The Cumulative Environmental Effects of Development and Land Use at Gros Morne National Park, Newfoundland

FINAL REPORT

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Abstract

The development and operation of Gros Morne National Park has led to cumulative environmental changes. Historical and current land use in and around the park also contribute to environmental changes within the park, and in the greater park ecosystem. A literature review is presented which provides some definitions of cumulative effects. Some conceptual and methodological approaches to cumulative effects assessment are then explored, and limitations of traditional project-specific impact statements are discussed. A brief discussion of the role of Parks Canada in conducting cumulative effects assessment is provided with reference to the legislative and policy context.

Through an extensive literature review, map and air photo analysis, personal interviews, and field observations, an assessment of cumulative effects at Gros Morne was made. Many sources of environmental stress were identified which contribute to cumulative impacts. The loss of habitat due to both large scale land disturbance and less intensive land use, the destruction of glaciofluvial deposits for aggregate use, and the aesthetic degradation of scenic and wilderness resources are the most significant impacts affecting the ecological integrity of the park. Other impacts of lesser, or unknown significance include: potential contamination of aquatic systems, degradation of sand dunes, and recreational effects on flora and fauna.

Mitigation measures are suggested, which include the prevention of further habitat loss, particularly in the most affected coastal and lowland forests, the prohibition of further aggregate extraction sites, and the adoption of future planning standards which are more sensitive to ecological protection requirements. Better waste management practices are also recommended to reduce associated environmental effects.

Previous and existing monitoring programs are discussed, and further monitoring strategies are suggested. Habitat loss and fragmentation is recommended as an indicator of broad ecosystem health. Strategies to detect changes in the ecological integrity of forest ecosystems, vegetation communities, and aquatic systems are suggested. Continued monitoring of visitor activity and associated effects is recommended.

Executive Summary

Gros Morne National Park Reserve (GMNP) was established in 1973 to protect a representative sample of the Western Newfoundland Highlands natural region. The park encompasses an area of 1805 km^2 in the Bonne Bay region of western Newfoundland, and is the largest national park in the Atlantic Region. The park was declared a UNESCO World Heritage Site in 1987 in recognition of its globally significant geological features and outstanding scenic beauty.

Development and land use within and adjacent to the park has led to numerous environmental impacts. Collectively all of these sources of environmental stress contribute to cumulative impacts on park resources and on the greater park ecosystem. This study documents existing cumulative effects in Gros Morne, suggests mitigation measures to reduce or eliminate those effects, and recommends monitoring strategies for the study of environmental change.

Cumulative Effects Assessment
(modified from Keith, 1994)

Cumulative environmental effects refer to the accumulated impacts on ecosystems of many different actions and developments distributed in space and time. Interest in cumulative effects grew out of the realisation that many seemingly insignificant impacts from individual projects can incrementally result in significant cumulative effects.

Traditional methods of environmental impact assessment (EIA) are not well suited to addressing cumulative effects. EIA is a project-driven exercise, designed to identify potential environmental impacts of a specific proposal, and suggest ways of eliminating, or minimising those effects. Rarely does EIA ever consider the effects of the specific project in relation to other projects affecting the same ecosystem.

Cumulative effects assessment (CEA) is a broader form of impact assessment designed to consider the combined effects of all previous, existing, and foreseeable future developments on a given area or resource. To achieve this task, CEA must adopt a broader context in both space and time than has traditionally been used in EIA. The definition of appropriate spatial and temporal boundaries is a major problem in CEA, and may be complicated by political, jurisdictional, and financial limitations.

Another problem restricting effective use of CEA is the limited knowledge base regarding natural ecosystems. There are fundamental gaps in human understanding of complex ecosystem responses to individual and combined stress. In particular, non-linear or threshold responses are of major concern to CEA. Basic field studies and inventories are often lacking.

Research into methods of CEA suggests that a multidisciplinary approach must be taken to effectively address cumulative effects. Such an approach involves the integration of objective scientific analysis with goal-oriented planning activities.

The limitations of traditional EIA are widely recognised. The forthcoming Canadian Environmental Assessment Act includes a provision for assessing the cumulative effects of proposals. Consequently, Parks Canada is anticipating the inclusion of CEA into their existing assessment procedures. This study is the second CEA to be conducted at a national park in the Atlantic Region.

Cumulative Effects at Gros Morne National Park

Three categories of stress were identified at GMNP: those sources occurring within the park; those sources likely to occur from proposed developments in the park; and those sources originating beyond park boundaries.

The most important cumulative impact identified in the study is the loss and fragmentation of coastal and lowland forest habitat. The combined effect of park development, community development, highway construction, utility corridors, domestic forest harvesting, moose browsing, and recreational use has had a profound effect on the front country of the park.

The destruction of glaciofluvial deposits within the park is another major cumulative impact. Demand for aggregate resources for park and community development, and road construction has maintained pressure on these resources. Similar deposits outside GMNP are afforded no protection, so the loss of the park resources is particularly significant.

Aesthetic degradation of scenic resources within the park is another major cumulative effect. The World Heritage Designation was applied, in part, in recognition of these outstanding scenic resources. The same factors causing habitat disturbance, namely park development, community development, highway construction, utility corridors, domestic forest harvesting, and recreational use, are also the main sources of visual degradation. The development at Western Brook Pond is a special case of aesthetic degradation of a wilderness landscape.

Several potential contamination sources were identified which might contribute to cumulative effects in aquatic systems, including landfill sites, and park sewage facilities. Limited evidence suggests that these effects are not currently significant.

Recreational activity has also led to limited cumulative effects on flora and fauna. Of particular concern are the potential effects of snowmobile use on flora and fauna of the Long Range plateau, and of increased use of Western Brook Pond.

The habitat impacts can be mitigated by the restoration of degraded sites, and the establishment of protected corridors between remaining habitat fragments. Further loss or fragmentation of park habitat must also be prevented.

Lost glaciofluvial deposits cannot be replaced. However, further damage can be prevented by prohibiting any new aggregate extraction sites in the park. Existing sites must be rehabilitated with native species to reduce negative effects on habitat.

New waste management systems need to be developed for the park and the enclave communities. Either an engineered landfill that prevents leachate from entering groundwater, or removal of garbage to Deer Lake is recommended. Better recycling and composting programs are also required.

Monitoring

Both natural and human influences continue to contribute to environmental change in the area of GMNP. To understand the nature and effect of these changes on ecosystem integrity, long-term monitoring programs are required.

Monitoring of the degree and rate of habitat change is recommended as an indicator of ecological integrity on the landscape scale. Comparative analysis of aerial photographs at five year intervals is suggested.

Monitoring of ecological integrity of forest ecosystems at both the watershed and the stand level is also recommended. Changes in species diversity, and nutrient losses are suggested as indicators.

Existing mammal and avifauna monitoring programs should continue. Further mammal investigations could utilise winter track and scat transects to gain information on coyote, arctic hare, and other small mammal populations.

Monitoring of aquatic systems is also required to investigate potential contamination from landfills and sewage sites. Event monitoring should be conducted in areas potentially affected by aerial spraying programs adjacent to the park.

Existing visitor activity monitoring programs should be continued. Methods of improving the recent studies of snowmobile use should be explored to improve the monitoring of the effects of OSV corridors.

Cumulative Effects in Future Assessments

The concept of CEA implies that even effects that are considered to be relatively insignificant at a project level, may be significant in an ecosystem context over the long-term. As Parks Canada is concerned principally with protecting natural heritage "for all time", the importance of addressing the issue of cumulative effects cannot be understated.

In order to appreciate the cumulative effects which may be relevant to a project specific assessment, Parks Canada must remain cognisant of the environmental and developmental context in which the project is being proposed. For example, if a proposal is going to have an impact on existing habitat, then the assessment must consider the current effects that previous and ongoing activities have had on habitat. A reasonable estimate of potential future impacts must also be made. Only then can the real impact of the new development be understood.

The park database and GIS will be important tools in this process, although their usefulness will only be as good as the data contained therein. Important parameters that can be analysed through the use of GIS include habitat loss and fragmentation, human disturbance areas, recreational use, species diversity and distribution, and water quality parameters. Information on environmental change can be added as it is acquired through inventory and monitoring studies. However, it is important to note that the GIS is just one tool that can be used in making management decisions. Many knowledgeable park staff, as well as individuals outside of Parks Canada, possess information useful to park managers. Cumulative effects assessment, and subsequent resource management decisions should be based on consultation with as many of these individuals as possible.

This report can serve as a basic reference source for information on existing sources of stress and resources of concern in GMNP. Additional work remains to be done to quantify and determine the significance of certain environmental effects. As more information is acquired, an updated database on documented stressors and associated effects should be developed which can be consulted during assessments of the cumulative effects of future development proposals.

Chapter 1: Introduction

1.0 Background

Gros Morne National Park Reserve (GMNP) was established in 1973 to protect a representative sample of the Western Newfoundland Highlands natural region. The park encompasses an area of 1805 km^2 in the Bonne Bay region of western Newfoundland, and is the largest and newest national park in the Atlantic Region (Figure 1.1). The park was declared a UNESCO World Heritage Site in 1987 in recognition of its globally significant geological features and outstanding scenic beauty.

The park was established under the terms of an agreement negotiated between the Government of Canada and the Government of Newfoundland and Labrador in 1973, and amended in 1983. This federal-provincial agreement imposed certain obligations and commitments on the federal government in exchange for the land required for park establishment. The agreement also provided for the relocation of several communities within the proposed park area. The amended agreement has expired, although not all of the terms of the agreement have been fulfilled. A five year extension to the agreement is currently being negotiated (K. Cossey, pers. comm.)

The development of GMNP has changed the very nature of the Bonne Bay region. Roads, buildings, and other forms of infrastructure have been constructed, aggregate has been mined, and facilities have been provided which encourage various types of recreational activity. Consequently, the area has evolved from a previously remote and relatively unknown region into an easily accessible and widely recognised tourist destination. The developments and activities contributing to this transformation have produced some significant environmental changes which have had an impact on the natural resources the park was established to protect.

Under the terms of the federal-provincial agreement, Parks Canada is also required to fulfil certain commitments related to development and land use within the park. Chief among these are the right of local people to harvest wood from specified areas within the park, the commitment to construct a Discovery Centre as an alternative to a plateau access system, the provision of aggregate resources as needed, and the plan to develop winter motorised access corridors through the park.

Environmental degradation resulting from development and use of GMNP has already been recognised. The 1990 State of the Parks Report identified a number of concerns including:

Figure 1.1: Regional Setting of Gros Morne National Park

! damage to plant communities due to recreational overuse;
! reduction of species diversity in forest harvesting blocks;
! potential long-term effects of forest and snowshoe hare harvesting;
! potential long-term negative effects of snowmobiling on plant and animal populations; and
! various effects associated with land use adjacent to the park (Environment Canada, Parks Service, 1991).

Each of these concerns addresses observed or predicted impacts caused by individual stressors. Cumulative impacts, resulting from numerous stressors acting on a resource or ecosystem, may be more important.

Parks Canada policy states that all programs, policies, and plans must be subjected to an environmental impact assessment (EIA) in accordance with the federal Environmental Assessment and Review Process (EARP) Guidelines Order. In the past, this has meant that individual projects have been assessed for their potential impact on park resources, and modifications or mitigative measures have been proposed to eliminate or minimise those impacts. However, little attention has been paid to the potential cumulative impacts of various projects distributed in time and space. As a result, the individual assessments conducted on site-specific proposals may not have been accurate in their prediction of potential effects on the surrounding environment. The consideration of cumulative effects arising from natural disturbance processes, and from historical, current, and future human influences at GMNP, is essential to effective management planning if the future of the park's resources is to be ensured.

This study was conceived to address the issue of cumulative effects at Gros Morne. The objectives of the study are:

1. to document the cumulative effects of park development and visitor use at GMNP;
2. to identify any potential cumulative effects of proposals contained in the current draft Park Management Plan;
3. to identify mitigation measures which can be used to minimise or eliminate effects of infrastructure development;
4. to recommend monitoring strategies;
5. to document cumulative effects techniques, and develop guidelines for the assessment of cumulative effects in future proposals

1.1 Methodology

Research for the preparation of this report was accomplished through a comprehensive literature review, map and air photo analysis, personal interviews, and field observations.

Literature reviewed included park plans, inventories, surveys, and resource studies, park EARP files, historical files, government reports and maps, and pertinent papers from the scientific literature. Literature sources included the Parks Canada library in Halifax, Resource Conservation and Visitor Centre collections at Gros Morne, Government of Newfoundland and Labrador, Dalhousie University libraries, and the author's personal collection.

Map and air photo assessments were conducted in conjunction with field observations recorded during a two-week visit to the park in September, 1994. Colour infrared aerial photographs taken in 1990 were examined for areas of special concern or high use. Maps of various land use and resource features were studied. Field visits were made to relevant areas, including: Shallow Bay and Western Brook sand dune systems; domestic resource harvesting blocks; various day-use facilities; Western Brook Pond and Trout River Pond boat tour facilities; campgrounds; hiking trails; aggregate extraction sites; waste disposal sites; and recent road maintenance and construction sites.

Personal interviews were conducted with numerous staff at GMNP, and Parks Canada Atlantic Region, as well as with individuals from the Government of Newfoundland and Labrador. A list of individuals contacted is included in the references section of this report.

Chapter 2: Literature Review of Cumulative Effects Assessment

Note: The following chapter is modified from Keith (1994).

2.0 Cumulative Environmental Effects

Cumulative environmental effects are generally considered to encompass all those actions affecting a resource or area of interest over space and time. They include the progressive addition of materials to the environment, such as industrial pollution, as well as the progressive removal of materials from the environment, such as habitat loss (Peterson et al., 1987). Cumulative effects represent the combined effects of all actions which result in a system's digression from the predicted natural state. Cumulative effects may include impacts from many seemingly insignificant actions which when combined may be more substantial and of a qualitatively different nature than the impacts of single events or stresses (Orians, 1986). Cumulative effects may include both human and natural forms of disturbance.

The U.S. Council on Environmental Quality in its 1978 implementing guidelines for the U.S. National Environmental Policy Act (NEPA) (cited in Stakhiv, 1988) has defined a cumulative impact as:

> "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."

As summarised by Spaling and Smit (1993), cumulative effects "refer generally to the phenomenon of temporal and spatial accumulation of change in environmental systems in an additive or interactive manner".

The scales of space and time implied in these definitions help to define the scope and complexity of the problem of cumulative effects. The persistent addition of toxic chemicals to a river may slowly degrade a specific watershed, the fragmentation of habitat may have repercussions over an entire landscape, and the progressive accumulation of ozone depleting substances and "greenhouse gases" may produce cumulative effects of a global nature.

Several classifications of cumulative effects have been developed. The Canadian Environmental Assessment Research Council (CEARC), and the U.S. National Research Council (NRC) in their proceedings of a binational workshop on cumulative effects, listed five distinct mechanisms that can contribute to cumulative effects (CEARC, NRC, 1986):

1. Time-crowded Perturbations: Perturbations so close in time, that the affected environment cannot recover from one insult before the onset of the next. An example would be the loss of a salmon stock due to a decline caused by fishing pressure, followed

by the destruction of spawning habitat due to siltation originating from land-based disturbances.

2. Space-crowded Perturbations: Perturbations occurring so closely in space that their effects overlap. Two or more pulp mills discharging effluent to a single watershed is a good example.

3. Synergistic Effects: Combined effects, from two or more different perturbations, which may be qualitatively or quantitatively greater than the sum of the individual impacts. For example, innocuous chemical products could combine to form toxic compounds.

4. Indirect effects: Effects that are manifest at some distance or time from the perturbation, or through complex pathways. Delays are due to time lags, spatial extent of stressor, system complexity. A well known example is the acidification of freshwater due to atmospheric deposition of SO_4 and NO_x particulates.

5. Nibbling: effects which cause incremental degradation of the environment. Many national parks suffer from chronic nibbling, where new facilities and developments are continually being constructed, resulting in the gradual degradation of the natural environment.

The fundamental concept is that many small effects may yield significant ecosystem responses through additive or interactive processes. These processes arise either out of the repetition of a single stressor at frequencies greater than can be assimilated by the environment, the combined effect of different stressors acting on the same environment, or a combination of these two mechanisms.

In addition to this typology, several other issues need to be considered in relation to cumulative environmental change. Chief among these are "precedent-setting", or growth inducement actions which lead to an increase in development pressure on a system (Contant and Wiggins, 1991), and hence to an associated litany of cumulative effects. Another issue is the cycling of actions or events such as clearcutting over space and time (Baskerville, 1986), which can lead to time-crowded cumulative effects. Finally, an issue that presents particular scientific difficulty is the uncertainty related to ecosystem structure and function which may lead to unanticipated responses. For example the notions of carrying capacity and thresholds are germane to assessing cumulative effects, but are not well understood in an ecosystem context. Further, "catastrophe and surprise" are characteristic features of most ecosystems (Woodley, 1993). Potential non-linear ecosystem responses to increasing cumulative impacts may lead to fundamental, irreversible changes once a threshold is reached beyond which the system can no longer recover from disturbance (U.S. NRC, 1986). The worsening fisheries crisis in Atlantic Canada is a salient example of this phenomenon.

2.1 Limitations of Traditional Environmental Impact Assessment and the Emergence of Cumulative Effects Assessment

The complexities of cumulative impacts have not been adequately dealt with by traditional methods of environmental impact assessment (EIA). Cocklin et al. (1992a) suggest that EIA is perceived to be inadequate because of a discrepancy between the resultant outcomes of the process and the expectations of people regarding what is environmentally acceptable. However, with respect to cumulative effects, the EIA process itself is flawed because of the limited context in which it operates. In the past, EIA has been almost exclusively a project-oriented activity, focused primarily on assessing the potential environmental, and to a lesser extent social and economic, effects of a single proposed project. This has meant that assessments have focused on relatively narrow scales of space and time. Analysis has not focused on the larger scales at which natural systems and collective human disturbances operate. Consequently, the process has often failed to consider potential secondary or indirect effects, or the combined effects of two or more independent or related developments (Cocklin et al., 1992a). Further, EIA has tended to completely ignore the individually minor, but collectively significant impacts that are a major contributor to cumulative effects (Cocklin et al., 1992a). In order to address these issues, EIA must adopt a broader context in space and time so that "regional assessments would consider the incremental and cumulative impact of many individual site proposals" (Spaling et al., 1993).

The project-oriented focus of EIA also means that the process is simply a reactive one, responding to foregone development decisions. Rees (1988) has argued that previous experience with EIA has proved this concept to be "inadequate if not naive". The failure of EIA to adopt a context of comprehensive regional planning, based on broad societal goals is one of the driving forces behind interest in cumulative effects studies (Sonntag et al., 1987). If EIA is to effectively deal with the problems of development and environmental degradation, it must adopt a more anticipatory or proactive approach, including the incorporation of CEA into regional multi-objective planning activities (Stakhiv, 1988).

Recognition of the inherent limitations of EIA as it is traditionally practised, has led to an increasing effort to develop techniques of cumulative effects assessment (CEA). In its simplest form, CEA involves the "analysis, interpretation, and management of the accumulation of impacts resulting from a number of individual developments on the environment" (O'Riordan, 1986). In its most complex form it involves a broad application of environmental assessment, scientific analysis, and regional planning, informed by societal goals (Rees, 1988; Munro, 1986).

2.2 Conceptual Frameworks for CEA

a) Problems

Several problems are inherent in the concept of a comprehensive CEA process. First, the concept implies that any assessment of cumulative effects must adopt a broad perspective in both space and time. The use of limited boundaries influenced by project design and administrative constraints is one of the "trade-offs" made when conducting traditional EIA (Beanlands and Duinker, 1983). Expanding the boundaries of impact assessments is the first obstacle to be overcome.

Because of the complex interactions within ecosystems, an assessment of cumulative effects should ideally adopt study limits which reflect some form of natural boundary (landscape, ecosystem, watershed). The assessment boundaries must be chosen so they encompass the "spatial and temporal dynamics of the environmental resources of concern and the anthropogenic activities influencing them" (Preston and Bedford, 1988). A watershed boundary may be sufficient for determining cumulative effects of pulp mill effluent on water quality within that defined area, but the effects on migratory birds utilising wetlands within that watershed would require a larger spatial context encompassing the entire migratory ranges of the species of interest. For example, a study of the effect of hydro development on caribou in Newfoundland utilising herd productivity as an indicator required the use of spatial boundaries which encompassed the entire range of the herd (Kiell et al., 1986).

The definition of spatial limits is complicated by the fact that the boundaries of natural systems are rarely coincident with jurisdictional or administrative ones. Consequently, effective use of CEA, particularly with respect to its planning function, normally requires cooperation between several agencies or interests. Some progress has been made toward resolving this issue in New Zealand where new regional government boundaries have been defined based on physical environmental characteristics (watersheds) (Cocklin et al., 1992a).

Temporal boundaries also present some difficulties. In order to predict future cumulative effects, current and future proposals must be studied in the context of past developments, and the impacts of those previous actions must be understood. Further, a reasonable forecast of future development pressure on the study area is necessary. However, as Cocklin et al. (1992a) point out, "the paucity of data on environmental change through time severely compromises the ability to introduce an historical perspective". Contant and Wiggins (1991) suggest that the expanded use of geographic information systems (GIS) and remote sensing will improve this situation in the future.

While the spatial and temporal contexts have to be broadened, the definition of precise boundaries for CEA in national parks must be made on a case-by-case basis. Recognising that parks are seldom large enough to protect viable whole ecosystems, the spatial boundaries must encompass all activities and developments affecting resources within the park and in the surrounding ecosystem. Temporal boundaries must include historical and existing activities and developments, and future forecasts. In remote parks where previous development has been limited, the historical perspective may only involve a review of natural processes contributing to environmental change. Conversely, in more developed areas such as GMNP, a greater retrospective study is required.

A second fundamental problem facing CEA is the extremely incomplete knowledge base regarding the behaviour of ecosystems in response to cumulative stressors. A lack of knowledge on the structure and dynamics of the ecosystem may also result in the delineation of inappropriate study boundaries (Preston and Bedford, 1988). With respect to wetland ecosystems, Bedford and Preston (1988) acknowledge that the "scientific understanding required by decision makers for evaluating consequences of multiple disturbances ... is far from complete". The situation is even worse for complex terrestrial systems which have been less studied with respect to cumulative effects.

Detailed knowledge of predicted ecosystem responses to stress and of potential threshold levels for given variables is also essential to understanding the significance of cumulative effects. Unfortunately, little of either a quantitative or qualitative nature is known, and predicting thresholds has been cited as one of the most difficult problems facing science and CEA (Preston and Bedford, 1988; U.S. NRC, 1986). The incomplete knowledge base has been extended to include the functioning of socioeconomic systems which provide the impetus for land use development (Contant and Wiggins, 1991).

b) Conceptual Approaches to CEA

While much has been published on the limitations of EIA, and the need for a better proactive approach involving CEA, literature on how to achieve this goal is sparse, and less unanimous. Beanlands (1992) cited two recent bibliographies of cumulative effects which indicated that only 20-30% of papers on the topic actually offered guidance on conducting CEA. Notable efforts have been made to address the cumulative effects on wetlands (Stakhiv, 1988), and on soil and water resources (Sidle and Sharpley, 1991). However, there is a dearth of literature on the more complex issues of cumulative effects on terrestrial and marine ecosystems. Nevertheless, some general issues regarding concepts of CEA are emerging in the literature.

One of the main disparities in the literature involves the relative contributions of rigorous science, and subjective planning. Baskerville (1986) argues that CEA must focus on rigorous science because it must attempt to forecast the future of a system first in the absence of perturbations, and then under the influence of all existing and foreseeable perturbations, in order to measure cumulative environmental change. Similarly, Preston and Bedford (1988) focus almost exclusively on scientific issues in their discussion of cumulative effects on wetland ecosystems[1]. Spaling and Smit (1993) concluded that this information-gathering, scientific approach to CEA is the prevalent one.

However, Munro (1986) suggests that the "question of social goals is of primary importance" in defining the objectives of CEA. This view is supported by others who see broad based multi-objective regional planning as a prerequisite for any meaningful CEA (Rees, 1988; Stakhiv, 1988). According to Beanlands (1992), this view has found its way into practice, such that in some cases methods of CEA are difficult to distinguish from regional planning and integrated resource management exercises. While social goals certainly have a great deal of relevance, they are also subject to political manipulation and economic pressures which may deflect attention away from the environmental consequences of development actions.

Probably the most logical and useful approach to CEA involves an amalgamation of the two concepts. This idea is expressed in much of the recent literature. In a review article on the topic, Spaling and Smit (1993) discuss the two different philosophies and conclude that "one approach does not preclude the other, and for effective management they are both essential". The authors envisage a linkage between science and planning whereby:

> "a planning approach to CEA can provide the regional context for assessing the cumulative significance of any proposed human activities at the site level. Conversely, a scientific analysis of cumulative environmental change attributable to past, present, or anticipated development actions provides information pertinent to the setting of environmental, economic, and social goals for planning and to the evaluation of alternative courses of action".

The idea is supported by Gosselink et al. (1990) who contend that in addition to scientific analysis, effective management of cumulative effects requires that decisions made at the site level be "governed by earlier decisions made about the allowable extent of modification of the whole landscape unit".

Regardless of the theoretical approach taken, environmental monitoring must play a fundamental role in CEA. The repetitive measurement of attributes made to understand the state of an environmental system over time has been a focus of interest since the emergence of EIA (Duinker, 1989). The increased complexity and uncertainty inherent in the analysis of cumulative effects makes monitoring even more important.

Monitoring for cumulative effects has been defined by Davies (1991) as the "repetitive measurement of the combined effects associated with multiple environmental stressors". The purpose of most monitoring programs is to identify trends in the state of the ecosystem, and to link these trends to causal sources in order to gauge the effectiveness of assessment and mitigation strategies.

c) Methodological Approaches to CEA

The conceptual framework of cumulative effects has continued to evolve since the 1986 CEARC and U.S. NRC workshop. There is still no widely accepted methodology for conducting CEAs, but several methods have been discussed by various authors. Sonntag et al. (1987) suggest that adaptation of existing EIA techniques has had some success where the scale and causes of impacts can be assessed on a local or regional basis (simple additive or interactive relationships). However, they call for new assessment techniques where effects occur over a large spatial scale or over very long time frames.

Among existing techniques with some applicability to CEA are matrix methods which provide a connection between cause and effect. A matrix used by Clark (1986) to assess cumulative impacts on the atmosphere relies on the summation of impacts to reduce a variety of values to a single parameter. The matrix, which lists sources of impacts in the vertical column and atmospheric attributes in the horizontal row, will yield two sets of information: summation of the columns will give the net effect of all sources on each attribute, and summation of the rows will give the net effect of each source on all attributes. According to Sonntag et al. (1987), such matrix methods have been criticised because they fail to account for interactions between ecosystem components and project activities and outputs, and therefore do not address a major cause of cumulative effects. Likewise, Cocklin et al. (1992b) concluded that matrix methods generally fail to deal adequately with the complex inter-relationships typical of cumulative effects. An attempt at defining a more complex "system matrix" was made by Sonntag et al. (1987) but the application of the theory has not been fully developed.

The first CEA study conducted for Parks Canada, Atlantic Region used a similar, simplified approach to assess cumulative effects of development and land use at Prince Edward Island National Park (Keith, 1994). The study focused on documenting all known and potential sources of stress acting on the park ecosystem, and then considered the combined effect of the various stresses on specific key park resources.

Another technique is the input-output method, adapted from industry models of supply and demand, to model economy - environment interactions. Cocklin et al. (1992b) maintain that these methods are limited due to the difficulty of modelling environmental responses. However, input-output techniques have been used in conjunction with other methods in an integrated approach to wetlands assessment (Stakhiv, 1988).

A less rigorous approach was advanced by Gosselink et al. (1990) consisting of a three-phase methodology for assessing cumulative effects incorporating both scientific and planning components:

1. Assessment - characterisation of ecosystem structure and functional processes in a designated landscape unit,

2. Goal-setting - public consensus on environmental goals based on the assessment and pertinent legislation

3. Implementation - development of management plans reflecting goals and landscape structure and function of the area.

The assessment process utilises a number of "landscape indices" to monitor the health of a broad ecosystem. In applying the method to a forested wetland ecosystem, Gosselink et al. (1990) used measures of forest structure and land use, stream discharge and water-quality records, breeding bird surveys and Christmas bird counts to assess changes in ecosystem health. The authors acknowledge that the latter two steps are value-laden components. However, in the context of national park planning and management, the use of similar procedures is a well accepted and necessary approach to dealing with the protection of natural heritage. Ideally, national parks in developed settings such as Gros Morne can incorporate goals established through regional planning processes that will allow for a balance between environmental protection and regional development.

Four existing methods of assessment which may have some application to CEA have been outlined by Stakhiv (1988):

1. Valuation methods and models based on subjective statistical determinations of impacts on predetermined ecosystem attributes. In itself this is too reductionist an approach.

2. Ecosystem effects modelling, using mass balance, or input-output techniques to simulate system response. Examples cited by Stakhiv (1988) all failed due to the complexity and information needs involved.

3. Theoretical approaches based on conceptual perspectives such as resource economics, or energetics. These models are too narrowly constrained by one perspective to be effective methods of CEA.

4. Land use designation approaches which translate societal goals and environmental objectives into land use restrictions. Planning must include consideration of both "technically supported goals related to resource conservation and social goals related to the local political and social setting". In essence this defines the history of park planning and development at Gros Morne.

Stakhiv (1988) drew heavily on this last approach, and to a lesser degree on the other concepts and methods discussed above, to develop a model for wetlands CEA and permit processing in the United States. The model takes an integrated approach which relies on the following four sets of information:

"(1) a set of development-conservation goals against which alternative actions and policies may be evaluated;

(2) a set of forecasts of expected growth and development scenarios that attempt to fulfil the desired goals;

(3) a set of biophysical wetlands constraints operating within a developed theory or model of ecosystem response to natural and human disturbance; and

(4) a set of environmental protection standards and criteria that serve as minimal constraints, defining acceptable carrying capacity, within which a comprehensive

assessment of impacts on an area can be made" (Stakhiv, 1988).

The model also uses input-output analysis to evaluate ecologic-economic impacts. A similar "systems model" put forth by Sonntag et al. (1987) focused on cause-effect relationships between perturbations and ecosystem structure and processes, but did not fully develop the associated planning context. The information needs inherent in the above approach reflect the complexity of CEA.

The evolution of conceptual models of CEA has been accompanied by the development of analytical tools to assist in prediction and assessment. A study by Johnston et al. (1988) utilised current and historical water-quality data, aerial photo interpretation, statistical analysis, and GIS techniques to study the relationship between disturbed and undisturbed areas in an upland watershed, and the associated cumulative effects on downstream water quality. The GIS provided the ability to consider a broad spatial and temporal context, and evaluate the importance of the position of various wetlands within the landscape. In a similar study, Sebastiani et al. (1989) utilised a similar approach to map changes in land use and environmental characteristics over a 37 year period in a coastal landscape in Argentina. The results of the study were then used to develop proposed guidelines for further land use planning in the area.

This approach has recently been used at Gros Morne, where a georeferenced baseline study of the intertidal zone was conducted in 1993. This will provide input to the park GIS, and will assist in determining the degree of change in the intertidal zone over time.

In addition to providing an effective means of representing spatial dimensions and relationships, and environmental changes over time, a GIS can also evaluate various future scenarios. Computer modelling programs are other important analytical tools which may be used in conjunction with GIS. Since a GIS is limited in its ability to represent cause-effect relationships, Cocklin et al. (1992b) have suggested the use of "side models" designed to represent ecosystem processes which could provide information to the GIS in order to improve representation of causal links.

d) Conclusion

Perhaps the most important conclusion to be drawn from the literature review is that CEA requires a "plurality of approaches" (Spaling and Smit, 1993), encompassing rigorous science, goal-setting, and regional planning. The general principles which need to be considered in conducting a CEA are listed below.

1. Due to the spatial complexity of cumulative effects, an ecosystem approach must be adopted, and indicators of environmental health and ecosystem integrity must be identified.

2. Due to the temporal influence of cumulative effects, past and present developments and

activities must be documented and considered along with foreseeable future initiatives.

3. Ecosystem responses to previous and ongoing developments and activities must be understood as well as data allows. Lack of baseline data and historical monitoring hinders this process.

4. Environmental attributes, existing development and land use, and societal goals should be used to define permissable levels of development activity.

5. Ideally CEA will be conducted in relation to a regional land use plan developed as part of the process. This may be complicated by political and jurisdictional issues.

6. Continuing scientific investigation and ecosystem monitoring should be carried out in order to increase understanding of ecosystem processes, and to test the validity of previous and ongoing mitigative strategies and assumptions about ecosystem responses to stress.

7. Analytical tools such as GIS, aerial photogrammetry and satellite imagery, and computer modelling should be used to gain insights into system behaviour and cumulative environmental change.

2.3 EARP, the Canadian Environmental Assessment Act, CEA and Parks Canada

In Canada, the federal Environmental Assessment and Review Process (EARP) was established in 1973, and formalised in 1984 through the implementation of a Guidelines Order. The process was established to assess the environmental effects of any project proposal involving the federal government. As a means for comprehensive environmental assessment, EARP has proved inadequate in two major ways. First, it applies only to projects under federal jurisdiction, or where federal money is involved. Thus many significant private sector projects, and certainly many actions contributing to cumulative effects are exempt from consideration. Second, EARP applies only to the determination of the significance of effects related to individual projects, and not to cumulative effects, or higher level policy and management activities. Consequently many important policy and management decisions which contribute to cumulative effects, such as land use plans, farm subsidies, agricultural, fisheries and forest management practices, and transportation, trade, and urbanisation policies have not been subject to EARP evaluations (Munro, 1986; Rees, 1988). These problems have been compounded by the fact that the EARP has also been prone to "excessive political discretion" (Rees, 1988), although recent court decisions in the Rafferty-Alameda, and Oldman River cases have helped to rectify this problem.

In 1979, in response to the establishment of EARP, Parks Canada formalised EARP into its own policy and developed a management directive in 1981 relating to EIA for projects under its jurisdiction. The latest formulation of parks policy states that Parks Canada "will be exemplary in the implementation of federal legislation pertaining to environmental assessment and review in national parks" (Parks Canada, 1994b, s. 3.2.13). In addition to specific projects, the policy extends to programs, policies, and plans. In accordance with these documents, all projects or activities proposed by Parks Canada are subject to assessment at the appropriate levels of rigour (screening, initial environmental evaluation; or environmental impact statements in the case of some externally proposed activities) (Management Directive 2.4.2).

However, a review of 14 representative Parks Canada screening reports from across the country conducted by Elkin and Smith (1988) found half of the evaluations to be inadequate by EARP standards. Additionally, the authors found that cumulative effects were not discussed, and in fact the "existence of other past, current, or future projects in the (park) region (was) rarely acknowledged" (consideration of cumulative effects was not required by the EARP Guidelines Order). The lack of consistent and effective monitoring programs was cited as the weakest component of all the reports. The poor monitoring record reflects the inadequate level of resources that has been allocated to monitoring studies.

The EARP process takes a narrow view of EIA, utilising it as a reactive tool in response to project proposals, responsible for determining the way in which a project can proceed in the most appropriate manner. In his critique of traditional EIA and the EARP process, Rees (1988) discusses this limitation and suggests a connection between sustainable development and a reformed EIA process encompassing a comprehensive planning-based approach to CEA. He sees existing EIA as a reactive process whereby the

> "economy and proposal are considered to be the independent or driving variables, and the environment and EA the dependent ones. By contrast, sustainable development (including better EIA and CEA) requires a proactive and planning approach in which ecological integrity is the governing factor and the permissable level of economic activity is the dependent variable."

This view applies directly to Parks Canada's legislative mandate which gives the maintenance of ecological integrity primacy over other issues when considering park zoning and visitor use (National Parks Act, S.C. 1991, c. N-14, s. 5(1.2)).

For various political and legal reasons, the EARP Guidelines Order is being replaced by federal legislation. The Canadian Environmental Assessment Act (CEAA) was passed on June 23, 1992, and will likely be officially proclaimed in January, 1995. The new act recognises four different kinds of assessment: screening, comprehensive study, mediation, and panel review. Application of the Act is still limited to areas of federal involvement, and political discretion is still a potential problem. However, an important improvement over EARP is the requirement to assess the cumulative effects of proposals. The Act requires that all assessments shall consider:

> "(a)... any cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out;

(b) the significance of the effects referred to in paragraph (a)" (S.C. 1992, c. 37, s. 16(1)).

A discussion paper prepared by Ecosystems Consulting Inc. (1992) has interpreted this section to apply only to projects or activities that have already been approved at the time of a CEA, because of the phrase *or will be carried out*. The lack of a provision to assess the consequences of "reasonably foreseeable" future projects or actions may be a significant shortcoming of the act.

No definition of cumulative environmental effects is given in the Act, although environmental effects are defined as:

> "(a) any change that the project may cause in the environment, including any effect of any such change on health and socio-economic conditions, on physical and cultural heritage, on the current use of lands and resources for traditional purposes by aboriginal persons, or on any structure, site or thing that is of historical, archaeological, paleontological or architectural significance, and
>
> (b) any change to the project that may be caused by the environment, whether any such changes occur within or outside Canada" (S.C. 1992, c. 37, s. 2(1)).

This definition should be broad enough to allow the assessment of any significant cumulative environmental effects, subject to the limitation discussed above.

In accordance with current policy statements, Parks Canada is anticipating the inclusion of CEA into future EIA procedures at both the project and planning levels. The cumulative effects study conducted by Keith (1994) at Prince Edward Island National Park was the first attempt to apply the concept of CEA to a national park in the Atlantic Region. In addition to this study, cumulative effects studies are underway at Kouchibouguac and Terra Nova National Parks as part of a graduate student research project (A. d'Entremont, pers. comm.).

Chapter 3: Cumulative Effects of Development and Land Use at Gros Morne National Park

3.0 Background

Initial consideration of the Bonne Bay area as a national park dates back to Newfoundland's confederation with Canada in 1949 (Pruitt, 1970). Official activity began with reconnaissance resource surveys in 1965, and development studies in 1967 (Lothian, 1985). A memorandum of agreement between the federal and provincial governments was signed on October 31, 1970, and a final agreement was signed in Rocky Harbour, on August 13, 1973. The original agreement excluded from the park the communities of St. Paul's, Cow Head, Rocky Harbour, Norris Point, Trout River, and Curzon to Glenburnie on Bonne Bay. The community of Sally's Cove was subsequently excluded.

The final agreement, and amendments made in 1983, committed the federal government to provide various infrastructure and land use opportunities within the park. These commitments included:

- the construction of paved highways between Wiltondale and the north park boundary, and Wiltondale and Trout River;
- the construction of a park visitor centre
- the provision of various recreational facilities, including a heated swimming pool, campgrounds, hiking trails, day-use areas, and a golf course in one of the two Newfoundland national parks (eventually built in Terra Nova National Park);
- a plateau access system to allow all visitors to experience the park's upland areas;
- the provision of boat tours on Western Brook Pond and Trout River Pond;
- provision of domestic resource harvesting areas within the park for the harvest of lumber and fuelwood, and the snaring of snowshoe hare;
- provision of aggregate supply sources within the park for use in park infrastructure, and for provincial and enclave community needs;
- provision of access and maintenance for eight fish landing and staging areas within park boundaries;
- provision of areas for downhill skiing, ski touring, and snowmobile use (the downhill skiing concept has been eliminated from future consideration);

The original park boundary encompassed an area of 1,943 km^2 (Environment Canada, Parks Service, 1990). However, the 1983 amendments withdrew some land from the park around enclave communities, at the eight fish landing areas, at Sally's Cove, and in St Pauls Inlet, such that the area of the park is now 1,805 km^2. Land withdrawals adjacent to communities were aimed at providing additional resources for domestic and commercial forest harvesting.

The purpose of GMNP within the national park system is to preserve, protect, and present "for all time a representative area of national and world significance in the Western Newfoundland Island Highlands Natural Region" and to encourage "public understanding, appreciation, and enjoyment of this outstanding heritage...so as to leave it unimpaired for this and future generations" (Parks Canada, 1994a). Three ecoregions are represented in the park: the Northern Peninsula Forest (Coastal Plain subregion), the Long Range Barrens (Northern Long Range subregion), and the Western Newfoundland Forest (Serpentine Range, and Corner Brook subregions). Ideally, the park was meant to provide protection for a diversity of outstanding resources, including:

- coastal lowland forested ecosystems;
- coastal sand dune systems;
- various species of fauna (including arctic hare, three herds of migratory caribou, the harlequin duck, and possibly the Newfoundland pine marten, the latter two being endangered species);
- rare bryophyte and vascular flora (arctic-alpine, calciphilic, and serpentinicolous species);
- significant aquatic resources (pristine oligotrophic ponds, and salmonid populations);
- outstanding geological resources, including globally significant ophiolite complexes and fossil localities, glacial landforms, and nunataks; and
- exceptional scenic and "wilderness" resources.

However, the protection of these natural resources in GMNP is not assured, and is complicated by the federal-provincial agreement. For example, with reference to the protection of Zone 1 Special Preservation Areas within the park, the draft park management plan (PMP) states that resource manipulation will not be carried out unless it "is essential to provide for resource preservation, public health or safety and/or *federal provincial commitments*" (emphasis added). Many resource or land use decisions made during the negotiation of the agreement are contrary either to Parks Canada policy, or to the intent of that policy. Examples include aggregate resource extraction, domestic resource harvesting, and snowmobile use in wilderness areas.

Environmental degradation resulting from development and use of GMNP has already been recognised. The 1990 State of the Parks Report (Environment Canada, Parks Service, 1991) identified a number of concerns including:

- damage to plant communities due to recreational overuse;
- reduction of species diversity in forest harvesting blocks;
- potential long-term effects of forest harvesting;
- potential long-term effects of snowmobiling on plant and animal populations; and
- increased accessibility associated with forest harvesting adjacent to the park.

The combination of ecosystem stresses originating from development and land use within and adjacent to the park result in cumulative impacts on park resources. These impacts accumulate through one or both of the following processes:

1. Repetition of a particular activity over time, such that the resource or ecosystem cannot completely recover between events.

2. A combination of a number of discrete perturbations affecting a particular resource or ecosystem, so that effects from different sources are manifest over a similar time frame, to the extent that the resource or ecosystem cannot fully recover between events.

As a result, individual impacts which may be minor in isolation, accumulate, and may lead to a significant cumulative impact.

At GMNP, both mechanisms act to influence the state of park resources. Cumulative effects on park resources are discussed below in terms of those effects related to previous or existing development and activity in the park, those effects likely to result from proposals in the draft PMP, and those effects originating from development or land use outside of the park boundary. A discussion of the significance of identified cumulative effects is presented in Chapter 4.

3.1 Historical Environmental Change

a) Change Through Natural Processes

Natural processes of environmental change are a fundamental element of ecosystems, and have produced many of the features Gros Morne was established to protect. The powerful forces of continental collision are responsible for the unique geology of the Tablelands, and the erosive forces of continental glaciation produced the parks spectacular fjords. Less dramatic changes result from current active processes, and occur on a time scale relevant to park managers. These include processes such as cryoturbation, landslides, fluvial and aeolian erosion and deposition, storms, and natural vegetation succession.

Various natural processes have affected (and continue to influence) the character of the forests of GMNP. These include insects, disease, fire, wind, and interspecific composition. Throughout this century numerous outbreaks of forest insects have caused defoliation, and in some cases mortality of forest stands in Gros Morne and western Newfoundland. The most important forest insect in the park is the hemlock looper, but several other species have been historically significant. The major outbreaks of this century are listed by Anions (1994). Various fungal pathogens are also present in GMNP. These diseases affect certain isolated areas or specific species, and do not appear to contribute to significant environmental change.

The natural fire cycle is very low in western Newfoundland, and large fires are rare. Only a few small fire-generated forest stands have been identified in the region (Meades, 1990). In GMNP, there are seven small areas of fire origin identified as environmentally sensitive sites (Parks Canada, 1994a).

b) Anthropogenic Changes

The forests of the park have been extensively cut in the past. Large scale logging operations were carried out in the Southeast Hills area to supply timber for sawmills established at Lomond and Stanleyville (Lothian, 1985). From 1917 to 1941 St. Lawrence Timber, Pulp, and Steamship Company operated a mill at Lomond (Lothian, 1985). The company was cutting virgin forest, and their exports reportedly included hewn pine timbers up to three feet square (McLeod, 1988). The lumbering operation was the largest in eastern Canada at that time, and employed more than 400 people in the mill and forest (McLeod, 1988). An industry of such magnitude must have had a profound effect on the nature of the forest. More recently, the coastal plain was harvested for pulp and the hilly areas were harvested for domestic purposes (Dunfield, 1981).

The results of this activity are visible in the existing forests of GMNP. There are no virgin forests in the coastal zone, and balsam fir (*Abies balsamea*) has become the dominant tree species because of its ability to recolonise after disturbance (Dunfield, 1981).

Some historical accounts describe the Southeast Hills area as containing abundant white pine (*Pinus strobus*), a species that is now rare within the park. However, Deichmann et al. (1994) suggest that although white pine may have been a significant component of some stands, it rarely becomes the major species. Currently, within the park, white pine is found in the Lomond River valley, Stanleyville, Winter House Brook, and in the Trout River Gulch. Current estimates of white pine trees in the park are: 500 overmature, <100 mature, and <100 advanced reproduction stage trees (Deichmann, pers. comm.). While isolated individuals remain, the future of the species in Gros Morne is in doubt. Although existing trees are producing seed, natural regeneration is virtually non-existent due to site environmental factors (Anions, 1994). Further, recent examination of a group of pine stumps harvested in the 1920s indicates a former mature stand of pines in an area now dominated by balsam fir and black spruce (*Picea mariana*), and suggests that the stand was incapable of reproducing itself after being harvested (Deichmann, et al., 1994).

Logging in the early part of the century is only one of several factors implicated by Anions (1994) in the decline of white pine. Factors related to clearcutting include competition from vigorously regenerating balsam fir and spruce, and favourable conditions for currants (*Ribes sp.*) which hosts the White Pine Blister Rust. Further, it is questionable as to whether a white pine forest could ever have been dominant in this region due to the very low frequency of fire, as fire disturbance is critical to the regenerative ability of white pine stands.

The fauna currently extant in GMNP does not represent the full complement of species historically found in the region. In addition, several introduced species have become established. The Newfoundland wolf (*Canis lupus beothicus*) was extirpated from the island around 1910, and the Newfoundland marten (*Martes americana atrata*) was extirpated from the park area, although rare individuals may be present near the eastern park boundary due to a provincial reintroduction program in the Main River area (Caines and Deichmann, 1990). Vacant habitat suggests that the piping plover (*Charadrius melodus*) was also extirpated from the park area, although a small breeding population still exists along the province's south coast. Jacques Whitford Environment (1993) estimated a historical park population of up to 12 breeding pairs based on the amount of suitable habitat.

The most important introduced mammals in the park are moose (*Alces alces*) and snowshoe hare (*Lepus americanus*). The moose was introduced to the island in 1878 and 1904, and has become very abundant in certain areas of the park, to the extent that it has begun to affect forest succession. The snowshoe hare was introduced in the early 1800s, and has become very abundant in the lowland areas of the park. Its presence may have affected interactions among other species, particularly as an alternative to arctic hare (*Lepus timidus*) as a source of prey for the lynx (*Lynx canadensis*). Other introduced or accidentally released mammals include the red squirrel (*Tamiasciurus hudsonicus*), house mouse (*Mus musculus*), Norway rat (*Rattus norvegicus*), masked shrew (*Sorex cinereus acadicus*), and mink (*Mustela vison*). The coyote (*Canis latrans*) has recently colonised the island, and its presence has been recorded near GMNP.

Since the park was established, various developments and activities have led to further environmental change. These include highway development, aggregate extraction, recreational facilities. A chronology of development in GMNP is presented in Table 3.1. The effects of the various developments are discussed below.

Table 3.1: Chronology of Development in Gros Morne National Park
(Sources: Lothian, 1985; park asset files; park EARP files; Parks Service, 1991; Parks Canada, 1994a)

1972	-Green Point campground opened as a temporary facility (later to be established as a permanent, basic campground)
1973	-signing of official federal-provincial agreement establishing GMNP
1974	-commencement of upgrading and paving of route 430 between Wiltondale and Rocky Harbour
1975	-commencement of upgrading and paving of route 430 north of Rocky Harbour (ongoing until 1980) -construction of Berry Hill campground began -trail to Western Brook Pond completed
1976	-Berry Hill campground completed -Western Brook day-use area parking lot and water supply installed

1977 -Lomond campground opened as temporary facility (later to become permanent)
-Gros Morne Mountain trail constructed
-traditional snowshoe hare harvest was established

1978 -Visitor Reception Centre opened
-construction of Shallow Bay day-use area
-development of Green Gardens trail
-Mackenzie's Brook picnic area developed

1979 -Deer Arm and Gull Rocks picnic areas developed

1980 -construction of Western Brook Pond-Snug Harbour-Stag Brook trail

1981 -reconstruction of highway 431 began
-Shallow Bay campground opened as a temporary facility (later upgraded to permanent)
-construction of 138 kV power transmission line from Wiltondale to Berry Hill access road

1982 -upgrading and construction of new maintenance compound at Rocky Harbour
-Western Brook Pond boat tour facility constructed, tour operations commenced

1983 -reconstruction and upgrading of portions of highway 430 between Wiltondale and Rocky Harbour
-traditional forest harvest blocks established
-development of Lomond day-use area and wharf/boat launch
-construction of Tablelands parking lot and trailhead

1984 -construction of Rocky Harbour administration building commenced (completed in 1985)
-small wharf constructed at east end of Western Brook Pond for Long Range access
-development of Southeast Hills day-use area

1985 -Baker's Brook Falls trail constructed

1986 -construction of Trout River bridge for campground access
-development of Trout River day-use area and boat launch
-Western Brook day-use area shelters and toilets installed

1987 -expansion and upgrading of Shallow Bay campground (water, sewage, and electrical systems, dumping station, playground, service building)

1988 -upgrading of Western Brook Pond trail to accommodate ATV maintenance vehicles
-Baker's Brook picnic area developed
-construction of Trout River campground completed

-construction of the Rocky Harbour recreational complex commenced (within enclave, but funded by Parks Canada as per the agreement)

1989 -expansion and upgrading of Green Point campground (water and electrical systems, kitchen shelter, parking)
-expansion and upgrading of Lomond campground to permanent facility
-reconstruction of Lomond road
-construction of 138 kV power transmission line from Berry Hill to Daniel's Harbour commenced
-boat operations cabin built at Western Brook Pond
-completion of Rocky Harbour recreation complex
-upgrading of Shallow Bay day-use area

1990 -construction of Trout River Pond boat tour facility, including wharf
-Green Gardens Trail reconstruction, phase 1

1991 -construction of Mill Brook day-use area and wharf/boat launch
-upgrading of Green Gardens trail, phase 2

1992 -commencement of Western Brook Pond boat tour facility redevelopment
-further upgrading of Western Brook Pond trail

1993 -Western Brook Pond boat tour redevelopment completed
-Lobster Cove day-use area developed

1994 -resurfacing and upgrading of highway 430, Deer Arm to Berry Hill
-construction of Wiltondale park entrance kiosk (outside park boundary)
-enlargement of Gros Morne Mountain trailhead parking area

1994-2004 (proposed)

-establishment of designated oversnow vehicle corridors
-construction of the Discovery Centre (possibly outside park boundary)
-upgrading and maintenance of all park roads
-development of Wigwam Pond campground (up to 50 units, semi-serviced), and expansion of other campgrounds as demand warrants
-development of a southside administration facility
-upgrading and expansion of cross-country ski trail system

3.2 Cumulative Environmental Effects From Previous or Current Development and Land

Use in Gros Morne

Documented and potential effects of individual stressors are discussed below, and presented in Table 3.3. A discussion of the cumulative effects relative to key park resources is presented in Chapter 4.

a) Construction and Maintenance of Highways and Related Access Roads

There are more than 100 kilometres of paved highway within GMNP (Parks Canada, 1994a). In addition there are paved roads linking the various sectors of the park to, and providing access within, the enclave communities. Further, there are numerous gravel roads used to access campgrounds, fishing areas, and day-use facilities. All of these roads have certain environmental impacts arising from both the construction and maintenance phases of development.

The most obvious and inevitable effect of road development, particularly highway development, is that by its very nature it constitutes a major landscape disturbance. Trees, other vegetation, and soil must be removed, and the topography modified in order to meet engineering specifications. As a result, on a gross scale, a finite amount of natural habitat is permanently lost. In Gros Morne, the habitat lost includes major corridors through lowland and upland forest in the Southeast Hills and along the Bonne Bay shoreline, coastal plain scrub forest and tuckamore, and saltmarshes. In particular, a small saltmarsh at the head of Deer Arm has been entirely destroyed due to causeway construction with inadequate culvert capacity for tide water exchange. The alteration of hydrodynamics effectively eliminated the saltmarsh vegetation. The causeway also covered a significant portion of productive clam beds (Hooper and Stoodley, 1982).

Marine habitat, including that within Parks Canada jurisdiction (above the low water mark), was also damaged or lost due to highway construction. The East Arm of Bonne Bay has been affected by infilling required to construct highway 430, and by portions of the road which have been swept into the bay by rock slides originating on adjacent unstable slopes (M. Burzynski, pers. comm.; Lothian, 1985). The major impacts resulting from the construction of highway 430 in 1966 were related to high sediment influxes, and the burial of shorelines (Hooper and Stoodley, 1982). Between Rocky Barachois Brook and Deer Arm Brook 14 coastal segments of the bay were buried with rock fill (Le Sauteur, 1983). Between 1979 and 1981 extensive stabilisation work was conducted along the Wiltondale - Rocky Harbour segment to prevent further geological failures (Le Sauteur, 1983), which involved further infilling of four additional segments (Hooper and Stoodley, 1982). Loss or alteration of benthic habitat, and direct mortality of benthic flora and fauna are the chief effects of such activity. As a result, habitat has been reduced for some species, and enhanced for others. In particular, Hooper and Stoodley (1982) note a decrease in clam populations, and an increase in lobster (*Homarus americanus*) habitat due to the replacement of fine marine sediment with coarse boulder fill. Mussel (*Mytilus edulus*) populations in the intertidal and shallow subtidal waters might also be expected to increase in this situation.

Numerous siltation events were reported during or shortly after construction of highway

430, including cases at Southeast Brook, John White's Cove, and Dick's Brook, and minor events at Western Brook (Le Sauteur, 1983). It is not known whether these events had any significant effect on fish populations or spawning habitat.

During construction of the northern segment of the highway, sections around Western Brook and Shallow Bay were rerouted inland to avoid landward-migrating dune systems. This reduced the need for interference with natural geomorphic processes through the use of dune stabilisation projects, although it necessitated the destruction of more coastal tuckamore, and the infilling of portions of coastal wetlands.

Another major impact of road construction is related to the increased requirement for aggregate resource extraction. During the construction of highway 430, numerous small gravel pits were excavated along the coast, and moraines were mined in the Sally's Cove-Martins Head area, destroying vegetation and creating visible scars which are still present (M. Burzynski, pers. comm.). The environmental effects of aggregate extraction are more specifically discussed under section 3.2e.

A specific related impact involved a major slumping event which occurred at Seal Cove due to the stockpiling of granular material during the reconstruction of highway 430 on a buried, unstable marine silt deposit. The slumping uplifted and transported the marine deposit 300m seaward into the East Arm of Bonne Bay (Le Sauteur, 1983). This area has not been adequately rehabilitated, and still presents an unaesthetic appearance, although the new feature does possess significant interpretive potential as a lesson in geomorphology and environmental surprise in the absence of human forethought. The existing site has also become a popular habitat for beavers and otters (M. Burzynski, pers. comm.).

One site-specific impact of road construction and maintenance was observed during field visits to Dry Brook in the Tablelands area. When highway 431 was constructed to Trout River, a tiny bridge was designed for the crossing of the large alluvial fan at Dry Brook. The design of the bridge was insufficient to accommodate spring discharge from the brook, such that stream bed material has had to be dredged annually.

Dry Brook drains a cirque valley on the Tablelands plateau and discharges into Wallace Brook. Dry Brook flows through a wide, coarse, low profile alluvial fan thought to have been formed by a catastrophic release of ponded water in the cirque, caused by the collapse of a moraine dam following deglaciation (M. Burzynski, pers. comm.). The remains of the moraine are clearly evident at the lip of the cirque. The surface of the fan is composed predominantly of boulder to cobble size peridotite, with minor fine material. More fine material may be present in the subsurface layer. The brook's name is derived from the fact that it is dry most of the year. However, for a brief period each spring, the flow rate is strong enough to transport large boulders down the low sloping fan, which naturally are deposited in the channel excavated by the general works department to guide the flow beneath the bridge. The effect is exacerbated by the lateral emplacement of stone gabions, which effectively channel all of the material (water and transported rock and sediment) into a bottleneck under the bridge. It is inevitable that this channel will continually be filled, and that annual excavation will be required unless the problem (i.e. the grossly inadequate bridge) is rectified.

Annual dredging of Dry Brook requires bulldozing the stream bed each autumn to create a central channel bounded by artificial levees on both sides. Such direct intervention is contrary to parks policy, aimed at preserving ecological integrity and allowing systems to evolve naturally. Further, the annual dredging requirement, was used to justify a recent request by the general works department to remove 100 truckloads of rock from Dry Brook to be used as fill for a wharf at Trout River. The removal of ten to fifteen truckloads was permitted during one day in September (B. Burdett, pers comm.). The cumulative effect of highway construction on Dry Brook has clearly been substantial.

Another effect of roadways is related to the linear nature of the corridor, which may constitute a barrier, or danger to wildlife movements. Moose-vehicle accidents are a particular concern because of the danger to humans, but other species of mammals and birds could be affected by vehicle mortality. Road corridors also provide access for human disturbance of wildlife, in the form of animal harassment, poaching, and vegetation removal (flower or berry picking, tree harvesting).

Roadway corridors also provide avenues for the invasion of exotic plant species, a process which may be assisted by the use of seed mixes for revegetation which contain non-native plant species. In GMNP, 6% of the flora is introduced (Anions, 1994). Many of the introduced plants are species which colonise open disturbance areas, such as European foxglove (*Digitalis purpurea*), black knapweed (*Centaurea nigra*), orange hawkweed (*Hieracium aurantiacum*), common dandelion (*Taraxacum officinale*), common buttercup (*Ranunculus acris*), and yarrow (*Achillea millefolium*). Invasion of exotic plants has been a particular problem along route 431 through the Tablelands. Road-fill composed of different primary geological material than that of the underlying peridotite has provided a substrate for the colonisation of species that would otherwise not be found there (M. Burzynski, pers. comm.). The use of foreign gravel in the Tablelands will no longer be permitted (B. Burdett, pers. comm.). However, this decision will necessitate the use of some Tablelands peridotite for roadside maintenance. This material will likely be obtained through the crushing of some material from Dry Brook (B. Burdett, pers. comm.).

Negative aesthetic effects represent a further impact of roadway construction. GMNP was established, and subsequently designated a UNESCO World Heritage Site in part for its outstanding natural beauty. Visual degradation associated with open highway corridors and large rock cuts must therefore be considered a negative environmental effect, notwithstanding the significant geological interest of some of these roadcuts.

The draft PMP states that no new road development will be undertaken during the term of the plan. However, if the plan proposals are implemented some access road construction will be required for the Wigwam Pond campground, and possibly for the Discovery Centre and the southside administration facility. Further, the plan also states that all of the existing park roads will require upgrading and maintenance during the life of the plan. Consequently, any major disturbances due to new road development will likely be minor, although effects due to upgrading and maintenance will continue to occur.

b) Campgrounds

There are five existing campgrounds in GMNP. Capacity and visitor use statistics for each campground are presented in Table 3.2. A number of primitive campsites are also scattered throughout the park.

Campground development requires the loss or alteration of significant areas of park habitat. The Berry Hill and Lomond campgrounds are located in lowland forest habitat, although the Lomond site was constructed on the previously disturbed Lomond townsite. Shallow Bay and Green Point campgrounds are located in coastal scrub and tuckamore forest, and Trout River is located in scrub balsam fir - white spruce forest. Openings in the forest created by campground development can cause changes in species abundance and diversity, particularly in avifauna and large mammals. Utilisation of the remaining habitat by certain species, such as lynx, moose, and various birds, may be affected due to the presence of human activity. New forest openings may also contribute to greater wind damage in adjacent forest areas. Some blowdown was observed in mature forest adjacent to openings in the Berry Hill campground.

The development of campgrounds requires a large volume of granular material for the construction of access roads, tent pads, septic fields, and trails to surrounding areas. This places additional pressure on aggregate supplies both within the park and outside of the park boundaries.

Large campgrounds also tend to focus intensive visitor use on adjacent or nearby recreational resources. This is of particular concern at Shallow Bay, where the campground is situated adjacent to a highly sensitive sand dune environment. Currently visitor-use impacts in the dune areas appear to be minimal, and the dune-crossing structures seem to be working effectively.

Primitive campsites also focus recreational use at these sites. This may lead to significant environmental effects in sensitive habitats such as the arctic-alpine tundra along the Long Range traverse. Vegetation destruction and increased soil erosion around some of these sites has occurred (author's observation). Disposal of grey water and seepage from toilet facilities at two primitive campsites on Western Brook Pond is probably minor, but may contribute to cumulative effects on the pristine water quality of the pond.

Numerous other effects related to campgrounds have occurred. These include: soil compaction; creation of random trails within or adjacent to campground areas; picking of wildflowers; and the cutting of trees or branches for firewood.

c) Day-Use Facilities and Parking Areas

The federal-provincial agreement committed Parks Canada to providing a number of day-use areas within GMNP. There are thirteen park day-use areas providing various activities such as picnicking, sightseeing, beach access, and boating access. The areas are: Shallow Bay, Western Brook/Broom Point, Western Brook Pond, Baker's Brook, Lobster Cove Head, Deer Arm, Gull Rocks, Mill Brook, Southeast Hills Lookout, Lomond, Mackenzie Brook, Wallace Brook, and Trout River Pond (Figure 3.1).

Immediate effects of these areas include the loss of portions of various habitat types. There are several sensitive areas, such as sand dunes at Shallow Bay, where boardwalks and viewing platforms have been constructed. Presently these dunes appear to be stable and no erosion or deposition problems are occurring, however further development in these sensitive

Figure 3.1: Visitor Facilities in Gros Morne National Park

habitats should be restricted. Other areas of concern include the shallow marine habitat around wharves and boat launching areas. For example, the large rock fill wharf at Mill Brook provides an effective barrier reducing wave energy impinging on a small crescent beach immediately southeast of the structure. This could significantly alter the energy regime to this stretch of coast since it blocks the prevailing westerly wind-generated waves. Other wharves constructed at day-use areas are at Trout River Pond, Lomond, and Western Brook Pond (private tour use only),

d) Domestic Resource Harvesting

Forest Harvesting

The 1973 federal-provincial agreement provided for the harvest of wood from park lands for domestic purposes by local people. Eligible residents are those people who were living in the park on or before August 13, 1973, and children born to those people. Originally ten cutting blocks were established totalling 26,000 hectares (Parks Canada, 1985a).

Currently there are twelve domestic harvesting blocks in the park (Figure 3.2). Taken together with the enclave communities, there is very little forested area protected on the coastal plain portion of Gros Morne. According to Anions (1994), the amount of land currently being actively used for domestic harvesting in the park totals 78 km^2, which amounts to 25% of the park's forested area, or 4% of the total park area. The total area of all cutting blocks available for harvesting exceeds 180 km^2 or approximately 10% of the park area.

Concerns that the harvest of timber from the designated blocks was exceeding the sustainable yield were expressed during the management plan review. Harvesting has been poorly regulated, and cutters have been allowed to cut from anywhere within the blocks, which has led to depletion of the most easily accessible stands, and to poor stand management. Park managers have been unable to accurately determine the amount of forest area harvested each year, although the level of domestic harvesting has more than doubled since the park was established (Moreland, 1994). An attempt to implement stand allocation procedures and reduced harvest quotas is now being initiated.

Because forest harvesting is conducted under limited, controlled conditions, the environmental effects are somewhat moderated. Cutting can begin after October 15, but no hauling is permitted until the ground is frozen and there is sufficient snowcover. Tree removal is primarily by snowmobile, although horse logging is also permitted. Winter cutting prevents any damage to the soil or surface vegetation, but it also results in some waste, as most of the trees are cut at a metre or more above ground level due to snow depth. Maintenance of an intact ground vegetation layer also helps to reduce erosion. To date, most of the cutting has occurred in small patches, so there has not been any erosion problem

Figure 3.2: Domestic Harvest Blocks in Gros Morne National Park

observed. However, the absence of ground disturbance may also hinder the regeneration of hardwood species which require a seed bed of mineral soil. Only bole-only harvesting is permitted, with tops and branches remaining at the site, so the effects of harvesting on site nutrient capital are probably not significant over the time frame that harvesting will continue.

However, there are several potential environmental effects of domestic harvesting, which could contribute to cumulative effects. The harvesting of trees creates an unnatural disturbance in the forest ecosystem. The disturbance may be augmented by the increased susceptibility of the disturbed areas to wind damage, a feature noted by Caines and Deichmann (1990). Some forest management practices aim to mimic natural forest disturbance patterns, such as fire, wind throw, or insect outbreaks, but at Gros Morne no accurate baseline knowledge of these patterns exists. Historic fire cycles indicate that 1,527 km^2 of Gros Morne's area should be affected by fire every 500-1000 years (Day et al., 1990, cited in Pardy, 1994). Thus harvesting can not be said to mimic any natural fire regime in the park. The harvest plan aims to mimic small insect outbreaks by utilising small patch cuts. However, this does not accurately replicate insect-killed stands, as no dead timber is left standing or fallen to the ground. Therefore habitat for various insects, spiders, mosses, fungi, lichens, and cavity nesting birds is not provided. Further, under the new harvest plan, natural insect-killed stands will be harvested, thus further reducing the habitat for species requiring dead, standing or fallen timber.

Creating new disturbance patterns in the forest may alter the species diversity and/or abundance of the area, by increasing the amount of open and edge habitat, and decreasing the amount of forest interior habitat. The increased availability of browse in the clearings is believed to have contributed to the dramatic increase in moose populations in the park. Individually this habitat alteration may not be significant, however, when combined with other blocks, and particularly with enclave communities where land use is more intense, the cumulative effect on forest habitat and species diversity and abundance could be significant.

Trail erosion was noted in harvest block 4 where the access trail ascended steep slopes. Several of the sites are on steep terrain and therefore erosion of access routes or cutting areas could become a problem if forest openings become too large. There is a particular concern for erosion in cutting blocks 6a and 6b which are located in the Rocky Barachois Brook and Dick's Brook areas, characterised by steep terrain. These blocks have not been heavily utilised. Dunfield (1981) recommended that the area along Bonne Bay around Rocky Barachois Brook not be harvested because of the steep terrain, severe climatic effects on regenerating forest, and aesthetics.

One of the most serious concerns is the ability of harvested areas to regenerate. The forests in the cutting areas are dominated by balsam fir, with lesser abundance of white birch (*Betula papyrifera*), mountain ash (*Sorbus americana*), mountain maple (*Acer spicatum*), red maple (*Acer rubrum*), black spruce (*Picea mariana*), and white spruce (*Picea glauca*). After harvesting, initial regeneration of the dominant fir is vigorous. However healthy moose populations have been heavily browsing young fir trees and broad-leaved trees to the point of severely retarding forest regeneration. A study of regeneration on harvested and insect-killed sites in GMNP by Lawlor (1993) found that moose browsing was "severely limiting and in some instances halting vertical growth" of balsam fir and hardwood species in the Western Newfoundland Ecoregion, while the browse damage in the Northern Peninsula Ecoregion was concentrated on the hardwood species. The browse damage to fir was found to be greater in harvested sites than on insect-killed sites, and it was concluded that a harvestable supply of wood will not regenerate on these sites (Lawlor, 1993).

Domestic harvesting and moose browsing of regenerating sites appears to be altering the species abundance, and possibly even the diversity over the long-term. There is also a change in age class, since prime mature trees are often targeted for harvesting. A change in insect susceptibility may also occur. According to Anions (1994) trends indicate a preference for insects to invade recently harvested or thinned sites.

Snowshoe Hare Harvesting

This activity is not a significant concern to the resource itself, as the hares are plentiful, and are an introduced species. However there are concerns regarding the accidental snaring of non-target species such as fox (*Vulpes vulpes*), lynx, mink, and marten. To address this issue, the snaring regulations stipulate the gauge of snare wire to be used which is determined to be of a strength capable of being broken by animals larger than the hare (i.e. lynx and fox) (Parks Canada, 1984). A new type of snare is currently being introduced which is designed to reduce accidental marten mortality (H. Deichmann, pers. comm.).

e) Aggregate Extraction

The federal-provincial agreement commits the park to making aggregate resources available for park and provincial use as needed "bearing in mind the protection of national park values" (letter from the Honourable John Roberts to the Honourable Leonard Simms, May 16, 1983, appended to Parks Canada, 1985a). The major activities requiring aggregate resources are road construction and maintenance, and infrastructure development within the park and in adjacent communities.

The major aggregate resources in the Gros Morne area are found predominantly in glacial alluvial deposits. Some material is also obtained from rock quarry operations. Stratified deposits of glaciofluvial origin occur in valleys flowing into the East Arm and South Arm of Bonne Bay, such as Rocky Barachois Brook, Three Tom Brook (Lomond), McKenzie's Brook, and Middle Brook. Extensive moraine deposits, locally containing a high percentage of gravels, occur on the coastal plain (Berger et al., 1992).

The main extraction sites are at Middle Brook in the Glenburnie enclave, and at Rocky Barachois Brook in GMNP. During the upgrading of highway 430 from Wiltondale to Deer Arm

Brook, more than 800,000 tonnes of material were extracted from the Rocky Barachois pit (Public Works Canada, 1993). The Cod Knox rock quarry in the park is also a major source of material. Additionally, the annual dredging of Dry Brook, discussed in section 3.2a, has become a consistent source of supply for cobble and boulder fill.

Several environmental effects result from these extractive activities, some of which contribute to broader cumulative effects. These include loss of geological heritage resources and interpretation opportunities, landscape disturbance and loss of habitat, siltation, and aesthetic effects.

Perhaps the most significant of these is the loss of the resource itself. The destruction of heritage resources is contrary to national park objectives. The destruction of these resources in GMNP is particularly significant because it is added to the routine loss of similar resources outside of protected areas. Most communities in the park also have sand and gravel quarries within their boundaries.

Another obvious impact of aggregate extraction is the loss of habitat caused by such major landscape disturbance. The Rocky Barachois pit covers a 10 hectare area, and has resulted in the "complete destruction of site-specific wildlife habitat" (Public Works Canada, 1993). The Cod Knox quarry also covers several hectares of destroyed habitat. Initial rehabilitation of both of these sites has been inadequate. The potential for rehabilitation of the Cod Knox quarry is also limited by the nature of the affected site (an excavated bedrock cavity).

Siltation of watercourses from disturbance of unconsolidated surficial deposits is also a potential effect of quarry operations. The McKenzie's Brook pit was developed without any buffer to protect the stream bank or prevent siltation (Le Sauteur, 1983). The deposit at Rocky Barachois Brook contains a significant amount of silt and clay which could contribute to sediment loading in the adjacent brook (Public Works Canada, 1993). This could consequently affect fish spawning habitat, or marine benthic communities at the mouth of the brook. No evidence has been documented so far, and there is an existing buffer of vegetation between the pit and the brook. Protection of this buffer must be ensured.

The negative aesthetic effects caused by aggregate extraction are significant. The three main quarry operations discussed above are all visible from at least one of the main roads in the park. The Rocky Barachois pit is plainly visible across the East Arm from the Lomond campground. GMNP was established in part to protect and present an area of outstanding scenic beauty. The extraction of natural resources is clearly incompatible with this goal, and affects the perceptions of visitors. The aggregate pits contribute to cumulative negative aesthetic effects along with other major landscape disturbances such as highways and powerlines.

A final environmental risk posed by quarrying operations is the potential contamination of groundwater resulting from operational spills of oil, fuel, and lubricants. With proper precautionary procedures this threat should be minimised.

Resource extraction plans have recently been developed for the Rocky Barachois and Cod Knox pits. The plans suggest that there will be a shortfall of aggregate resources based on demand forecasts over the next fifty years (D. Anions, pers. comm.). Consequently, new sources of aggregate will be sought, both within and outside of the park.

f) Waste Disposal

Solid waste generated within the park, and in the enclave communities is disposed of at four existing landfills: Lomond, 4.5 km from the Lomond campground within park boundaries; and three enclave sites at Norris Point, Trout River, and Cow Head. Martins Point was previously a garbage dump for residents of Sallys Cove, and is occasionally still used for that purpose by some (M. Burzynski, pers. comm.). In 1990, there were 209 sites within the park where garbage was collected (Porter, 1990). Park visitors generated 137 tons of garbage in 1985, and it has been estimated that this figure will rise to 620 tons by 1995 (Brunt, 1987). Contamination from sewage and solid waste disposal was one of five chemical threats identified in a pollution contingency plan (Environment Canada, Parks Service, 1988b).

A number of problems have arisen due to the nature of these landfill sites. At Lomond, the waste is disposed of in open trenches, with a separate section for large metal, or other atypical products. Household wastes are periodically burned, and the open trench is occasionally bulldozed and buried when funding is available.

The unrestricted nature of this landfill has led to previous problems in attracting black bears (*Ursus americanus hamiltoni*) which has led to the destruction of some animals. According to Porter (1990), there were 12 bears killed at the site in 1983, and at least 14 killed between 1984 and 1988. Although no bears have been killed at Lomond during the last several years, they are still known to frequent the site. On the first field visit to the site for this project two bears were observed foraging in the main trench. Bear problems can also be expected around park garbage collection facilities, not all of which have been converted to bear-proof containers.

Another potential effect of the Lomond landfill is surface and groundwater contamination due to leaching of the waste material. The garbage trenches have no liners, and there is no means of preventing leachate from entering the watertable or nearby streams. A tributary of the Lomond River is within 500m of the site, and the Lomond River itself is only one kilometre distant. To date, no water monitoring has been conducted either in groundwater wells or in nearby watercourses.

In addition to bears, landfill sites and garbage collection sites also attract opportunistic birds such as ravens and gulls. The easy access to human garbage and fish offal is one of the factors implicated in the dramatic rise of some gull populations in North America. The increase in gull populations in eastern North America is threatening populations of terns which compete for nesting sites and whose eggs and nests are predated by the gulls (Brown and Nettleship, 1984). The landfill at Cow Head could be a contributing factor to the decline in tern populations at

Stearin Island. Although tern populations have increased in the St. Paul's area since the park was established, terns have been displaced from traditional nesting sites on Stearin Island by expanding gull populations (Deichmann, 1993). Tern populations on the White Rock Islets at Shallow Bay are also threatened by increasing gull populations (Payne and Saunders, 1989).

The burning of garbage contributes to airborne pollution in the area, and produces a negative aesthetic effect. While conducting fieldwork for this project on a clear calm day, smoke from the Lomond landfill was seen hanging in the Lomond valley, and dispersing slowly as a thick haze over the East Arm of Bonne Bay. At the Rocky Harbour - Norris Point landfill, this is a problem throughout the year. This situation degrades the natural beauty of the Gros Morne area, and diminishes the visitor experience for travellers on highway 430, or hikers on Gros Morne Mountain.

The effects of enclave landfills are similar to those discussed above for Lomond.

Disposal of sewage is another activity which may result in effects of a cumulative nature. Enclave communities have sewage collection systems without treatment, which release waste water directly into Bonne Bay and the Gulf of St. Lawrence (Forrest, 1994). Park campground facilities have tile bed septic systems, and day-use areas and primitive campsites have pit privies. No research has been done on the environmental effects of sewage in the park area. Potential effects include eutrophication of freshwater streams and ponds through nutrient enrichment, and contamination of shallow marine environments. The likelihood of significant effects originating from most park facilities is small due to the dispersed nature of these facilities, and the effectiveness of the tile bed systems. The cumulative effects of sewage disposal in the marine environment of Bonne Bay, particularly with respect to fish and shellfish resources, does present some risk. Although the size of the communities is small, tidal flushing in Bonne Bay is minimal, with a tide of less than one metre (M. Burzynski, pers. comm.). Shellfish harvesting in the South Arm of the bay is currently closed due to high faecal bacteria counts.

g) Recreation

GMNP has become a focus for outdoor recreational activity in western Newfoundland. Activities such as front country and back country hiking, camping, sea kayaking, and ski touring are becoming increasingly popular. These recreational activities have limited environmental effects at the current use levels, due to their low-impact, self-propelled nature, although degradation of some hiking trails is becoming a concern. However, certain more intensive recreational activities which are becoming increasingly popular at GMNP, may have significant effects. These activities are discussed below.

<u>Snowmobiling</u>

The federal-provincial agreement commits Parks Canada to allow snowmobiling in areas where it will not negatively "affect wildlife, vegetation, or terrain" (letter from the Honourable Jean Chrétien to the Honourable E. Maynard, August 1, 1973, appended to Parks Canada, 1985). This stipulation was reiterated in the 1983 amendments. The use of snowmobiles has become common in the park, but accurate data on impacts is lacking.

Currently used snowmobile trails traverse the park, and particularly the Long Range plateau. The most frequently used routes are depicted in Figure 3.3, although many more routes are known to exist. In 1987, there were 31 major routes identified in the enclaves and harvest blocks, and 12 identified access routes into the plateau country (Parks Canada, 1987). Currently, at least one outfitter guides snowmobile tours into Western Brook Pond from east of the park boundary (C. Reid, pers. comm.; D. Chaisson, pers. comm.). In an effort to estimate current OSV use, counters were installed at 5 locations on the Long Range during the winters of 1993 and 1994. This program has been plagued with difficulties, related both to the accuracy and precision of the counters, and with the use of many unmonitored OSV trails, so that an accurate estimate of backcountry OSV use in GMNP is still lacking (Reid, 1994; Simpson, 1993).

A snowmobile management plan prepared for the park in 1987 (Parks Canada, 1987) identified a number of potential impacts from existing literature. A comprehensive list of potential detrimental effects on vegetation is given by Anions (1994). Some of the more important potential impacts on wildlife, vegetation and terrain are:

→ severe compaction of snow resulting in the loss of its insulating capacity, thus leading to deep freezing of soil and overwintering plants beneath the trail;
→ persistence of compacted snow for a longer period into the spring, thus affecting the thermal regime and the growing conditions for buried or adjacent plant communities (delay in growing season, decline in plant productivity, possible change in species composition to more hardy communities). The authors note that this is particularly significant in alpine environments with short growing seasons;
→ compaction and abrasion of soil where snow cover is removed. This most often occurs on steep grades, such as are common on the approaches to the Long Range, or where OSV activity occurs without sufficient snow cover;
→ direct physical damage to exposed portions of plants, such as the removal of bark and needles, or the breakage of branches and stems (tuckamore and exposed heath communities are cited as particularly vulnerable), and the deliberate destruction of trees and other plants to clear trails;
→ stress, mobility restrictions, and mortality to small subnivean mammals such as shrews, and voles;
→ disturbance to wildlife, harassment, and poaching (the potential effects on mammals are discussed further below).

Figure 3.3: Location of Major OSV Trails in Gros Morne National Park

Several studies have examined the effects of snowmobile use on sensitive habitats within the park, and some negative impacts have been observed. According to Caines and Deichmann (1990), moderate to severe vegetation disturbance has occurred along snowmobile access routes to the plateau areas, and in coastal heaths and bogs where OSV use has led to accelerated erosion. Other sensitive habitats are the coastal sand dunes, tuckamore, and alpine heath and tundra. In particular, OSV use is widespread in the Big Level area which according to Anions (1994) harbours 20% of the park's rare plant species. Damage to vegetation is particularly significant when OSV use occurs too early or too late in the season. Snowmobilers have been observed crossing exposed fens and rocks on the Tablelands while travelling between small disintegrating snow patches in spring (M. Burzynski, pers. comm.).

An assessment of OSV impact on salt marsh vegetation at St. Paul's was conducted by Deichmann (1988). The study concluded that damage to the vegetation at the study site was negligible, and undetectable by the end of the growing season. It was suggested that this was due to the "damage resistant" nature of the dominant vegetation (*Potentilla anserina*), and to the necessity of heavy snow or ice cover before the OSV route could be used in the salt marsh. However, for comparison, the study also made a cursory assessment of OSV impact on bog and tuckamore communities at Green Point. Here it was found that the OSV trail was eroded into the substrate, and that damage to bryophytes, sedges, and conifers was readily apparent (Deichmann, 1988).

A broader assessment of the environmental impact of OSV use was conducted by Deichmann (1990). However this study was limited in that it focused primarily on dominant plant species at 25 chosen sites, and did not examine the effect on rare species. With the exception of a brief literature review, the study did not address the effects of OSV use on fauna in the park. Drawing on the OSV Management Plan (Parks Canada, 1987) and on the field work, Deichmann (1990) outlined the major effects on plant communities. The alpine communities are thought to be particularly vulnerable because of the already short growing season, the exposed conditions, and their sensitive nature. In OSV corridors shortened growing seasons will occur even in the least impacted areas, and the most impacted areas will be characterised by the replacement of heath vegetation by rock barrens, or grassy meadows (Deichmann, 1990). The alpine areas are also subject to uncontrolled use due to the open nature of the landscape. Tuckamore can also be severely damaged by OSVs through two mechanisms: exposure to winter winds and cold temperatures due to mechanical snow removal; and abrasion, crushing, or destruction of upper branches and leaders. In some upland areas these effects are reduced by thick, wind-packed snow cover. Similar effects have been noted on *Kalmia* and black spruce heaths, and hummocky *Sphagnum* bogs of the coastal lowlands. These areas are often damaged most significantly in late spring when local people are using OSVs to remove wood cut during the winter. Tuckamore and forested sections are also affected by clearing of illegal trails by OSV users.

Further impacts have been suggested due to the emission of airborne pollutants from OSVs. Deichmann (1990) noted that the average snowmobile engine emits 40% of its fuel uncombusted, and estimated that 20,000 litres of unburnt fuel are dispersed over the coastal plain in GMNP each winter by OSVs.

All recent studies have also noted a strong correlation between popular OSV destinations on the Long Range plateau and accumulations of litter (Deichmann, 1990; Simpson, 1993; Reid, 1994). Litter found on the Long Range includes oil cans, beer cans, glass food containers, and various broken OSV parts.

Extensive use of OSVs in the park also has several potential negative impacts on wildlife. Baird (1985) considered the effect of OSV activity on woodland caribou (*Rangifer tarandus caribou*) near the eastern boundary of the park and suggested that the "impact they (OSVs) have on wintering caribou cannot be underestimated". However, no direct evidence was cited to support this claim, and very few investigations have been done on the animals in the park. Both caribou and moose have been observed avoiding OSVs, but frequently make use of the resultant trails. Likewise, Banfield (1974) found that barren ground caribou in the western arctic quickly began utilising seismic lines and winter roads because of the easy passage afforded by the well-packed and clear routes. Wolves were also observed to hunt more frequently along these routes, thus creating a general negative impact on the caribou population (Banfield, 1974). If caribou were to begin utilising designated OSV trails in GMNP, the effect of predators (humans, coyotes, lynx) would need to be monitored.

Various studies on the behavioural response of caribou to vehicular harassment have been done elsewhere. A study of the response of reindeer (*R. t. platyrhynchus*) to snowmobile disturbance in Svalbard found that animals became alarmed as OSVs approached within a distance of 410m (median) (Tyler, 1991). The animals fled at a distance of 80m (median). Tyler (1991) concluded that the increased energy expenditure, and the lost grazing time due to disturbance was small and probably not significant at current levels of snowmobile use in the Svalbard area. However, his study was conducted using a single snowmobile approaching a group of reindeer at a speed of 20 kilometres per hour. The approach terminated when the OSV reached the initial location of the reindeer group, and no single group was repeatedly provoked. Existing use patterns in GMNP typically involve groups of snowmobiles travelling at higher speeds. Repeated or prolonged disturbance may occur. Even the individually minor effects documented in the Svalbard study may be significant, as suggested by Tyler (1991):

> "the time and energy costs of flight following deliberate provocation are small but, in a marginal environment, the cumulative effect of small costs may have substantial ecological significance".

In an earlier study, Horejsi (1981) documented the response of barren ground caribou (*R. t. granti*) to a fast moving pickup truck on the Dempster Highway in Yukon. He found that the animals exhibited signs of anxiety and fear, and strenuously exerted themselves to withdraw from the stimuli. As the truck was confined to the roadway, the caribou were able to retreat to a distant location to resume their activities. It was suggested that repeated disturbance may cause the animals to begin to avoid the highway (Horejsi, 1981). This avoidance response was also recognised by Tyler (1991), and must be considered a significant concern in GMNP, especially with regard to the Big Level calving area. Snowmobile access across the eastern park boundary may persist into April and May, when the animals are proceeding toward Big Level, and OSV activity on the coastal lowlands may inhibit caribou movements toward the plateau. Stress and disturbance due to OSV use could result in avoidance of some of the traditional routes and ranges.

Studies were also conducted to estimate the effects on caribou of pipeline construction in the arctic. A paper by Miller and Gunn (1979), which focused on helicopter harassment of Peary caribou (*R. t. pearyi*), found that ground activity was even more disturbing to caribou than low altitude helicopter disturbance. On judging the significance of potential disturbance associated with human activity on the ground, Miller and Gunn (1979), cautioned that the

> "late winter period (March to May) is when animals lack, or have their lowest, energy reserves and the effects of harassment may be the most severe at that time. ... Although the energy costs of responses to harassment may appear low, any extra drain of energy over a long period could seriously deplete the reserves essential for successful reproduction and survival."

To better determine the effects of OSV use on caribou in GMNP, a 3-year study was initiated in 1994 by park wardens in conjunction with the Newfoundland Wildlife Division. The study will use the same methodology as Tyler's Svalbard study, but will also document three additional variables: differences in response between caribou on the lowlands and those on the highlands; differences in response from early winter to late winter; differences in response when OSV approach is oblique rather than direct (C. McCarthy, pers. comm.).

One of the greatest concerns is poaching and harassment of caribou and moose. Aggressive harassment by individuals on OSVs is known to occur in the park. Snowmobiles have been observed chasing caribou on Big Level (Simpson, 1993), and drunk and reckless behaviour has been noted (Reid, 1994). Wardens discovered a site of five caribou kills, apparently part of a larger mass poaching incident staged with the use of snowmobiles (B. Thexton, pers. comm.). Thirty-seven poaching or wildlife harassment incidents were reported between 1981 and 1987 (Parks Canada, 1987). The actual number of incidents was likely higher.

Concerns were expressed by Parks Canada (1987) about the increased ease of snowmobile access to the Long Range that is now provided by forest roads in the Main and Humber rivers area east of the park. In Gros Morne, caribou begin returning to calving grounds such as Big Level in the late winter when snowmobile use is the greatest. Harassment, whether intended or unintended, may cause "considerable stress and energy output during a period when energy requirements are the greatest" (Parks Canada, 1987).

Extensive OSV use may also have unknown impacts on other wildlife species. Impacts to arctic hare are unknown, but susceptibility to harassment and poaching will increase with increasing snowmobile use. Potential effects on small sub-nivean animals were noted earlier. Willow and rock ptarmigan could also be subject to harassment and poaching.

Increased fishing pressure is also a concern, as ice fishing tends to be a common activity among OSV users (Reid, 1994), and widespread access to most areas of the park inhibits enforcement of fishing regulations. Of particular concern is Candlestick Pond which contains two unique fish species - dwarf char, and dwarf salmon (ouananiche), which may be distinct relict genotypes, having evolved in isolation since deglaciation 10,000 years ago (Parks Canada, 1990). The char (*Salvelinus alpinus oquassa*) is a "genetically pure relict population of Western European origin", with only a few other isolated populations in Maine, New Brunswick, and Quebec (Parks Canada, 1990).

Other concerns involve aesthetics, use conflicts with self-propelled park visitors (ski touring, and snowshoeing), and the incompatible nature of motorised recreational use in wilderness areas of a national park. The allowance of OSV in GMNP could be one of several elements leading to the incremental degradation and loss of viable wilderness in Canadian national parks.

<u>Fjord Pond Boat Tours</u>

The federal-provincial agreement committed Parks Canada to provide for boat tour operations on two of the fjord ponds in the park. Initially a tour was to be operated on Baker's Brook Pond, but Western Brook Pond was later chosen as the first site for commercial boat tours. Subsequently a second boat tour operation was developed on Trout River Pond.

The tour operation on Western Brook Pond provides an interesting example of incremental cumulative impact related to visitor use and facility development. As the tour operation was developed and promoted, and facilities were provided and upgraded, the tour became more widely known resulting in a steady increase in visitor use (Figure 3.4). The boat tours began on the pond in 1976, using two 6.7m dories powered by outboard motors, with a capacity of eight passengers each (IDP Consultants, 1986; P. Lane and Associates, 1986). By 1986 two inboards were being used (8.5m and 13.3m). Two Cape Islander boats are now used with a capacity of 40 passengers each. The largest single season increases in tourist use occurred following upgrades to the boat service. A 70.6% increase was recorded in 1983 following a boat upgrade, and a 33% increase was recorded in 1986 following the addition of a second upgraded boat to the tour operation (IDP Consultants, 1986). A further 44% increase was recorded in 1989 following the switch to the larger boats. During the summer season each boat may make three trips a day depending on demand. In 1993, 10,437 passengers were recorded on the tour (park stats. from G. Case).

Environmental concerns related to the boat tour operations include increasing recreational use and further expansion of facilities, habitat loss and wildlife disturbance due to the level of visitor use, and pollution of the pristine pond water from potential fuel spills and leaks. The pond has a very slow flushing rate, with a residence time of 15.4 years (Kerekes, 1990), so any effect on water quality is of particular significance. Small leaks have occurred in the past, resulting in some contamination of soil and water at dockside (B. Burdett, pers. comm.).

In the mid-1980s, an enhanced Western Brook Pond development plan was considered that would have included road access, parking facilities, an interpretation centre, picnic areas and primitive campsites (P. Lane and Associates, 1986). While this proposal was eventually considered to be inappropriate, a substantial redevelopment of the site still took place. This involved upgrades to the existing trail so that motorised vehicles could be used for construction and operational needs, construction of a new docking facility, enclosed passenger waiting areas, restrooms, and ticketing facilities at pondside, development of interpretive displays along the trail and at pondside, erection of ancillary operations buildings, and construction of a major new boat storage facility. The project cost in the vicinity of $5 million (D. Anions, pers. comm.), and has significantly altered the character of the pondside environment.

The pond is zoned as a wilderness area, with a temporal summer zoning as a natural environment area to allow for motorised use. However, the buildings and infrastructure at pondside provide conveniences not normally associated with a wilderness experience. Further, the level of use encouraged by the scale of the development has raised concerns about the ability of the sensitive pond environment to withstand the potential impacts. Although new toilets were installed, they are inadequate to meet the demands during peak summer periods, when visitors still seek out their own private space in the woods. The sewage from the toilet facilities is being pumped via diesel power over the height of land away from the pond drainage basin to prevent aquatic contamination. The new septic field drains toward an older section of trail along Long Steady, and may affect a spring there commonly used for drinking water by hikers (M. Burzynski, pers. comm.). No monitoring has been done on this spring, or elsewhere in the new tile drainage. The effectiveness of the system in preventing sewage drainage from reaching the pond is still not known. During the shoulder season, the diesel system is not operated, and the old pit privies which drain into the pond are used. An obvious alternative to these problems would have been to provide a larger toilet facility at the roadside trailhead, while making visitors aware of a lack of facilities at pondside.

Perhaps the most incongruous element of the development scheme is the boat storage facility, which has been constructed to specifications completely out of proportion to the need, and out of character with the surrounding "wilderness" environment. It is a 35' tall beige aluminum structure, located in a sparse, stunted fir and spruce forest where the tallest trees are only 15' high. The building is visually offensive, and is visible from the passenger decks as the tour boats approach the fjord. Many passengers consider the building an "eyesore". It is also plainly visible from the north rim of the fjord. Aesthetic effects could be somewhat mitigated by the use of camouflage paint, as was originally suggested in the plan. The construction required dredging of the beach and near-shore overburden to allow the boats to enter the building directly from the pond, where they are then hoisted out of the water by overhead cranes. Ongoing dredging is now required to maintain the channel (D. Anions, pers. comm.).

In a cumulative sense, the negative aesthetic effects of these developments, including large groups of people on large tour boats, result in a diminishing sense of wilderness for visitors to the pond. Rather than a wilderness, an image of the pond as a semi-developed recreational area is beginning to emerge. A precedent has been set, and with increased popularity of the tour, additional facilities may be requested to accommodate demand. Gros Morne's World Heritage status gives Parks Canada an even greater obligation to protect the scenic beauty of this area, and hence the cumulative negative aesthetic effects of development are a major concern.

A second commercial boat tour operation began on Trout River Pond in 1991. This operation has seen a modest increase in use, but has not been subject to the pressure and demand of the Western Brook pond tour. However, a small area of forest habitat has been lost at the tour site, and benthic habitat has been altered at the wharf site.

Construction of the Trout River Pond facility required dredging of the wharf site and of the narrows between the upper and lower ponds. Sedimentation in the narrows is being fed by the erosion of a nearby glaciofluvial deposit by a stream that enters the upper pond just above the narrows. Longshore drift of beach gravel is also a contributor to deposition in the narrows (NORDCO Limited, 1985). Further dredging may be required as these natural processes continue to cause infilling of the narrows, although this process appears to be slow. Sedimentation and turbidity related to dredging is thought to be negligible, but its effect on the general lake benthos may contribute to cumulative effects along with increased sediment loads due to soil erosion from forestry activity.

<u>Hiking trails</u>

There are more than 177 kilometres of hiking trails in GMNP (Parks Canada, 1994a). This figure includes more than 60 kilometres of designated map and compass routes in the Long Range backcountry. Most of the developed trails are graded with gravel in many sections. Bogs, fens, and other wet areas are normally boardwalked, and bridges are constructed at most stream and river crossings. Some of the major trails, in particular Western Brook Pond, have been upgraded to allow for the use of ATVs during trail maintenance activities.

The environmental effects of these trails include the loss of a small portion of habitat under the trail bed, increased erosion due to pedestrian traffic, increased runoff due to soil compaction, and damage to adjacent vegetation due to hiker activity and maintenance vehicles. The environmental impacts of trail construction are dealt with through screenings under EARP, and include cutting of vegetation, use of borrow pits, erosion, and sedimentation of watercourses.

A peculiar impact was documented on the Western Brook Pond trail when limestone gravel was used as a trail bed over acidic sphagnum bogs. Limestone buffers the acids that are produced naturally by sphagnum moss to mobilise nutrients from the surrounding organic soil and thus results in the decline of sphagnum adjacent to the trail. (M. Burzynski, pers. comm.). Any future fill will be granitic material which is of acidic composition.

The effects of provision of access to sensitive habitats may also be significant. Effects may include trampling of vegetation, removal of rare plant specimens, soil degradation and erosion, disposal of garbage and human waste, and wildlife disturbance.

A study of hiker impact on the flora and fauna of Gros Morne Mountain was conducted by Bridgland and Brassard (1984). Their research concluded that there were significant impacts to heath communities, and less significant impacts on felsenmeer, alpine scrub, and tuckamore. Some effects on lichen were noted due to the removal of rocks for wind shelters, stone cairns, and stone writing (graffiti). Park statistics indicate that between July 20 and September 23, 1993, 2,703 people hiked up the mountain, an increase of 27% over a similar period in 1992 (park stats from G. Case, pers. comm.).

The high number of hikers found on the mountain during the brief summer hiking season may have significant stress-related effects on resident arctic hare and rock ptarmigan (*Lagopus* *mutus*) populations. Bridgland and Brassard (1984) noted that unleashed dogs are a particular concern with respect to nesting rock ptarmigan. According to Deichmann (pers. comm.) a concerted effort will be made to prohibit dogs from the James Callaghan hiking trail in the future.

Concerns related to the potential cumulative effects of hikers in the Lookout Hills were expressed by Burzynski (1993), who recognised that sensitive bog and fen habitats on the proposed trail route were incapable of supporting frequent pedestrian traffic without sustaining significant damage. Consequently a major portion of this trail development was abandoned.

According to the draft PMP, the park hiking trail system is considered to be complete, however reconstruction of the majority of these trails is expected during the next ten years (Parks Canada, 1994a). Additional trails for cross-country skiing are also proposed. This could result in some minor environmental impacts such as stream siltation, wildlife disturbance, and further borrow pit excavation.

h) Livestock Grazing

The grazing of livestock is not permitted within national parks. However, some residents of enclave communities do graze animals within GMNP, principally in the Green Gardens area, but also to a limited extent in the Green Point and Sally's Cove area. This activity is not condoned, but is currently tolerated until the park is officially gazetted, at which time grazing will be prohibited (D. Anions, pers. comm.).

Environmental concerns related to livestock grazing include: habitat disturbance through the prevention of succession, including increased potential for colonisation by exotic species; selective grazing which tends to increase proportion of non-native species such as knapweed; trampling of vegetation; contamination of watercourses; and conflicts with other park users.

i) Utility Corridors

Like highways, utility corridors represent major landscape disturbances which persist for the life of the facility (more or less indefinitely). Effects caused by small utility corridors may be negligible, while those caused by larger facilities may be significant.

In GMNP, the utility corridor of most concern is the 138 kV transmission line operated by Newfoundland and Labrador Hydro that runs from Wiltondale to the northern park boundary. This powerline was constructed in two segments. In 1981 the first section was constructed from Wiltondale to the Berry Hill access road, and the remainder was constructed in 1990.

Construction related impacts of this project involve vegetation removal, soil disturbance, and potential damage to watercourses through erosion and sedimentation. According to Le

Sauteur (1983), the initial construction phase resulted in "severe impact to the soil" in the corridor. However, the second phase of the project was constructed during the winter, with very little impact to either soil or water quality (Burdett, 1990).

The main impact of these facilities is the loss of a wide, linear corridor of habitat from the eastern to the northern boundary, and the fragmentation of remaining habitat. Because the corridor traverses lowland for most of its length, lowland forests and bogs are the habitats most affected. The E.I.S. conducted for phase two of the project concluded that the disturbance of suitable habitat for rare and endangered plants, and the disturbance or destruction of isolated populations of rare and endangered plants was a major residual impact of the project (Newfoundland and Labrador Hydro, 1989). Full vegetative recovery and succession cannot be permitted within the corridor while the facility is still in use. However, herbicide applications will not be used within the boundaries of GMNP. The resulting reduction of natural flora may increase the potential for colonisation by exotic species. For example, near Deer Arm, the utility corridor has been invaded by thousands of European foxglove plants (M. Burzynski, pers. comm.).

The second major effect of this project is its visual impact. In the natural or wilderness environment of Gros Morne, a large linear structure of this nature is incongruous. The phase two E.I.S. summarised this effect as follows:

> "a transmission facility will change the character of a landscape through which it passes ... and a viewer's perception of this change will likely result in a negative response".

This project specific impact is augmented when considered in the context of existing landscape alterations such as the highway corridor, and the existing power transmission and telephone corridor.

One small benefit of the corridor is the nesting habitat for ospreys provided by the transmission towers. This is particularly relevant since most of the mature tall trees have been long since removed.

Table 3.3: Environmental Impacts and Cumulative Effects of Previous or Current Developments and Activities in Gros Morne National Park

Development or Activity	Impacts	Cumulative Effects
Construction and Maintenance of Highways and Roads	! major landscape disturbance ! habitat loss and fragmentation ! soil erosion and siltation ! aesthetic effects ! loss of wilderness	! additive with other sources of habitat loss ! additive with similar impacts from quarries, and potentially from forest harvesting ! additive with other negative aesthetic features
Campgrounds	! habitat loss, and wildlife disturbance ! visitor impacts (trampling, tree cutting, litter, trails)	! minor additive effects
Day-Use Facilities and Parking Areas	! habitat loss ! visitor impacts (trampling, garbage, trails)	! minor additive effects
Domestic Resource Harvesting	! loss or alteration of habitat ! potential long-term effects on forest succession and biodiversity ! some potential for erosion problems ! trails and riparian damage	! additive with extensive loss and alteration of habitat elsewhere ! additive with other sources of soil erosion
Aggregate Extraction	! loss of habitat ! destruction of geological resources	! additive with other sources of habitat loss ! additive with aggregate extraction outside the park such that if continued all alluvial deposits will be destroyed, resulting in the loss of natural heritage values in the region

Waste Management	! surface and groundwater contamination ! foraging source for wildlife, particularly bears and gulls ! aesthetic effects ! air pollution	! additive with other sources of chemical input ! additive with other negative aesthetic effects
Snowmobiling	! various effects on vegetation, particularly alpine heath and tuckamore communities ! disturbance to wildlife ! poaching ! air pollution ! litter ! user conflicts	! additive with other factors affecting vegetation and wildlife (trails, utility corridors)
Boat Tours	! landscape disturbance ! visual degradation of wilderness character of Western Brook Pond ! disturbance of benthic habitat in Trout River Pond	! precedent setting activity, leading to incremental development ! additive with other alien elements in the landscape
Hiking	! damage to vegetation ! localised soil effects (compaction, erosion, excavation) ! wildlife disturbance	! additive with other disturbance factors ! particularly significant where high-use levels cause repeated impact
Livestock Grazing	! negative effects on vegetation succession ! invasion of exotic plant species ! streamwater contamination	! additive with other stresses perpetuating primary stages of succession ! additive with contamination from human sewage

Utility Corridors	! habitat loss and fragmentation ! aesthetic effects	! additive with other large landscape disturbances ! additive with other corridors, highways and infrastructure

3.3 Cumulative Environmental Effects of Proposed Initiatives in the Draft Park Management Plan

The first Park Management Plan for Gros Morne was approved in 1984 (Parks Canada, 1985a). The plan was intended to provide management direction for 10 to 15 years. The current draft PMP (Parks Canada, 1994a) represents the results of the first formal review of the initial management document.

The draft PMP sets the direction for park management for the next ten years, as Gros Morne moves from the developmental stage to the fully operational phase. Further infrastructure development will be minimal, and the focus of park management will increasingly be on heritage protection and interpretation. However, several initiatives are proposed in the plan which may contribute to cumulative environmental effects. Some of the initiatives are at the conceptual stage, and will require further environmental assessment as development plans are produced. The following discussion is meant to provide an initial assessment of potential effects from these proposals, with special emphasis on cumulative effects. Summary information is presented in Table 3.4. A discussion of cumulative effects relative to key park resources is presented in Chapter 4.

a) Establishment of OSV Corridors

Over the past twenty years, snowmobiling activity has become increasingly popular in the Gros Morne area. Although Parks Canada policy states that motorised access to Zone 1 and Zone 2 areas is prohibited, park wardens and managers have been unable to enforce these regulations because the park has not yet been proclaimed under the National Parks Act. Further, in consideration of the commitment to provide OSV access made under the federal-provincial agreement, Parks Canada has decided to legitimise the use of snowmobiles, in an effort to limit the activity to a number of specified corridors through the park.

A number of Zone 4 OSV corridors are proposed, that would allow users access between enclave communities, and across the park to the eastern boundary. The potential environmental effects of OSV use were discussed above. This proposal was designed to limit any such effects to specific corridors. However, this official management response could have significant cumulative effects due to its practical policy implications. From the perspective of heritage protection, this proposal is flawed in two important ways. Firstly, the designated routes allow access to all areas of the park except the Tablelands. The limited numbers of park enforcement personnel are not sufficient to ensure that OSV activity remains confined to these routes, and therefore the protection of park resources cannot be assured. Secondly, and most importantly, permitting OSV activity in these corridors suggests that motorised access is acceptable in special preservation and wilderness areas - it simply requires the manipulation of the zoning system through the use of temporal zoning designations. This also applies to the temporal zoning of Western Brook Pond discussed below. In these cases zoning designations are being applied on the basis of desired uses and political goals, rather than on the basis of ecological protection priorities. The Zone 4 corridors effectively fragment the large wilderness zones, and firmly entrench the OSV activity in the park. The implications of this precedent-setting action for Gros Morne, and for the entire national park system could lead to significant cumulative impacts related to the ability of park managers to respond to future user demands. It may lead to the further erosion of the park zoning system, the principle tool available to park managers for protecting significant natural resources.

b) Road and Highway Upgrading

The draft PMP states that no new road development is foreseen in GMNP. However, it does suggest that all existing roads will require upgrading and maintenance activities. Specific environmental effects of any such activity will need to be addressed on a site-specific basis. However, one inevitable impact of this activity which is cumulative in nature, is the prolonged need for additional aggregate supply. Further upgrading of roads and highways will require new granular material for roadbeds and asphalt. Consequently, further pressure will be placed on the aggregate sources both within and outside the park. A major concern is that future aggregate requirements will result in the identification and exploitation of new deposits in the park, thus augmenting the effects already associated with the existing quarries (see Section 3.2e on effects of aggregate extraction).

Another cumulative impact which may occur is the loss of more natural habitat along the road corridors. This may be significant if additional lanes are constructed, or large vehicle pull-off areas are developed in conjunction with scenic viewpoints or interpretive displays. Careful attention will have to be paid to habitat types, significance, and degree of current impact in any such areas before development plans proceed.

c) Development of a Gros Morne Discovery Centre and a Southside Administration Facility

The federal-provincial agreement committed Parks Canada to construct a plateau access system. However, this concept proved to be unfeasible, and the construction of a Discovery Centre has been proposed as a suitable alternative. It is also proposed to construct a southside administration facility to deal with visitor reception and park management in this portion of the park. It is possible that both functions may be fulfilled with the development of a single, multi-purpose facility.

While undoubtedly a much less damaging project than the original plateau access plan, this proposal, regardless of the final design, will generate several environmental impacts which will contribute to cumulative effects. A small amount of habitat will be permanently lost due to infrastructure, parking, and access roads, either within the park, or in an enclave community. An increase in demand for aggregate resources will produce similar effects to those identified above.

Another potential impact is the tendency for a facility of this nature to attract large numbers of visitors to the site. Recreational pressure on nearby natural areas, such as the Lookout Hills, the Tablelands, Green Gardens, and the Lomond area, can be expected to increase as a result.

A potential environmental benefit from the proposed Discovery Centre will be an expanded knowledge base acquired through research conducted at, or supported by the facility. Properly focused research can lead to a better understanding of natural ecosystem processes and responses to natural and anthropogenic stress, which will assist in making informed, appropriate management decisions.

d) Expansion of Campground System

In accordance with the federal-provincial agreement, the draft PMP allows for the expansion of the existing campground system as demand warrants. This includes potential expansion of the Shallow Bay and Trout River campgrounds, and the construction of a new campground at Wigwam Pond in the Southeast Hills.

The potential effects of such proposals include the same effects discussed under the previous section on campgrounds (section 3.1b). Additionally, several site specific effects would be associated with the development of the Wigwam Pond site. In particular an access road would need to be constructed with a bridge across the Lomond River. This would have two potential effects on aquatic resources: damage or loss of benthic habitat due to erosion and siltation associated with bridge construction; and increased fishing pressure on the Atlantic salmon (*Salmo salar*) and brook trout (*Salvelinus fontinalis*) populations due to improved access. Increased pressure on the char (*Salvelinus alpinus*) population in Wigwam Pond is also a concern. Populations of the showy lady's slipper (*Cypripedium reginae*) and the hooded ladies'-tresses (*Spiranthes romanzoffiana*) found around the pond would also be threatened.

The Wigwam Pond proposal represents a development for which no obvious need exists. Campground occupancy statistics indicate that Lomond campground is not fully utilised, even during the peak season (Table 3.2).

e) Active Promotion of Gros Morne as a Tourist Destination

The draft PMP proposes to increase tourism to the area by aggressively marketing Gros Morne. Park visitation has already seen a steady increase over the last decade (Figures 3.5 and

3.6). No comprehensive study of recreational carrying capacity has been conducted at Gros Morne, and the effects of intensive visitor use have already started to appear. Therefore the proposal to attract more visitors must be carefully considered. Encouraging more visitors requires the development of more facilities and services to cater to their demands. The incremental development that has occurred hand-in-hand with steadily increasing visitor use at Western Brook Pond is a good example. The cumulative effects of increasing tourist pressure on Gros Morne could be substantial, and would include: increased sewage and garbage generation; increased demands for additional accommodation facilities and related public services; increased need for expanded parking areas at trailheads and day-use areas; accelerated degradation of recreational facilities and resources (i.e. trail compaction and erosion, campsite degradation, trampling and removal of vegetation; wildlife disturbance); reduction of the quality of visitor experience due to overcrowding; traffic congestion and increased road maintenance requirements. A thorough assessment of the potential impacts based on projected visitation should be made before any promotional program is adopted. This assessment should carefully consider the effect the strategy would have on the park's ability to fulfil its mandate of protecting the natural heritage of Gros Morne.

One area where visitor use could be expanded at Gros Morne is through the promotion of shoulder season and winter use. The majority of visitors to Gros Morne come in July and August. Active promotion of visitation in the "off season" could provide additional park revenue and local economic benefits, without the need for expansion of existing facilities.

Figure 3.5: Number of People Entering the Park on Main Highways, 1988 - 1993

Figure 3.6: Number of People Entering the Visitor Reception Centre, 1985 - 1993

f) Park Zoning

Park zoning is a management tool used by Parks Canada to reflect the balance of resource protection and visitor use that is allowed for given areas in national parks. Although zoning does not result in any direct environmental effects, land uses and activities which may be permitted as a result of zoning designations may involve significant impacts. In particular, any changes to less restrictive status may lead to a future increase in stress on park resources. Consequently, consideration of proposed zoning changes must be considered in the assessment of cumulative effects.

The original PMP developed in 1984 included a zoning plan and a list of environmentally sensitive sites (ESS). The ESS designation is applied to special features or resources sensitive to development or use, but which lack the characteristics required for a Zone 1 designation. In the current draft PMP the designation of ESS has been augmented by the identification of environmentally sensitive areas. The only change in the current list of ESS is the addition of two oligotrophic lakes, Harding's Pond and Candlestick Pond. These changes should result in positive cumulative effects in the form of greater protection and consideration of natural heritage values in these identified areas.

Two zoning changes are proposed in the current draft PMP: Western Brook Pond has been upgraded from a Zone 3 to a Zone 2 area; and temporal Zone 3 OSV corridors are planned for numerous localities in the park. Western Brook Pond will be designated a Zone 3 area for the summer months to allow the existing boat tour operation to continue, hence it gains no additional protection by the upgraded zoning. The OSV corridors, and their potential cumulative effects have been discussed above, as have the cumulative effects of the Western Brook Pond operation. The danger of manipulating the zoning system through the use of temporal zoning designations was also discussed above.

Table 3.4: Environmental Impacts and Cumulative Effects of Proposed Initiatives in the Draft Park Management Plan

Proposed Initiative or Activity	Impacts	Cumulative Effects
OSV Corridors	! negative policy implications ! see Table 3.3 for environmental impacts	! precedent setting management response may lead to further concessions, and erosion of the park zoning system across the park system

Road and Highway Upgrading	! increased pressure on aggregate resources ! small habitat losses	! additive with other aggregate demands ! additive with other habitat factors
Development of Discovery Centre	! increased pressure on aggregate resources ! small habitat losses ! encourages more visitation to site and nearby areas	! additive with other aggregate demands ! additive with other habitat factors ! incremental high-use factor ! better option than the plateau access system (reduced environmental effects)
Expansion of Campground System	! see Table 3.3 for general campground effects ! siltation in Lomond River during Wigwam Pond construction ! increased pressure on fish populations in Lomond River	! additive with erosion from forest harvesting ! additive with existing fishing pressure (which is already high)
Marketing and Promotion	! encouragement of visitor use	! potentially precedent setting, leading to incremental increases in development in response to demand ! increased "off season" use could provide positive benefits while taking advantage of underutilised facilities

Park Zoning Changes	! legitimises non-conforming uses with potential environmental effects	! potential reduction in the effectiveness of the zoning system across the national park system

3.4 Cumulative Environmental Effects of External Development and Land Use

a) Commercial Forest Harvesting

Commercial forest harvesting is being conducted by Corner Brook Pulp and Paper in the Upper Humber River and Whites River watersheds east of the park. Current harvesting operations are within six kilometres of the park boundary, and cutting is scheduled to proceed to the boundary within the next five years. Associated haul-road construction will proceed to within 500m of the park boundary. Clearcutting has occurred within 50m of the Humber River. (Newfoundland Department of Forestry, Forest Inventory maps).

Commercial cutting is also occurring in the southern sector of the park in the Trout River and Lomond River watersheds. Current activity is concentrated in the Trout River - Governor's Pond area, where logging is occurring up to the park boundary. According to K. Sutton (Dept. of Forestry, pers. comm.) logging in this area is being carried out by small independent cutters who were displaced from traditional cutting areas when the park was established, and consequently it is not feasible from a socio-political perspective to establish any buffers between the park boundary and forest harvest areas.

There are no commercial logging operations adjacent to the northern boundary of GMNP due to poor forest productivity in this area. However, the area around Parson's Pond is used for domestic harvesting purposes. Commercial logging operations are conducted further north between Daniel's Harbour and Hawke's Bay, where harvesting is dispersed in many cutting blocks of "overmature" timber throughout the coastal plain. (P. Benoit, Dept. of Forestry, pers. comm.).

Clearcutting produces numerous environmental changes which may be manifest beyond the limits of the forest disturbance, and thus may contribute to cumulative effects in GMNP. A dramatic change in the nature of habitat occurs, with an increase in edge habitat where adjacent forest is left standing. Changes in diversity and abundance of wildlife species may result. Removal of all standing vegetation and damage to groundcover can cause increased runoff and erosion, with accompanying effects on nearby watercourses. Herbicide applications to suppress hardwood growth following harvesting may have negative effects on other flora and fauna, and may contaminate surface and groundwater.

Several of these environmental effects have been identified in Gros Morne. East of the park, virgin balsam fir forest is currently being harvested in the Upper Humber River watershed (Anions, 1994). Small remnants of this forest type remain within the park on the Long Range plateau. The loss of this old growth forest type could negatively impact remnant marten populations in this area. Further, very little research has been done on the ecology of these old growth forests in the Gros Morne area, and therefore the potential effects of removing these forests can not be adequately described.

In the southern sector, there has been an increase in sediment load and flow rate of the Trout River due to extensive forest harvesting by independent commercial cutters east of the park boundary (A. Moreland, pers. comm.). In the northern sector, clearcutting along the Humber could lead to similar increased, rapid runoff, erosion and siltation. It could also cause a depletion of winter snowcover due to increased wind exposure, thus decreasing the average annual spring runoff. This potential was recognised in a comparison of virgin and harvested forests in the area by Pruitt (1970). Clearcuts along the upper Humber witnessed by the author from the air during a caribou telemetry flight, have left only very narrow riparian buffers. Although resultant increased erosion, or changes in hydrological parameters of the Upper Humber will not directly affect park waters, indirect effects might be observed, particularly with respect to regional salmonid populations.

The conversion of natural forest ecosystems to managed woodlands often requires the use of chemical insecticides and herbicides. These pesticides may have negative effects on non-target flora and fauna. In particular a decline in songbird populations, and direct mortality of fish and non-target terrestrial and aquatic arthropods has been documented following the use of forest pesticides (Freedman, 1989). A provincial spray program using B.t. (*Bacillus thuringiensis*) was conducted in 1988 to combat a hemlock looper outbreak. This bacterial pesticide has a relatively low non-target toxicity, although it can cause mortality of other arthropods (Freedman, 1989). The spray program included limited applications within GMNP.

It is hypothesised that woodland caribou, particularly females and young-of-the-year are driven out of traditional areas where logging is occurring, and that they often avoid these areas long after the disturbance occurs (Chubbs, 1991, cited in Environment Canada, Parks Service, 1992). Avoidance behaviour has been observed in association with clearcutting in east-central Newfoundland (Chubbs et al., 1993). Anecdotal evidence suggests caribou populations are increasing in the Long Range Mountains, and numerous sightings have been reported on the coastal plain, and in the Tablelands area since 1985 (Environment Canada, Parks Service, 1992). It is not known whether this trend is in part due to habitat disturbance in the Humber watershed.

Moose distribution may also be affected by large-scale forest disturbance. Clearcutting in the Humber, Lomond, and Trout River watersheds could drive moose into the protected habitats of GMNP. Residents of Glenburnie have noticed an increase in moose numbers within the park and low numbers in cutover areas outside the park (D. Anions, pers. comm.). Further increases in moose populations could have significant cumulative effects on vegetation, as the moose population in the park is already sufficiently high to produce severe damage in some domestic cutting blocks (Lawlor, 1994).

A potentially significant cumulative effect related to forest harvesting is the increased access provided by logging roads. In GMNP, this issue is particularly relevant to the upland areas of the park. Access to the plateau from the provincial road system and communities on the coastal plain is difficult (by boat and foot in summer, and snowmobile in winter), and thus human use has been low. Forest roads approaching the park from the east make access to the remote plateau region easier, allowing users to reach the park boundary by motorised means at most times of the year. Consequently, recreational use of this zone 2 wilderness area of the park is likely to increase, and will probably include an increase in hunting, trapping, and fishing pressure adjacent to and within GMNP. A study by Kiell et al. (1986) designed to assess the impact of hydro development on caribou in south-central Newfoundland found that the effect of increased human access may be the most significant impact of development "because of general disturbance and increased human legal or illegal hunting".

b) Tourism and Recreational Activity

Recreational activities and associated developments pose a potential risk to the ecological integrity of the park ecosystem. The greatest risk is presented by intensive developments such as ski resorts, amusement parks, and golf courses. These types of facilities require the destruction or alteration of large areas of natural habitat, encourage large numbers of visitors, and degrade the aesthetic qualities of the wilderness landscape. The Rocky Harbour fun park is an example of a small amusement facility in the park area. However, since the feasibility of constructing and operating a ski resort in Gros Morne was found to be dubious, and due to the terrain and climate which is not easily amenable to golf course development, the potential threat is low.

Accommodation facilities in the form of hotels, lodges, cottages, and guest cabins have been constructed near GMNP since the park was created. These facilities contribute to loss of habitat, and landscape change, and to the generation of sewage and solid waste. This has been a particular problem at the Lomond River Lodge, where poor garbage management has contributed to bear problems in this area of the park (Porter, 1990). Other potential environmental effects include changes in surface or groundwater quality and quantity, and aesthetic effects.

Tourism to the Gros Morne area is likely to increase over the short term, and further development to meet increased demand can be expected. A study by IDP Consultants Limited (1986) suggested a high, unfulfilled demand for roofed accommodation in the Gros Morne area. A major campaign has been recently launched to promote the Northern Peninsula as a 'world class' tourist destination. The government-supported Viking Trail Tourism Accord will focus on developing more services and marketing material to attract more visitors to this region of Newfoundland (Barry Wheaton, CBC Radio, Corner Brook, Sept. 16). The primary attractions of this area are the three national parks and historic sites, Gros Morne, Port au Choix, and L'Anse aux Meadows, resulting in an intensification of visitor activities and visitor services there. Associated visitor use impacts can thus be expected around these sites.

Increased access to the Long Range plateau has resulted in more intensive use of this area by snowmobiles. According to the draft PMP, commercial motorised tours are prohibited in GMNP, but at least one outfitter is conducting guided tours to the Western Brook Pond gorge from east of the park (D, Chaisson, pers. comm.). The potential effects of this activity have been discussed previously.

Another effect of recreational activity is increased pressure on fish and game resources. Lands surrounding a protected area are often considered prime hunting grounds, benefitting from the protection of wildlife within the boundaries of the protected area. In the Long Range Mountains, there are twelve remote hunting and/or fishing camps within a twenty kilometre radius of GMNP (D. Chaisson, per. comm.). Hunting outside of GMNP is managed on a quota system by the Newfoundland Wildlife Division. Currently both moose and caribou populations appear to be increasing, and are therefore capable of sustaining the current hunt.

Fishing pressure from both outside and inside park boundaries has led to a decline in salmonid populations in all of the rivers in the Gros Morne area. An additional threat was placed on park fish resources when a proposal was put forth to introduce Atlantic Salmon into the Upper Humber River. This colonisation program would threaten the survival of the extremely significant relict dwarf char and ouananiche populations in Candlestick Pond. Although this proposal has been deferred, its potential resurrection must be viewed as a threat. A prohibition on all fishing in Gros Morne should be considered if the park is serious about fulfilling its mandate to protect the full complement of species comprising Gros Morne's natural heritage.

c) Enclave Community Development

Many of the environmental effects of development in the enclaves have been discussed under other specific land uses. These include effects associated with road construction, aggregate resource extraction, facility and infrastructure development, and forest harvesting. In a cumulative sense, the most significant effects of enclave community development around GMNP are the loss or alteration of large portions of habitat (coastal plain and lowland forest) due to housing, facility development, infrastructure, and forest harvesting, and the loss of glaciofluvial aggregate resources. Some forms of development, such as the Rocky Harbour recreation complex have also resulted in negative aesthetic effects.

d) Petroleum Exploration and Development

The first oil discovered in western Newfoundland was at Parson's Pond, where the presence of natural oil seeps was rumoured as early as 1812 (Petroleum and Energy Resources Branch, 1994). The first well was drilled in the area in 1867. Around the turn of the century, approximately 6,000 barrels of oil were produced from this area (Petroleum and Energy Resources Branch, 1994). Presently, both onshore exploration north of the park, and offshore exploration in the Gulf of St. Lawrence west of the park have the potential to cause significant environmental effects on Gros Morne and the greater park ecosystem. There are currently eight offshore exploration licenses covering the immediate offshore area from Daniel's Harbour to Cape Anguille (Canada-Newfoundland Offshore Petroleum Board, 1994). There are three onshore exploration permits covering the area north of GMNP from Parson's Pond to Hawke's Bay. Additional permits in western Newfoundland have been issued at Castors River, Hare Bay, Deer Lake (two permits), the Port aux Port Peninsula, and Crabbs River (Petroleum and Energy Resources Branch, 1994).

Currently there is no activity in the Parson's Pond area, (J. Gorman, pers. comm.). An onshore well with a target depth of 4600m was started on September 18th on the Port au Port peninsula (CBC radio, Corner Brook, Sept. 20). An onshore/offshore well designed to test the stratigraphy offshore from a land-based site is proposed, but the company is awaiting the results of the current onshore well (P. Barnes, pers. comm.).

The environmental effects of onshore oil exploration include habitat loss and disturbance, wildlife disturbance, and potential contamination of terrestrial and aquatic habitats from oil spills, blowouts, or spills of drilling muds, fuels and lubricants. Contamination of aquatic spawning habitat could be particularly critical for already depressed salmonid populations.

The potential environmental effects of offshore activity are related primarily to operational or accidental spills of petroleum products. Should a large spill or blowout occur which results in oil deposits on the shore, park resources could be directly affected. Of particular concern are the tern colonies of Stearin Island, other shorebirds, marine resources in the intertidal zone, and aquatic resources in estuaries. Depressed salmon populations could also be affected by shoreline and estuarine oil contamination.

e) Mining and Mineral Exploration

Mining was a previous land use activity in the park area. A zinc mine was operated in Daniel's Harbour, which resulted in some habitat loss due to infrastructure and tailings disposal. Teck Corporation is still conducting some rehabilitation work there, but no other activity is occurring in the area north of the park. Several mineral claims in the Gregory River area south of the park are held by Noranda Exploration Company Limited, but no recent work has been conducted there (K. Andrews, pers. comm.). The area has some potential to host gold and base metal mineralisation, however the likelihood of any major mining operations developing in the region appears to be small.

f) Waste disposal

Park enclave communities dispose of solid waste at three enclave sites in Trout River, Norris Point, and Cow Head, and at the Lomond site in GMNP. In 1985 enclave residents produced 4,587 tons of garbage, and by 1995 this figure is projected to rise to 7,635 tons (Brunt, 1987). Sewage is collected and discharged untreated into the marine environment (Forrest, 1994).

The generation and disposal of this material contributes to the effects of waste management within the park. The environmental effects of waste disposal have been discussed previously in section 3.2e.

g) Illegal Hunting

Poaching of wildlife has had significant historical environmental impacts, and could contribute to future effects. Illegal hunting was one of the primary factors leading to dramatic declines in caribou populations in the early 1900s, and poaching has led to the complete destruction of introduced herds before viable populations could be established (Baird, 1985). Illegal sales of poached salmon was one factor implicated in declining fish stocks in rivers in the park area (Parks Canada, 1990).

Although the main big game species are not threatened, continued poaching both within and outside the park could have a significant effect on the ability of Parks Canada, and the Newfoundland Wildlife Division to effectively manage fish and game species. Salmonid populations are of particular concern because of their depressed populations relative to historical levels.

h) Introduced and Newly Colonised Species

Introduced, or recently colonised mammals include the moose, snowshoe hare, coyote, red squirrel, mink, house mouse, and Norway rat. Introduced plants include coltsfoot (*Tussilago farfara*), black knapweed, purple loosestrife (*Lythrum salicaria*), dandelion, and European foxglove. These species can cause environmental effects on native flora and fauna. The most significant species are moose, coyote, knapweed, and purple loosestrife.

Moose were introduced to the island at the turn of the century. The 1990 population estimate for the park is 2700 animals, compared to <1000 animals at the time of park establishment (Environment Canada, Parks Service, 1991). The moose has become established in the absence of a natural predator, and thus hunting by humans and natural mortality are the only means of population control. Increasing moose populations in the park, where hunting is prohibited, have led to negative impacts on vegetation, and an increasing road safety hazard (Environment Canada, Parks Service, 1991).

The coyote has recently colonised insular Newfoundland. It is thought to have arrived in 1985, and has established a population on the Port aux Port peninsula (Environment Canada, Parks Service, 1991). Its presence has not been positively documented within the park, but there have been several reported sightings (H. Deichmann, pers. comm.). The extreme adaptability and dispersal capability of this species suggests that it will eventually establish a population in the Gros Morne area. This species may fill the role of a natural predator for moose and caribou. However, having lived for several generations in the absence of such a predator, the responses of these populations to new predation are unpredictable.

Two of the most significant introduced plants are coltsfoot and black knapweed, both invasive species. Knapweed is appearing in fens as well as the fields it usually prefers, and coltsfoot is invading streams, gravelly areas, and forest clearings (M. Burzynski, pers. comm.). Knapweed is particularly significant because of its ability to colonise a wide variety of soils. It's tenacity and growth habit suggest that it may be capable of choking out other species, and it has been found in fens where the rare showy lady's slipper grows (M. Burzynski, pers. comm.).

Purple loosestrife is another significant introduced plant species, and possibly the only exotic plant species that can be eradicated from the park. It has been identified at four locations along the Lomond River (Anions, 1994). This species has the ability to completely dominate freshwater wetlands, eventually resulting in the elimination of almost all other native species. The wetland may disappear altogether. The wetland habitats in GMNP harbour a large number of rare species, and therefore the continued spread of purple loosestrife is a serious concern. However, since it requires rich wetland habitat, its range is restricted, and a concerted effort to eradicate it could be successful.

i) Fisheries

Historically, fishing has been the mainstay of the park enclave communities, and it still forms an important component of the local economy. Several environmental effects associated with fishing contribute to cumulative impacts on park resources.

Commercial fisheries in offshore waters require the maintenance of onshore landing and staging areas within park boundaries. Six of these areas are maintained in the park in accordance with the federal-provincial agreement. This results in the loss of a small portion of coastal habitat.

The commercial cod trap fishery in Bonne Bay has landed a significant by-catch of salmon which has contributed to the decline of this species in park rivers. In 1976, in the DFO fisheries zone that includes GMNP, 51% of landings were salmon by-catch. Cod traps were banned in Bonne Bay in 1984, and catches in the Lomond River subsequently increased (Parks Canada, 1990). The demise of the cod fishery has at least temporarily alleviated this stress.

Disposal of fish offal from commercial operations may pose a threat to tern populations in the park by contributing to a general increase in gull populations. Competition and predation by gulls is a significant factor in the decline of tern populations in eastern North America (Brown and

Nettleship, 1984).

Table 3.5: Impacts and Cumulative Effects of Development and Land Use Beyond Park Boundaries

Development or Activity	Impacts	Cumulative Effects
Commercial Forest Harvesting	! loss or alteration of habitat, including old growth forest ecosystems ! increased runoff, erosion and sediment loading of aquatic systems ! mortality of non-target organisms through the use of pesticides ! wildlife disturbance ! increased access to previously remote areas via forest roads	! additive with other sources of habitat loss, wildlife disturbance and mortality ! potential "high-use" factor leading to increasing visitor-use impacts
Tourism and Recreational Activity	! habitat loss or alteration ! increase in visitor-use impacts ! increased pressure on fish and game resources	! additive with other habitat disturbance ! additive high-use factor ! additive with other exploitive pressures
Enclave Community Development	! loss of habitat (coastal plain and lowland forest) ! impacts associated with development activities (aggregate extraction)	! additive with other factors causing habitat loss in this area ! additive with highway development, park infrastructure etc.

Petroleum Exploration and Development	! loss of habitat ! wildlife disturbance ! potential contamination of coastal and estuarine environment	! additive with other sources of habitat loss and wildlife disturbance ! additive or synergistic effects with other chemical contaminants
Mineral Exploration	! habitat loss or alteration	! additive
Waste Management	! contamination of surface and groundwater ! foraging source for wildlife, particularly bears and gulls ! aesthetic effects ! air pollution	! additive or synergistic with other contaminant sources (oil, sewage) ! additive with park waste management ! additive with other aesthetic effects
Illegal Hunting	! increased pressure on fish and game species ! increased difficulty in properly managing resources	! additive with losses due to legal hunting, and with potential negative effects of other activities such as logging and snowmobile use
Introduced Species	! alteration of habitat ! decline or loss of native flora and fauna	! additive with other sources of habitat loss or alteration, and loss of native biodiversity

Fisheries	! loss of small area of coastal habitat ! decline in anadromous fish stocks ! pollution through disposal of offal	! additive with other developments and land use in the coastal zone ! additive with declines due to recreational fishing pressure ! contributor to tern decline through increase in gull populations

Chapter 4: Significance of Impacts on Key Resources and VECs, and Suggested Mitigation Measures

4.0 Impact Significance and Ecological Integrity

The preceding chapter identified a number of individual stressors which cause, or may cause environmental effects on park resources. Some of these effects may be slight or insignificant. However, the assessment of cumulative environmental effects is based on the concept that a number of singly insignificant effects can collectively cause significant impacts. Nevertheless, some cumulative impacts are likely to be more severe than others, and hence an estimate of impact significance must be made.

In a discussion of the ecological perspective on impact significance, Duinker and Beanlands (1986) stated that while there was no consensus on a precise definition, important considerations included "loss of critical breeding habitat, local extinction of species, and reduction in primary productivity, ... loss of ecosystem stability, exceeding tolerance limits, and reduction in assimilative capacity". These definitions involve value judgements, or "the existence of some nonbiological standard against which to interpret the severity of impact" (Duinker and Beanlands, 1986). With respect to Parks Canada policy, the obligation to consider the protection of ecological integrity above all other considerations serves as such a standard.

Many researchers have attempted to define ecological integrity (Woodley, 1993; Munn, 1993; Freedman et al., in press). Most definitions focus on the perpetuation of ecological processes such that ecosystems can continue to evolve and respond to routine, or periodic extreme natural stresses. For national parks, Woodley (1993) disturbance and integrity as follows:

> "Ecosystems are viewed as dynamic systems that are adapted to internal stresses such as fire. However, ecosystems are not adapted to many human-caused stresses. These stresses lead to degradation and loss of integrity."

The definition provided by Freedman et al. (in press), reflects a similar notion, and suggests that an ecosystem has a high degree of integrity if it is part of a "natural" sere rather than a human influenced system. The definition put forth in the Gros Morne draft PMP equates ecological integrity with "a condition in which the structure and function of the Park's ecosystem are unimpaired by human caused stresses, and are likely to persist in that condition".

Additionally, protecting ecological integrity can draw support from ethical or cultural domains (Steedman and Haider, 1993). This is particularly relevant for national parks which are regarded with a different set of values than surrounding lands. For Parks Canada, significance has to be judged in the context of their primary objective which is to protect natural heritage " so as to leave it unimpaired for future generations" (Parks Canada, 1994b).

Considering the foregoing, any impact which tends to reduce ecological integrity, or cause environmental changes, including aesthetic changes on landscape scales, that diverge from expected normal environmental change should be considered significant. Beanlands and Duinker (1983) introduced the concept of "valued ecosystem components" (VECs) to focus attention on the most critical aspects of the ecosystem. The following sections present a discussion of the significance of cumulative impacts relative to broader key park resources. Within each category, impacts on specific VECs may be discussed. A summary is presented in Table 4.1.

4.1 Natural Habitat

a) Significance

The forests of GMNP have been subjected to considerable anthropogenic stress. Most of the coastal and lowland forest has been previously harvested for sawlogs, pulpwood, fuelwood and other domestic purposes.

Gros Morne is the northern limit of the Western Newfoundland Forest ecoregion, which is also the northern limit for the following tree species: white pine, red maple, trembling aspen (*Populus tremuloides*), and black ash (*Fraxinus nigra*) (Meades, 1990). Protection of these species is particularly critical as they may be an important element in the ability of the ecosystem to respond to climate change.

The integrity of the lowland forest ecosystems in GMNP is under considerable threat. The majority of this ecosystem between Trout River and the northern park boundary is being affected by human stresses. The largest areas are those within enclave communities which have either been eliminated for community development, or are subject to domestic resource harvesting. Next are the large domestic harvest blocks established within GMNP. Although harvesting is limited here it has been poorly controlled, and high-grading, where many of the best quality trees are removed before they are able to reproduce, has been a common practice. This situation may improve as a result of the new domestic harvest plan.

The moose was successfully introduced to Newfoundland in 1904, and is now contributing to negative effects on vegetation within GMNP. Protection within the park, and the absence of natural predators has led to a rapid increase in moose population. The population in 1990 was estimated to be approximately 2700 animals, compared to <1000 animals at the time of park establishment (Environment Canada, Parks Service, 1991). Moose browse damage is most severe in regenerating disturbed areas, primarily in the domestic harvesting blocks where regeneration is being impeded on the stand level. Continued browse damage could lead to changes in species diversity in these blocks, and may have long-term negative impacts on the ecological integrity of the forest ecosystem.

Other stressors affecting lowland forest habitat are highway development, utility corridors, park infrastructure, and aggregate and rock extraction areas. Collectively, these stressors, the enclave communities, and the domestic harvest blocks directly affect the majority of this ecosystem type within the boundaries of GMNP. Very little remains truly protected where it is allowed to evolve in a natural state, and these remaining areas are highly fragmented. North of the park, the coastal lowland forest is also subject to domestic harvesting, community development, and commercial harvesting further north, resulting in further loss and fragmentation of this habitat. Consequently, the protection of remnant stands in the park, free of human disturbance, is essential.

The upland forest in the park, located on the Long Range Plateau, the Southeast Hills, the Lomond Peninsula, and on the margins of the Lookout Hills, has been less affected due to inaccessibility. The only current effects in the park are a small loss of habitat due to highway development through the Southeast Hills. Some virgin balsam fir forest remains in the Upper Humber River watershed on the Long Range plateau. Protection of these sites is imperative since the remainder of this forest type outside the park is currently being harvested for pulpwood.

The foregoing indicates that the cumulative effects of current land-use and development on the lowland forest habitat of the Gros Morne area must be considered significant. The cumulative effects on the upland forest are minimal within the park, but are considered significant on the greater ecosystem scale.

b) Mitigation

As noted above, the principle factors affecting forest habitats are enclave community development, infrastructure, and domestic harvesting resulting in habitat loss and fragmentation. Lost habitat due to enclave communities and park infrastructure cannot be mitigated. However, some management actions could be used to mitigate the effects on the landscape and stand levels. Strictly protected corridors could be established between existing blocks of low disturbance, and more sustainable harvest operations could be implemented in the domestic harvest blocks within the park.

As stipulated in the federal-provincial agreement, Parks Canada is committed to provide suitable areas within the park for the harvesting of domestic wood supplies. The boundaries of these areas cannot be expected to decrease. A change in harvest practices could help to mitigate some of the effects of this anthropogenic disturbance. Allocating the harvest of old, diseased, or frail trees, and leaving the most vigorous, healthy, mature trees as seed sources, while providing a suitable, disturbed seed bed, may improve regeneration and preserve the best genetic stock. However this will still have negative effects on other species such as cavity-nesting birds, insects, lichens and mosses that depend on dead, standing or fallen trees for habitat. Minimising the size of forest openings will help to reduce or eliminate any changes in species composition and abundance which normally occurs in clearcuts due to changes in the amount of open, edge, and interior habitat.

The loss of ecosystem integrity in the lowland forest habitats can be mitigated by the prevention of any further loss, alteration, or fragmentation of this habitat. In considering any future development, a planning process based primarily on habitat protection requirements, and strict adherence to environmental assessment procedures will be required. Site selection for proposed developments such as the Discovery Centre and southside administration facility should focus on previously degraded sites. The proposed development of the Wigwam Pond campground should be abandoned, as current demand does not warrant its construction.

Habitat restoration of currently degraded areas can serve to reduce cumulative effects. Of particular note are the aggregate extraction areas which have been inadequately rehabilitated. Rehabilitation of these heavily disturbed sites should focus on the establishment of native species suited to the site in order to prevent colonisation by exotic species. Rehabilitation of some harvest blocks that are understocked and heavily browsed by moose will also be required (Deichmann, pers. comm.).

4.2 Coastal Beach and Dune Systems

a) Significance

Sand beach and dune systems are found in the northern sector of the park at the outlet of Western Brook, and in Shallow Bay. According to Catto (1994), these systems, as well as other dune systems on the west and south coasts of Newfoundland, are largely relict features, originally deposited in the earlier Holocene era during a post-glacial phase of coastal emergence (Catto, 1994). However, sand is still being eroded from surficial deposits and transported by rivers such as Western Brook. Further, submarine sand "rivers" have been mapped off the shore of GMNP which continue to supply sand to the coastal dune systems (M. Burzynski, pers. comm.).

The dunes were stabilised by a climax forest ecosystem, but have since been destabilised, initially by logging and grazing activity, and more recently by recreational pressure (Greenwood, 1982). Other factors affecting dune stability include: facility development, recreational use, motorised ATV damage, and a gradual rise in sea level.

Catto (1994) noted some ATV damage at Western Brook. ATVs are also used by local residents to harvest kelp from the beaches at Shallow Bay (Environment Canada, Parks Service, 1991). However, the current phase of marine transgression presents the ultimate, and inevitable threat to the Gros Morne dune systems.

During this research project both the Western Brook and Shallow Bay dune systems were studied through air photos and field observation. No pedestrian damage was observed at Western Brook, however some natural blowouts have occurred, and the remains of some old sand fencing are still visible. Some minor pedestrian damage was apparent at Shallow Bay, but the dune crossing structures employed there seem to be working effectively.

An extensive program of dune rehabilitation was recommended by Greenwood (1982) for the Western Brook dune systems. No rehabilitation is currently being conducted. The spreading sand sheets which were of concern in 1981 are now well vegetated with marram grass, sea rocket, beach pea, and various other species, although according to Anions (1994) some sand mobility persists in the one sand sheet on the south side of Western Brook.

Historical logging and grazing produced significant impacts on the previously stabilised relict dune systems. Current land use does not appear to be producing any significant impacts on these systems, although it is uncertain as to whether a new stabilised climax forest ecosystem will be attainable. It is important to note that the potential exists for increased pedestrian impacts on the dunes at Shallow Bay due to the proximity of the campground. The planned expansion of this facility would result in increased recreational pressure on the adjacent dunes.

b) Mitigation

As noted above, the persistence of these dunes in perpetuity is probably not possible even on a time scale relevant to humans. However, considering the notion of ecological integrity, the processes of natural evolution should be protected and allowed to proceed unimpeded by human interference. No erosion protection devices such as gabions, or sand fences should be used. However, efforts to prevent accelerated degradation due to human impacts should continue.

Further prevention of human impacts requires the prohibition of further facility development in the dunes. A concerted effort must be made to educate park visitors about the sensitivity of dune ecosystems to pedestrian traffic. Prominent signage in the Shallow Bay campground and at the Shallow Bay and Western Brook day-use areas is an important element of this effort. Signage is still required along the trail leading from Broom Point to Western Brook. Further, the park user's guide, *Tuckamore,* could also be used to provide interpretive information on dune ecosystems, and to request that visitors refrain from trampling dune vegetation.

4.3 Terrestrial Flora

a) Significance

A total of 723 vascular plants, 326 mosses, and 92 liverworts have been identified so far in GMNP (Anions, 1994).
There are nine endemics, confined either to the Gulf of St. Lawrence region, or to the western Newfoundland region (Anions, 1994).

Bouchard et al. (1986) listed 43 vascular plants that were considered "significantly rare" in GMNP, 39 of which were also listed as rare in other provinces, states, or national parks in the Gulf region. As a result of more recent work, the list of rare plants in the park has now grown to

97, all of which are also considered rare in Newfoundland by virtue of their limited distribution, or their occurrence at the extreme limit of their range (Anions, 1994). Ten of these species are considered rare in Canada. There are also 29 rare bryophyte species in the park (Anions, 1994).

Bouchard et al. (1986) suggest that the only way to protect these plants is to protect their specialised habitats, chiefly the limestone escarpments and talus, alpine snowbeds, peridotite areas, and wetlands. Loss or alteration of habitat remains the most important stress affecting flora. Significant examples include highway and utility corridors, and infrastructure development.

Many of the rare species in the park are remote or poorly accessible, so the threats from habitat loss are not great. However, these species may be threatened by other land-uses such as snowmobiling and recreational activity. Anions (1994) points out that the Big Level area harbours 20% of the park's rare plants. This Zone 1 area will be traversed by an OSV corridor. The potential effects of this activity on rare plants are not fully understood. Other activities such as hiking and rock climbing may threaten specific populations of rare plants. One concentration of rare plants that may be affected by rock or ice climbing has been documented on the north face of Gros Morne Mountain (A. Marceau, pers. comm.). Other potential climbing sites have not even been investigated by botanists, and hence no data on potentially threatened rare plant communities there exists (M. Burzynski, pers. comm.).

Some rare plants may also be threatened by the colonisation of exotic species. Purple loosestrife in the Lomond and East Branch watersheds is one example which may threaten specific rare plant populations (Anions, 1994).

No extirpated plant species have been documented in GMNP, although several plants that were previously reported, namely the fairy candelabra (*Androsace septentrionalis*) (identified in 1929 and 1974), the sedge *Carex petricosa var. misandroides* (1958), and the arctic willow (*Salix arctica*) (1978), have not been re-documented despite later searches (A. Marceau, pers. comm.) They may still exist in inaccessible places, but they must be considered extremely rare in the park.

The cumulative environmental effects on rare plants based on current knowledge do not appear to be significant. However, inventories for most species are not sufficient to determine changes in population status due to anthropogenic stress. Further, most of the rare plant communities and phytogeographically important habitats in the park are not protected elsewhere in the province (Caines and Deichmann, 1990). For these reasons, the protection of rare flora in Gros Morne is specially critical.

b) Mitigation

With respect to rare flora, mitigation of cumulative effects requires the prevention of further losses of rare plant habitat. The most significant habitats for rare plants have been documented, and therefore can be easily avoided during any future development or land use considerations. Detailed investigations of specific sites should be conducted as part of an environmental screening of any proposed project likely to damage or alter in any way these significant habitats.

Where rare plants are threatened by exotic species, management intervention may be warranted. For example, a campaign to eradicate purple loosestrife from the Lomond area might prevent the further spread of this invasive species. Anions (1994) suggests manual removal for such a program.

4.4 Terrestrial Fauna

a) Significance

Previous development and land use at GMNP has affected several of the significant species in the park. Habitat destruction due to historical and recent logging of old growth forest both within and beyond park boundaries has contributed to the decline of the Newfoundland marten. This species was extirpated from the park, although there may be a small population near the eastern boundary in the Humber watershed derived from a provincial reintroduction program (A. Moreland, pers. comm.). Reintroduction in the park is not being considered now because of the lack of sufficient suitable habitat (mature fir forest with closed canopy), and the lack of available martens. The only high quality habitat remaining is in the Southeast Hills and Lomond peninsula area. A study conducted in 1988 calculated the total potential habitat to be 510 km^2, although 40% of this comprises poor winter habitat in the Long Range uplands (Environment Canada, Parks Service, 1988a). The park carrying capacity was calculated to be between 13 and 22 individuals. The study recommended a trial reintroduction in the Stuckless Pond area in the Southeast Hills, accompanied by radio telemetry monitoring. The two harvest blocks in this area (No. 5 & 10) are not well utilised, and hare snaring is not permitted in order to protect potential marten. However, even in this area, if marten were occupying typical ranges they would be forced to move beyond park boundaries, into an area of active commercial logging, hunting, and trapping. The chances for success would be small.

The woodland caribou is the only native ungulate in the park. Its population on the island is thought to be increasing (K. Mawhinney, pers. comm.), but is still substantially below historic levels. It is estimated that at the turn of the century there were approximately 40,000 caribou on the island of Newfoundland, but that increased hunting pressure in conjunction with predation of calves by lynx caused the population to decline to a couple of thousand animals by 1930 (Bergerud, 1971). During this dramatic decline caribou populations vanished in some areas where they had previously been abundant. Bergerud (1971) estimated that an annual harvest of 6,000 to 8,000 animals by hunters must have occurred in order to precipitate such a rapid decline. Following a moderate recovery, a second decline occurred between the early 1950s and the early 1960s (Baird, 1985).

Two separate herds utilise the park, the Humber and the Gregory Plateau. The Northern Peninsula herd primarily occupies the area north of Gros Morne, although some of these animals may utilise the northern sector of the park. Following the decline in caribou population prior to 1930, Bergerud (1971) estimated that there were probably less than 100 animals in each of the Humber and Northern Peninsula herds. The Gregory Plateau herd was extirpated around 1950, but a reintroduction of 15 animals was conducted in 1965 (Pruitt, 1970). This herd is now estimated to number 330 animals (based on 1987 census data, K. Mawhinney, pers. comm.). The Humber herd population was estimated by Pruitt (1970) to be around 150 animals. The most recent estimate for this herd is 1,999 animals (based on 1989 census data, K. Mawhinney, pers. comm.). The Northern Peninsula herd has also increased, although less dramatically, from an estimate of 450 animals in 1970 to a current population of 1,429 (based on 1994 census data, K. Mawhinney, pers. comm.).

The protection offered by the park, and by provincial wildlife management efforts, appears to have had a positive effect on caribou populations. However, the herds have not completely recolonised former habitat. According to Pruitt (1970), caribou frequented the large coastal bogs north of Rocky Harbour as late as 1850. Recent sightings of caribou on the coastal plain in GMNP suggest that caribou may be slowly returning to this historic habitat.

Despite the growth of the caribou population since park establishment, several factors threaten the integrity of the herds. The extirpation of the Newfoundland wolf in the early 1900s removed one of the main predators of caribou. The only other natural predators are black bears and lynx. The recent colonisation of the island by the coyote may result in predation stress on the caribou. The arrival of the coyote is a part of a natural range extension involving an opportunistic species, and therefore the species should be protected within GMNP. This may have repercussions for other park wildlife, especially if the coyote is aggressively hunted outside park boundaries. The wolf may also recolonise the island from Labrador by crossing the ice in the Strait of Belle Isle. This would add another factor to the predator-prey dynamics within the Gros Morne area, with unknown consequences.

Anthropogenic factors which may contribute to environmental impacts on caribou populations are habitat destruction and fragmentation, disturbance or harassment by snowmobiles, and poaching. Clearcut logging may drive caribou out of a disturbed area for a period of time. A study in east-central Newfoundland found that caribou were displaced from clearcuts during logging activity, and often moved further away the following year (Chubbs et al., 1993). This study also noted a particular sensitivity to disturbance among females with calves. Commercial activity outside of park boundaries may affect all three of the regional herds, with unknown consequences.

The potential effects of snowmobile use on the caribou of Gros Morne have been previously discussed. It must be reiterated that the calving range on Big Level is of particular concern. The congregation of pregnant females here in late winter, at a time when energy levels are low and must be conserved, coincides with the busiest snowmobile season when the likelihood of disturbance or harassment is greatest.

Although the significance of these impacts on caribou population dynamics is not known, the stresses are beyond what can be considered natural, and thus from a national parks perspective must be considered significant in that they reduce ecosystem integrity. Further, in a harsh environment, at a critical time in the reproductive cycle, even marginal effects from such stresses could become cumulatively significant (Tyler, 1991). In the face of such uncertainty, a precautionary management approach would be advisable.

The arctic hare population in GMNP is at the extreme southern limit of its range. Very little is known about the population status and distribution. It is estimated that there are 500 km^2 of available arctic hare habitat in Gros Morne. The lack of knowledge is reflected in the population estimates for the park which range from 25 to 500 animals (based on an estimate of an average habitat requirement of 1 km^2 per animal) (A. Moreland, pers. comm.). This species is confined to the upland heath-tundra communities of the park, and thus has not been substantially affected by development. However, some behavioural responses to human disturbance are thought to occur, which have unknown impacts on the species population and ecology. Disturbance is caused by hikers and dogs on Gros Morne Mountain (Bridgland and Brassard, 1984) and potentially on the Long Range plateau. Snowmobiles may also affect arctic hare on the Long Range. The significance of these effects is unknown.

Raptors, lynx and red fox are the only remaining natural predators of the arctic hare in Newfoundland. Raptor predation pressure is unknown. Lynx predation is currently low, but could become more significant if snowshoe hare populations decline due to domestic harvesting. The newly colonised coyote could become a significant predator, as could the wolf if it is able to recolonise the island.

Black bears are under threat because of inappropriate waste management practices. Bears that become habituated to human garbage are usually considered a nuisance and a safety hazard, so they are often destroyed. Routine destruction of nuisance bears has been shown to alter the natural age class distribution (Porter, 1990). Physiological changes in habituated bears have also been noted. Although there is a dearth of baseline data on bears around GMNP, any changes in natural mortality or other population characteristics must be considered significant.

Several bird species are of special concern at Gros Morne, due to declining numbers or endangered status. Both common tern (*Sterna hirundo*) and arctic tern (*Sterna paradisaea*) populations have been displaced from traditional nesting areas by increasing gull populations (Deichmann, 1993b). Disposal of solid waste and fish offal may be contributing to the increase in gulls.

The piping plover (*Charadrius melodus*) is listed as endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). It has been extirpated from the park although suitable habitat still exists at Shallow Bay and Western Brook. However the level of human use at these sites is probably sufficiently high to discourage any recolonisation attempts by this sensitive species.

The harlequin duck (*Histrionicus histrionicus*) is also listed as endangered in eastern Canada by COSEWIC. Breeding activity was confirmed on Western Brook Pond in 1992, but its status in GMNP is a concern. The last previous confirmed breeding in the park was in 1979. Hunting pressure has been implicated as the chief cause of this bird's decline, so its protection in Gros Morne is of special significance. Currently human disturbance and poaching is the only identified stress in GMNP.

b) Mitigation

Since the consequences of most of the identified stressors on fauna are not well understood, more research is required before effective measures to eliminate or minimise impacts can be defined. However, several initiatives can be implemented now.

If the creation of OSV corridors continues as planned, further research and detailed monitoring of effects on wildlife needs to be conducted to assess the effects of this activity on ecological integrity. If any effects likely to cause changes in population status or demographics are identified, a prohibition on snowmobile activity should be enforced once the park is gazetted. This response would be consistent with the federal-provincial agreement, which stipulates that snowmobile activity will be allowed only where it does not cause adverse environmental impacts.

A ban on dogs on park trails is recommended to reduce disturbance to wildlife. This is particularly significant on Gros Morne Mountain where mortality of young rock ptarmigan, and perhaps arctic hare is suspected due to predation by unleashed dogs.

An assessment of the domestic snowshoe hare harvest should be conducted to gauge the state of the resource and to determine the effects of snaring on non-target species. These include lynx, fox, mink, and potentially marten.

Improved waste management strategies need to be implemented to reduce the amount of garbage available to scavenging wildlife, chiefly bears and gulls. Community recycling and composting programs should be strengthened, and the use of exposed garbage 'pits' must be eliminated.

Reintroduction campaigns for the Newfoundland marten, and the piping plover are not recommended. Habitat for the marten is limited, and success would be threatened by resource harvesting activities outside of the park. Suitable habitat exists for piping plover in the park, but the level of human use is such that any recolonisation effort would probably fail.

4.5 Aquatic Systems

a) Significance

The freshwater resources of GMNP are considered to be extremely significant because of their pristine quality. There are over 1000 documented lakes and ponds ranging in size from less than one hectare to 1,180 hectares (Caines and Deichmann, 1990). The lakes and ponds on the Long Range plateau, and the fjord ponds carved into the plateau are classified as oligotrophic to ultra-oligotrophic, whereas water bodies on the coastal plain generally have more productive trophic states. The fjord ponds are characterised by unusually long water retention times, and thus are highly susceptible to anthropogenic degradation (Caines and Deichmann, 1990).

The principle factors which could threaten the integrity of park waters are chemical contamination from fuel spills, forest and utility corridor pesticide use, landfill leachate, and bacteriological contamination from sewage. No water quality monitoring has been done in the vicinity of the Lomond landfill or park sanitary facilities, so any potential effects from these contaminant sources are not known. A minor concern is the potential bacteriological contamination of Western Brook Pond. Old pit privies at the tour boat landing are still used during the shoulder seasons. These facilities drain into the pond. Backcountry campsites with pit privies are located at two locations on the pond: Snug Harbour, and the Long Range trailhead at the eastern end of the pond. Visitor use of these sites is increasing dramatically (17% increase in Long Range trail use in 1990, G. Case, pers. comm.) and thus the potential for increased nutrient input to the pond is increasing.

Chemical contamination from forest pesticides can result from their use in the park, and from drift from aerial applications outside of the park. The significance of any such contamination would be dependent on the type and persistence of the pesticide used, and on the dose received within the aquatic system. The greatest potential for impact is in the southeast corner of the park, within the Western Newfoundland Forest ecoregion, where utilisation of forest resources is greatest.

Limited monitoring of Western Brook Pond has been conducted as part of an ongoing survey of selected world lakes (Kerekes, 1990). Results for Western Brook Pond indicate the absence of any significant effects on water quality. However, this data was obtained before the recent expansion of the boat tour facility, and ongoing monitoring is required to verify existing data.

Anecdotal data and existing evidence suggest that any environmental effects from anthropogenic activities on aquatic systems in GMNP are not significant. However, extensive monitoring is required in order to substantiate or refute this assumption.

b) Mitigation

Several actions could be taken to mitigate potential aquatic impacts. Better waste management practices need to be implemented. Existing landfill sites should be phased out and be replaced by a regional engineered landfill designed to prevent leachate from reaching surface or groundwater supplies. Alternatively, waste could be transported to the existing incinerator at Deer Lake. Educational campaigns aimed at waste reduction should be implemented in conjunction with provincial authorities.

The potential for contamination from pesticides can be reduced by eliminating their use in the park, and by encouraging alternative methods of pest control and forest management adjacent to the park. For example, selection cutting and maintenance of forest diversity can help to reduce susceptibility to widespread disease and insect attack (Perry and Maghembe, 1989). Such practices would also be beneficial in maintaining ecological integrity, forest habitat, flora and fauna.

4.6 Glaciofluvial Deposits

a) Significance

The loss of glaciofluvial deposits in GMNP due to aggregate extraction is significant. These deposits are distinctive landscape features, and elements of the natural diversity the park was established to protect. Glacial erosional and depositional processes were some of the dominant factors contributing to the present landscape mosaic of Gros Morne. The surficial sedimentary deposits provide opportunities for interpretation of glaciofluvial processes and the glacial history of the area. In a cumulative sense, the loss of these resources in Gros Morne is particularly significant because of the increased pressure on aggregate sources outside the park. The increasing demand placed on aggregate resources by industrialised society makes the protection of such resources within protected areas even more crucial. Also of notable scientific and heritage interest is the loss of Pleistocene shelly fossils contained in the alluvial deposits.

The federal-provincial agreement establishing GMNP made these aggregate resources available for park, provincial, and community needs as required. Their destruction clearly results in a decrease in the ecological integrity of Gros Morne. Further pressure will be placed on surficial deposits in the park because of proposals to reconstruct or upgrade portions of the park road system over the next twenty years. Further significant losses of glaciofluvial heritage features will occur if the status quo is maintained. Consequently, Parks Canada should reconsider how much natural heritage they are willing to sacrifice in order to meet federal-provincial commitments, when those commitments conflict fundamentally with the mandate of national parks, and with the original intent of establishing Gros Morne as one element of Canada's national park system. A full environmental assessment of aggregate extraction in Gros Morne should be conducted, including the implications of forecasted demand over the next fifty years on remaining surficial or bedrock deposits in the park.

b) Mitigation

Since the major glaciofluvial deposits in the park have already been largely depleted, mitigation of impacts there can only be in the form of rehabilitation. However, to prevent further cumulative effects, Parks Canada should establish a moratorium on any further aggregate extraction sites until alternative sources of material can be found. This should include any proposed expansion of the Rocky Barachois pit, where some surficial material remains north of the current pit, and on the east side of Rocky Barachois Brook. Rehabilitation of the existing site has been ineffective. Consideration could be given to creating a day-use area at this site with interpretive exhibits which illustrate the processes of glaciofluvial deposition, and discuss the increasing threats to the preservation of these deposits in modern society.

Perspective on this issue could be gained by considering the case of sand dunes. Once considered a prime quality resource to be mined for development purposes, dunes are now considered highly significant and worthy of protection. While less visible to the general public, glaciofluvial deposits are also worthy of protection for the reasons cited above. The perception of them as simply easily accessible sand and gravel deposits to be mined as needed must be altered.

The need for obtaining additional aggregate material can also be reduced by minimising the amount of new development within the park. Expansion of campgrounds could be reconsidered, as demand does not currently warrant their development. Further road construction and creation of vehicle turnoffs and parking areas should be kept to a minimum.

4.7 Scenic and "Wilderness" Resources

a) Significance

In 1987 GMNP was designated a UNESCO World Heritage Site, primarily for its outstanding, and globally significant geology, but also in recognition of the area's scenic beauty. Since the establishment of the park, the degree of anthropogenic environmental change in the area has been substantial. Within the front country of the park, particularly in the northern sector, it has become increasingly difficult to view large natural landscapes without the intrusion of some visually displeasing human elements. The most prominent features are the road and highway system, utility corridors, aggregate extraction sites, and smoke from the burning of waste at landfill sites. The new boat tour facilities at Western Brook Pond are a site-specific example of incongruous human elements in a wilderness environment, which are clearly visible from the tour boat and from the North Rim backcountry trail.

Providing access and accommodation facilities within a natural environment can set a precedent that often leads to incremental negative effects on aesthetic resources. By encouraging people to come and experience the scenic grandeur, a positive feedback process is initiated whereby an increasing number of visitors leads to the development of new or upgraded facilities to service visitor demands, which in turn leads to further increases in visitation. As development proceeds, the natural beauty that first attracted visitors becomes increasingly degraded. A good example is the intensive development and visitor use at Cavendish Beach in Prince Edward Island National Park (Keith, 1994).

b) Mitigation

Obviously the complete elimination of human features in GMNP is neither practical or desirable. However, a balance between environmental protection, and appropriate development sensitive to the natural context in which it is situated is required. A moratorium should be placed on further large development projects in wilderness areas, to prevent the type of site degradation that has occurred at Western Brook Pond. Future park facilities should be planned only after a comprehensive study has been conducted assessing the carrying capacity based on ecological protection principles.

Rehabilitation of degraded quarry and aggregate pits could help mitigate the visual impact of these sites. The minimal rehabilitation efforts undertaken at Cod Knox and Rocky Barachois pits have done little to temper the visual impacts. Planting of native species of trees, grasses and wildflowers would help to improve the visual characteristics of these degraded sites.

Table 4.1: Summary of Cumulative Stressors Relative to Key Park Resources

Key Resources	Cumulative Stressors
Natural Habitat	! forest harvesting (domestic and commercial) ! park infrastructure, campgrounds, day-use facilities and parking areas ! highway and road construction ! enclave community development ! aggregate extraction ! utility corridors ! moose browsing
Coastal Beach/Dune Systems	! historical logging and grazing ! infrastructure ! recreational use ! ATV use

Terrestrial Flora	! habitat loss or alteration ! OSV corridors ! recreational activity ! exotic species
Terrestrial Fauna	! habitat loss, degradation , and fragmentation ! snowmobile use ! disturbance due to recreational activity from hikers and dogs ! disposal of solid waste and fish offal (indirect effects on bears, terns)
Aquatic Systems	! contamination from fuel spills ! landfill leachate ! contamination from park sewage disposal ! pesticides (within park, and drift from forestry and utility corridors outside the park)
Glaciofluvial Deposits	! extraction for aggregate resources, from both inside and outside park boundaries
Scenic and "Wilderness" Resources	! park infrastructure and facilities ! roads and highways ! aggregate extraction sites ! utility corridors ! landfill sites (smoke)

Chapter 5: Environmental Monitoring

5.0 Introduction

Documentation pertaining to the causes and effects of previous natural and anthropogenic environmental change in GMNP is sporadic. Partial monitoring data has been gathered on some VECs, such as salmonids and caribou, while other environmental components, such as the arctic hare and black bear, lack any record of change. Still other components, such as lichens and aquatic flora, have yet to be inventoried. This lack of baseline information reduces the ability of park managers and researchers to predict or measure future environmental changes that may occur in response to natural or anthropogenic stress. The internal and external threats documented in this report have the potential to cause significant measurable changes in the park ecosystem. In order to understand both the natural and anthropogenic changes affecting park resources, and to be able to respond to those changes in an appropriate way, long-term monitoring programs are required.

Environmental monitoring has been defined by Davies (1990) as the "repetitive measurement of variables to understand and determine spatial and temporal changes in environmental quality". In order to identify reliable trends, a long-term commitment, involving substantial increases in both financial and human resources, must be made to establish monitoring programs that will continue for many years (Keith, 1994). Current and previous monitoring programs at GMNP have had limited continuity so that long-term repetitive measurements have not been obtained.

The goals for monitoring ecosystems within Canada's national parks were outlined by Woodley (1991) as follows:

> "1. To measure and detect changes in the ecological integrity or state of health of the ecosystem(s) that a given national park has been established to protect...
>
> 2. To measure the effects of perceived threats to the ecosystem(s) that a national park has been established to protect...
>
> 3. To provide data on the state of Canadian national parks to other national and international agencies and researchers conducting state of environment reporting or monitoring large scale environmental change...
>
> 4. To provide a data base that can be used for the preparation of a report on the state of national parks in Canada..."

All of these objectives apply to the recommended monitoring strategies for GMNP.

The draft PMP suggests the establishment of monitoring programs for almost every resource or identified threat. However, Woodley (1993) rejects this reductionist approach to monitoring because it is "costly and cumbersome". Instead he recommends an integrated monitoring approach which attempts to measure broad indicators of ecosystem integrity, combined with threat-specific monitoring to determine effects of known stresses. The integrated approach uses a system of hierarchical indicators (i.e. they measure changes at different levels of ecosystem organisation, from individual species to landscape change) (Woodley, 1993).

The integrated approach is still in the early stages of development (Woodley, 1993), and hence this report will focus on monitoring of specific resources known to be at risk from various threats identified in previous chapters. The major environmental components which require monitoring at Gros Morne are: natural habitat and human disturbance areas; coastal sand dune systems; flora and fauna; aquatic resources; and visitor activity.

5.1 Natural Habitat and Human Disturbance Areas

a) Previous Work

Good baseline data exists on the general boundaries of major existing habitat types in GMNP (Anions, 1994). This information has been entered into the park GIS and good vegetation and habitat maps are available. However, no change mapping has been conducted to reveal the extent and rate of habitat alteration over time.

b) Monitoring Strategies

The existence of intact, representative habitat is one of the principle gross measures of ecological integrity, since it measures change on a landscape level. Habitat loss and fragmentation due to human action can serve as indicators of ecosystem degradation. Meaningful measures of large scale habitat change need to assess the effects of disturbance both within and beyond park boundaries. Human influence in GMNP is largely confined to the lowland coastal areas, whereas outside the park human disturbance is more widespread due to commercial forest exploitation.

Monitoring the state of natural habitat can be accomplished by mapping habitat changes from aerial photography at frequent intervals. Updated aerial photography obtained at five year intervals is probably sufficient. Main habitat types should be distinguished (various forest and wetland types, dunes, heath, etc.) as well as areas of natural or human disturbance. Areas of human disturbance such as roads and facilities should include an adjacent impact zone, or zone of influence (Woodley, 1991). The various polygons defined on air photos can then be input directly into the park GIS, and comparisons with previous results can be made. These comparisons can yield a quantifiable measure of habitat change. Forecasts of future change can also be made based on proposed developments within the park and enclave communities, and forest harvest plans for domestic cutting blocks and commercial forestry in areas adjacent to the park.

Changes in forest ecosystem health due to domestic harvesting should also be monitored. The most obvious measure of these effects is changes in species diversity and abundance on harvested sites compared to baseline data or adjacent reference sites. Changes in natural diversity are one of the important indicators of changes in ecosystem integrity (Freedman et al., in press). Another significant parameter is nutrient losses, which may be manifest in increased stream runoff of nitrate, calcium, and potassium (Woodley, 1993). Chemical analysis of streamwater can be used to measure nutrient losses on a watershed scale. This may be an effective strategy for assessing the effects of commercial forestry in the Lomond and Trout River watersheds. For small scale domestic resource harvesting, changes in groundwater chemistry, particularly nitrate concentrations, could be measured through the use of lysimeters to estimate nutrient losses (B. Freedman, pers. comm.). Again groundwater and streamwater chemistry would need to be compared to baseline data or undisturbed reference sites.

5.2 Coastal Sand Dunes

a) Previous Work

The only work related specifically to sand dunes was conducted by Greenwood (1982). This work focused on rehabilitation work at Western Brook, but did not include any long-term monitoring programs. Regular aerial photography monitoring was recommended by Parks Canada (1985b), but has not been implemented.

b) Monitoring Strategies

Low level aerial photography flown at five year intervals will provide the necessary data to assess the degree of human disturbance and natural change occurring in the dunes. Pedestrian pathways and associated bare sand areas are indicators of dune stress that can be mapped and compared over five year intervals to asses the cumulative effects of any human abuse, and the effectiveness of dune crossing structures. Natural vegetation changes can also be compared in this manner in order to document succession and dune evolution.

If quantitative data on the volume of sand transport and deposition are desired, topographic maps of dune areas can be produced from aerial photographs using a stereo plotter. GIS analysis and modelling can then be used to accurately identify changes in dune morphology and spatial distribution.

General field observation could also be an important component of sand dune monitoring. Information gathered through the use of warden observation cards could help to identify new areas of human impact before the damage becomes severe. Preventative measures can then be implemented to reduce further impacts.

5.3 Flora

a) Previous Work

A number of isolated monitoring programs have been undertaken in the park, but no comprehensive programs have been initiated. A study by Deichmann (1991) established 10 random vegetation plots in areas of OSV use and 10 complementary control plots nearby but out of probable OSV corridors. This study was conducted in the Heather Pond - Big Pond area on the eastern slopes of the Long Range. Damage to woody vegetation occurring one metre or more above the ground surface was noted in 9 of the 10 plots and was suspected to be caused by OSVs. Follow up monitoring was recommended for 1993, 1996, 1999, etc., but was never done because of lack of funding. This program also has a low priority because it is generally felt that the impacts of OSVs on vegetation are not great (Deichmann, pers. comm.).

Vegetation plots were also established in saltmarsh vegetation in the spring of 1988 by Deichmann (1988) to monitor the effect of OSV use. These plots were re-visited at the end of the growing season, but subsequent yearly monitoring was not conducted.

The establishment of permanent vegetation sample plots has been recommended by Caines and Deichmann (1990), Munro (1993), and Anions (1994). Permanent plots for long-term vegetation monitoring have yet to be established. One of the reasons monitoring of this kind has not been conducted in the past is that there tends to be a lack of continuity of staff due to a high turnover of employees in the warden and resource conservation service (Deichmann, pers. comm.).

b) Monitoring Strategies

As recommended by previous authors, a series of permanent sample plots should be established in various representative habitats throughout the park. These plots should include reference sites that are unlikely to be disturbed by human activity, as well as sites in areas of known or suspected human impact. This two-tiered approach will reveal data on natural change or stability in the reference plots, and data on the nature and severity of impacts in the plots affected by human use.

Vegetation areas where human use should be monitored are: dune vegetation affected by pedestrian or ATV use; various vegetation types along proposed OSV corridors, including tuckamore, heath communities, wetland sites, and locations of rare plant distribution on Big Level (Bouchard et al., 1993, cited in Anions, 1994); vegetation along hiking routes, including James Callaghan, Green Gardens, and the Long Range with comparative plots of caribou trails; and rehabilitation areas around aggregate extraction sites.

General field observations should also be recorded where obvious vegetation impacts are apparent. Observations could include pedestrian damage to dune vegetation, OSV damage to tuckamore and heath communities, forest damage caused by hikers or campers, and natural disturbance events such as wind, fire, and insect damage. Observations of this nature could lead to the early identification of unpredicted impacts, or to the identification of areas in need of more detailed monitoring studies. The warden report forms currently used for wildlife observations could be adapted for this purpose.

5.4 Fauna

a) Previous Work

Mammals

Extensive long-term mammal monitoring has not been conducted at Gros Morne, although periodic monitoring of certain mammal species has occurred, and several monitoring programs have been recently initiated. The following is a discussion of the various species-specific programs that have been, or are currently being conducted.

1. Woodland caribou

Aerial surveys were conducted in 1976 and 1977, and the population for the park was estimated to be approximately 250 animals in the winter, and 500 animals in the summer (Baird, 1985). Recent estimates made by the Newfoundland Wildlife Division (NWD) for the major herds are: 1,429 in the Northern Peninsula herd (1994); 1,999 in the Humber River herd (1989); and 330 animals for the Gregory Plateau herd (1987) (Mawhinney, pers. comm.).

Several caribou monitoring and research programs have been implemented in the park, although none were long-term. In 1978 and 1979 a calf tagging program was carried out involving a total of 33 calves, although follow-up monitoring was not conducted due to lack of funding (Baird, 1985). A cooperative radio telemetry monitoring program between GMNP and the NWD was initiated in 1980 and continued for four years. A total of 20 caribou were collared in GMNP (10 in 1980, and 10 in 1982), and 15 were collared in the Cat Arm area north of GMNP by NWD in 1981 (Baird, 1985).

A caribou monitoring study has been underway since 1992. Currently, ten caribou are tracked by satellite using ARGOS collars, and 35 animals are tracked using conventional VHF telemetry (A. Moreland, pers. comm.). The satellite transmitters are equipped with motion activity sensors, and thus a large volume of data is gathered on caribou behaviour. The VHF transmitters are mostly found on calves and are used primarily for distribution and mortality statistics. The caribou-OSV reaction study is being conducted in conjunction with this program. None of the data from this program has been analysed.

2. Black Bears

Very little is known about the black bear population or behaviour in GMNP. No detailed surveys of population, sex ratios, feeding or denning areas have been done (Brunt, 1987). Wildlife observation cards have been used to record anecdotal information since 1976, although reporting has been sporadic so the data is unreliable (Brunt, 1987). Most sightings are recorded near roads or garbage dumps, with very little knowledge of backcountry activity (A. Moreland, pers. comm.).

Currently six bears are collared with conventional VHF transmitters. This is part of an ongoing cooperative research project with the NWD, being conducted by a graduate student and park staff.

3. Arctic Hare

It is estimated that there are 500 km^2 of available arctic hare habitat in Gros Morne. The population in the park is unknown, but the estimates range from 25 to 500 (based on an estimate of an average habitat requirement of 1 km^2 per animal). The only monitoring to date has been personal observation by wardens. This tends to be biased toward the OSV trail areas which are regularly patrolled. Tentative approval has been granted for a two year arctic hare inventory study utilising pellet and winter track transects. The program is designed to gain an understanding of population, distribution, and ecology of arctic hare. (Moreland, pers. comm.)

Arctic hare are difficult to monitor with conventional radio telemetry because they are very sensitive animals prone to extreme stress and shock when handled (Deichmann, per. comm.). One experimental collar was placed on an arctic hare in 1993, but the animal was able to chew it off (Moreland, pers. comm.).

4. Moose

A four year cooperative study is to begin this year between GMNP, and the NWD which will collar six moose with GPS transmitters (A. Moreland, pers. comm.). These transmitters will yield a large quantity of data on moose activity and habitat use. In conjunction with this data, park wardens will be conducting browse and pellet surveys, and using moose exclosures to help gain an understanding of moose impacts on vegetation and carrying capacity.

Avifauna

A number of bird surveys are currently being conducted in the park. They are as follows:

1. Maritime Shorebird Surveys

Approximately 100 surveys were conducted between 1989 and 1993. Surveys are continuing in 1994. Analysis of the results indicates that there has been a significant decline in the total number of shorebirds counted during the time of the survey (Deichmann, 1993a). It is unclear as to whether this reflects a true population decline, or whether it may be due to survey factors such as observer bias (time of survey), and climatic factors such as wind.

2. Christmas Bird Counts

Christmas bird counts are conducted at two localities adjacent to the park: St. Paul's Inlet, and Bonne Bay.

3. Breeding Bird Surveys

The St. Paul's route breeding bird survey (BBS) has been conducted nine times between 1974 and 1994 in accordance with Canadian Wildlife Survey guidelines. The number of species and individuals counted are given in Table 5.1.

Table 5.1: St. Paul's Breeding Bird Survey Results, 1974-1994
(Source: Deichmann, 1994).

Year	**Species**	**Individuals**
1974	41	908
1975	38	712
1981	29	842
1982	46	1454
1983	40	1585
1984	40	927
1992	45	807
1993	47	586
1994	54	372

A second BBS route was established in 1992 in the Lomond area by Jacques Whitford Environment (1993) as part of the park avifauna inventory. A total of 54 species and 2,706 individuals was recorded during two coverages of the route in June, 1992. This route was not accepted by the CWS, and it will not likely be repeated (Deichmann, pers. comm.).

4. Breeding Bird Transects

In addition to BBS, three transects were also established by Jacques Whitford Environment (1993): Western Brook transect; Pond Point transect; and Southeast Brook transect.

5. Breeding Bird Sample Plots

Breeding bird plots have not been surveyed repeatedly in GMNP. However, a sample plot was established by Lamberton (1976, cited in Jacques Whitford Environment, 1993) at Candlestick Pond, which should be resurveyed to provide data on changes in population abundance and diversity.

6. Spring Waterfowl Surveys

This survey simply uses standard forms to record observations of waterfowl species and numbers on easily accessible waterbodies in the park (i.e. those adjacent to, or near roads). It was initiated in 1993, and will be repeated in 1995 (Deichmann, pers. comm.).

Fish

Monitoring of fish populations has been accomplished through the use of fish counting fences on Western Brook and creel censuses. The fence in Western Brook was removed in 1991, due to smolt mortality and poaching at the fence (Deichmann, pers. comm.). Current salmon catch statistics are monitored through a licensing and tagging program, and a voluntary creel census was instituted in 1989 for all other freshwater fish species (Parks Canada, 1990).

b) Monitoring Strategies

The existing mammal monitoring programs should begin to yield important data on the demographics of target species within the park, and should be prolonged. Extensive winter track or scat transects have not been carried out but could prove valuable in gaining more insight on animal activity and habitat use. These methods could be very effective in gaining a better understanding of arctic hare populations. Bait stations could also be used to monitor marten, mink, and coyote (Deichmann, pers. comm.). Information on coyotes will become increasingly important in order to determine the status of this colonising species, and to understand the effects on potential prey species such as caribou and arctic hare.

Existing avifauna surveys are beginning to yield long-term data, and should be continued. Monitoring of tern-gull interactions should be continued on a regular basis. Monitoring of harlequin duck breeding activity should be a priority, and effects of disturbance by human activity should be observed. Any effects of the Western Brook Pond boat tour operation on breeding harlequin ducks should be monitored by direct observation.

Current angling regulations yield useful catch and effort data for salmon, which can be used to estimate population status. Mandatory tagging procedures should also be implemented for trout and char angling. Continual monitoring of other environmental factors, both natural (beaver activity, detritus, and log jams) and anthropogenic (riparian damage due to overuse, pollution from privies, river debris from logging, logging adjacent to streams and ponds) was recommended in the salmonid management plan (Parks Canada, 1990). Monitoring of these factors can be achieved through simple observation, using warden observation cards and occurrence reports. However, naturally occurring log jams and beaver activity should be tolerated as an element of natural evolution within aquatic systems.

5.5 Aquatic Systems

a) Previous Work

Very little water quality monitoring has been conducted in GMNP, with the exception of the Harding's Pond site. Since 1989 Harding's Pond on the Long Range plateau has been monitored as an LRTAP (long range transport of air pollutants) site. Data on lakewater pH, benthos, and fish populations is gathered yearly. Over the 5 year period since monitoring began the pH has slowly risen which is indicative of postulated declines in acid precipitation in the region, and is consistent with other records in Newfoundland (Ryan, 1993). The abundance of benthic organisms is low, and no trends have yet been established. The fish studies indicate a significant decline in the population of arctic char, with small but stable populations of atlantic salmon and brook trout (Ryan, 1993). However, since fishing is allowed in this pond, the decline does not yield any accurate information about the response of the fish populations to environmental factors.

Water quality was conducted in Western Brook Pond in cooperation with the Inland Waters Directorate during the construction of the boat tour facility. Hydrocarbons, heavy metals, and oxygen were monitored, and no significant impacts were identified. Some monitoring has also been conducted in Western Brook Pond as part of an ongoing study of selected world lakes (Kerekes, 1990).

b) Monitoring Strategies

Monitoring of anthropogenic influences on water quality needs to be established in GMNP. In particular, potential effects of leachate from landfills, nutrient enrichment from privies and sewage systems, contamination from operational and accidental fuel releases in Western Brook Pond and Trout River Pond, changes in sediment load due to disturbances such as clearcutting, and contamination from pesticide applications need to be assessed.

A number of monitoring wells should be established around the Lomond landfill to determine the effects of leachate on groundwater quality. A streamwater survey should also be conducted, especially during periods of high runoff, in order to determine whether flushing of large volumes of leachate is occurring. During any provincial forest or utility corridor spraying programs, event monitoring should be conducted in areas where water quality might be potentially affected. Sampling should include baseline data collected prior to the spraying event.

Addition of contaminants to the aquatic system over time can also be monitored through the use of aquatic sediment sampling. Sediment cores taken from depositional areas near the landfill, upstream and downstream sites, can be analysed to provide an indication of long term buildups of heavy metals arising from landfill leachate.

Any persistent increase in nutrient inputs to freshwater lakes and ponds may result in eutrophication. Changes to a more productive state are of particular concern in the oligotrophic fjord ponds and waterbodies on the Long Range plateau. To monitor for changes in trophic state, measurements of water clarity can be obtained using Secchi disc measurements, or water samples can be analysed for total chlorophyll or total phosphorous concentration. Secchi disc measurements should be taken in Western Brook Pond, Harding's Pond, and Ferry Gulch Lake to monitor for changes in trophic state related to increasing use of pit privies. Water samples could also be analysed for coliform bacteria. Measurements should be taken in the spring, summer, and autumn to assess seasonal variation.

Ongoing water sampling for hydrocarbons should also be conducted in Western Brook Pond to determine the effectiveness of fuel-spill prevention and mitigation measures.

Secchi disc measurements and analyses of total suspended solids should also be taken in areas likely to be affected by increased sediment loading from nearby terrestrial disturbances. Commercial logging activity, aggregate extraction activities, and road and facility construction are the primary disturbances to be considered.

5.6 Visitor Activity

a) Previous Work

Statistics on visitor activity in GMNP are routinely gathered. These include the number of visitors entering the park (calculated by a formula based on number of vehicles), the number of visitors at the Visitor Reception Centre, number of party nights at all park campgrounds, number of passengers on the boat tours, and number of hikers on the main park trails.

In addition, a snowmobile monitoring program using electronic counters was implemented in 1993 in an attempt to gather information on the number of snowmobilers using the park. (Reid, 1994; Simpson, 1993). However, the effectiveness of this program has been limited due to problems with the accuracy of the counters, and with the extensive use of alternate trails by OSV users where no counters exist.

b) Monitoring Strategies

The existing monitoring of visitor activity in the park should continue, and yearly analysis of this data should be conducted in order to establish reliable trends. This information should be widely distributed to resource managers in the park.

Attempts to monitor snowmobile activity should continue, using both electronic counters, and extensive personal observation. OSV track transects should be conducted in an effort to determine general numbers and extent of snowmobile use in the park. If official OSV corridors are established special attention should be paid to the level of adherence to these corridors. Occasional aerial monitoring flights should be made during the snowmobile season, in conjunction with the telemetry flights for mammal monitoring.

Chapter 6: Conclusions and Recommendations

6.0 Cumulative Effects Assessment

The following conclusions pertaining to cumulative effects and cumulative effects assessment are modified from Keith (1994):

1. Cumulative effects result from one of (or a combination of) two situations: the repetitive occurrence of a single stress acting on an ecosystem; or two or more different stresses acting on the same ecosystem. Cumulative effects occur when one stress is applied before the system can fully recover from the previous or coincident stress.

2. A number of individually insignificant actions can collectively result in significant cumulative effects, through simple additive, or complex synergistic processes.

3. Traditional EIA procedures have tended to ignore cumulative effects.

4. Addressing cumulative effects requires a new assessment context. CEA procedures must adopt larger spatial, temporal, and disciplinary boundaries.

The following recommendations for conducting CEAs are re-stated from section 2.2d:

1. Due to the spatial complexity of cumulative effects, an ecosystem approach must be adopted, and indicators of environmental health and ecosystem integrity must be identified.

2. Due to the temporal influence of cumulative effects, past and present developments and activities must be documented and considered along with foreseeable future initiatives.

3. Ecosystem responses to previous and ongoing developments and activities must be understood as well as data allows. Lack of baseline data and historical monitoring hinders this process.

4. Environmental attributes, existing development and land use, and societal goals should be used to define permissable levels of development activity.

5. Ideally CEA will be conducted in relation to a regional land use plan developed as part of the process. This may be complicated by political and jurisdictional issues.

6. Continuing scientific investigation and ecosystem monitoring should be carried out in order to increase understanding of ecosystem processes, and to test the validity of

previous and ongoing mitigative strategies and assumptions about ecosystem responses to stress.

7. Analytical tools such as GIS, aerial photogrammetry and satellite imagery, and computer modelling should be used to gain insights into system behaviour and cumulative environmental change.

6.1 CEA and Parks Canada

Conclusion:

1. Parks Canada will be obliged to consider the cumulative effects of any new proposals when the new CEAA is proclaimed (expected in January 1995).

Recommendation:

1. Given Parks Canada's mandate of maintaining natural heritage unimpaired for future generations, assessment of cumulative environmental effects should receive a high priority in national parks to ensure the long-term protection of heritage resources.

2. CEA in national parks should be conducted in the context of Parks Canada's legislated mandate which gives the maintenance of ecological integrity primacy over other issues.

6.2 Cumulative Effects at Gros Morne National Park

Many individual stressors, both inside and outside the park boundaries, were identified which contribute to cumulative effects. The most significant cumulative impacts are:

1. Habitat loss, alteration, and fragmentation. Habitat in the coastal and lowland forested ecosystems of the park area has been dramatically affected by large landscape disturbances such as highway construction, park facility development, community development and aggregate extraction, and by smaller disturbances such as domestic forest harvesting, and recreational activity. Beyond the park boundary, commercial forestry is a major cause of landscape change.

2. Loss of glaciofluvial deposits. The destruction of these resources for aggregate use is particularly significant when considered cumulatively with the pressure placed on similar resources outside park boundaries. Other than remote or inaccessible sites, protected areas are the only places where these kinds of heritage resources are likely to be preserved.

3. Aesthetic degradation. The outstanding scenic beauty of Gros Morne is being

compromised by the nature and intensity of development. Visual impacts are most significant in the park "front country", and in the "wilderness" zone at Western Brook Pond.

Other important cumulative impacts of lesser or unknown significance are:

1. Water Quality. Limited information is available on water quality impacts due to a lack of monitoring, but the existing evidence suggests that cumulative impacts are not significant. However, several sources of potential aquatic contamination remain to be addressed.

2. Degradation of Sand Dune Systems. Destabilisation of sand dunes has occurred due to historical land use. Dunes are stabilising, but some human disturbance remains, and the potential for increased disturbance exists.

3. Recreational Effects on Terrestrial Flora and Fauna. Trampling or other damage to vegetation, and disturbance to wildlife has been caused by recreational use. Of particular concern is the potential effects of snowmobile use on the Long Range plateau.

Recommendations pertaining to the mitigation of cumulative effects are:

1. Sustainable harvesting practices must be implemented in the domestic harvest blocks. Management must be sensitive to the need to preserve biodiversity, and to maintain the natural processes of forest succession.

2. Strictly protected corridors should be established between remaining habitat fragments in the coastal plain and lowland forests.

3. Loss or alteration of habitat must be minimised. Of special concern is habitat for rare plants, endangered species, and other sensitive species. Because of significant current losses, any further loss or fragmentation of the coastal and lowland forest habitat in the park must be prevented.

4. Currently degraded areas should be restored. Native vegetation should be established to prevent colonisation by exotic species.

5. Further infrastructure development should not be permitted in sand dune areas, and education and interpretation efforts should focus on increasing visitor awareness of the fragility of dune ecosystems.

6. Management intervention should be considered to minimise the effects of invasive plant

species.

7. Further research needs to be conducted on the effects of snowmobile disturbance or harassment on wildlife.

8. Dogs should be prohibited from park trails to prevent disturbance and mortality of young ptarmigan, arctic hare, and other small mammals.

9. Domestic snowshoe hare harvesting should continue. However, an assessment of the impact of snaring on non-target animals (mink, fox, marten if any are present) is required.

10. Waste management facilities in the park and in the enclaves need to be improved to reduce the availability of human garbage to wildlife (particularly bears and gulls), and to reduce the potential for aquatic contamination. A new engineered landfill, or removal of garbage to Deer Lake are the main options. More effective community recycling and composting programs are also needed.

11. The use of pesticides in the park should be eliminated, and alternative methods of pest control should be encouraged outside of the park.

12. No new aggregate extraction sites should be developed within the park. Expansion of the Rocky Barachois pit should not be permitted. A full environmental assessment of aggregate extraction and future aggregate demands should be undertaken as soon as possible.

13. Existing aggregate extraction sites should be rehabilitated to higher standards. Consideration should be given to using the Rocky Barachois pit as an interpretive site to discuss glaciofluvial deposits and resource exploitation in modern society.

14. A moratorium should be placed on further large development projects in the park, and particularly in wilderness areas. Future park facilities should be planned only after a comprehensive study has been conducted assessing the need for the facility, and the carrying capacity of the area based on ecological protection principles.

6.3 Monitoring

In order to determine the effects of various stresses, and to understand the rate and magnitude of natural and human-caused environmental change in Gros Morne, long-term monitoring programs need to be established. The conclusions of this study with respect to monitoring are:

1. Previous monitoring efforts in the park have been sporadic, and have been primarily

focused on single species studies.

2. Monitoring programs designed to provide accurate long-term data on the ecological integrity of Gros Morne require a long-term commitment from park management. Current financial and human resource commitments are inadequate to sustain such programs.

The following monitoring programs are recommended for Gros Morne:

1. Changes in the amount of specific habitat types should be used as an indicator of ecological integrity at the landscape level. Habitat changes should be mapped from aerial photography obtained at five year intervals.

2. Monitoring of species diversity should be conducted in areas of forest disturbance (domestic harvest blocks, campgrounds, development areas) as a measure of forest ecosystem integrity.

4. Site nutrient losses may occur due to forest harvesting activity. Monitoring for site nutrient depletion should be conducted in domestic harvest blocks using lysimeters, and in the Lomond and Trout River watersheds using stream water chemistry.

5. Sand dune degradation should be monitored through the comparative analysis of aerial photography flown on five year intervals. General field observation may also be effective.

6. Permanent vegetation plots should be established in various plant communities throughout the park. Monitoring sites should include areas of known and potential impact, and areas unlikely to be affected by anthropogenic activity.

7. Existing mammal monitoring programs should be prolonged to yield long-term data. Special emphasis should be placed on monitoring the effects of OSV use on caribou.

8. Winter track and scat transects should be conducted to provide further information on animal distribution and habitat use. Transects might be very useful in gaining knowledge of the arctic hare population.

9. Monitoring of coyote activity will become increasingly important as this species begins to colonise the park area. Track and scat transects, bait stations, and telemetry are possible monitoring methods.

10. Existing avifauna and fish surveys should be continued.

11. Groundwater wells, streamwater chemistry, and aquatic sediment sampling should be used to assess the effects of landfill leachate on water quality.

12. Stream water sampling should be conducted on an event basis if any pesticide spraying programs are conducted near park boundaries.

13. Secchi disc monitoring, and water sampling for coliform bacteria, should be conducted in Western Brook Pond, Harding's Pond, and Ferry Gulch Lake to test for bacteriological contamination from toilet facilities.

14. Secchi disc and total suspended solids measurements should also be taken in areas subject to sediment loading from adjacent landscape disturbances.

15. Existing visitor monitoring in the park should continue. Special emphasis should be placed on refining the techniques used in previous seasons to monitor snowmobile activity.

6.4 Addressing Cumulative Effects During Project Specific Assessments

The concept of CEA implies that even effects that are considered to be relatively insignificant at a project level, may be significant in an ecosystem context over the long-term. Thus all stresses acting upon a particular resource or ecosystem must be considered in the context of other previous or ongoing stresses that may also affect the same resource. As Parks Canada is concerned principally with protecting natural heritage "for all time", the importance of addressing the issue of cumulative effects cannot be understated.

When Parks Canada is assessing future project-specific proposals, the assessor must be cognisant of cumulative effects, and of the potential of the project to further augment existing effects. The park database and GIS will be important tools in this process. Important parameters that can be analysed through the use of GIS include habitat loss and fragmentation, human disturbance areas, recreational use, species diversity and distribution, and water quality parameters. Information on environmental change can be added as it is acquired through inventory and monitoring studies.

This report can serve as a basic reference source for information on existing sources of stress and resources of concern in GMNP. Additional work remains to be done to quantify and determine the significance of certain environmental effects. As more information is acquired, an updated database on documented stressors and associated effects should be developed which can be referred to in assessing the cumulative effects of future development proposals.

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