarily from conservation biology principles. Any approach used to describe the boundaries of a Greater Park Ecosystem should be consistent with the objectives and principles of ecosystem management and national park management, which will be outlined in Chapter 2. It should also consider the significant features of and threats to, the particular national park in question. The approach developed in this study will be illustrated by applying it to Gros Morne National Park.

The Greater Gros Morne Ecosystem

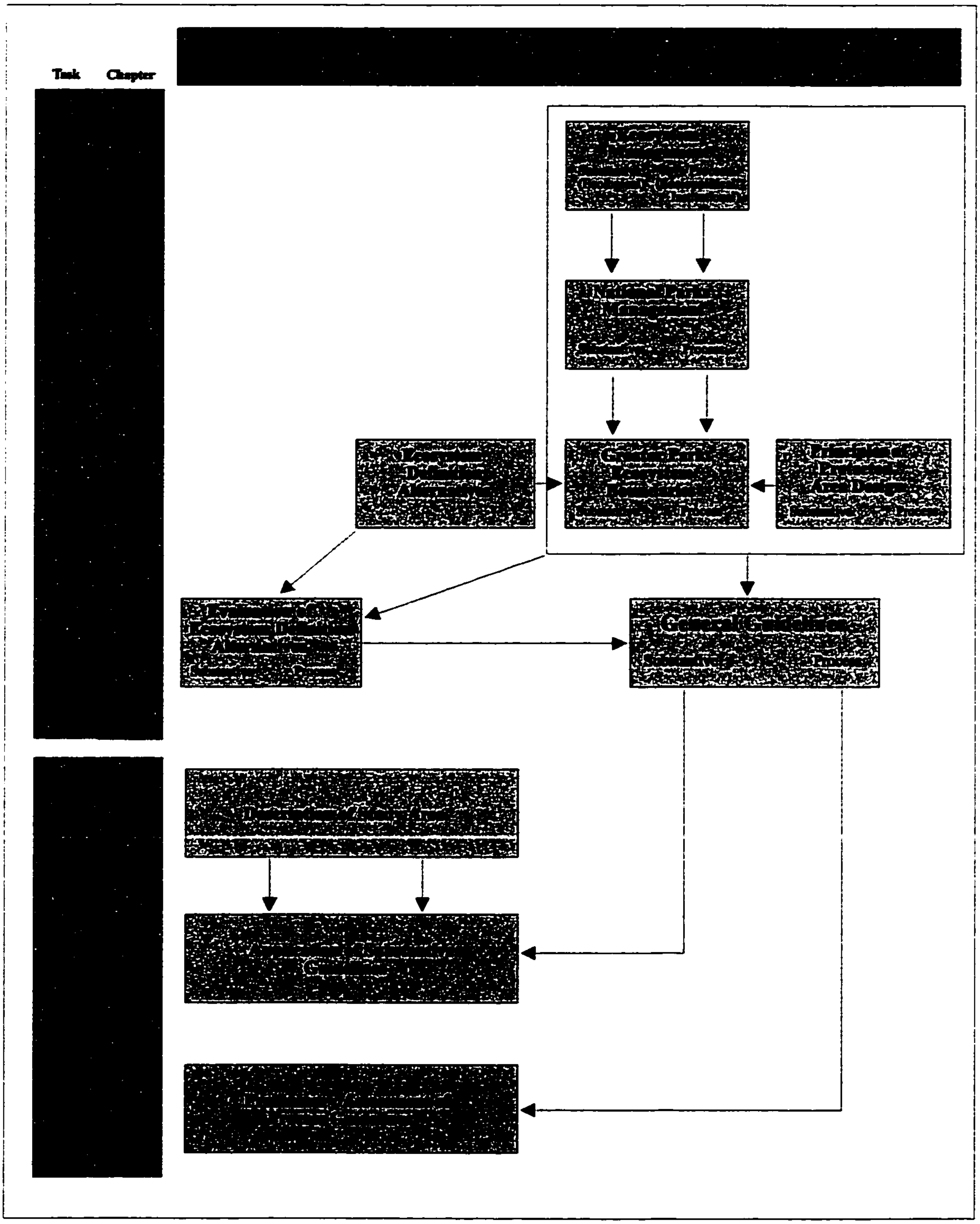
Gros Morne National Park in Western Newfoundland listed the Greater Park Ecosystem concept as a critical issue in its 1993 Management Plan Review (Canadian Parks Service, 1993). Increased tourism, resource extraction, and commercial outfitting are seen as potential threats to the integrity of the Park's natural processes. Conflict between the mandate of the Park and the interests of external resource users and managers, and concern over potentially significant transboundary impacts have provided the impetus for the Park to initiate the formation of partnerships with adjacent land owners, managers, and users under the Greater Park Ecosystem concept.

As noted previously, a Greater Park Ecosystem may be defined in a number of ways, using several different bases. Among the most significant biotic, abiotic, or cultural features for Gros Morne are watersheds; geological features; the rural, subsistence culture;

and the ecology of large mammals such as moose, caribou, and black bear. This study will consider these and other features and processes in delineating suggested boundaries for a Greater Gros Morne Ecosystem.

The preceding overview presented a brief introduction to the main ideas of the paper. Chapter 2 will provide a more in depth review of the literature, focusing on (1) the ecological and sociopolitical/institutional aspects of ecosystem management and national parks management and how they have evolved to their current state; (2) on Greater Park Ecosystems and how they may be defined, and (3) on the challenges to implementing an ecosystem management regime. This review provides the basis for the evaluation of previous ecosystem definition efforts and for the development of general guidelines for defining Greater Park Ecosystems in Chapter 3. Chapter 4 will describe the study area, Gros Morne National Park and surrounding region. Chapter 5 will illustrate how a Greater Gros Morne Ecosystem is defined based on the approach described in Chapter 3, tailored to the specific features and processes of my study area, as described in chapter 4. Chapter 6 will examine the major socioeconomic and institutional factors that may effect the potential for implementing a Greater Park Ecosystem concept for Gros Morne National Park. Chapter 7 will provide a summary and conclusions. An overview of the thesis is presented diagrammatically in Figure 1.

Figure 1: Overview of Thesis



II. LITERATURE REVIEW

The first research question requires that previous approaches to defining ecosystems be reviewed and evaluated in the context of ecosystem management and national parks management. In order to carry this out, I reviewed the relevant literature on ecosystem management, national parks management in Canada, and protected area design. This review is used in the process of developing criteria for evaluating the strengths and weaknesses of the various approaches.

Ecosystem Management

The term ecosystem management has been used to describe a new approach adopted for the management of forests in the United States (Jones et. al., 1995) and in some Canadian provinces (Forestry Division, Department of Natural Resources, Government of Newfoundland and Labrador, 1995), the management of parks in the United States and in Canada (Grumbine, 1994b; Parks Canada, 1995b), and the management of the Great Lakes region (Caldwell, 1988), among others. However, it has been difficult to arrive at a consensus as to what the term means. Because of this it is necessary to provide a detailed clarification of its meaning in the context of the current research. The following sections will accomplish this by tracing the evolution of the terms 'ecosystem' and 'ecosystem management' and by reviewing current thinking based on the most recent literature.

Evolution of the Ecosystem Concept

The term 'ecosystem' was first used by Tansley in 1935 (Major, 1969), but the idea has been around in one form or another for centuries. The English words moss, fen, and heath, among others, denote various associations of plant and animal life, habitat, and landscape (Major, 1969), which may constitute a narrow definition of ecosystem. Major (1969) described many other societies over the past several centuries that used similar terms. Von Humboldt's assertion in 1807, that "[i]n the great chain of causes and effects no thing and no activity should be regarded in isolation" (Major, 1969) reflected an ecosystem perspective.

Since Tansley coined the term and gave explicit recognition to the interdependencies implied by the use of the above terms, the meaning of the term ecosystem has both undergone, and continues to undergo, many changes. While Tansley and Clements assumed a profound difference between the living and non-living components of the environment, as implied by their "...focus on species acting within their physical environment..." (Bocking, 1994: 15), their notions of the ecosystem concept were very different. Clements viewed the ecosystem as a type of organism, whereas Tansley distinguished it from both organisms and inorganic systems (Bocking, 1994). Over the next several years, through the work of prominent ecologists such as Raymond Lindemann, G.E. Hutchinson, Howard Odum and Eugene Odum, ecology and ecosystem research became more mathematically based (Bocking, 1994). Ecosystems were described and analyzed quantitatively, much like other physical systems, and the barrier between the living and non-living components of nature was blurred. According to Bocking (1994:15), "Nature became less an organism than a machine... susceptible to manipulation [by humans]..."

These views remained prominent into the 1960's and 1970's. The anthropocentric focus was demonstrated by Spurr (1969:3), "A natural resource ecosystem is an integrated ecological system, one element of which is a product of direct or indirect use to man." The view that an ecosystem was something that could be described by resort to scientific fact also remained widespread: "...we today regard the ecosystem idea as an essentially scientific one" (Major, 1969:11). However, as the 1970's progressed it became clear that neither ecosystem science, nor science in general could alone provide a precise understanding of complex natural systems (Bocking, 1994).

Through the late 1980's and 1990's the concept of the ecosystem evolved in a new direction. Although one view might have it defined on the basis of a combination of scientific understanding and political, economic and social factors, and by a feeling of 'home' (Bocking, 1994), it is still widely considered an ecological and biophysical concept. A systems perspective remains prominent, but the view of nature and of ecosystems as complex and often incomprehensible has replaced the machine analogy.

Evolution of Ecosystem Management

The traditional approach to natural resource management, described earlier as anthropocentric, reductionist, and competitive, was prevalent as late as the 1980's, but signs of an emerging alternative first appeared several decades earlier in the 1930's. In 1932, The Ecological Society of America's Committee for the Study of Plant and Animal

Communities pointed out that a system of nature reserves, including, where possible, highly protected cores and buffer zones, was needed to provide protection of entire ecosystems (Grumbine, 1994a). The Society also foresaw the need for greater interagency cooperation to ensure protection (Grumbine, 1994a). In 1935, Wright and Thompson's Fauna of the National Parks of the U.S. suggested that because of size and boundary limitations, parks do not necessarily represent full functional ecosystems (Grumbine, 1994a). Leopold's (1949) contribution came in the form of his 'land ethic', which espoused a view of humans as part of nature rather than separate from and above it, his call for greater cooperation, a stronger focus on community interests and community participation, and a greater contribution from the non-scientific community. These aspects of Leopold's philosophy reflected the emerging ecosystem management paradigm. Caldwell (1970) also suggested that a new approach to land management was needed -- one based on ecosystems, with greater community and public control over the rights and responsibilities associated with ownership and use.

The rise of conservation biology in the late 1970's and 1980's gave greater credence to the criticisms of traditional resource management and legitimized many of the emerging ideas associated with ecosystem management. Grumbine (1994b) referred to ecosystem management as the policy offspring of conservation biology. Through the 1970's, biologists Frank and John Craighead focused attention on ecosystem management through their work on grizzly bears (Grumbine, 1994a). Speaking particularly of Yellowstone National Park, they suggested that Greater Park Ecosystems should contain sufficient habitat to satisfy a viable population of the largest carnivore in the region (Grumbine, 1994a). This period also saw more explicit acknowledgement of the limitations of scientific understanding, for example in Holling's (1978) 'adaptive management'. Greater integration was suggested by research that examined the relationships between scientific and non-scientific factors, such as Salwasser, et. al.'s (1987) study of the relationship between population viability and interagency behaviour (quoted in Grumbine, 1994a).

Through the 1980's and 1990's, the ideas of ecosystem management gained increasing theoretical acceptance. The goal of management moved away from a purely anthropocentric focus, to a more ecocentric focus with the emphasis on ecosystem integrity, which Grumbine (1994a) defined as the maintenance of native diversity and the patterns and processes required to maintain that diversity.

Bocking (1994:18) suggested that the evolution of the ecosystem concept was a reflection of "...our changing understanding of nature... our evolving sense of the role of science, and of our place in the world". The evolution of ecosystem management may be similarly characterized.

Current Thinking

In recent years ecosystem management has been discussed from a variety of perspectives, from the ecological (LaJeunesse, et.al., 1995; Laacke, 1995; Wilcove and Blair, 1995), to the social/political/institutional (Caldwell, 1994; Clark, et.al., 1991; Jobes, 1991; Reading, et. al., 1994), to the ethical (Bell, 1994; Stanley, 1995). Grumbine (1994a) reviewed the literature on ecosystem management and provided a comprehensive analysis and definition.

According to Grumbine (1994a), the overriding objective of ecosystem management is the maintenance of ecological integrity. The more specific goals related to this overriding objective are listed in Table 2. For the most part these goals reflect an ecological perspective, and their significance for maintaining ecological integrity is well-supported. For example, the importance of maintaining ecological processes and functions, as well as structures, is a pervasive theme in Woodley, et. al.(1993) and Soule and Mills (1992). Woodley (1993) and Soule and Mills (1992) also highlight the importance of maintaining minimum viable populations of all native species. However, goal #5 in Table 2, (accommodate human use and occupancy within these constraints) suggests that maintenance of ecological integrity requires a broader understanding of the interrelationships between human and natural systems than is provided by the science of ecology. The literature dealing with this concept, while grappling with a clear definition, suggests likewise. Woodley (1993:158), while recognizing the need for ethical judgments in evaluating ecological integrity noted that ecological integrity, in the context of national parks, "...implies that ecosystem structures and functions are unimpaired by human-caused stresses..." It is widely acknowledged that humans always have and always will be a component of the ecosystem. Human-caused changes in the biosphere can be measured by scientists, but the determination of the degree of impairment that is considered 'unnatural' and a threat to ecological integrity is a value judgment and is not measurable by science (Kay, 1993). Kay (1993:202) suggested that a "...discussion of ecological integrity without a discussion of social, economic, political, and policy concerns is not a meaningful discussion." He suggested that "...the understanding of physical and biological scientists...

Table 2: Ecosystem Management Objectives and Principles

Objectives:

Primary Objective: Maintenance of Ecological Integrity

Specific Goals:

1. Maintain viable populations of all native species in situ
2. Represent, within protected areas, all native ecosystem types across their natural range of variation
3. Maintain evolutionary and ecological processes
4. Manage over periods of time long enough to maintain the evolutionary potential of species/ecosystems
5. Accommodate human use and occupancy within these constraints

Principles:

Ecological:	Social/Political/Institutional:	Ethical:
1. Hierarchical Context	6. Interagency Cooperation	10. Humans as Part of Nature
2. Ecological Boundaries	7. Organizational Change	
3. Ecological Integrity	8. Adaptive Management	
4. Data Collection	9. Values	
5. Monitoring		

Source: Grumbine (1994a)

be combined with the concerns of society as voiced by elected officials, policy makers, public interest groups, and others" (Kay, 1993: 209) in efforts toward the maintenance of ecological integrity.

Also presented in Table 2 are Grumbine's (1994a) ten dominant themes or principles. These represent a good summary of the principles required of a management process designed for the maintenance of ecological integrity and its more specific goals. They reflect the broad definition of ecological integrity discussed above.

The first five themes, hierarchical context, ecological boundaries, ecological integrity, data collection, and monitoring imply a new ecological perspective. They suggest the need for improved ecological understanding using a more holistic approach to balance traditional reductionist methods.

The idea of hierarchical context suggests such integration -- that management should focus not on the level of genes, species, populations, etc. in isolation, but on the interactions between these levels, that is on the total system (Grumbine, 1994a). Since ecosystems may range in size from the microscopic to the planetary, a hierarchical approach also implies that in making decisions related to a particular ecosystem one should also consider the smaller ecosystems within it and the larger ones of which it is part. Soule and Mills (1992) attribute the 'failure' of endangered species campaigns in part to a singular focus on the species level at the expense of other hierarchical levels. In the context of national parks consideration of hierarchical context suggests that consideration of transboundary processes is important in evaluating ecological integrity.

The next principle, that of ecological boundaries, refers to the idea that management should be based on ecosystems whose boundaries are defined by ecological criteria. Because humans are considered an integral component of nature, this includes consideration of socioeconomic factors. Ecological boundaries will often conflict with political and administrative boundaries.

As noted above, maintenance of ecological integrity should be the primary objective of the ecosystem management process. Effective management of ecological integrity requires the use of appropriate boundaries.

The inclusion of data collection and monitoring as important themes implies that human understanding of ecological relationships can be improved but can never be perfected -- monitoring will help those responsible for management of resources to learn and adapt as they go.

The next four themes, interagency cooperation, organizational change, adaptive management, and values relate to the way in which institutions will have to change the way they are organized and the way they operate, and to the way decisions are made regarding management of resources. Since ecosystem boundaries will seldom be consistent with political and administrative boundaries, management on an ecosystem basis will require the cooperation of many organizations having conflicting mandates, or it will require a change in institutional structure and organization to more closely match the new management unit boundaries. Organizations will also have to consider implementing an adaptive management strategy to deal with increasing complexity and uncertainty. Consideration of values, as noted above, is also significant. It implies that science cannot provide absolute guidance in efforts to maintain ecological integrity, and that human beings, individually, or through elected officials, governments, corporations, and interest groups must make judgments regarding their "...sense of wholeness and well-being of ecological systems..." (Kay, 1993:203).

The final theme, humans as part of nature, reflects an ecocentric view. It suggests that management on an ecosystem basis requires a radical change in attitude regarding the relationship between humans and nature from one featuring humans having dominion over the earth to one in which humans are simply one species among many, each having the right to survive. This remains a major point of contention between the anthropocentric view of ecosystem management, which supports the former, and the ecocentric view, which supports the latter (Stanley, 1995). This current study supports the ecocentric view, in theory, because the alternative suggests fragmentation, which is antithetical to one of the major principles of ecosystem management: integration. This theme may be broadened to include other dualisms. For example, a change in attitude that reflects a healing of the split between mind and body and between thought and feeling, which has been attributed to Descartes (Capra, 1982), might show itself as greater appreciation of the value of other ways of knowing, such as experiential knowledge.

There is an inherent contradiction between the ecocentric view and the suggestion that human values be considered in the resource management process because this view is in itself a value judgment. Other views, including the view that human interests should be considered ahead of other species' interests, are, according to the values principle, equally valid. Although the view that humans are part of nature is supported here on theoretical grounds, the problems with prescribing a particular value and with implementing an ecocentric approach are acknowledged.

A comparison of Table 1 and Table 2 reveals that the ecosystem management principles or themes offered by Grumbine (1994a) reflect the major features of the new approach to dealing with societal changes discussed earlier. Grumbine (1994a) attempts to incorporate this broad range of themes into a cohesive definition of ecosystem management: "Ecosystem management integrates scientific knowledge of ecological relationships within a complex sociopolitical and values framework toward the general goal of protecting native ecosystem integrity over the long term."

To summarize and further illustrate the ecosystem management concept, and how it has evolved, Table 3 summarizes the differences between traditional resource management and ecosystem management. Having clarified these terms and how ecosystem management has evolved, I will now turn to the specific branch of resource management with which this research is concerned --- management of Canada's national parks.

National Parks in Canada

In many ways the changes in parks management have mirrored changes in resource management generally. Societal change, as described in a previous section, provided the impetus for this evolution. Increased population, resource use, and the use of destructive technologies have created pressures on parks ranging from the pressure to expand recreation facilities and opportunities within the park to pressure for resource extraction and development beyond the park borders (Agee and Johnson, 1988). This has contributed to increased environmental and institutional complexity, greater uncertainty, and more conflict among resource users, which in turn has made it more difficult to understand, manage, and resolve problems. One problem of particular concern for parks and protected

Table 3: A Comparison of Ecosystem Management and Traditional Natural Resource Management

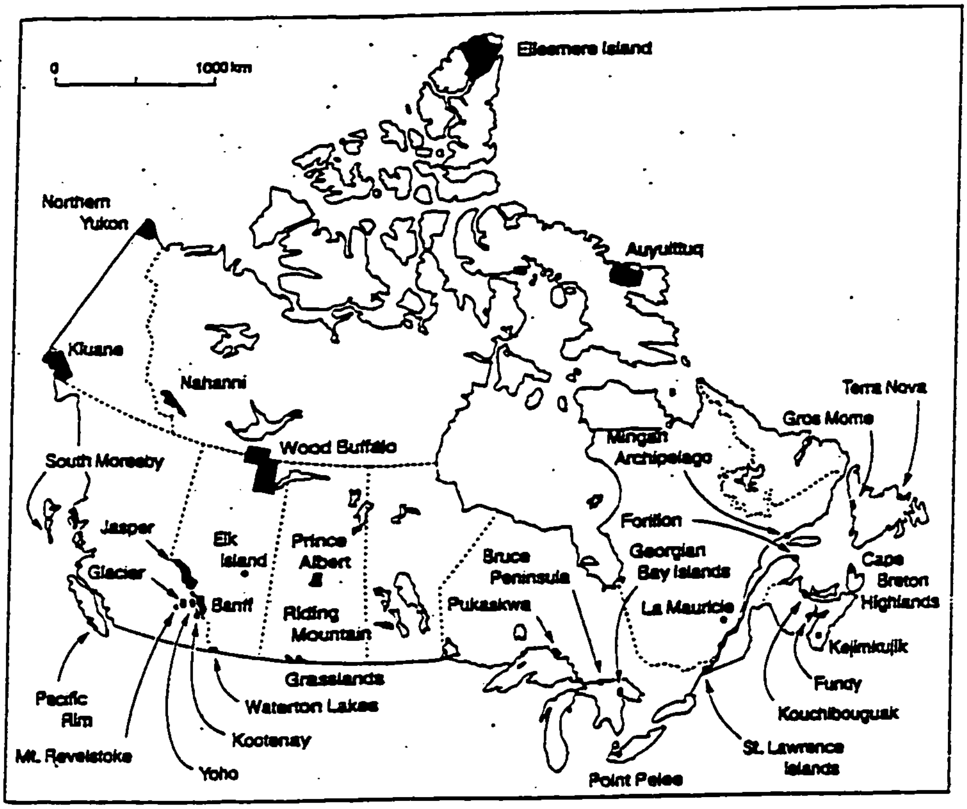
Basis for Comparison	Traditional Resource Management	Ecosystem Management
1. Central Goal	Manage/extract individual resource or target species	Maintain long-term viability of natural processes
2. Management Unit	Arbitrary or based on political/ administrative boundaries	Based on biophysical relationships; consideration to socioeconomic similarities
3. Knowledge	Failure to acknowledge the limitations of scientific knowledge or the value of local or experiential knowledge	Limitations acknowledged; local knowledge/input encouraged
4. Taxonomic Bias	Higher vertebrates; species with commercial value	All organisms
5. Management Institutions	Arranged around arbitrary management units; competition among agencies	Changes in institutional structure; interagency cooperation
6. Beneficiaries of Management	Primarily human consumers	All species including humans
7. Values	Primarily extrinsic and anthropocentric	Both extrinsic and intrinsic; ecocentric

Source: Grumbine (1990); Slocombe (1993)

areas is the loss of biodiversity. Uncontrolled growth has created a situation in which parks and protected areas represent the only habitat available for some species. The majority of these parks and protected areas are not large enough to support viable populations of many large species (see Figure 2); hence the threat to biodiversity.

To better understand the changing nature of national parks management in Canada, a

Figure 2: National Parks in Canada and Area Required for Large Mammals (a)



		Area Required to Maintain Population of:		
	Home Range	50	500	2000
Grizzly Bear	60 sq. km (b)			
Wolf	100 sq. km (c)			

Note: 3 new parks, Vuntut (Yukon), North Baffin Island (Baffin Island) and Aulavik (Banks Island) have been established since this map was produced

Sources: (a) map: McNamee, 1993
(b) calculated from data provided in Grumbine (1992)
(c) Theberge (1993) (Western Canada populations)

review of the history of national parks in Canada is provided below. This is followed by a discussion of external threats, a significant current issue for parks management and one which has direct implications for ecosystem management in national parks.

A History of Canada's National Parks

Canada's first national parks, established in the late 1800's and the early 1900's in the mountains of Alberta and British Columbia included Rocky Mountain Park (Banff), Yoho, Glacier, and Waterton Lakes. The primary motive for establishing these early parks, according to McNamee (1993) was commercial; human recreation was a secondary concern. Resource extraction and tourism were the focus of commercial development. This began to change throughout the term of James B. Harkin, who was the chief civil servant in charge of parks from 1911 to 1936 (McNamee, 1993). In 1930 the National Parks Act was passed prohibiting resource extraction and dedicating the national parks to 'the people of Canada for their benefit, education and enjoyment '(McNamee, 1993). The commercial focus remained, but had switched from resource extraction to tourism. Some park boundaries were also changed to exclude areas containing valuable resources (McNamee, 1993).

Few significant changes occurred in the park system from the 1930's to the 1960's. In fact, only two new parks were added from 1936 to 1968: Fundy National Park in New Brunswick (1948) and Terra Nova National Park in Newfoundland (1957)(McNamee, 1993). However, the growing environmental awareness of the 1960's brought with it a demand for more parks and for less industrial and recreational development (McNamee, 1993). The National Parks Policy that was established in 1964 and revised in 1979 reflected these changing values and called for greater preservation initiatives, primary consideration for the maintenance of ecological integrity, and increased public consultation on matters related to national parks (McNamee, 1993).

The 1970's saw several significant changes to parks policy which were reflected in the process to create Gros Morne National Park. Local people no longer had their land forcefully expropriated nor were they forced to relocate. There was greater community involvement in park establishment and resource extraction activities were once again allowed within parks, but on a scale far smaller than had previously been the case (McNamee, 1993).

The growing problem of threats to the ecological integrity of the parks as a result of developments outside its borders was recognized in a 1987 Canadian Parks Service report (McNamee, 1993). This resulted in an amendment to the National Parks Act in 1988. According to McNamee, this amendment "...compels the government to act against threats to park resources that emanate from areas outside the parks" (McNamee, 1993:40). Throughout the late 1980's public concern over the state of the parks increased, as reflected by the launch of the Endangered Spaces Campaign by World Wildlife Fund Canada and the Canadian Parks and Wilderness Society in 1989 (McNamee, 1993).

Despite the tremendous growth in new parks establishment over the last 25 years, the amount of land set aside for national parks in Canada is still only about 2 percent of the total land area (McNamee, 1993), far below the 12 percent recommended by the World Commission on Environment and Development (WCED, 1987). However, this brief review of the history of Canada's national parks has revealed some encouraging trends. There has been a move from parks as agents of commercial activity, to parks as areas for human recreation and then beyond this primarily anthropocentric view to one based on ecological integrity. The evolution of parks policy on resource extraction has moved from a policy encouraging large scale extraction to complete prohibition to limited extraction, basically for subsistence purposes. The relative influence of outside interests on park activities has changed -- entrepeneurs have less influence, while environmental and aboriginal groups enjoy greater influence (Dearden and Rollins, 1993) -- and the call for more cooperation between groups has increased. Finally, there has been a move from an emphasis on internal threats to an emphasis on external threats. This may be as much a reflection of increasing intensity of external development activity as it is a reflection of improved understanding and awareness.

A review of Parks Canada's (1994) recent document Guiding Principles and Operational Policies illustrates the current state of parks management in Canada. It highlights many of the changes noted above and reflects many of the ecosystem management principles discussed earlier. Table 4 presents a comparison of the ten guiding principles for Parks Canada and the ecosystem management principles laid out in Table 2. The overall objective of the National Parks system, "[t]o protect for all time representative natural areas of Canadian significance ... so as to leave it unimpaired for future generations" (Parks Canada, 1994: 25) is also similar to the overall goal of ecosystem management, maintenance of ecological integrity. The management of national parks, then, appears to be moving toward the philosophy of ecosystem management.

Table 4: Parks Canada Guiding Principles and Ecosystem Management Principles

Parks Canada Guiding Principle	Related Ecosystem Management Theme
1. Ecological and Commemorative Integrity	Ecological Integrity
2. Leadership and Stewardship	Humans as Part of Nature Values Interagency Cooperation
3. New Protected Heritage Areas	Interagency Cooperation
4. Education and Presentation	Humans as Part of Nature Values
5. Human-Environment Relationship	Humans as Part of Nature
6. Research and Science	Hierarchical Context Ecological Integrity Data Collection Monitoring Interagency Cooperation
7. Appropriate Visitor Activities	Ecological Integrity
8. Public Involvement	Interagency Cooperation
9. Collaboration and Cooperation	Organizational Change Interagency Cooperation
10. Accountability	None

Note: The discussion following each principle in the Parks Canada document was reviewed for key words, phrases, or ideas that indicated correspondence with an ecosystem management theme.

Source: Parks Canada (1994)

The two ecosystem management themes that are not explicitly represented in the Parks Canada document are ecological boundaries and adaptive management. The idea of ecological boundaries is suggested in a later section of the document dealing with ecosystem protection and ecosystem-based management (Parks Canada, 1994). However, the ideas embodied by adaptive management are not apparent in the document. Although the value of local knowledge is acknowledged, there is a strong emphasis on the "...rigorous application of science..." (Parks Canada, 1994:33) : "Ecosystem management must be credible and therefore solidly based in science" (Parks Canada, 1994:33). While the importance of science is recognized, it should be balanced by the recognition that science may not provide a perfect understanding of complex natural and social systems. This recognition, which is the basis of adaptive management, appears to be missing.

External Threats

As noted above, the environment in which Canada's national parks operate is becoming increasingly complex. The growing number and intensity of the interdependencies between national parks and other organizations and the increasing recognition of the complexity of the scientific questions addressed in national parks, makes it difficult for parks to control their own affairs or to predict in any reliable way the outcome of their actions. This is an illustration of Trist's (1980) notion of turbulence. He suggested that the key to operating in a turbulent environment is cooperation and adaptation. The growing concern over external threats to the integrity of parks' natural processes may be attributed in part to this increasingly complex environment.

According to an international study carried out by Machlis and Tichnell (1985), external threats represent a significant proportion of total threats, as reported by national park managers: 35 percent of all threats originated both inside and outside park boundaries, 24 percent entirely outside, and 34 percent entirely inside. The most commonly reported threats included illegal removal of animal life, lack of personnel, removal of vegetation, erosion, local attitudes, conflicting demands, fire, human harassment, loss of habitat, and trampling (Machlis and Tichnell, 1985). Clearly, several of these originate at least partly outside park boundaries.

In Parks Canada's State of the Parks 1994 Report, 53 percent of all ecological stressors originated both inside and outside park borders, 36 percent originated entirely outside, and 11 percent originated entirely inside (Parks Canada, 1995a). The major external threats were related to resource extraction activities: forestry, agriculture, sport hunting, and mining (Parks Canada, 1995a). Major threats originating both inside and outside included visitor and tourism facilities, exotic vegetation, utility corridors, urbanization, dams, and exotic mammals (Parks Canada, 1995a). Park management practices were cited as the most common internal threat (Parks Canada, 1995a). In addition, 38 percent of threats to national parks were acting on an area greater than 10,000 square kilometers, and more than 50 percent over 100 square kilometers, suggesting that many threats are non-local and that a larger perspective is required (Parks Canada, 1995a). Finally, 43 percent of threats were thought to be increasing versus 29 percent that were considered to be decreasing (Parks Canada, 1995a).

Freemuth (1991:143) noted that the "...external threats issue is a problem of competing values" and suggested that ecosystem management is one approach to dealing with such threats. The Greater Park Ecosystem concept may be seen as an attempt to deal with external threats and to implement ecosystem management in the region.

Greater Park Ecosystems and Ecosystem Boundary Delineation

A Greater Park Ecosystem may be defined as a region, centered on the park, that serves as a unit of cooperative management with the maintenance of ecological integrity as its overriding objective. The idea may be considered a compromise made necessary by the inability to set aside in strictly protected core reserves the amount of habitat required for minimum viable populations of many large mammals. On the other hand, it represents an opportunity to establish a region whose boundaries more faithfully conform to protected area design principles. Although the Greater Park Ecosystem concept has been widely discussed, there is no generally accepted approach for delineating the boundaries of such a region. Indeed, there is no consensus as to how to define or delineate the boundaries of an ecosystem, generally.

This section will provide a brief review of the literature on protected area design, including ecological and sociopolitical/institutional aspects. It will describe several approaches to ecosystem delineation, which may or may not be appropriate for the design of protected areas. Two of the approaches described are directed specifically to Greater Park Ecosystems.

Ecological Foundations of Protected Area Design

It has been emphasized several times in previous sections that human efforts to acquire knowledge about the workings of the natural world, including those based on science, are inherently limited. Perfect understanding is unattainable. Nevertheless, it is imperative that the knowledge and understanding that has been have acquired, however imperfect or incomplete, be utilized within an adaptive management framework to manage resources in a sustainable way.

This section will review some of the ecological concepts relevant to national park management, and particularly to the design of parks and protected areas and the boundary definition process. The review will focus primarily on the conservation biology literature since that discipline represents the scientific foundation of ecosystem management and has published widely on protected area design.

Island Biogeography: The theory of island biogeography was developed in the 1960's by Robert MacArthur and E. O. Wilson (Shafer, 1990). It suggested that the number of species on an island represented an equilibrium between extinction and immigration, which are in turn determined in part by the distance between the island and a source of colonization. In theory, a large island will have a lower rate of extinction than a smaller island, and all else being equal, will support a larger number of species. Similarly, an island close to a source of colonization will have greater immigration potential than one farther away, and will likewise support a higher population.

Although there have been concerns about empirical support for this theory (Shafer, 1990), it has been widely discussed over the past 25-30 years, particularly in relation to the design of nature reserves, which are becoming more island-like as a result of development around their borders. This theory suggests that larger parks and protected areas will have a lower extinction rate and will support a larger number of species. It also suggests that a system of nature reserves that minimizes the distance between protected areas or that allows for dispersal corridors between protected areas will reduce the possibility of extinction for an individual reserve by increasing immigration potential.

Minimum Viable Population: This concept was noted above in the discussion of the specific goals of ecosystem management. It has been defined by Soule (1987) as the population that ensures "...the survival of a population in a state that maintains its vigor and its potential for evolutionary adaptation." The following questions must be answered to calculate a minimum viable population estimate (Shaffer, 1987):

1. how much space is required by each individual of the most space-demanding species in an area (ie. its home range)?

2. what is the minimum number of individuals required to maintain the probability of extinction at an acceptable level over an acceptable period of time.

Information on the first is readily available or can be relatively easily obtained through research. The second requires value judgements as to what constitutes 'acceptable', as well as determination of a probability of extinction, the latter being somewhat conducive to scientific measurement (Shaffer, 1987). This measurement in turn is based on different types of uncertainty including genetic, demographic, environmental, and catastrophic

(Shaffer, 1987; Grumbine, 1992). These four factors are considered to have an impact on extinction rates.

Although the above calculations must be species- and situation-specific, some general rules of thumb have been proposed. To prevent extinction due to chance genetic events, a population should have less than 1 percent inbreeding per generation (Franklin, 1980, cited in Theberge, 1993; Soule, 1980, cited in Theberge, 1993). Based on mathematical calculations, this works out to a breeding population of approximately 50 individuals (Franklin, 1980, cited in Theberge, 1993; Soule, 1980, cited in Theberge, 1993). Grumbine (1992) suggested that this provides a degree of short-term assurance. For longer term security, an estimate of 500 has been suggested, and when non-breeding individuals and other types of uncertainty are factored in, it may be 2000 or more (Grumbine, 1992). These numbers were put in perspective in the context of Canadian protected area size in Figure 2.

The concept of minimum viable population has great significance for the design of nature reserves and for the approach to management of all natural resources in areas surrounding these reserves. Rapidly increasing human population, resource use and development have contributed to the degradation, destruction, and fragmentation of wildlife habitat. The speed at which these processes are occurring makes adaptation by wildlife populations impossible (Soule, 1987). As a result, nature reserves may come to represent the only habitat available for some species. Knowledge of minimum viable population sizes, and the area required to support them can guide park planners and other resource managers in designing appropriate systems of nature reserves, including, where necessary, larger regions of cooperative management.

Habitat Fragmentation: Habitat destruction, resulting from expanding population and development, is considered to be the primary cause of species extinction, particularly in the last two hundred years (Ehrlich, 1988; Wilson, 1992). Shafer (1990) provided several illustrations of how this destruction has severely fragmented the landscape, creating tens or hundreds of small landscape patches from a single large patch. There remains much uncertainty as to how such fragmentation affects the variety of species and ecosystems within an area, but it is generally agreed that as these habitat fragments get smaller and more dispersed, extinction of both species and whole ecosystems increases.

An understanding of the dynamics of these habitat patches, which may be derived in part from island biogeography theory, is necessary to guide decisions regarding the size, number, shape, and distribution of protected areas throughout the landscape. Competing land uses, and growing population and development, increasingly limit the design choices that can be made. Suggestions for reserve designs that include a highly protected core and less restricted surrounding areas, buffer zones, and local and regional corridors connecting reserves represent attempts to work within these limitations (Shafer, 1990; Meffe and Carroll, 1994). Theoretically, such a design should help overcome problems related to diminishing reserve size and increasing dispersion, and accommodate a variety of habitat types, including deep forest, open space, edge habitat, and various combinations of these.

This concept is similar to that used in UNESCO Man and the Biosphere Program's biosphere reserves (Slocombe, 1992).

Significant Species: A significant species is one which may be used to represent a group of species or an ecosystem, is particularly crucial in maintaining ecosystem processes, or provides early indications of disturbance. Several types have been discussed.

Keystone species are commonly used as representatives of an ecosystem. According to Mills et. al., (1993:219) keystone species are those whose "...presence is crucial to maintaining the organization and diversity of their ecological communities" and that are "...exceptional, relative to the rest of the community, in their importance". Summit predators, major vegetation influencers, certain important plant hosts, and species that significantly modify their environment, such as the beaver, are commonly-cited examples of keystone species. Mills et. al. (1993) acknowledged that the term is poorly understood and often misused and that the term may be habitat as well as species-specific.

An indicator species is one whose narrow tolerance to environmental change makes it useful as an indicator of such change (Hunter, 1990). The term "miners' canary" reflects the meaning of the indicator species concept.

Flagship species is a term used for large, conspicuous animals with extensive home ranges and fairly broad habitat needs (Hunter, 1990). They are often highly visible, popular species such as the tiger or grizzly bear which are used to garner support for conservation efforts.

Other types of species which may be considered significant include those that are vulnerable because of biological characteristics, because their numbers are low or because their habitat is severely endangered (Theberge, 1994). Examples include rare species, habitat specialists, species that have low reproductive capability, are susceptible to pollution, are space-demanding, are seasonally concentrating, have limited powers of dispersal, and range edge species (Theberge, 1989; Theberge, 1994).

One of the specific goals of ecosystem management is the maintenance of minimum viable populations of all native species. However, as Wilcove and Blair (1995) point out, it is not possible to assess the viability of all species in an ecosystem. In the design of protected areas choices have to be made as to which species are significant. The species discussed above, and their habitat needs, may provide a focus for protected area design. Because they are designated as significant species, protection of their habitat should contribute to the protection of the entire ecosystem. The above discussion covers a broad range of species, so it is important to consider species which have a significant combination of these characteristics.

In addition to these general ecological concepts, Table 5 lists several more specific guidelines for drawing ecologically sound boundaries.

Sociopolitical/Institutional Considerations in Protected Area Design

There are suggestions in some of the literature that protected areas should be designed on the basis of ecological considerations only. However, there is a literature, albeit scarce compared to that dealing with ecological considerations, which suggests that

Table 5: Guidelines for Drawing Ecologically Sound Boundaries for National Parks and Nature Reserves	
Abiotic	**Objective: To maintain hydrologic-geologic regimes** 1. Boundaries should severe drainage areas as little as possible. 2. Boundaries should not leave out headwater areas. 3. Boundaries should consider subsurface trans-basin water flow. 4. Boundaries should not cross active terrain (i.e. slopes subject to mass wasting or fluvial erosion, upwind surface material susceptible to wind erosion, and land forms, slopes and other processes operating with change at human time scales). 5. Boundaries should include and not threaten rare geomorphic and hydrologic features and processes.
Biotic	**Objective: To prevent loss of natural species diversity** 6. No rare or unique community should be severed with a boundary. 7. Boundaries should not sever highly diverse communities, especially wetlands, ecotones, riparian zones, lakes or coastal zones. 8. Boundaries should not sever communities with a high proportion of dependent faunal species. 9. Boundaries should not jeopardize the ecological requirements of either numerically rare or distributionally rare (uncommon) species. 10. Boundaries should not jeopardize the ecological requirements of niche specialists. 11. Boundaries should not jeopardize populations of spatially vulnerable species: those which migrate locally, are space-demanding, seasonally concentrating, or limited in dispersal. 12. Boundaries should not jeopardize populations of K-selected species (low reproductive species). 13. Boundaries should not jeopardize populations of range-edge or disjunct species. 14. Boundaries should take into account pollution-susceptible species. 15. Boundary delineation should take into account the ecological requirements of ungulate species.
Cultural	**Objective: To incorporate human beings into the park ecology** 16. Attention should be paid to nodes of human activity, especially ones where land use is increasing or plans and/or policies are in place to further increase land use activities. 17. Attention should be paid to corridors of human activity, especially corridors where land use is increasing or plans and/or policies are in place to further increase land use activities. 18. Attention should be given to areas of cultural significance. At least one sample of all significant cultural themes should be included in a park. Special attention should be given to including sites that help park users and visitors understand the impacts of human beings on the environment. 19. Attention should be paid to tension and conflict zones (cultural constraints). It may be felt that competing land uses or large scale, rapid, and controversial land use changes may best be managed outside a national park. If so, an understanding is needed of institutional arrangements operating outside current park boundaries to put them into the context of greater ecosystem planning for a national park.
Source: Theberge (1989),Skibicki (1995a)	

sociopolitical/institutional considerations are equally important. It does not suggest that provincial, state, or national governments set protected area boundaries on an ad hoc political basis, as is often the case in practice. It does argue that local individuals, groups, and institutions should be involved in this process, that their understanding of the people and the land and the interactions between the two can be a valuable contribution to the boundary delineation process, and that local involvement at all stages from planning and design to ongoing management of the protected area reduces conflict and enhances the ability of protected area managers to achieve their objectives. Some of this literature is discussed below.

Garratt (1984:66) echoed the above sentiments when he called for "...programmes of public participation and education [in the] selection of new protected areas [as well as the] management of existing protected areas." Chambers (1991:8, cited in Pimbert and Pretty, 1995:30) suggested that education should be a reciprocal process, allowing "...insight less from 'our' often out of date knowledge in books and lectures, and more from 'their' knowledge of their livelihoods and conditions which is always up-to-date ... not standing, lecturing and motivating, but sitting, listening and learning." The need to involve local people in the design of protected areas was also noted in Lucas (1992) for a specific class of protected area known as a protected landscape, in Colchester (1994) in relation to local indigenous peoples, and in the literature on bioregionalism: "... the final boundaries [of a bioregion] are best described by people who have lived within it" (Berg, 1977, cited in Parsons, 1985:2).

The participatory approach to protected area design may also be extended from local individuals, groups, and communities, to resource management institutions and agencies, and other resource interests. The need for greater cooperation across administrative boundaries and institutional jurisdictions was noted earlier in the discussion of ecosystem management and national parks management, and will not be repeated here. Although that discussion was in reference to the management process, it should also apply to the design of the management units, in this case protected areas, to which the management process will be applied.

In delineating the boundaries of a Greater Park Ecosystem, these ecological and sociopolitical/institutional aspects of protected area design should be kept in mind. Guidance may also come from one or more of the many approaches to ecosystem definition that have been used in the past. A discussion of these follows.

Survey of Previous Ecosystem Definition Efforts

Since Tansley coined the term in 1935 there has been much debate about what constitutes an ecosystem. Although it is generally agreed that an ecosystem contains all the abiotic, biotic, and (sometimes) cultural components within its boundaries, along with the interrelationships among these components and the components of the input and output environments, a more concrete definition remains elusive.

Delineation of ecosystem boundaries has proven to be at least as difficult as defining the term ecosystem. In the real world, specific, well-defined boundaries between ecosystems do not exist. Nevertheless, effective management of resources, including national parks, requires a division of land into management units. Ecosystem management suggests that these management units should approximate ecosystems. Several approaches to ecosystem boundary delineation have been developed, including some specific to national parks. Some of these approaches are discussed below.

1. Watershed. Watersheds are commonly used to describe ecosystem boundaries. Theberge (1989:695), speaking specifically in reference to national parks, noted: "...the principal abiotic objective in boundary delineation should be to maintain drainage basin integrity." Watersheds are relatively easy to describe, and the significance of water as a resource for living things and as an agent which shapes the land, helps to explain its widespread use in ecosystem definition. However, Bailey (1996) noted several problems with using watersheds to define ecosystem boundaries: (1) some areas do not have clearly defined drainage networks, (2) a watershed is usually defined by surface water drainage, which may not coincide with groundwater drainage, and (3) single watersheds may contain diverse climates, soils, landforms, vegetation, or other biophysical characteristics.

One of the earliest and most widely cited attempts to study ecosystem processes and ecosystem development was the Hubbard Brook Ecosystem Study in New Hampshire which began in 1963 (Bormann and Likens, 1994; Bocking, 1994). Bormann and Likens defined their study area, their ecosystem, by the boundaries of the watershed.

Watersheds remain widely used as a basis for defining a unit of study and analysis, a management unit, or an ecosystem. Hornbeck and Swank (1992), in their discussion of multiple use forest management, used watershed boundaries to define their ecosystem.

Montgomery et. al. (1995) defined their management unit as the watershed in their discussion of ecosystem management. Clearly, ecosystems defined by watershed boundaries can vary greatly in size depending on the size of the river or water body whose watershed is being described.

A special case of the watershed basis for ecosystem definition has been the Great Lakes Ecosystem, defined to include all the land which drains into the Great Lakes and the lakes themselves (Caldwell, 1988). It is defined not by a single river, but by a group of large lakes. The significance of the Great Lakes to the many large population centres along its shores and the serious environmental problems associated with the lakes have provided the impetus for efforts to more effectively manage, and thus establish boundaries for, this region. Although the Great Lakes Ecosystem comprises an area much larger than that normally associated with a watershed-based ecosystem it, like the previous examples is defined by a naturally occurring physical feature.

*2. **Bioregions and Bioregionalism.*** Bioregionalism is a growing cultural movement which endorses a philosophy characterized by living within and respecting natural limits, autonomous living, and the use of natural boundaries separating regions. A bioregion is defined by biophysical similarities -- climate, soils, geology, vegetation -- and cultural similarities. To distinguish it from other attempts to define ecosystems, Berg (1977) (cited in Parsons, 1985:2) described it as follows:

> "The term bioregion refers both to a geographical terrain and to a 'terrain of consciousness' -- to a place and the ideas that have developed about how to live in that place. A bioregion can be determined initially by use of climatology, physiography, animal and plant geography, natural history, and other descriptive natural sciences, [but] the final boundaries are best described by people who have lived within it."

Although watersheds are sometimes used to define a bioregion (Parsons, 1985), they may also be used simply as an initial approximation of a bioregion (Aberley, 1993a). Several attempts to map bioregion boundaries have been made, particularly in western North America where the high mountain ranges and deep valleys create well-defined natural boundaries. McCloskey (1993) created a map of Cascadia, a bioregion extending from Washington State to southern Alaska. A Northern California Bioregion was described and discussed in Berg (1978). Aberley (1993b) illustrated the process of mapping a bioregion using an area of northwest British Columbia. A wide range of abiotic (watersheds, physiography, climate, geology), biotic (vegetation, wildlife, ecoregions), and cultural (current and historic political boundaries, current landuse, aboriginal territories, special places) characteristics were integrated to produce a final bioregion map (Aberley, 1993b).

The term bioregion has also been used to describe the Greater Metropolitan Toronto area (Crombie, 1992). This primarily urban bioregion is defined in terms of natural, physical structures and the urban communities of metropolitan Toronto and surrounding region. The defining natural features include the Oak Ridges moraine to the north and east of metropolitan Toronto, the Niagara Escarpment to the west, and Lake Ontario to the south (Crombie, 1990). Although most uses of the term ecosystem bring to mind the interplay of natural, biophysical components, the human communities of this ecosystem dominate the landscape and are considered an integral component of it. Although it may be argued that the Greater Toronto Bioregion does not, in many ways, embody the bioregional philosophy, the description of the region as "... our home -- the ecosystem in which we live, work, and play" (Crombie, 1990:22) does bring this philosophy to mind.

3. Ecological Land Classification. A term that is sometimes used interchangeably with bioregion is ecoregion. However, as they are used here, the terms have very different meanings. Ecoregions are generally associated with a process of ecological land classification, which, according to Sims, et al. (1996) is "...the scientific endeavour that, for various management purposes, permits the organization and stratification of ecosystems and ecosystem complexes." Sims, et al. (1996) described it as a "... combination of science and art..." The process was also described as hierarchical, with ecoregions representing but one hierarchical level. Although the specific terms vary among users, Sims, et al. (1996) described the successively divided hierarchical levels using the terms ecozones, ecoregions, ecoprovinces, and ecodistricts.

The objectives of this process differ little from other attempts to describe ecosystems; however, the process itself is more structured and comprehensive. The classification is generally based on biophysical characteristics such as climate, physiography, vegetation, soil, water, and fauna (Marshall, et al., 1996). However, Rowe (1996) recognized the need for a more explicit consideration of values and attitudes in ecological land classification.

Udvardy's (1975) classification of the biogeographical provinces of the world is a widely cited example of ecological land classification. It differs from that described by Sims, et al. (1996) in that it focuses more on differences and similarities in flora and fauna and less on other abiotic features of the environment. Udvardy's (1975) biogeographical provinces are, however similar in extent to Sims, et al's (1996) ecozones. Unlike Sims, et al. (1996), no further subdivision is provided.

Host, et al. (1996) provided another example of ecological land classification. They saw the subjectivity of many ecological land classification systems as a weakness and attempted to overcome this subjectivity with a more quantitative approach. Their approach utilized GIS capabilities and multivariate statistical analysis applied to climatic and physiographic data to devise a regional ecosystem classification for northern Wisconsin.

Bailey (1996) suggested that climate and landforms, in that order, are the primary determinants of ecosystem distribution, and as such should be used as the main criteria in defining ecosystem boundaries at the scale of hundreds of thousands to thousands of square kilometers, respectively. At local scales (ie. square kilometers), local climatic effects and soil moisture should be considered as criteria (Bailey, 1996). He also noted that present vegetation and land cover, and as noted previously, watersheds should not be used as the basis for ecosystem definition, and that all ecosystem boundaries should correspond to biological boundaries (Bailey, 1996).

4. Biosphere Reserves. Biosphere reserve is a term associated with UNESCO's Man and the Biosphere Programme which was initiated in 1968 (Batisse, 1982). The biosphere reserve designation was initially meant to be applied to a region that was set aside primarily for scientific research and monitoring (Batisse, 1982). Conservation and regional integration are now equally important aspects of the concept (Batisse, 1982; Francis, 1985). According to Canada/MAB (1987), the important functions of biosphere reserves include:

(i) to conserve biological resources,
(ii) to learn from traditional forms of land use,
(iii) to understand the effects and processes of natural and man-caused changes,
(iv) to improve management of natural resources,
(v) to share knowledge,
(vi) to promote cooperation in natural resource management and use, and
(vii) to involve local people in the management of their environment.

The design of biosphere reserves is meant to facilitate these functions. They are comprised of a stricly protected core, one or more buffer zones where specified uses are permitted, and where possible, connecting corridors linking the system of reserves (Batisse, 1982). Some biosphere reserves have been established around existing national parks (eg. Waterton Lakes/Glacier National Park, Riding Mountain National Park, Great Smoky Mountains National Park), with the park itself, or its designated wilderness zone serving as the strictly protected core of the biosphere reserve (Lieff, 1985; Canada/MAB, 1987; Francis, 1985; Batisse, 1982). Research into similar designations is continuing (eg, Kluane/Wrangell-St.Elias National Parks)(Slocombe, 1992).

There is little specific guidance in the literature on the delineation of specific boundaries for biosphere reserves. In fact, according to Canada/MAB (1987:5) "[b]iosphere reserves do not have a fixed outer boundary around the zone of cooperation." There are references to the necessary size of the reserve by Francis (1985:25) who suggested that "...the core should be of sufficient size to be a self-sustaining ecosystem with regard to the particular components which are judged to make it representative." Batisse (1982) suggested that the reserve should be large enough to support a minimum viable population of all native species.

Regarding the process of reserve design, the importance of local involvement in reserve establishment and management and the importanec of interagency cooperation is a central feature of the biosphere reserve model.

5. The Greater Yellowstone Ecosystem. As previously noted, in recent years national parks across North America have demonstrated a concern about the impacts on the park of incompatible activities outside the park boundaries (Buechner et.al., 1992). In an effort to better understand cross-boundary issues, attempts have been made to define, for purposes of subsequent research and management, ecosystems of which these parks are part (Theberge, 1994; Wilcove and May, 1986; Newmark, 1985).

In Yellowstone National Park, the concept of a Greater Yellowstone Ecosystem (GYE) grew out of a concern that the area enclosed by the park did not constitute an entire ecosystem and that the area was not large enough to protect populations of wide-ranging mammals such as the grizzly bear (Grumbine, 1994a). Although the concept of a Greater Yellowstone Ecosystem has been studied for years, a well-defined, broadly accepted boundary has been elusive. The GYE is widely accepted to include "the high mountainous region centered around Yellowstone National Park and surrounded by dry regions" (Congressional Research Service, 1986, cited in Clark and Zaunbrecher, 1987). It is also generally agreed that it includes two National Parks (Yellowstone and Grand Teton), seven National Forests, three National Wildlife Refuges, and other public and private lands (Clark and Zaunbrecher, 1987; Reading et.al., 1994). Furthermore, it is assumed to be large enough to support a minimum viable population of grizzly bears. As noted above, this was a major impetus to research and interest in the GYE concept. However, estimates of the size of the GYE still vary widely -- from 14 million acres (Clark and Zaunbrecher, 1987) to 18 million acres (Rasker, 1993) to 19 million acres (Lichtman and Clark, 1994) among other estimates.

The boundary definition process at Yellowstone uses a combination of well-defined physical features and existing administrative boundaries. The choice of features and existing boundaries is directed, in part, by the requirement that the GYE contain sufficient habitat for a viable population of grizzly bears. Although the need to establish natural boundaries for the GYE is acknowledged (Clark and Zaunbrecher, 1987) and attempts to do so continue, the Yellowstone experience illustrates the difficulty in defining such a boundary.

6. The ABC Resource Survey Approach (The Greater Pukaskwa Ecosystem). The ABC Resource Survey approach, developed at the University of Waterloo, presents a methodology for gathering and organizing abiotic, biotic, and cultural information about a region so as to improve decisions regarding land use and management. It has been applied in identifying and describing environmentally significant areas (Smith et al., 1986, cited in Skibicki, 1995b), in assessing coastal regions subject to major land use change (Nelson et al., 1991, cited in Skibicki, 1995b), and in the planning and management of national parks and surrounding regions (Forbes et al., 1989; Skibicki, 1995a; Skibicki, 1995b). The following description of the ABC Resource Survey Method, and its evaluation in the following chapter will be based on its application to Pukaskwa National Park and surrounding region (Skibicki, 1995a; Skibicki, 1995b).

The ABC Resource Survey Approach was used to carry out a preliminary boundary analysis for Pukaskwa National Park in Ontario. Under this approach, structural and functional components of the abiotic, biotic, and cultural environments were examined and mapped. These maps were used to locate areas of significance and areas of constraints, and in conjunction with a set of guidelines for drawing ecologically sound boundaries (Table 5), a preliminary boundary for a Greater Pukaskwa Ecosystem was determined (Skibicki, 1995a).

In a follow-up study (Skibicki, 1995b), this resource survey exercise was extended to include the entire area from Pukaskwa National Park to Lake Superior Provincial Park. This latter report in particular highlighted the importance of greater cooperation between the various stakeholders in the region, greater sharing of knowledge about the region, and greater local involvement (Skibicki, 1995b)

This discussion highlighted the complex dynamics of protected area design and underlined the notion that there is no single generally accepted way to define the boundaries of an ecosystem generally, or a Greater Park Ecosystem, in particular. Several alternative approaches were presented and will be analyzed in more detail in Chapter 3. Nevertheless establishing appropriate boundaries remains one of the most significant challenges to effective implementation of ecosystem management.

Challenges to Implementation

As suggested previously, the term ecosystem management is increasingly used in the formulation of resource management policy, and is being applied to a broad range of resource management activities. However, in practice, these applications are not always consistent with ecosystem management as defined above. There remains a gap between the theory of ecosystem management and its practical implementation. Narrowing this gap will require that certain challenges be dealt with. These challenges are discussed below with particular reference to national parks and the application of ecosystem management through the Greater Park Ecosystem concept.

First, definition of the appropriate management unit remains a difficult issue to resolve (Slocombe, 1993). Consideration must be given to features of the physical environment, characteristics of native wildlife populations, socioeconomic parameters, and the structure of institutions in the surrounding region. This may be particularly difficult for national parks because their objectives are often very different from those of other major resource users in the region, and because the very idea of a Greater Park Ecosystem tends to arouse suspicion that the park is attempting to extend its jurisdiction beyond its official boundaries.The issue of defining appropriate boundaries for a Greater Park Ecosystem will be the focus of the remainder of this study.

Related to this is the need to change institutional structures and mandates and/or encourage increased cooperation among the many interested organizations and individuals (Slocombe, 1993; Goldstein, 1992). Again, this may be particularly difficult, but especially important for national parks because of the potential for great conflict with resource interests beyond the park boundaries.

In many regions, understanding of ecological processes and patterns is currently not adequate to provide the basis for defining an appropriate ecosystem and for managing on an ecosystem basis. Increased ecological research will help to provide this base (Slocombe, 1993; Goldstein, 1992). In addition, increased monitoring is necessary to track the effect of various activities on ecosystem integrity and to aid in further refining ecosystem boundaries (Goldstein, 1992). Because areas of 'unaltered' nature are disappearing rapidly, parks and reserves are becoming more important for the gathering of baseline data which will facilitate research into the effects of human activity beyond the park borders.

Finally, the need for a change in human attitudes and values concerning the relationship of humans to nature has been expressed by a number of authors (Grumbine, 1994a; Bell, 1994; Stanley, 1995; Gunter, 1992; Sessions, 1995; McKibben, 1989; Carson, 1962; Livingston, 1994; Rogers, 1994; Sessions, 1992). They suggest that a change from an anthropocentric to an ecocentric view of nature is required. This is a difficult challenge because such a change cannot be imposed but has to evolve within the society. Furthermore, it is necessary as the basis for political action. There is some evidence that the early stages of such a change are underway (Milbrath, 1989).

The preceding literature review has presented the conceptual background that will be used as the basis for the subsequent evaluation, development of general guidelines, and application to Gros Morne National Park. It has shown how traditional resource management has evolved into ecosystem management -- an approach characterized by greater integration, cooperation, and adaptability. It has demonstrated how the objectives and principles of ecosystem management, including both ecological (substantive) and sociopolitical/institutional (process) aspects, are reflected in recent literature on national parks management, Greater Park Ecosystems, and protected area design. This is both expected, given the common link to the conservation biology literature, and necessary, to ensure consistency between design and management of protected areas.

The Greater Park Ecosystem concept may be viewed as the application of ecosystem management to a national park. How this greater ecosystem is defined represents a difficult challenge. Guidance is provided by the literature on protected area design. Previous efforts at delineating ecosystem boundaries may also provide some direction. Some of these efforts, which were described in this chapter, will be evaluated in chapter 3.

III. EVALUATION OF ALTERNATIVE APPROACHES TO DEFINING GREATER PARK ECOSYSTEMS

In the previous chapter I examined the concept of ecosystem management and reviewed a variety of approaches to defining the boundaries of an ecosystem. In this chapter an evaluation of selected approaches to ecosystem definition will be carried out and a set of guidelines for defining Greater Park Ecosystems will be developed.

The criteria chosen to evaluate these approaches will reflect my objectives -- the alternatives will be evaluated on the basis of how well they help to achieve these objectives. My first objective in defining an ecosystem boundary is to describe a management unit or units on which a new management strategy can be implemented. My second objective is to apply this idea specifically to national parks and surrounding areas in order to assist the park in meeting its objectives and to protect it from external threats -- in other words, to define the boundaries of a Greater Park Ecosystem whose core will be the national park itself. With the foregoing in mind, the criteria chosen to evaluate the alternatives will be consistent with the principles of ecosystem management and national park management (See Table 6), and by doing so, they will also reflect the principles of protected area design.

The guidelines for defining Greater Park Ecosystems likewise will be derived from the objectives and principles of ecosystem management and national parks management. The following analysis of the strengths and weaknesses of the alternatives will be used in developing the guidelines. Again, consideration will be given to protected area design

Table 6: Objectives and Principles of Ecosystem Management and National Parks Management

Ecosystem Management

Objectives:

Primary Objective: Maintenance of Ecological Integrity
Specific Goals:
1. Maintain viable populations of all native species in situ
2. Represent, within protected areas, all native ecosystem types across their natural range of variation
3. Maintain evolutionary and ecological processes
4. Manage over periods of time long enough to maintain the evolutionary potential of species/ecosystems
5. Accommodate human use and occupancy within these constraints

Principles:
1. Hierarchical Context
2. Ecological Boundaries
3. Ecological Integrity
4. Data Collection
5. Monitoring
6. Interagency Cooperation
7. Organizational Change
8. Adaptive Management
9. Humans as Part of Nature
10. Values

National Parks Management

Objective:

Primary Objective:
To protect for all time representative natural areas of Canadian significance in a system of national parks, and to encourage public understanding, appreciation, and enjoyment of this natural heritage so as to leave it unimpaired for future generations.

Principles:
1. Ecological and Commemorative Integrity
2. Leadership and Stewardship
3. New Protected Heritage Areas
4. Education and Presentation
5. Human-Environment Relationship
6. Research and Science
7. Appropriate Visitor Activities
8. Public Involvement
9. Collaboration and Cooperation
10. Accountability

Source: Grumbine (1994a), Parks Canada (1994) principles (eg., island biogeography theory, minimum viable populations, habitat fragmentation, significant species).

The discussion of each criterion will include a brief explanation, a reference to ecosystem management and/or national parks management principles where applicable, and a comment on the types of evidence used as a basis for the evaluation. The evaluation criteria and the point system are described below.

Evaluation Criteria

1. Are abiotic, biotic, and cultural components of the environment, and the interrelationships among them considered as part of the boundary definition process?

This criterion reflects the need to examine spatially, significant components of the region, and to acknowledge the interrelationships of all components, even where only one or several representative components may be used to define ecosystem boundaries. It is consistent with the emphasis on integration that is fundamental to ecosystem management. The inclusion of cultural components reflects the view that humans are part of nature and not separate from it.

Whether abiotic, biotic, or cultural components are used in the definition of ecosystem boundaries should be readily apparent from a review of the boundary description or the process by which it is determined. Evidence of the integration of several components will require some judgment. For example, consideration of the interrelationships between abiotic, biotic, and cultural components, and the implications of these for boundary placement purposes might suggest an integrative approach.

2. Is the preservation of ecological integrity considered in the boundary definition process?

I am accepting Grumbine's (1994a) assertion that preservation of ecological integrity requires that an area be large enough to support a minimum viable population of the most space-demanding species in the area and that it be capable of maintaining evolutionary and ecological processes. This is fundamental to ecosystem management and to national parks management in Canada (Grumbine, 1994a; Parks Canada, 1994).

Although the concept of ecological integrity, like ecosystem management itself, is poorly defined, its basic premises are integral to many ecosystem definition approaches. Evidence to be used in the evaluation of this criterion includes, apart from explicit acknowledgment, considerations of the minimum size of the ecosystem in relation to wide-ranging species, and consideration of abiotic, biotic, and cultural components and of the patterns and processes that tie them together.

3. Are the boundaries themselves ecologically based?

This criterion suggests that boundaries should be based on mountain ranges, valleys, climate zones, identified animal habitat, geological zones or other natural features of the environment. In other words, the boundaries should be ecologically based. This represents one of the principles of ecosystem management (Grumbine, 1994a) and is also emphasized in Parks Canada's Guiding Principles and Operational Policies document (Parks Canada, 1994).

Evaluation should be relatively straightforward. The use of natural features to represent ecosystem boundaries should be readily apparent. Guidance may also be provided by Theberge (1989) and Skibicki (1995a) who present a set of guidelines for drawing ecologically sound boundaries for parks and reserves (Table 5). Theberge (1989) suggests that due to conflicting land uses, natural boundaries can seldom be used exclusively in setting park boundaries. The less restrictive nature of Greater Park Ecosystems, in relation to the park proper, may allow greater use of natural boundaries and more adherence to these guidelines.

4. Is there a balance between scientific or professional expertise and local knowledge/participation in the boundary determination process?

As has already been acknowledged, there are no precise boundaries between ecosystems in the real world. No amount of scientific or professional expertise can identify precisely that which does not exist precisely. Science can provide a base of knowledge and understanding that can allow us to distinguish regions from each other on some rational basis. This should be supplemented by the knowledge, understanding, and values of those with a history of habitation in the area. This is consistent with that aspect of ecosystem management which calls for a move toward a community focus and also that which emphasizes a balance between rational, scientific knowledge and experiential knowledge.

Parks Canada is also moving towards greater community involvement in park establishment and management (Parks Canada, 1994).

It is assumed that the boundary placement process is at least partly political. Evaluation as to whether one or both of scientific and local knowledge also plays a significant role will require some judgment. An approach that is based primarily on the application of mathematical and scientific models or other academic methodology might suggest limited local involvement unless accompanied by explicit acknowledgement of the value of experiential knowledge and encouragement of local input early in the process. Alternatively, an approach that requires the use of easily recognizable features of the environment such as mountain ranges and river valleys to define the boundary might be thought of as unscientific and requiring little professional expertise.

5. Does the new approach go beyond current institutional/administrative arrangements where necessary?

Traditionally, the boundaries for resource management units were not ecologically based, but were based on political considerations. Current institutional and administrative infrastructure is based on such management units. The change to ecologically based units will require changes in this infrastructure and the cooperation of the many agencies and departments and other organizations who have an interest in the resource in question.

This criterion reflects the ecosystem management principles dealing with interagency cooperation and organizational change. They also reflect Parks Canada's emphasis on partnership formation.

Evaluation should be relatively straightforward. The answer to the question of whether these organizational concerns are addressed in the boundary determination process should be readily apparent. For example, documentation related to the boundary determination process might suggest that current administrative boundaries and mandates may have to be adjusted, and that some form of cooperative or consensus-building process might be needed.

6. Practicality/ Ease of Application

All else being equal, an approach that is easier to apply would be favoured over one that is more difficult to apply.

The criteria described above are meant to be used to evaluate both the substantive basis for defining ecosystem boundaries (criteria 1 - 3), and the process of boundary definition itself (criteria 4 - 6). Although it is important to have a scientific or technical basis for determining an appropriate ecosystem boundary, ecosystem management is as much about process as it is about final product. This should be kept in mind from the beginning of the ecosystem management process -- defining the management unit -- to the end. Table 7 illustrates how each criteria was derived from the principles of ecosystem management and national parks management.

Table 7: Evaluation Criteria and Related Ecosystem Management and Park Management Principle

	Criteria 1	2	3	4	5	6
Ecosystem Management Principles:						
1. Hierarchical Context						
2. Ecological Boundaries	x	x	x			
3. Ecological Integrity		x				
4. Data Collection						
5. Monitoring						
6. Interagency Cooperation				x	x	
7. Organizational Change			x		x	
8. Adaptive Management				x		
9. Humans as Part of Nature	x			x		
10. Values				x	x	
Parks Canada Guiding Principles:						
1. Ecological Integrity		x				
2. Leadership/Stewardship				x	x	
3. New Protected Heritage Areas					x	
4. Education/Presentation				x		
5. Human-Environment Relationship				x		
6. Research and Science		x			x	
7. Appropriate Visitor Activities		x				
8. Public Involvement				x	x	
9. Collaboration and Cooperation					x	
10. Accountability						

Criteria:

1. Integration of Abiotic, Biotic, and Cultural Components
2. Ecological Integrity
3. Ecological Boundaries
4. Technical Expertise/ Local Participation and Knowledge
5. Interagency Cooperation/ Institutional Change
6. Practicality/ Ease of Application

Evaluation of Ecosystem Definition Alternatives

To facilitate comparison among the various boundary definition alternatives, a point system will be used in the evaluation. To minimize difficulties related to the subjectivity of this approach, the basis for the assignment of points for each criteria is described in Table 8. In addition, an attempt was made in the preceding description of each criteria to identify where judgment might be required and what information might be used to inform such judgment..

This approach to evaluation is meant solely to provide a means of comparing the alternatives and assessing their relative strengths and weaknesses in relation to the objectives. Although numbers are assigned in the evaluation process, they are not intended as a measure of how much one alternative is better or worse than another, simply that it *is* better or worse in the context of the objectives.

Subjective ranking systems have been used extensively in other evaluations. Gros Morne National Park used such a system to rank resource issues in their recent Ecosystem Conservation Plan (Parks Canada, 1996). Smith and Theberge (1987) reviewed a number of qualitative and quantitative methods for evaluating natural areas and laid out a list of principles for choosing an evaluation method. Several of these principles are used for my evaluation. For example, Smith and Theberge (1987: 456) suggested that an evaluation method should "[b]e based on principles and assumptions that are valid and easily illustrated". I have used the principles of ecosystem management, parks management, and protected area design as the basis for my evaluation. They also suggested that subjective values and judgments should be made explicit, which I have done in the preceding section,

Table 8: Assignment of Points in Evaluation Process		
Criteria	**Range**	**Assignment of Points** **Basis of Assignment**
1. Integration of Abiotic, Biotic, and Cultural Components	1-5	Are abiotic (1), biotic (1), and cultural (1) components of the region considered; are multiple features/components considered (1); is integration of the components attempted (1) (points are additive).
2. Ecological Integrity	1-5	Is ecological integrity explicitly considered (1); is adequate consideration given to patterns and processes within the ecosystem (2), and to minimum size required for viable populations (2) (points are additive).
3. Ecological Boundaries	1-5	Scored on a continuum from not ecologically based (1) to entirely ecologically based (5).
4. Technical Expertise/ Local Participation and Knowledge	1-5	Boundary placement process political (1); approach requires scientific/professional expertise (2); approach allows for local knowledge and participation (2) (points are additive).
5. Interagency Cooperation/ Institutional Change	1-5	Boundaries based on existing administrative boundaries alone (1), ecological features alone (2), or a combination of the two (1.5) (these three mutually exclusive); approach calls for cooperative effort across agency lines (3) (points are additive).
6. Practicality/ Ease of Application	1-5	Scored on a continuum from difficult (1) to easy (5). Based on cost, data needs, number of personnel, required expertise, etc.

and that "...any method employing subjective judgments should provide specific guidelines to structure these judgments so as to enhance replicability" (Smith and Theberge, 1987:456). Table 8 provides such guidelines.

1. Watershed

Waterways and water bodies are abiotic components of the ecosystem. However, water is strongly associated with biotic and cultural components. Abundant life exists in the water and all life requires water. In addition, human settlement and culture have historically been associated with rivers, lakes, and the ocean, although this is less important today. Water is also an important agent shaping the land. Therefore, patterns of life and of the land may be expected to be associated with patterns of water. Thus, although water is a single component of an ecosystem, it is a significant component and one that represents the integration of many.

The use of a watershed to delineate ecosystem boundaries does not directly address the concern for ecological integrity. As noted above, the size of a watershed may vary greatly and may bear no relationship to minimum viable population for the larger mammal species in a region. However, the use of a watershed based management unit reflects, at least indirectly, a concern for the patterns and processes operating within the region.

A watershed based management unit is clearly based on natural, physical features of the landscape. It supports Theberge's (1989) principal abiotic objective of maintaining drainage basin integrity, but does not directly address his biotic guidelines.

In the watershed studies discussed earlier, the watershed was defined by the professional engaged in research. With an introduction to basic technical jargon and tools (eg. maps), members of local communities would have little difficulty in outlining the boundaries of their local watershed, and could therefore very easily participate in the determination of appropriate watershed boundaries.

Although administrative boundaries sometimes follow portions of natural features such as rivers or watersheds, new boundaries would clearly be required if watersheds were used exclusively to define the management unit. The studies by Hornbeck and Swank (1992) and Bormann and Likens (1994) used the watershed as a unit for research so issues of interagency cooperation and organizational change were not relevant issues. However, Montgomery et.al. (1995) and Caldwell (1994) dealt with the use of a watershed as a unit of management and emphasized the need for cooperation and new institutional arrangements.

In terms of applying this definition of a management unit to a real world situation, it is relatively straightforward. The major difficulty lies in reorganizing institutions to reflect the new boundaries. A decision would also be required as to what scale of waterway or water body to use. The alternatives may range from a small stream or pond to a continental-scale river or series of large lakes. In describing a Greater Park Ecosystem, the scale might range from hundreds to tens of thousands of square kilometers.

2. Bioregion

It is difficult to generalize about the substantive basis for defining the boundaries of a bioregion because there are no well-defined guidelines, there is a dearth of literature and real world application, and because bioregions are considered unique and the process of defining them location-specific. Nevertheless, a general statement can be made that they are defined by their abiotic, biotic, and cultural similarities, and that they are, by definition, integrative.

The preservation of both natural and cultural heritage is an integral part of bioregionalism and thus is an important consideration in defining a bioregion. However, considerations of size in relation to minimum viable populations and to patterns and processes are implicit rather than explicit.

Again, by definition, bioregion boundaries are defined by natural, physical features. The most widely cited examples are the clearly defined large mountain ranges and river valleys of Western North America. In addition, whole watersheds are often used as a starting point for defining the bioregion, with adjustments made as more understanding is acquired.

As for the basis of knowledge for determining the boundary for the bioregion, local knowledge is of primary importance, perhaps supplemented by scientific or professional expertise. Similarly, the local autonomy that is characteristic of the bioregional approach indicates that participation of local people and organizations is greatly encouraged.

Because bioregions are defined by natural and cultural boundaries, and not by administrative boundaries, new institutions and a more cooperative, community-oriented approach are implied.

A major problem with the use of a bioregion as a management unit is the difficulty in arriving at agreement as to what constitutes the bioregion. The prevalence of 'soft' criteria/considerations such as human culture and values and the need for local initiative and participation are major impediments.

3. Ecological Land Classification

Ecological land classification systems use a variety of abiotic and biotic features of the environment to define ecosystem boundaries. The usefulness of a particular component or combination of components of the environment in representing ecological processes and defining ecosystem boundaries may vary depending on the spatial scale of the study area (Host et.al., 1996). The choice of components may also be based in part on the judgment of the researcher (Host et.al., 1996). Host et. al. (1996) used data on climate and physiography as a basis for their classification. Although they were concerned, for purposes of their quantitative analysis, solely with abiotic features of the ecosystem, they noted the relationship with biotic characteristics such as forest composition (Host et.al., 1996). They also attempted to integrate climate and physiography. Marshall et.al. (1996) defined ecoregions on the basis of factors such as regional physiography, surficial geology, climate, vegetation, soil, water, and fauna. Clearly, abiotic and biotic factors are well represented and integration of them is important. However, cultural features are not generally considered.

Although preservation of natural heritage/ecological integrity is not specifically addressed, one would expect that protection of an area defined on the basis of biophysical criteria would contribute to some degree to protecting ecological integrity. The units defined by an ecological land classification scheme represent successively subdivided parcels of land, none of which bears any particular relationship to minimum viable populations of large mammals. However, consideration of ecological processes and patterns, which is a defining characteristic of the notion of ecological integrity, is fundamental to ecological land classification.

Specific ecosystem boundaries, determined under an ecological land classification approach, may not be represented by well-defined physical features. However, theoretically, the boundaries are ecologically-based and may be represented by naturally-occurring, but subtle, ecotones or transition zones. This type of approach does not directly address Theberge's (1989) abiotic guidelines, and may violate the biotic guideline that suggests that highly diverse communities (eg. ecotones) not be traversed by a boundary.

This method of boundary determination requires a high degree of scientific or technical expertise, particularly the very quantitative method proposed by Host et.al. (1996). This represents a significant deterrant to local, non-expert participation.

Ecological land classification has traditionally been used to divide the land into distinct ecological units. It has not been constrained by the requirement that these units also serve as management units. For this reason, institutional and administrative boundaries could be virtually ignored. These boundaries may present a problem where the purpose of the classification is to define ecological as well as management units. Host et.al. (1996) foresaw the need for greater cooperation and for institutional change when they suggested that their approach be a "...tool for interagency strategic planning across regional areas and ownership boundaries."

Although this approach is not burdened with the problems associated with the 'softer' issues, it requires specialized knowledge and expertise. In terms of ease of application, it is more difficult than the watershed approach but less so than the bioregion approach.

4. Biosphere Reserves

The process of biosphere reserve designation does not explicitly use particular abiotic, biotic, or cultural components of the ecosystem as the basis for boundary delineation. It does rely on Udvardy's (1975) classification of the biogeographical provinces of the world, which are based primarily on floristic and faunistic similarities and differences, in an attempt to represent all ecosystem types (Batisse, 1982). Integration of the abiotic, biotic, and cultural components of a region is fundamental to the biosphere reserve concept.

The importance of ecological integrity was reflected early in the development of the biosphere reserve concept: "The integrity of the essential characteristics of many ecosystems cannot be safeguarded unless the protected areas are large and varied..." (UNESCO, 1974:14). The significance of biosphere reserve size, particularly in relation to the habitat needs of space-demanding species, is also noted by Batisse (1982).

As noted previously, there is little guidance in the biosphere reserve literature regarding actual boundary delineation, or even the need for a fixed boundary (Canada/MAB, 1987). There may be some basis for inferring that because a biosphere reserve is intended to represent a "...more or less self-regulating ecosystem" (Canada/MAB, 1976), that its boundaries are ecological boundaries, but this is questionable.

As for the level of technical expertise required for the boundary delineation, again there is little explicit guidance. However, it *is* safe to asssume in this case that a combination of scientific and technical expertise, and local knowledge and participation would be used as increased scientific understanding and local participation and management are integral to the biosphere reserve concept.

Although it is difficult to ascertain whether specific boundaries -- if there is even a need for them -- are to be ecologically based, there is some indication that the buffer zone that forms part of the biosphere reserve is a fluid zone defined by administrative boundaries of cooperating institutions and jurisdictions. For example, the outer buffer zone, or zone of cooperation, for Waterton Lakes Biosphere Reserve, has been described as including "[p]rivate lands, to the east and north of the park used for ranches, farms, oil and gas wells and tourist development" (Canada/MAB, 1987:9). For Riding Mountain Biosphere Reserve in Manitoba, the zone of cooperation is comprised of "...the surrounding farm lands..." (Canada/MAB, 1987:9). This brings to mind the description of the Greater Yellowstone Ecosystem which is described by a combination of natural features and existing administrative boundaries. The idea of cooperation among stakeholders is a fundamental characteristic of a biosphere reserve.

Because a biosphere reserve boundary is both poorly defined, and flexible, and because of the necessary involvement of a broad range of interests, the application of this approach would be moderately difficult.

5. The Yellowstone Model

The area commonly referred to as the Greater Yellowstone Ecosystem is defined primarily be abiotic (mountainous area surrounded by dry regions) and biotic features (sufficient habitat for viable grizzly bear population) and to a lesser extent cultural features (the human communities and way of life of people within the greater ecosystem). Integration of these components is a significant feature of this approach to ecosystem definition.

Preservation of ecological integrity/natural heritage is also a significant feature of this approach. Brussard (1991), demonstrated the concern for ecological integrity that is common in writings about the Greater Yellowstone Ecosystem when he noted "...the Greater Yellowstone Ecosystem [if allowed to revert to its natural state] would probably be large enough to support viable populations of all its native species along with the local disturbance regime on an appropriate scale" (Brussard, 1991:337).

The boundaries of the Greater Yellowstone Ecosystem, as noted previously, have not been firmly established. Both natural features (natural transition between mountains and surrounding dry region) and existing administrative boundaries (eg. those of the several National Forests and National Wildlife Refuges in the region) have been suggested as appropriate boundaries.

There is little indication in the literature that local people have been actively involved in the actual boundary determination process. However, the numerous studies dealing with local attitudes and knowledge (Reading et.al., 1994), political considerations (Cawley and Freemuth, 1993) and other social aspects (Jobes, 1991; Jobes, 1993) indicate that local involvement, at least at a very basic level, is important for successful management. There has also been much research on biophysical and ecological relationships within the region, but the actual boundary determination process has not relied to any great extent on this scientific and professional expertise. These factors indicate that greater local involvement could be accommodated.

Again, as noted above, several attempts to define the GYE boundary have referred specifically to existing administrative boundaries such as those of the National Forests and National Wildlife Refuges. Others moved beyond such restrictions. The importance of cooperation among agencies and other stakeholders has been explicitly acknowledged (Clark et.al., 1991; Burroughs and Clark, 1995).

In terms of practicality and ease of application, the various attempts to define the boundaries of the GYE have suggested a degree of subjectivity and also the use of relatively well-defined natural features or existing cultural boundaries. It has appeared relatively straightforward. However, a brief review of the literature indicates that obtaining agreement from all stakeholders has made the process extremely difficult.

6. The ABC Resource Survey Method (The Pukaskwa Model)

The ABC Resource Survey approach used by Skibicki (1995a and 1995b) for Pukaskwa National Park explicitly considers the various abiotic, biotic, and cultural components of the ecosystem in an integrative way.

The preservation of natural heritage/ecological integrity as well as cultural heritage is also addressed. Although size considerations in relation to minimum viable populations are not explicitly considered, ecological patterns and processes are, specifically through the focus on structural aspects and functional aspects.

Although the final boundaries are the product of the entire process and will not necessarily be defined entirely by natural features, the inclusion of specific abiotic, biotic and cultural guidelines for drawing the boundaries should ensure that the boundaries are ecologically based.

The primary source of information that was used in the application of this approach is scientific, professional expertise. However, local participation could be accommodated and is explicitly called for in Skibicki (1995b)

This approach does not rely on existing administrative boundaries but proposes new boundaries based on natural and cultural features. An institutional analysis is an explicit feature of this approach, addressing the potential need for institutional change and improved interagency cooperation.

Although this method attempts to deal with the 'softer' issues, its structured approach makes it somewhat easier to apply than the bioregional approach.

Table 9 illustrates how the evaluation system, which was described in Table 8, is applied to the six alternatives. Table 10 provides a summary which will facilitate comparison of these alternatives. The numbers in Table 10 can best be understood by referring to Tables 8 and 9, and by acknowledging a degree of unavoidable subjectivity. Explanation of how points were assigned to one of the alternative approaches, for example the watershed approach (alternative 1), will further illustrate the application of the scoring system.

Table 9: Application of Evaluation System

Criteria	Alternatives 1	2	3	4	5	6
Substantive:						
1. Integration of Components:						
Abiotic components comsidered?	Y	Y	Y	S	Y	Y
Biotic components considered?	S	Y	S	S	Y	Y
Cultural components considered?	S	Y	N	S	Y	Y
Multiple components used?	N	Y	Y	Y	Y	Y
Integration of components?	S	S	Y	Y	S	Y
2. Ecological Integrity						
Explicitly considered?	S	S	N	S	S	Y
Ecosystem patterns/processes considered?	Y	Y	Y	Y	Y	Y
Minimum size re MVP?	N	N	N	S	Y	N
3. Ecological Boundaries	S	S	S	S	S	S
Process:						
4. Local Participation/Technical Expertise						
Boundary placement political?	N	S	S	S	Y	N
Approach requires scientific expertise?	Y	Y	Y	Y	S	Y
Approach allows for local participation?	Y	Y	N	Y	S	Y
5. Cooperation/Institutional Change						
Existing administrative boundaries?	N	N	N	N	N	N
Boundaries based on ecological features?	Y	N	Y	N	N	N
Combination of administrative/ecological?	N	Y	N	Y	Y	Y
Approach calls for cooperative effort?	S	S	S	Y	Y	Y
6. Practicality/Ease of Application	S	S	S	S	S	S

Alternatives
1. Watershed
2. Bioregion
3. Ecological Land Classification
4. Biosphere Reserves
5. The Yellowstone Model
6. The ABC Resource Survey Method (The Pukaskwa Model)

Y - Yes/Directly
S - Somewhat/Indirectly
N - No

Table 10: Evaluation Summary

Criteria	Alternatives 1	2	3	4	5	6
Substantive:						
1. Integration of Components	2.5	4.5	3.5	3.5	4.5	5.0
2. Ecological Integrity	2.5	2.5	2.0	4.0	4.5	3.0
3. Ecological Boundaries	3.5	3.5	2.5	1.5	2.0	4.0
Sub-Total	**8.5**	**10.5**	**8.0**	**9.0**	**11.0**	**12.0**
Process:						
4. Local Participation/Technical Expertise	4.0	4.5	2.5	4.5	3.5	4.0
5. Cooperation/Institutional Change	3.0	3.5	2.5	4.0	4.0	4.0
6. Practicality/Ease of Application	4.0	1.5	2.5	2.0	3.5	3.0
Sub-Total	**11.0**	**9.5**	**7.5**	**10.5**	**11.0**	**11.0**
TOTAL	**19.5**	**20.0**	**15.5**	**19.5**	**22.0**	**23.0**

Alternatives
1. Watershed
2. Bioregion
3. Ecological Land Classification
4. Biosphere Reserves
5. The Yellowstone Model
6. The ABC Resource Survey Method (The Pukaskwa Model)

The watershed approach scored 2.5 for the first criterion. This value was given because an abiotic component, the watershed boundary, was used (score 1), biotic and cultural components were considered indirectly (score 0.5 for each), and because the use of watershed boundaries suggests integration in an indirect way (score 0.5). For criterion 2, the watershed approach also scored 2.5. The notion of ecological integrity is implied in an indirect way by this approach (score 0.5), and the use of watershed boundaries suggests a significant concern with ecological processes -- particularly the movement of water moving over the land, and other related processes (score 2). A score of 3.5 was assigned for criterion 3 because watershed boundaries are natural features. A higher score might have been assigned if greater consideration was given to more of Theberge (1989) and Skibicki's (1995a) guidelines for drawing ecologically sound boundaries. For criterion 4, a score of 4 was assigned because there is no political element to the use of watershed boundaries (score 0), and because although there is a degree of expertise required to identify a watershed boundary (score 2), understanding of the concept does not require significant academic training, and thus might allow for a greater degree of local involvement (score 2). A score of 3 was given for criterion 5 because first, the ecosystem boundaries are based on an ecological feature (ie., the watershed boundaries) (score 2), and second, because existing administrative boundaries are not used, some degree of cooperation between administrative units is suggested (score 1). Finally, for criterion 6 , a score of 4 was given because the watershed approach was considered the easiest to apply among all alternatives. One would expect that the identification of watershed boundaries would require a relatively low level of expertise, few personnel, and a well-defined and limited data set.

Several conclusions can be drawn from the above discussion and the following summary. First, as may be expected, the approaches that are considered best overall in the context of my objectives are the approaches that have been applied already to National Park situations (The Yellowstone Model and The ABC Resource Survey Method). Other integrated approaches (Watershed, Bioregion and Biosphere Reserve) also scored high. Second, the more narrowly focused Ecological Land Classification Approach had the lowest score. Again, this reflects the comprehensiveness of my objectives. Third, the best approach from a substantive point of view was the ABC Resource Survey approach applied to Pukaskwa National Park. From a process point of view, the approaches applied to Yellowstone and Pukaskwa national parks, and the watershed basis with its high ease of application score, scored highest.

Although the ABC Resource Survey Method was the best overall approach, it will not be demonstrated in the application to Gros Morne National Park for two major reasons. First, its full application is beyond the scope of this report. Limitations related to time preclude the compilation of the detailed information necessary for a complete ABC application. Second, my objective is to identify a general region for a Greater Park Ecosystem and to use physical features such as watershed boundaries, mountain ranges, or large river valleys where possible to outline this general region. A full application of the ABC methodology is not necessary to identify such a general region.

An ideal approach to defining a Greater Park Ecosystem, then, may be hypothesized to combine the following attributes:

a) the comprehensiveness, structure, and concern for pattern and process and institutional analysis that is characteristic of the ABC Resource Survey Method,

b) the concern for ecological integrity, particularly minimum viable populations, and interagency cooperation that is evident in writings about the Greater Yellowstone Ecosystem,

c) the concern for local participation, ecological integrity, and natural boundaries that is fundamental to the bioregional approach,

d) the physical layout, and concern for local participation that characterizes the biosphere reserve approach,

e) the ease of application of the watershed approach, and

f) the scientific rigour of ecological land classification.

General Guidelines

In the preceding evaluation an attempt was made to highlight the strengths and weaknesses of several approaches to ecosystem boundary delineation. Because this study is concerned with Greater Park Ecosystems, the criteria used in the evaluation were based on the principles and objectives of ecosystem management and national park management. They also reflected the principles of protected area design. Although no single approach was considered ideal, each had particular strengths. By combining these strengths and by drawing on the literature from which the evaluation criteria were derived, a set of general guidelines for delineating the boundaries of a Greater Park Ecosystem was developed.

1. An initial area of examination should be determined. It should:
   i) be centered on the park,
   ii) be large enough to support some multiple of a minimum viable population of the most space-demanding species in the area,
   iii) consider the location of significant features and processes in the region.

2. The process of delineating the boundary should consider:
   i) abiotic, biotic, and cultural features and processes that are significant to the park and surrounding region,
   ii) threats to ecological integrity of the park and region,
   iii) significant transboundary processes.

3. The guidelines for drawing ecologically sound boundaries outlined in Theberge (1989) and Skibicki (1995a) should be adhered to wherever possible (Table 5).

4. An institutional analysis should be carried out to determine where institutional boundaries and mandates may be adjusted to reflect ecological considerations and where cooperative action is possible.

5. All stakeholder organizations and local individuals having interests in the area of examination should be encouraged to participate in the process of defining the new management unit.

6. Where there has been a long history of resource use among local people, their experiential knowledge should be sought out and its value acknowledged.

These guidelines will be used to define the boundaries of a greater ecosystem for Gros Morne National Park in western Newfoundland. An understanding of this region is required to transform the guidelines into a detailed methodology.

IV. THE STUDY AREA

This chapter will provide a detailed description of Gros Morne National Park and surrounding region. It will define the extent of the study area as per guideline #1 in the previous chapter, and describe the various abiotic, biotic, and cultural features of this region. Because protection of the ecological integrity of the park itself is the underlying reason for establishing a Greater Gros Morne Ecosystem, those features or processes that are considered significant to the Park, that are threatened or are themselves a threat, and that cross the Park boundary, are highlighted. As noted in guideline #2 in the previous chapter, these will be considered in the process of delineating the Greater Gros Morne Ecosystem in the next chapter.

Extent of Study Area

The boundaries of a Greater Park Ecosystem should, by definition, be ecological and based on natural features of the environment. However, the boundaries of the initial study area, within which this Greater Park Ecosystem will be contained, must necessarily be somewhat arbitrary.

The initial study area for determination of a Greater Gros Morne Ecosystem will encompass all the land and inland waters from approximately 56.1 degrees west longitude in the east to approximately 59.2 degrees west longitude in the west, and from approximately 48.4 degrees north latitude in the south to approximately 51.0 degrees north latitude in the north. In terms of UTM coordinates, this corresponds to eastings of

563100 to 337100 and northings of 5363000 and 5650000, respectively. The study area includes the west coast of the Island of Newfoundland from the Port au Port Peninsula in the southwest, through Gros Morne National Park to the area of St. John Bay in the northwest. From there it runs across the Northern Peninsula to the Roddickton area, down the west coast of the Northern Peninsula, around the shores of White Bay and south from there to include the western half of the Baie Verte Peninsula and Red Indian Lake in the southeast (Figure 3).

These extents can be justified on several bases. First, the widest-ranging mammals in the region are the black bear and the woodland caribou. Given estimates of black bear home ranges (Brown, 1993), the fact that such home ranges tend to overlap, the relatively large size of the Newfoundland subspecies of black bear (Mahoney, 1985), and their general habitat requirements, the above study area, which encompasses approximately 35000 square kilometers, should support some multiple of the 500 individuals suggested previously as a mid-range estimate of a minimum viable population. Furthermore, the northern limit of the study area corresponds, approximately, to the northern limit of the range of the caribou herds in and around Gros Morne National Park (Figure 4)

Second, the study area encompasses several entire watersheds in and around Gros Morne National Park, including the largest watershed in the region, the Humber River watershed (Figure 5).

Third, the study area takes in the Western Newfoundland Model Forest, where an approach to cooperative management is currently being tested (Figure 6).

Finally, the proximity of the eastern boundary of the study area to another major protected area in central Newfoundland allows for the possibility of a dispersal corridor.

Figure 3: Study Area

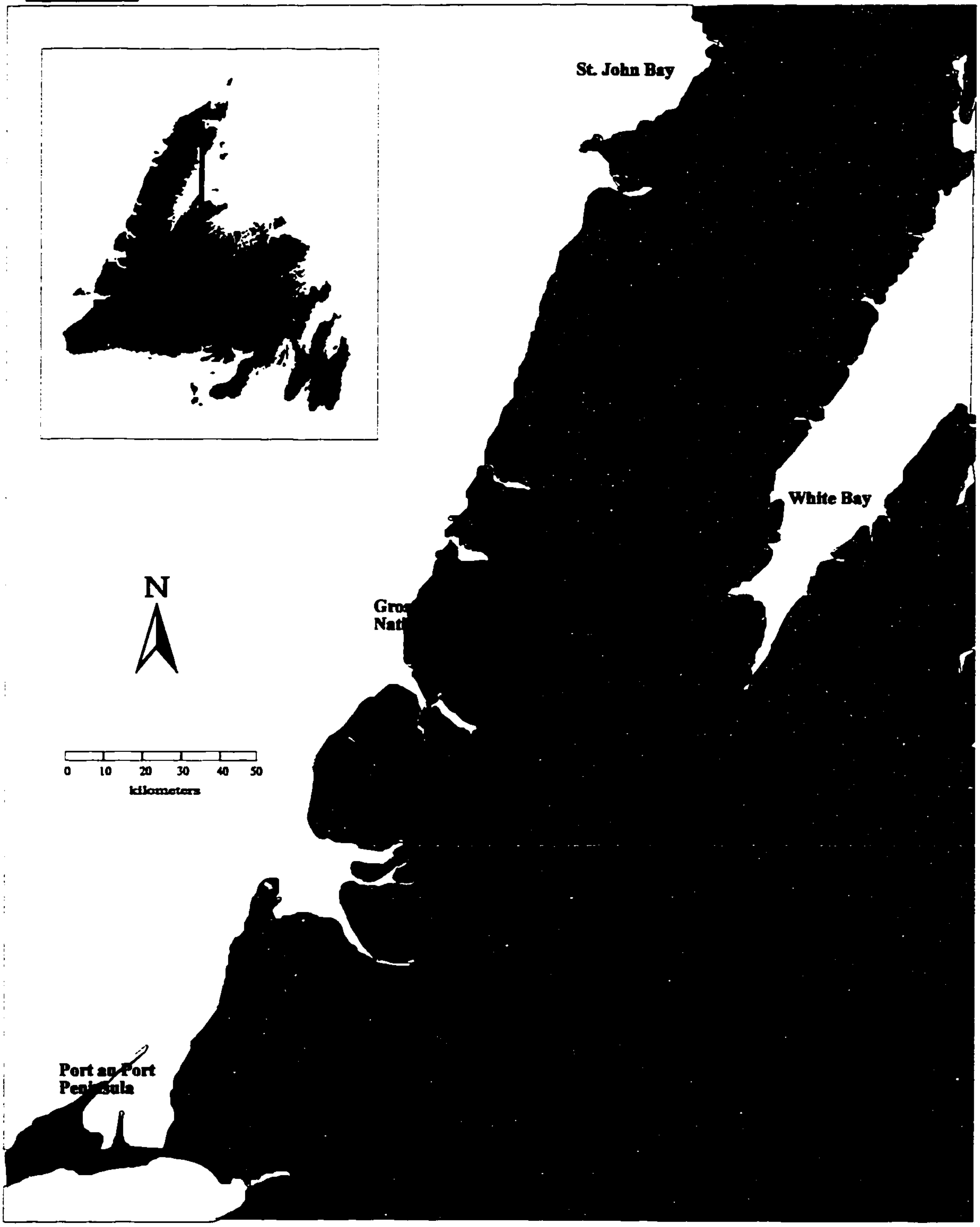
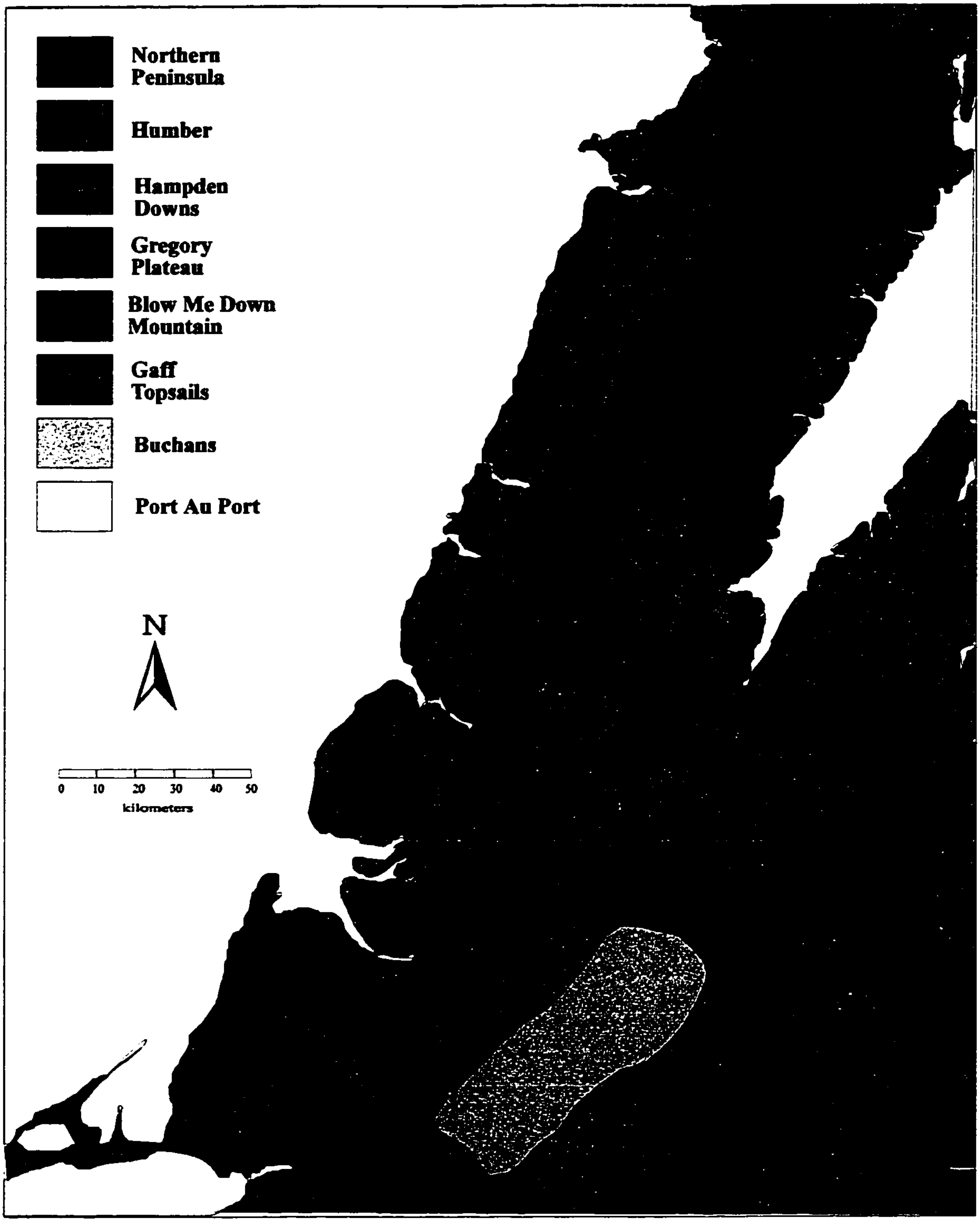
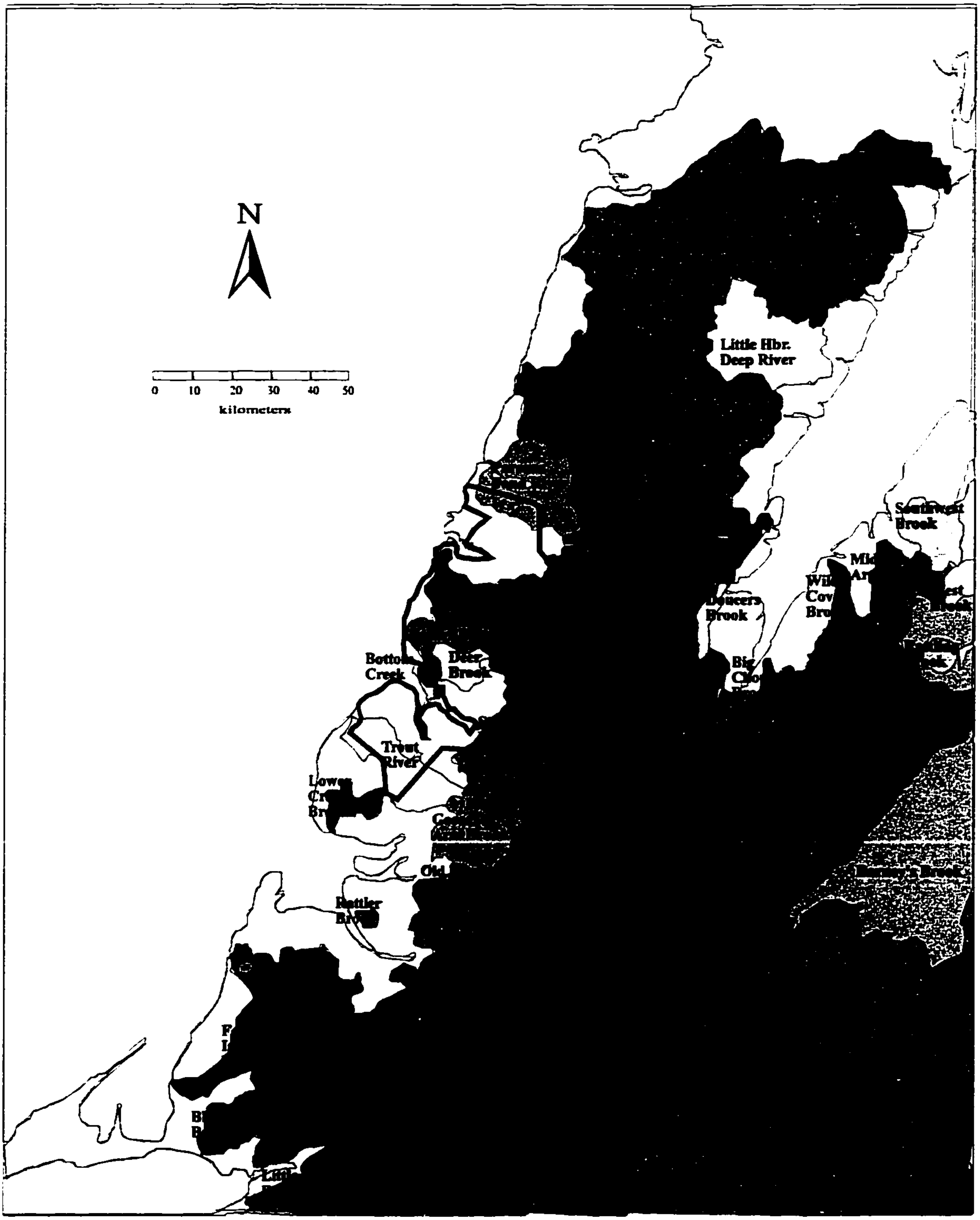


Figure 4: Woodland Caribou Herds in Western Newfoundland



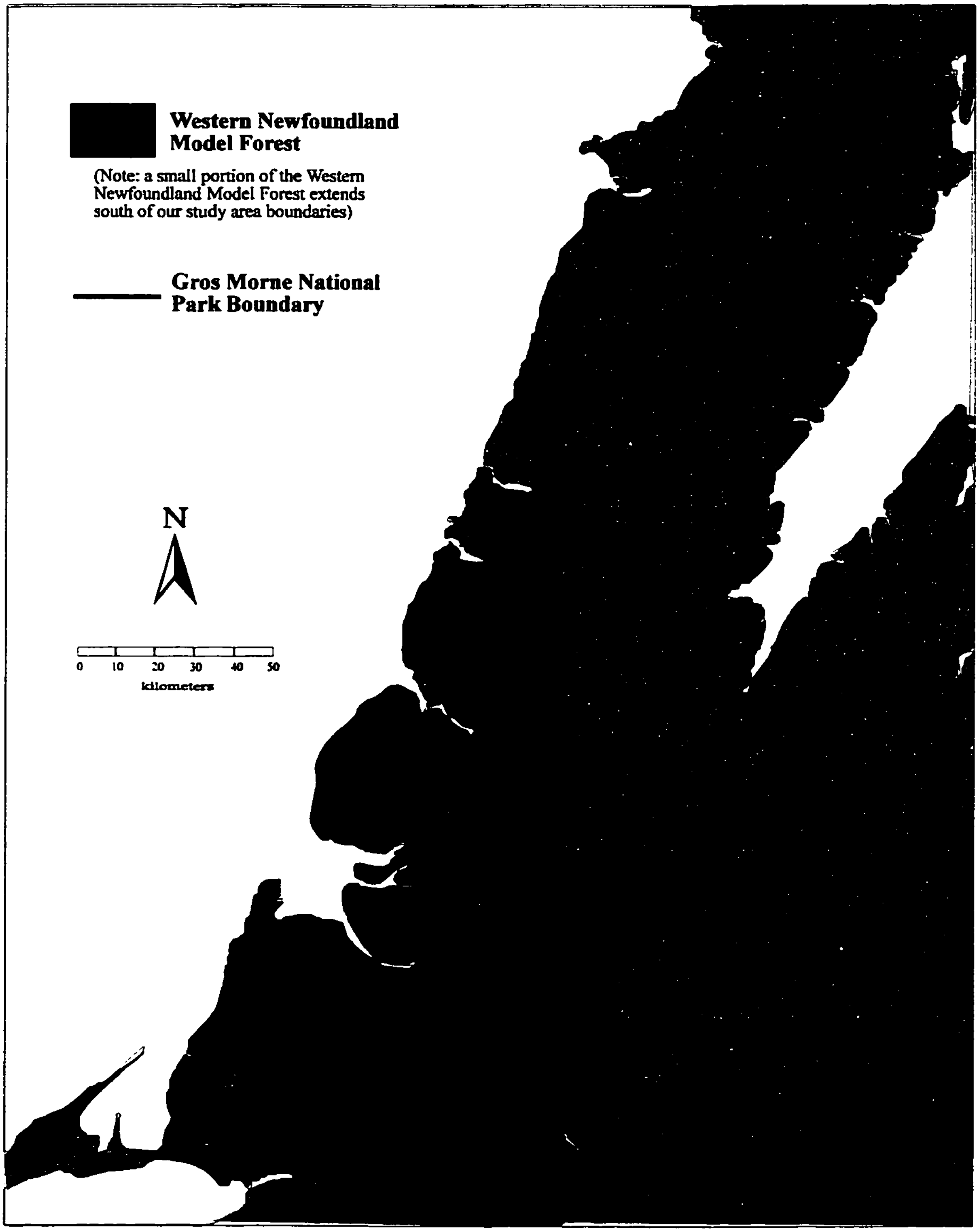
Source: Mercer et. al., 1985

Figure 5: Watersheds of Western Newfoundland



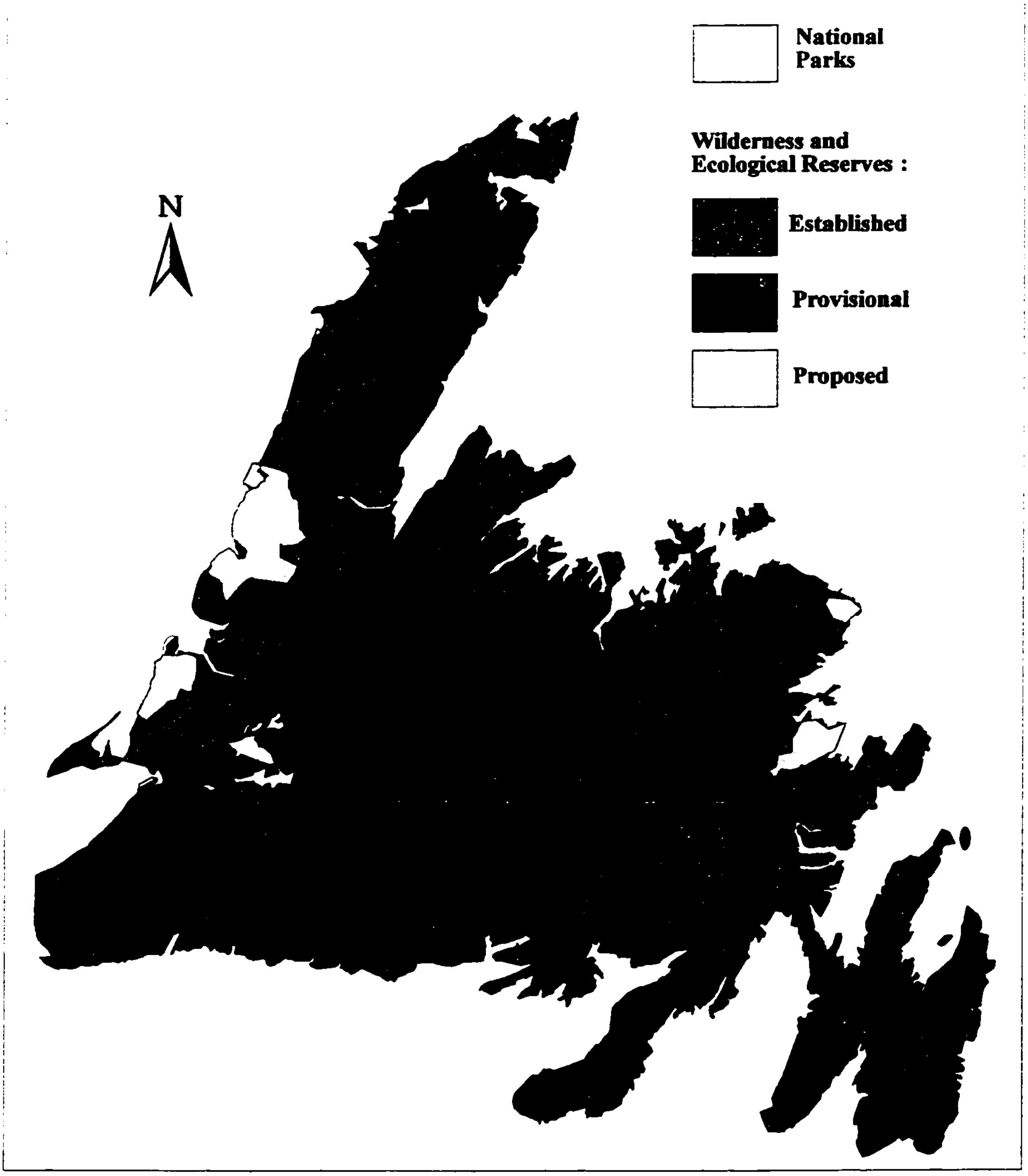
Source: Ullah (1992)

Figure 6: Western Newfoundland Model Forest



Source: Western Newfoundland Model Forest (1997)

Figure 7: Major Protected Areas of Newfoundland



Source: Lands Branch, Department of Environment and Lands (1988)

General Description

Abiotic Features and Processes

1. Geology. The Island of Newfoundland is made up of three major geological zones. The Western Zone, which includes a large proportion of the study area, formed the eastern edge of the ancient continent of Laurentia about 500 million years ago. It was separated from the Eastern Zone, which formed the western edge of the continent of Gondwana, by the ancient Iapetus Ocean. As these two continents collided, the process of subduction created volcanic island arcs, forming what is now the Central Zone on the Island of Newfoundland (Colman-Sadd and Scott, 1994).

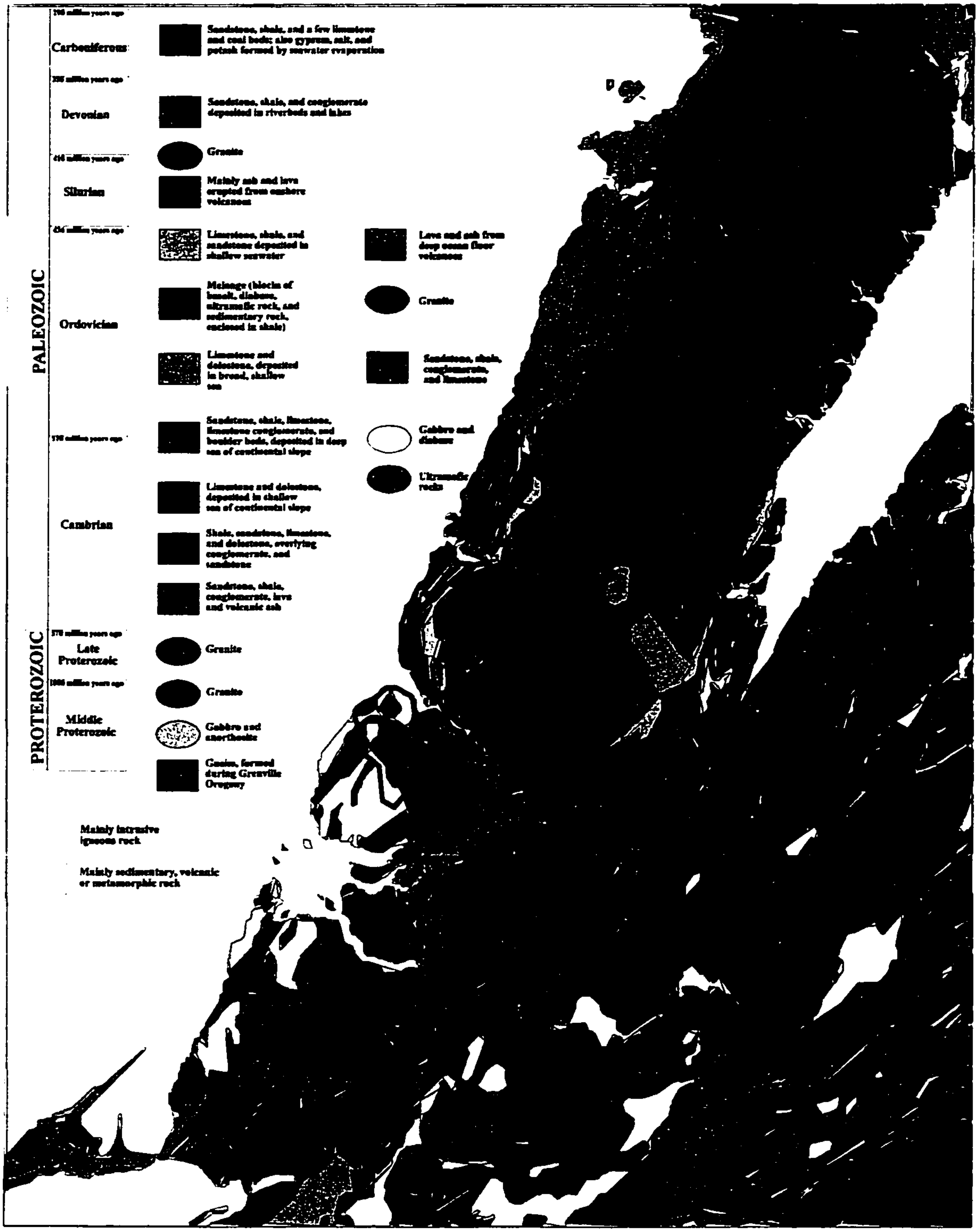
These processes have created many interesting and significant geological features on the Island of Newfoundland. In the study area precambrian granites and gneisses dominate, particularly along the Long Range Mountains of the Northern Peninsula (Parks Canada, 1996). These were formed during the Grenville Orogeny, which preceded the formation of the Iapetus Ocean (Colman-Sadd and Scott, 1994; Berger et. al., 1992). A very significant geological feature which is contained within Gros Morne National Park is what is known as the ophiolite group. This group of minerals was initially formed as part of the deap ocean crust and mantle and emplaced on the land during the collision of the continents about 500 million years ago (Berger et. al., 1992). Another geological feature, which is again within the park and with which an important fossil find is associated, is the sedimentary rock that was formed at the continental margin prior to the collision of Laurentia and Gondwana (Parks Canada, 1996). Figure 8 illustrates the geology of the study area.

2. Climate. Newfoundland's climate was classified by Strahler and Strahler (1987) as a boreal forest climate of the perhumid subtype. This climate may be characterized as very wet with long, cold winters and great temperature extremes (Strahler and Strahler, 1987). Newfoundland's maritime influence results in even higher precipitation levels, but more moderate temperatures than the typical boreal forest climate.

Figure 9 illustrates a more detailed classification of the climates of insular Newfoundland. My study area is more typical of the boreal forest climate than the central and eastern regions of the island. With the exception of the high elevations of the western mountains, where precipitation may exceed 1500 mm, precipitation levels are generally lower in the western part of the island (900-1200 mm vs 1200-1700 mm), and a greater proportion of the precipitation falls as snow (Banfield, 1983). Temperature extremes are also generally greater in the west with colder winters, particularly at high elevations, and warmer summers. Temperatures may range from -25 to -30 degrees Celsius in the winter to 30 degrees Celsius in the summer (Banfield, 1983).

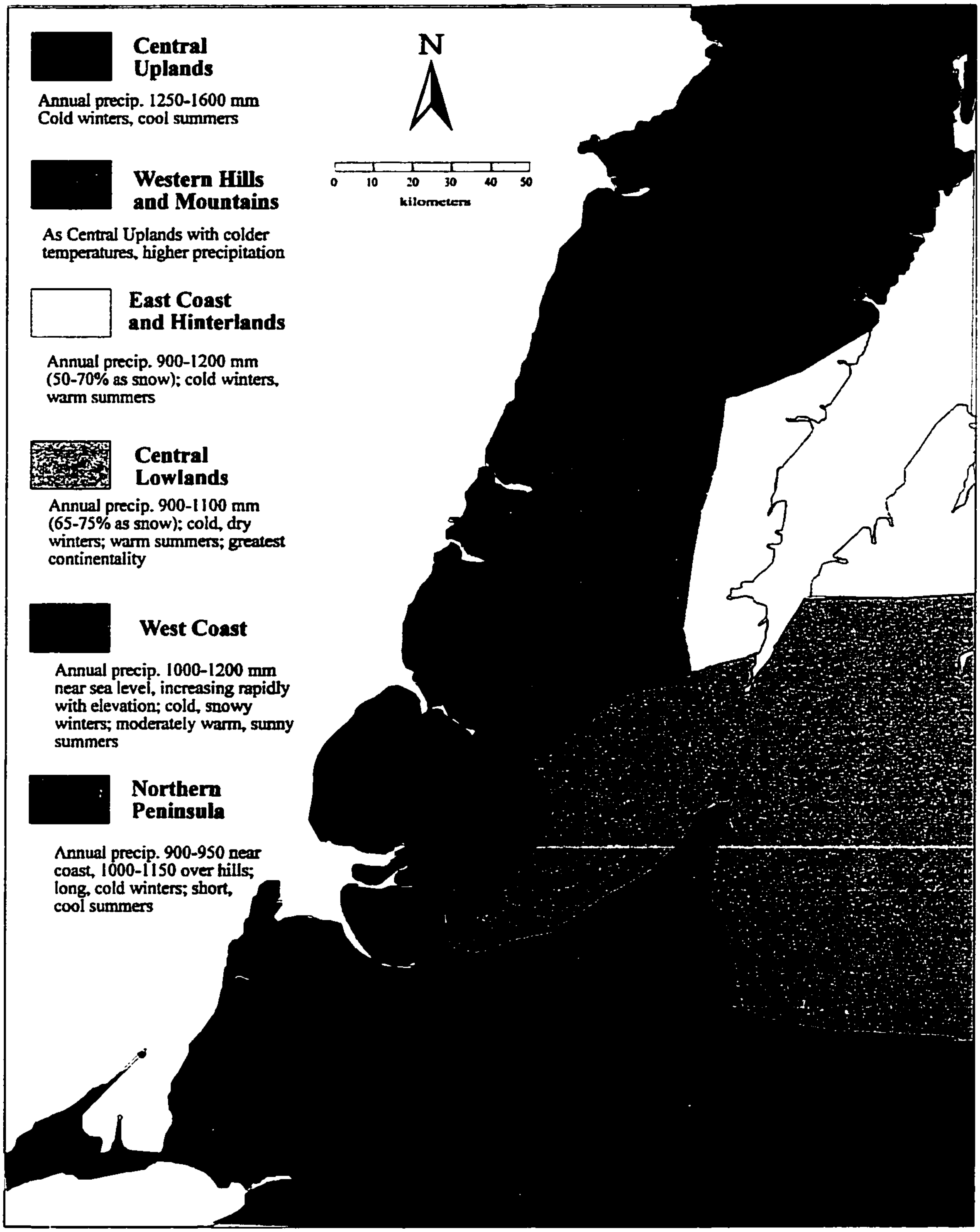
3. Landforms and Physiography. The physiographic divisions of the Island of Newfoundland are shown in Figure 10. The study area is dominated by the Long Range Mountains which run virtually along the entire length of western Newfoundland, and reach

Figure 8: Geology of Western Newfoundland



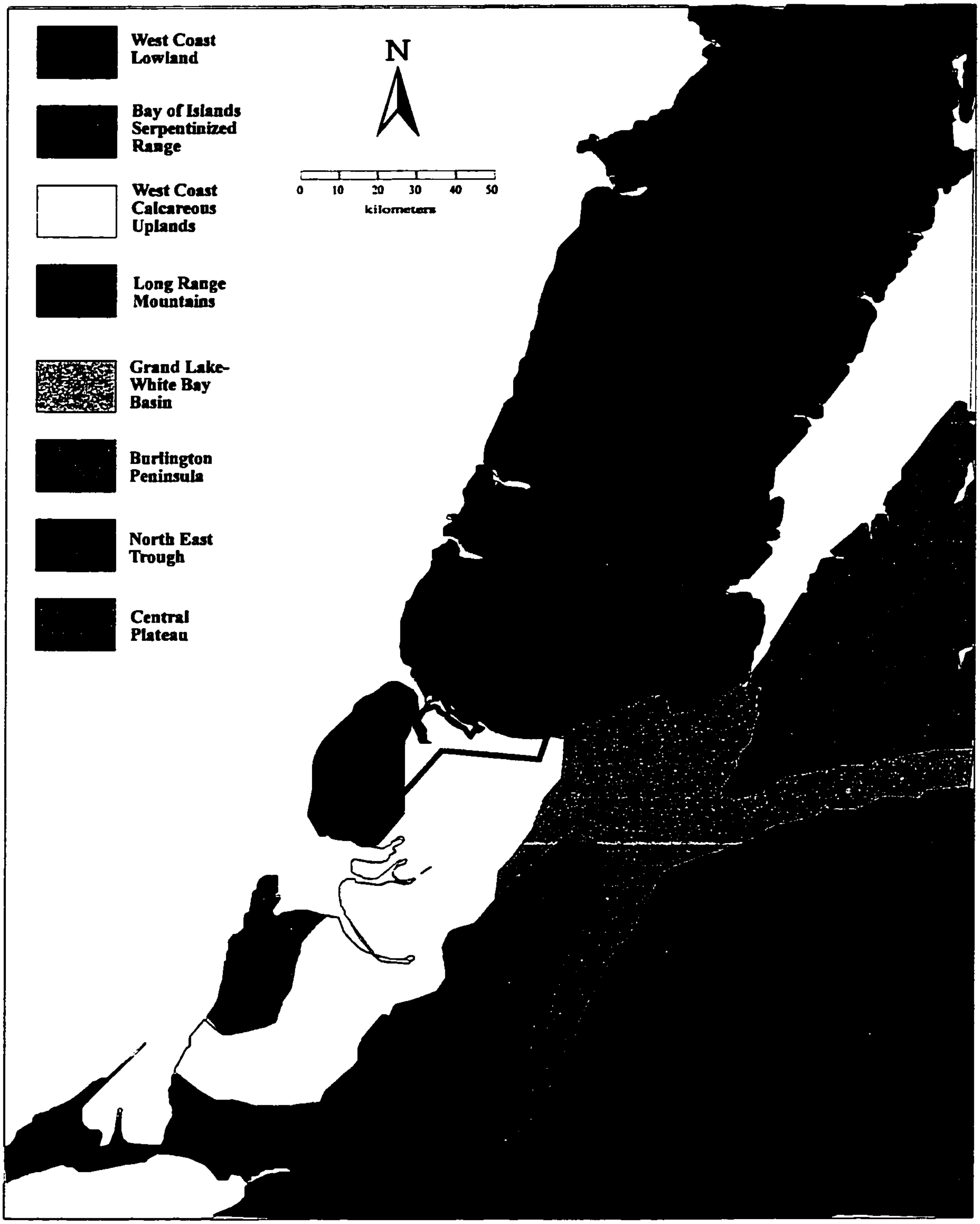
Source: Colman-Sadd and Scott (1994)

Figure 9: Climate Regions of Western Newfoundland



Source: Banfield (1983)

Figure 10: Physiographic Regions of Western Newfoundland



Source: Roberts (1983)

elevations of over 800 meters in places. Other significant regions in the study area include the West Coast Lowland, which was submerged beneath the ocean during the last glaciation, and the Bay of Islands Serpentinized Range, on which are exposed portions of the ocean crust and mantle of the ancient Iapetus Ocean (Berger et. al., 1992). Portions of these three regions fall within the boundaries of the park.

Among the significant landforms within the study area are the land-locked fiords that form the western edge of the Long Range Mountains. These fiords were carved out by glaciers during the last glaciation. When the glaciers receded and the previously submerged lowlands rebounded, the fiords were cut off from the ocean and large waterbodies such as Western Brook Pond were formed (Parks Canada, 1996). These fiords are among the most well-known and photographed features of Gros Morne National Park.

4. Major Lakes, Rivers, and Watersheds. Major lakes and rivers may represent a natural boundary restricting the movement of animal populations. A watershed is an important unit of study because it is relatively self-contained in terms of water movement (however, groundwater may have different flow patterns). The major lakes and rivers, and watershed boundaries for the study area are shown in Figure 11 and Figure 5, respectively.

5. Ecoregions. Attempts have been made to integrate abiotic (and sometimes biotic) features of an area, such as geology, climate, and physiography, by dividing the area into

Figure 11: Major Lakes and Rivers of Western Newfoundland

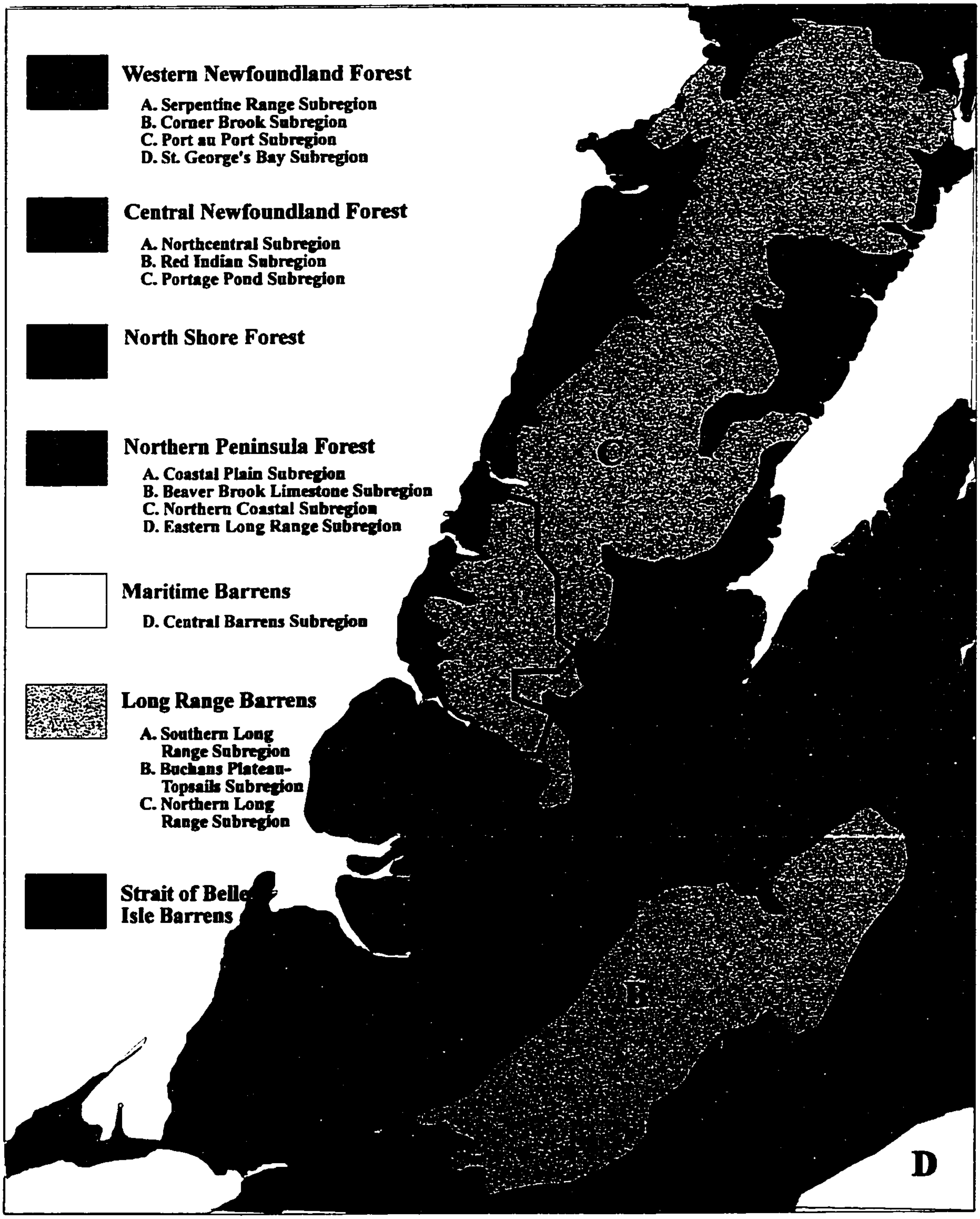
Source: Lands Branch, Department of Environment and Lands (1988)

ecologically coherent ecoregions. Damman (1983) attempted such a subdivision for the Island of Newfoundland. He suggested that climate acted as the primary control over processes in a region and that differences in physiography and the underlying geology modified the effects of climate and accounted for the major differences within a region (Damman, 1983). It is not surprising then that Damman's (1983) map of the ecoregions and subregions of Newfoundland (Figure 12) bears some general resemblance to the map of climatic regions of Newfoundland (Figure 9).

There is no general consensus that this approach is best for delineating ecosystems or that these determinants (climate, geology, physiography) drive ecosystem processes. Bailey (1996) held a view similar to that of Damman (1983) regarding the major determinants of ecosystem processes, but Scott et. al. (1989, cited in Grumbine, 1990) suggested that such an approach does not "... capture important elements of local and regional diversity." The purpose for which the division into regions is being carried out should be considered when deciding which features are most appropriate as a basis for defining ecosystem boundaries.

6. Forest Fires. Forest fires are one of the most significant natural disturbance regimes in the region. Maintenance of ecological integrity requires that these disturbance events be allowed to take their natural course. Wilton and Evans (1974) provided a history of forest fires in Newfoundland from 1619 to 1960. Where the information was available the area burned was noted. A review of this data indicates that for the study area in the years 1900 to 1960, the area burned per forest fire event ranged from approximately 4

Figure 12: Ecoregions of Western Newfoundland



Source: Damman (1983)

hectares (.04 square kilometer) to approximately 11,200 hectares (112 square kilometers), with an average of approximately 1200 hectares (12 square kilometers).

Biotic Features and Processes

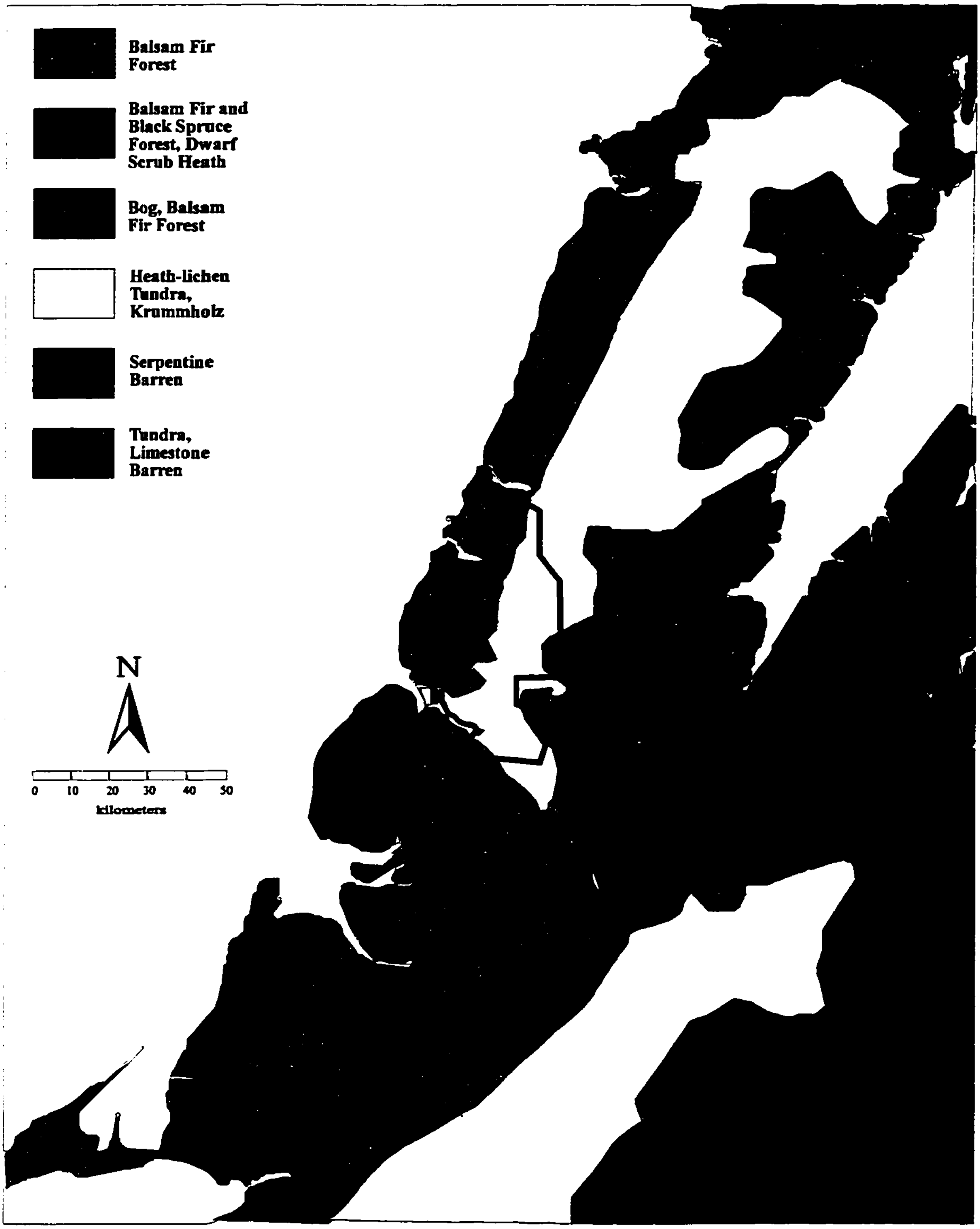
*1. **Flora.*** Figure 13 shows the general distribution of the major vegetation types within the study area. It is dominated by regions of boreal forest and regions of tundra vegetation. Several significant points may be made about the vegetation of the region.

First, the southern part of Gros Morne National Park represents the northern limit of the range of several tree species typical of the warmer Acadian and Great Lakes - St. Lawrence forest regions. These include white pine, red maple, yellow birch, black ash, and trembling aspen (Canadian Parks Service, 1990; Anions, 1994). These species may be particularly important to the evolution of the ecosystem if global warming predictions are substantiated (Parks Canada, 1996).

Second, this region contains some of the most southerly occurrences of several arctic-alpine plant species. The low temperatures, low snow cover, high winds, dessication, high precipitation, poor soils, and short growing season that characterize some areas of the Long Range Mountains Plateau where these plants are found are typical of arctic-circumpolar environments (Berger et. al., 1992).

Third, the study area contains several rare or unique plant species. The tree species and arctic alpine species noted above are considered rare by virtue of being at their northern and southern distribution limits, respectively. Gros Morne National Park alone is considered to have a total of 96 rare vascular species, 29 rare bryophyte species (Anions,

Figure 13: Vegetation Regions of Western Newfoundland



Source: Berger et. al. (1992)

1994), and an estimated 28 to 54 rare lichen species (Parks Canada, 1996). Studies of fungi and aquatic flora are not yet complete so estimates of rare species of these types are not available (Parks Canada, 1996). The major vegetation regions of the study area (Figure 13) are represented within Gros Morne National Park, so numbers of rare species within the total study area should not be markedly different than those noted above for the park. The region also contains the unique tuckamore or krummholz vegetation. These are stunted, wind-blown, often extremely dense stands of balsam fir and spruce that occur along the coastal lowland. Their unusual appearance is attributed to the cold temperatures and persistent westerly winds.

*2. **Fauna.*** According to Northcott (1974), the island of Newfoundland contains fourteen native and ten introduced land mammal species.The recent colonization of the coyote increases the number of species by one. The study area contains most of these land mammals, as well as many species of birds, fishes, and invertebrates. Gros Morne National Park alone is home to 20 species of mammal, 177 species of birds, 12 species of fish, and an unknown number of invertebrate species (Parks Canada, 1996). Although similar estimates are not available for this specific study area, the park represents a good cross-section of the habitat types found throughout the study area, so a similar range of species would be expected in this larger region. Several of these species may be considered significant or of special concern because they are rare, endangered, space-demanding, or because they represent distinct subspecies found only on the Island of Newfoundland.

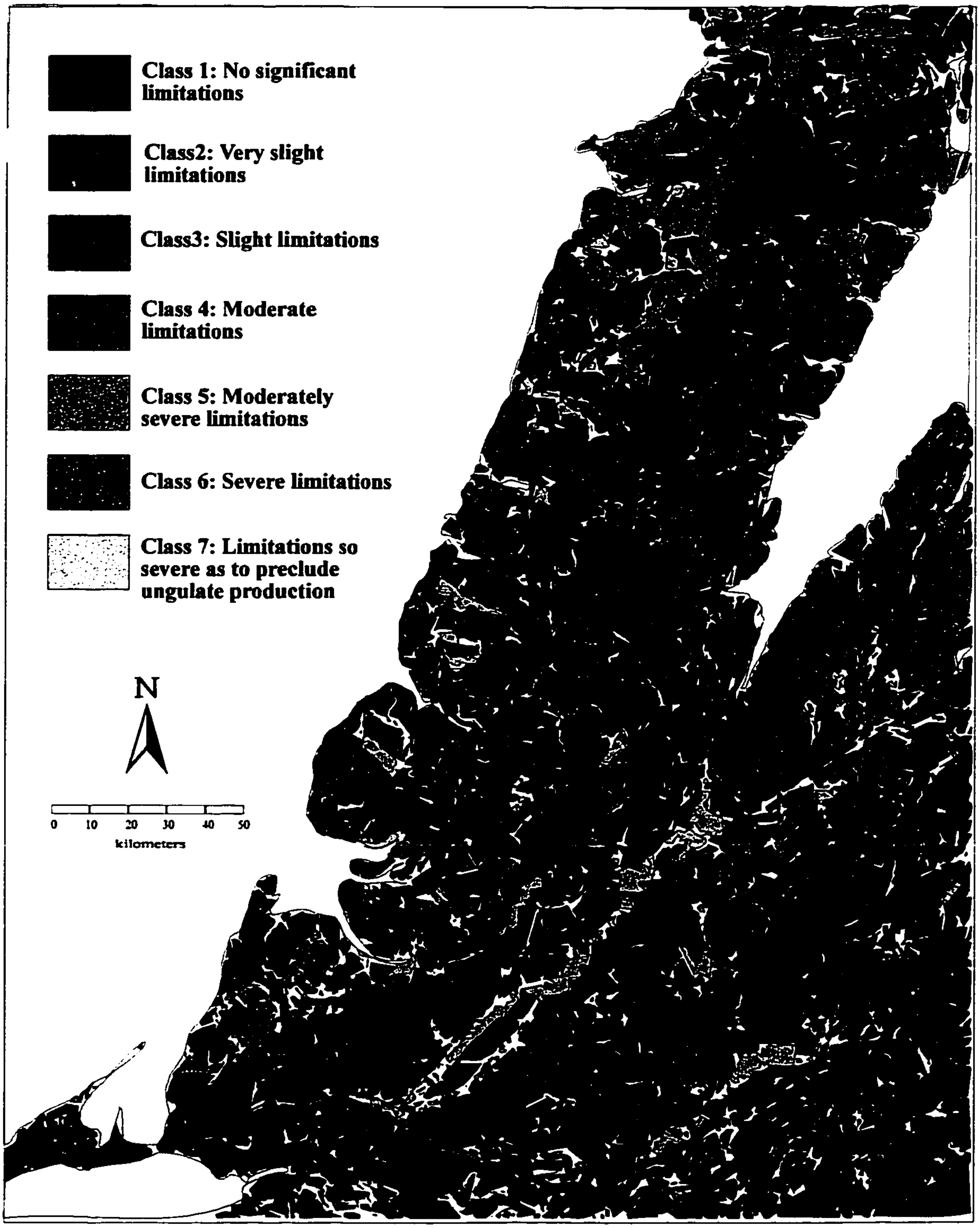
The Newfoundland black bear is considered a distinct subspecies of the American black bear and is the only large predator remaining on the Island of Newfoundland. It is larger than most mainland populations of black bears (Mahoney, 1985) and may be the most space-demanding species on the island. Estimates of home range size for black bears vary widely. Brown (1993) suggested a typical home range size for female black bears in North America of 20 square kilometers and for males of 110 square kilometers. The home range for the larger Newfoundland black bear (female) around Gros Morne National Park has been estimated to be approximately 40 square kilometers (Day, pers. comm.). Because home ranges tend to overlap (Brown, 1993), and because of variations in habitat quality, home range size may only provide a rough estimate of the number of individuals that an area can support. Actual bear densities may provide additional information to refine such estimates. Reliable data are not available on black bear population numbers in the study area. However, the black bear population on the Island of Newfoundland has been estimated to be in the range of 6000-10000 individuals (Department of Tourism, Recreation, and Culture, 1997; Day, pers. comm.). Assuming a broad distribution and habitat use, and excluding the Avalon Peninsula, where bears are not believed to occur, the density of black bears on the Island of Newfoundland would be approximately one to every 10-20 square kilometers.

In terms of habitat and diet, black bears are considered generalists. Although they prefer forested areas, they are also found in marshes, bogs, and fens (Brown, 1993; Canadian Parks Service, 1990). In the case of the Newfoundland black bear, they have also been known to inhabit the higher barren regions of the Long Range Mountains, probably because of the availability of caribou as a food source (Mahoney, 1985; Parks Canada, 1996). The diet of black bears is estimated to be primarily vegetarian (Hummel and Pettigrew, 1991; Brown, 1993), but they have also been known to prey on moose and caribou (Mahoney, 1985; Parks Canada, 1996).

The woodland caribou is another species that is significant to Gros Morne National Park and the surrounding region. Like the black bear, it is a very space-demanding, wide-ranging mammal. There are several herds in and around Gros Morne National Park and they migrate great distances across the park boundary (Figure 4). They are considered a representative species of the alpine tundra environment (Canadian Parks Service, 1990; Parks Canada, 1996) and are being considered as an indicator of ecosystem health (Parks Canada, 1996). The woodland caribou is the only native ungulate species on the Island of Newfoundland (Parks Canada, 1996) and the Newfoundland herds are considered to be a separate subspecies (Canadian Parks Service, 1990).

The woodland caribou have more specific habitat needs and food preferences than the black bear. The tundra environment of the Long Range Plateau is important caribou habitat and some areas such as Big Level in Gros Morne National Park are critical calving areas (Canadian Parks Service, 1990; Parks Canada, 1996). Despite their name, the woodland caribou are less common and spend less time in forested regions (Canadian Parks Service, 1990), although large numbers of them have recently been overwintering on the coastal lowlands and western slopes of the Long Range Mountains (Canadian Parks Service, 1990; Parks Canada, 1996). Figure 14 shows the suitability of different regions within the study area for caribou habitat. The suitability ratings are based on optimum

Figure 14: Land Capability for Ungulates



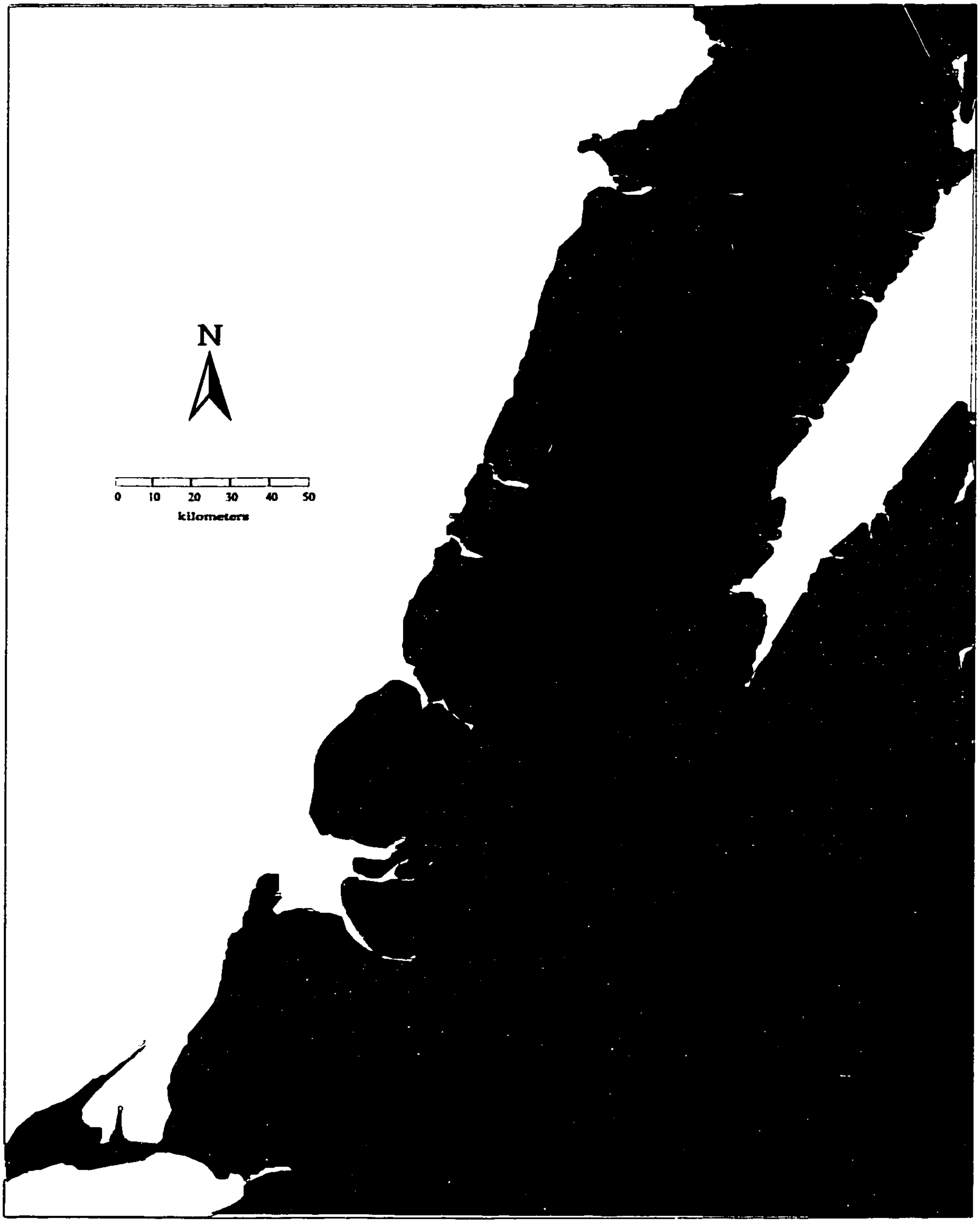
Source: Canadian Wildlife Service (19??a)

vegetational stage, and consider such factors as climate, landform, and soil characteristics. Since the extirpation of the Newfoundland wolf in the early 1900's, the caribou's only natural predator (other than humans) is the black bear (Canadian Parks Service, 1990; Parks Canada, 1996).

The arctic hare is significant because it is rare in the region, because it is, like the woodland caribou, considered representative of the alpine tundra, and because the populations occurring in western Newfoundland (Figure 15) are the most southerly populations in Canada (Canadian Parks Service, 1990; Parks Canada, 1996). The arctic hare is restricted to the Long Range Plateau and other upland regions (Canadian Parks Service, 1990). Its absence in low lying regions may be the result of competition from the snowshoe hare, which was introduced to the island in the early 1800's (Canadian Parks Service, 1990), although lack of preferred habitat at lower elevations may also be a factor (Mercer, n.d). Its major predators include the red fox, pine marten, lynx, humans, and the coyote, which has colonized the island over the last ten years (Parks Canada, 1996).

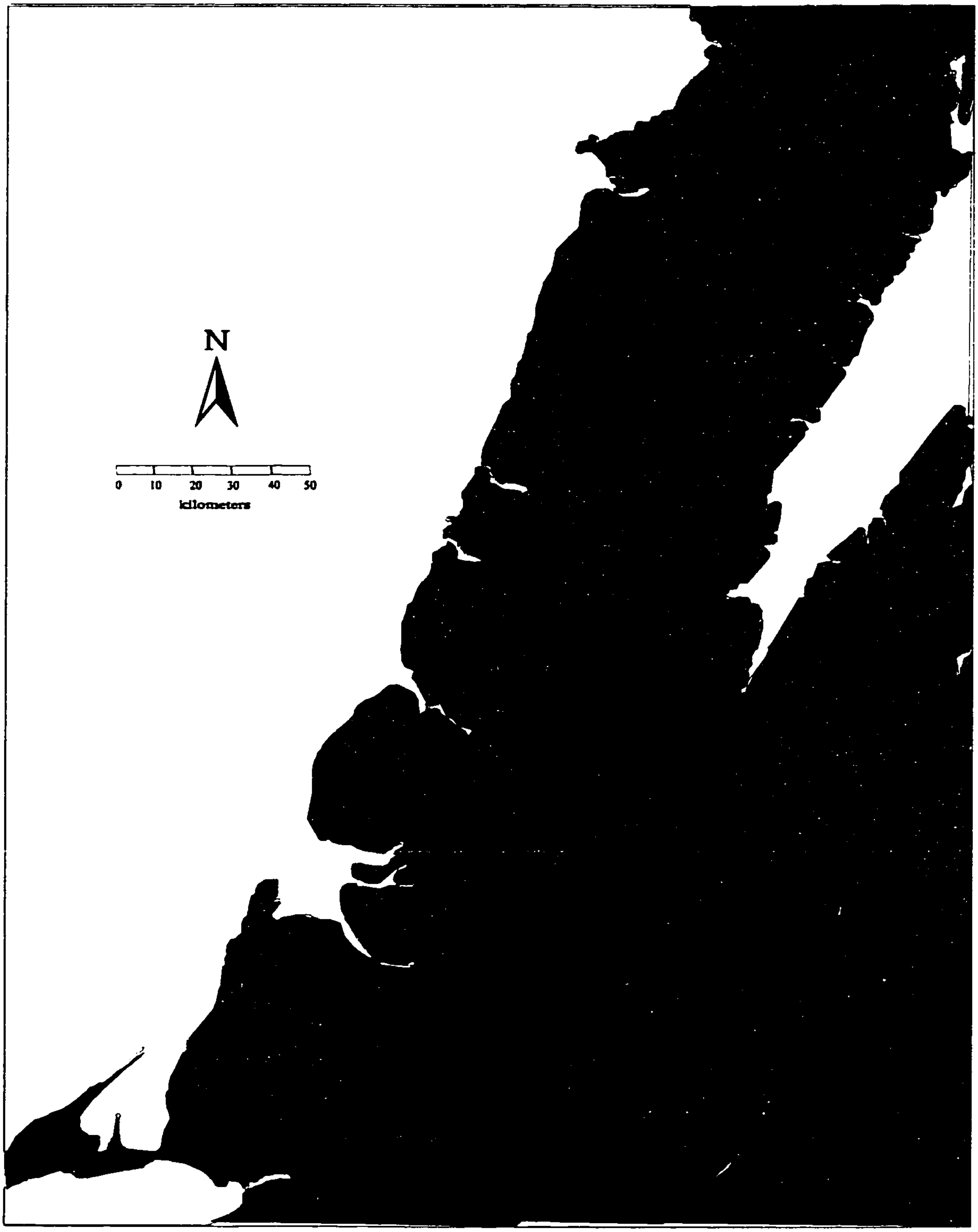
The Newfoundland pine marten was recently uplisted from threatened to endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC)(Parks Canada, 1996). There are several small populations in western Newfoundland, including one just east of Gros Morne National Park (Forsey et. al., 1995)(Figure 16). There are not believed to be any pine marten left within the park (Parks Canada, 1996). They are threatened primarily by the destruction of old growth forest habitat through logging and other development activities (Forsey et. al., 1995; Bissonette et. al., 1988) but also by illegal hunting and snaring, and possibly by competition from mink (introduced in the

Figure 15: Arctic Hare Distribution in Western Newfoundlnad



Source: Parks Canada (1996)

Figure 16: Pine Marten Distribution in Western Newfoundland, 1988-1993



Source: Forsey et. al. (1995

1930's) (Bateman, 1980, cited in Parks Canada, 1996), the red fox, and humans who hunt and snare snowshoe hare, an important pine marten prey species (Forsey et. al., 1995).

Another large mammal species which is common in the study area is the moose. They were introduced to the island in the late 1800's and early 1900's and have since spread throughout the island. They are a concern in Gros Morne National Park and the surrounding region, primarily because of their impact on vegetation (Parks Canada, 1996). Moose prefer regenerating balsam fir forest. Their numbers have increased in recent years, particularly in the park because they are protected, and because they have no natural predator except for the black bear. The density of moose is estimated to be 3 per square kilometer in the park and there are concerns that these large numbers are having an adverse effect on forest regeneration and may actually change the composition of the forest (Parks Canada, 1996).

Other significant fauna found within the study area include salmonid species such as Atlantic salmon (both anadromous and landlocked forms), brook trout and Arctic char, some of which have experienced significant population declines, harlequin ducks, listed as endangered by COSEWIC (Montevecchi et. al., 1995), rock ptarmigan, the most southerly population in North America, and the common and arctic terns, which are being displaced by gull populations that are expanding in response to anthropogenic change (Parks Canada, 1996).

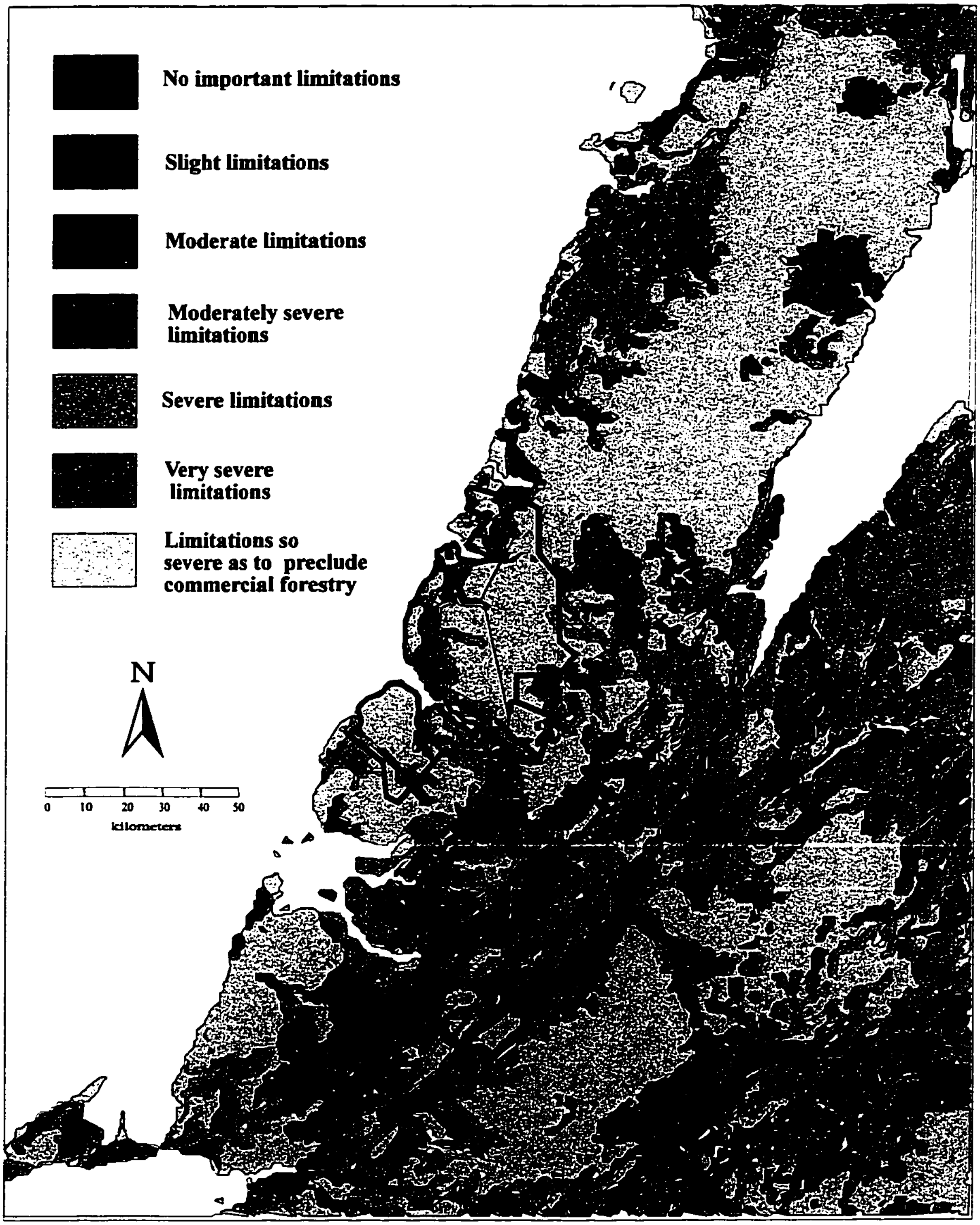
Cultural Features and Processes

*1. **Forestry Activities.*** The capability of the land for commercial forestry, and the areas owned and leased by the major forestry companies are shown in figures 17 and 18 respectively. A significant proportion of the land within the study area is being used for commercial forestry activities. Apart from the direct effects of forestry operations on animal habitat, runoff, and water quality, the construction of logging roads makes previously inaccessible regions accessible to humans and further threatens the integrity of natural ecosystems. Logging roads constructed within several kilometers of the eastern boundary of the park have greatly increased the accessibility of remote backcountry areas of the park, and forestry operations in this area threaten important habitat for the endangered pine marten (Parks Canada, 1996).

Apart from the two major commercial forestry companies (Abitibi-Price and Corner Brook Pulp and Paper), there are many smaller sawmills in the region and within the park itself timber harvesting for domestic use is allowed in certain designated areas (See Figure 19).

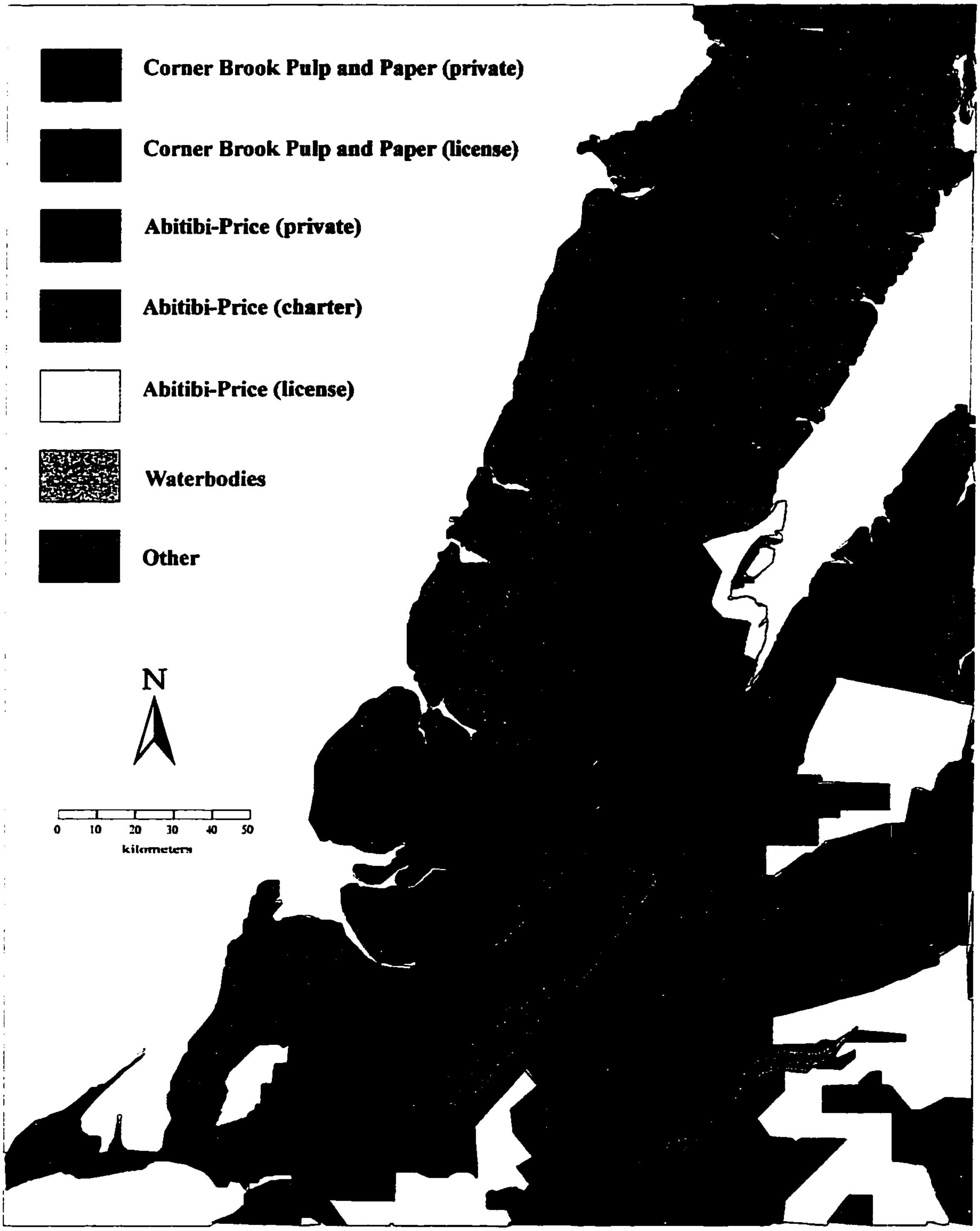
2. Mineral and Petroleum Exploration and Development. Several mineral deposits have been developed within the study area. Figure 20 shows the location of the most significant of these. The Daniel's Harbour zinc mine, just north of the park boundary, operated from 1975 to 1990, producing over 500,000 tonnes of zinc. Rehabilitation measures include removal of buildings, contouring of open pits, and seeding of the tailings area (Colman-Sadd and Scott, 1994).

Figure 17: Land Capability for Commercial Forestry



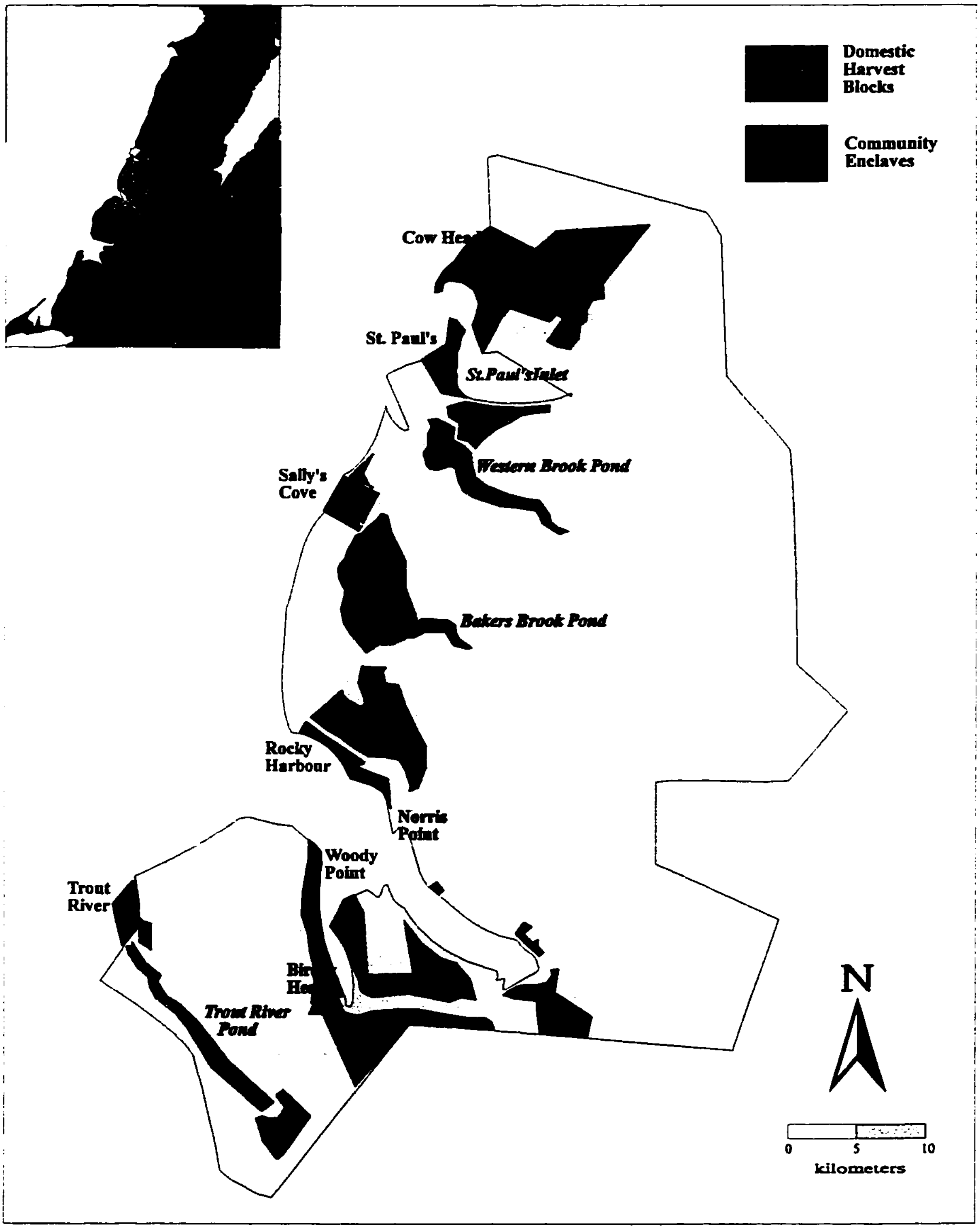
Source: Canadian Wildlife Service (19??b)

Figure 18: Land Ownership and Timber Leases for Commercial Forest Companies



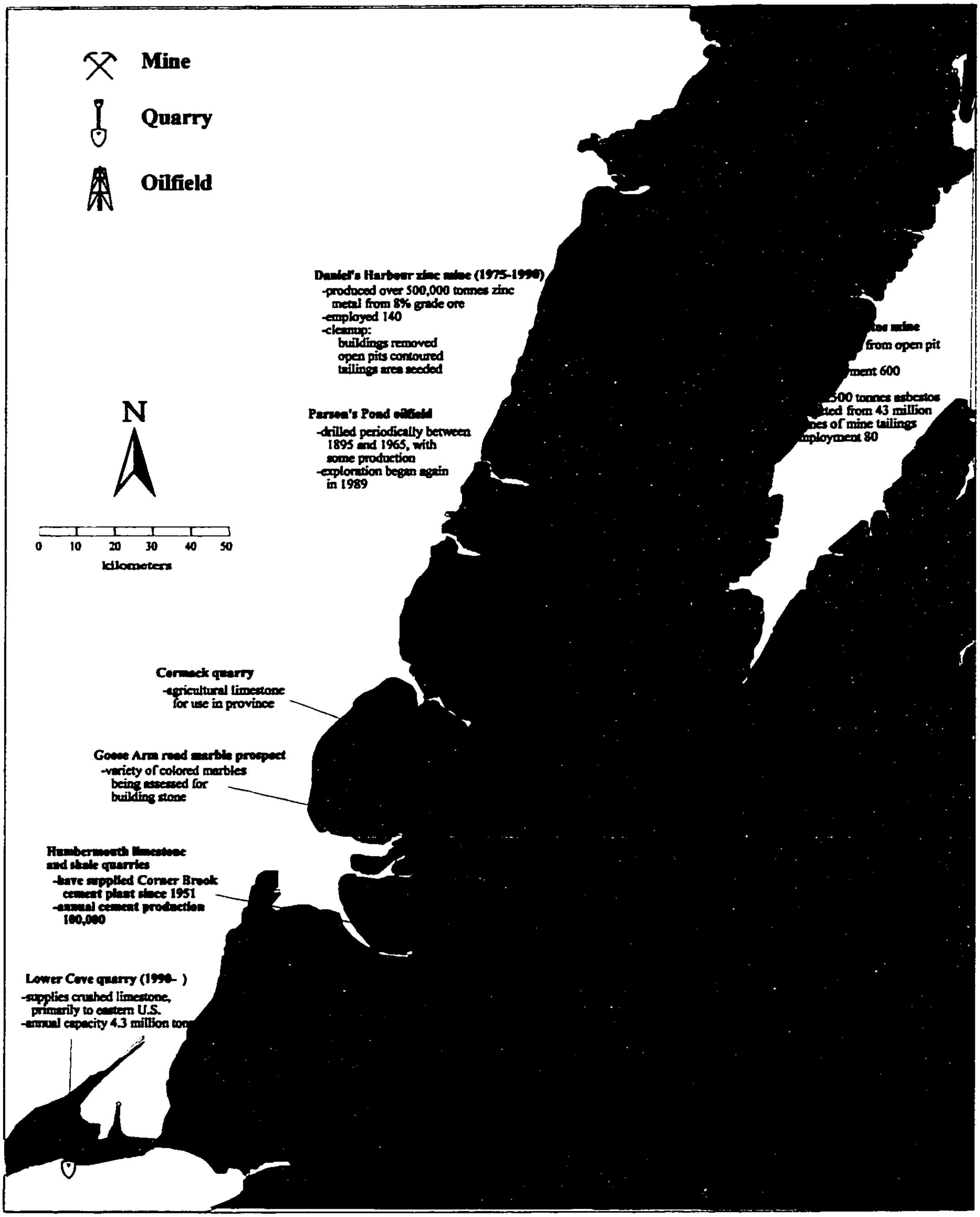
Source: Newfoundland Forest Service (1995)

Figure 19: Domestic Harvest Blocks and Community Enclaves in Gros Morne National Park



Source: Parks Canada (1996)

Figure 20: Major Mineral Developments in Western Newfoundland



Source: Colman-Sadd and Scott (1994)

The Baie Verte asbestos mine operated from 1960 to 1991. Recent activity included the extraction of asbestos from the mine tailings (Colman-Sadd and Scott, 1994), and a proposal to use the mine to store hazardous waste from the United States.

The Buchans mines, operating from 1927 to 1984 produced 17.8 million tonnes of zinc-lead ore (Colman-Sadd and Scott, 1994). These mines are no longer operating.

Other significant developments, current and planned, include quarries at Cormack, Goose Arm, Humbermouth, and Lower Cove on the Port au Port Peninsula which supply limestone and shale to Canada and the United States (Colman-Sadd and Scott, 1994).

There has been a resurgence of interest in petroleum exploration on Newfoundland's west coast in recent years since the discovery of an oil deposit on the Port au Port Peninsula (Parks Canada, 1996). In the past 7-8 years seismic surveys have been done at Parsons Pond just north of the park (Colman-Sadd and Scott, 1994), and a recent request to carry out a seismic survey within the park was denied (Parks Canada, 1996).

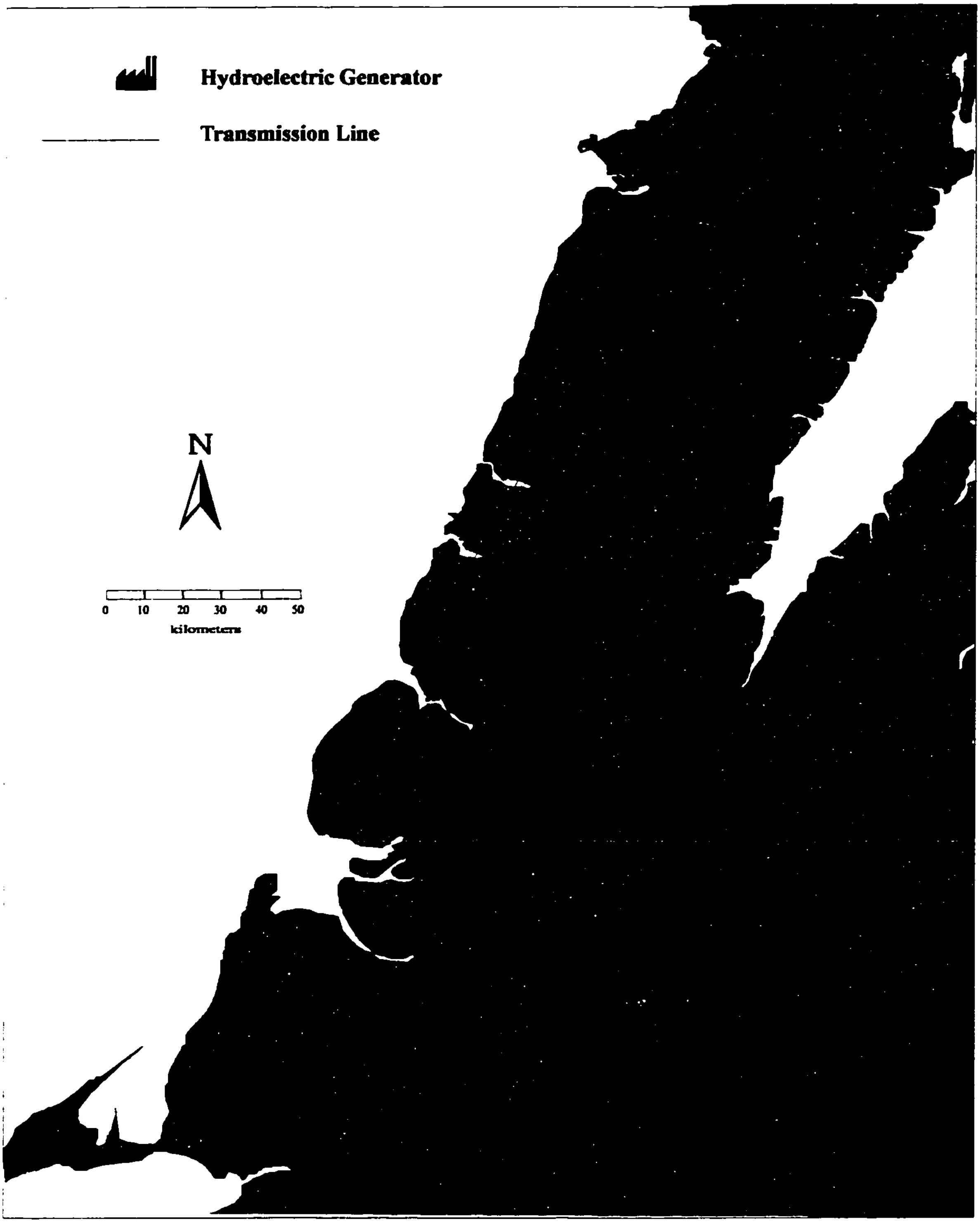
Potential threats associated with mineral and petroleum exploration and development include destruction or loss of significant geological or fossil material, negative impacts on downstream water quality and soil quality resulting from inadequate waste treatment and disposal, damage to coastal areas as a result of oil spills, and increased pressure to expropriate additional lands from the park in response to signs of rich oil or mineral deposits (Parks Canada, 1996).

3. Hydroelectric Development. There are several significant hydroelectric developments within the study area. These and the utility corridors through which the hydro transmission lines run (Figure 21) have the potential to affect the ecological integrity of a region in a number of ways. First, by flooding the land they may destroy important habitat for terrestrial species. Second, by disrupting stream flow they may destroy important habitat for aquatic species. Third, the utility corridors may create a barrier, restricting the movement of certain animal species, and effectively cutting them off from important habitat (Parks Canada, 1996). Fourth, the corridors can make remote areas more accessible to humans (Parks Canada, 1996). Finally, the disturbance of natural vegetation caused by such development may allow exotic species to gain a foothold (Parks Canada, 1996).

4. Recreational Activity. The level of recreational activity in the region surrounding the park has increased significantly since the park was established in the early 1970's (Parks Canada, 1996). The region contains several major canoe routes, golf courses, and downhill ski facilities. These further fragment the landscape and bring greater numbers of visitors to the area.

Recreational hunting and fishing are also important in the study area and throughout Newfoundland and Labrador in general. According to a 1991 survey (Filion et. al., 1993) a greater percentage of Newfoundlanders participated in or expressed an interest in participating in, both hunting and recreational fishing, than residents of any other province. Interestingly, the same survey found that a lower percentage of Newfoundlanders found it very or fairly important to maintain abundant wildlife or to preserve endangered wildlife or to pay for increased protection of habitat or protection of endangered wildlife from

Figure 21: Major Hydroelectric Developments and Utility Corridors in Western Newfoundland



Source: McManus and Wood (1991)

pollution, than residents of any other province (except New Brunswick which was lower on the question of the importance of protecting endangered wildlife)(Filion et. al., 1993). A large number of commercial outfitters (over 100 on the island) also bring significant numbers of non-residents to Newfoundland to fish and to hunt (primarily for moose, caribou, and black bear).

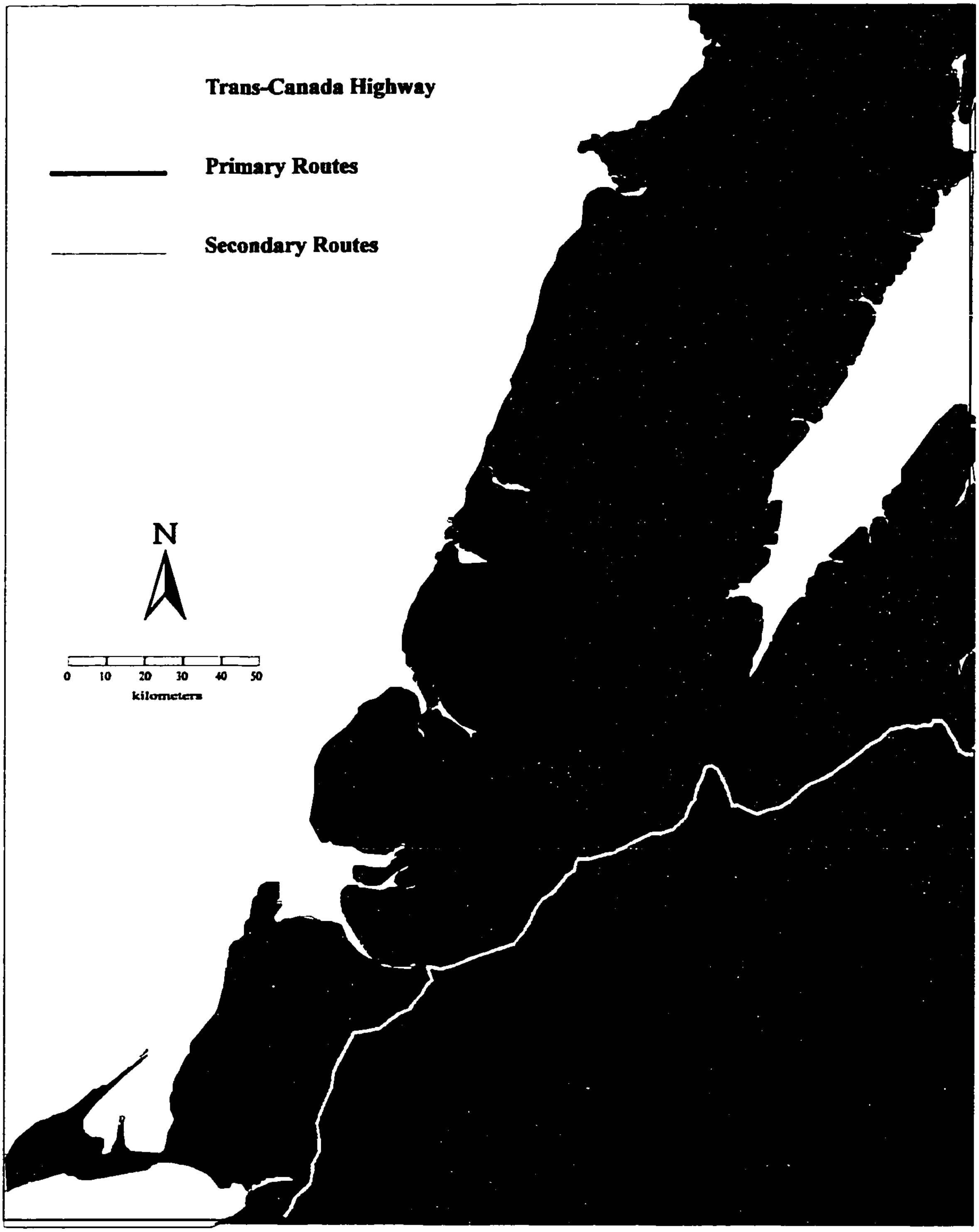
5. Roads. Like utility corridors, roads fragment habitat, allow greater access to humans, and allow for exotic plants to gain a foothold. Figure 22 shows the major roads in the study area.

6. Agricultural Development. Although most of Newfoundland is unsuitable for commercial agriculture, there are many patches of agricultural development on the Island. Figure 23 shows the location of proposed agricultural development in Newfoundland. Several sites fall within the study area.

Gros Morne National Park

Gros Morne National Park is located in the Bonne Bay region of western Newfoundland at the base of the Great Northern Peninsula. It was established in 1973, and at 1805 square kilometers, it is the largest national park in the Atlantic Region (Parks Canada, 1996). The Western Newfoundland Island Highlands and the St. Lawrence

Figure 22: Roads Network Western Newfoundland



Source: Lands Branch, Department of Environment and Lands (1988)

Figure 23: Proposed Agricultural Development in Newfoundland

Source: Roberts (1983)

Lowlands are the National Park Natural Regions represented within the park (Parks Canada, 1994).

Significant Features

Gros Morne National Park has a number of features that have great significance -- regionally, nationally, or internationally. The park is perhaps most well-known for its interesting geology and spectacular landscapes. It was these features that led to the park's designation in 1987 as a UNESCO World Heritage Site (Parks Canada, 1996). The exposed ancient oceanic crust and the fossils associated with the ancient continental margin are considered globally significant geological features. The park is also very well-known for its spectacular glacier-carved, land-locked fiords.

Several species of flora and fauna have some significance at regional or greater scales. The woodland caribou and the arctic hare are considered to be representative of the alpine tundra environment of the park. The arctic hare is also rare and near the southern limit of its range. The woodland caribou and the black bear are two of the widest ranging animals on the island of Newfoundland, and the black bear also represents a distinct subspecies and the only large predator on the island. There are several other species of flora and fauna that are rare, or are near the southern or northern limit of their distribution (eg. pine marten, harlequin duck, rock ptarmigan, white pine, red maple, yellow birch, black ash).

There are several features of the park's relationship with surrounding communities which may also be considered significant. First, several communities that existed prior to establishment of the park remain today. These park enclaves (Figure 19) are partially or completely surrounded by the park. Second, several domestic harvest blocks (Figure 19) have been established within the park boundaries (outside park enclaves) to allow local residents to continue traditional subsistence activities such as woodcutting for domestic use and snaring of snowshoe hares (Parks Canada, 1996). The park enclaves and the domestic harvest blocks together comprise the majority of the coastal lowlands within the park region (Parks Canada, 1996). Third, the use of snowmobiles is permitted within the park. This allows for relatively easy access to remote areas of the park. These features suggest a need for cooperative management not just beyond park borders, but also within them.

Threats to Park Integrity

Gros Morne National Park's Ecosystem Conservation Plan discussed major resource issues for the park. These issues were ranked as to priority according to a ranking scheme developed by Parks Canada. It considered legal, political, visitor, and resource factors, problem characteristics, and constraint factors. Table 11 lists these issues in order of priority. It also lists potential threats to park integrity related to each issue, and the source of such threats, whether internal or external.

Table 11 suggests that the majority of threats to the ecological integrity of Gros Morne National Park originate both within and outside the park itself, highlighting the significance of transboundary processes.

Table 11: Major Resource Issues and Related Threats: Gros Morne National Park

RESOURCE ISSUE	POTENTIAL THREAT	Internal	External
1. Timber Harvest	- harvest levels not sustainable - altering natural forest succession - altering disturbance regimes	x	x
2. OSV Use	- damage to rare vegetation - disturbance of wildlife (esp. caribou, arctic hare, ptarmigan)	x	x
3. Salmonids	- recreational overfishing - poaching - effect of forest harvesting on water quality - introduction of non-native species	x	x
4. Black Bear	- legal bear hunt outside park border - poaching - garbage habituated bears - habitat fragmentation	x	x
5. Peripheral Land Use	- habitat destruction, fragmentation - incompatible land use		x
6. Geological Resources and Aggregate Supplies	- degradation of aesthetic values - siltation and contamination of surface and groundwater - invasion of exotic vegetation	x	
7. Newfoundland Marten	- currently endangered due to: habitat loss poaching competition from humans, fox		x
8. Moose and Vegetation Impact	- high moose numbers due to: protected status lack of natural predator - significant browse damage, esp. in domestic harvest blocks - changing forest composition	x	
9. Arctic Hare	- low population - susceptible to human disturbance - competition from introduced snowshoe hare	x	x
10. Park Zoning	- inadequate protection of improperly zoned environmentally sensitive areas	x	
11. Rock Ptarmigan	- low population - susceptible to human disturbance - poaching	x	x
12. Woodland Caribou	- OSV disturbance, esp. on calving grounds - poaching - habitat destruction outside park	x	x

Table 11 (continued):

RESOURCE ISSUE	POTENTIAL THREAT	Internal	External
13. Harlequin Duck	- currently endangered - threats include accidental shooting and coastal oil pollution	x	x
14. Rare/Uncommon Trees	- poor regeneration - forest harvesting - domestic harvesting - moose browse damage	x	x
15. Rare Flora	- damage from hiking activity - domestic harvesting activity - invasion of exotic species	x	x
16. Site Rehabilitation	- destruction of aesthetic values	x	
17. Water Quality	- contamination from landfills - increased runoff, nutrient leaching, and erosion due to commercial forest harvesting - pollution from OSV engines - bacterial contamination from sewage facilities	x	x
18. Park Boundaries	- expropriation of additional lands from park - configuration -- low park area to boundary length ratio		x
19. Waste Management	- pollution of air, water, and soil - aesthetic effects - garbage habituated bears	x	x
20. Sand Dunes	- natural dune migration disrupted by road construction, logging, livestock grazing, facility development, and visitor use	x	
21. Fossils and Rare Minerals	- loss and destruction due to visitation and sample collection	x	
22. Common and Arctic Terns	- displacement of terns by gull populations which are expanding in response to human activity	x	x
23. Invasive Exotic Plants	- loss of native species due to competition for space, water, and nutrients	x	x
24. Snowshoe Hare	- snaring in non-designated areas - accidental snaring of non-target species	x	x
25. Beaver	- effects of beaver damming activity on road stability	x	

Source: Adapted from Parks Canada (1996)

Trans-Park Boundary Processes and Concerns

The impact of activities outside the park's boundaries was considered to be the fifth most immediate priority for Gros Morne National Park (Table 11). The significance of such activities for the integrity of the park is underlined also by Figure 24, which shows the cross-correlation table used in the Parks Canada priority ranking exercise. As noted above, this exercise ranked issues of concern on the basis of legal, political, resource and other factors. Although the cross-correlation score is only one portion of the resource factor section of the entire ranking process, and thus contributes only slightly to an issue's total ranking score, it is significant in that it measures the degree of interrelatedness of each issue with the other issues in the table. The issue of peripheral use has the highest score in the cross-correlation table indicating that it has the greatest web of interrelationships of all the issues in the table.

Further examination of the cross-correlation table indicates that the issues showing the most direct relationship to peripheral land use are those related to wide-ranging fauna such as the larger mammals, salmonids, and terns. Direct relationships are also shown for activities associated with the community enclaves and their residents. Indirect relationships are shown for the smaller mammals, and for issues associated with water such as timber harvesting, and water quality. These observations make sense because one would expect that the movement of water and fauna, particularly large fauna, would be among the most significant trans-boundary processes.

Figure 24: Cross-correlation Table Used in Issue Priority Ranking for Gros Morne National Park

Ecosystem Conservation Plan Cross-Correlation Table 2 = direct relationship 1 = indirect relationship 0 = no relationship	Geological Resources	Fossils	Sand Dunes	Black Bear	Woodland Caribou	Moose	Arctic Hare	Snowshoe Hare	Newfoundland Marten	Beaver	Salmonids	Harlequin Duck	Rock Ptarmigan	Terns	Rare Flora	Rare Trees	Exotic Plants	OSV Use	Timber Harvest	Waste Management	Peripheral Use	Park Boundaries	Park Zoning	Water Quality	Site Rehabilitation
Geological Resources and Aggregate											1					1	2				2			2	2
Fossils																							1		
Sand Dunes															1										1
Black Bear					2	1	1											1	1	2	2	1			
Woodland Caribou				2											1			2	2		2	1	2		
Moose				1												2		2	2		2	1			
Arctic Hare				1				1										2			1	1	1		
Snowshoe Hare							1		1									2	1		1				
Newfoundland Marten								1										1	2		2	2	2		
Beaver																1								2	
Salmonids	1																	1			2		1	2	
Harlequin Duck																							2	1	
Rock Ptarmigan																		2			1		1		
Terns																				1	2				
Rare Flora			1		1												2	2					2		
Rare Trees	1					2				1									2				2		
Exotic Plants	2														2										1
OSV Use				1	2	2	2	2	1		1		2		2						2		2	1	
Timber Harvest				1	2	2		1	2							2					2	2	1	2	2
Waste Management				2										1							2		1	2	2
Peripheral Use	2			2	2	2	1	1	2		2		1	2				2	2	2		2		1	
Park Boundaries				1	1	1	1		2										2		2				
Park Zoning		1			2		1		2		1	2	1		2	2		2	1	1					
Water Quality	2									2	2	1						1	2	2	1				1
Site Rehabilitation	2		1														1		2	2				1	
TOTALS	10	1	2	11	12	10	7	6	10	3	7	3	4	3	8	8	5	20	19	10	26	10	18	11	9
Normalised Scores (0 to 4)	2	0	0	2	2	2	1	1	2	0	1	0	1	0	1	1	1	3	3	2	4	2	3	2	1

Source: Parks Canada (1996)

Other natural processes that operate across the artificial park boundary are those associated with climate and geology. These processes are controlled globally and significant changes occur over extremely long time periods, so they would be of less immediate and direct concern for regional management purposes. For example human activity has significantly reduced or eliminated the populations of large mammals in many regions of the world, but a dry, continental climate is not as easily transformed into an entirely different regime, nor is the slow process of mountain-building halted by human activity.

The description of the study area given in this chapter provides a general understanding of the region. It also highlights the abiotic, biotic, and cultural features of the region that are considered significant to the park and surrounding area. It described potential threats to the region's ecological integrity and discussed trans-park boundary concerns. These will be used in selecting a set of representative features and processes which are consistent with the guidelines of Chapter 3. These representative features and processes will in turn be incorporated into a series of map layers which will be used to define those areas around which a Greater Gros Morne Ecosystem boundary should be drawn.

V. APPLICATION TO GROS MORNE NATIONAL PARK: THE SUBSTANTIVE COMPONENTS

The approach to Greater Ecosystem definition for Gros Morne National Park follows the general guidelines outlined in Chapter 3. These guidelines were derived from the basic principles and objectives of ecosystem management and national park management. For purposes of this application these guidelines were tailored to the specific features, threats, and trans-boundary processes of Gros Morne National Park and the surrounding region.

The following sections describe the scope and limitations of the application, provide a detailed description of the approach, and discuss the results of its application.

Scope and Limitations

The general guidelines noted in Chapter 3 suggest an approach to delineating a Greater Park Ecosystem that contains substantive components (guidelines 1-3) and process components (guidelines 4-5). For the most part the process components are beyond the scope of this study. Ideally, all stakeholder organizations, including local individuals and groups, should be encouraged to participate in the process of defining the boundary of a Greater Park Ecosystem. Additionally, local knowledge and understanding of the physical and cultural environment should be solicited and a full institutional analysis carried out to investigate the possibility of adjusting current institutional boundaries and mandates. It is not the intent of this study to illustrate these process components. However, a preliminary assessment of these components, which will be helpful in assessing the potential for acceptance of a Greater Gros Morne Ecosystem concept, is carried out in the next chapter

The intent of this study is to illustrate the substantive components of the approach; however, there were limitations related to these components also. The most significant limitation related to data availability. The size of the study area and the breadth of factors to be considered precluded the use of extensive field work to gather data. A significant amount of data were available for the park itself, but there were significant gaps for the remainder of the study area outside the park. Where the required data were not available, substitutes were sometimes available to serve the same general purpose. For example, at the scale of analysis used in this research, it was difficult to map specific future forest harvest locations. Harvest blocks are often too small and too dispersed to map in a meaningful way. To show areas of possible future forest company interest, I used instead a map of forest company land ownership and timber rights, and a map of forest capability values.

There were also limitations related to data accuracy. Much of the data that had been gathered for purposes of defining a Greater Gros Morne Ecosystem were derived from 1:250,000 or smaller scale maps, so data would be expected to be accurate only to within 250-500 meters. Furthermore, some of the maps, particularly those showing animal habitat use, are generalized, and are by their nature not intended to depict well-defined boundaries.

Despite the limitations, sufficient data were available to illustrate the basic features of the approach. Further research should fill the data gaps, increase understanding, and examine in greater detail the implications of the process components to the placement of the boundary.

Methodology

In the previous chapter the major features and processes of Gros Morne National Park and surrounding region were described. In some cases the study area was divided into smaller regions on the basis of climate, physiography, geology, and wildlife distribution, among others. The boundaries of these various divisions did not coincide, and none of the divisions, individually, was adequate to describe a Greater Gros Morne Ecosystem . I needed a single unit for management purposes that considered the various features and processes and the interactions among them. However, the great number of features and processes and the great complexity of interactions among them required that I choose representative features or processes for purposes of defining the greater ecosystem. Furthermore, I needed some basis for deciding which features or processes to choose.

My first step, then, was to determine which features or processes would be used to represent all others in defining a Greater Gros Morne Ecosystem. Consideration was given to features and processes that were significant to the park and surrounding region, to features and processes that were threatened or were considered a threat, and to significant trans-park boundary concerns. This is consistent with the guidelines in Chapter 3.

Following this, a list of criteria was developed. These criteria were based on the features or processes chosen above to represent the ecosystem, as well as the guidelines for drawing ecologically sound boundaries, which are listed in Theberge (1989) and Skibicki (1995a) and which are reproduced as Table 5. Each criterion was represented by a single map layer. Then using GIS software (in this case IDRISI), the study area was divided into pixels, and each pixel was assigned a value for each of the criteria noted above. A series of map overlays was performed,using the addition function in IDRISI, with the final result being a single map whose pixel values represented the sum of the pixel values at the same location on the individual map layers. This final value assigned to each pixel represented its suitability for inclusion in the Greater Gros Morne Ecosystem. Additional manipulations were required to group pixels and eliminate patchiness, and to ensure that the final boundaries were ecologically based.

The following sections will (1) list the features and processes selected as representative and provide a rationale for their inclusion, and (2) provide a more detailed description of the steps followed in the analysis.

Representative Features and Processes

Black Bear Habitat

The black bear was chosen because of its significance: it is the widest-ranging mammal in the region, it is the only large predator on the Island of Newfoundland, and the Newfoundland population is a distinct subspecies of the American black bear. It is also vulnerable to threats such as poaching, and encroaching human development.

Furthermore, because it often moves over large distances it is considered a significant transboundary concern.

Although the black bear tends to prefer forests, it is considered a habitat generalist, making it difficult to define a specific set of suitable habitat conditions. I will make the assumption that the entire study area is suitable for black bear habitat, and include this significant species in my analysis by using Grumbine's (1994a) contention that a Greater Park Ecosystem be large enough to support a minimum viable population of the largest predator in the region. Using the mid-range number for a minimum viable population, 500 individuals, and an estimated density of one bear per 15 square kilometers (estimated in previous section to be one bear per 10-20 square kilometers), the greater ecosystem should be approximately 7500 square kilometers.

Caribou Habitat

The woodland caribou is considered significant in the region because it is a wide-ranging mammal that may be useful as an indicator of ecosystem health. Potential threats to caribou populations include human disturbance such as snowmobile use, and forest clearcutting. The ranges of several herds cross the park boundary.

Caribou habitat will be included in the analysis in two ways. First, the current estimated range of herds in and around Gros Morne National Park (Figure 4) will be considered important for inclusion in a greater ecosystem, and preferred habitat that is not currently being used by caribou herds (Figure 14) will be considered important. This will give recognition to the fact that habitat use changes over time.

Other Small Mammal Habitat

Habitat required for arctic hare and pine marten will also be considered in the analysis. The arctic hare is significant because it is rare, it is considered representative of the park region, and because it is at the southern limit of its distribution; the pine marten because it is rare. Both are threatened by encroaching human development and by poaching, and the pine marten, which is officially listed as endangered, by the clearing of old growth forest. Although neither species ranges as widely as the black bear or caribou, both are impacted by processes occurring beyond the park boundaries.

The current distribution of arctic hare and pine marten (Figure 15 and 16, respectively) will be considered important for inclusion in the greater ecosystem.

Watersheds

Theberge (1989:696) suggested that "...the principal abiotic objective in boundary delineation should be to maintain drainage basin integrity." Theberge (1989) and Skibicki (1995a) suggested several general guidelines related to this primary objective (see Table 5). Limitations on data availability preclude us from considering all these guidelines in the analysis. For example, data on subsurface water flow is not available. However, where possible, entire watersheds will be included. Figure 5 shows all the major watersheds in the study area.

Forestry

Forestry is considered the most significant threat to ecological integrity within the study area, but it is also very significant culturally. It is the major industry in the region and provides employment for large numbers of people. Therefore, a small negative value will be assigned to areas which have a high capability for forestry (Figure 17) and for which the major forest companies have timber rights or ownership (Figure 18). Although this area represents a large proportion of the study area, other criteria noted above will ensure that forested areas will not be excluded.

The exclusion of several major features and processes from the analysis needs some explanation. First, climate was considered by Bailey (1996) to be the primary control over ecosystem distribution. He suggested that for large scale analyses, similarities in climate should be the major consideration in delineating ecosystem boundaries. It has been excluded in this analysis for several reasons. First, Bailey (1996) argued that climate be used for scales in the hundreds of thousands of square kilometers. The study area used in this research covers some tens of thousands of square kilometers. Second, although examples of arctic alpine climate at higher elevations in the study area are regionally significant, climate is not generally considered an identifying feature of the park and surrounding region. Third, although climate processes are certainly transboundary, they are controlled far beyond the boundaries of this region. Management for maintenance of ecological integrity should use units that are defined by more regional processes. In other words, regional management actions will have little effect on the general climate of the region, but could significantly impact black bear populations or water quality.

The geology of Gros Morne National Park is considered very significant. However, like climate, the major tectonic forces responsible for the most significant geological features are beyond the control of regional management agencies, and for the most part are beyond human control at any scale. The significant geologic features of the Tablelands are not generally threatened nor will they be preserved by regional management actions. The more localized, vulnerable features, such as important fossil sites are not significantly threatened by transboundary processes and can be adequately preserved by effective management actions within the park boundaries, where park management has full jurisdiction.

The guidelines of Theberge (1989) and Skibicki (1995a) also suggested that rare or unique sites (cultural, geomorphic, hydrologic) be included within the boundary (Table 5). Several such sites already exist within the official park boundary. These include Broom Point, the site of prehistoric Paleo-Eskimo occupation (Canadian Parks Service, 1990), a number of fossil and rare mineral sites (Parks Canada, 1996), the extremely significant geological formations, and the glacier carved fiords, such as Western Brook Pond.

Details of Approach

The following map layers will be used in the analysis. The value assigned to each factor below reflects the author's judgment as to its relative importance, and is based on the discussion in chapter IV on significant features, threats to ecological integrity, and transboundary processes. For example, caribou are considered more important, *for purposes of ecosystem boundary delineation,* than arctic hare or pine marten, for the reasons discussed in chapter IV. The different scales used below, although somewhat subjective, reflect these different levels of importance. All layers contain pixels of 250 meters by 250 meters.

1. Caribou herds in and around Gros Morne National Park. (based on Figure 4). All pixels within the current range of the herds assigned a value of 5; all others 0.

2. Land capability for caribou (based on Figure 14). Each pixel assigned a value from 0-5 depending on its suitability for caribou habitat.

3. Arctic hare distribution (based on Figure 15). All pixels within current distribution assigned a value of 2; all others 0.

4. Pine marten distribution (based on Figure 16). All pixels within current distribution assigned a value of 2; all others 0.

5. Forest Company Interest (based on Figures 19 and 20). Each pixel assigned a value from 0 to **minus** 5. All pixels for which a major forest company has no current ownership or lease right will be assigned a value of 0. All others will be assigned a negative value depending on its capability for commercial forestry. Pixels with higher capability values will be assigned greater negative values.

6. Distance from park boundary. Each pixel assigned a value from 0-10 depending on its distance from the park boundary. The closer the pixel is to the park boundary, the higher its value.

7. Gros Morne National Park. All pixels contained within the boundary of the park will be assigned a value of 100 to ensure its inclusion in the greater ecosystem.

The combination of all layers will yield a final layer showing a value for each pixel related to its suitability for inclusion in a Greater Gros Morne Ecosystem. Each pixel can then be ranked in descending order and the 120,000 pixels with the highest ranking will represent those deemed most suitable for a 7500 square kilometer greater ecosystem (1 pixel = 250m x 250m; 16 pixels = 1 square kilometer; 120,000 pixels = 7500 square kilometers). Based on the above discussion, this is theoretically large enough to support a population of 500 black bears, and a larger population of less wide-ranging species. Because these highest value pixels will likely not represent a single contiguous group, further manipulation will be required to eliminate pockets of lower value pixels contained within groups of high value pixels, to examine how the final product relates to watershed boundaries and to ensure the boundaries have some ecological basis.

Results and Discussion

The result of combining the layers noted above was a map showing values from minus 1 to 24. To make this easier to read a reclassification was performed on the basis of information in Table 12. Table 12 shows each value from 0 to 24, and the area, in square kilometers, occupied by pixels of that value (all negative numbers forced to zero). I am interested in the 7500 square kilometers having the greatest value. Pixels (as noted previously each pixel represents an area 250 meters by 250 meters) with values from 13 to

Table 12: Total Area per Map Combination Value

Map Value	Area (square km)	Map Value	Area (square km)	Map Value	Area (square km)
0	29590	9	2655	18	359
1	125	10	2725	19	166
2	1680	11	2917	20	131
3	4400	12	2661	21	137
4	3544	13	1608	22	33
5	2534	14	1202	23	0
6	1479	15	918	24	1922
7	1348	16	636		
8	1581	17	511		

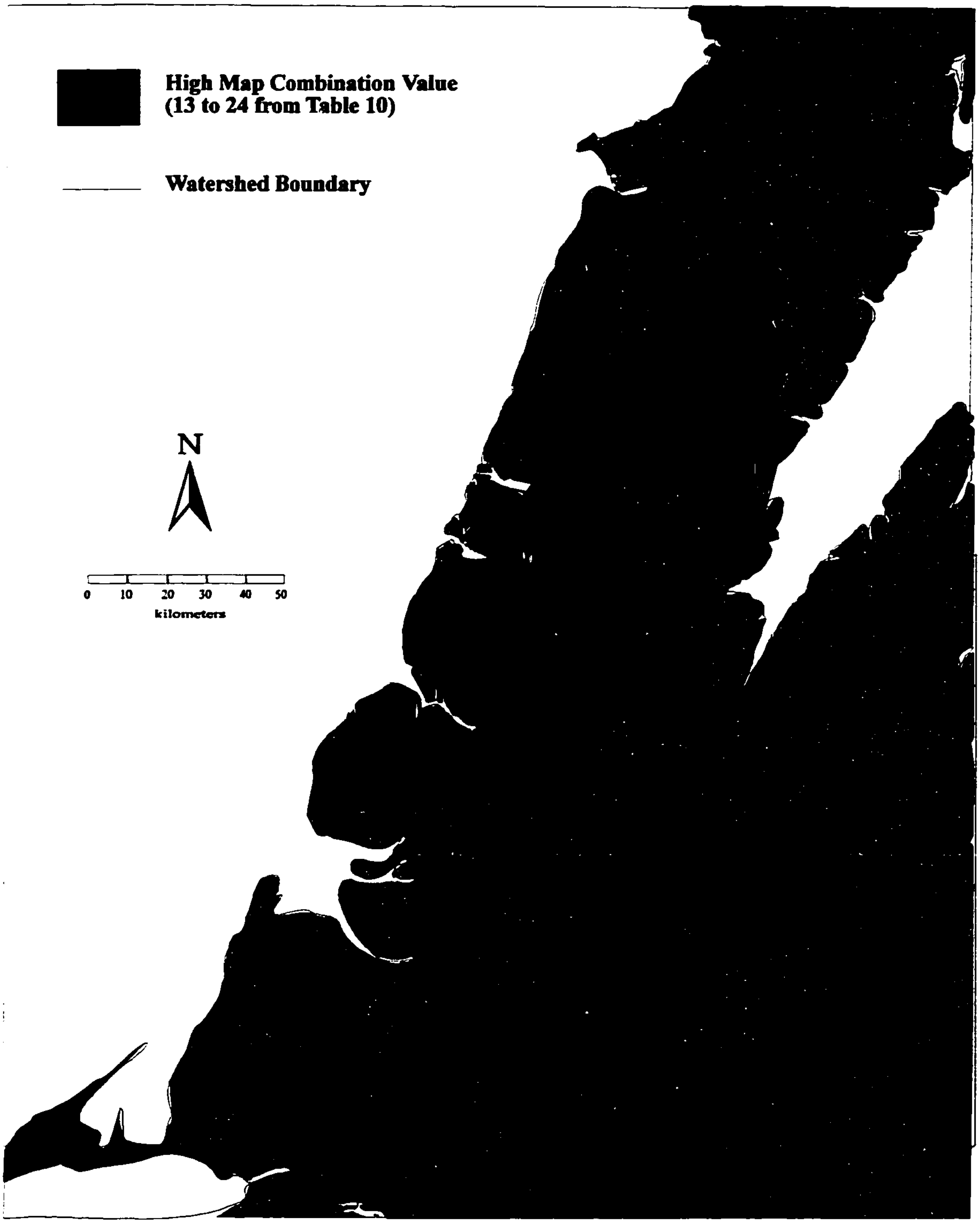
24 occupy 7623.125 square kilometers, and thus represent those areas deemed most suitable for inclusion in a Greater Gros Morne Ecosystem. Using this information the initial map was reclassified so that all pixels with a value of 0 remained 0; values from 1 to 12 were reclassified to 1; values from 13 to 24 were reclassified to 3 and of this the park itself was reclassified to 4. The result, shown as Figure 25, gave an indication of the general region to be occupied by a Greater Gros Morne Ecosystem. The most favourable areas are to the north and northeast of the park. There is also an area of favorable territory 60-70 kilometers southeast of the park border, although this area is somewhat fragmented and is interspersed with less favorable territory.

Watershed boundaries, also shown in Figure 25, provided additional information for boundary definition. An attempt was made to include entire drainage basins in the greater ecosystem. Those in and around the Park, particularly the region to the north and northeast as indicated in Figure 25, were considered. Where entire watersheds could not be included, as with the Humber River watershed, the higher elevation headwaters were given consideration.

The final greater ecosystem boundary was set by examining Figure 25 to determine the general location of the majority of high value pixels and where possible, using the boundaries of the watersheds in these regions as the greater ecosystem boundary. Where these boundaries could not be used, the location of other features would be considered.

Using this procedure, the Greater Gros Morne Ecosystem was determined to include all watersheds from Goose Arm Brook watershed which flows into Middle Arm of Bay of Islands in the southwest to White Bay in the east to Portland Creek in the north. It

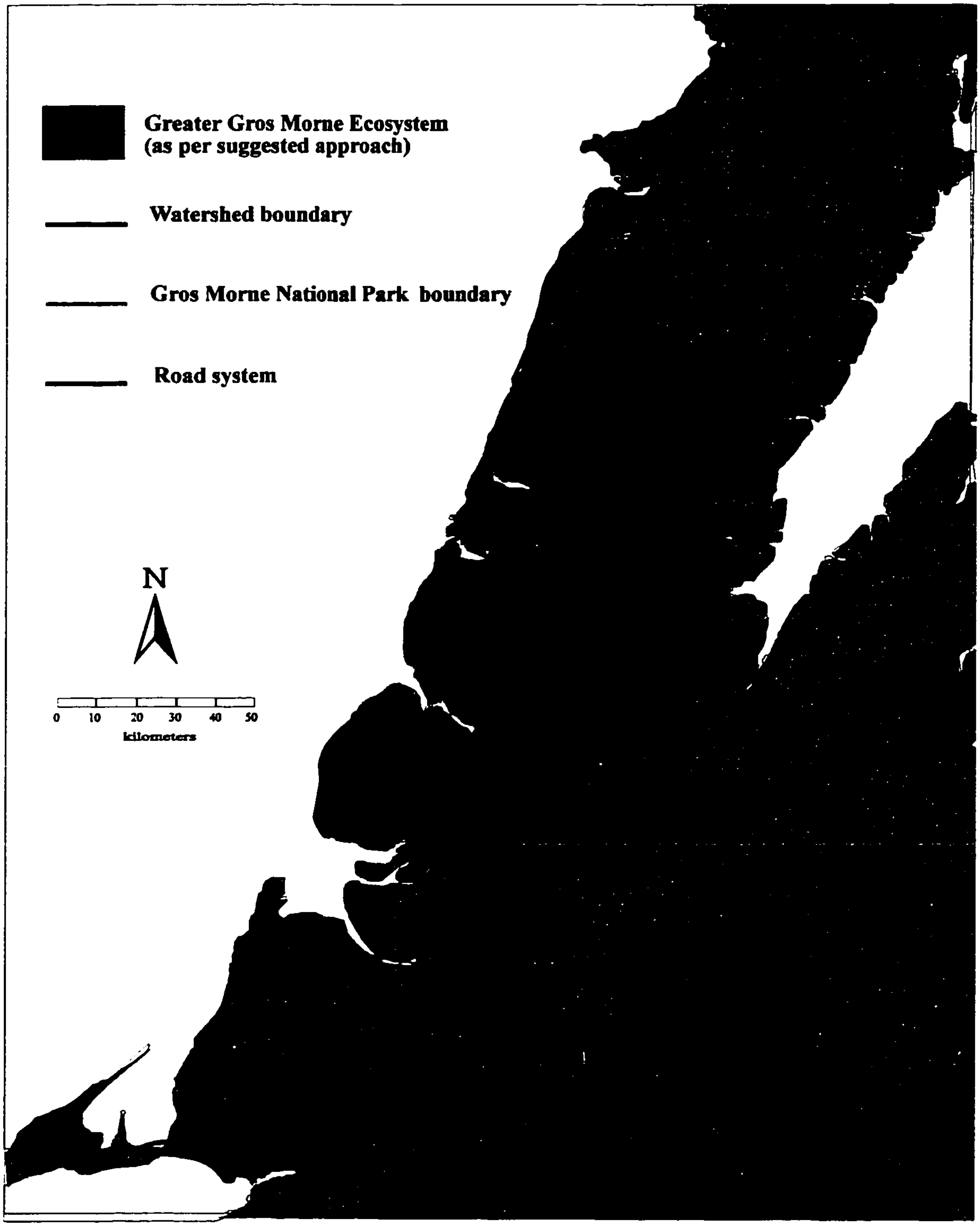
Figure 25: Regions of High Map Combination Value



excluded the Hampden River watershed which flows into White Bay, and the watershed of an unnamed river between Cat Arm River and Main River, which also flows into White Bay (see Figure 5). Figure 5 also shows several coastal areas which are not shown to be part of a particular drainage basin. These areas are included in the greater ecosystem where they lie on the west coast, but are excluded where they lie along the east coast of the Northern Peninsula, in the region of White Bay. This decision was based on the fact that the Park itself borders the west coast, because the exclusion of the eastern coastal area provides a corridor that may be useful for other development interests, and because of the need to keep the total area of the greater ecosystem within approximately 7500 square kilometers. Finally, a portion of the Humber River watershed around its headwaters east of the Park is included. To determine the exact boundary through the Humber watershed, a five kilometer buffer was drawn to the north and west of highways 420 and 422, which are located east of the Park (see Figure 22). Those parts of the Humber River watershed that are situated north and west of this buffer are included in the greater ecosystem. This not only allows the inclusion of the headwaters of this major river, but also minimizes the degree to which the greater ecosystem is fragmented by highways, and impacted by human activity.

Figure 26 shows the boundaries of the Greater Gros Morne Ecosystem as described above. It encompasses an area of 7567 square kilometers. Assuming that all this region can support black bears, which are habitat generalists, and assuming the minimum viable population numbers discussed in chapter 2 are reasonable, this region should support a viable population of black bears, which are the most space-demanding species in the

Figure 26: Greater Gros Morne Ecosystem



region, in the short-term. Long term viability may be possible if appropriately managed dispersal corridors are used to connect the Greater Gros Morne Ecosystem with other protected areas to the southwest or to the southeast (see Figure 7). The areas that were considered suitable for inclusion in a Greater Gros Morne Ecosystem but that lie at a distance to the southeast (Figure 25), may be a good region through which to pass a dispersal corridor.

The Greater Gros Morne Ecosystem also encompasses the range of the Humber and Gregory Plateau caribou herds, and a significant portion of the range of the Northern Peninsula caribou herd (Figure 4). However, it excludes the calving grounds of the Northern Peninsula herd (Mercer et. al., 1985). The boundaries include a significant proportion of the current range of arctic hare on the Northern Peninsula (Figure 15), as well as a region to the east of the Park that is thought to support a small population of pine marten (Figure 16).

The Greater Gros Morne Ecosystem, as shown in Figure 26, is traversed by only one major highway, and with the exception of a stretch of about 30 kilometers leading into Bonne Bay, this highway follows very close to the coastline and therefore leaves the majority of the greater ecosystem relatively unfragmented (see Figure 22). Furthermore, the major forest companies have private ownership or leasehold rights to only 43% of the territory within the greater ecosystem, compared to 60% of the total study area (see Figure 18). Also, according to the CLI Land Capability Classification for Forestry (Figure 17), approximately 13% of the total study area is classified as having from no important limitations to moderately severe limitations to the growth of commercial forestry. Less than 5.5% of the greater ecosystem is similarly classified. Conversely, nearly 60% of the greater ecosystem is classified as having conditions so severe as to preclude commercial forestry, compared to nearly 42% for the entire study area.

As suggested by the above discussion, the boundaries of the Greater Gros Morne Ecosystem were established to help ensure that viable populations of significant species, which are meant to represent all biota, are maintained in the long term, and that conflicting resource uses, fragmentation, and other human disturbance are minimized. To assess how well these objectives might be achieved using the approach described in this report, a comparison was made between the greater ecosystem shown in Figure 26 and alternative greater ecosystems defined by other currently established or described boundaries. The alternatives used in the comparison included: (1) the Western Newfoundland Model Forest (Figure 6), (2) the physiographic regions of western Newfoundland (figure 11), and (3) Damman's (1983) ecoregions of Newfoundland (Figure 12). The alternative greater ecosystems defined using the divisions of the physiographic regions and the ecoregions of western Newfoundland are assumed to include all regions or subregions, part of which fall within the boundaries of Gros Morne National Park. The greater ecosystem boundaries shown in Figure 26 were compared with these other three alternatives on the basis of criteria designed to reflect the objectives referred to above -- maintenance of viable populations of significant species, and minimization of conflicting resource use, fragmentation, and human disturbance. The boundaries for each alternative are shown in Figure 27. The comparison is shown in Table11.

Figure 27: Alternative Boundaries for a Greater Gros Morne Ecosystem

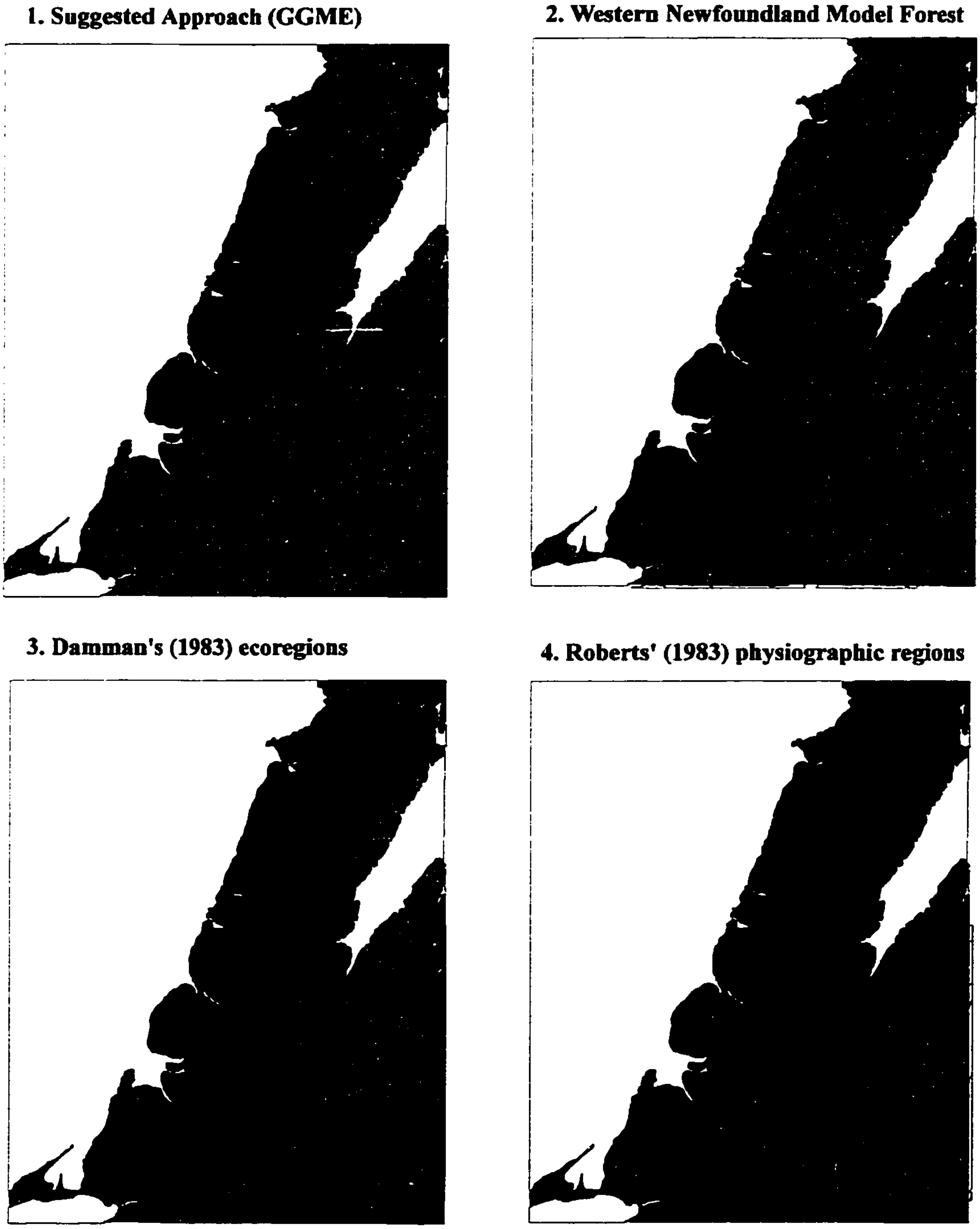


Table 13: Comparison of Alternative Greater Gros Morne Ecosystem Boundaries				
	Alternatives			
Basis for Comparison	GGME	WNMF	Ecoregions	Physio.Regions
1. Total area (square km)	7567	9651	16741	15864
2. Total forested area (square km)(per Figure 13 classes)	4345	6148	11338	10187
3. Perimeter to area ratio	10.3	11.1	10.0	9.3
4. Coefficient of relative dispersion (percent)	29	33	57	54
5. % forest co. interest	43	58	49	41
6. % precluded from forestry	59	38	49	55
7. % severe ungulate limitation	6	12	11	12
8. % current caribou range	30	20	31	36
9. % current arctic hare range	55	10	38	44
10. % current marten range	11	25	15	4
11. Distance (km): geographic center of Park to geographic center of region	22	65	28	49
12. Watershed based?	Partly	Partly	No	No
13. Extent traversed by major roads?	Low	High	Medium	Medium

The total area of the greater ecosystem is significant in that it should be large enough to support the maintenance of ecological integrity of the Park. As noted previously, this is assumed to be the area required to support a minimum viable population of black bears in the short term, which was suggested to be approximately 7500 square kilometers. Of course, the Greater Gros Morne Ecosystem defined on the basis of the approach presented in this study (hereinafter referred to as GGME), was defined specifically to encompass an area of this size. As presented in Table 13, the actual area covered by the GGME is 7567 square kilometers. The Western Newfoundland Model Forest (WNMF) is slightly larger at 9651 square kilometers, and the other two alternatives significantly larger. All four alternatives are of sufficient size to meet the minimum viable population objective. However, because the greater ecosystem will be a region of restricted use, areas significantly greater than that required, such as that of alternatives 3 and 4 (hereinafter referred to as ALT3 and ALT4), may be justifiably resisted by other interests.

Total forested area is based on the vegetation regions shown in Figure 13. The first three classes (balsam fir forest; balsam fir and black spruce forest, dwarf scrub heath; bog, baslam fir forest) are considered forested, the others non-forested. This measure is significant for the maintenance of natural forest fire activity in the region. Noss (1994:257) noted that for a protected area to "... maintain a relatively stable mix of seral stages and species over time, it must be large enough that only a relatively small part of it is disturbed at any one time." Shugart and West (1981)(cited in Noss, 1994) suggested that the protected area should be 50 to 100 times larger than the average disturbance patch. Since the average forest fire event between 1900 and 1960 burned approximately 12 square kilometers in the study area (Wilton and Evans, 1974), this suggests that the greater ecosystem should contain from 600 to 1200 square kilometers of forested area. All four alternatives meet this requirement with the GGME having the least forested area at 4345 square kilometers. ALT3 has the largest area of forest, at 11338 square kilometers. Again, above the minimum requirement, more is not necessarily better, as the more forested land included in the greater ecosystem, the more land subject to increased restrictions on commercial forestry, and thus the more potential conflict and opposition to the greater park ecosystem idea.

The perimeter to area ratio and the coefficient of relative dispersion are measures that describe the general shape of the regions defined by the four alternatives. Generally, the lower these values the shorter is the length of the boundary relative to total area, the less dispersed is the region, and the less vulnerable is the boundary and the interior to external activities. There is little difference between the perimeter to area ratios of the four alternatives, although ALT4 is the lowest at 9.3. One might expect that the long, narrow regions described by the physiographic divisions and the ecoregions would have a higher perimeter to area ratio than the more compact region described by the GGME. The unexpected result may be attributable to the nature of the physiographic and ecoregion divisions. The boundaries of these regions tend to be less well-defined and more general than those that follow the meanderings of a watershed or coastline. Such meanderings, which are more apparent in the GGME and WNMF tend to increase the perimeter to area ratio, although this increase may be somewhat artificial. The coefficient of dispersion appears to provide a more accurate reflection of the true spatial nature of the regions. It is lowest for the GGME, slightly higher for the WNMF, and significantly higher for ALT3 and ALT4.

The next two criteria relate to the major competing cultural activity of the region, forestry. The first, percent forest company interest, was derived from Figure 18 which indicates what percentage of the region is either owned or leased by the major forest companies. The GGME and ALT4 have the lowest forest company interest at 43% and 41%, respectively. The next criteria, percent of the region excluded from commercial forestry, is derived from Figure 17, which indicates the capability of the land in the study area for commercial forestry. The percent indicated in the table above is that percent of each region that has limitations so severe as to preclude the use of the land for commercial forestry. Again, the GGME and ALT4 had the best results at 59% and 55%, respectively.

The next four criteria are based on figures 14, 4, 15, and 16, in that order, and relate to the current range of significant mammal species, and in the case of caribou, its potential range. Among the four alternatives GGME has the lowest percentage of its land having severe limitations for the production of ungulates. This percentage actually reflects a capability ranging from "moderately severe" to "limitations so severe that there is no ungulate production" to "unclassified", in the classification terms used by the CLI classification. ALT4 had the highest percentage of its land area in current caribou range, the GGME was highest for current arctic hare range, and the WNMF had the greatest percentage of its land as current pine marten range.

GGME also had the shortest distance between its geographic center and that of Gros Morne National Park, suggesting that it was more park-centered than the other alternatives. The other alternatives also left portions, and in the case of the WNMF, significant portions, of the park boundary exposed, and potentially vulnerable. The park boundary was buffered on all sides under the GGME alternative. The boundaries of the GGME and the WNMF were also partly based on watershed boundaries, the GGME to a greater extent than the WNMF, and as suggested earlier the GGME is traversed by very few major roads, and for the most part the major highway running through follows the coastline and thus results in a minimum of fragmentation. There is more significant fragmentation by major roads under the other three alternatives.

The above analysis shows that the GGME approach is at or near the top for all criteria. It is appropriately sized in terms of minimum viable populations of space-demanding species and maintenance of natural forest fire disturbance, has the lowest measure of dispersion, the highest percentage of land excluded from commercial forestry, the lowest percentage subject to severe limitations on ungulate production, the highest in terms of percentage of current arctic hare range, is park centered, watershed-based, and is traversed by few major roads. It also has a relatively low percent forest company interest.

Although there is no one definitive set of boundaries that can maximize all criteria and objectives, it is suggested that this approach is superior to the other approaches whose boundaries are shown in Figure 27. The inclusion of the process components would undoubtedly alter these suggested boundaries; however, they should serve as a useful basis for further discussion, consultation, and negotiation.

VI. A PRELIMINARY ASSESSMENT OF THE PROCESS COMPONENTS

In the previous chapter the boundaries of a Greater Gros Morne Ecosystem were defined. As noted previously, it was not possible to illustrate those components of the suggested approach that dealt with consultation and negotiation with other stakeholder organizations and individuals. The input of these stakeholders would undoubtedly result in a different set of boundaries.

The processes of consultation and negotiation are not restricted to the boundary definition process. Effective implementation of ecosystem management through the Greater Park Ecosystem concept requires ongoing consultation and negotiation. It requires agreement among the stakeholders regarding the general approach to resource management. In other words, it requires that they endorse the principles of ecosystem management.

In this chapter a preliminary assessment of the process components will be carried out. This will involve reviewing selected examples of resource management policy to illustrate the recent history of resource management in Newfoundland and provide some indication as to whether the major resource management institutions and agencies might be receptive to the philosophy of ecosystem management and its implementation via a Greater Gros Morne Ecosystem. I will also discuss some economic and cultural factors that may affect how receptive the general public are to these ideas.

Resource Management in Newfoundland

Resource management in Newfoundland is evolving in response to changing societal conditions. In this section I will examine several examples that reflect these changes. It is not meant to provide a comprehensive review of the history of resource management in the province or a comprehensive discussion of current resource management practices. It is intended to illustrate several recent approaches to resource management which can be compared to the conception of ecosystem management used in this report for purposes of commenting on the potential for implementing ecosystem management in a Greater Gros Morne Ecosystem.

Interdepartmental Land Use Committee

The Interdepartmental Land Use Committee (ILUC) is a committee of the Lands Division of the Department of Natural Resources. It is composed of representatives from several government departments having an ongoing interest in land use and resource allocation. It evolved from the Crown Lands Committee, which was set up to administer requests for Crown land. The mandate of the ILUC was broader and included provisions for resolution of the growing number of conflicts over land and resource use.

Today the ILUC is responsible for resolving land use conflicts and for providing advice on land use and resource allocation. It is responsible for reviewing proposals such as those related to silviculture treatments, resource access roads, ecological reserves, and municipal plans, and ensuring that the resulting use is "...properly integrated and without conflict" (ILUC mandate and terms of reference). It is also involved in the preparation of regional integrated resource management plans, the development of provincial land use policies, and the initial screening of private development projects.

The ILUC reflects many of the important characteristics of ecosystem management. Its focus on greater integration and cooperation is noted above. The importance of flexibility is stressed by Fugate (1986). The ILUC represents one of the early attempts by the provincial government to deal with increasing conflict, complexity, and uncertainty in the management and allocation of land and natural resources.

Report on Integrated Resource Planning in Newfoundland

In May and June of 1989 a workshop was held in St. John's, Newfoundland to discuss the development of a framework for integrated resource planning in the province. It was guided by a Steering Committee composed of representatives from the Canadian Environmental Assessments Research Council (CEARC), the federal Department of Fisheries and Oceans, and the Newfoundland and Labrador Department of Environment and Lands (Land Management Division and Environmental Assessment Division). Representatives of government agencies having resource management responsibilities participated in the workshop (Government of Newfoundland and Labrador, 1989).

The workshop grew out of a concern that resource planning and management in Newfoundland was not adequate to deal with increasing demands on natural resources. Specific problems noted in the workshop report included: (i) overlapping and fragmented jurisdictions, (ii) increased resource conflicts, (iii) increased intensity of resource use combined with diminished resource management budgets, (iv) increased awareness of the complexity of resource management problems, (v) lack of public consultation, (vi) incomplete resource inventories and incomplete understanding of environmental phenomena, (vii) lack of coordination among resource agencies, and (viii) lack of clearly defined planning boundaries (Government of Newfoundland and Labrador, 1989).

Several current planning processes or bodies were discussed but were found to be inadequate to deal with these problems. For example, ILUC is an interdepartmental body involved to some degree in resource and land use planning, but it is seen primarily as a conflict-resolution mechanism (Government of Newfoundland and Labrador, 1989). Furthermore, its recommendations do not carry binding authority. The environmental assessment process was also seen to be limited by the fact that it is used to evaluate specific proposals, and is therefore reactive in nature and not appropriate for providing comprehensive guidance in the use of natural resources (Government of Newfoundland and Labrador, 1989). The municipal planning process was found to be well developed in Newfoundland, but because it applied only to land within municipal jurisdictions, it excluded large, resource-rich regions of the province (Government of Newfoundland and Labrador, 1989).

The problems and limitations of current resource planning and management processes noted above were discussed by the workshop participants and several alternatives were suggested for further consideration. The final recommendations called for the Land Management Division of the Department of Environment and Lands to develop a comprehensive, province-wide policy on integrated resource planning that would respond to these problems and limitations (Government of Newfoundland and Labrador, 1989).

Western Newfoundland Model Forest

The Western Newfoundland Model Forest (WNMF), established in 1993, is one of ten model forests across Canada. The Model Forest network is an important part of the Partners in Sustainable Development of Forests program, which is part of Canada's Green Plan (Forestry Canada, 1992). The WNMF comprises an area of more than 700,000 hectares in western Newfoundland south of Gros Morne National Park (Forestry Canada, 1992) (Figure 6). Its partners include the Newfoundland Forest Service, Corner Brook Pulp and Paper Company, Humber Environment Action Group, Centre for Forestry and Environmental Studies, Abitibi-Price Inc., City of Corner Brook, and the Wildlife Division of the Department of Natural Resources (WNMF, 1995a).

The Model Forest concept grew out of the increasing concern for sustainable development of natural resources. Its emphasis on partnership formation reflects a growing concern about resource conflict and the need for cooperation to address this. The Model Forest Program is also defined by (i) a change in approach to forest management from one emphasizing timber supply to one concerned with ecological integrity, (ii) concern for a variety of forest values, (iii) a call for improved scientific understanding and technology, (iv) greater adaptability to changing conditions, (v) the encouragement of greater community involvement, and (vi) the acknowledgement of the value of traditional knowledge (Canadian Forest Service, 1994). Each Model Forest, managed by a multi-stakeholder partnership, is encouraged to develop its own version of sustainable forest management based on these general principles (Canadian Forest Service, 1994).

The WNMF has its own vision of sustainable forest management (WNMF, 1994):

> "To manage the forests of the Western Newfoundland Ecoregion within a system where short-term (1-5 year) management options are identified and decisions are rationalized with long-term (50-100 year) goals of protecting biodiversity and providing social benefits including employment, recreation, and a healthy environment."

Achievement of the following strategic goals will help to fulfill this vision (WNMF, 1994):

1. To develop an integrated resource management planning process for Newfoundland.

2. To integrate wildlife and timber management objectives.

3. To integrate water quality and timber management objectives.

4. To instill within the public a greater awareness of forest resource management.

5. To operate the Model Forest as a Working Forest.

For the first two years of the WNMF attention was focused on building good working relationships among the founding partners, and encouraging other interested groups to become part of the process (WNMF, 1995a). Several working groups, comprising representatives from the founding partners as well as other groups, were established to deal with specific issues of concern (WNMF, 1995a). One such working group was the Integrated Resource Management working group. They developed a draft Integrated Resource Management Plan in 1995. The plan identified a set of ecosystem values representing the interests of the major forest users. For each of these values an overall goal and specific objectives were identified, the current status of the resource was determined and specific action plans geared toward achievement of objectives were developed (WNMF, 1995b). Then potential conflicts, information gaps, forecasting tools, and monitoring and feedback mechanisms were identified (WNMF, 1995b). The Integrated Resource Management Plan was developed on the basis of five guiding principles: environmental sustainability, economic sustainability, political sustainability, social sustainability, and cultural sustainability (WNMF, 1995b).

The WNMF, as described above, represents a significant advance in dealing with current resource problems. It represents a move away from traditional resource management towards ecosystem management. However, concerns have been raised about whether the process, in practice, is significantly different from the traditional approach to management. Concerns have been expressed that the forest industry is still the single most powerful influence on resource decisions, that scientific studies conducted by the Model Forest are still not truly integrative and that meaningful consensus is difficult and time-consuming to achieve. Last year the Humber Environment Action Group, one of the founding partners, dropped out of the process because they feared their continued participation would be seen as an endorsement of a process that did not adequately address their environmental concerns. Nevertheless, many participants believe that an important first step has been made in the gathering of a variety of stakeholders, and the sharing of often different, but sometimes surprisingly similar goals and perspectives on the relationship between humans and their natural environment.

Adaptive Ecosystem Management in the Newfoundland Forest Service

The Newfoundland Forest Service has recently embraced a new approach to forest management that is very similar to the notion of ecosystem management used in this report. They refer to it as adaptive ecosystem management. Newfoundland forests have historically been managed for timber. Other forest values were not generally considered. The need to consider these other values was recognized in the 1973 Report of the Newfoundland Provincial Task Force on Forestry (Moores, 1995). However, management for sustained yield was still the primary objective -- other values were seen as constraints on this goal (Moores, 1995). With the passing of a new Forestry Act in 1990 the philosophy of forest management in Newfoundland changed. Non-forest values were no longer assumed to be subordinate to timber values and the importance of maintaining ecosystem health and ecological integrity was recognized (Moores, 1995).

The definition of ecosystem management used by the Newfoundland Forest Service is similar to that suggested by Grumbine (1994a): "Forest ecosystem management integrates scientific knowledge of ecological relationships with social values, and has the goal of sustaining natural ecosystem integrity and health over the long term " (Forestry Division, 1995). Holling's (1978) adaptive management approach, which recognizes the limitations of predictive models and treats the management process as an ongoing experiment, is integral to the new management philosophy proposed by the Newfoundland Forest Service. This new adaptive ecosystem management approach also emphasizes the importance of cooperation among all stakeholders, the importance of public consultation, and, despite the impossibility of obtaining perfect understanding, increased scientific research aimed at understanding the complexities of forest ecosystem processes (Forestry Division, 1995).

Ecosystem Management in Gros Morne National Park

Gros Morne National Park's 1996 Ecosystem Conservation Plan represents "...the guiding document for the park's ecosystem management program" (Parks Canada, 1996). It is an attempt by the park to implement a new holistic, ecosystem-based management regime as provided by the new policy document Guiding Principles and Operational Policies (Parks Canada, 1994) and as such is consistent, in most respects, with the notion of ecosystem management used in this report (See Table 4).

The Ecosystem Conservation Plan discusses the concept of ecological integrity at great length and emphasizes its importance to ecosystem-based management. The importance given to data collection, monitoring, and the formation of partnerships is evident in the park's vision for the future: "...Partnerships will be developed and science and research will be an active part of management" (Parks Canada, 1995b, cited in Parks Canada, 1996). Furthermore, numerous scientific studies have been completed, are in progress, or have been proposed, including several in cooperation with the Newfoundland Wildlife Division, the Canadian Wildlife Service, and the Department of Fisheries and Oceans (Parks Canada, 1996). Cooperative arrangements in which the park, officially, or park staff, unofficially, participate include the Western Newfoundland Model Forest, the Canadian Heritage Rivers System, the Gros Morne Cooperative Association, and the Viking Trail Tourism Association (Parks Canada, 1996).

These changes in management approach (to ecosystem-based management) and the formation of cooperative arrangements suggest an openness to a degree of organizational change that will be necessary for successful implementation of ecosystem management. However, continuing conflicts over domestic resource use within the park and commercial extractive use outside the park suggest the need for greater understanding or improved cooperative efforts between the parties.

The spirit of adaptive management is evident in the strong focus on monitoring to better understand the outcomes of management actions, and in the call for continuous evaluation and, where necessary, modification of program results. It is not clear, however, to what degree the non-scientific, experience-based understanding of local people is acknowledged as a valid form of knowledge. The emphasis on public education is evidence that the significance of human values is acknowledged.

Of particular interest for this study is the ecological boundaries theme. This is discussed as a separate resource issue in the Ecosystem Management Plan. However, in that context, it deals with the boundaries of the park itself and how they should be situated on the basis of ideas such as least edge exposure, greatest area to edge ratio and other ecological concepts. However, in the introduction, reference is made to the concept of a greater ecosystem which extends beyond the official park boundaries. There is a suggestion that the greater ecosystem boundaries will change depending on the scale of the issue under consideration (Parks Canada, 1996). This is consistent with Agee and Johnson's (1988) proposals. However, in this study I take the position that a single Greater Park Ecosystem should be delineated and used as a basis for cooperative management. This would eliminate, not exacerbate some of the jurisdictional complexity. A general, multi-purpose classification system is supported by Bailey (1996).

These examples of recent resource management activities in Newfoundland reflect a significant philosophical shift toward a more integrative, cooperative, adaptive, and ecocentric approach -- in other words, towards ecosystem management. (Table 14 shows how well the ideas discussed above reflect ecosystem management goals and principles.) Concerns have been expressed about whether the practical implementation of this new approach will truly reflect the new philosophy, or whether ecosystem management is a new term used to describe the same old approach. Given the degree to which the competitive, reductionist, anthropocentric philosophy has been ingrained in Western society, the embracing of these new ideas must be seen as a first step in what will

Table 14: Moving Toward an Ecosystem Management Philosophy in Newfoundland

Ecosystem Management Principles (Table 2)	ILUC	IRM Report	WNMF	NF Forest Service	GMNP
1. Hierarchical Context				x	
2. Ecological Boundaries					x
3. Ecological Integrity*				x	x
4. Data Collection		x	x	x	x
5. Monitoring		x	x	x	x
6. Interagency Cooperation	x	x	x	x	x
7. Organizational Change		x			
8. Adaptive Management		x	x	x	x
9. Humans as Part of Nature**					x
10. Values			x	x	x

* ecological integrity overrides all other objectives
** ecocentric versus anthropocentric approach

undoubtedly be a long and difficult transition. It also suggests an atmosphere of openness to new ideas in resource management which is a positive sign for future efforts to implement ecosystem management in a Greater Gros Morne Ecosystem.

Economic and Cultural Factors

Several aspects of Newfoundland's economy and culture may affect the potential for effective implementation of ecosystem management in a Greater Gros Morne Ecosystem. First, Newfoundland is one of the most rural of Canadian provinces (Felt and Locke, 1995), with approximately one-half of its population living in small fishing communities (Parsons, 1993). Until the middle decades of this century, many of these people were almost entirely self-sufficient, relying on resources of the surrounding land and sea to provide food, clothing, and shelter. Although this is no longer the case, rural Newfoundlanders still feel they have an inherent right to use the resources in their local area for domestic use to supplement their sometimes meagre incomes. This is evidenced by Filion et. al. (1993) who found that a greater percentage of Newfoundlanders participated in hunting and recreational fishing in 1991 than residents of any other province. Many Newfoundlanders also use the surrounding forests as a source of fuelwood for heating or sawlogs for building purposes. This aspect of rural Newfoundland culture represented a challenge for officials responsible for the establishment of Gros Morne National Park (McNamee, 1993). It remains a challenge for park management today (Parks Canada, 1996). In terms of implementing an ecosystem management regime, this may also represent a challenge for those responsible for ensuring that resource uses do not negatively effect the ecological integrity of the region. On the other hand, the long history of domestic resource use in the region may bring with it an understanding of society's ultimate dependence on natural resources and a respect for the idea of sustainable use.

Second, in addition to the utilization of local resources for domestic use, many Newfoundlanders, particularly those in Western and Central Newfoundland, have relied on the large extractive resource industries for employment. Forestry, mining, and commercial fishing have provided, directly or indirectly, significant numbers of jobs for Newfoundland residents. Threats of reduced activity -- and jobs -- in these sectors in the interests of maintaining ecological integrity may be met with some resistance.

Third, the state of the economy in Newfoundland leaves few alternative sources of employment. At approximately 20 percent, and even higher when the capital city region is excluded, the unemployment rate in Newfoundland is by far the highest in the country. The notion of maintaining ecological integrity will garner little public support if it threatens short-term employment prospects. The situation appears even more bleak when one considers that over the next several months several thousand fishers who have been displaced by the collapse of the Northern Cod fishery will see their funding under The Atlantic Groundfish Strategy (TAGS) discontinued.

Finally, the collapse of the Northern Cod fishery has forced many people in Newfoundland to re-examine how the resources on which society depends are managed. It has driven home emphatically the point that natural systems are very complex, and not capable of being understood precisely using scientific and economic models. It has highlighted the consequences of non-sustainable resource use. It may have given the notion of ecosystem management -- a holistic, cooperative, adaptive philosophy of resource management, based on maintenance of ecological integrity -- some real credibility in the minds of the public.

From the above cursory review of the cultural and institutional environments, it is possible to make a preliminary evaluation concerning the potential for implementing ecosystem management in a Greater Gros Morne Ecosystem. Planning for such a cooperative venture requires some understanding of the internal environment of the lead agency (for my purposes, I will assume this to be Gros Morne National Park), and of other potential participants or stakeholders. Borrowing from Bryson and Roering's (1988) strategic planning framework, the internal strengths and weaknesses, and the external opportunities and threats, as they relate to the implementation of ecosystem management, are derived from the above discussion. These are presented in Table 15.

It is apparent from this preliminary examination that although the philosophy of resource management and public attitudes have evolved in Newfoundland, there is still some distance to go before the notion of ecosystem management put forth by Grumbine (1994a) and others, and supported by the current research, is embraced fully, and even further before the idea of a Greater Gros Morne Ecosystem is accepted. Increased public concern for conservation and sustainable resource use, changed political priorities, and an improved provincial economy may contribute to greater acceptance. In the meantime, continued public education initiatives, research, and partnership formation should speed the process and lay the groundwork for more effective implementation.

Table 15: Greater Gros Morne Ecosystem: Preliminary Assessment of Institutional, Cultural and Economic Factors

Strengths	Concept of ecosystem management officially embraced by Parks Canada and Gros Morne National Park Partnerships or other cooperative arrangements established with Newfoundland Wildlife Division, Canadian Wildlife Service, Department of Fisheries and Oceans, Western Newfoundland Model Forest, Canadian Heritage Rivers System, among others. Efforts ongoing to establish additional partnerships. Strong emphasis on increasing ecological knowledge through scientific research.
Weaknesses	Unresolved conflict with local communities over domestic resource harvesting and with extractive resource sectors beyond park borders. Reluctance to advocate a Greater Gros Morne Ecosystem concept for political reasons. Lack of attention to understanding social, cultural, political, institutional impediments to effective implementation of ecosystem management beyond park borders.
Opportunities	Many aspects of ecosystem management philosophy embraced by provincial resource agencies, particularly the Newfoundland Forest Service. Recognition of the need for, and increased efforts towards the establishment of cooperative arrangements in the management of resources. Increased public concern, heightened by the collapse of the Northern Cod fishery, for conservation and sustainable resource use. Long tradition within local communities of 'living close to the land'.
Threats	Concerns regarding possible gap between the philosophy of ecosystem management as espoused by provincial resource agencies, and its real world application. Poor provincial economy; lack of employment alternatives outside extractive resource sectors. Long tradition of domestic resource use and resulting reluctance on the part of local residents to accept significant restrictions on domestic resource harvesting. Reduced resource budgets and research funding.

VII. CONCLUSIONS AND RECOMMENDATIONS

The overriding objective of Canadian national parks, as noted in Parks Canada's Guiding Principles and Operational Policies, is to "...protect for all time representative natural areas of Canadian significance ... so as to leave it unimpaired for future generations." This implies that ecological and evolutionary processes, viable populations of native species, and the ability to recover from natural disturbance, be maintained within the park. In other words, that ecological integrity be maintained. However, two factors make this a difficult proposition for national parks:

> (1) human activities and natural processes occurring outside the park boundaries affect the ecological integrity of the park, but the park has no control over these activities because their jurisdiction ends at the park border, and
>
> (2) most Canadian national parks are not large enough to support viable populations of the largest mammal species in the long term.

The result is increasing conflict between parks and other resource users, and increasing complexity of resource decisions both within the park and beyond its borders. The Greater Park Ecosystem concept is a response to this problem. Essentially, it represents an attempt to apply new ideas in resource management that address increased conflict, complexity, and uncertainty (ecosystem management) to a new unit of management that is centered on the park and defined using ecological and cultural criteria. The park itself would form the core reserve that is managed to standards which prohibit resource uses that are not consistent with the park's mandate. The greater ecosystem would be a region available to a variety of resource users, but managed with the objective of ensuring the ecological integrity *of the park*. Therefore, standards more restrictive than traditionally associated with unprotected lands would have to be established. Dispersal corridors established to link a system of greater ecosystems would be managed to similar standards. These three components, core reserves, buffers, and dispersal corridors are those suggested by Noss (1994) as the basic components of a wilderness recovery network, and also form the basis for the biosphere reserves of UNESCO's Man and the Biosphere Program. The use of different classes of standards for resource extraction activities also has some precedents. For example, the Newfoundland Forest Service classifies land into three classes, with each subject to different standards (Forestry Division, 1995).

The central problem of this study was the development of an approach to defining the boundaries of a Greater Park Ecosystem. The literature was reviewed for previous efforts to define the boundaries of an ecosystem, generally, and a Greater Park Ecosystem, in particular. In the past ecosystem boundaries were defined using the boundaries of watersheds, a variety of ecological land classification methods, and an approach referred to as bioregionalism, which combined biophysical features and a recognition of the significance of local culture, history, and landuse. Attempts to define Greater Park Ecosystems for Yellowstone National Park and Pukaskwa National Park were also described. These and other approaches were evaluated using a set of criteria which reflected the principles of ecosystem management and national park management. A good approach, using these criteria, would be one that reflected a concern for substantive ecological factors (primarily maintenance of ecological integrity), as well as the process of defining the boundary using the knowledge and input of local communities, groups, and institutions. This evaluation revealed the major strengths and weaknesses of each approach and in so doing responded to research question number 1.

An attempt was made to put together a set of general guidelines for defining a Greater Park Ecosystem, using both substantive and process components. The guidelines were drawn from the above evaluation, primarily the approaches judged to be the most appropriate for defining Greater Park Ecosystem boundaries, such as the ABC Resource Survey approach applied to Pukaskwa National Park. Central to the guidelines was Grumbine's (1994a) assertion that a Greater Park Ecosystem be large enough to support a minimum viable population of the most space-demanding species in the region and Theberge's (1989) principle abiotic objective in boundary determination -- maintenance of drainage basin integrity. These guidelines, and their application to Gros Morne National Park address research question number 2.

Figure 26 shows the boundaries of a Greater Gros Morne Ecosystem as defined using the approach developed in this study. It is not intended to be *the* definitive set of boundaries. The inclusion of the process components of the suggested approach (ie. full institutional analysis, and consultation and negotiation with local individuals, communities and organizations), improved ecological understanding, and the use of different combinations of criteria and assigned weights, would undoubtedly result in a modified set of boundaries. The important point is that a single set of boundaries should be established to delineate an ecosystem that will be managed as a single unit.

The use of a single unit of management instead of different units for forest management, wildlife management, or management of other natural resources, alleviates some of the problems associated with interjurisdictional complexity. It is thought that a greater degree of integration and more effective resolution of conflict would be possible if a single board or management structure having representation from all major resource interests was responsible for overseeing all resource decisions in the region.

This Greater Gros Morne Ecosystem, if managed to maintain ecological integrity, should in theory be large enough to support a viable population of the most space-demanding species in the area, the black bear, in the short term. Because of the different habitat needs of other species this does not necessarily mean that viable populations of less space-demanding species will be accommodated by the boundaries described above. However, the combination of this and consideration of specific habitat requirements of other significant and/or wide-ranging species such as the caribou, marten, and arctic hare is considered to be the most reasonable approach to ensure the protection of the biota and its habitat in the short term. To improve the chances of long term viability of the larger mammals in this region, consideration should be given to completing a system of protected areas, in which movement between the Gros Morne region and other protected areas would be accommodated via dispersal corridors. Continued development, in the absence of such corridors, may eliminate future dispersal options, and potentially threaten large mammal populations.

Successful establishment of a Greater Gros Morne Ecosystem and implementation of an ecosystem management regime will depend on its acceptance by the many individuals, groups, communities, and institutions who have an interest in the resources of the region. It will also require that government embrace the idea, which is ultimately dependent in large part on public perception of the issues. There appears to be a growing acceptance of the philosophy of ecosystem management by resource management agencies in the province. There is also a growing concern, fuelled by the recent fisheries crisis, about sustainable use of resources. On the other hand, the poor economic situation in Newfoundland leaves few alternatives in many communities beyond traditional resource extraction activities.

Figure 28 summarizes the approach to defining greater park ecosystem boundaries that was described in this study, as well as its application to Gros Morne National Park.

Conclusions

Several points can be made in conclusion. (1) With the exception of the ABC Resource Survey Method, none of the approaches to ecosystem definition evaluated in this study adequately addresses the problems of increasing conflict, complexity, and uncertainty as they relate to resource management in general, and national parks management, in particular. The ABC Resource Survey Approach, which was applied to Pukaskwa National Park was considered the best of all approaches evaluated. However, its full application was beyond the scope of this report, and was considered unnecessary for purposes of identifying a general region in which a Greater Gros Morne Ecosystem would be located.

(2) The approach described in this study and illustrated by Figure 28 addresses conflict by requiring multi-stakeholder participation. It addresses complexity by attempting

Figure 28: An Approach to Defining Greater Park Ecosystems

GENERAL GUIDELINES

Substantive:

1. Initial area of examination should:
   i) be centered on park
   ii) be of sufficient size to support some multiple of MVP of most space-demanding species
   iii) consider location of significant features and processes
2. Boundary-definition process should consider:
   i) abiotic, biotic, and cultural features and processes that are significant to the park and surrounding region
   ii) threats to ecological integrity
   iii) significant transboundary processes
3. The guidelines for drawing ecologically sound boundaries (Table5) should be adhered to to the extent possible

Process :

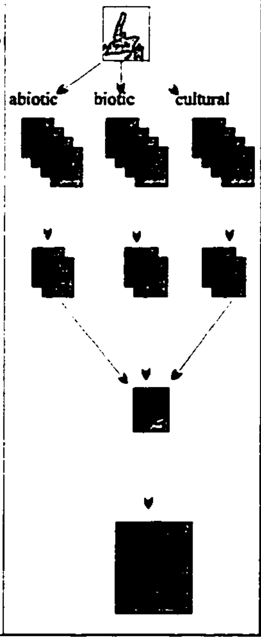
4. An institutional analysis should be carried out to determine where institutional boundaries and mandates might be adjusted to reflect ecological considerations, and where cooperative action is possible.
5. All stakeholder organizations and local individuals having interests in the area of examination should be encouraged to participate in the process of defining the new management unit.
6. Where there has been a long history of resource use among local people, their experiential knowledge should be sought out and its value acknowledged.

APPLICATION TO GROS MORNE NATIONAL PARK

Substantive:

Consider:

1. Define initial study area
   - park-centered
   - size required for MVP
   - significant features of region
2. Describe/map study area
3. Select representative features and processes
   - significance to park and region
   - threats to ecological integrity
   - transboundary processes
4. Combine representative features and processes so as to assign suitability values to all locations in study area
5. Define boundaries for greater ecosystem
   - suitability values
   - watershed boundaries
   - size required for MVP



Process:

Further Research Required to:
- investigate stakeholder attitudes about ecosystem management principles and the need for greater conservation
- investigate stakeholder attitudes about a Greater Gros Morne Ecosystem and where the boundaries should be located
- document and evaluate ecological knowledge of local inhabitants
- carry out full institutional analysis

to integrate significant abiotic, biotic, and cultural features and processes in the boundary definition process, and by calling for a single management unit to be managed as a unit by a multi-disciplinary body. It responds to uncertainty by acknowledging that although we may need to define a specific boundary for management purposes, there is no single correct set of boundaries that can be defined precisely by improved science. However, it does recognize that such improved understanding can contribute greatly to delineating ecological units.

(3) The approach described in this study and illustrated by Figure 28 draws on the strengths of the ABC Resource Survey Approach applied to Pukaskwa National Park, but does not require the same level of detail in the resource description and analysis. It does this by following the same general structure but focusing on the size of the ecosystem required to maintain minimum viable populations of the most space-demanding species in the region, and by focusing on a selected number of significant abiotic, biotic, and cultural features to represent the ecosystem.

(4) The approach described in this study and illustrated by Figure 28 has been shown to be consistent with the objectives and principles of ecosystem management and national parks management (as described in Parks Canada, 1994), which were themselves shown to be responsive to the problems of increased conflict, complexity, and uncertainty in resource management. In particular, it has focused on the principal objective of maintenance of ecological integrity, and the specific goals related to this, as described in table 2.

(5) The application of this approach to Gros Morne National Park in western Newfoundland has resulted in a Greater Gros Morne Ecosystem that is, on the basis of the best information currently available, large enough to support a minimum viable population of the Newfoundland black bear, the most space-demanding species in the region, in the short term. Connection to other protected areas via appropriately managed and situated dispersal corridors should ensure long term viability. The Greater Gros Morne Ecosystem also contains important habitat for other significant species in the region, contains a relatively low percentage of land that has high commercial forestry potential but sufficient forested land to maintain natural forest fire regimes, is traversed by few major roads, and where possible is defined by watershed boundaries.

(6) The Greater Gros Morne Ecosystem, as described above was shown to be superior to several other alternatives which used existing ecological or other boundaries. The comparison was done on the basis of a number of indicators including the percentage of land with high potential for competing resource use (ie. commercial forestry), the percentage of land considered suitable for other significant species (eg. caribou), perimeter to area ratio, and the degree to which the region is traversed by major roads.

(7) The institutional and cultural environment in Newfoundland appears to be moving toward greater acceptance of the ideas embodied in ecosystem management. There appears to be a growing awareness of the need for better management of natural resources. However, the choice of more conservation versus additional economic opportunity remains a difficult one for government and the general public. Further

evolution of public attitudes may be necessary if the idea of a Greater Gros Morne Ecosystem, defined and managed as described in this study, is to be generally accepted.

Recommendations for Further Study

To further refine the boundaries of a Greater Gros Morne Ecosystem and to meet the challenges to implementation, further research is needed to: (1) investigate stakeholder attitudes about ecosystem management principles and the need for greater conservation; (2) investigate stakeholder attitudes about a Greater Gros Morne Ecosystem and where the boundaries should be located; (3) document and evaluate ecological knowledge of local inhabitants; and (4) carry out a complete institutional analysis. Full application of the ABC Resource Survey Method to Gros Morne National Park may provide the forum for this additional research, as well as the opportunity to carry out more detailed ecological research or to compile more comprehensive ecological understanding of the region from previous research.

APPENDIX 1: List of Interviews

Doug Anions - Acting Chief Park Warden, Gros Morne National Park

Sean Dolter - Executive Director, Humber Arm ACAP

Fred Earle - Manager, Resource Evaluation and Policy Integration, Land Management Division, Department of Natural Resources, Government of Newfoundland and Labrador

Hasim Khan - Manager, Surface Water Section, Water Resources Division, Department of Environment, Government of Newfoundland and Labrador

Shane Mahoney - Chief of Wildlife and Ecosystem Research, Newfoundland Wildlife Division

Lori March - Member of local environmental organizations including Humber Environment Action Group and Humber Arm ACAP

Allan Masters - Regional Resource Director, Western Region, Newfoundland Forest Service

Bob Mercer - General Manager, Western Newfoundland Model Forest

Len Moores - Section Head, Management Planning and Environmental/Landuse Planning, Newfoundland Forest Service

Nick Payne - Mayor, Rocky Harbour (Park Enclave Community)

Kevin Sutton - District Manager of Forest Ecosystems, Newfoundland Forest Service

George van Deusen - Chief Forester, Corner Brook Pulp and Paper

Martin von Mirbach - Sustainable Development Chair, Centre for Forest and Environmental Studies, West Viking College, Corner Brook, NF

All interviews conducted between July, 1995 and January, 1996

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