A SPATIAL ANALYSIS OF TOURISM DEVELOPMENT ON HECLA ISLAND IN RELATION TO KEY ENVIRONMENTAL COMPONENTS

by

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A Thesis

Submitted to the Faculty of Graduate Studies

In Partial Fulfilment of the Requirements

for the
Degree of

MASTER OF ARTS

Department of Geography

University of Manitoba
Winnipeg, Manitoba

THE UNIVERSITY OF MANITOBA

FACULTY OF GRADUATE STUDIES

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Abstract

This study was initiated to trace development of tourism on Hecla Island. The focus was to first discuss the role of tourism within Hecla's environment, including the positive and negative impacts. The research also characterized past development on Hecla Island by documenting and quantifying the land affected by these developments. This provided essential information that can be used to assess the quality of land within these areas in order that appropriate decisions can be made on location of future developments. Secondly, an analysis was undertaken to map key environmental components on Hecla Island, including moose and waterfowl habitats, colonial nesting bird sites, significant cultural sites, unique plants and vegetation, and the soil and recreation suitability of the area. This included determining the potential consequences of tourism development on the key environmental components on Hecla Island. The final step was to spatially illustrate areas where future tourism development should be expanded by considering the degree of impact that tourism development and associated activities have on the key environmental components on Hecla Island.

Results indicate that the use of the Geographic Information System is an effective tool for the integrated management of resources on Hecla Island, and is efficient in the organization and analysis of data. The Ultimate Environmental Threshold (UET) method is a powerful technique that also aided in the analyses by organizing the data, providing methods to process the data, and formulating rules for targeting areas sensitive to tourism development and activities on Hecla Island. The final products of the study

are maps illustrating considerations for future development for airstrips, primitive hiking areas, roads, snowmobile trails, cross-country skiing and snowshoeing trails, and recreational hiking areas. The areas that were targeted were based on the sensitivity of the key components of the environment, which were divided into the vegetation/terrain component (vegetation status, land modification, significant plants and unique natural and cultural features, and land use) and the wildlife component (waterfowl significance/sensitivity, significant/sensitive colonial nesting species sites, and significant/sensitive areas for moose in winter and summer). For expansion of intensive recreation developments and campground areas on Hecla Island, a soil and recreation suitability component was added to the vegetation/terrain and wildlife components to further narrow down the areas suitable for expansion. This demonstrated how the precision of the system could be increased with the inclusion of additional datasets to the study. Although the final maps indicate areas that should be considered for expansion of various tourism development on Hecla Island, it is stressed that detailed site investigations should be undertaken before development takes place.

Acknowledgements

I would like express thanks to my advisor Dr. M. Benbow for assisting in this project, and to my committee of Dr. R. H. Foster, and Dr. R. K Baydack for reviewing this thesis.

I also appreciate the help of the staff at the Manitoba Land Resource Unit for the use of data and computer equipment.

Finally, I want to express my sincere appreciation to my wife Shelley and children Alexa and Jadon for their patience and support throughout the completion of my thesis. I promise I will try to recover every minute that could have been spent with all of you.

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Chapter 1 - Introduction

1.1 Background

"Canadian wilderness areas are disappearing at an ever increasing rate. The WWF report on the status of efforts to protect wilderness in 1992 found that Canada was losing at least 1 km^2 of wilderness every hour. In the 10 provinces, nearly 60% of land has been claimed for development. Less than 3.8% of the country's productive forest lands are found in the national and provincial park systems" (Dearden and Rollins, 1993, p.5). The role of provincial parks, as stated in the Provincial Park Lands Act, is for the conservation of flora and fauna, and for the preservation of geological, cultural, and ecological interests, as well providing enjoyment and recreational opportunities for the people of, and visitors to Manitoba (Department of Natural Resources, 1985). Parks were established to set aside lands that are free from human exploitation. However, the constant pressure from developers, as well as the demands by the typical tourist, is fragmenting the landscape and competing for lands that are valued for wildlife, and unique in terms of vegetation and aesthetic appeal. If this rate of development continues in parks, there will be nothing that separates parks from other developed areas.

Protecting parks from too much development is difficult since tourism depends on the environment, while the environment is susceptible to the impacts of tourism (Wong, 1993). The goal of achieving the delicate balance of protecting the environment within a park, while also promoting tourism, requires that limits to development are instituted and maintained.

Increased concern for the environment and the exploitation of finite natural resources have prompted public sensitivity to the loss of wilderness areas, with survey results suggesting that in the industrialized world, 85% of people state that the number one world issue is the environment. Even during recessionary times, the belief is that environmental management should be governments' top priority, even if it is at the expense of development (Wight, 1993). It is in our best interest to protect parks and wilderness areas since the maintenance of the natural diversity of the Earth is critical for the survival of our planet's economy (Dearden and Rollins, 1993).

1.2 Research Problem

Over the past three decades, tourism has provided the main impetus for a number of developments that have modified the natural environment of Hecla Island. Most of the investment has been directed towards providing facilities in order to attract more tourists into the region. Like many other tourist developments, there has been a lack of effort directed towards understanding the effects of development on the surrounding environment, and the associated conflicts. The main goal of this research is to develop a spatial decision support system that provides crucial information on key environmental components on Hecla Island to enable informed evaluations on where future tourism development should take place. The intent is also to develop the system as a model whereby the methods and analyses can be employed as a decision making tool in many environments.

1.3 Research Objectives

The objectives of this study are:

1. To review the literature to identify the role of tourism development in Hecla Island's environment. By focussing on the conflict between development and conservation, the impacts of tourism on key environmental components will be evaluated. Methods to analyse the resulting environmental problems will also be reviewed.

2. To devise a methodological framework that simplifies the classification of wildlife habitat, vegetation, soils, land use, and recreation data in order to formulate analytical techniques and modelling of the data to support the decision making process and guide future development on Hecla Island.

3. To develop a list of activities and developments that result directly from tourism and investigate the relationship between them and the key environmental components on Hecla Island. This information provides an important input into the analyses because these relationships determine the criteria for defining ultimate environmental thresholds (UETs) to developments and activities (i.e. which environmental components create thresholds to particular developments and activities, and why). The relationships are classified as follows:

i) The role of the resources

ii) The impacts of developments and activities

iii) The sensitivity of resources to the impacts

iv) The potential consequences of development and activities

4. To discuss the key issues and conflicts concerning past and current development on Hecla Island, while documenting, through GIS analysis, the characteristics and quality of land affected by these developments including the vegetation, soil, and land use components; land modification; vegetation status (uniqueness) and presence of significant plants and unique natural and cultural sites; moose significance/sensitivity in summer and winter, waterfowl significance/sensitivity, and significant/sensitive colonial nesting species sites; recreation capability, soil suitability for recreation uses (paths/trails and camping areas), and soil suitability for engineering uses (roads and buildings).

5. To produce maps of each of the above layers and overlay them within the GIS to facilitate the development of thresholds maps for each of the selected developments and activities on Hecla Island.

6. To Utilize the UET method to generate scenarios that illustrate potential areas that are suitable for expansion of tourism development and activities on Hecla Island. This will be illustrated by interpretive maps for each activity or development that target the following:

1. Areas that are considered suitable for development

2. Areas that are considered suitable for development, but the activities and developments are high impact and thus have to be carefully controlled and managed

3. Areas that are considered exclusion zones since the activity or development may have impact on the unique, sensitive, or key environmental component

1.4 Assumptions

This thesis is based on the acquisition of existing data from files, reports, and digital databases. Although some field work took place in the form of surveying vegetation types and utilizing GPS to check the locations cultural features, there were no detailed examinations.

- It is important to recognize the differences in scale of the data provided in this thesis. All point locations are site specific and are entered as either latitude/longitude or Universal Transverse Mercator (UTM) Coordinates. Most of the derived maps are based on detailed Forest Inventory Maps (FRI) at a scale 1:15,480 (4 inches to 1 mile). The soils were mapped at a scale of 1:126, 720 (1 inch to 2 miles), and the recreation classes mapped at a scale of 1:250,000. Since the information on the soils and recreation maps is portrayed at a reconnaissance level, the data was used as an example of how the UET analyses could be expanded to include ancillary layers of information for a more precise appraisal of

the land for future development. Further research could extend this capability by providing detailed analyses of the soils for specific uses, and the recreation capability or aesthetic appeal of an area.

- Some of the names and exact locations of rare plants and nesting birds could not be disclosed to protect the sites from human interference.

- Soil interpretations are based on the major soil occurring within an enclosed area (polygon), while there sometimes may be up to three soils present.

- The primary goal of this research was to study unique plants, vegetation, landscape features, and important wildlife in the region including moose, waterfowl, and colonial nesting birds, all of which are critical in attracting tourists to Hecla Island. Therefore, no attention has been paid to other wildlife species that may not be as appealing to tourists, but are important in maintaining the bio-diversity of the Island. This could be a subject of further study.

- The study looks specifically at land resources. Further research could examine effects of water-based activities and development of aquatic ecosystems.

- The interpretations provided in this study are to be used as a general guide for targeting areas where certain tourism development and activities can take place.

The next step requires more detailed examination of the land base to determine suitability of the area.

- The structure of data within the GIS database allows users to customize their requests, provided there is support through new information or data.

Chapter 2 - Study Area

2.1 Introduction

Hecla Island is part of Hecla Provincial Park, which is located 190 kms north of Winnipeg and can be reached by Provincial Trunk Highway #8 north and Provincial Road #233 east (Figure 2.1). The area was set aside as a provincial park in 1969, and encompasses Hecla, Black, Deer, Punk, Little Punk, and Goose Islands, occupying 85,310 hectares of land and water (NRD, 1979). The region has a diversity of plant and animal life, and an attractive natural landscape including rugged limestone cliffs, vast marshes and forests, various rare plant species, a thriving moose population, cormorant nesting colonies, and an abundance of recreational opportunities (McConnell, 1986). In addition, the Hecla Island town site is a remnant of an Icelandic settlement that once flourished on the island, having been established upon their arrival in 1876. Gull Harbour, located on the north eastern tip of Hecla Island is the most developed part of the island and is the site for most of the recreational facilities, while the rest of Hecla Island is supposed to remain in an as natural state as possible (DNR, 1988) (Figure 2.2).

In 1988, the Department of Natural Resources (DNR) completed a management plan for Hecla Provincial Park to settle potential conflicts over preservation of natural areas, commercial use of some natural resources, and recreational use in the park (DNR, 1988). According to the plan, Hecla Provincial Park will:

Figure 2.1 Location of Hecla Island Source: MNR - Parks and Natural Areas (1994)

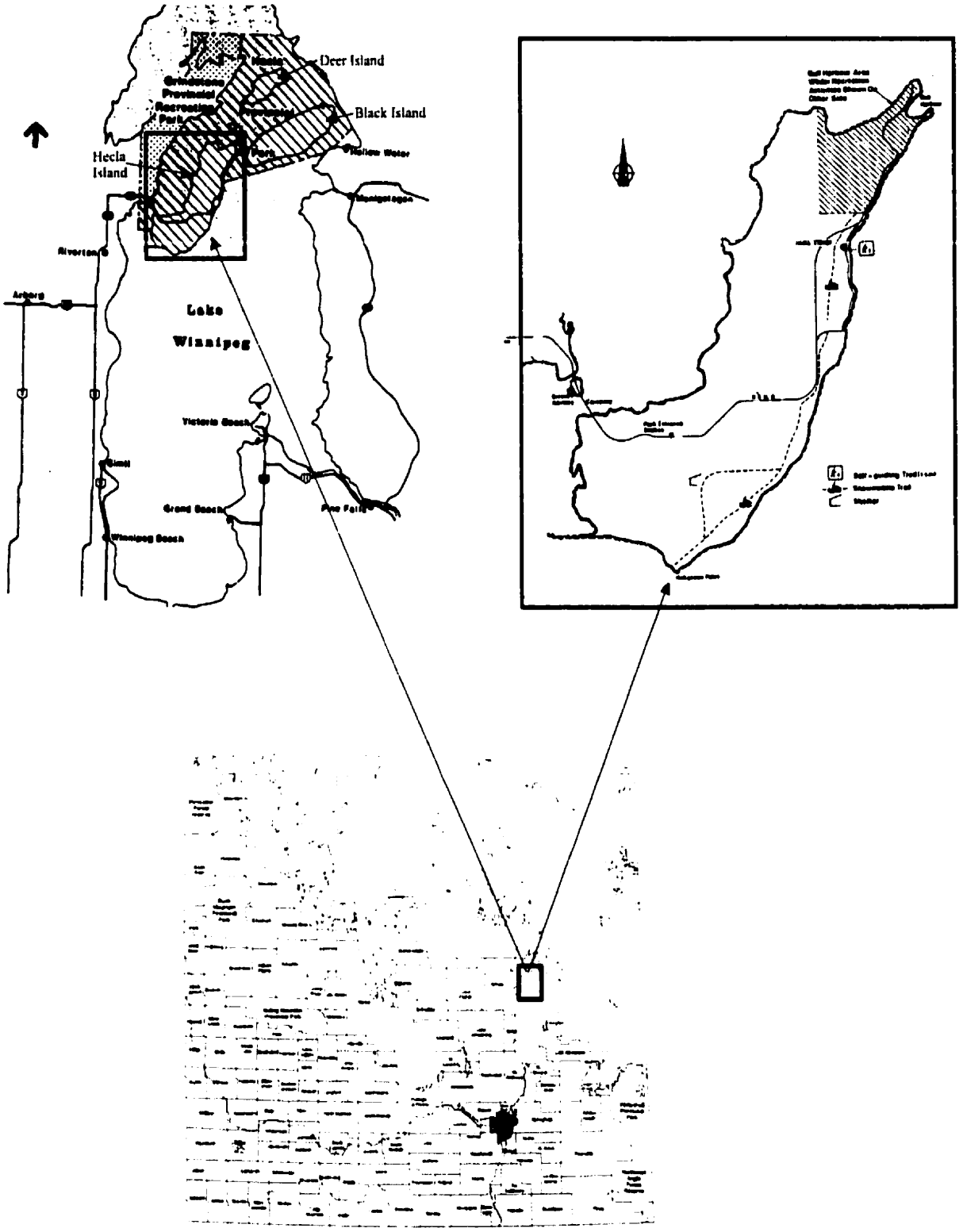
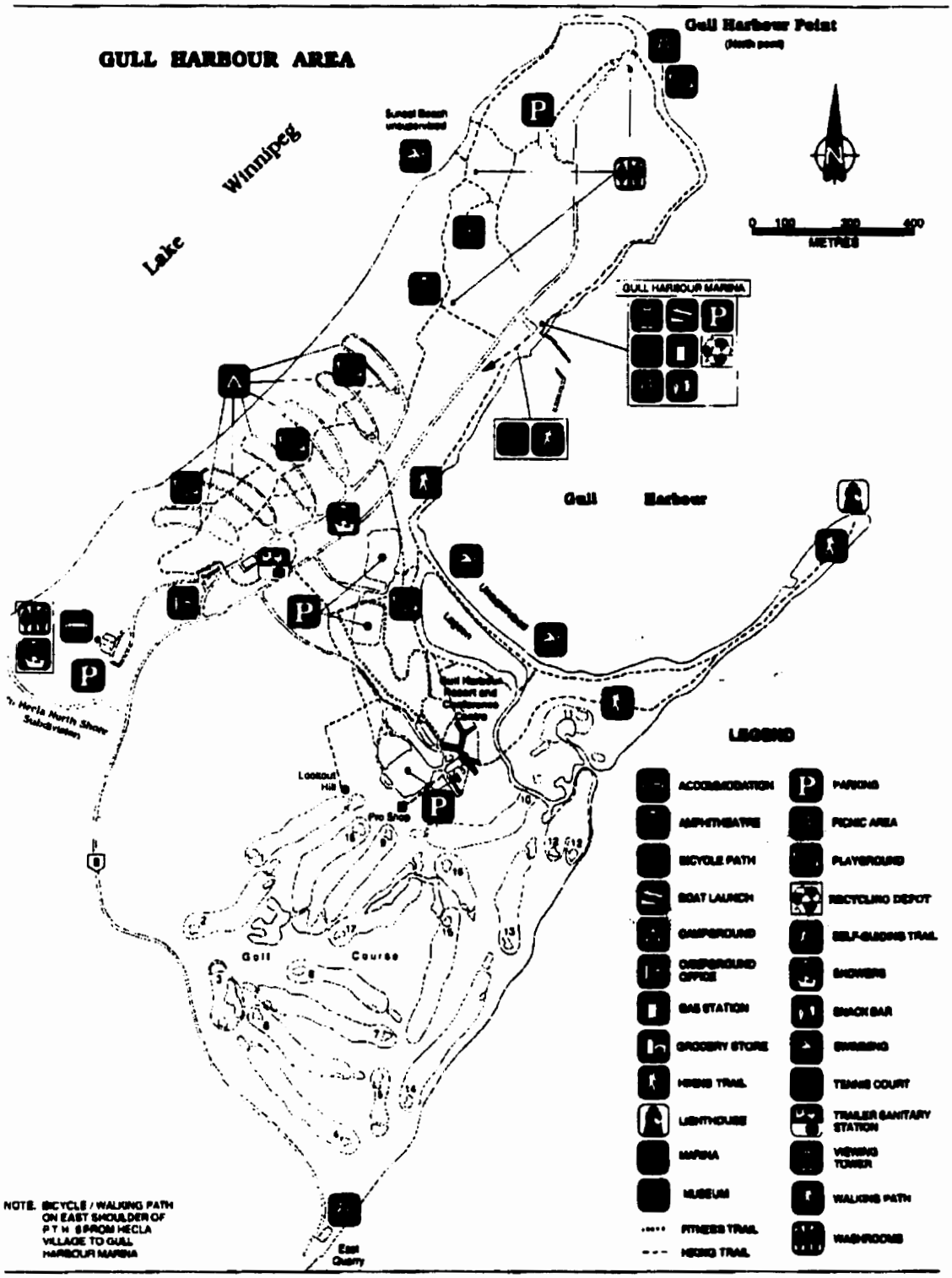


Figure 2.2 Gull Harbour Source: MNR - Parks and Natural Areas (1994)



i) "represent and conserve the flora, fauna and geology of the Manitoba Lowlands and associated "inland sea" image;

ii) reflect and preserve Icelandic cultural history;

iii) reflect and preserve Native cultural history;

iv) provide a range of accommodations from high-quality resort to primitive campsites;

v) enhance the water and marine-based recreational opportunities of this part of Lake Winnipeg; and

vi) provide a refuge for moose and colonial nesting birds" (DNR, 1988, pp. 8-9).

2.2 Cultural History

Anishinabe (Ojibwe)

Long before any Europeans arrived in the area, the Anishinabe (Ojibwe) inhabited Black Island (Figure 2.1), which today still has special meaning to aboriginals living in the neighbouring Lake Winnipeg region. There are several traditional sites on the eastern end of the island where ceremonies took place, and a number of burial sites and food cache areas. Currently, aboriginals from the surrounding region use the area for berry picking and hunting (MNR, 1994).

Icelandic People

The first exodus of Icelandic people from their homeland to Hecla Island came in 1875, and again in 1876. This migration was prompted by the eruption of Mount Hekla in Northern Iceland, which left two to three inches of lava over approximately 2500 miles

of Iceland (McMillan, 1975). The harsh climate, earthquakes, the failure of the cod industry, and the unlikelihood of gaining independence from Denmark also contributed to their departure. Approximately 25% of Icelanders migrated to the reserve on Hecla Island which was granted to them by the Dominion Government of Canada. The region extended from Boundary Creek, which was the northern border of Manitoba at the time, to the northern tip of Hecla Island. Before the majority of Icelanders arrived in 1876, most of the original group settled on the west side. However, this land was very marshy and prone to flooding, and resulted in the main group choosing to settle on the east side. This region, named New Iceland, gave Icelanders a chance to improve their lives while also maintaining their language and culture in a familiar environment (Figure 2.3). In 1887, New Iceland came under the control of the Government of Manitoba (MNR, 1994).

The lifestyle of the islanders differed considerably from their experiences in Iceland. Ice houses had to be built on Hecla Island since people in Canada preferred fresh fish over dried fish, which had been important in the diet of Icelanders in their home country. They also had to learn to fish through thick winter ice, since in Iceland the ocean was rarely frozen. With an abundance of wildlife and forest resources, they quickly developed new skills in hunting and lumber jacking. Cultivation of wheat and barley was attempted on limited sections of Hecla Island, but was unsuccessful as most land was prone to flooding and early frosts, and poor soil precluded farming on a large scale.

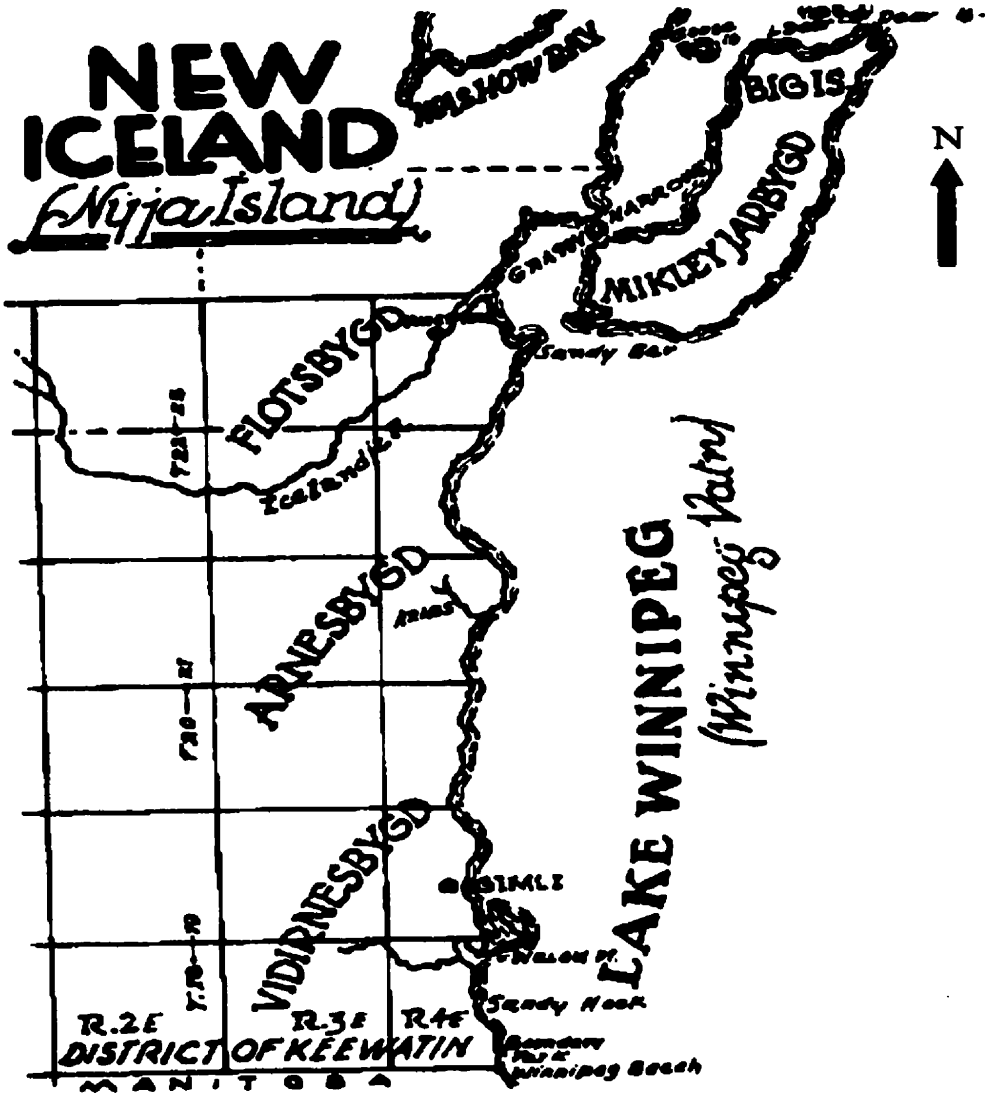


Figure 2.3 Republic of New Iceland
Source - Department of Natural Resources (1988)

2.3 Settlement Decline

From the beginning of the 20th century to 1930, Hecla Island became a thriving community with two schools, a community hall, a church, an icehouse, and a general store, as the population rose to 500. However, around 1960, a steady decline in the population occurred, resulting in the closure of the Hecla School in 1966, and due to this, the remaining families with children left the island. In 1969, only 24 families remained (Winnipeg Tribune, 1969).

The attraction and opportunity afforded by larger urban centres contributed to the movement of people away from the island. The region also suffered economically from depleted fish stocks caused by overfishing and the closure of the lake to fishing between 1970 and 1972 due to mercury pollution. In addition, commercial fishing became unprofitable due to competition and low prices. At the same time, the sawmill closed because the best timber along the shore had been depleted. Many of the original buildings in the Icelandic village have been restored to maintain some semblance of the Icelandic culture on Hecla Island.

2.4 Natural Environment

Hecla Island formed approximately 450 million years ago when tropical seas deposited sand and mud, which eventually compacted and hardened into sandstone and shale respectively. As the sea deepened and marine life became abundant, the calcium

rich skeletons of these sea creatures accumulated on the sea floor leading to the formation of limestone. There are also a few areas with granitic and volcanic outcrops on the island (MNR, 1994).

The surficial geology is dominated by limestone and glacial debris. The uplands consist of calcareous moraines with till deposits laid down during the Pleistocene glaciations. Its thickness varies from 53 to 150 metres and there are areas along the north shore where exposed limestone bedrock can be found. The bedrock on Hecla Island is limestone and dolomite mainly from the Red River Formation (Kress, 1978). When glaciers began to retreat approximately 10,000 years ago, an ice dam was formed, leading to the creation of glacial Lake Agassiz. The lake left some areas with thin deposits throughout the island; however, till still dominates, and many areas of organic deposits underlain by deep lacustrine clay are poorly drained (Smith *et al.*, 1975). The beaches surrounding Hecla Island were formed from eroded sandstone that was deposited by lake currents (DNR, 1988)

2.5 Vegetation

Much of the attractiveness of Hecla Island to tourists is the naturalness of the area, with its flourishing forests and colourful array of plants. Hecla Island represents a transition between Aspen Parkland and Boreal Forest, with hardwood species such as white birch, trembling aspen, green ash, and balsam poplar. On poorly drained sites, softwood species such as black spruce and tamarack dominate, while better drained,

upland sites consist of white spruce and balsam fir. Non-productive vegetation includes treed muskeg and willow/alder (Goulet, 1992). The region also possesses a number of rare plant species including sensitive ferns and orchids, and the red pine stand located on Black Island is the most northerly and westerly in North America. There are certain forested stands and a number of plant sites that have been designated as rare or unique, and these areas have to be protected in order that the beauty and diversity of the island remains in tact.

2.6 Wildlife

Hecla Island has a diversity of habitats, including extensive shore lands and marshes, small islands and reefs, and heavily wooded uplands resulting in a range of wildlife species throughout the island (DNR, 1988). During the summer, the island's western marshes become important nesting areas for fifty thousand northern migrants, including 15 species of ducks, Canada geese, snow geese and blue geese (McMillan, 1975). On the northern tip of Hecla Island is Pipestone Rocks, which provides excellent breeding and nesting grounds for pelicans, cormorants, terns and gulls (DNR, 1988). Bald eagles and herons nest in trees along the shoreline, and numerous varieties of hawks also make their home on the island. In addition, the many varieties of song birds are important tourist attractions. Hecla Island is also a haven for many varieties of amphibians and reptiles. Five of the nine species that are at the extremes of their range are found on Hecla Island. They are the Western Painted Turtle, Canadian Toad,

American Toad, Spring Creeper, and the endangered Grey Tree Frog. Although not as prevalent as moose, white-tailed deer are also found on Hecla Island, and there are even rare sightings of black bears (DNR, 1988). In addition, wolf packs have been known to travel from Black Island to Hecla Island in the winter time (Werier, 1981).

A large moose population exists on Hecla Island thriving on the wetlands and mixed forest environment. Moose use open habitats such as shrub lands, muskeg, and willow/alder trees, which are abundant on Hecla Island (Goulet, 1992). Currently, Hecla Island is a wildlife refuge for moose, and therefore hunting is not allowed. The moose on Hecla Island are managed to provide for the viewing enjoyment and education of visitors to the park. Grassy Narrows Marsh, located on the south end of the island, provides trails for hiking and cycling along dykes, and these provide excellent opportunities for visitors to view moose. In addition, a number of wildlife viewing towers have been built to view moose as they stroll and feed in the marsh. In the past, there have been various habitat management programs put in place to sustain the moose population on the island. The Department of Natural Resources encourages studies to examine moose distributions, the use of food plants, and interactions with park visitors (DNR, 1988). Moose, along with the waterfowl and colonial nesting species, are very important to the tourist industry on Hecla Island, and hence were the main focus of this research.

2.7 Significant and Unique Sites

Among the significant natural landscape features on Hecla Island are the limestone cliffs at the northern tip of Gull Harbour, and the quarry pits scattered around the island. In terms of cultural resources, there are many examples of past land uses of the Icelandic people including agriculture and lumbering, as well as fishing. There are also some remnants of native peoples' existence on the Island, although more evidence suggests Black Island was a focal point for native people of the area.

2.8 Recreation and Activities

There are many opportunities on Hecla Island for simply enjoying the magnificent natural landscape. The area possesses miles of limestone cliffs, and expanses of diverse vegetation with many opportunities for viewing wildlife. In the summer time, there are various interpretation programs, including outdoor amphitheatre programs, guided walks of the village, and traditional campfire talks. There are also a number of recreational activities, including hiking on well established trails through Grassy Narrows Marsh, the West Quarry Trail, and the trail systems around Gull Harbour (MNR, 1994). Another popular summer activity is golfing at Gull Harbour Golf Course, which is one of the top rated courses in Manitoba. In addition, there are numerous sites within the vicinity of Hecla Island that can be reached by boat, such as Black Island, which provides a very distinct environment with many interesting features to investigate. There are also

excellent sandy beaches on the northwest shore of Hecla Island, and the south shore of Gull Harbour Bay, with both areas being very popular for swimming. In the winter, activities include cross-country skiing, snowmobiling, tobogganing, snowshoeing, ice skating, and ice fishing. There is also the Hecla Self-Guiding Trail through the scenic fishing village, where commercial fishing is demonstrated by local fisherman.

2.9 Commercial Resource Use

In terms of resource use, potential exists in Hecla Provincial Park for commercial fishing, peat extraction, forestry, farming, and silica sand operations. Silica sand mining on Black Island has continued for nearly 60 years and is considered a historic land use. The sand is important in the manufacturing of glass, and has a number of other industrial uses. A peat lease issued on Grindstone Provincial Recreation Park to produce soil mixtures, exists although it is subject to various regulations (DNR, 1988).

Due to excessive wetness and a high water table, most of the soils on Hecla Island are marginal, with only a small area capable of producing crops. In order for areas on the island to be capable of producing crops, large tracts of lands would have to be cleared and drained (CLI, 1973).

Forestry operations took place in what is now Hecla Provincial Park prior to park designation in 1969, however, Black Island now remains in a natural state, and Hecla Island only allows cuts where they assist in park programs. Extensive areas of spruce, birch, and poplar that were cut for logs have regenerated. Grindstone Provincial

Recreation Park continues to permit forestry operations and limited agricultural activities (DNR, 1988).

There are forty-eight native species of fish in Lake Winnipeg and four introduced species. Despite the fact that Lake Winnipeg's fish resource is not as critical to the livelihood of most residents of Hecla Island as it was in the past, it is still important to several fishermen who live there. The three main commercial fish breeds are whitefish, pickerel and sauger. Pike and carp are found in the causeway marsh, and reefs on the south end of the island are critical spawning grounds for walleye (Kjartanson, 1995). The maintenance of Icelandic culture by illustration of commercial fishing techniques and sport fishing are a key appeal to tourists. Commercial fishing remains consistent with park objectives because it identifies with the past way of life of the Icelandic people.

Chapter 3 - Literature Review

3.1 Introduction

The landscape and natural surroundings of the parks and wilderness areas of Canada are among their greatest assets, and a primary attraction for tourists from within Canada, and around the world. The period from 1911 to 1957 saw a large expansion of parks in Canada, however, there were still many of these areas that remained relatively untouched by human beings, and free from development (McNamee, 1993). Although some of these lands may have been occupied and utilized for traditional means, and by wilderness seekers, there was less demand on the surrounding land, and the bio-physical inter-relationships within the environment were allowed to take their course. However, the increase in disposable income and leisure time led to the need by governments to provide areas where people could enjoy nature, and seek refuge from their busy lifestyle. The challenge for government was to locate areas that were in proximity to urban centres, and provided people with a natural experience that was unique and distinct from urban life (Whelan, 1991). As a result, tourism became a main focus in areas that contained special environmental attributes which were favoured by this new brand of tourist. At the same time, there became an overwhelming need to provide tourists with the necessary facilities such as infrastructure and recreational development in order that their experiences could be enjoyed to the fullest.

In order to develop large scale tourism, there has to be proper planning and

management to protect the environment from the effects of development. However, the majority of tourists require developed facilities, therefore, the goal for developers are to satisfy the greatest number of tourists, ultimately leading to more tourist dollars into the region, and more development. The question that remains is whether to strive for a developed or a wilderness environment, or a balance between them.

In the short term, tourism and environmental conservation may be able to exist in concert with one another. However, over a long period of time, the success of tourism will ultimately lead to changes in the environment. In light of this, there is a definite need to understand these complexities and provide specific answers to these problems. This entails undertaking research that illustrates the relationship of tourism and environmental change, and the specific impacts that have occurred, or are still at work.

In Manitoba, provincial parks have existed since 1961 when the provinces began accepting control of their natural resources from the Federal Government. At this time, Grand Beach, Duck Mountain, Turtle Mountain, and the Whiteshell were designated as Manitoba's first provincial parks (Government of Manitoba, 1960). The government's mandate through the Provincial Park Lands Act of 1972 was " to provide healthful and enriching areas in perpetuity for the enjoyment and use of Manitobans" (DNR, 1985, p. 1). There was also the provision for the conservation of flora and fauna, and the preservation of specific areas and objects. Although the provincial government had taken responsibility in terms of enacting rules and regulations in parks, as well as developing plans for the management of these parks, the act itself was somewhat conflicting. To promote enjoyment for Manitobans within these parks meant providing

activities that necessitated park developments, resulting in an array of changes and modifications to the environment.

The objective of this review will be to gain some insight into the role of tourism within the environment, and the associated effects that tourist development can have on the people, land, vegetation, and wildlife of the region. In doing so, major topics related to the impact of change on the nature of the local environment will also be examined. Following this, the focus will be on techniques that are used to illustrate environmental change over time, and the impact of change due to development.

3.2 Benefits of Tourism

For many destinations, the initial justification for tourism development has been based mainly on economics. The focus has been to attract as many tourists as possible, and maintain a constant flow of tourists, at all costs. Of utmost importance is providing all necessary requirements for the tourist, and maintaining a high degree of satisfaction, and hence profitability (Dixon and Sherman, 1990). Nonetheless, it is still very crucial that tourism's main attractions, such as wildlife, scenic quality, and recreation opportunities, are not sacrificed, because once these are lost, then so too will the tourists.

According to Bentham (1983), tourism for areas such as Hecla Island provides a means of stimulating regional development in areas that are depressed and lacking other resources that are required to become economically self sufficient. This development contributes to short term employment through the creation of the tourist infrastructure, as

well as long term employment through the growth of the tourist industry. The income produced through tourist expenditures and employment provides a source of reinvestment in the local economy. The money that is being spent provides other opportunities for development, since there are more available dollars in the local economy than previously. Hence, the standard of living is constantly improving if tourist demand continues to be met. The process of money being constantly re-spent and regenerated through the economy is referred to as the "multiplier effect", and it is this which continually drives the economy.

Another benefit of tourism is that it promotes local involvement in cultural activities and their relationship to the natural environment. Tourism also encourages the preservation of heritage and cultural buildings in need of improvements, and can act to revitalize the infrastructure of a depressed community by providing the means of converting old run down buildings into new tourist developments (Clements *et al.*, 1993). The development of the village on Hecla Island illustrates the once thriving community through the restoration of many buildings including the Hecla Church and School, Museum, Ice House, General Store, Community Hall, Sawmill, Tomasson Boarding House, Dockside Fishing Station, and two single family residences (MNR, 1994).

Tourism also encourages conservation of scenic areas, archaeological sites, and historic monuments. Various species of flora and fauna, which are very critical in maintaining the biological diversity of a region, are also preserved for the viewing enjoyment of the public (Romeril, 1989). Grassy Narrows Marsh, a channel separating Hecla from the mainland, is one of Hecla Island's most significant features. The variety

of waterfowl species and sheer splendour of the site, as well as the development of trails for hiking and cycling, have made this area a haven for tourists (MNR, 1991).

In many developing countries with unique natural attractions, tourism is a way of conserving the natural environment. This has been illustrated by studies that have shown tourists' willingness to pay for areas that they frequently visit (Boyd and Butler, 1993). First and foremost, however, is the goal of attracting tourists. In other words, tourism provides revenue to conserve areas that probably would have not been protected for other reasons (Mathieson and Wall, 1982).

3.3 Development vs. Conservation

Hecla Island has been identified as "Manitoba's answer to Isle Royale" with its island ecosystem surrounded by a large lake, and isolated moose population. However, the combination of intense tourism and recreational development, and the control over some of the natural processes on Hecla (fire, hunting), have subsequently removed this label (Crichton, 1977). Nevertheless, the island still remains a marvel within the spectacle of Lake Winnipeg, and with proper planning and management will endure for years to come.

For tourism to be successful within parks, there has to be a balance achieved between development and protection of the environment. For developers, their focus is to provide everything necessary to satisfy tourists, and to gain as much profit from it as possible. The preservationists maintain that the stakes are much higher, and argue if the

ecology continues to be impacted, in the long run, tourism will also be affected. Mieczkowski (1995), suggests that " ... adverse environmental conditions spell immediate trouble for tourism. The reason for this high degree of sensitivity to the natural environment is that tourism is the only economic sector that offers the natural environment as a very important part of its product. Hence, one can expect no high quality tourist product without a high quality environment" (p.11).

On Hecla Island, areas that exhibit attributes that are important in the maintenance of the environment including key areas of wildlife habitat, and unique vegetation and landscape features, are those that will continue to attract to tourists to the area. Therefore, prior to development, it is critical to properly evaluate all the far-reaching impacts that tourism development can have on a site, including its surrounding area. The decision by the Provincial Government of Manitoba to allow cottage development on Hecla Island in 1997 resulted in the consumption of over 100 hectares of quality land along the shoreline, and displaced important habitat for many significant wildlife species critical for the island's tourism. According to Krueger (1997), the subdivision was a reversal of Hecla's mandate which was to move the island back to a more traditional and natural state. In addition, it was stated that Parks are areas where people choose to go because they want to escape economic development, and therefore development should remain specifically in one zone, instead of being spread throughout the entire island (Winnipeg Free Press, 1997). Olson (1972), suggests that preserving park land provides people with the satisfaction of co-existing within nature in a surrounding that is relatively untouched by human activities. If over development persists in an area, it will not

continue to attract people who are interested in viewing the surroundings and enjoying the natural landscape. The result is an environment crowded with hotels and other developments that have little attraction or appeal for tourists interested in the environment.

It is very difficult to put a price tag on the value that solitude within the environment provides for some people. In fact, many people conserve for one simple reason, their love for the land. If this were not true, we would not be concerned with preserving the environment, since in our lifespan, we would not be dramatically affected if we continually exploited the environment. Therefore, our concerns are based on our admiration for the environment, and the regard and care we have for our children and the future of the world.

3.4 Human Effects on Wildlife in Parks

On Hecla Island, one of the main attractions of the park, and a popular activity for tourists, is observing and experiencing wildlife in their natural and undisturbed habitat. This appreciation by tourists provides the stimulus for the maintenance of the wildlife and their surrounding habitat. If wildlife sightings decline due to hunting or other activities, and if habitats are lost or degraded by over development within a park, the area will lose its appeal to many tourists.

Within the natural habitat of wildlife, there is a concern that wildlife viewing by large masses of tourists may have negative effects on wildlife and the surrounding

habitat. Many species react differently when approached by human beings. Some species in constant contact with people have been known to develop new patterns of behaviour that sometimes can be detrimental to the animals' survival (Mieczkowski, 1995). For instance, constant disruption of animals while feeding or hunting prey can sometimes agitate them, causing a withdrawal from their daily routine. Similarly, persistent harassment of wildlife by tourists can sometimes upset the animals and force them to lose their prey. If this is a mother hunting for her offspring, their survival is dependent on her success. Even activities such as photographing wildlife can be very unsettling for some animals (Inskeep, 1987). Some tourists will go to extremes to pester animals by chasing and even throwing objects at them. Like humans, wildlife can become affected psychologically by constant harassment, and this stress can ultimately lead to a number of ailments, and in extreme cases, death by heart failure can occur. Similarly, birds that are frightened from their nests can leave their eggs or young open to predators (Mathieson and Wall, 1982).

Over the years, one of the great attractions for tourists visiting Hecla Island has been its moose population. Moose thrive in Hecla's habitat, in which there is an abundance of balsam, fir, poplar, and birch. The Department of Natural Resources has taken every opportunity to showcase the moose by building wildlife viewing towers and board walks along the marsh, where the moose can often be observed by tourists. With these facilities, the moose are able thrive in their normal habitat at a safe distance from tourists.

Since the opening of the park, there have been a number of battles that have

erupted over the moose population on Hecla Island. The first conflict occurred in 1977, when it was reported that the moose population, estimated at 215, had increased 73% from 1972. Provincial biologist Dr. Vince Crichton believed that Hecla could only sustain 120 moose at this time, and it was thought that their food source would become depleted (Winnipeg Free Press, 1977). In a heavy snowfall, it was stated that as many as 50% could die. Some advocates asserted that hunting should be allowed to control the moose population during the non-peak tourist season. The controversy then was whether to allow hunting at specific times, even if it conflicted with the park's goal of providing tourists with the opportunity to view the moose. It was a very difficult problem to solve, because traditionally, there has been hunting on Hecla Island with little opposition to it. At this time however, it was decided that hunting away from roads and campgrounds, would be permitted at specific seasons.

In the mid 1980s, the issue over whether to allow hunting on Hecla Island once again resurfaced. The Manitoba Naturalists Society was convinced that the Department of Natural Resources had proposed to expand the moose population by increasing the food supply in order to generate more hunting revenue. The Naturalists Society's opinion was that hunting revenue could be offset by more tourists visiting the park for viewing and photographing the moose (Armstrong, 1986). Subsequently, the Department of Natural Resources became interested in designating the park as a wildlife refuge in order to preserve the moose population. The Manitoba Wildlife Federation also became involved in the controversy stating that they were opposed to a wildlife refuge because there were no natural predators for moose, and if the population increased there would not

be enough habitat to sustain the moose (Lakritz, 1986). Legal hunting on Hecla Island had occurred seasonally between 1978 and 1988, but ceased the following season (Whaley,1992).

Aboriginals, according to treaties, could hunt at any time of the year. However, in summer, moose were easy targets for the hunters because they would venture from the bush to escape from insects, and were often found near water to cool down during hot days (Owen, 1992). At the time, the moose population had dropped from 102 animals to 57, mostly due to aboriginal hunting. As a result, the province moved quickly in turning the island into a wildlife refuge to save the remaining moose population. In spite of this designation, provisions can be made in the future to allow hunting once again if the moose population reaches a certain level.

It can be argued that permitting hunting in provincial parks can have a negative effect on tourists and their perception of the park. Tourists visit parks to enjoy scenery in a peaceful setting that is free from human exploitation, and hunting conflicts with every part of the tourist experience. The loss of tourists means a reduction of revenue for the province, and therefore the issue becomes very complex and difficult to solve. There are strong arguments for both sides over whether it is morally right or wrong to hunt. However, in the case of Hecla Island, disallowing hunting not only protects the island's most famous resource, but also the tourists that are observing them.

In parks where hunting is banned, some wildlife species are very friendly when confronted by humans. It may appear appropriate to some people, yet wildlife can become dependent on human interaction if they are continually fed, or cared for by

humans. Littering around campgrounds enables wildlife to have easy access to food, altering their traditional way of gathering. This can be potentially dangerous for people because certain foods can cause strange reactions for some wildlife, and can sometimes foster aggressive behaviour. Obviously, the attraction of animals to these areas where they are able to easily access food will continue unless appropriate steps are taken to ensure that there is nothing that will entice wildlife back to these areas.

Another concern of animals' reliance on humans, is a lack of motivation, and hence, the inability to subsist in their own environment. In Banff National Park, where hunting is not allowed, it is very common for wildlife to approach people since they have little fear of humans. Tourists are constantly feeding the wildlife, and therefore, the animals become dependent on these artificial meals. Although many tourists enjoy the chance of contacting wildlife, the experience is somewhat spurious if wildlife are constantly being observed in unnatural surroundings.

Dealing with these issues is very complex since it is difficult to control tourists entering the park, and wildlife populations within the park. On one hand, park planners may decide to increase the cost of entering the park. Undoubtably, this will outrage some interest groups for the main reason that it discriminates against people who earn less, and are not able to afford to take their family to the park. The matter of controlling the wildlife population is also subject to controversy because most people do not approve of hunting when it conflicts with tourism. Therefore, hunting in most parks is not allowed unless certain circumstances prevail, such as extreme overpopulation, which forces park officials to designate limited hunting seasons during the tourist off-season.

3.5 Impact of Tourist Development and Activities on Wildlife

Within the natural environment in which tourism is a major activity, there are continually changes occurring to the landscape fostered by the needs of tourists visiting the area. While the attraction for tourists is based on the naturalness of the area, scenic quality of the landscape, and wildlife significance, the degree of development that is allowed within the park will often determine the success in attracting particular types of tourists. If an area does not have facilities that are required by the "typical" tourist, then it is possible the place will be more suited to the "adventurous type" of tourist who is likely to be interested is less developed surroundings and little contact with other individuals. Often, however, the majority of tourists require more developed facilities for their stay within the park, and thus, the focus for developers has been to provide for this group of tourists. As a consequence, the greater number of tourists results in more facilities, and hence, pressure on wildlife and their surrounding habitat. This displacement of wildlife by tourism development sometimes is not immediately evident, but as development continues, encroachment on wildlife can have damaging effects.

To control the tourist demand within parks, elaborate highways sometimes have to be built such that they are safe and effective in providing a steady flow of traffic through the park. Before these highways were built, diverse wildlife habitats at one time may have thrived in the area. Not only is the habitat that the highway is built on destroyed, but there is also the peripheral outlying habitat around the highway that is affected. Some species of wildlife will not venture within a certain distance of highways

or other major roads. In essence, the land may have high quality habitat, but the area becomes unusable by species that are unwilling to inhabit it. A further concern is that, as the density of roads within the park increases, the loss of habitat is magnified, since the habitat that is useable by wildlife is concentrated in very small pockets making it virtually unusable by wildlife. In addition, reduction in habitat is not just limited to rights-of-way, but also other areas that support highway development, including quarries, camps, and staging areas (Donihee and Gray, 1982).

In the mid 1980s, after spending millions of dollars on Hecla Island and Gull Harbour resort, the government believed that the major highway into Hecla Provincial Park and other roads should be improved. The existing highway was in a poor state, and in need of upgrading. The question remained whether a full upgrade, including paving and widening of the highway, should take place. The provincial government stated the improvements were required to ensure highway safety in all weather road conditions and to allow for smoother flows of traffic (Werier, 1988). Others argued that it was a waste of taxpayers' money, and took away from the naturalness of the park. Many tourists were not interested in speeding through the park, but rather leisurely making their way to their destination and enjoying the forested environment, and therefore, the existing road was adequate. The road improvement project resulted in 56 hectares of land being given up, including loss of trees and excavations for 19 borrow pits (Werier, 1988).

From an environmental standpoint, it can be argued that there are many impacts that a new right of way has on the habitat. As the tourist industry continues to expand, the increasing isolation of habitats into smaller and smaller non-connected segments, a

problem commonly known as habitat fragmentation will become a major issue in many parks around Canada (Winnipeg Free Press, 1998). Habitat fragmentation has a profound effect on biological diversity and is one of the main causes of extinction. The most affected species of wildlife include deep forest species and long distance migrants, while other sensitive species are those with large territories, specialized habitats, and colonial habitats (Theberge, 1993). In Canada, 23 of 36 parks, including Riding Mountain National Park, are being affected by forces that result in fragmentation and hence, serious environmental impacts are occurring. The conditions on Hecla Island are not as threatened, however, with expansion of trail networks and road systems, and other tourist facilities, there may be cause for concern.

With increasing numbers of wildlife within parks, another dilemma is the movement of animals across highways, which can be dangerous for motorists travelling at high speeds. Most highways have caution signs, although they are seldom acknowledged. On the other hand, many scavengers rely on the food source of wildlife killed on highways, and it is also one way of slowing the population growth of some ungulates (Mathieson and Wall, 1982).

Another major problem with the development of highway systems and roads is the access it provides for unintended uses such as hunting. Because of the ease of travel, the roads also become commuting corridors for moose, while the roadsides are an important source of browse (Scaife, 1980). Studies have found that roads that were constructed in areas that were previously unaccessible resulted in over hunting and decreases in wildlife populations. Crichton and Wielgus (1980) found that the presence

of hunters near roads and trails did not influence the results in their study on *Browse Utilization, Health and Habitat Relations of Moose on Hecla Island*, in that inaccessible forests stands did not experience heavier browsing then accessible sites. The suggestion illustrates that moose use these areas frequently, and it is therefore important to protect them. Consequently, it was assumed that the duration and intensity of hunting were not large enough to seriously affect the spatial distribution of the moose. Donaldson and Fleck (1980) suggest certain measures should be taken to reduce the pressure of hunting on wildlife such as ungulates, bear and beavers. First, no hunting should be allowed within 5 kilometres of either side of a highway. Next, in areas of critical habitats, there should be a limit on the construction of side roads. Third, side road access should be limited and monitored, and roads no longer in use should be closed off to hunters.

Throughout Hecla Island are networks of trails that are integral in providing many recreational opportunities for tourists. Many of these trails are used passively for hikers just enjoying the natural surroundings. In winter, trails of this nature are used by cross-country skiers. At this level, both activities have very little impact on wildlife if they are properly managed. In parks which permit other trail-based activities, such as off road motor-biking and snowmobiling, more pronounced impacts on wildlife can be identified. Farrell and McLellan (1987) pointed out that along coastal areas where the hard and soft landscape provided for various types of recreation, overuse of road vehicles and motorcycles had caused damage to bird breeding areas. The noise from the vehicles can have permanent detrimental effects to animals that inhabit the areas such that some are forced to move to other areas.

Although conflicting with wildlife and many other activities, snowmobiling is still allowed in many parks. Like off-roading, snowmobiling has similar impacts. First, the loud screeching from snowmobiles aggravates animals, essentially forcing them out of their traditional breeding grounds. According to Masyk (1973), the extremities in temperature in the winter time, coupled with very deep snow and a lack of food, puts the animals at greatest risk of death. Wielgus (1980) found that moose on Hecla Island utilized forest dogwood more than peripheral dogwood, which is found in open areas and therefore subject to deeper snows, greater wind exposures, and colder temperatures. Since this is the time of year where their bodies are the weakest, any major agitation may cause death. Finally, snowmobiles will also discourage certain animals from using areas in close proximity to snowmobiling areas (Masyk, 1973).

Although snowmobiles are commonly used for recreational purposes, they are also used for illegal hunting in parks. In addition, snowmobiles allow hunters and other individuals into areas that are not accessible by foot, and thus there has been a concern that large numbers of wildlife are being lost, since hunting is being undertaken more like a game than a sport (Michaelson, 1972).

It is sometimes assumed that water-based activities have little impact on wildlife since they are not located near suitable habitats. However, according to Edwards (1987), it is clear that noise from motor boats can have an impact on cliff breeding seabirds if boats approach their nesting colonies. The Pipestone Rocks at the Northern Point of Hecla Provincial Park is an important nesting area for pelicans, cormorants, and gulls, and it is crucial that this site is properly protected from boaters and other activities that

may threaten their habitat (DNR, 1988). At the same time, non motorized boats can also impact habitats, especially near marshes or wetland where prime feeding habitats for waterfowl are located.

When planning locations of facilities and natural tourist attractions within park environments, all possible effects should be carefully analysed, including the impact that certain activities can have on wildlife (Inskeep, 1987). Finally, wildlife habitats should also be maintained to provide the basic necessities for the animals, such as feeding, breeding, nesting, and resting (Breedlove and Styne, 1992).

3.6 Ecological Impact

One of the problems with the tourist industry is that environmental impacts are not always easily discerned, since they take considerable amounts of time to develop. Kavallinis and Pizam (1994) explain that impacts occurring at a destination are not always visible, and tourists sometimes are unaware of what impacts they induce. For example, it is much easier to identify and quantify the impact of clear-cut logging on wildlife, than it is to study the effects of tourism on wildlife. To study the problems involved in tourist impact requires evaluating a number of variables over a long period of time. Given this view of analysing the impact of tourism on environmental change once development has been established, it may be more appropriate to assess the possible impacts that may occur prior to development (Cocklin *et al.*, 1992). In this way, mitigative measures can be planned and carried out before the project is undertaken.

Another factor in analyzing the impact of tourism on the environment is realizing that the ecological complexity of land varies dramatically. While some environments can resist the impacts of change brought on by tourism, others are more fragile and very susceptible to change (Boyd and Butler, 1993). It is thus a function of an ecosystem's sensitivity to various elements that produces change in the environment. That is, one element or activity may work in harmony in a particular environment having little or no impact, but be very unsuitable in another environment.

There are numerous impacts that occur from tourists visiting a managed environment. Tourists will affect land in different ways because each has an interest in a particular activity. As a result, a proper environmental evaluation for sites offering tourism opportunities has to take place, whether this is in the form of an environmental impact assessment, or a study into the effects of a specific tourist activity.

The forested environment is one of the major attractions for tourists within a park. Many activities that tourists engage in have an impact on vegetation. In the past, campers have had an abundance of firewood that was made available to them at no cost. Recently, however, this practice has changed with parks selling bundles of firewood at a set price. The change occurred because it was felt that many tourists were wasteful of the firewood. Now, it may be more common for some individuals to deliberately cut down trees and if this practice continues over the long term, forest structure will be modified, and there will also be fewer trees left to mature. Other ways campers impact the environment are removal of vegetation, compaction of the soil, and dumping their garbage around their campsites (Mathieson and Wall, 1982).

Another major concern in protected areas is the introduction of non-native species, which potentially can cause very damaging effects to other plant species and wildlife, and can be as severe as causing their extinction. Island environments are most at risk since the isolation provides a diverse ecosystem that is very sensitive to change, and therefore, it is crucial to maintain the uniqueness of this environment. On Hecla Island, the causeway link to the mainland makes the island easily accessible for tourists as well as other species. Even with a number of controls in place, it was found that over 100 non-native species have been introduced to the Galapagos Islands during a recent 20 year period (Woodley, 1993). Furthermore, there is concern over the production of toxins and pollutants, which can cause devastating effects to fragile plants and vegetation. Many tropical islands are particularly sensitive environments, because to many, tourism is a main industry and therefore there is a great demand for development that caters to it (Wilkinson, 1989).

Off-road vehicles can also have negative effects on the ecosystem of the park by causing irreversible damage to sensitive vegetation. Further damage can occur near slopes where vegetation provides a barrier from the soil underlay, which upon exposure, becomes easily eroded by further use of these vehicles (Edwards, 1987). Snowmobiles also cause damage to vegetation by breaking branches of small shrubs and saplings. It was also found that compaction of snow under the vehicle track resulted in a 100-fold decrease in soil bacteria which are essential to the plant food cycle. In addition, over use of some areas by snowmobiles may, over the long run, eliminate certain plant species (Masyk, 1973). Furthermore, since snowmobiles operate on a 2-stroke engine cycle, the

carbon monoxide emitted is 100 times greater than that of regular automobile engines. Although these effects may not be immediately evident, it is obvious that there will be long term implications.

3.7 Carrying Capacity

There is a certain level at which tourists can be absorbed into an area without any noticeable negative impacts. This is what is meant by carrying capacity, and it deals with the risks associated with over-use of a particular tourist site. There are major consequences of overcrowding an area, including an individual's loss of the nature experience. Ultimately, the destination may lose its original appeal towards these genuine tourists. The original intention of preserving and protecting the natural environment within a park is overlooked, since the economics of attracting greater numbers of tourists becomes a more powerful allure. This can be very devastating to many areas where forests have to be cleared, and key species removed to make room for the tourist infrastructure. Another problem is the refuse that is brought into, and generated in the parks by tourists, and the disregard shown in disposing of it. For some individuals, there is a lack of respect towards the environment and the true meaning of wilderness.

It is very difficult to quantify carrying capacity. In terms of an individual, it can vary depending on the tourist's perception. For example, a wilderness trekker who comes into contact with one or two individuals per day may feel crowded. Another group

enjoying wilderness hiking and camping might feel very comfortable being in contact with a number of individuals throughout their daily pursuits (Romeril, 1989). Nevertheless, a point is reached where there is a loss of enjoyment in a tourist experience, if there are too many tourists crammed into one small area. When maximum capacity is reached, and all the park land becomes utilized, this can potentially lead to devastating environmental consequences (Wren, 1972). Consequently, parks such as Hecla Island have developed management plans that designate areas for the development of tourist facilities and activities, classified as an intensive land use. However, since there are opportunities for development in other areas, the economic pressure sometimes prevails.

A number of environmental factors were identified and should be considered when determining carrying capacity. Size and usable space determine how much area is available, and spaces that are accessible. Sensitive environments will have limits on tourists, and will be preserved in their natural state if tourist development is kept out of these areas. Lastly, the wildlife behaviour patterns should be studied to determine their sensitivity to humans (WTO, 1992).

To increase carrying capacity, certain management techniques can be utilized. Land can be modified to conceal the effects of tourists. For example, trees can be planted to act as buffers to separate the influence of tourists in specific zones. Second, trails and viewing tracks can be designed and distributed throughout the site. An attempt can also be made to reduce the conflict between uses. Each land use can be designated a specific land type and zoned appropriately in order that other uses do not destroy the perception of the activity in a specific land use. That is, there would be obvious conflicts if a hotel is

constructed in the same place as a wildlife viewing platform. Another consideration is to encourage use during all seasons, and actively promote it. If suitable, the site could be marketed as a year round facility, either through special tour packages or off season prices. Many tourists are interested in travelling to sites during non peak periods, and this can aid in distributing the population more evenly throughout the year. Hecla Island constantly promotes the resort in the winter for business conference retreats, as well as family getaways where a number of recreational and planned winter activities can be enjoyed.

3.8 Social Impact of Tourism

Tourism's impact on communities is generally perceived as having mostly positive effects. Tourism provides employment opportunities for local citizens, infrastructure improvements, and increases foreign exchange. Bentham (1983) found that local expenditures by visitors to Hecla Provincial Park in the summer of 1978 were $885,810 for a an estimated $1,257,850 in total gross income, which produced 26.5 person years of employment. Likewise, tourism can act to revitalize local traditions and cultures by show casing it as a selling feature for would be tourists (Clements *et al.*, 1993). Communities that are able to maintain their local customs and culture are the ones that will be the most attractive to tourists (Lankford, 1994). With the restoration of Hecla Village, and the historic lands settlement that is being developed around the Hecla town site, the descendants of original settlers to Hecla Island may finally enjoy a flourishing

community once again.

Tourism, like other industries, can also have many negative social impacts. Some of these include increases in crime, disruption of local lives due to increase in population density, and displacement of locals by new development (McCool and Martin, 1994).

Conflicts regarding particular cultures and values that locals feel are being threatened by tourism can also occur in the community. In addition, competition between local residents and tourists regarding the use of resources (Romeril, 1989), and over who should pay for them can lead to further dissension between the groups (Stynes and Stewart, 1993). Consequently, the tension that arises between locals and tourists can ultimately lead to the failure of an otherwise successful operation.

It is critical for decision makers, in initial phases of development, to allow locals to be a part of the planning and policy making process. This will ensure that they are in agreement on specific plans, and enables them to propose certain development projects that will guarantee protection of their land and culture.

3.9 Land Use Conflict and Environmental Attitudes

It is evident that if land has the potential for forest-based tourism, there are also a multitude of other activities for which the land can be used. As a result, the most valued land will be sought for a variety of uses, which in turn can ignite conflict among users of the land. This can have very adverse impacts on tourism if the land is being utilized for

purposes that will deplete the resources.

Demand for land in Canada was first for highly valued activities such as mining, housing, and transportation, and then agriculture, forestry and recreation. Traditionally, wildlife has held little value in terms of providing generated capital. However, studies have shown that wildlife and their habitat are important to us in many more ways than originally perceived (Environment Canada, 1981). One of the problems of designating uses to parcels of land, is the land that generates the most capital in the short run is utilized. To achieve this, the land that provides the best quality for developing recreation opportunities for tourists, will ultimately attract the most people. However, in the long term, the cumulative effects of tourism can have dramatic impacts on the flora and fauna of an area. Therefore, the biocentric approach is favoured, since it places a greater value on maintenance of the environment by controlling excessive recreational use, and managing the lands at a sustainable level. In this approach, more effort is put towards developing tourist programs and activities with more emphasis on the primitive environment (McKercher, 1992).

The competition for resources within the environment is no more evident than the conflict that exists between the demand for timber and wildlife habitat. This is clearly illustrated in a study by Brown *et al.* (1994), which dealt with the conflicts between forestry and wildlife within the trans-boundary between Mount Revelstoke and Glacier National Parks in British Columbia. The major conflict was between caribou habitats and the logging value present in the same area. Their research linked GIS with spatially referenced, integrated multi-resource database, forest growth, yield and economic models

to generate and evaluate multiple use management options. The model enabled the analysis of the trade-offs between the two competing uses, fostering the development of a number of planning scenarios. Since commercial forestry operations are restricted on Hecla Island unless they can contribute to park programs such as sanitation cutting and wildlife habitat works, tourism development, rather than timber extraction, competes with wildlife for land (DNR, 1988).

One of the favourite activities for tourists visiting Hecla Island has been recreational boating and fishing. Commercial fishing has been a part of the local culture for over 100 years, and at times, there have been confrontations with recreational users. Since Lake Winnipeg provides substantial area for both of these groups, there have been information and awareness programs put forth to avoid further conflict (DNR, 1988). According to McKercher (1992), prime wilderness tourism lands in Ontario are facing a crisis. Heavy pressure by anglers on traditionally remote lakes has yielded reduced catches and thus a lower satisfaction for tourists using the lake. Lands that were once in a relatively undisturbed state are now subject to overcrowding, vandalism, littering, and noise pollution because of increased use. The problem was attributed to commercial forest activities that expanded into the area. The logging industry created a network of roads which opened the area to mass recreational use. In the past, wilderness tourists were one of the few groups accessing the area until the wilderness was threatened by other uses, and other users of the land (McKercher, 1992). It is certain that within this type of environment, competing land uses will persist. Each group has its claim within the environment, and as discussed previously, the challenge is to establish a reasonable

balance between them.

Saremba and Gill (1991) found conflicting environmental attitudes between residents living in Vancouver and those close to the Whistler corridor, which is a prime recreation area. The people who lived in Vancouver believed that the area should be better preserved, while those near the park within the Whistler corridor wanted more recreation development. Not only did this area provide recreational opportunities for the people living around it, but it also provided economic activity resulting from tourism. The study demonstrated that attitudes vary spatially, dependent on the degree of impact on a particular group of people. Kilskey and Kearsley (1993) isolated four groups of tourists based on how they perceive the wilderness. This allowed them to spatially illustrate each group's presence within the environment. Ultimately, the research provided planners with information to model how development impact may affect each group. In addition, activities can be planned so that they are compatible with each specific group, and are not conflicting with other groups. In a similar study, Mitchell (1989) examined how attitudes of resource managers and recreationists differed on the following: 1) the importance of wilderness qualities to other potential uses; 2) the area to be considered wilderness; and 3) the essential characteristics of wilderness and acceptable types of use. The study showed that perceptions of wilderness differed from official park boundaries, and that views changed pertaining to appropriate uses. Finally, it was found that views were different on all three points between the three groups of recreationists (canoeists, roadside campers, and other users), and the resource managers. This type of research is valuable because it allows managers to understand each group,

such that future planning can work to eliminate some of the conflicts that exist between them.

3.10 Techniques for Assessing Environmental Change and Impact

Assessing the impact of tourism development on the environment has always presented a challenge. Not only is there an absence of comprehensive assessments in the literature, impact assessments have also not traditionally been a mandatory procedure since tourism has been regarded by many as an environmentally friendly industry (Butler, 1993).

Measuring change within the environment is very complex since it involves the combination of a multitude of effects, and the relationship of these in modifying and impacting certain elements of the environment. Assessing the impact of activities on the environment means recognizing that the current state of the environment is not just the outcome of individual impacts occurring independently of one another, but rather the result of many interrelated factors from the past and the present (Cocklin *et al.*,1992, I). This is known as cumulative effects assessment (CEA). CEA is concerned with environmental change through time, the associations and interactions between the activities of humans, the inputs and outputs of the environment, and measured environmental change with reference to valued environmental components (VEC). One VEC can be affected by various types of human activities, or each specific activity may impact more than one VEC. As well, changes to one VEC can force changes in other

VECs (Cocklin *et al.*, 1992, I). An example of this could be the change in forest structure (VEC) brought on by human activities, which can also affect wildlife habitat, another valued environmental component.

A number of methods have been identified to measure and analyse environmental change. The first are environmental checklists, which are lists of environmental effects and impact indicators. This technique involves a subjective assessment, with no reference to qualitative or quantitative impacts. Rather, it is only an acceptance of impact as a result, and has limited utility for denoting change in single, non-cumulative assessments (Cocklin *et al.*, 1992, II). The second method uses a matrix design of rows and columns, with project activities placed on the horizontal axis, and the impacts placed on the vertical axis. In contrast to checklists, matrices encompass an association between cause and effect (Mitchell, 1989). A problem with matrix methods is the lack of sufficient spatial and temporal resolution. That is, they do not illustrate spatial change, and can only define temporal change on phases of project activity. Secondly, although a measure of combined effects on activities on each valued component can be determined by simply summing the columns, it is probably not representative of the complexity of the interactions between cumulative effects. The network method utilizes a tree-branch approach to provide a better approximation of the cause-process-effects-associations. Quantitative evaluations of impacts are possible by allocating probabilities to the network limbs and measuring the effects.

In the case study by Cocklin *et al.* (1992, II), a combination of a matrix structure and geographic information system (GIS) technology was used to assess cumulative

effects within a region of New Zealand. Initially, a matrix was developed that listed human activities on the vertical axis and measured environmental changes on the horizontal axis. The next step in the matrix was to combine measured changes within the environment with valued environmental components (VECs), and then relate this back to the activities that were originally impacted upon them. Once all the relationships between VECs and the activities that affect them were determined, GIS was employed to illustrate the impacts spatially. For example, wetland areas lost due to high producing pasture were mapped by combining inferred historical wetlands areas with current vegetation mapping indicating areas of high producing pasture. It was also noted that aerial photography could be used to clarify the pattern of change through a number of intervals. Other assessments that took place in this study were the effects of a single activity on multiple VECs, and multiple activities on a single VEC. The final evaluation identified multiple activities (transportation, human activities, and mining activities) and the impact on multiple VECs (bird habitat and remnant forest). Each activity along with the VECs were first mapped, and then overlay and buffer techniques were employed to depict the influence of each activity based on the degree of damage that it may have on the VECs.

Green *et al.* (1993) focussed on forestry practices such as timber harvesting, clear-cutting, road building and herbicides, as having both short and long term cumulative effects on the environment. The research identified areas based on degree of sensitivity to forest activities. All areas vary spatially because of their different climate, geology, vegetation, soils, and terrain. As a result, each has different susceptibilities to

forest practices. GIS was crucial to the study because it was used to map environmental sensitivities for hydrological basins within the study area based on the different resource layers represented in the GIS database.

Measuring the change in land use over a period time allows researchers to understand patterns of change, and speculate why certain conditions have developed. To undertake these types of studies, it is necessary to determine an appropriate period that represents pre-conditions that can be contrasted with current conditions. As such, the spatial data should be similar in scale and resolution for an accurate assessment to be made. Buse (1992) acquired data from base line environmental surveys as identified by habitat recording in 1972 and 1987 to measure environmental change and predict future land use change. The surveys provided habitat content for randomly positioned 30m quadrats in each of the 410 km^2 squares which permitted the type and cover of each habitat to be quantified for each period. To estimate future changes in land use, a Markov Analysis that used the recorded change from 1972 to 1987 to construct a matrix of transition possibilities predicted habitat change potential for a fifteen year period to 2002.

Habitat data provide vital information that enables decisions to be made concerning wildlife areas that need to be protected. In a study mapping biological diversity in California, Stoms (1992) indicated that it was necessary to identify lands with high concentrations of species richness. GIS was used with vegetation maps, along with biological knowledge of wildlife preferences, to determine distribution of wildlife species. The approach used a grid-based method to predict wildlife species within equal area cells. A main objective of the study was to determine the effects of habitat map

generalization of biodiversity assessment. It was found that as the map was generalized, the number of habitat types decreased with a similar decrease in number of species predicted. The conclusion drawn was that areas of the highest conservation value resulting from species richness can be dependent on the GIS data resolution.

To measure the change in land use within a region, quality source data in the form of aerial photographs or remote images are required to effectively portray environmental features that are being studied and compared. Aerial photography enables a detailed view of a region, and provides a large amount of information quickly, and relatively inexpensively when compared with old mapping techniques. When mapping with aerial photographs, the initial step in the procedure is to develop a system of classification that represents the information that is being measured. It should also be decided whether the study will require field work to verify some of the interpretations made on the aerial photographs. In undeveloped areas that lack appropriate ground control points, Global Positioning System Technology (GPS) can be used to locate points in the field, while densifying the control network, and establishing an accurate control base (Welch *et al.*, 1992). Next, the points on the photo can be linked to topographic maps, or the photos can be geometrically corrected. For representation in the GIS, the information on the photos can be captured through the process of map digitization or scanning. In most cases the polygons on the photos are transferred onto a controlled map base with a transferscope or vertical sketchmaster, which can be registered to a common coordinate system within the GIS (Lo and Shipman, 1990). The second method, called digital orthoimagery, represents the aerial photograph within a GIS as a true portrayal of present

environmental conditions. According to Michael (1993), "Digital Orthoimagery is potentially the most significant breakthrough in mapping technology in recent memory. Not only will the technology which underlies digital orthoimagery change the way we produce maps, it will also change our concept of a map" (p. 110). The Digital Orthoimage is considerably more useful than traditional vector maps which use an assortment of symbols to represent ground features. The orthoimage provides a digitally corrected aerial photo image that represents objects as "real phenomena" and can be converted to vectors at any time if GIS analysis is required. A digital orthoimage is produced by scanning a vertical aerial photograph and removing the tilt in the camera and other displacements resulting from the relief in the area with digital correction software. The procedure uses a scanned aerial photo, the X-Y coordinates of a number of ground control points, and a digital elevation model to generate the digital orthoimage (Parent, 1991). Regardless of the method of data conversion, land use change can be determined within most GIS systems by overlaying the polygon cover for the first period over the cover that represents current conditions.

Pyrovetsi and Karteris (1986) described the use of black and white aerial photographs for 1945 and 1969-1970 updated to 1984 conditions to map land use change within Prespa National Park in Greece. The study uncovered numerous land use changes due to the exploitation of the park resources over the last forty years. The main findings were increases in agricultural and eroded lands, and the reduction of marshland. In brief, the ecological makeup of the park was drastically influenced by the activities of humans, and it was suggested that proper environmental conservation techniques should be

implemented to alleviate these impacts.

While GIS is a powerful tool for analysing changes within the environment and determining consequences of activities before they are implemented, there has to be caution taken on ways the data are modified within the system. It is also important to remember that a GIS is only as good as its original source data.

Essentially, GIS techniques are no different from some of the traditional techniques used to analyze spatial data. It is the speed at which computers are able to analyze and process the data that provides the real power for GIS. GIS also offers certain modelling and analysis routines that could never be attempted using traditional techniques (Aspinall *et al.*, 1993). Consequently, there are numerous places where errors can be entered into the system, and thus careful planning at the data gathering stage, through the analysis and output, has to take place.

The analysis undertaken in this thesis is a combination of some of the techniques described above with a further expansion of the analysis in order to plan for future expansion of tourism development and activities on Hecla Island. In the first part of the analysis, GIS techniques are used to map and quantify the resources affected by the current development and tourist activities. If forest inventory data were available prior to tourism development on Hecla Island, an analysis could have been undertaken to show patterned changes in vegetation and species composition. Nevertheless, GIS analysis was used to illustrate past development proposals, and quantify key environmental components that would be affected if future development eventually does takes place on certain sites that were proposed. Aerial photographs were used to describe change that

had occurred on Hecla Island between 1962 and 1992, and GPS was utilized to map important cultural sites on the islands. The final part of the analysis deals with locating areas where certain tourism development and activities can be expanded. To assist in this analysis, the Ultimate Environmental Threshold (UET) method was employed. "The Ultimate Environmental Threshold (UET) method is a land-use planning technique that can be used in the planning process to identify and screen harmful environmental effects of development proposals" (Kozlowski and Hill, 1993, p. 36). The UET method was originally adapted from Threshold Analysis in urban planning, which deals with the growth of towns and the limitations they endure due to their expansion, such as physiography, land use and infrastructure. These limits, known as developmental thresholds, can be overcome with additional, often high costs, called threshold costs (Bigwood *et al.*, 1973). This permits the identification of urban growth options in the initial stages of planning, and helps to illustrate how and when thresholds can be overcome most efficiently (Kozlowski and Hughes, 1972). The UET method was created to indicate final ecological limits for sustainable use, or development in a given region. The goal of the method is to identify environmental elements that need protection due to their unique and special nature. The Ultimate Environmental Threshold (UET) method is a screening process that pinpoints areas of uncertainty, and can be used as a starting point to limit development, and then areas affected can be targeted for further research (Kozlowski and Hill, 1993). One of the main goals of the UET method is to ensure that situations requiring remedial actions do not happen in the first place. Instead of assessing the impact of the environment after development takes place, the UET

method targets areas prior to development. Characteristic of the matrix approach, the UET method first analyzes the relationship between resources and activities in a number of tables (matrices) to determine the degree of impact that each activity and development has on the environment. A major part of the procedure involves determining the quality of the environment, and determining environments that are most susceptible to tourism impacts (Kozłowski, 1986). On Hecla Island, for example, these are sensitive plants and vegetation, lands that have very high habitat productivity for moose or waterfowl, and other significant sights and areas. In this study these resources are referred to as key environmental components (KEC), which are analogous to the valued environmental components (VEC) that were discussed in the first part of this section. In order to properly describe the KECs in the study, a classification system was developed to enable KEC to be represented in a GIS. This enabled each KEC to be portrayed on one map, and areas of each class could be calculated. The final part of the analysis consisted of employing the final table which describes the potential environmental consequences of development, and overlaying all the KECs, to determine environmental thresholds of each activity and development on Hecla Island. In other words, the objective was to locate future development and activities in areas that have the least impact on the key environmental components on Hecla Island. For example, high impact activities such as snowmobiling should be located in areas that have no value in terms of moose habitat or vegetation uniqueness, while lower impact activities such as nature study may be appropriate in areas that have higher value for moose, waterfowl, vegetation, and other significant features. An important aspect of the Ultimate Environmental Threshold

method is that it is a starting point to determine the suitability of tourism development within a particular environment. Once areas are targeted, further, more detailed investigations of the chosen site can take place.

3.11 Conclusion

In summary, this chapter has focussed on major topics related to the role of tourism, and the relationship of tourism to change within the environment. The initial discussion was on the benefits to communities, as well as parks that have environmental qualities that are favourable for tourism. It is certain that there are many positive effects of tourism, particularly the growth and economic spinoffs that it can provide for regions that in the past may have been financially depressed. The primary emphasis of this review was on the impact of tourism on the environment. First there was a discussion that dealt with balancing conservation with development. Although this may be difficult, it is in our best interest to try to find some harmony in order that there can be some satisfaction by people trying to protect the environment, and those trying to enjoy it.

The next part of the literature review was an examination of specific aspects of tourism impacts on the environment, including the human effects on wildlife in parks, the impact of development and activities of tourists, and the ecological impact. Human effects on wildlife dealt mostly with the conflict between wildlife and humans, particularly the encroachment of humans in areas highly suitable for wildlife, while following were examples illustrating how tourist infrastructure and recreational activities

can have a profound effect on the environment. The next sections concentrated on the problems associated with tourism development within local communities, such as the isolation that can occur if local people do not take part in the planning process, and finally the conflict that can occur between different users of the environment.

The final part of the chapter was an overview of literature pertaining to the methods of measuring and analysing environmental change. Although it can be very difficult to study all the variables that may impact a particular component within the environment, the use of some of these techniques contributes to efficient organization and representation of the data. In addition, the methods enable data to be properly captured, analysed, and modelled, such that a problem can be solved in the most effective manner.

To conclude, when studying environmental change and the possible impacts of tourism on the environment, it is imperative that there is a clear and concise definition of what components are being analyzed, and what techniques will be utilized to provide answers to the research problem.

Chapter 4 - Methods and Analysis

4.1 Introduction

The approach that is used to produce the final maps that suggest areas where certain activities and developments should be targeted on Hecla Island involves eight stages (Figure 4.1). The first stage is the production of an inventory of all the activities and developments on Hecla Island. Stage 2 uses the information in stage 1 to refine the inventory by combining similar activities or developments and eliminating ones irrelevant to this study. Stage 3 deals with assessing which key environmental components on Hecla Island are significant to this study, and stage 4 consists of compiling the data into a form that it is suitable for input into a Geographic Information System. Stage 5 is a more complex process because it deals with methods used to classify the key environmental components on Hecla Island, such that the quality of the natural resources is characterized effectively when the development of the environmental thresholds takes place. Stage 6 represents methodology that was developed to map land characteristics on Hecla Island. Stage 7 is part of the UET approach that was formulated in *Towards Planning for Sustainable Development: A Guide for the Ultimate Environmental Threshold UET*, whereby a five-step cumulative process is carried out, with the goal of producing a final table that rates the potential environmental consequences of development and activities on key environmental components (Kozlowski, 1993). The purpose of stage 7 is that it assists in providing support in creating Ultimate Environmental Thresholds for future development and activities on Hecla Island (Stage 8).

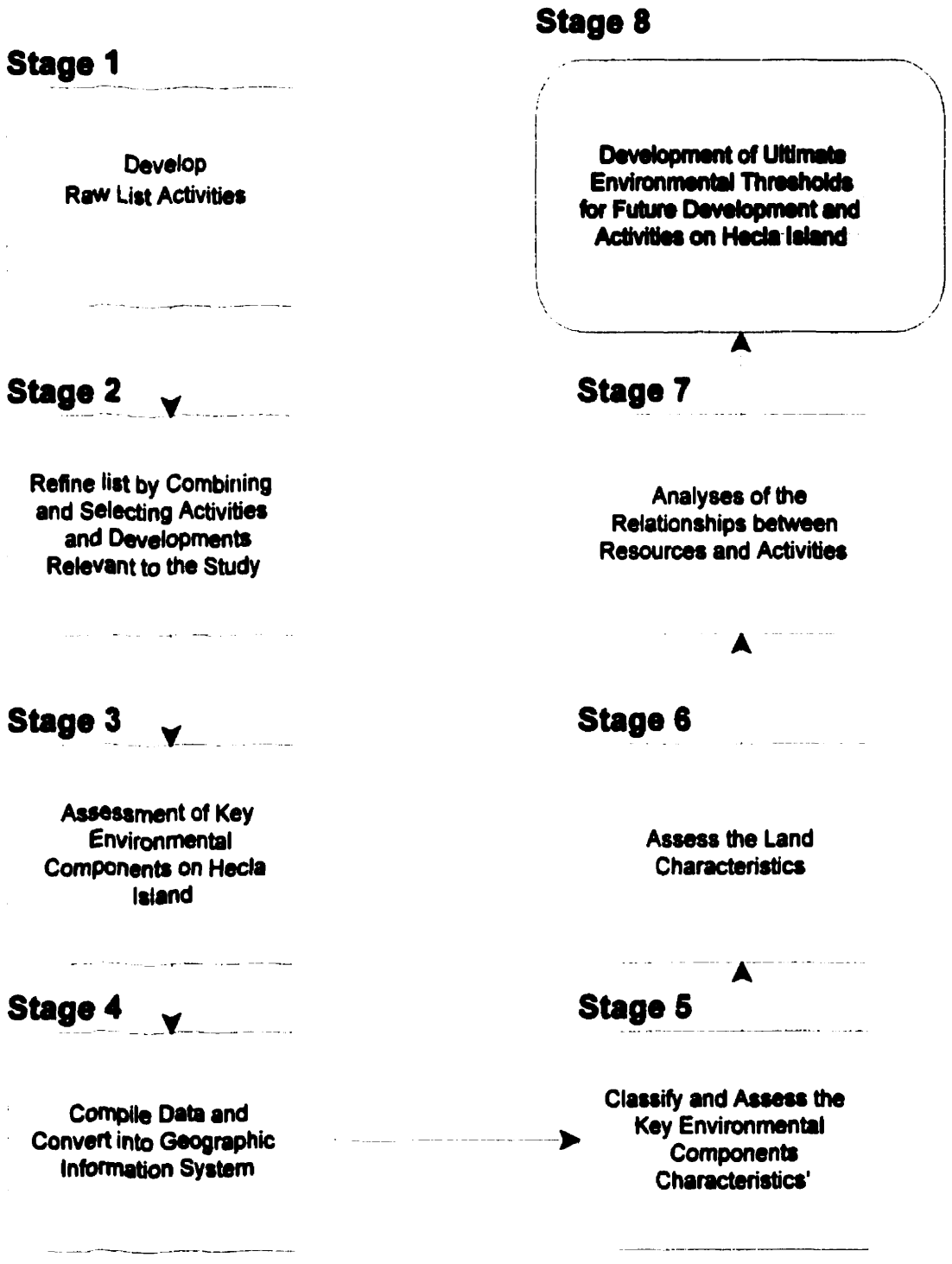


Figure 4.1 Stages in Development of Final UET Maps

4.2 Defining the Developments and Activities on Hecla Island

The first part of this research dealt with compiling a list of all developments and activities that can be attributed to tourism on Hecla Island. From this list, the developments and activities were separated into three classes:

1. Past/Present - developments built in the past and that are currently part of the park system
2. Future - developments in progress
3. Potential - expansion of tourist related development to handle future demand

This process involved combining similar developments and activities, and eliminating ones that were not important to this study. For example, cross-country skiing and snowshoeing are two activities that require similar demands within Hecla's environment, thus they were combined into one category, while canoeing, kayaking, and water skiing, were omitted since they represented water-based activities on Lake Winnipeg. As a result, these activities were designated 'NR' (not relevant) since it is beyond the scope of this study to analyse the relationship of tourism development and water ecosystems. The following is the initial list of developments/activities that was compiled for Hecla Island. Roman numerals denote the class that each development or activity occupies in the final list.

Raw List of Developments and Activities on Hecla Island

1. Gull Harbour Development - i
2. Golf Course/Golfing - ii
3. Campground/Camping - iii, xvii
4. Roads - iv, xix
5. Snowmobiling - v, xx
6. Cross-Country Skiing - vi, xxi
7. Snowshoeing - vi, xxi
8. Ski Skating - NR
9. Ice Skating - NR
10. Winter Hiking - vi, xxi
11. Summer Recreational Hiking - vii, xxii
12. Primitive Hiking - viii, xviii
13. Controlled Marsh/Viewing Facilities - x
14. Causeway - ix
15. Motorized Boating - NR
16. Water skiing - NR
17. Kayaking - NR
18. Canoeing - NR
19. Swimming - NR
20. Fishing - NR
21. Pedal biking - NR
22. Commercial Fishing - NR
23. Nature Study and Interpretation - viii, xviii
24. North Shore Cottage Development (In Progress) - xi
25. Historic Lands Resettlement (In Progress) - xii
26. Air Strip/Runway - xiii
27. Float Plane Base - NR
28. Minor Recreation Complex - xiv
29. West Quarry Development Area - xvi
30. Family Vacation Resort - xvi

Tourism Developments and Activities Examined

Past/Present Development and Activities

i) Gull Harbour Development
ii) Golf Course/Golfing
iii) Campground/Camping
iv) Roads
v) Snowmobiling
vi) X-Country Skiing/Snowshoeing
vii) Recreational Hiking
viii) Primitive Hiking/Nature Study
ix) Causeway
x) Controlled Marsh/Viewing Facilities

Future Development - In Progress

xi) North Shore Cottage Development
xii) Historic Lands Resettlement

Potential Development and Activities

xiii) Air Strip/Runway
xiv) Minor Recreation Complex
xv) West Quarry Development Area
xvi) Family Vacation Resort
xvii) Camping Expansion
xviii) Primitive Hiking/Nature Study
xix) Roads Expansion
xx) Snowmobiling Expansion
xxi) X-Country Skiing/Snowshoeing Expansion
xxii) Recreational Hiking Expansion

4.3 Resource and Land Assessment

Following the generation of the development and activities list, an inventory of the important natural resources that may be threatened by tourism was developed. This inventory categorized key environmental components of flora and fauna on Hecla Island, including unique landscape features, and enduring cultural resources. In addition, fundamental land attributes such as soil suitability and recreation capability were identified to establish areas of potential development (Sections 2.5-2.7).

4.4 Initial Data Conversion and Database Development

Base Map

An accurate base map was necessary, since all other maps and spatial features in other formats were registered to it. The most current base map was a 1:50,000 National Topographic System (NTS) map published in 1993, and produced by Energy Mines and Resources Canada. The map utilizes the North American Datum (1983), and provides a Universal Transverse Mercator Grid and Latitude and Longitude coordinates for registration of the map and conversion into digital format. The features represented on the base layer included the shoreline of Hecla Island and surrounding islands, roads, trails, rivers, streams, and lakes.

Vegetation Map

Vegetation information was represented by Forest Resource Inventory (FRI) maps which were produced as township maps at a scale of 1:15,840 (1 inch=1 mile) by the Forestry Branch of Manitoba Natural Resources. The maps were available in digital form as ARC/INFO files, and were acquired for the six townships (Tp 23-24, Rge. 5-6W and Tp 25 Rge. 6-7W) on Hecla Island. As each township map was digitized independently of the others, it was necessary to edgematch forest polygons along each township boundary, and delete duplicate polygon codes. Each township also had to be adjusted to fit the base map. This was accomplished by utilizing features common to both maps, such as the lake and the shoreline, and applying a rubber sheeting algorithm to shift the forest polygons to the fixed base map. The rubber sheeting technique involved distributing points along the base layer on known features that could be matched within additional points that were placed on the vegetation layer. In essence, the process stretches the source map to fit the base layer. With the rectification of the map complete, the data associated with each forest polygon (the external database) were linked to the internal database by a common numeric indicator. The standard database format includes stand number, area, perimeter, ownership, and cover type, which can be either productive forest land, non-productive forest land, non-forested land or water. In addition, productive forested land is described in terms of general type, sub type, site class, cutting class, and crown closure (Table 4.1). Species composition and year of origin, which refer to the percentage of individual tree species and age of the forest stand respectively, are also determined for each stand. Figure 4.2 depicts the vegetation of Hecla Island, sub-

divided into 13 classes by habitat type. A large part of Hecla Island consists of Marsh/Muskeg and Treed Muskeg through the southwest and central region of Hecla Island respectively. On the west side of the marsh, there exists a number of immature deciduous stands, while many of the other species are evenly distributed throughout the island. The following tables outline the fields in the vegetation cover database and the attributes that describe them:

Table 4.1 Vegetation Cover Data Fields and Attributes

1. Ownership

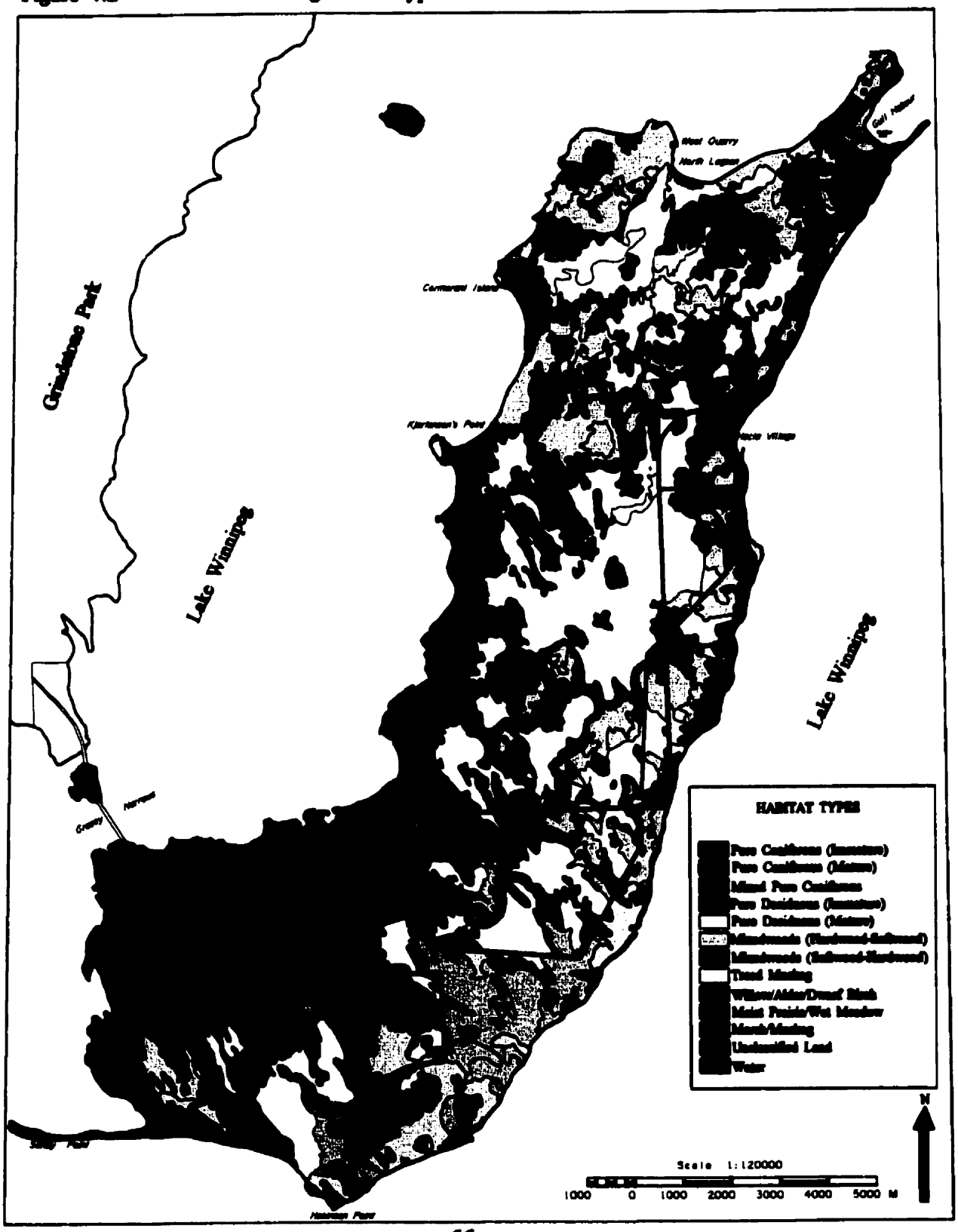
Provincial Crown Land -Closed	0
Provincial Crown Land - Open	1
Provincial Crown Land - Restricted	2
Federal Crown Land	3
Municipal Land	4
Patented Land	5
Local Government District	6
Indian Reserve	7
Other (include Community Pasture)	9

2. Cover Type

2a) Productive Forested Land

1) Softwood: 'S'	- (Cover Type 0-3) - includes all stands where 76 percent and over of the total basal area consists of coniferous species.
2) Mixedwood: 'M'	- (Cover Type 4-7) - includes all stands where the basal area of all the coniferous species is between 51 percent and 75 percent of the total basal area.
3) Mixedwood: 'N'	- (Cover Type 8) - includes all stands where the basal area of all coniferous species is between 26 percent and 50 percent of the total basal area.
4) Hardwood: 'H'	- (Cover Type 9) - includes all stands where the basal area of all coniferous species is less than 25 percent of the total basal area.

Figure 4.2 Vegetation Types on Hecla Island



ii) Subtype Code

Cover type 'S' > 76% S	Code	Cover type 'S' > 76% S	Code
Red Pine 71-100%	01	Balsam Fir 71-100%	20
Red Pine 40-70%-jp	02	Balsam Fir 40-70%-spr	21
Jack Pine 71-100%	04	Balsam Fir 40-70%-ec	22
Jack Pine 40-70%-rp,sp	05	Tamarack 71-100%	30
Jack Pine 40-70%-spr	06	Tamarack 40-70%-spr	31
Scots Pine 71-100%	08	Tamarack 40-70%-ec	32
Scots Pine 40-70%-jp	09	Cedar 71-100%	36
White Spruce 71-100%	10	Cedar 40-70%	37
White Spruce 40-70%-bf,jp,bs	11		
Black Spruce 71-100%	13		
Black Spruce 40-70%-jp	14		
Black Spruce 40-70%- bf,ws	15		
Black Spruce 40-70%-tl	16		
Black Spruce 40-70%-ec	17		

Cover type 'M' 51-75% S	Code	Cover type 'M' 51-75% S	Code
Red Pine 51%+	41	Balsam Fir 51%+	60
Red Pine 50% or less-jp	42	Balsam Fir 50% or less-spr	61
White Pine 51%+	43	Balsam Fir 50% or less-ec	62
Jack Pine 51%+	44	Tamarack 51%+	70
Jack Pine 50% or less-rp	45	Tamarack 50% or less-spr	71
Jack Pine 50% or less-spr	46	Tamarack 50% or less-ec	72
Scots Pine 51%+	48	Cedar 51%+	76
Scots Pine 50% or less	49	Cedar 50% or less	77
White Spruce 51%+	50		
White Spruce 50% or less-bf,jp,bs	51		
Black Spruce 51%+	53		
Black Spruce 50% or less-jp	54		
Black Spruce 50% or less-bf	55		
Black Spruce 50% or less-tl	56		
Black Spruce 50% or less-ec	57		
Black Spruce 50% or less-ws	58		

Cover Type 'N' 26-50% S	Code
Trembling Aspen-rp	80
Trembling Aspen-jp	81
Trembling Aspen-spr,bf,tl	82
Birch-rp	85
Birch-jp	86
Birch-spr & bf	87
Balsam Poplar-spr,bf,tl	88

Cover Type 'H'< 25% S	Code
Trembling Aspen	90*
Trembling Aspen < 50%, wb(20%+)	91
Birch	92
Basswood	93
Ash	94
Elm	95
Oak	96

Manitoba Maple	97
Balsam Poplar	98**
Largetooth Aspen	9A
Eastern Cottonwood	9B
Hackberry	9C
Hop Hornbeam	9D
Willow	9E
Northern Region & Lake Winnipeg East***	Code
All Hardwoods	99

Northern Region & Lake Winnipeg East	Code
Hardwood - Pine	83
Hardwood - Spruce	84

b) Non-Productive Forested Land

i) Treed Muskeg (700)- Similar to open muskeg, except that the area is supporting semi-stagnated or stagnated trees. At least 10 percent of the area will be tree covered.

701 - Black Spruce Treed Muskeg	51 Percent of Species Composition
702 - Tamarack Larch Treed Muskeg	51 Percent of Species Composition
703 - Eastern Cedar Treed Muskeg	51 Percent of Species Composition
704 - Taiga (Northern Transition Forest)	

ii) Treed Rock (710) - Rock with a very shallow soil, supporting semi-stagnated or stagnated trees. At least 26 percent of the area will be tree covered. These sites do not produce merchantable stands.

711 - Jack Pine Treed Rock	51 Percent of Species Composition
712 - Black Spruce Treed Rock	51 Percent of Species Composition
713 - Hardwood Treed Rock	51 Percent of Species Composition

iii) Willow/Alder (720) - Low lying areas with a saturated water table presently supporting willow or alder growth. Without improvements these sites are not capable of producing merchantable timber stands. At least 51 percent of the area must be shrub covered.

721 - Willow	51 Percent of ground cover
722 - Alder	51 Percent of ground cover
723 - Dwarf Birch	51 Percent of ground cover
724 - Shrub	76 Percent of ground cover
725 - Shrub/Prairie	Shrub 51 Percent of ground cover

iv) Protection Forest (730) - Presently developed or reserved recreational areas and small islands (less than 2 hectares)

731 - Recreational sites
732 - Small Islands (less than 2 ha.)
733 - Precipitous slopes/Fragile sites
734 - Shelter Belts

2c) Non-Forested Land

Includes areas withdrawn from timber production for a long period of time, such as cultivated fields, hay meadows, pastures, settlements, rights-of-way, gravel pits, beaches, wide ditches, summer resorts, bare rock, barren, mines, marsh and muskeg.

I) Barren-Bare Rock (800) - Tundra and rock with less than 25 percent tree cover.

801 - Barrens - Tundra
802 - Bare Rock - Igneous
803 - Bare Rock - Sedimentary
804 - Open Sand Dunes

ii) Fields (Agriculture) (810) - Areas of private and leased land cleared of tree cover and presently under an agricultural use. Less than 10 percent of the area will be tree covered.

811 - Hayland - cultivated
812 - Cropland - cultivated
813 - Pastureland - domestic animals
815 - Land clearing in progress
816 - Abandoned cultivated land

iii) Meadow (820) - Moist to wet grassland suitable for hay production (natural hay land), at least 51 percent of the area is covered by grass.

821 - Dry Upland Ridge Prairie
822 - Moist Prairie
823 - Wet Meadow
24 - Sand Prairie

iv) Marsh - Muskeg (830)

831 - Muskeg - Wetland which has a vegetative cover consisting mainly of sphagnum moss and heath plants with very scattered brush. Black Spruce, Tamarack or Cedar cover does no exceed 10 percent
832 - String Bogs
835 - Marsh - Wetland completely or partially covered with tall grass, rushes, or sedges, unsuitable for hay but can be used as a habitat for furbearing animals.
838 - Mud/Salt Flats
839 - Sand Beaches

v) Unclassified (840-859) - right-of-way, roads, gravel pits, beaches, summer resorts, mines, oil fields, etc.

841 - Townsites/Residential Sites
842 - Airstrips
843 - Roads/Railroads
844 - Transmission lines/Pipelines
845 - Gravel Pits/Mine sites
846 - Fence lines (Community Pastures), fire guards
847 - Drainage Ditches
848 - Beaver Flood
849 - Dugouts/Water holes
851 - Oil Fields - oil wells, all structures pertaining to.

2d) Water (900)

Includes lakes and rivers, measured at the high water mark, able to be delineated with a double line on the aerial photographs. Narrow river and creeks marked by a single blue line are not to be considered as separate types, nor as type boundaries.

901 - Rivers, arrows showing direction of flow
991 - Lake Winnipeg
992 - Lake Manitoba
993 - Lake Winnipegosis
994 - Red River
995 - Assiniboine River

3. Site Classification

The following site classification has been described for the INTERLAKE SECTION of Manitoba ONLY. All factors of landform, indicator plants and tree growth should be considered when assigning site class. The following indicator plants should be used as a guide when evaluating site.

MOISTURE REGIME	LANDFORM	INDICATOR PLANTS		SUBTYPE AND SITE CLASS					
		ABUNDANT	SCATTERED	JP	WS	BP	BS	TL	TA
ARID	rock outcrop, higher gravel beach ridges	reindeer moss, creeping savin	bearberry	2	3	-	-	-	3
DRY	higher beach, outwash and moraine ridges	bearberry, creeping savin, reindeer moss, slender mountain rice	common juniper, soapberry	2	3	3	3	-	2
MOIST (groundwater and vadose water types)	low positions and flaring-out margins on beach and outwash OR till plains, lacustrine flats and higher flood plains	red-ozier dogwood, bunchberry, Ribes sp. naked niterwort, creeping snowberry	buffalo berry, common juniper, rough grained mountain rice, alder	1	1	1	1	-	1
VERY MOIST	depressional positions on beach and outwash and lacustrine deposits	red-ozier dogwood, naked miterwort, bunch-berry, Ribes sp., alder	bog cranberry	1	1	1	1	1	1
WET	depressional positions on till and lacustrine material	alder, marsh marigold, bog cranberry		-	-	-	1	1	1
SATURATED	deep organic terrain	sphagnum sp., labrador tea, marsh marigold		-	-	-	2	2	-

NOTE: - Arid sites are generally devoid of tree cover.

4. Cutting Class

Cutting class is based on size, vigour, state of development, and maturity of a stand for harvesting purposes.

a) Class 0 - Forest land not restocked following fire, cutting, windfall or other major disturbances (hence, potentially productive land). Some reproduction or scattered residual trees (with net merchantable volume less than 20 m^3 per hectare) may be present.

b) Class 1 - Stands which have been restocked either naturally or artificially. There may be scattered residual trees present as in Cutting Class 0. To be in Cutting Class 1 the average height of the stand must be less than 3 metres.

c) Class 2 - Advanced young growth of post size, with some merchantable volume. The average height of the stand must be over 3 metres in order to be in this cutting class.

d) Class 3 - Immature stands with merchantable volume growing at or near their maximum rate, which definitely should not be cut. The average height of the stand should be over 10 metres and the average diameter should be over 9.0 centimetre (9.0 cm) at Dbh (1.3 m).

e) Class 4 - Mature stands which may be cut as they have reached rotation age (+\-) 10 years on Site 1 or (+\-) 20 years on Site 2.

f) Class 5 - Overmature stands, which should be given priority in cutting.

5. Crown Closure Class

Crown closure will be estimated from the photographs by the photo-interpreter. Four classes will be recognized and entered onto the stand description sheet for each township as part of the photo-interpreter type aggregate. Changes of this estimate can be made only under exceptional circumstances.

Code

0 - 0 % - 20% crown closure
2 - 21% - 50% crown closure
3 - 51% - 70% crown closure
4 - 71% and over

Example of type aggregate written in full

04-1-3-4

Where:

0 - Cover Type: Softwood
4 - Subtype: Jack Pine 71% - 100%
1 - Site 1
3 - Cutting Class 3
4 - Crown closure 71% and over

(MNR, 1996)

6. V-TYPE

A V-Type (Vegetation Type) designation has also been incorporated into the new mapping definitions. The V-Type value (Table 4.2) that is now coded into each forest stand provides additional information that relates directly to the ecological aspect of a stand. Instead of focussing only on productive capability of a stand in terms of timber, V-Types provide detailed information on the overstory and the understory of the stand including common shrubs, herbs and mosses, forest clover floor characteristics, and soil-site characteristics, all of which are crucial on the multi-resource use of the areas for recreation, mining, logging, preservation, and the suitability of the stand for producing habitat for various wildlife species (Zoladeski *et al.*, 1995). Currently, forest stands in Manitoba are being coded with a V-type class, and with the aid of the Forest Ecosystem Classification Manual of Manitoba, interpretations can be done directly in the field by qualified personnel. There are also manuals that provide interpretations for various wildlife species that can be linked to each V-Type. In this study, the V-Types were used with other data to locate areas that were most suitable for moose on Hecla Island.

Table 4.2 Forest Ecosystem Classification Vegetation Types

Mainly Hardwood	V1	Balsam Poplar Hardwood and Mixedwood
	V2	Black Ash (White Elm) Hardwood
	V3	Miscellaneous Hardwoods
	V4	White Birch Hardwood and Mixedwood
	V5	Aspen Hardwood
	V6	Trembling Aspen-Balsam Fir/Mountain Maple/Herb-Rich
	V7	Trembling Aspen-Balsam Fir/Shrub- and Herb-Poor
	V8	Trembling Aspen Mixedwood/Tall Shrub
	V9	Trembling Aspen Mixedwood/Low Shrub
	V10	Trembling Aspen Mixedwood/Feather Moss
Conifer Mixedwood	V11	White Pine Mixedwood
	V12	Red Pine Mixedwood
	V13	White Spruce Mixedwood
	V14	White Spruce Mixedwood/Feather Moss
	V15	Jack Pine Mixedwood/Shrub-Rich
	V16	Jack Pine Mixedwood/Feather Moss
	V17	Black Spruce Mixedwood/Shrub- and Herb-Rich
	V18	Black Spruce Mixedwood/Feather Moss
Conifer	V19	Cedar Conifer and Mixedwood
	V20	Tamarack/Labrador Tea
	V21	White Spruce/Balsam Fir Shrub
	V22	White Pine Conifer
	V23	Red Pine Conifer
	V24	Jack Pine Conifer
	V25	Jack Pine/Feather Moss
	V26	Jack Pine-Black Spruce/Lichen
	V27	Black Spruce/Shrub- and Herb-Poor
	V28	Jack Pine-Black Spruce/Feather Moss
	V29	Black Spruce/Feather Moss
	V30	Black Spruce/Labrador Tea/Feather Moss (Sphagnum)
	V31	Black Spruce/Herb-Rich/Sphagnum (Feather Moss)
	V32	Black Spruce/Herb-Poor/Sphagnum (Feather Moss)
	V33	Black Spruce/Sphagnum

See the Forest Ecosystem Classification for Manitoba (field guide) for descriptions of the vegetation types.

Soil Map

Soil data for Hecla Island were acquired from the Soils of the Red Rose-Washow Bay Area Report No. 19 produced by Manitoba Soil Survey in 1975. Although the soils were mapped at a reconnaissance level (1:126,720), which provides fewer observations than detailed reports (1:50,000 - 1:20,000), this scale does provide a good representation of the area since the soils are quite uniform throughout the island.

The basic unit for describing and classifying soils is the 'series', which initially groups soils according to parent material and drainage. Polygons can contain one soil unit or a variation of three soil units called a complex. A new soil boundary is drawn if soils have similar profiles but vary in terms of surface texture, erosion, topography, stoniness, and salinity (Smith *et al.*, 1975).

To convert the soil data into the GIS, common points on the soil map were located on the corresponding digital base map. Although only four points are required to register the map, up to eight points were used to provide for a more accurate product. After the soil lines were converted into digital format, a utility was run in the GIS that clipped and extended lines to the boundary of the study area, and indicated soil polygons that were not closed, and in need of polygon indicators. Next, an internal database was set up within the GIS in order to enter soil types (MAPUNITNOM) into the GIS, that later would be identifiers that could be linked to other soil data sets. The last stage involved running a polygon formation routine which converts the polygon lines into raster format (cells) in order to perform overlay functions and other forms of analysis.

The soil map was now in the form from which the next phase of developing the database could proceed. Figure 4.3 illustrates the distribution of soils throughout Hecla Island by dominant soil name (original two letter codes), and Table 4.3 is the legend describing important characteristics of each series. The two letter reconnaissance codes are assessed by pedologists and converted into the modern three letter codes which reside in a separate look-up table (database). The internal soil database that was built in the GIS was joined to a look-up table comprised of the linking field (MAPUNITNOM), which also included an expanded database describing attributes of each soil code within a polygon (Table 4.4). With the database in this form, it can provide linkages to other databases such as: the Soil Names File (SNF), which has attributes describing particular soil series; the Soil Layer File (SLF), which provides detailed information on each profile within a series; and the Soil Interpretation File (SIF), which supplies information on the use and management of soils for agricultural uses (agriculture capability, irrigation suitability, potential impact, and management considerations), soil suitability for various engineering uses (topsoil, sand and gravel, buildings with basements etc.), and soil suitability for various recreation uses such as campsites and trails.

According to Figure 4.3, most of the southwest periphery of Hecla Island is considered marsh, with some poorly drained gleysols (Fyala) and pockets of imperfectly drained clay (Arborg) soils in the south. The central part of Hecla Island is also poorly drained, with a large area comprised of Molson Complex which consists of 24-64 inches of sphagnum underlain by significant amounts of forest and sedge peat. The northern part of Hecla Island provides the most suitable soils for development, with good natural drainage and soil structure (Kinkow and Hilbre soils).

Table 4.3 Legend Describing the Soils within Hecla Island

Map Symbol	Soil Name	Profile Type	Parent Material	Natural Drainage	Native Vegetation	Topography	Stoniness
Ab	Arborg Series (clay)	Gleyed Solenetzic Dark Gray	Moderately to strongly calcareous lacustrine clay	Imperfect	Aspen and Spruce	Level	Stone-free
Cax	Cayer Complex	Terric Mesisol	16 to 52 inches of stratified moderately decomposed mesic sedge peat, underlain by strongly to moderately calcareous, medium to fine textured sediments	Very Poor	Sedges, willow, alder, balsam poplar, black spruce	Depressional to level	Stone-free
Co	Caliento Series (fine sand)	Gleyed Gray Luvisol	Weakly to moderately calcareous, moderately coarse to coarse deposits underlain by medium textured glacial till	Imperfect	Aspen, balsam poplar	Undulating	Moderately to slight stony
Dl	Devils Lake (loam)	Orthic Gray Luvisol	20 to 30 inches of extremely calcareous medium textured glacial over limestone bedrock	Good	Aspen, Jack pine and white spruce	Gently undulating to undulating	Excessively stony
Fy	Fyala Series (clay)	Rego Humic Gleysol	Moderately to strongly calcareous lacustrine clay	Poor	Sedges, meadow grasses, spruce	Depressional to level	Stone-free
Fy(P)	Fyala Series peaty phase (clay)	Rego Humic Gleysol	Moderately to strongly calcareous lacustrine clay, 6 to 24 inches of fibric moss or 6 to 16 inches of other kids of organic material occurs on the surface	Poor	Sedges, meadow grasses, spruce	Depressional to level	Stone-free
Hi	Hilbre Series (loam)	Degraded Eutric Brunisol	20 to 30 inches of extremely calcareous medium textured glacial till over limestone bedrock	Good	Jack pine, aspen	Gently undulating to undulating	Excessively stony
Jx	Julius Complex	Fibrosol	Greater than 36 inches of fibric Sphagnum moss underlain by a significant layer or layers of mesic forest peat. Fibric sphagnum moss peat greater than 64 inches thick, over moderately to strongly calcareous fine to medium textured lacustrine sediments	Poor to Very Poor	Stunted black spruce and tamarack, with dominantly Sphagnum moss, eracious shrub understory	Depressional to level	Stone free
Ki	Kinkow series (clay)	Orthic Gray Luvisol	6 to 36 inches of moderately to strongly calcareous fine textured lacustrine deposits underlain by extremely calcareous medium textured till	Good	Aspen, spruce, jack pine, bl	Gently to undulating	Slightly to moderately Stony
Lt	Lettonia Seres (clay)	Solodic Gray Luvisol	moderately to strongly to calcareous lacustrine clay	Good	Aspen, balsam poplar, balsam fir, birch and spruce	Gently undulating to undulating	Moderately to very stony

Map Symbol	Soil Name	Profile Type	Parent Material	Natural Drainage	Native Vegetation	Topography	Stoniness
Lyx	Leary Complex	Orthic Dark Grey Luvisol	Stratified, strongly calcareous, outwash and beach deposits	Good to excessive	Jack Pine, aspen and some bur oak	Gently undulating to undulating (low narrow ridges)	Slightly stony
Mh	Marsh Complex (mucky silty clay)	Carbonated Rego Gleysol	Thin mucky loam deposits over extremely calcareous till and moderately calcareous clay	Very poor	Reeds. sedges	Depressional to level	moderately to exceedingly stony
Mx	Molson Complex	Fibrisol Mesisol	24 to 64 inches of fibric sphagnum moss underlain by significant amounts of mesic forest in sedge peat; moderately to strongly calcareous medium to find textured lacustrine sediments within 64 inches of the surface.	Poor to very Poor	Stunted black spruce and tamarack with an understory of Sphagnum mosses and eraceous shrubs	Depressional to level	Stone-free
Ox	Okno Complex	Mesisol Fibrisol	16 to 52 inches of mesic forest peat or thin (0 to 24 inches) of fibric sphagnum moss peat. Moderately to strongly calcareous fines to medium textured sediments occurs within 64 inches of the surface	Poor to very poor	Black spruce with an understory of feather and sphagnum mosses and eracious shrubs	Level to depressional	Stone-free
Pa	Pinawa Series (Sandy loam)	Gleyed Greyed Luvisol	Moderately coarse to medium textured, moderately calcareous stony glacial till	Imperfect	Aspen spruce, and some balsam fir	Gently sloping	Moderately stony
Pc	Partridge Creek (clay)	Rego Humic Gleysol	6 to 30 inches of moderately calcareous, lacustrine clay over extremely calcareous medium textured glacial till	Poor	Sedges, meadow grasses, balsam poplar, spruce	Depressional to level	Slightly stony
Pe	Peguis Series (clay)	Gleyed Dark Grey	6 to 30 inches of moderately to strongly calcareous lacustrine clay v or extremely calcareous medium textured glacial till	Imperfect	Aspen, some white spruce	Level	Slight stoney
Sb	Sand Beaches (sand)	Orthic Regosol	Recent cobbly sand beach deposits	Rapid to imperfect	Scattered aspen, balsam poplar, willow	low narrow ridges	Stone-free to very stony
Sl	St. Labre Series (fine sand)	Orthic Grey Luvisol	Weakly to moderately calcareous sand which is underlain by extremely calcareous medium textured glacial till within 30 inches of the surface	Good	Aspen, birch, jack pine, spruce	Gently undulating to undulating	Slightly to moderately stony

Figure 4.3 Soils of Hecla Island

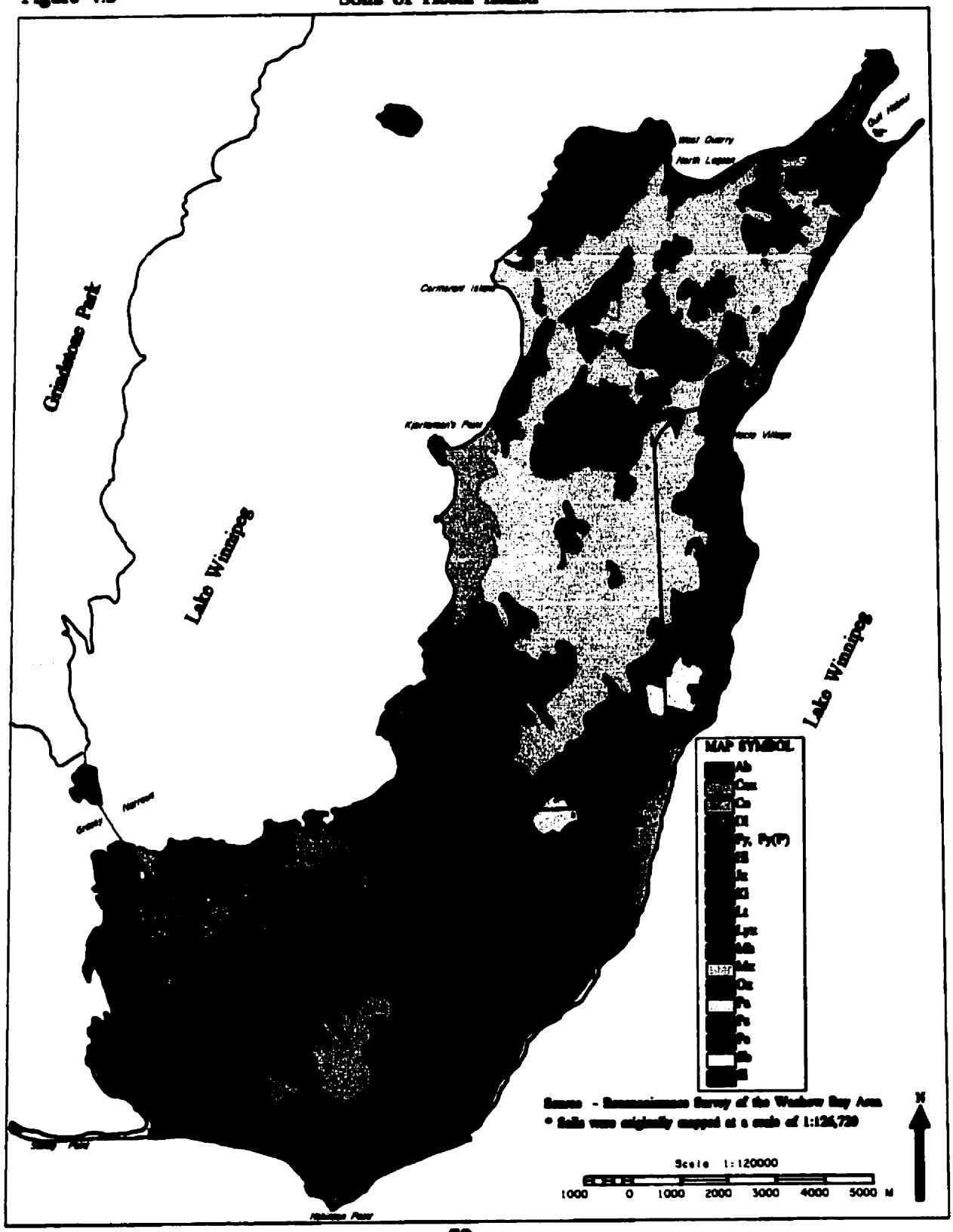


Table 4.4 Structure of Soil Database

Internal Soil Database — Linking Code — Soil Map Unit File (Look Up Table)

Tagid	Poly Area	Mapunitnom
1	105 08	Ab
2	122 90 8	Ab5-Fd4-In1
3	144 92	Cax
4	186 64	Fy
5	24 28	Fy(P)
7	11 28	Fy(P)7-Ab3
8	79 76	Lyx
9	143 24	Mh
10	235 76	Mx6-Cax4
11	22 48	Ox
12	53 92	Sb

Mapunitnom	Soil_code	Modifier	Class	Extent1	Soil_code2	Modifier2	Extent2	Soil_code3	Modifier3	Extent3	Slopep1	Slopep2	Slopep3	Stone1	Stone2	Stone3	Erosion1	Erosion2	Erosion3	Salinity1	Salinity1	Salinity3
Ab	ABG		xxxx	100			0			0	05	-90	-90	0	-	-	0	-	-	0	-	-
Ab5-Fd4-In1	ABG		xxxx	50	FFD		40	IWO		10	05	35	10	0	4	3	0	0	0	0	0	0
Cax	CAY		xxxx	70	HWL		30			0	05	05	-90	0	-	-	0	0	-	0	0	-
Fy	FYL		xxxx	100			0			0	05	-90	-90	0	-	-	0	-	-	0	-	-
Fy(P)	FYL	p	xxxx	100			0			0	05	-90	-90	0	-	-	0	-	-	0	-	-
Fy(P)7-Ab3	FYL	p	xxxx	70	ABG		30			0	05	05	-90	0	-	-	0	0	-	0	0	-
Lyx	LRY		xc1x	70	VLW		30			0	35	35	-90	1	1	-	0	0	-	0	0	-
Mh	$MH		xx3x	100			0			0	05	-90	-90	3	-	-	-	-	-	-	-	-
Mx6-Cax4	MLS		xxxx	40	CAY		30	SSB		10	05	05	05	0	-	-	0	0	0	0	0	0
Ox	OKO		xxxx	70	OOK		20			0	05	05	-90	0	-	-	0	0	-	0	0	-
Sb	$SB		xcxx	100			0			0	35	-90	-90	0	-	-	-	-	-	-	-	-

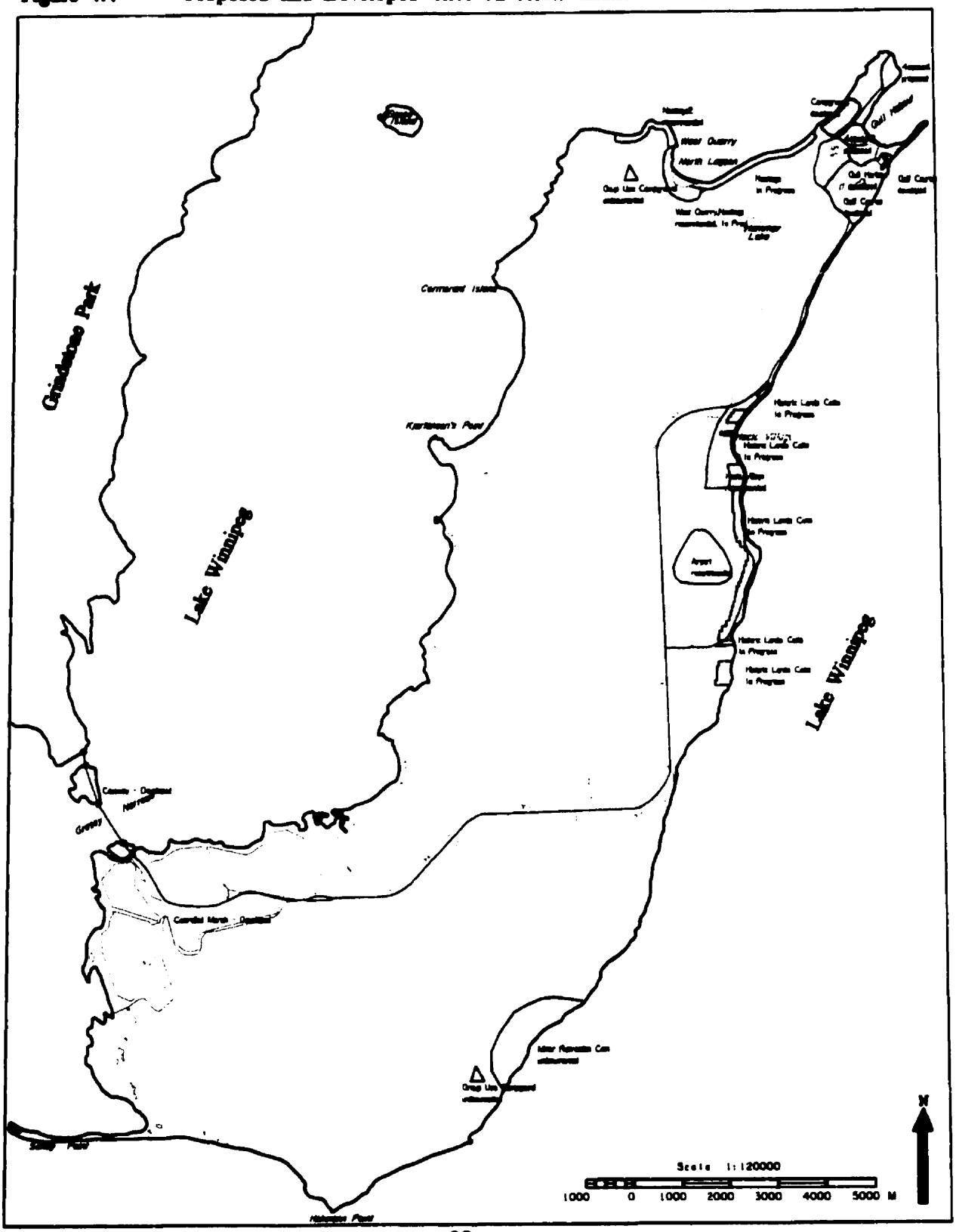
Proposed and Developed Sites on Hecla Island

Figure 4.4 shows developed areas on Hecla Island and sites proposed in the past, but not constructed. The data were used to analyse past development to determine the quality of land, vegetation, and wildlife habitat lost. Once the locations of potential areas of development were mapped, an overlay routine was used with the other layers to illustrate spatially and quantitatively the possible loss of future key environmental components if certain projects are allowed to proceed. Table 4.5 is a record of past and proposed developments on Hecla Island compiled from various inventories and recreation studies.

Table 4.5 Proposed and Developed Sites on Hecla Island - 1962 to Present

DEVELOPMENT	TYPE	SOURCE
4season Site 1	Proposed	DNR - 1988
4season Site 2	Proposed	DNR - 1988
North Cottage	In Progress	MNR - 1997
Airport	Recommended	Man Taylor Muret - 1968
Gull Harbour	Developed	MNR - 1994
Golf Course	Developed	MNR - 1994
Campground	Developed	MNR - 1994
Hecla Village	Recommended	Man Taylor Muret - 1968
West Quarry	Recommended	Man Taylor Muret, TAEM - 1997
Minor Recreation Complex	Undocumented	Man Taylor Muret - 1968
North Cottage 2	Recommended	TAEM - 1997
Group Use Campgound	Undocumented	HIRI - 1979, Man Taylor Muret - 1968
Goup Use Campground 2	Undocumented	DTR - 1978
Historic Lands Cottage	In Progress	MNR - 1997

Figure 4.4 Proposed and Developed Sites on Hecla Island - 1962 to Present



4.5 Classifying and Assessing the Characteristics of the Key Environmental Components

This part of the methodology consists of characterising the key flora and fauna on Hecla Island, and classifying the data for efficient representation in the GIS. The information is coded into discrete databases to first produce individual maps for each layer of information, illustrating significant and sensitive areas of flora and fauna on Hecla Island. Next, all the layers are overlaid to produce a map that portrays the combination of each key environmental component layer. For example, any area on the map can be queried to return a result that provides the following:

1. The presence of a significant plant or other feature.
2. Vegetation/Terrain Status
3. Significance/Sensitivity for Waterfowl
4. Presence of a Significant/Sensitive Colonial Nesting Species Site
5 Significance/Sensitivity for Moose in Summer and Winter

Finally, the key environmental component map is overlaid with the combined map of land characteristics to produce a final map that is used to develop ultimate environmental thresholds for each component of the environment, including Vegetation/Terrain Component, Wildlife Component and the Soil/Recreation Suitability Component. These thresholds, which refer to the limits that are imposed by development, are found by analysing the relationship between the resources and activities, and enable maps to be produced for each activity and development depicting areas where they are acceptable.

A map for the Vegetation/Terrain and Wildlife Component was produced to illustrate thresholds for each component of the environment, while the combined map indicated the final limitations of an area for a specific tourist activity or development, including all environmental components. The Soil/Recreation components were used as inclusion layers to further enhance the analyses by targeting suitable areas in terms of soil and recreational attributes.

Uniqueness of Flora

The ranking of species is a standardized system that has been developed by scientists over the past 23 years. The elements are ranked to target areas of conservation that are in need of special protection (MBCDC, 1996). The species ranking describes the frequency of occurrence of an environmental element throughout its current/former range and can be denoted as GRANK, NRANK, and SRANK which refers to its global, national and provincial rank respectively (MBCDC,1996). The classes are as follows:

G1/N1/S1 - Very rare throughout its range/country/subnation (typically 5 or fewer occurrences or very few remaining individuals or acres). May be especially vulnerable to extirpation.

G2/N2/S2 - Very rare throughout its range/country/subnation (typically 6 to 20 occurrences). May be vulnerable to extirpation.

G3/N3/S3 - Uncommon throughout its range/country/subnation (21 to 100 occurrences).

G4/N4/S4 - Widespread, abundant, and apparently secure throughout its range/country/subnation, with many occurrences, but the element is of long term concern (100 + occurrences).

G5/N5/S5 - Demonstrably widespread, abundant, and secure, throughout its range/country/subnation, and essentially ineradicable under present conditions.

To make the data useable, Vegetation Type codes (V-Types) were added for each cover type within the vegetation database. This was accomplished by developing a unique list of cover types, and comparing them with a list of probable V-Types provided by the Forestry Branch of Manitoba Natural Resources. A description of plant communities and other landscapes for northern and boreal Manitoba was acquired through the Manitoba Conservation Data Centre, which provided a species ranking and associated V-Type for each species. This provided a common linking field with the vegetation database, and therefore allowed a map to be produced which represented the Vegetation/Terrain status of Hecla Island.

It is crucial on Hecla Island to preserve environments that are unique and occur infrequently throughout the island. As a result, some classes were grouped together to reflect their particular status and rank (Table 4.6). Figure 4.5 depicts the status of vegetation and other unique areas throughout Hecla Island. There are a number of areas that require special protection, although most of the vegetation species throughout the island are considered common and abundant. There were also classes in the database that were combined into unclassified land. These include recreation and man-made land, and

areas with no associated rankings such as willow, wet meadow, and moist prairie. Presumably, these areas could have been classed as either common or abundant since they occur frequently throughout the island.

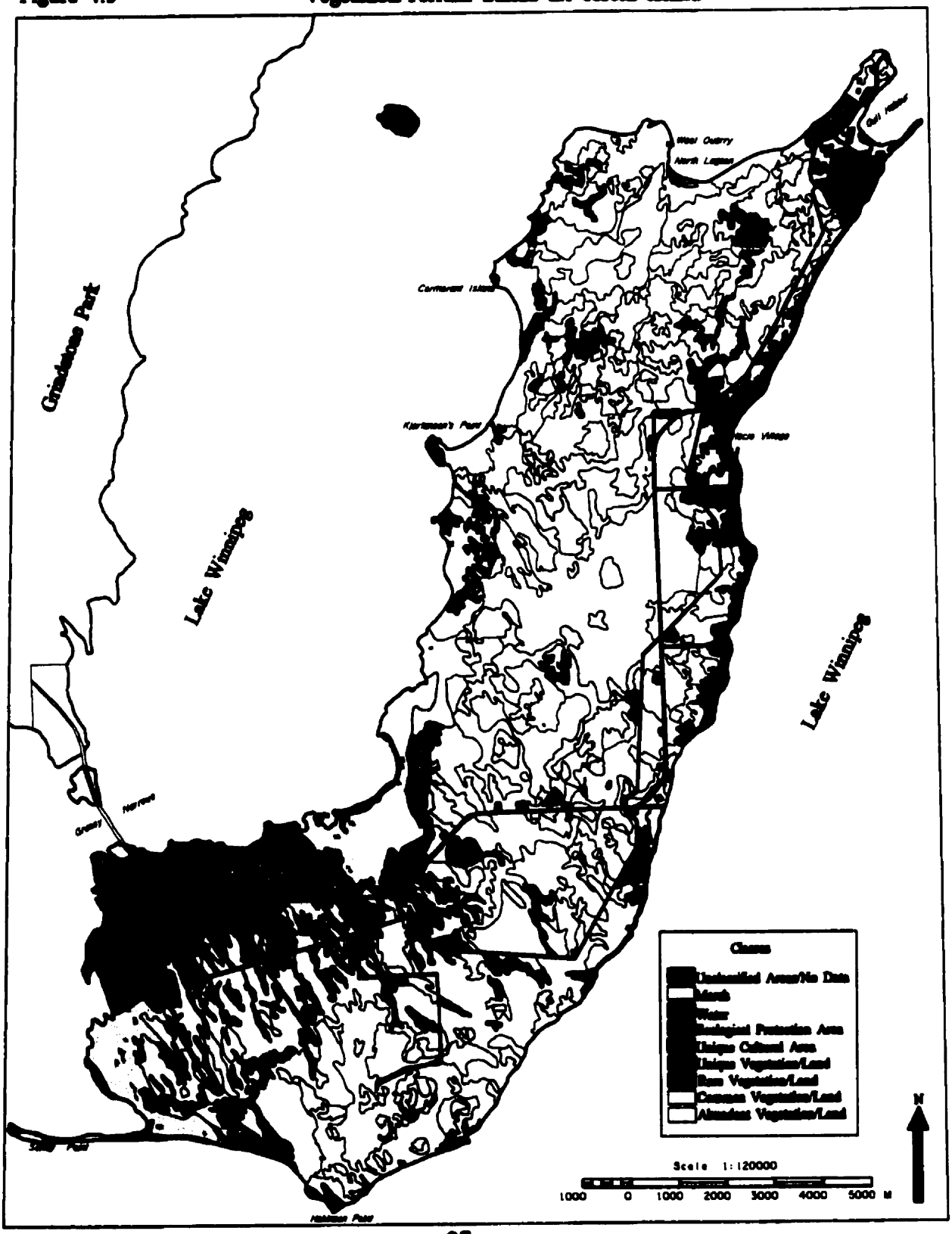
Table 4.6 Vegetation/Terrain Status Classes

Code	Description	Class	Frequency
UA	UA - Unclassified Areas - Areas that have been updated from 1:50k topographic map.	Unclassified	4
ND	ND - No Data - Covertypes or V-Types that could not be ranked. Includes areas of willow, wet meadow, and moist prairie.	Unclassified	158
RL	Recreation Land - Land partially modified for human use.	Unclassified	4
ML	Man Made Land - Land that has completely been changed by man.	Unclassified	125
SU	Marsh (Status Unknown) - Code has not been developed	Marsh	28
ZZ	Water	Water	82
EP	Defined Land Use - Ecological Protection Area.	Ecological	13
HL	Unique Cultural Area	Unique	35
S2	Vegetation	Unique	4
S3S4	Vegetation	Rare/Common	25
S4	Vegetation	Common	404
S4-S5, S5	Vegetation	Abundant	214

1. Derived from the combination of forest cover maps, Forest Ecosystem Classification, Plant descriptions of Northern and Boreal Manitoba (MBCDC), and proposed Land Use Classification for Hecla/Grindstone Provincial Park.

2. The West Quarry was classified as unique because it represents a remnant of past Icelandic culture. The same is true for certain areas within the Hecla town site, just outside of Hecla village. Many of these lands provide very good illustrations of past Icelandic agricultural practices and farm units. As a result, these were also classed as culturally unique.

Figure 4.5 Vegetation/Terrain Status for Hecla Island



Significant Plants and Unique Natural and Cultural Features

Significant Plants and Unique Natural and Cultural Features (Table 4.7) is a point database that was derived from the Manitoba Conservation Data Centre (MBCDC), the Hecla Island Resource Inventory (HIRI), the Global Positioning System (GPS), and personal communication from a wildlife specialist in the area (P.C. - D. Roberts). MBCDC provided data on very unique or rare plant sites that require special protection on Hecla Island. The common names of these sites can not be disclosed, since MBCDC does not want them disturbed. Because there were no specific guidelines in Manitoba for setbacks for unique plants as there were for other significant resources, a 50-metre buffer was used to indicate a protective zone that should be examined before developing in the area. Furthermore, this is only the initial step when analysing the suitability of an area for development. More detailed site assessments should be made after a general location is determined, because there may be other sensitive sites that are present in areas that have not been found or documented. An approximated 150 metre buffer was used for the burial site, as the exact area that it had encompassed was not known. The other sites were compiled from other sources in which the common names of the sites and location were published (Figure 4.6).

Table 4.7 Significant Plants and Unique Natural and Cultural Features

Tagid	Type	Common Name	Grank	Srank	Source	Corridor
1	Plant/habitat	undisclosed	G5	S3	MBCDC	50
2	Plant/habitat	undisclosed	G5	S3S4	MBCDC	50
3	Plant/habitat	undisclosed	G5	S3S4	MBCDC	50
4	Plant/habitat	undisclosed	G5	S1	MBCDC	50
8	Plant/habitat	Grass Pink Orchid		S2	HIRI	50
9	Plant/habitat	Ragged Fringed Orchid	G5	S2	HIRI	50
10	Burial Site	Undetermined			Gps-1997	150
12	Plant	Canada Yew	G5	S3	HIRI	50
14	Plant/habitat	Fringed Orchid	G5	S2	MBCDC	50
15	Plant/habitat	Necklace Sedge	G5	S2?	MBCDC	50
16	Natural Salt Lick			S2	P.C. - D. Roberts	50
17	Artificial Salt Lick			S2	P.C. - D. Roberts	50

1. MBCDC - Natural Heritage Biological and Conservation Data System, Developed by: Manitoba Data Conservation Centre

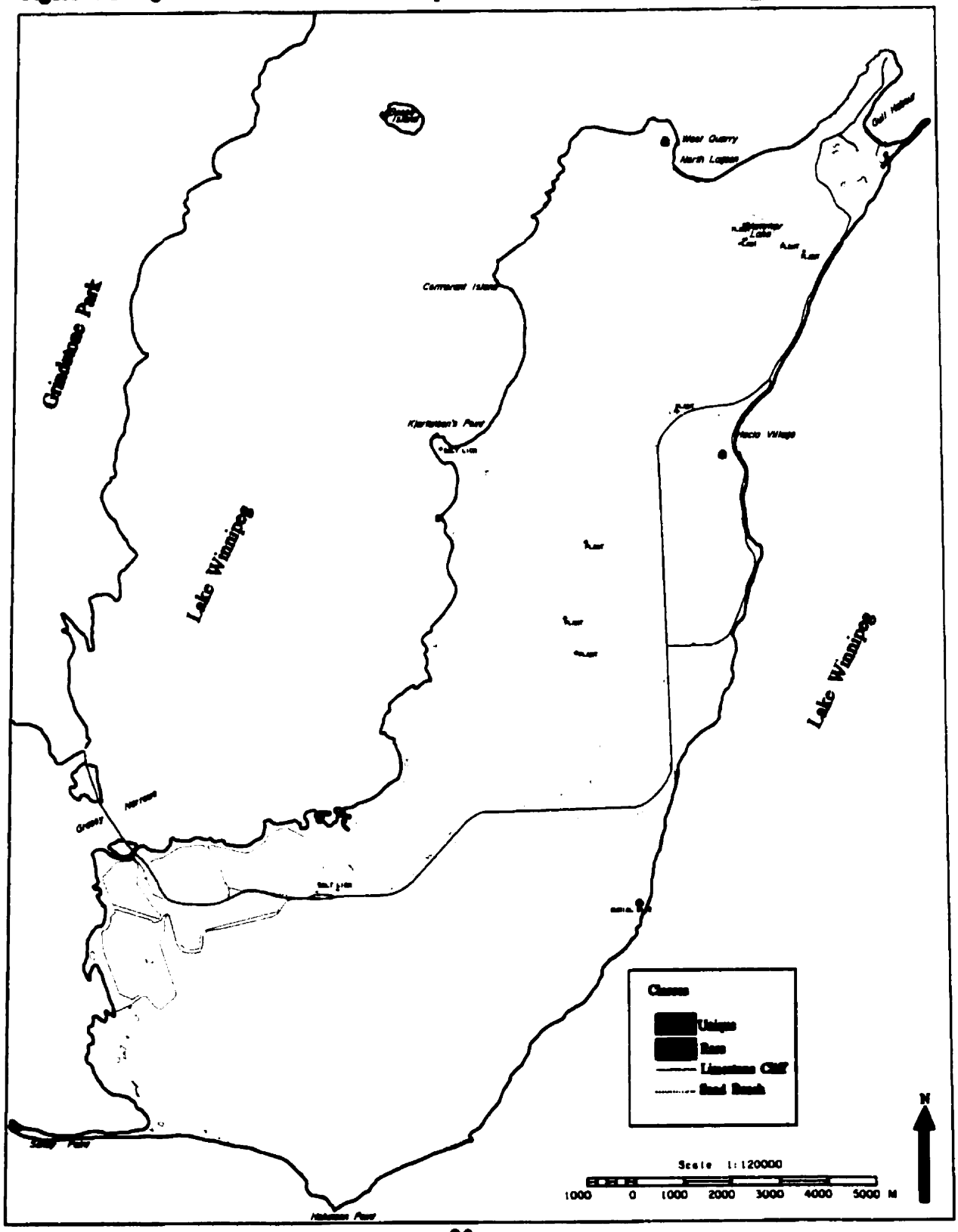
2. HIRI - Hecla Island Resource Inventory

3. Gps - Global Positioning System

Fauna Significance/Sensitivity

Much of the success of tourism on Hecla Island has been the allure of Hecla's two main attractions, moose and waterfowl/colonial nesting birds. Hecla's environment provides excellent nesting areas for a variety of waterfowl, with the island marshes located on the central flyway of North America. The moose population also thrives within Hecla's environment, and although the moose are less isolated than they once

Figure 4.6 Significant Plant Sites and Unique Natural and Cultural Features on Hecla Island



were, they remain a distinct entity on the island. With the development that has occurred on Hecla Island, it can no longer be considered a genuinely unique island ecosystem. However, much of the naturalness and primitive aspects remain. Therefore, in order to maintain these attributes, it is crucial for the wildlife habitat to be protected. This will ensure that future generations can observe the moose and waterfowl, and appreciate the wilderness that Hecla Island has to offer. To produce a measure for the importance of key fauna on Hecla Island, biological significance of their habitat in terms of the quality of the land for food and cover was used, since it is these areas that the wildlife will frequent the most (Kozlowski, 1986).

Significant/Sensitive Waterfowl Nesting Areas

The map of waterfowl nesting areas on Hecla Island identifies optimal habitat for waterfowl by using the base map, the vegetation cover map, the land use map, and the Hecla Island Resource Inventory (HIRI). The land use map (Figure 4.14) shows Hecla and Grassy Narrows Marsh as an Ecological Protection Area, as it is an essential breeding and feeding ground for many species of waterfowl. Additional marshes on Hecla Island were identified by querying the *cover type field* in the vegetation database. Other important areas were described in the HIRI and classified based on their significance to waterfowl. Unnamed ponds and streams, and other wet areas were given a moderate rating since these areas may be used by waterfowl, but it is not known how valuable they are. Table 4.8 represents the ratings assigned to waterfowl nesting areas on Hecla Island.

It is evident from Figure 4.7 that the most valuable area for waterfowl is located in the marshes on the southwest part of Hecla Island.

Table 4.8 Significant/Sensitive Waterfowl Nesting Areas

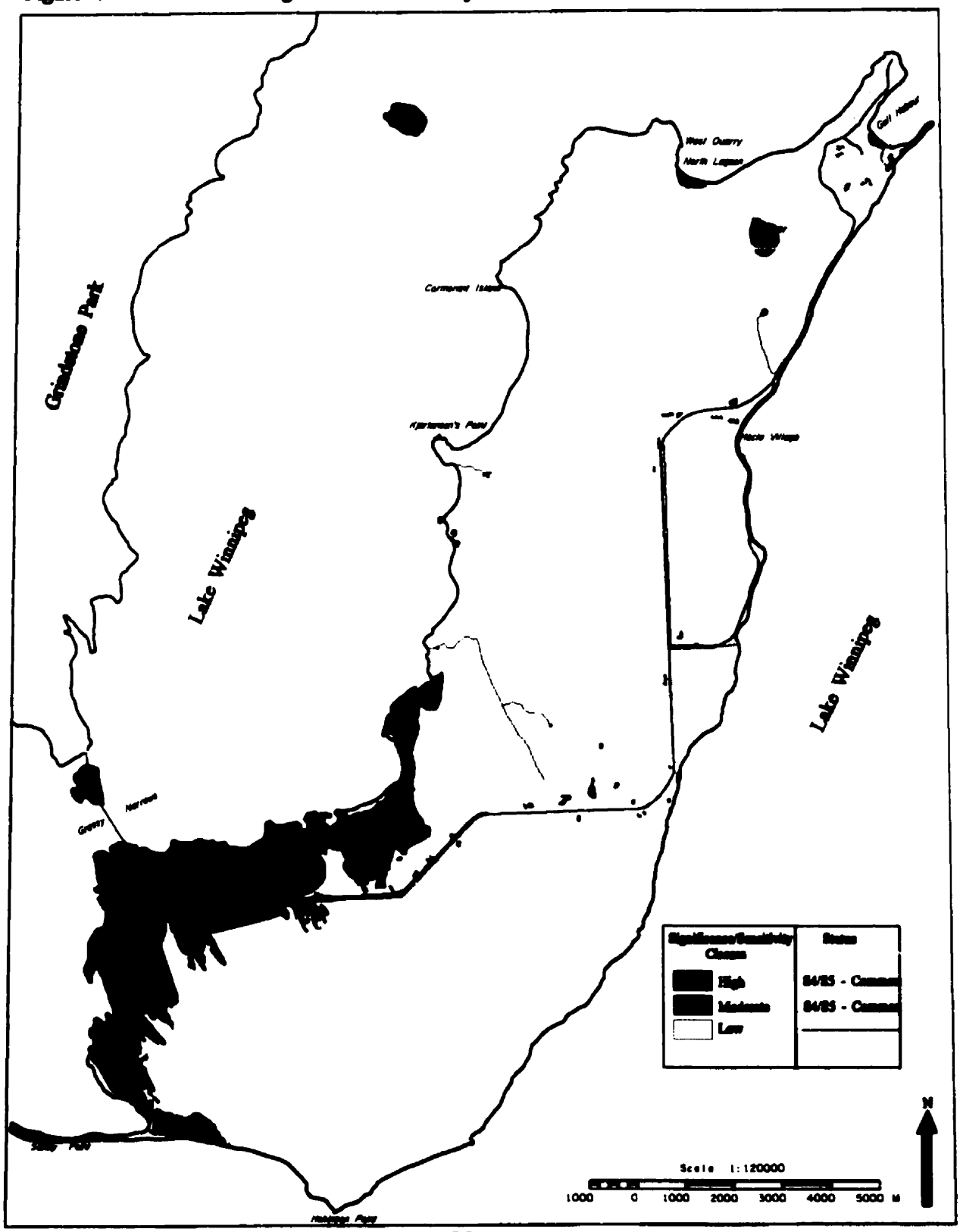
Area	Habitat Significance/ Sensitivity	Sensitivity (2.)
Hecla Marsh	High	High (E,W,N,H,B)
Grassy Narrows Marsh	High	High (W,N,H,F)
Other Marshes	High	Moderate (N,H,)
North Lagoon	Moderate	Moderate (N,H)
Hammer Lake	Moderate	Moderate (N,H)
Goose Island	Moderate	Low (N)
Roadside Ditches (1.)	High	Moderate (N,H)
Ponds and streams	Moderate	Moderate (N,H)

1. Created buffer around roadside ditches to represent waterfowl nesting areas according to species list in the HIRI. Streams were also buffered to determine other possible waterfowl nesting areas. The field bio_c=4 indicated roadside ditches, while bio_c=3 was the value assigned to streams. The surface level that resulted was later overlaid onto terrain/vegetation layer to produce the final product.

2. Sensitivity Codes

E - Ecological Protection Area
W - Water Levels
N - Nesting Period (May-June)
H - Human Disturbance (Sensitive if within proximity of Human development or activity)
B - Extreme Breeding Range

Figure 4.7 Significance/Sensitivity for Waterfowl On Hecla Island



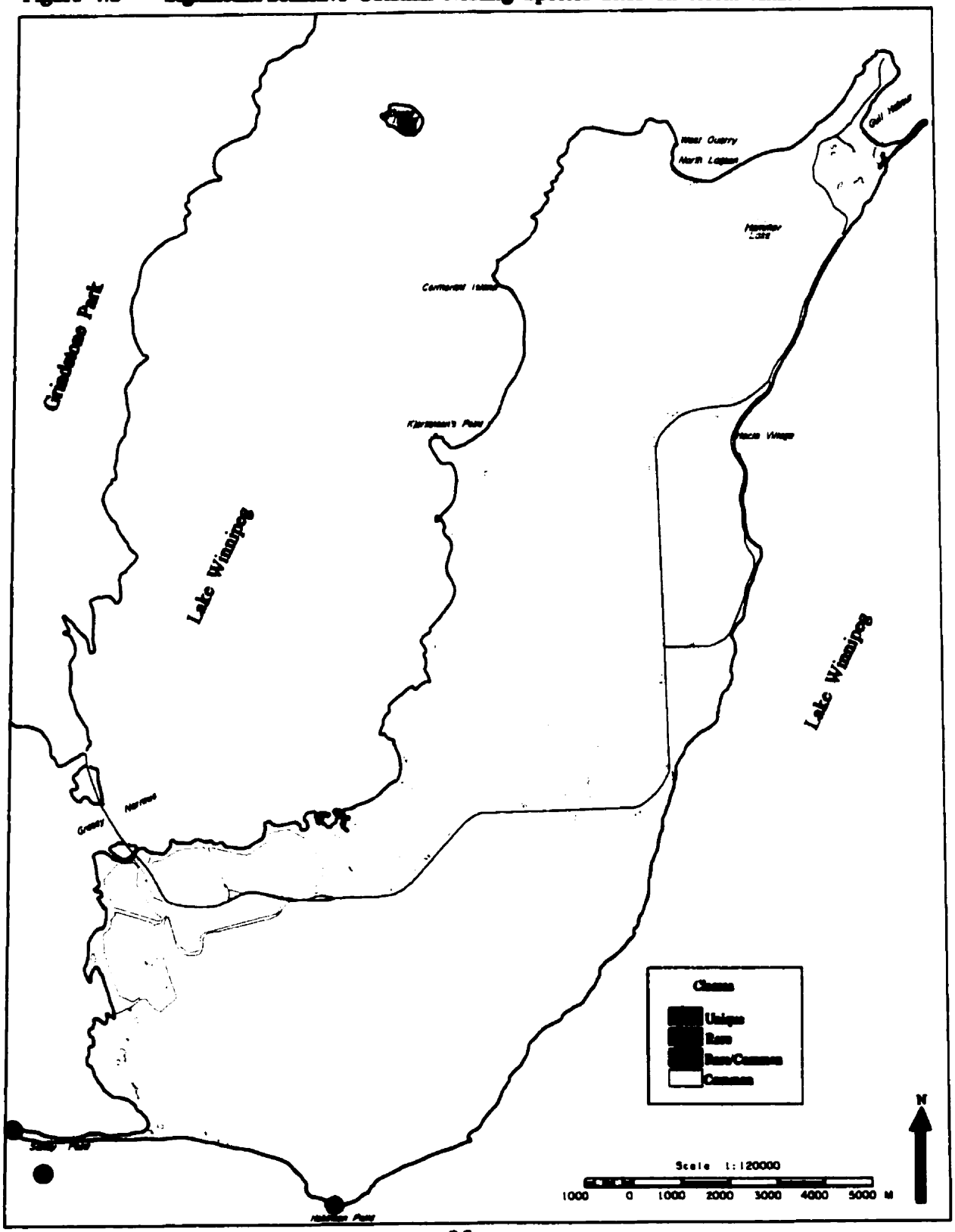
Significant/Sensitive Colonial Nesting Species Point Sites

These sites include areas that are essential for nesting or breeding for Colonial Nesting Species and other key nesting areas on Hecla Island. Each site was identified by entering its UTM coordinate location in the GIS. Next, a buffer of 200 metres, based on the *Manitoba Natural Resources Consolidated Buffer Management Guidelines* was generated to protect each site and surrounding area from the effects of tourism development (Figure 4.8). According to MNR (1999) "a resource buffer is defined as a strip of land that is managed to reduce or eliminate the impacts of land use practices on sensitive areas or natural features (p. 1). Table 4.9 indicates the important nesting grounds for colonial birds and one significant site for Piping Plover.

Table 4.9 Significant/Sensitive Colonial Nesting Species Point Sites

Site	Common Name (s)	Habitat Significance/ Sensitivity	Uniqueness
1	Undisclosed	High	S4 - (Common)
2	Undisclosed	High	S5,S4 - (Common)
3	Double Crested Cormorants Colony	High	S4 - (Common)
5	Undisclosed	High	S4 - (Common)
6	Great Blue Herons Colony	High	S4 - (Common)
7	Common Tern, Herring and Ringed Billed Gull, Cormorant, Pelican	High	S4, S5, S5, S4, S3 (Common-Rare)
8	Undisclosed	High	S4S5 - (Common)
9	Piping Plover	High	S2 - (Unique)
10	Undisclosed	High	S2 - (Unique)
11	Franklin's, Ringed Billed and Herring Gulls, Common Terns, Pelican	High	S4S5,S5,S5, S4S5,S3 - (Common-Rare)

Figure 4.8 Significant/Sensitive Colonial Nesting Species Sites on Hecla Island



Significant/Sensitive Areas for Moose

The moose of Hecla Island are considered a unique resource and a main attraction for tourists. Over the years, efforts have focussed on maintaining their numbers in order that their special value can be preserved. However, the persistent intrusion of tourism development and activities may eventually force the moose into smaller, more detached areas. Since there are limited habitats available within island environments, the area may become less desirable for the moose, and inevitably numbers will start to decline. Consequently, the goal of this analysis was to locate and map areas with important moose habitats, as well as critical areas which moose use as cover, in order to develop thresholds that protect certain areas from high impact activities or developments.

Since moose use different areas in the winter and summer, a temporal threshold was established to represent a combined measure of sensitive areas for both seasons. To derive this measure, a rating for habitat suitability based on forest ecosystem classification was employed (Table 4.10). In addition, it was decided that not only are high valued habitats crucial, but so is the thermoregulation potential of a specific region, as well as its surrounding area.

Thermoregulation is a measure of cover that protects the moose from heat in the summer, and snow and frigid temperatures in the winter. While a value for moose theromoregulation potential (MTRP) was provided in the Forest Ecosystems Classification Manual, and linked by Vegetation Type (V-Type) to an associated cover type for each polygon, the significance of surrounding polygons as areas of cover in the

winter time had to be generated through the GIS. Since the moose are more stressed in winter, it was important to locate areas that not only have food, but also effective cover, so that the moose do not have to travel great distances to find food and cover. To accomplish this, a *neighbourhood routine* was set up in PAMAP GIS that extracted information on areas directly surrounding polygons. A new field was created that updated the perimeter of a shared polygon that had a MTRP that was HIGH. This value was important to areas that were rated LOW in terms MTRP, but had surrounding polygons that provided good quality cover, since moose require areas that are in close proximity to go after feeding, and escape from the cold. This becomes even more critical in winters with heavy snow, when moose are expending more energy to move from areas of food to areas of cover. In the summer season, cover is also important, but to a lesser extent since movement through the forest is less demanding. Figures 4.9 and 4.10 illustrate the areas most suitable for moose in the summer and winter respectively. Magenta and red indicate the most suitable habitat for moose. The marsh is rated high for moose in the summer, and low in the winter since it is frozen and provides no food or cover. Tables 4.11 and 4.12 characterise the groupings of Table 4.10 into associated Summer and Winter Significance/Sensitivity classes.

Table 4.10 V-Type Ratings for Moose Summer/Winter Feeding and Thermoregulation Potential

V-Type	Summer Feeding	MTRP	Winter Feeding
V1	H	L	M
V2	M	M	M
V4	H	M	H
V5	H	M	H
V6	H	M	H
V13	M	H	M
V17	M/L	H	M/L
V18	M/L	H	L
V20	M/L	H	M/L
V21	M	H	M/L
V29	L	M	L
V30	L	M	L
V31	L	M	L
V32	L	L	L
V33	L	L	L

1. - There are no occurrences for V-Type 3, 7-12, 19, and 22-28 on Hecla Island, therefore there ratings were not shown.

Table 4.11 Moose Summer Significance/Sensitivity Classes

Class	Moose Feeding Potential	Moose Thermoregulation Potential
1	High High	Moderate High
2	High Moderate	Low High
3	Moderate Low	Moderate High
4	Moderate Low	Low Moderate
5	Low	Low
6	No Value	No Value

Table 4.12 Moose Winter Significance/Sensitivity Classes

Class	Moose Feeding Potential	Moose Thermoregulation Potential
1	High	Moderate (Neighbour MTRP=High occupying 25% of polygon perimeter)
	High	Low (Neighbour MTRP=High occupying 50% of polygon perimeter)
2	High	Moderate
	Moderate	High
	High	Low
3	Moderate	Moderate
	Low	High
4	Moderate	Low
	Low	Moderate
5	Low	Low
6	No Value	No Value

Figure 4.9 Significant/Sensitive Areas for Moose on Hecla Island (Summer)

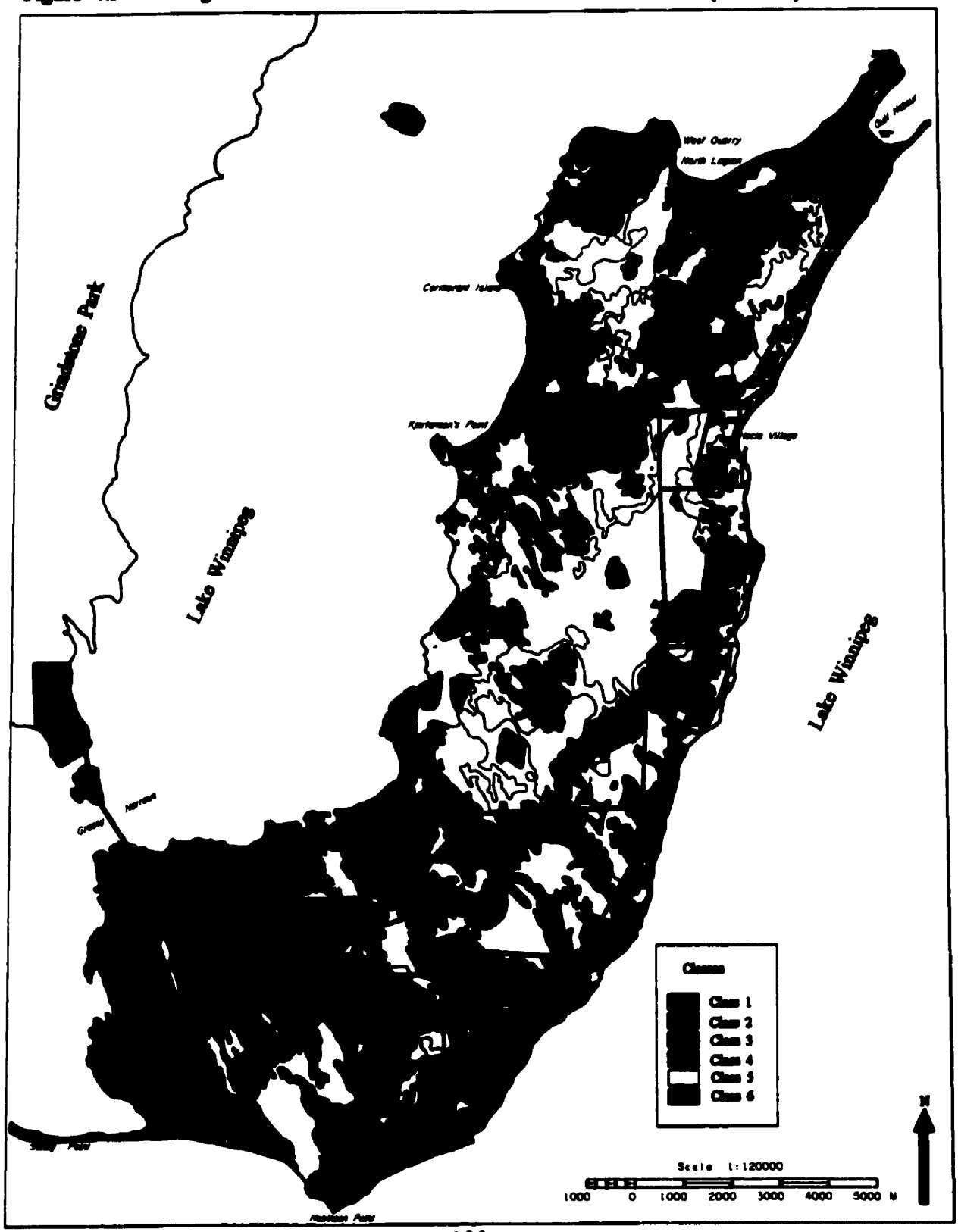
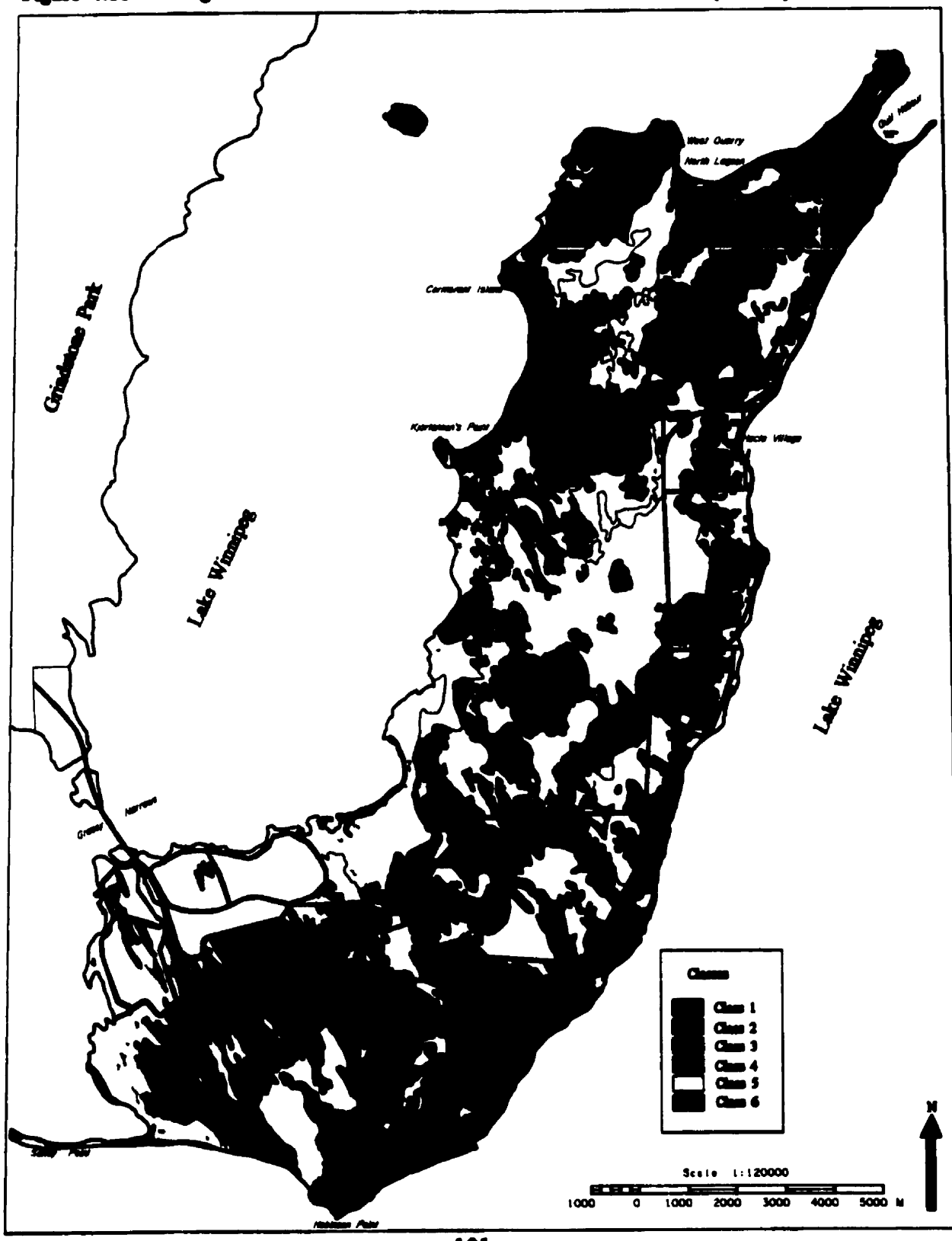


Figure 4.10 Significant/Sensitive Areas for Moose on Hecla Island (Winter)



Adjustments to the V-Type Ratings for Moose on Hecla Island

The interpretations provided for moose feeding and thermoregulation potential are based on habitat requirements for animal species that relate to the structural characteristics of vegetation, including plant height, stand age, canopy density, diversity of conditions, abundance of a thick understory, lichen ground and boreal cover, and the proportion of deciduous and coniferous trees (Zoladeski *et al.*,1995). This method evaluates forest ecosystems throughout the entire province of Manitoba and provides a very effective measure for mapping moose habitat requirements on Hecla Island. In addition, it was also beneficial to utilize the most recent information on moose within Hecla's environment. In "*An Assessment of Winter Habitat for Moose on Hecla Island with Emphasis on Browse Production and Browse Utilization*" , Goulet (1992) provided local interpretations of moose habitat requirements on Hecla Island. As a result, some adjustments were made to the ratings for winter feeding potential for moose on Hecla Island based on the following:

Table 4.13 Adjustments to Winter Feeding Potential based on Goulet (1992)

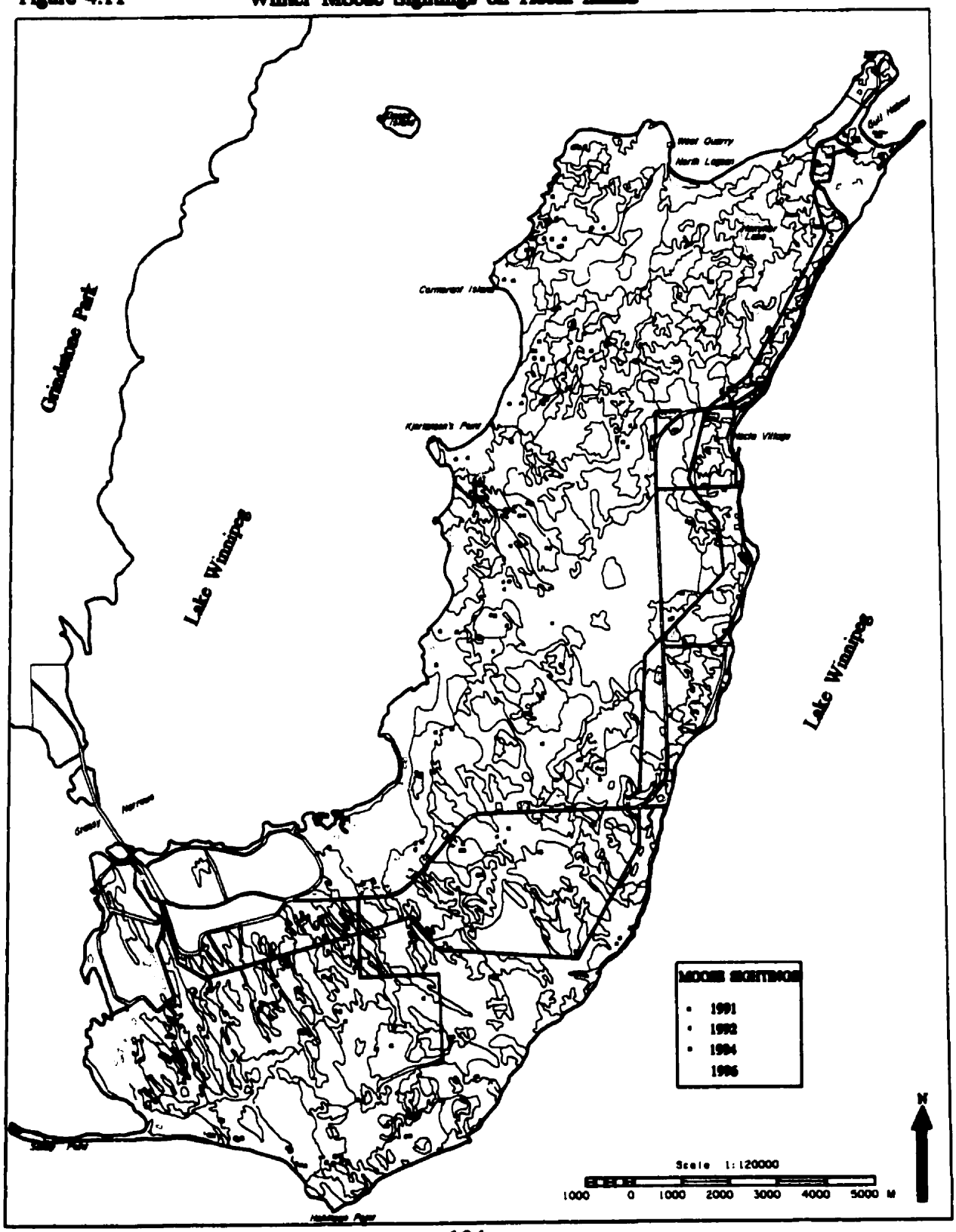
Species Composition	Winter Feeding Potential
Willow Alder	High
Immature Coniferous	High
Immature Deciduous	High
Mixedwood (S-H)	Moderate
Mixedwood (H-S)	Moderate
Mature Deciduous	Moderate
Mature Coniferous	Low
Treed Muskeg	Low
Marsh Muskeg	Low
Mixed Pure Coniferous	Low

An adjustment was also made to disturbed sites, which are areas affected by past logging, fire, windthrow or disease, and are currently being rejuvenated. In the vegetation database, the site is considered disturbed if its cutting class is zero. At this stage of development, these areas have a limited capacity and quality of habitat to support food or cover for moose. Therefore, these sites have been downgraded in the database by one class in terms of moose summer and winter feeding potential, and moose thermoregulation potential.

Relationship Between Moose Sightings and Winter Significance/Sensitivity

Moose population surveys were conducted by the Manitoba Department of Natural Resources on Hecla Island for the winters of 1991-1993 and 1996. The surveys were based on an aerial census, with a Bell 206 Jet Ranger helicopter travelling at approximately 120 metres above ground at speeds between 60-100 kms/hour (Whaley, 1992-1997). The data were gathered from aerial survey maps and placed as point sightings on a map of Hecla Island (Figure 4.11). The points were then input into the GIS and overlaid onto the forest inventory layer (vegetation map). The purpose of this analysis was to discover the relationship between the moose sightings and the quality of the habitat in which they are residing. Although moose are roaming animals, in winter cooler temperatures and snow force them to remain near areas of suitable habitat and cover (Collins, 1998). The goal of this analysis was to verify the classification for moose significance/sensitivity by determining whether moose are found in more highly

Figure 4.11 Winter Moose Sightings on Hecla Island



suitable classes for moose habitat and cover (Class 1-3), as opposed to the lower classes (4-6) with poor habitat/cover. The results are indicated in the following tables:

Table 4.14 1991 Moose Sightings

Winter Significance/ Sensitivity Class	Moose Sightings
1	1
2	18
3	14
4	8
5	13
6	0
Total	54

Table 4.15 1992 Moose Sightings

Winter Significance/ Sensitivity Class	Moose Sightings
1	4
2	28
3	23
4	5
5	9
6	0
Total	69

Table 4.16 1993 Moose Sightings

Winter Significance/ Sensitivity Class	Moose Sightings
1	2
2	32
3	33
4	9
5	6
6	0
Total	82

Table 4.17 1996 Moose Sightings

Winter Significance/ Sensitivity Class	Moose Sightings
1	10
2	22
3	12
4	6
5	9
6	0
Total	59

Table 4.18 Total Moose Sightings 1992-1994, 1996

Winter Significance/ Sensitivity Class	Moose Sightings
1	17
2	100
3	81
4	29
5	37
6	0
Total	264

The data suggest that there is a strong positive relationship between moose sightings and the Significance/Sensitivity classes. That is, moose were found much more frequently in classes 1-3 (198 sightings), than in classes 4-6 (63 sightings) in 1992-1994 and 1997. There are few sightings in Class 1, because this class occupies only 467.00 hectares and six polygons (Table 4.19). Conversely, there are over 3500 hectares of Class 2 habitat, and as a result, these areas contain over 100 total sightings from 1991-1993 and 1996. One slight anomaly occurs from class 4 to 5 when the number of total moose sightings again increases. According to Table 4.19, a large part of Hecla Island is within this area (5861.24 hectares) and therefore, this area may be used as travel corridors for the moose.

Table 4.19 Frequency of Significant/Sensitive Wintering Areas for Moose on Hecla Island

Class	Frequency (Number of Polygons)	Area (Hectares)
1	6	467
2	193	3660.56
3	112	3610.12
4	66	1324.76
5	148	5861.24
6	91	775.24
0	84	81684.16

Although this technique provides support for the moose sensitivity/significance classes, there are certain errors that may be introduced when the data are being transferred to the map. First, the location of the points placed by the observer in the plane may not be entered precisely without specific reference points, and conceivably, a point that is only slightly offset could translate into 100 of metres of error in the GIS. Similarly, when transferring the points into the GIS, it is difficult to judge the distance between the points, since some sightings represent groups of moose in one area, and therefore the scatter of points in the GIS will produce sightings on the border, or in adjacent habitat.

4.6 Land Characteristics

Vegetation/Land Modification

Vegetation/Land modification identifies the degree to which an environmental element has been transformed from its original state. Transformation on Hecla Island occurs in many forms. However, since the goal is to preserve the land for park purposes, major developments and modifications by tourist activities should only take place in limited zones, while less intensive activities should be allowed in other areas that do not affect unique vegetation, plants, and other features, or areas that possess key habitat for wildlife. In most areas where there is human development, there are noticeable degrees of transformation, although it may be difficult to observe or measure. Nonetheless, these impacts will have varying effects dependent on the sensitivity of the ecosystems. It is, therefore, critical to identify and protect ecosystems from further degradation and develop techniques to promote regeneration (Kozlowski and Hill, 1993). For example, the loss of mature forest for development impacts habitat for wildlife and the aesthetic appeal of the environment. In contrast, to increase the value of habitats, vegetation may be removed since moose feed on the smaller shrubs or browse which is less evident in mature forests.

In this analysis, the Vegetation/Land Modification map was used to illustrate and quantify land lost to tourism development. The map is applied in the development of UETs, whereby certain considerations for location of tourism development and activities are based on the transformation status of the area. The four classes of Vegetation/Land Modification on Hecla Island are:

1. Total - areas that have been completely transformed.

2. Major - areas that have been vastly modified but have maintained some tree cover.

3. Partial - areas which have not been directly impacted by tourist related development or activities, but have been changed since the introduction of tourism to the area.

4. Minimal - areas with little or no change.

As evident in Figure 4.12, most of the modification on Hecla Island is due to the development of the tourist infrastructure, including roads, gravel pits, transmission lines, the town site, and the intensive recreation around Gull Harbour. Although the development of trails for various tourist activities does not consume as much land as other uses, the impacts of these activities can be dramatic (Figure 4.13) .

Table 4.20 Vegetation/Land Modification Classes

Code	Description	Class
Total	Covertype = 840-851 (Townsites/Residential, roads/dikes, transmission lines, gravel pits, etc.)	Total
Major	Covertype=731 (Recreational Sites)	Major
Partial	Year of origin > 1962, Hecla managed Marsh Cutting Class = 0 Transformed From: 1- Fire 2 - Timber cutover 3- Disease, 4 - Wildlife/Vegetation management.	Partial
Minimal	All other Areas with little or no transformation	Minimal

Figure 4.12 Vegetation/Land Modification on Hecla Island 1962-1992

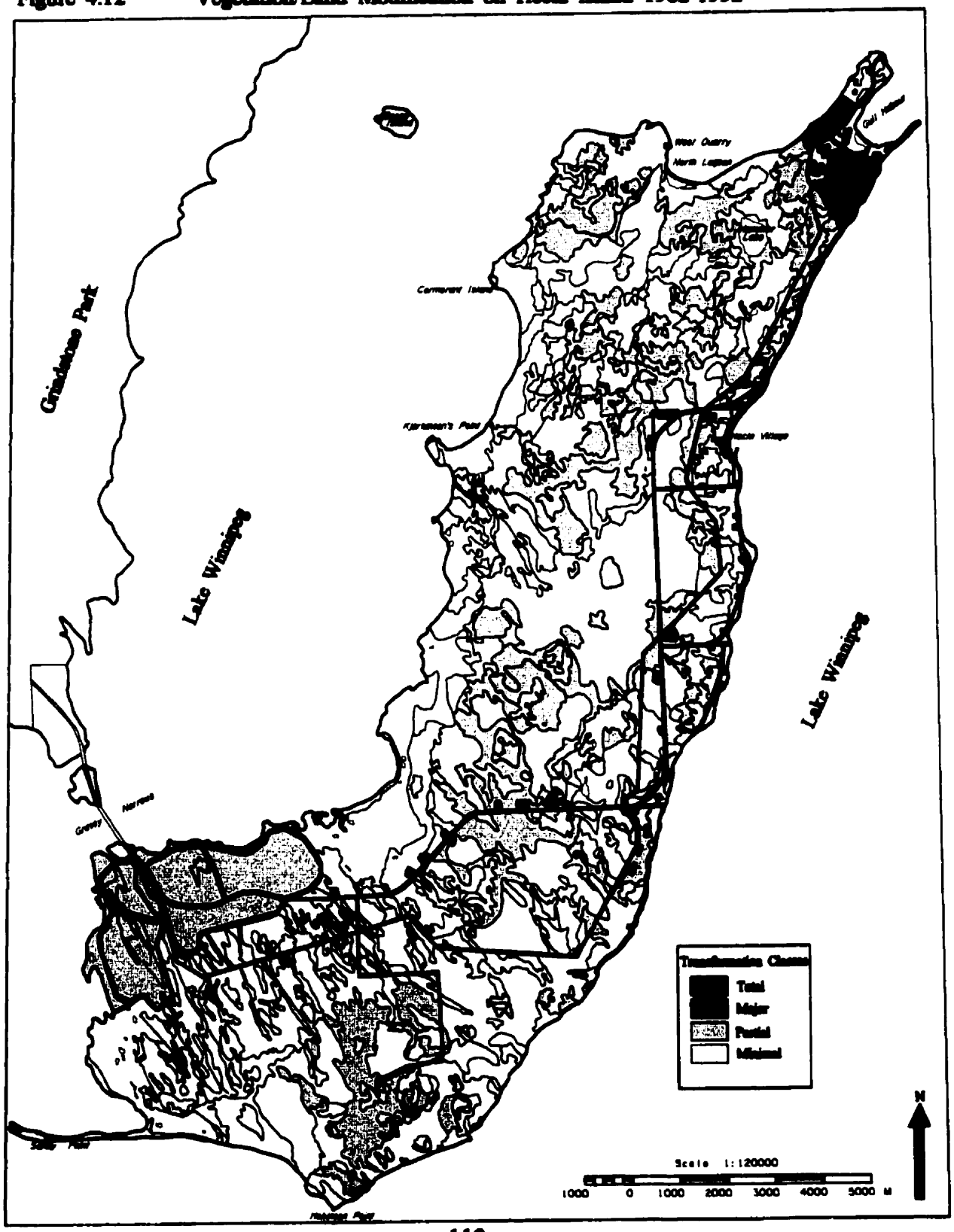
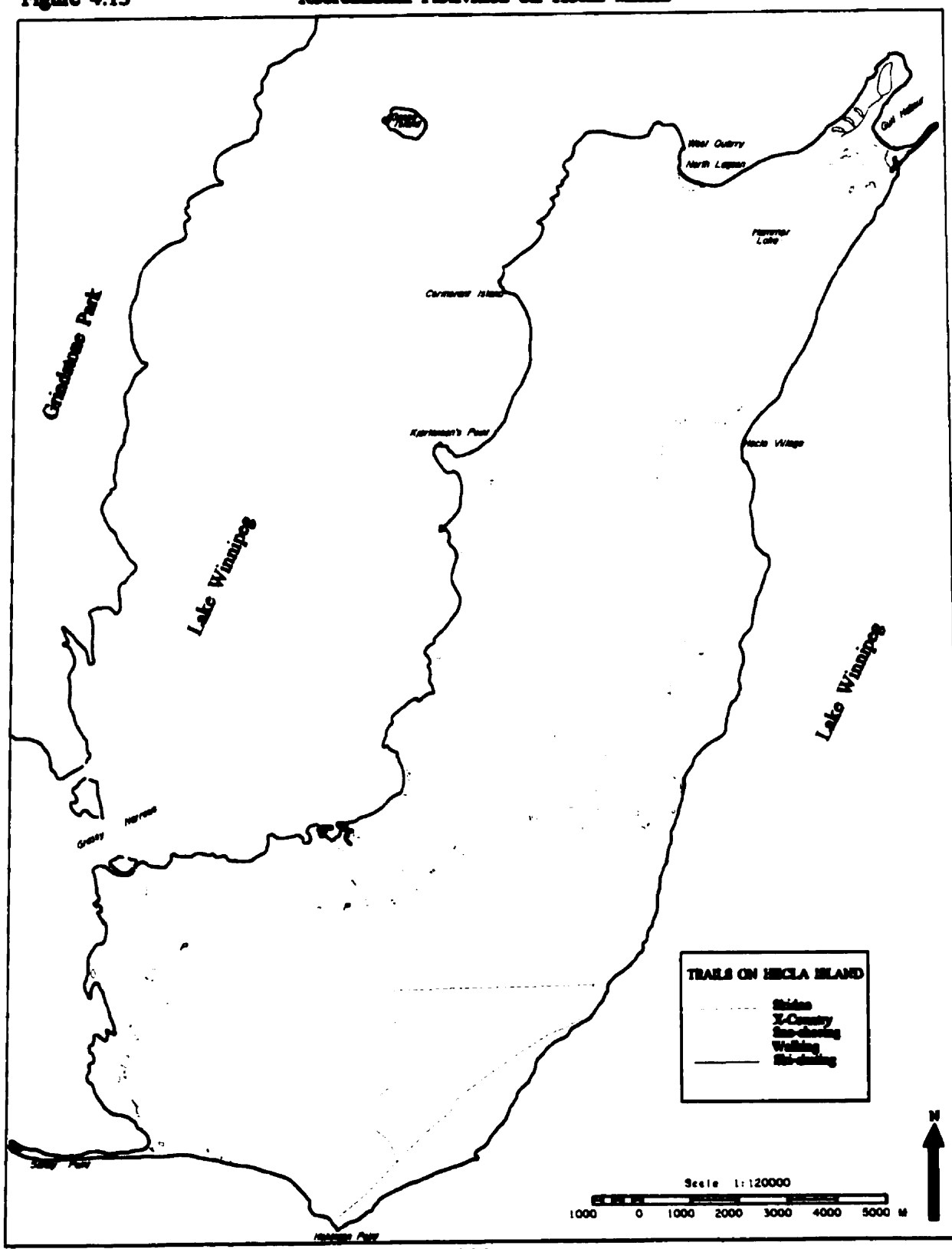


Figure 4.13 Recreational Activities on Hecla Island



Land Use

Land use zones for Hecla Island were designated for the purpose of protection, management, and development of the park's resources (DNR, 1988). The land use map was part of the Vegetation/Terrain Component in the final analysis to establish UETs for siting specific developments and activities on Hecla Island. Figure 4.14 shows the location of these zones within Hecla Island. The following classes have been proposed:

Land Use Classes

i) "Heritage - protects sites that are of significance to Icelandic and Aboriginal cultures.

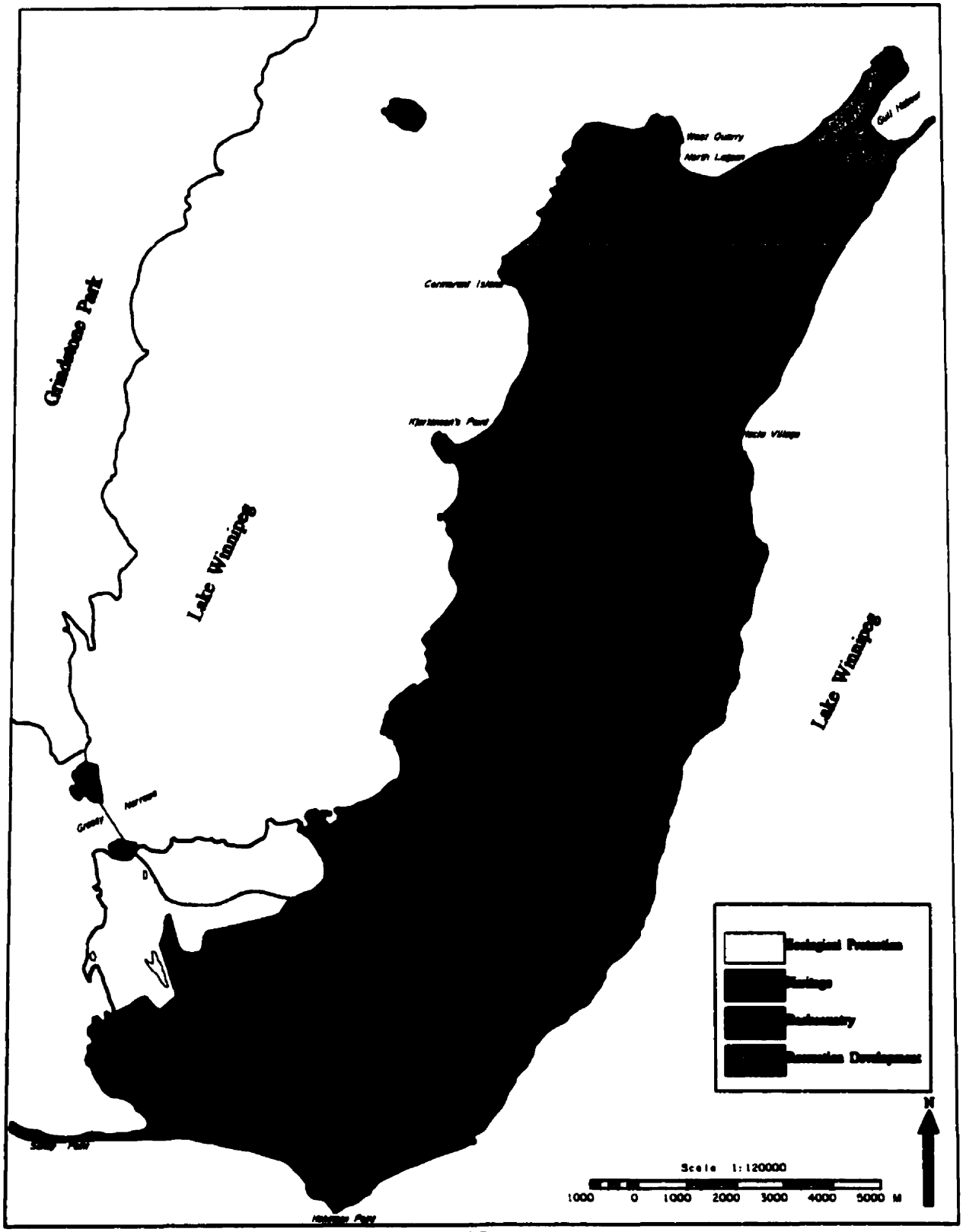
ii) Recreational Development - provides a range of recreational opportunities including campgrounds, beach, day use areas, boating, fishing, water sports, harbours, self guiding trails, amphitheatre, visitor centre, resort complex, rental cabins, and cottaging.

iii) Resource Management - permits commercial resource opportunities including haying and peat mining.

iv) Backcountry - protects undisturbed habitat for wildlife including colonial nesting birds, bald eagles and moose; protects special areas and sites including relict red pine community, colonial nesting islands, limestone cliff formations and natural salt licks; provides recreation opportunities such as hiking, cross-country skiing, snowmobiling, and enhanced wildlife viewing areas.

v) Access - provides existing automobile and public utility rights-of-way through backcountry and heritage areas of the park" (MNR,1997).

Figure 4.14 **Land Use for Hecla Island**



Land Suitability for Future Expansion

In this study, the assessment of environmental thresholds for locating developments and activities is based primarily on the significant flora and fauna on Hecla Island. However, another important aspect of this study is the land suitability for future expansion in terms of soils suitability and recreation capability. Since the source of these data is at smaller scales than the original vegetation data (Soils - 1:125,000, Recreation - 1:250,000), it was decided that these layers would be used as inclusion layers to illustrate soil suitability for intensive development (engineering use), and soil suitability and recreation capability for camping. For example, if recreation capability suggests that an area has little suitability for camping, there may be areas within the suggested location that are suitable but cannot be drawn at this scale, or the surroundings may be enhanced to make the site more favourable for another activity. Many other interpretations can be made from the Soil Interpretation File (SIF), as well as the recreation capability database, and therefore, they provide crucial data when it becomes necessary to develop an area.

Soil Suitability for Development

When evaluating suitable areas for development, land that may be considered poor for road construction is seldom avoided if the site can be improved and costs are justified. Due to the scale of the soil, there may be soil units that can not be mapped, and therefore, it may be necessary to initiate detailed surveys and on-site investigations in an area where new development is planned (Langman, 1986).

Table 4.21 indicates either suitable (good or fair rating) or unsuitable (poor or very poor rating) areas for development based on the initial ratings of the soils from the SIF which are present in Table 4.22. Figures 4.15 to 4.18 give four examples of interpretations made from the SIF based on the suitability of the soil for different uses. The maps indicate that most of the south and southwest part of Hecla Island soil is unsuitable for these activities, although there are some isolated areas that are rated good and fair. As previously indicated, this by no means eliminates these uses, but rather places more soil limitations on the development of these activities in those areas. In contrast, the area from Kjartanson's Point northward to Gull Harbour has significant areas that are suitable for camping, buildings, local roads, and trails.

Table 4.21 Soil Suitability for Selected Recreation and Engineering Uses

	Soil Name and Dominant Texture																	
	Arborg (clay)	Cayer Complex	Caliento (fine sand)	Devils Lake (loam)	Fyala (clay), Fyala (peaty)	Hilbre (loam)	Julius complex	Kinkow (clay)	Lettonia (clay)	Leary Complex (coarse sand and gravel)	Marsh Complex	Molson Complex	Okno Complex	Pinawa (sandy loam)	Partridge Creek (clay)	Peguis (clay)	Sand Beaches (sand and cobbles)	St. Labre (fine sand)
Camping Areas	U	U	S	U	U	U	U	S	S	S	U	U	U	S	U	U	S	S
Intensive Development (Buildings)	U	U	S	S	U	S	U	S	S	S	U	U	U	S	U	U	U	S

S - Suitable U- Unsuitable

Table 4.22 indicates the initial ratings for the soils within the study area and includes a description of the classes and limitations:

Table 4.22 Soil Ratings for Camping Areas and Buildings from the SIF

	Soil Name and Dominant Texture																	
	Arborg (clay)	Cayer Complex	Caliento (fine sand)	Devils Lake (loam)	Fyala (clay), Fyala (peaty)	Hilbre (loam)	Julius complex	Kinkow (clay)	Lettonia (clay)	Leary Complex (coarse sand and gravel)	Marsh Complex	Molson Complex	Okno Complex	Pinawa (sandy loam)	Partridge Creek (clay)	Peguis (clay)	Sand Beaches (sand and cobbles)	St. Labre (fine sand)
Camping Areas	Pws	Vsw	Fsw	Vp	Vws	Pp	Vsw	Fsp	Fs	G	Vw	Vsw	Vws	Fw	Pws	Ps	G	G
Intensive Development (Buildings)	Pa	Vaw	Fw	F	Va	F	Vaw	G	Faf	G	Vh	Vaw	Va	Fw	Pws	Pa	Pi	G

Soil Suitability Classes

G- Good - Soils in their present state have few or minor limitations that would affect the proposed used. The limitations would be easily overcome with minimal cost.

F- Fair - Soils under present state have one or more moderate limitations that would affect the proposed use. These moderate limitations would be overcome with special construction, design, planning or maintenance.

P- Poor - Soils in their present state have one or more severe limitations that would severely affect the proposed use. To overcome the severe limitations would require the removal of limitations or difficult and costly alteration of the soil or of special design or intensive maintenance.

V- Very Poor - Soils have one or more features so unfavourable for the proposed use that the limitation is very difficult and expensive to overcome or the soil would require such extreme alteration that the proposed use is economically impractical.

Limitations in Evaluating Soil Suitability for Selected Engineering and Recreational Uses

a subgrade properties
b thickness of topsoil
c course fragments on surface
d depth to bedrock
e erosion or erodability
f susceptibility to frost hazard
g contamination hazard of groundwater
h depth to seasonal water table
i flooding or inundation
j thickness of slowly permeable materiel
k permeability or hydraulic conductivity
l shrinks well properties
m moisture limitations or deficit
n salinity or sulfate hazard
o organic matter
p stoniness
q depth to sand or gravel
r rockiness
s surface texture
t topographic slope classes
u moisture consistence
w wetness or soil drainage class
z permafrost

Figure 4.15 **Soil Suitability for Camping on Hecla Island**

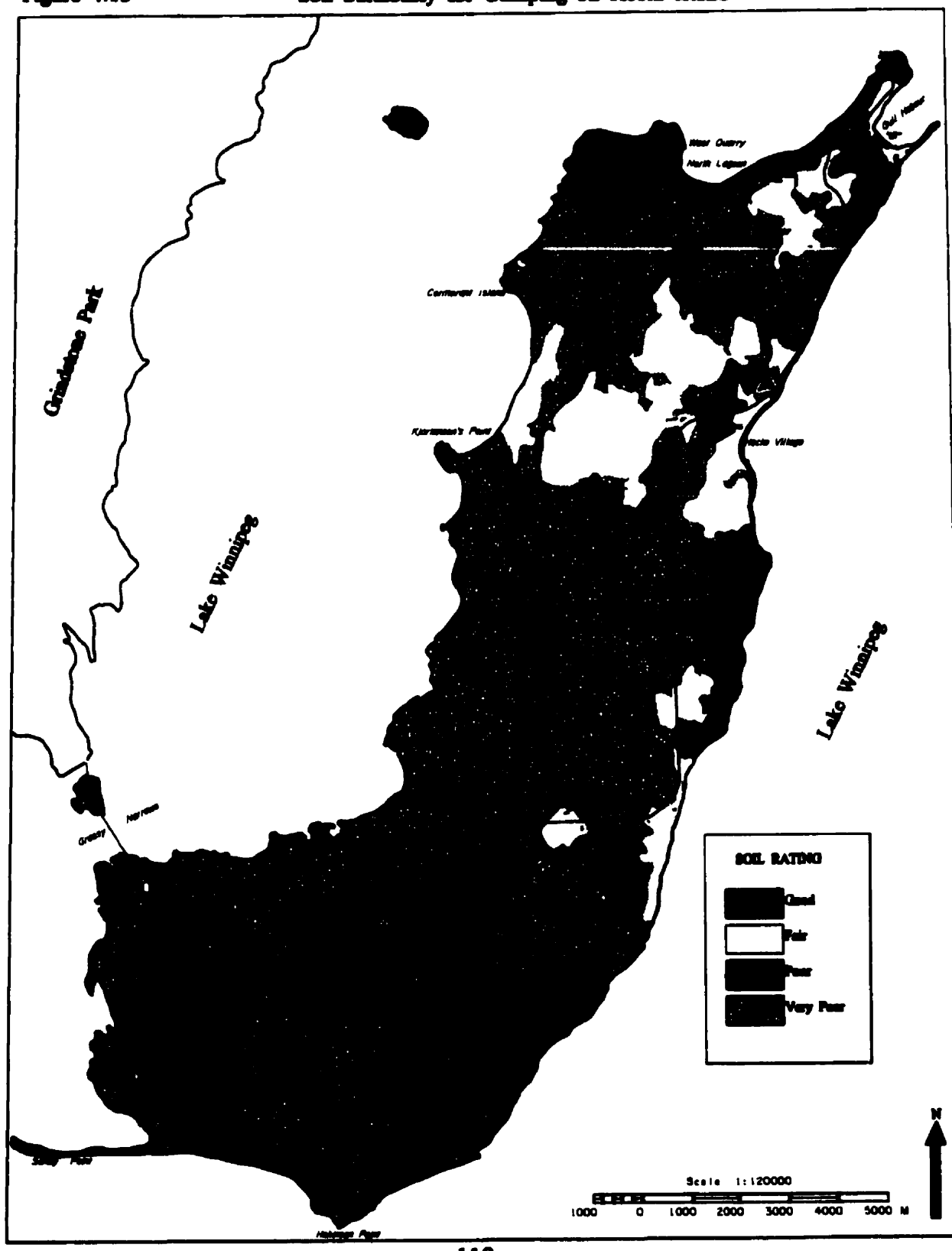


Figure 4.16 Soil Suitability for Buildlings on Hecla Island

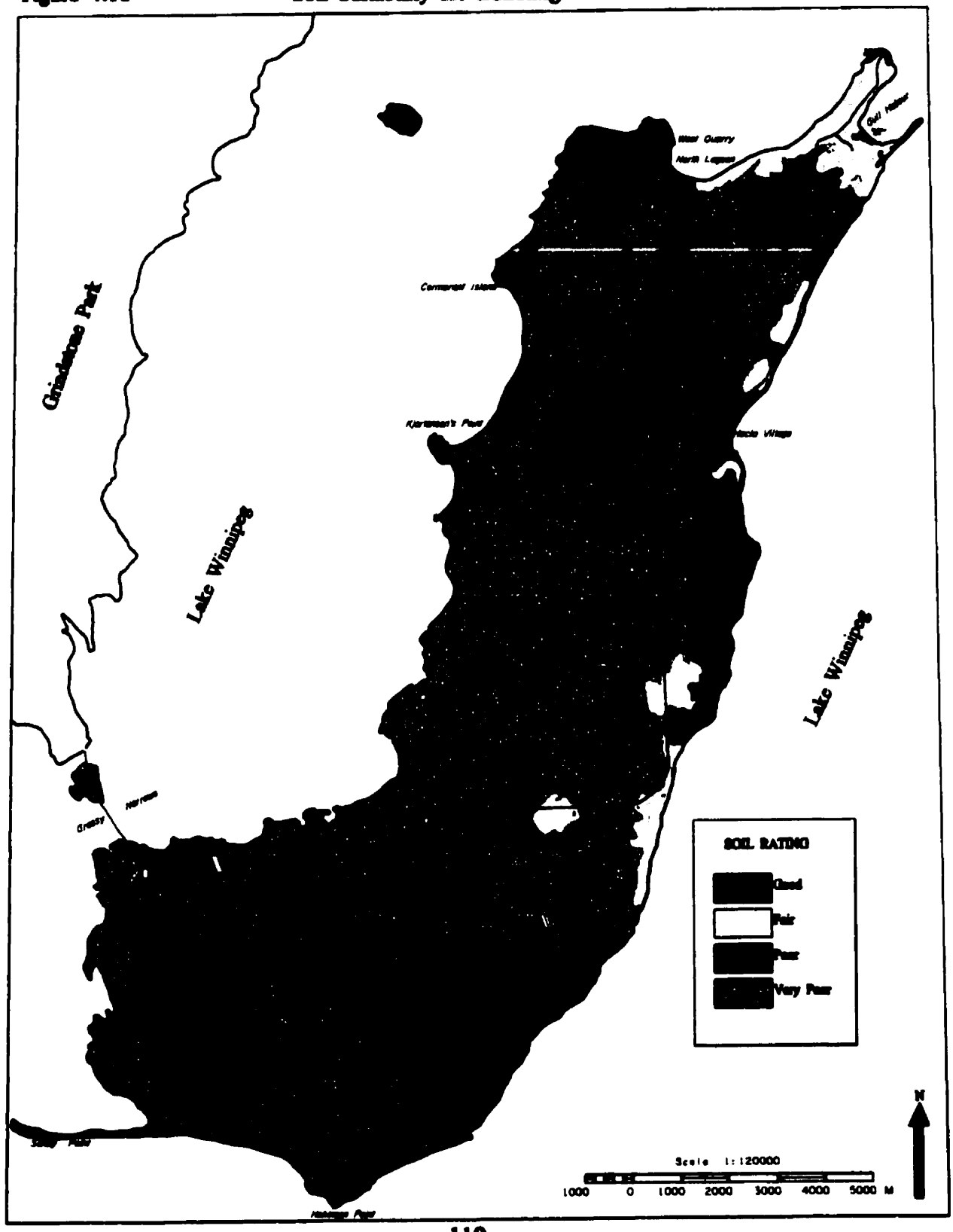


Figure 4.17 Soil Suitability for Roads on Hecla Island

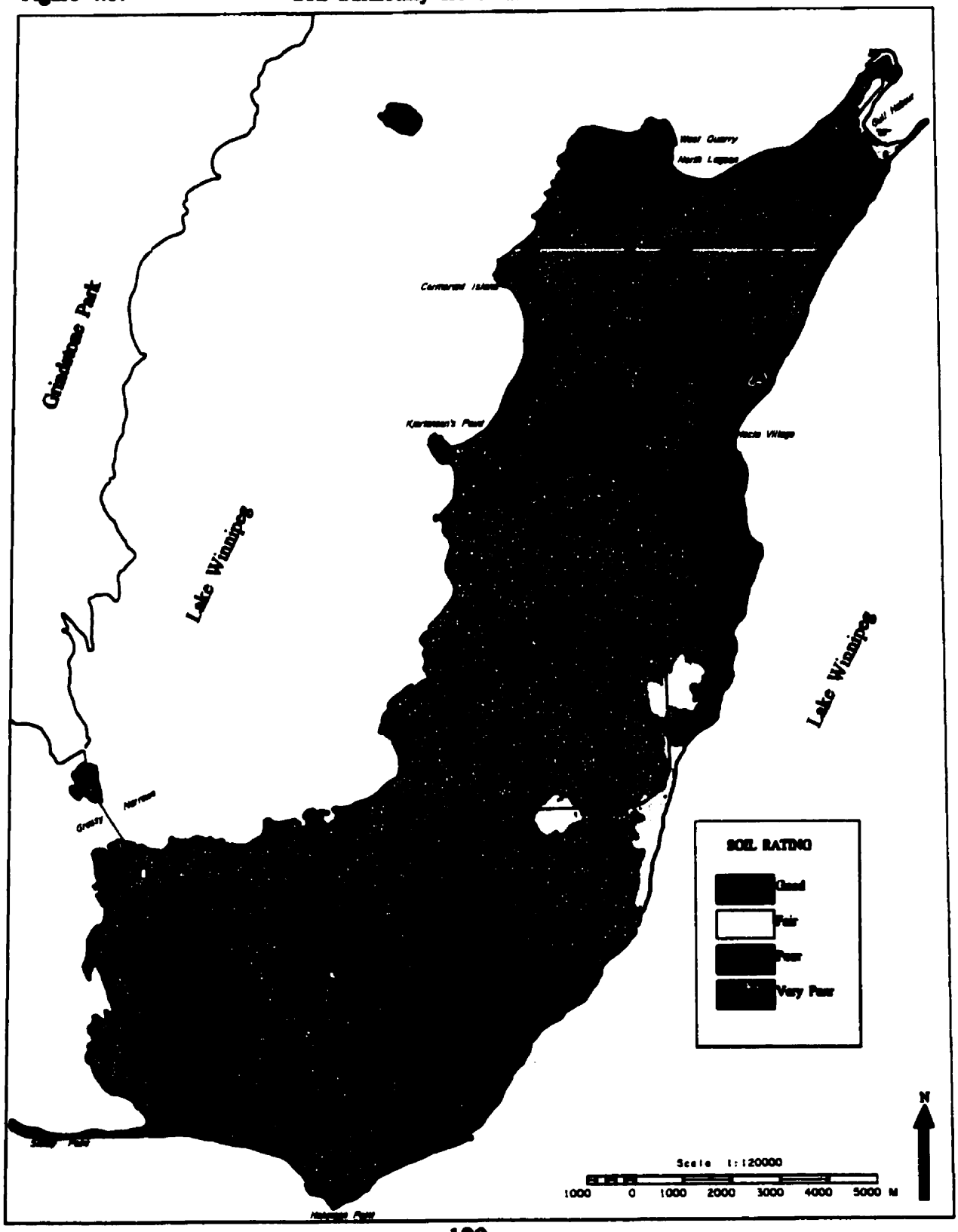
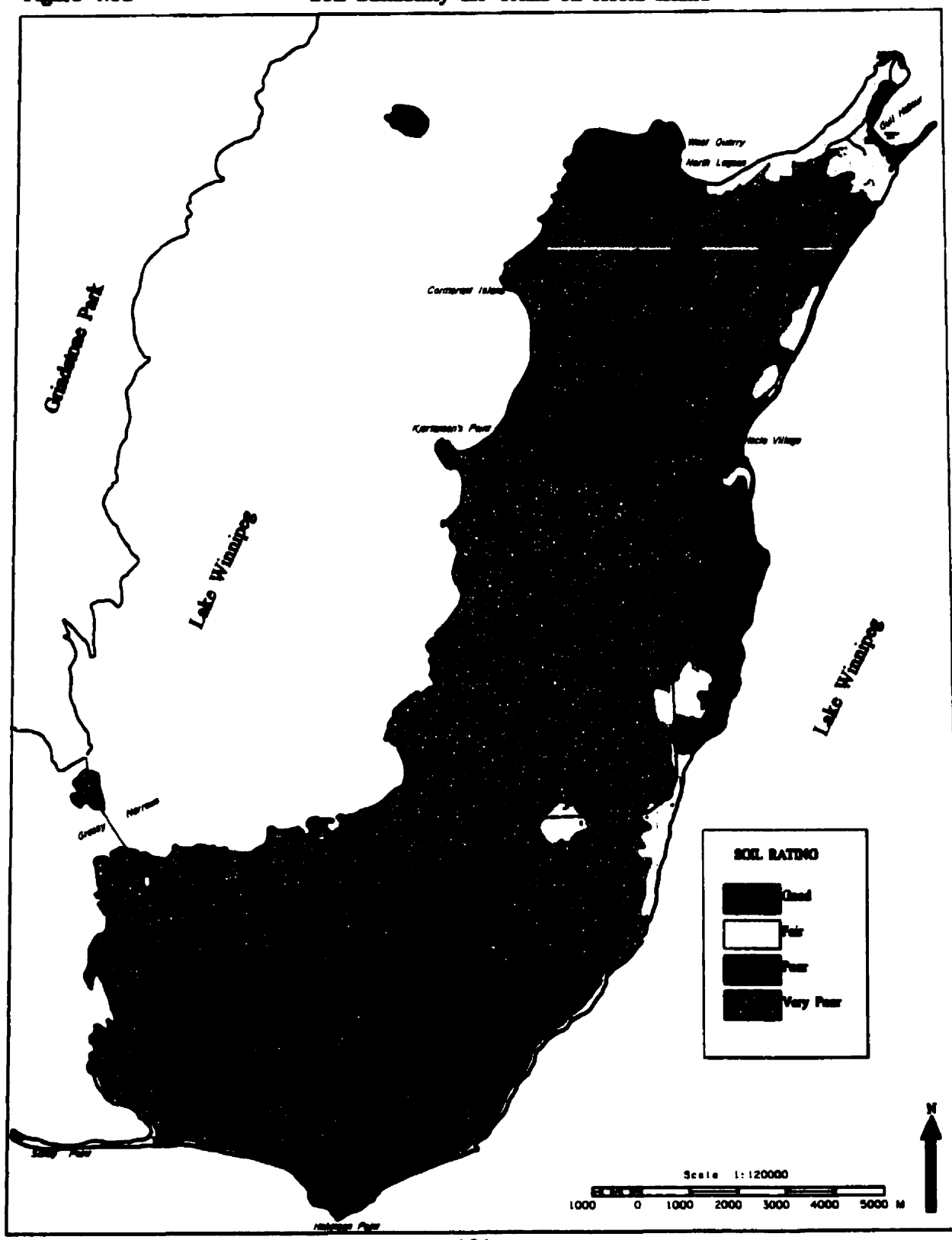


Figure 4.18 Soil Suitability for Trails on Hecla Island



Recreation Capability for Camping

Recreation capability deals with the potential recreational opportunities that the land can provide, and is based on the number and diversity of recreational features, aesthetics, and accessibility (CLI, 1976). According to Figure 4.19, most of the locations suitable for recreation are on the periphery of the island along the shorelines of Lake Winnipeg. Since classes 1-4 all afford recreational opportunities on Hecla Island, these were used as an inclusion to the Vegetation/Terrain, Wildlife, and Soil Components to demonstrate the use of additional sources of data to further target areas that are suitable for camping (Table 4.23).

Table 4.23 Inclusions of Recreation Activities by Class

	Suitability Classes						
	1	2	3	4	5	6	7
Camping	I	I	I	I	E	E	E

E - Exclude I - Include

Recreation Capability Classes

1 - Lands in this class have very high capability for outdoor recreation
2 - Lands in this class have a high capability for outdoor recreation
3 - Lands in this class have a moderately high capability approach to recreation
4 - Lands in this class have moderate capability for outdoor recreation
5 - Lands in this class have moderately low capability for outdoor recreation
6 - Lands in this class have low capability for outdoor recreation
7 - Lands in this class have very low capability for outdoor recreation

Recreation Capability Subclasses

Subclass A - Land providing access to water affording opportunity for angling or viewing of sport fish .

Subclass B - Shoreland capable of supporting family beach activities. In high class units this will include family bathing. For classes 4 and 5, the activities may be confined to dry land due to cold water or other

limitations.

Subclass C - Land fronting taller and providing direct access to waterways with significant capability for canoe tripping

Subclass D - Shoreland with deeper inshore water suitable for swimming or boat mooring or launching.

Subclass E - Land with vegetation possessing recreational value.

Subclass F - Waterfall or rapids.

Subclass G - Significant glacier view or experience.

Subclass H - Historic or prehistoric site.

Subclass J - Area offering particular opportunities for gathering and collecting items of popular interest.

Subclass K - Shoreland or upland suited to organized camping, usually associated with other features.

Subclass L - Interesting landform features other than rock formations.

Subclass M - Frequent small water bodies or continuous streams occurring in upland areas.

Subclass N - Land (usually shoreland) suited to family or other recreation lodging use.

Subclass O - Land affording opportunities for viewing upland wildlife.

Subclass P - Areas exhibiting variety in topography or land wand water relationships, which enhances opportunities for general outdoor recreation such as hiking and nature study or for aesthetic appreciation of the area.

Subclass R - Interesting rock formations

Subclass U - Shoreland fronting water accommodating yachting or deep water boat tripping.

Subclass V - A vantage point or area which offers a superior view relative to the class of the unit(s) which contain it, or a corridor or other area which provides frequent viewing opportunities.

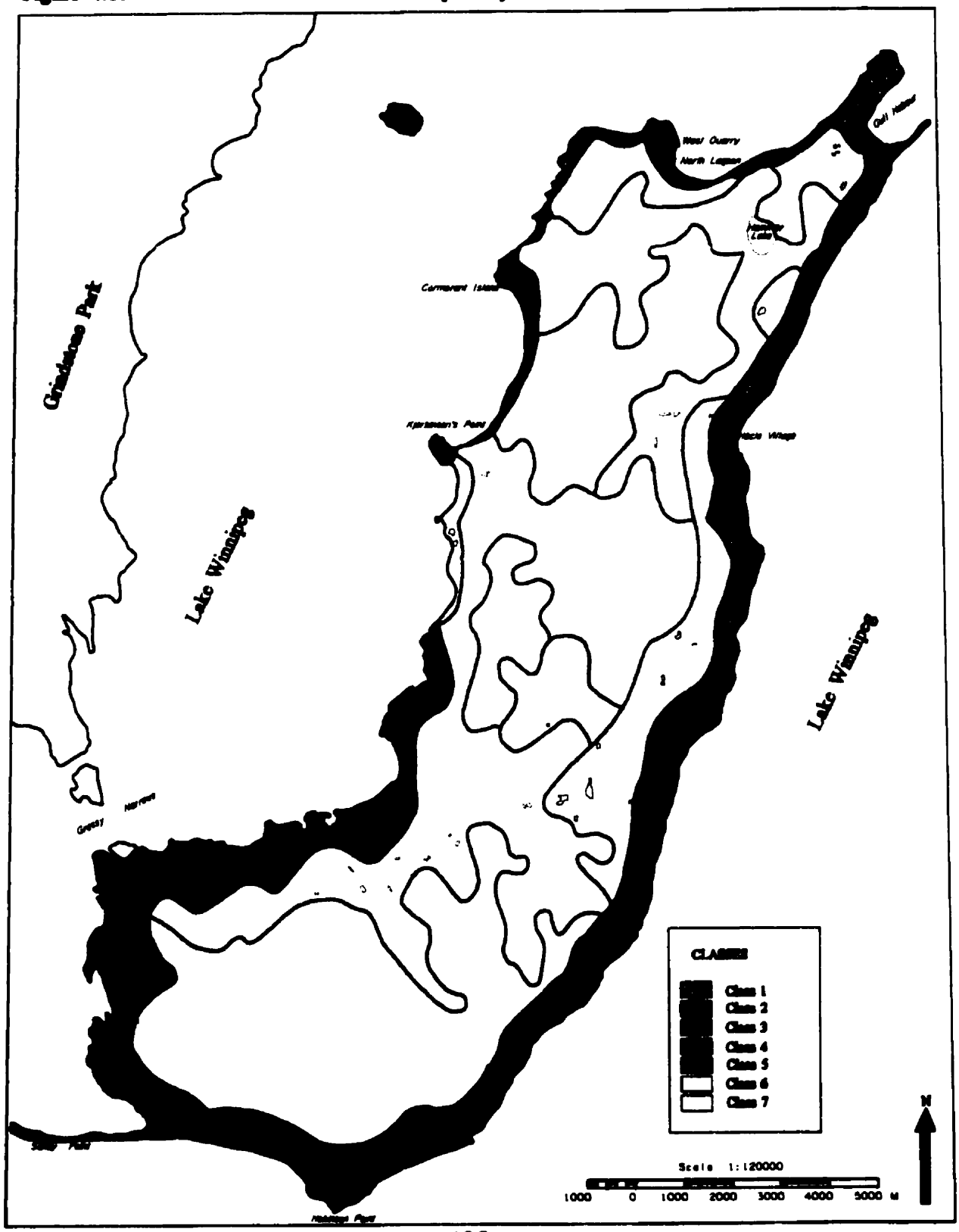
Subclass W - Land affording opportunities for viewing of wetland wildlife.

Subclass X - Miscellaneous features with recreational capability.

Subclass Y - Shoreland providing access to water suitable for popular forms of boating.

Subclass Z - Areas exhibiting major, permanent, non-urban man-made structures or recreational interest.

Figure 4.19 Recreational Capability on Hecla Island



Chapter 5 - Relationships Between Resources and Activities

5.1 Introduction

In the last chapter, a methodology for classifying data was developed and various spatial and database analyses were undertaken to identify thresholds for new developments and activities on Hecla Island. At this stage, the relationship between tourism developments and activities, and key natural resources on Hecla Island are defined. This will determine the criteria for developing the UETs for the developments and activities. In order to properly investigate development possibilities, the analysis should look at characterizing activities according to their resource requirements and side effects, while studying the elements and features of the geographic environment, emphasizing their utility and sensitivity (Kozlowski, 1986). The technique developed by Kozlowski (1986) involves four stages and the use of matrices to cumulatively build upon the information acquired from the prior stages to arrive at the final result that assists in the production of the threshold maps. The steps are as follows:

Step 1 - The role of natural and human resources (in supporting the development types and related activities).

Step 2 - The impacts that have and will continue to occur from the developments and related activities.

Step 3 - The sensitivity of the natural resources to these impacts.

Step 4 - The potential environmental consequences (of the developments/activities concerned).

5.2 Role of the Resources

Two major uses of this matrix are to provide an inventory for assessing the impacts of development and to classify the resources into appropriate use categories. As a result, the natural elements required for the activities and developments within the study area are identified (Kozolowski and Hill, 1993). Possible conflicts that can occur between the resources and developments are also indicated (Table 5.1).

The role of the resources is divided into 4 classes:

1. Basic - the use can not be implemented unless the resource is available.

2. Enhancing - the use or experience of an activity is enhanced by the resource but development can proceed without it.

3. Indifferent (Not concerned) - the resource is not crucial to the activity or development, or has no value to it. However, it may be determined through subsequent steps that an activity or development may have a negative impact on the resource.

4. Not Relevant.

Table 5.1 Role of the Resources

		Unique Natural and Cultural Features							Vegetation Status			Wildlife Status/ Habitat Suit./Sen.					Land Suitability			
									Forest				Water-fowl/		Moose		Soils		Rec-reation	
		Archaeological Sites	Limestone Cliffs	Beaches	Unique Cultural Areas	Salt Licks	Ponds/Lakes	Creeks/Rivers	Unique	Common	Unique and Sensitive Plant Sites	Sensitive Colonial Nesting Sites	High/Unique	Low	High /Unique	Low	High	Low	High	Low
Past/Present Tourism Development and Activities	Gull Harbour Development	#	#	o	#	#	+	+	#	o	#	#	#	#	+	#	o	#	+	#
	Golf Course/Golfing	#	#	#	#	#	+	+	#	o	#	#	#	#	#	#	o	#	+	#
	Campground/Camping	#	+	+	+	+	+	+	+	o	#	#	+	#	+	#	o	#	+	#
	Roads	+	+	+	+	+	+	+	+	+	#	#	+	#	+	#	o	#	+	#
	Snowmobiling	#	+	#	#	#	+	+	+	+	#	#	#	#	+	#	#	#	+	#
	Cross-Country Skiing/Snowshoeing	+	+	+	+	+	+	+	+	+	+	+	+	#	+	#	+	#	+	#
	Recreational Hiking	+	+	+	+	+	+	+	+	o	+	+	+	#	+	#	+	#	+	#
	Primitive Hiking/Nature Study Areas	+	+	+	+	+	+	+	+	o	+	+	+	#	+	#	+	#	+	#
	Causeway	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#
	Controlled Marsh/Viewing Facilities	#	#	#	#	+	+	+	+	#	+	+	+	#	+	#	#	#	#	#
Future Dev./ Activ.	North Shore Cottage Dev. (In Prog.)	+	+	+	+	+	+	+	+	+	#	+	+	#	+	#	o	#	+	#
	Historic Lands Resettlement (In Prog.)	+	+	+	+	+	+	+	+	+	#	+	+	#	+	#	o	#	+	#
Potential Tourism Development and Activities	Air Strip/Runway	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	o	#	#	#
	Minor Recreation Complex	#	+	+	+	+	+	+	+	+	#	#	+	#	+	#	+	#	+	#
	West Quarry Development Area	#	+	+	+	+	+	+	+	+	#	#	+	#	+	#	+	#	+	#
	Family Vacation Resort	#	+	+	+	+	+	+	+	+	#	#	+	#	+	#	+	#	+	#
	Campground Expansion Areas	#	+	+	+	+	+	+	+	o	#	#	+	#	+	#	o	#	+	#
	Primitive Hiking/ Nature Study Areas	+	+	+	+	+	+	+	+	+	+	+	+	#	+	#	+	#	+	#
	Road Expansion	+	+	+	+	+	+	+	+	+	#	#	+	#	+	#	o	#	+	#
	Snowmobiling Expansion	#	+	#	#	#	+	+	+	+	#	#	#	#	+	#	#	#	+	#
	Cross-Country Skiing/Snowshoeing Exp.	+	+	+	+	+	+	+	+	+	+	+	+	#	+	#	+	#	+	#
	Recreational Hiking Expansion	+	+	+	+	+	+	+	+	o	+	+	+	#	+	#	+	#	+	#

Basic o Enhancing + Indifferent #

5.3 Impacts of Development and Activities

This stage is concerned with identifying the impacts that result from tourism development and associated activities. There are varying degrees of impacts which can be categorized into a disturbance or modification of the environment. A disturbance refers to a less dramatic change to the land, while a modification is a more permanent change that maintains few aspects of the original landscape. For example, a disturbance refers to the development of a new campground that preserves many components of the environment, whereas a modification could be a permanent structure that destroys most of the land it occupies, thereby removing key flora and potentially important wildlife habitat from the area (Kozlowski and Hill, 1993). Clearly, the key to sound management is to address all the environmental issues prior to the construction of the development, since it is difficult to restore a landscape once a development is already in place. Table 5.2 describes the degree of impact or side effects that particular development and activities produce.

The following classes have been identified:

1. High Impact - the impact cannot be avoided.

2. Low or Insignificant - the impact can be reversed with effective management inputs that are easily obtainable.

3. Indifferent - there is less concern about the impact on a resource.

Table 5.2 Impacts of Development and Activities

		Pollution				Disturbance						Change/Modification					
		Noise	Litter/Dumping/Effluent	Air	Water	Aesthetic Impact	Vegetation Impact (Unique)	Vegetation Impact (Common)	Wildlife Impact (Significant)	Wildlife Impact (Moderate)	Lake Habitat Impact	Aesthesis Changed	Vegetation Loss (Unique)	Vegetation Loss (Common)	Loss of Significant Wildlife Habitat	Loss of Moderate Wildlife Habitat	Lake Habitats Damaged
Past/Present Tourism Development and Activities	Gull Harbour Development	-	x	-	-							x	x	#	x	#	-
	Golf Course/Golfing	-	-	-	-							x	x	#	x	#	-
	Campground/Camping	-	-	-	-	x	x	#	x	#	-						
	Roads	x	-	x	-							x	x	#	x	#	-
	Snowmobiling	x	x	x	-							x	x	#	x	#	-
	Cross-Country Skiing/Snowshoeing	-	-	-	-	-	x	#	x	#	-						
	Recreational Hiking	-	-	-	-	-	x	#	x	#	-						
	Primitive Hiking/Nature Study Areas	-	-	-	-	-	-	#	-	#	-						
	Causeway	x	-	x	x							x	x	#	x	#	x
	Controlled Marsh/Viewing Facilities	-	-	-	-	-	x	#	x	#	-						
Future Dev./ Activ.	North Shore Cottage Dev. (In Progress)	-	x	-	-							x	x	#	x	#	-
	Historic Lands Resettlement (In Progress)	-	x	-	-							x	x	#	x	#	-
Potential Tourism Development and Activities	Air Strip/Runway	x	-	x	-							x	x	x	x	x	-
	Minor Recreation Complex	-	x	-	-							x	x	#	x	#	-
	West Quarry Development Area	-	x	-	-							x	x	#	x	#	-
	Family Vacation Resort	-	x	-	-							x	x	#	x	#	-
	Group Use Campground	-	-	-	-	x	x	#	x	#	-						
	Campground Expansion Areas	-	-	-	-	x	x	#	x	#	-						
	Primitive Hiking/Nature Study Areas	-	-	-	-	-	-	#	-	#	-						
	Roads Expansion	x	-	x	-							x	x	#	x	#	-
	Snowmobiling Expansion	x	x	x	-							x	x	#	x	#	-
	Cross-Country Skiing/Snowshoeing Exp.	-	-	-	-	-	x	#	x	#	-						
	Recreational Hiking Expansion	-	-	-	-	-	x	#	x	#	-						

High Impact x Low or Insignificant Impact - Indifferent #

5.4 Analysis of Sensitivity of Resources

When the impacts of tourism development are identified, the next phase aims to determine the sensitivity of the key environmental components to the impacts (Table 5.3). The classes are as follows:

1. High - the environmental resource is very sensitive to this impact.

2. Low - impacts may occur but the environmental resource is relatively resistant to the impacts.

3. None - the environmental resource is not affected by this impact or not applicable.

4. Indifferent - the environmental resource is not concerned with the impact in these areas.

Table 5.3 Analysis of Sensitivity of Resources

		Unique Natural							Vegetation			Wildlife Status					Land Suitability			
									Forest				Water-fowl		Moose		Soils		Rec-reation	
		Archaeological Sites	Limestone Cliffs	Beaches	Unique Cultural Areas	Salt Licks	Ponds/Lakes	Creeks/Rivers	Unique	Common	Unique and Sensitive Plant Sites	Sensitive Colonial Nesting Sites	High/Unique	Low	High/Unique	Low	High	Low	High	Low
Pollution	Noise	/	/	/	/	/	/	/	/	/	/	x	x	#	x	#	/	/	#	#
	Litter/Dumping/Effluent	o	o	o	o	x	x	x	x	x	x	x	x	#	x	#	x	#	x	#
	Air	/	/	/	o	o	o	o	o	o	o	o	o	#	o	#	o	#	o	#
	Water	/	/	/	/	x	x	x	/	/	/	/	x	#	x	#	/	/	x	#
Disturbance	Aesthetics Disturbed	o	o	o	o	o	o	o	o	o	/	o	/	/	/	/	/	/	o	o
	Vegetation Impact (Unique)	/	/	o	o	o	o	o	x	o	x	x	o	o	o	o	/	/	o	/
	Vegetation Impact (Common)	o	o	o	/	o	/	o	o	o	o	x	o	o	o	o	o	o	o	/
	Wildlife Impact (Significant)	/	/	/	/	/	/	/	o	o	o	x	x	/	x	/	/	/	o	/
	Wildlife Impact (Moderate)	/	/	/	/	/	/	/	o	o	/	o	o	/	x	/	/	/	o	/
	Lake Habitat Impact	/	/	/	o	o	/	/	/	/	o	x	o	/	o	o	/	/	/	/
Degradation	Aesthetics Changed	x	x	x	x	o	o	o	o	o	/	o	/	/	/	/	/	/	x	o
	Vegetation Loss (Unique)	o	o	o	x	x	x	x	x	o	x	x	x	o	x	o	/	/	o	o
	Vegetation Loss (Common)	x	x	o	o	o	o	o	o	x	o	x	x	o	x	o	o	o	o	#
	Loss of Significant Wildlife Habitat	/	/	/	/	/	/	/	/	/	o	x	x	/	x	/	/	/	o	#
	Loss of Moderate Wildlife Habitat	/	/	/	/	/	/	o	/	/	o	o	x	o	x	o	/	/	x	o
	Lake Habitat Damaged	/	/	/	/	x	x	x	/	/	/	x	x	o	x	x	/	/	/	/

High x Low o None / Indifferent #

5.5 Potential Environmental Consequences of Development and Activities

This stage illustrates where environmental impacts will impact on the natural resources of the area, and which developments are the causal agents of these negative effects (Kozlowski and Hill, 1993). Table 5.4 is the combination of steps 2 and 3, whereby each table is cross referenced until all the cells are populated. The results of this table are employed in the final analysis to create thresholds for locating new developments and activities on Hecla Island.

Table 5.4 The Potential Environmental Consequences of Development and Activities

		Unique Natural and Cultural Features							Vegetation			Wildlife Status/ Habitat Suit./Sens.					Land Suitability			
									Forests				Water-fowl/		Moose		Soils		Rec-reation	
		Archaeological Sites	Limestone Cliffs	Beaches	Unique Cultural Areas	Salt Licks	Ponds/Lakes	Creeks/Rivers	Unique	Common	Unique and Sensitive Plant Sites	Sensitive Colonial Nesting Sites	High/Unique	Low	High/Unique	Low	High	Low	High	Low
Past/Present Tourism Development and Activities	Gull Harbour Development	x	x	x	x	x	+	+	x	/	x	x	x	/	x	/	/	+	+	/
	Golf Course/Golfing	x	+	+	x	x	+	+	x	+	x	x	x	+	x	+	/	+	x	/
	Campground/Camping	x	+	/	+	x	+	+	x	/	x	x	x	/	x	/	/	+	/	x
	Roads/Pleasure Driving	x	x	x	x	x	+	+	x	+	x	x	x	+	x	+	/	+	x	x
	Snowmobiling	x	x	x	x	x	+	+	x	+	x	x	x	+	x	+	/	+	+	/
	Cross-Country Skiing/Snowshoeing	x	+	/	/	x	/	/	x	/	x	x	+	/	x	/	/	+	/	x
	Recreational Hiking	x	+	/	/	x	x	x	x	/	x	x	x	/	x	/	/	+	/	x
	Primitive Hiking/Nature Study Areas	/	/	/	/	/	/	/	/	/	x	x	+	/	/	/	/	/	/	/
	Causeway	x	x	+	x	x	+	+	x	+	x	x	x	+	x	+	/	+	x	/
	Controlled Marsh/Viewing Facilities	x	x	+	x	x	+	+	x	+	x	x	x	+	x	+	/	+	x	/
Future Dev./ Activ.	North Shore Cottage Dev. (In Prog.)	x	x	+	x	x	+	+	x	/	x	x	x	+	x	+	/	+	x	/
	Historic Lands Resettlement (In Prog.)	x	x	+	+	x	+	+	x	/	x	x	x	+	x	+	/	+	x	/
Potential Tourism Development and Activities	Air Strip/Runway	x	x	x	x	x	x	x	x	+	x	x	x	+	x	+	/	+	x	+
	Minor Recreation Complex	x	x	+	x	x	+	+	x	+	x	x	x	+	x	+	/	+	+	+
	West Quarry Development Area	x	x	+	x	x	+	+	x	+	x	x	x	+	x	+	/	+	+	+
	Family Vacation Resort	x	x	+	x	x	+	+	x	+	x	x	x	+	x	+	/	+	+	+
	Campground Expansion Areas	x	+	x	+	x	/	/	x	/	x	x	x	/	x	/	/	+	/	/
	Primitive Hiking/Nature Study Areas	/	/	/	/	/	/	/	/	/	x	x	+	/	/	/	/	/	/	/
	Roads Expansion	x	x	x	x	x	+	+	x	+	x	x	x	+	x	+	/	+	+	/
	Snowmobiling Expansion	x	x	x	x	x	+	+	x	+	x	x	x	+	x	+	/	+	+	/
	Cross-Country Skiing/Snowshoeing Exp.	x	+	/	/	x	/	/	x	/	x	x	+	/	x	/	/	+	/	/
	Recreational Hiking Expansion	x	+	/	/	x	x	x	x	/	x	x	x	/	x	/	/	+	/	/

Significant (Exclude) x Partial (Managed) + None (Acceptable) / NA -

Chapter 6 - Results and Discussion

6.1 Introduction

Since one of the goals of Hecla Island Provincial Park is to provide a wide range of recreation opportunities for the public to enjoy, it is evident that tourism cannot be curtailed completely. Tourism can exist in many environments if a well thought-out plan is implemented prior to development. As expansion of tourism occurs, this plan should be continually updated to reflect the possible impacts that may occur in the future.

The objective of this chapter is to document the types of environments within which tourism-based facilities on Hecla Island have been developed, in order to gain an understanding of the potential effects of development on the environment, enabling improved plans to be devised for locating future tourism facilities and activities. The methods and classification systems of land, vegetation and wildlife resources described in chapter 4, and the relationships between resources and activities described in chapter 5, will be used to produce the final analysis to indicate the areas that are considered suitable for expansion of tourism development and activities on Hecla Island.

6.2 Description of Past/Present Tourism Development and Activities

Development on Hecla Island has taken place for more than 30 years, and aims primarily to attract tourists to the island. As a result, an infrastructure has developed to support the tourist industry. The following is a discussion of the major developments on

Hecla Island, and a description of the land resources, including key flora and fauna that may have been affected by tourism development. Although vegetation maps for Hecla Island existed prior to tourist development, a search produced only paper maps with no polygon descriptions, and therefore, it was difficult to make comparisons on the exact stand descriptions. Nevertheless, some inferences could be made on the general vegetation of the area by utilising the reconnaissance soil map which describes the native vegetation. There are also other reference maps, such as the Canada Land Inventory (CLI), that can be used to acquire an understanding of other resource components in the area prior to development.

Gull Harbour Development

Gull Harbour Development was the first major facility on Hecla Island that was used to attract 'the urban tourist' to the area. At the time, there was an overall decline in the economy of Hecla Island, which forced many people to leave. Gull Harbour Development was the Icelandic community's means of bolstering the Island's economy, and propping up their dwindling population. Figures 6.1 and 6.2 show aerial photographs of the Gull Harbour area in 1962 and 1992 respectively. It is evident from the photos that a dramatic change has taken place since 1962. Gull Harbour includes many facilities for overnight accommodations as well as providing numerous recreational opportunities. Some of the major facilities are the resort and conference centre, golf course, campground, and recreational trails.

Figure 6.1 Gull Harbour 1962

Figure 6.2 Gull Harbour 1992

Resort and Conference Centre

In the original plans for Hecla Island, a provision was made for the largest investment to be directed towards the construction of the new hotel and recreation complex. The provincial government envisioned large numbers of tourists entering the park and staying at the hotel. However, the hotel has lost money every year since 1982, and has only twice made a profit since it was built, costing Manitoba taxpayers millions of dollars.

The hotel/recreation complex cost 9 million dollars in 1977 to build, and the

government said it was supposed to create 40 jobs. As of 1985, the losses at Gull Harbour Resort were $2,447,917 (Mitchell, 1987). In 1992 the debt on Hecla was up to $3 million, forcing the government to put it up for sale. (Nairne, 1992).

According to Table 6.1, the conference centre (Figure 2.2) occupies approximately 19.160 hectares of land. Within this parcel of land, the land cover includes residential uses, roads, transmission lines, and recreational areas, with some remnant vegetation including trembling aspen, white spruce, and balsam fir. The land use (Figure 6.9), as designated by Manitoba Natural Resources, is intensive recreational development (MNR,1997). Tables 6.1 - 6.6 show the status of the land, vegetation, wildlife, soil suitability for recreation and engineering uses, and recreation capability of the area occupied by the resort and conference centre:

Table 6.1 Vegetation Resource Database

51124 - V13	0.68	3.55
82152 - V6	6.28	32.78
99731	3.16	16.49
99841	7.04	36.74
99843	1.44	7.52
99844	0.56	2.92
Total	19.16	100.00
ML	8.84	46.14
RL	3.16	16.49
S4S5	7.16	37.37
Total	19.16	100.00
None	0	0.00
Total	0	0.00

Table 6.2 Terrain Resource Database

Hi6-Bc1-R3	17.44	91.02
Lt	1.72	8.98
Total	19.16	100.00
IRD	19.16	100.00
Total	8.84	46.14
Major	3.16	16.49
Partial	0.68	3.55
Minimal	6.48	33.82
Total	19.16	100.00

Table 6.3 Wildlife Database

Class 1	0	0.00	0	0.00
Class 2	0.68	3.55	0.68	3.55
Class 3	6.28	32.78	6.28	32.78
Class 4	0.0	0.00	0	0.00
Class 5	0.0	0.00	0.00	0.00
Class 6	12.20	63.67	12.20	63.67
Total	19.16	100.00	19.16	100.00

High	0	0.00
Moderate	0	0.00
Low	19.16	100.00
Total	19.16	100.00
None	0	0.00
Total	0	0.00

Table 6.4 Recreation Capability Database

Class 1	7.76	40.50
Class 2	4.64	24.22
Class 3	0	0.00
Class 4	0	0.00
Class 5	0	0.00
Class 6	6.76	35.28
Class 7	0	0.00
Total	19.16	100.00

Table 6.5 Soil Suitability for Recreation Uses

Good	1.72	8.98	Good	0	0.00
Fair	17.44	91.02	Fair	1.72	8.98
Poor	0	0.00	Poor	17.44	91.02
Very Poor	0	0.00	Very Poor	0	0.00
Total	19.16	100.00	Total	19.16	100.00

Table 6.6 Soil Suitability for Engineering Uses

Good	0	0.00	Good	0	0.00
Fair	1.72	8.98	Fair	19.16	100.00
Poor	17.44	91.02	Poor	0	0.00
Very Poor	0	0.00	Very Poor	0	0.00
Total	19.16	100.00	Total	19.16	100.00

Golf Course

The golf course was built in 1975 to become part of the Gull Harbour Hotel Recreation Complex. The golf course on Hecla Island is a major attraction for overnight as well as daily visitors, and is rated as one the top golf courses in Manitoba. Figure 6.1 portrays the area in 1962, before the golf course and other tourist facilities were built around Gull Harbour. Significant changes have taken place in this area, preserving few aspects of the original environment.

In spite of the golf course being a key tourist attraction for Hecla Island, one can argue that it is incompatible in this environment, since the activity is not nature-oriented, and conflicts with other activities. In 1974, the golf course was flooded by heavy rains, and since most of the vegetation and trees were removed from the area, the land could not absorb the water. In addition, there were no studies undertaken to determine the loss of wildlife habitat or effect on the surrounding wildlife.

Tables 6.7-6.12 summarizes the land, vegetation, and wildlife components of the area occupied by the golf course:

Table 6.7 Terrain Resource Database

Hi6-Bc1-R3	56.52	53.12
Ki5-Pc5	16.2	15.23
Lt	3.68	3.46
Mx	0.52	0.49
Sl5-Ga5	29.48	27.71
Total	106.4	100.00
B	41.08	38.61
IRD	65.32	61.39
Total	19.88	100.00
Total	3.84	3.61
Major	102.16	96.02
Partial	0.0	0.00
Minimal	0.40	0.38
Total	106.4	100.00

Table 6.8 Vegetation Resource Database

90133 - V6	0.24	0.23
90153 - V6	0.16	0.15
99731	102.16	96.02
99841	1.76	1.65
99843	1.64	1.54
99844	0.44	0.41
Total	106.4	100.00
ML	3.84	3.61
RL	102.16	96.02
S4S5	0.40	0.38
Total	106.4	100.00
None	0	0.00
Total	0	0.00

Table 6.9 Wildlife Database

Class 1	0.24	0.23	0	0.00
Class 2	0.0	0.00	0.24	0.23
Class 3	0.16	0.15	0.16	0.15
Class 4	0.0	0.00	0.00	0.00
Class 5	0.0	0.00	0.00	0.00
Class 6	106.0	99.62	106.00	99.62
Total	106.4	100.00	106.40	100.00

High	0	0.00
Moderate	0	0.00
Low	106.4	100.00
Total	106.4	100.00

None	0	0.00
Total	0	0.00

Table 6.10 Recreation Capability Database

Class 1	0.0	0.00
Class 2	8.72	8.20
Class 3	0.0	0.00
Class 4	57.92	54.44
Class 5	0.0	0.00
Class 6	38.64	36.32
Class 7	1.12	1.05
Total	106.4	100.00

Table 6.11 Soil Suitability for Recreation Uses

Good	49.36	46.39	Good	29.48	27.71
Fair	56.52	53.12	Fair	19.88	18.68
Poor	0	0.00	Poor	56.52	53.12
Very Poor	0.52	0.49	Very Poor	0.52	0.49
Total	106.4	100.00	Total	106.40	100.00

Table 6.12 Soil Suitability for Engineering Uses

Good	45.68	42.93	Good	45.68	42.93
Fair	3.68	3.46	Fair	60.20	56.58
Poor	56.52	53.12	Poor	0	0.00
Very Poor	0.52	0.49	Very Poor	0.52	0.49
Total	106.4	100.00	Total	106.40	100.00

Gull Harbour Campground

The main campground on Hecla Island is located on the northwest side of Gull Harbour (Figure 2.2). Although much of the land set aside for the campground is classified as recreational in the forest inventory (731), the major forested areas remain intact except for trees removed for roads, paths, and areas for tents and trailers (Figure 6.2). According to Tables 6.13 to 6.15, since the area is classified as recreational land, there is no variation within the vegetation and wildlife ratings. Nevertheless, there are subtle changes in recreation capability as well soil suitability for recreation and engineering uses.

Table 6.13 Resource Database

5248	3.28	Hi6-Bc1-R3	IRD	99731	RL	MAJOR	-
5259	20	Hi6-Bc1-R3	IRD	99731	RL	MAJOR	-
5262	4.68	Hi6-Bc1-R3	IRD	99731	RL	MAJOR	-
5273	0.28	Lt	IRD	99731	RL	MAJOR	-
Total	28.2						

Table 6.14 Wildlife Database

5248	5	5	LOW	-
5259	5	5	LOW	-
5262	5	5	LOW	-
5273	5	5	LOW	-

Table 6.15 Recreation Capability/Soil Suitability for Recreation and Engineering Uses

5248	6OE	Pp	F	P	F
5259	1UNY	Pp	F	P	F
5262	4RKD	Pp	F	P	F
5273	1UNY	Fs	G	F	F

Roads

Roads on Hecla Island serve two main purposes. First, the roads are used as travel corridors for tourists driving to destinations for activities such as swimming,

hiking, or simply relaxing at one's own leisure. The second use of roads is to experience the area's natural surroundings. Since it is sometimes difficult to travel through the wilderness on foot, roads are built to carry tourists to areas that they would normally find it difficult to access.

Most roads on Hecla Island are situated along the east side of the island and throughout Gull Harbour. There will also be more roads required once two new cottage developments are built on the north shore of Hecla Island and along the east side by Hecla Village (Figure 4.4). There are three categories of roads on Hecla Island. The major highway, # 8, takes tourists from the beginning of the causeway to the northerly tip of Gull Harbour, with a route through Hecla Village which travels along the shores of Lake Winnipeg. The total road distance is 35.88 kms. Secondary roads are either loose or stabilized surface all weather roads, and comprise 5.17 kms on Hecla Island. The final class of roads is gravel/loose surface dry weather roads. Many of these roads are branches of the major and secondary roads and may be used for travel to campgrounds or other areas of interest. These roads are usually narrow, with less traffic, and as a result have a much lower impact on the environment than major roads. For major highways, more vegetation has to be removed for development, and automobiles travel at higher speeds. Not only is there less habitat available for wildlife, their use of periphery habitat may also be reduced because of noise impact. Since the most important points of interest on Hecla Island are Hecla Village and Gull Harbour, these areas and the roads leading to them have been the focus of improvements and expansion. However, further expansion of cottages and other facilities will require more roads to be built and upgraded.

Snowmobiling

There are many different recreational activities offered at Hecla Island during the summer and winter seasons that fit into the concept of a provincial park. Snowmobiling, however, does not seem to blend well into this type of environment because it takes away from the setting and tranquillity of the wilderness on Hecla Island. Not only does it conflict with nature oriented activities, it also can have negative impact on the flora and fauna of the island.

According to the DNR (1988), it was proposed that the existing 58 kms of snowmobile trails on Hecla Island be expanded to 100 kms. Studies have shown that snowmobiles can be very disruptive to flora by trampling sensitive plants and detaching critical vegetation as they move through terrain. Much of this can be avoided if a properly maintained trail system is put in place, however, there are still many snowmobilers who tend to make their own paths through the trees, which can be very damaging to sensitive and rare plant species.

Another often expressed concern is the disregard that some snowmobilers have for the environment. This stems from cases of trail littering, including disposal of liquor bottles and other garbage into the forest. Wildlife can also be agitated by the noise from snowmobiles, while there are also concerns when particular individuals pursue, and sometimes run down animals. Other effects include loss of wildlife habitat from the trail rights-of-way, including areas directly around the trail which some wildlife will not use. Therefore, the loss of habitat extends beyond the trail boundary. As more trails are cut into the forest, animals are forced into a smaller and smaller patches. Although these

patches may have suitable habitat, wildlife such as moose require more land to roam, and thus these areas become useless.

Another problem with snowmobiling in Hecla's environment is the conflicts that occur with other activities that are not compatible with it. For example, most wilderness seekers or cross-country skiers do not appreciate the noise and air pollution generated by snowmobilers. It is very difficult to satisfy all users of the environment, but for successful integrated resource management, some kind of conformity has to be reached. Consequently, when formulating park policy, legislators have to decide which activities really fit into the environmental framework by studying all the impacts to people, plants, and wildlife.

To analyse the trail system on Hecla Island, a vector database was constructed which coded the trails into 5 classes based on the type of activity. These were walking, snowmobiling, cross-country skiing, snowshoeing, and ski-skating (Figure 4.13). Activities that were similar in nature were then combined. For example, cross-country skiing and snowshoeing are activities that have similar demands on the environment. On the other hand, snowmobiling is a high impact activity, with more adverse effects on flora and fauna. Therefore, when developing snowmobile trails, the suitability of the habitat for various wildlife has to be considered. Development can take place in areas that provide good sites but which have less impact on wildlife. Tables 6.16-6.19 describes the trail system in terms of type and length within each of the main environmental components that have been classified on Hecla Island. For moose wintering areas, there are over 15 kilometres in Class 3 and under a kilometre in Class 1. Snowmobiles have

little impact on moose summering areas except for the fact that habitat is removed if expansion of trails takes place through these areas. In terms of other unique wildlife, there are approximately 40 metres of trails within the corridor surrounding the Piping Plover sighting on the southern tip of Hecla Island. The following tables illustrate the type and quality of the land and wildlife habitat that snowmobiles travel over on Hecla Island:

Table 6.16 Total Length of Snowmobile Trails within Moose Summer and Wintering Areas

Class	Moose - Winter	Moose - Summer
1	572.44	7788.19
2	6357.86	4580.95
3	15652.62	9446.56
4	3130.52	2903.04
5	3352.55	4347.25
6	5643.59	5643.59
TOTAL	34709.58	34709.58

Table 6.17 Transformation Status of Land within Snowmobile Trails

Class	Length (Metres)
Total	5248.11
Major	395.48
Partial	5855.52
Minimal	23274.55
TOTAL	34773.66

Table 6.18 Status of Waterfowl Nesting Areas within Snowmobile Trails

Waterfowl Sensitivity Class	Length (Metres)
High	20.06
Moderate	69.37
Low	34684.24
TOTAL	34773.67

Table 6.19 Snowmobile Trails and the Vegetation/Land Status of the Areas they Occupy (Metres)

Class	Length (Metres)
Ecological Protection Area	0
Modified Land	653.78
Heritage Land	5248.11
No Data (721,822,823)	1906.69
Recreation Land	395.48
S2	0
S3/S4	88.03
S4	4169.12
S4/S5	20162.77
S5	2085.59
TOTAL	34709.58

Cross-Country Skiing/Snowshoeing

Unlike snowmobiling, cross-country skiing and snowshoeing are two winter activities that are well suited to Hecla Island, with fewer side effects, and therefore less impact on the environment. There are a number of established trails for these activities in the Gull Harbour area. For most hobby skiers and snowshoers, it is important that well established trails are provided for their use. The following tables summarize these two activities in terms of the environment which they encompass:

Table 6.20 Total Length of Cross-Country Trails within Moose Summer and Wintering Areas (Metres)

Class	Moose - Winter	Moose - Summer
1	791.57	2657.81
2	2988.85	3152.47
3	10521.95	8830.10
4	2975.24	2388.86
5	2245.92	2494.29
6	6497.23	6497.23
Total	26020.76	26020.76

Table 6.21 Total Length of Snowshoeing Trails within Moose Summer and Wintering Areas (Metres)

Class	Moose - Winter	Moose - Summer
1	0.0	1330.04
2	1080.42	470.94
3	2406.65	1686.09
4	0	0
5	157.52	157.52
6	1560.94	1560.94
Total	5205.53	5205.53

Table 6.22 Cross-Country/Snowshoeing Trails and the Vegetation/Land Status of the Areas they Occupy (Metres)

Class	X-Country	Snowshoeing
Ecological Protection Area	0	0
Modified Land	892.23	915.54
Heritage Land	87.24	0
No Data (721,822,823)	1692.96	157.52
SU	338.02	0
Recreation Land	5517.77	119.33
S2	0	0
S3/S4	0	505.97
S4	3378.86	0
S4/S5	13215.67	3507.18
S5	898.02	0
Total	26020.77	5205.54

Table 6.23 Transformation Status of Land within Cross-Country/Snowshoeing Trails

Class	X-Country	Snowshoeing
Total	979.47	915.54
Major	5517.77	119.33
Partial	5204.73	0
Minimal	14382.55	4170.67
TOTAL	26084.52	5205.54

Table 6.24 Status of Waterfowl Nesting Areas within Cross-Country/Snowshoeing Trails

Waterfowl Sensitivity Class	X-Country	Snowshoeing
High	338.02	0
Moderate	111.53	0.0
Low	25634.96	5205.54
TOTAL	26084.51	5205.54

Recreational Hiking and Nature Study/Primitive Hiking

Hiking, particularly in the summer season, is a very popular activity on Hecla Island. Currently, there are over 66 kilometres of established trails that present an interesting and satisfying recreational experiences for hikers. Typically, most of the hiking takes place on the network of trails around the Gull Harbour area, although the system provides for long excursions throughout the island. There are also numerous trails that were originally developed as right of ways or old resource trails that are not as suitable for the typical hiker on Hecla Island (DNR, 1988). In many cases, these trails could be utilized more by nature study enthusiasts or primitive type hikers, for whom the challenge of hiking and passion for nature provides the attraction for them. Although

these areas are not maintained, they do provide travel corridors into areas that otherwise would be difficult to access. They are also used less frequently, and do not require the same level of development as established trails, and thus have little impact on the environment. In addition, experienced hikers have a concern for the environment, and thus are careful to protect it.

These trails, which span over 87 kilometres throughout the island, were identified on a 1:50,000 topographic map of Hecla Island (62P2) and entered into the GIS. Tables 6.25-6.29 describe the trail system on Hecla Island and the resources they overlay, divided into two classifications. There is only one case in which a recreational trail is within the buffer of a point site and that is a Piping Plover habitat. Within the primitive hiking areas there are two unique plants, Necklace Sedge and Engelman's Spike Rush.

Table 6.25 Total Length of Recreational Hiking Trails within Moose Summer and Wintering Areas (Metres)

Class	Moose - Winter	Moose - Summer
1	1386.89	11798.93
2	10433.32	14237.34
3	29590.49	20972.01
4	6137.27	5323.41
5	11782.78	6999.06
6	28316.60	28316.60
Total	87647.35	87647.35

Table 6.26 Total Length of Undeveloped Trails within Moose Summer and Wintering Areas (Metres)

Class	Moose - Winter	Moose - Summer
1	669.56	7418.27
2	13204.71	8858.06
3	18451.44	13018.62
4	8996.12	7472.16
5	20338.88	24893.60
6	5071.25	5071.25
Total	66731.96	66731.96

Table 6.27 Recreational/Undeveloped Hiking Trails and the Vegetation/Land Status of the Areas they Occupy (Metres)

Class	Recreational	Undeveloped
Ecological Protection Area	5831.56	0
Modified Land	21670.71	5030.02
Heritage Land	741.02	800.97
No Data (721,822,823)	3763.37	2983.01
SU	533.24	1158.49
Recreation Land	6032.58	0
S2	0	0
S3/S4	625.52	2215.80
S4	7547.08	13150.93
S4/S5	37917.76	23662.38
S5	2984.50	17730.37
Total	87647.34	66731.97

Table 6.28 Transformation Status of Land within Recreational/Primitive Hiking Trails

Class	Recreational	Undeveloped
Total	21757.95	5071.25
Major	6032.58	0
Partial	16923.33	18111.77
Minimal	42933.49	43548.93
TOTAL	87647.35	66731.95

Table 6.29 Status of Waterfowl Nesting Areas within Recreational/Primitive Hiking Trails

Waterfowl Sensitivity Class	Recreational	Undeveloped
High	20906.37	1224.94
Moderate	53.07	80.23
Low	66687.91	65426.78
TOTAL	87647.35	66731.95

Causeway

Before the causeway was built in 1971, the only link to the island was a ferry, which began operation in 1957 (Figure 6.3). Although the ferry enabled people access to the island by car, it did not lead to a large increase in the number of tourists to the island. The causeway was completed at a cost of $1,090,070, not including the cost of the bridge (ISB, 1970). With its completion, it was evident that there was significant potential to attract tourists to the island. Figure 6.4 is an aerial view of the causeway link from the mainland to Hecla Island.

Initially the causeway provided hope for the Icelandic community on Hecla

Island in terms of economic spinoffs from tourism, and employment for their people. However, their role diminished and dissension arose when the provincial government converted Hecla Island into a provincial park, and began to expropriate their land.

Figure 6.3 Ferry Route, 1962

Figure 6.4 Causeway, 1992

During the official unveiling of the park in 1974, the causeway became flooded, as the lake level rose and submersed a four-mile low spot that delayed the opening. An extra $722,000 had to be spent to upgrade the causeway road. This was not taken into consideration when the original 1.3 million dollar causeway was built (Mitchell, 1975). Although the economic pitfalls of the causeway were well publicised, the environmental impacts of the causeway on breeding grounds for many types of waterfowl were not really understood. According to DNR (1977), the disappearance of the Eared Grebe may have been related to the construction of the causeway. These birds were already at the northern extreme of their breeding range. Disturbance of their nesting sites on Grassy Island and in Hecla Marsh by construction of the causeway and navigation channel may have caused their extirpation (DNR, 1977).

Controlled Marsh and Viewing Facilities

The controlled marsh is located on the southern tip of Hecla Island and provides a diverse habitat for many species of waterfowl and colonial nesting birds. In the summer season the marsh also provides excellent opportunities for viewing moose from a number of observation structures that have been constructed around the area. In addition, a number of trails and a board-walk around the marsh have created an environment that is favourable for hiking and cycling (MNR, 1994).

Many of the improvements to the marsh were required since lake levels were falling from the regulation of Lake Winnipeg in 1975. In co-operation with Ducks Unlimited, a series of dikes and water control structures were erected through part of the marsh to make conditions more suitable for breeding waterfowl (DNR, 1988) (Figure 6.5 and 6.6).

Although the enhancements to the marsh have made it more appealing for tourists, there is the potential for adverse impacts, therefore, development around the area should be carefully monitored. The key to tourism on Hecla Island is the attraction of wildlife and other significant features, and appropriately, development should not take precedence over these valued resources. It is also critical for impact assessments to take place prior to development in these areas. This ensures that all the critical aspects of the environment are studied, therefore eliminating potential adverse effects.

Figure 6.5 Hecla Marsh, 1962

Figure 6.6 Hecla Marsh, 1992

6.3 Description of Future Tourism Development and Activities

This section focuses on two areas currently under development on Hecla Island, the north shore and the area around Hecla Village. First, a historical perspective of the area and some of the major conflicts and issues will be presented, followed by a tabular analysis of the area affected by these developments.

North Shore Cottage Development

The North Shore Cottage Development is being built on the northwest shores of Hecla Island. The lots, accessible by road, are located east of the rental cabins up to the lagoon, which is approximately 2 kms in length, and within 2 miles of Gull Harbour (Figure 2.2). The lots were first offered to many of the original descendants of Hecla Island who were expropriated from the area in the early 1970s when the island became a provincial park. Lots were then offered to the general public on a 21-year lease. The main rationale for setting up this subdivision according to Manitoba Natural Resources was as follows:

- "to provide ex-landowners and others with a quality cottaging opportunity
- to provide a population base to rejuvenate the Island's economy
- to enhance the viability of existing businesses and future business opportunities
- to create a positive economic impact on the Island and in the surrounding communities through the building and maintaining of cottages and lots" (MNR, 1997, p.1).

While it is certain there are many positive economic impacts to this project, there are some members of the public who views it as a contradiction to provincial park policy.

According to Turenne (1997), "Parks are not set up to be developed, parks are places to get away from economic development, not where you spread it out" (WFP, 1997). The development proposal suggests the land is within the Recreational Development land use category, however, upon examination of the area on that land use map, much of it is within the Backcountry class. The results from the GIS database suggested approximately 35 hectares would be lost to this development. This is somewhat underestimated since it only accounts for the area occupied by the lots, and there is much more land affected, including shoreline and other infrastructure. The WFP (1997) stated that approximately 100 hectares would be modified. The following tables describe the resources that will be affected by this development.

Table 6.30 Vegetation Resource Database

82123 - V6	7.04	19.84
82143 - V6	20.32	57.27
90152 - V6	5.04	14.21
99731	0.64	1.80
99835	1.24	3.49
99845	1.16	3.27
99991	0.04	0.11
Total	35.48	100.00
ML	1.16	3.27
RL	0.64	1.80
S4S5	32.40	91.32
SU	1.24	3.49
ZZ	0.04	0.11
Total	35.48	100.00

Table 6.31 Terrain Resource Database

Hi6-Bc1-R3	33.88	95.49
Ab9-Rs1	1.56	4.40
Mx	0.04	0.11
Total	35.48	100.00
B	33.12	93.35
IRD	2.36	6.65
Total	35.48	100.00
Total	1.16	3.27
Major	0.64	1.80
Partial	7.04	19.84
Minimal	26.64	75.08
Total	35.48	100.00

None	0	0.00
Total	0	0.00

Table 6.32 Wildlife Database

Class 1	7.04	19.84	0	0.00
Class 2	1.24	3.49	0.00	0.00
Class 3	25.36	71.48	32.40	91.32
Class 4	0.0	0.00	0.00	0.00
Class 5	0.0	0.00	1.24	3.49
Class 6	1.84	5.19	1.84	5.19
Total	35.48	100.00	35.48	100.00

High	1.24	3.49
Moderate	0	0.00
Low	34.24	96.51
Total	35.48	100.00
None	0	0.00
Total	0	0.00

Table 6.33 Recreation Capability Database

Class 1	0.0	0.00
Class 2	0.0	0.00
Class 3	4.88	13.75
Class 4	26.04	73.39
Class 5	0.0	0.00
Class 6	4.56	12.85
Class 7	0.0	0.00
Total	35.48	100.00

Table 6.34 Soil Suitability for Recreation Uses

Good	0.0	0.00	Good	0.00	0.00
Fair	33.88	95.49	Fair	0.00	0.00
Poor	1.56	4.40	Poor	35.44	99.89
Very Poor	0.04	0.11	Very Poor	0.04	0.11
Total	35.48	100.00	Total	35.48	100.00

Table 6.35 Soil Suitability for Engineering Uses

Good	0.0	0.00	Good	0.00	0.00
Fair	0.0	0.00	Fair	33.88	95.49
Poor	35.44	99.89	Poor	1.56	4.40
Very Poor	0.04	0.11	Very Poor	0.04	0.11
Total	35.48	100.00	Total	35.48	100.00

North Shore Cottage Development (Proposed)

Figure 6.7 illustrates the additional area being proposed for cottage development on Hecla Island, although no formal plans have yet been formulated to begin development. This section runs around the lagoon and along the shoreline for about 3 kilometres (TAEM, 1997). The following tables characterise the key environmental components of the area, as well as the recreation capability and soil suitability for specific uses.

Figure 6.7 Hecla North Shore, 1962

Table 6.36 Vegetation Resource Database

51123 - V13	5.68	10.40
82153 - V6	22.56	41.32
90152 - V6	20.64	37.80
99701 - V33	2.88	5.27
99721	0.60	1.10
99835	0.68	1.25
99839	0.60	1.10
99841	0.96	1.76
Total	54.60	100.00
HL	0.96	1.76
S3S4	0.60	1.10
S4S5	48.88	89.52
S5	2.88	5.27
ND	0.60	1.10
SU	0.68	1.25
Total	54.60	100.00

Table 6.37 Terrain Resource Database

Hi6-Bc1-R3	0.76	1.39
Ab9-Rs1	49.88	91.36
Mx	3.96	7.25
Total	54.60	100.00
B	54.60	100.00
Total	54.60	100.00
Total	0.96	1.76
Major	0.0	0.00
Partial	5.68	10.40
Minimal	47.96	87.84
Total	54.60	100.00

None	0	0.00
Total	0	0.00

Table 6.38 Wildlife Database

Class 1	0.0	0.00	0	0.00
Class 2	6.96	12.75	6.28	11.50
Class 3	43.20	79.12	43.20	79.12
Class 4	0.0	0.00	0.00	0.00
Class 5	2.88	5.27	3.56	6.52
Class 6	1.56	2.86	1.56	2.86
Total	54.60	100.00	54.60	100.00

High	0.68	1.25
Moderate	0.0	0.00
Low	53.92	98.75
Total	54.60	100.00
None	0	0.00
Total	0	0.00

Table 6.39 Recreation Capability Database

Class 1	0.0	0.00
Class 2	13.80	25.27
Class 3	9.68	17.73
Class 4	16.40	30.04
Class 5	0.0	0.00
Class 6	14.72	26.96
Class 7	0.0	0.00
Total	54.60	100.00

Table 6.40 Soil Suitability for Recreation Uses

Good	0.0	0.00	Good	0.00	0.00
Fair	0.76	1.39	Fair	0.00	0.00
Poor	49.88	91.36	Poor	50.64	92.75
Very Poor	3.96	7.25	Very Poor	3.96	7.25
Total	54.60	100.00	Total	54.60	100.00

Table 6.41 Soil Suitability for Engineering Uses

Good	0.0	0.00	Good	0.00	0.00
Fair	0.0	0.00	Fair	0.76	1.39
Poor	50.64	92.75	Poor	49.88	91.36
Very Poor	3.96	7.25	Very Poor	3.96	7.25
Total	54.60	100.00	Total	54.60	100.00

Historic Lands Resettlement Area

In 1969, when Hecla Island was officially designated as a Provincial Park, there was much excitement from the remaining 84 people on the island because of the assurances by the province that there would be many economic spinoffs once the area was opened to tourism. Unfortunately, the promises of jobs and of the maintenance of the Icelandic culture were not kept.

Originally, some were told their homes may have to be moved, and others were offered life time lease backs. Later, the government retracted, giving only two residents lease backs while the rest were expropriated. According to Mitchell (1975), the government said it needed to expropriate the people in order to better administer the park.

Many of the landowners did not want to sell but were intimidated by the persistent pressure by government officials. Some were offered as low as 5 dollars an acre for their land, well below what it was worth. Others just wanted to remain because they had lived there all their lives and were not interested in starting over somewhere else. There were also a number of cottage owners who had been enjoying the peacefulness and exclusion of the island for a generation, but were forced to leave.

Many of the Icelandic people are still very bitter towards the government's handling of their situation. Helgi Thomasson expressed it in this way, " the people who wanted to stay left here in hatred, leaving behind the house their grandfathers had built and themselves were born in" (Nairne, 1992). The promise of rebuilding their townsite and restoring their culture was finally realized in 1989, 22 years after the original pledge, though it is clear that this did not erase the pain that was inflicted on the people in the

past. Furthermore, the government did not realize that although many of the village buildings were restored, there was one element that was missing from the town, its people.

In the spring of 1997, just after revealing that they were establishing a cottage development on the northwest shore of Hecla Island, the Government of Manitoba, under pressure, announced that they were facilitating the resettlement of Hecla Island. They were offering the original landowners and their families a choice of lots on the east side of Hecla Island, where they originally had settled. The 5 acre lots were offered at a lease price of $5,000. The historic land lots are located around Hecla Village, and are situated within the Heritage land use class. As illustrated in Figures 6.8 and 6.9, there has not been much physical change in the landscape from 1962 to 1992, however there has been some succession of vegetation towards the lake on fields that were traditionally used for farming (Kjartanson, 1995). In addition, there were also 15 lots made available in the North Shore Subdivision. Originally the descendants were excited about having a chance to return, but were not thrilled about the location or the lease price. Now, the Icelanders are being offered lots in an area they want to settle, and at a price they can afford. The only issue that could not be resolved is that they still have to lease the land they once owned and were forced to give up (Interlake Spectator, 1997). The following tables summarize the vegetation, wildlife, and soils of the resettlement area:

Figure 6.8 Hecla Village, 1962

Figure 6.9 Hecla Village, 1992

Table 6.42 Vegetation Resource Database

55124 - V17	1.36	1.06
82133 - V6	0.48	0.37
82134 - V6	1.44	1.12
82153 - V6	3.20	2.50
88143 - V1	7.96	6.21
90133 - V6	3.36	2.62
90153 - V6	2.08	1.62
99822	69.72	54.43
99841	7.76	6.06
99843	29.44	22.99
99900	1.28	1.00
Total	128.08	100.00
HL	71.40	55.75
ML	35.52	27.73
S3S4	7.96	6.21
S4S5	11.92	9.31
ZZ	1.28	1.00
Total	128.08	100.00
None	0	0.00
Total	0	0.00

Table 6.43 Terrain Resource Database

Ab8-Fy2	83.04	64.83
DI	13.40	10.46
Ki6-Pc4	31.64	24.70
Total	128.08	100.00
H	99.00	77.30
IRD	29.08	22.70
Total	128.08	100.00
Total	37.20	29.04
Major	0.0	0.00
Partial	1.36	1.06
Minimal	89.52	69.89
Total	128.08	100.00

Table 6.44 Wildlife Database

Class 1	5.28	4.12	0	0.00
Class 2	1.36	1.06	4.72	3.69
Class 3	5.28	4.12	7.20	5.62
Class 4	7.96	6.21	7.96	6.21
Class 5	69.72	54.43	69.72	54.43
Class 6	38.48	30.04	38.48	30.04
Total	128.08	100.00	128.08	100.00

High	0.0	0.00
Moderate	71.00	55.43
Low	57.08	44.57
Total	128.08	100.00
None	0	0.00
Total	0	0.00

Table 6.45 Recreation Capability Database

Class 1	0.0	0.00
Class 2	10.64	8.31
Class 3	43.20	33.74
Class 4	74.20	57.95
Class 5	0.0	0.00
Class 6	0.0	0.00
Class 7	0.0	0.00
Total	128.04	100.00

Table 6.46 Soil Suitability for Recreation Uses

Good	31.64	24.70	Good	0.00	0.00
Fair	13.40	10.46	Fair	31.64	24.70
Poor	83.04	64.83	Poor	83.04	64.83
Very Poor	0.0	0.00	Very Poor	13.40	10.46
Total	128.08	100.00	Total	128.08	100.00

Table 6.47 Soil Suitability for Engineering Uses

Good	31.64	24.70	Good	31.64	24.70
Fair	0	0.00	Fair	13.40	10.46
Poor	83.04	64.83	Poor	83.04	64.83
Very Poor	13.40	10.46	Very Poor	0.00	0.00
Total	128.08	100.00	Total	128.08	100.00

6.4 Identifying Territorial UETs For Potential Development

To identify UETs for future development on Hecla Island, the process used was to first study past developmental proposals, and then determine the key environmental components that would be affected by these developments if they are undertaken in the future. The approach consisted of finding the approximate location of these facilities from maps, and digitizing them into the Geographic Information System. The next step involved the use of the UET technique to suggest possible alternatives to the original site. This meant referencing the tables that were generated to analyse the relationships

between the resources and the activities and developments on Hecla Island.

The second stage of the process was the analysis of future developments that may take place based on the expansion of tourism on Hecla Island. For example, the *Hecla Management Plan* discusses the popularity of cross-country skiing and snowmobiling. There is a future demand for new trails for these activities, and hence, the UET technique was used to locate the most suitable areas for these activities. It should be noted that the location is determined by choosing an area that will have least effect on key fauna and flora, and other significant features on Hecla Island, depending on the degree of impact of each activity or development. The degree of impact on each resource was found by formulating four tables that determined the relationships between activities and the environmental components. There are also other factors that determine locations of tourism development and activities, such as aesthetics and economics. For example, when selecting locations for resort developments, an important consideration and key attraction for tourists, is proximity to lakes. Other factors, such as recreation capability and soil suitability for specific uses, were also described in this study, although for the development of UETs, they were used as examples of how additional sources of data can be used to further target areas of development for buildings (intensive developments) and camping areas. The suitability for buildings and camping areas was extracted directly from soil interpretation file. For this study, this data was useful for sites that had already been chosen based on the Vegetation/Terrain and Wildlife component, which was the main criteria in the analyses.

Since the recreation and soil maps that were entered into the GIS were relatively

broad scale, and many of the developments or activities are based on a micro-scale, more detailed analyses at these sites may reveal results that differ from the original maps. If costs are justified, an area that may not be suitable for a certain development or activity in terms of soil, can be improved to make the site suitable. These layers are crucial components to the analysis and with more detailed information and research, can provide for a more comprehensive examination to locate various developments and tourist activities.

Airstrip/Runway

Prior to the development of tourism on Hecla Island, a study was undertaken in 1968 to investigate the recreation potential of the area. The main objectives were to make land use decisions and develop conceptual land use plans for these areas, while not undermining the local ecological regenerative processes (Man Taylor Muret, 1968). Many of the recommendations were implemented, such as the developments within Gull Harbour and the Historic Village, yet there have also been a number of developments that have not been realized.

In the past, there was some discussion about providing better accessibility to Hecla Island in order to attract more tourists, and one provision was to build a turf-runway. The Man Taylor Muret Report (1968) stated that "a small airport should be built on Hecla Island. More and more North American businessmen own and operate their own aircraft. This usually affluent segment of the travelling population could be encouraged to fly onto the island if adequate facilities were provided" (p. 14).

Evidently, attitudes at that time were quite different from today, and there are

many reasons why an airstrip on Hecla Island is not appropriate. First of all, the park, and in particular Gull Harbour Resort, has had trouble attracting people from its own province. Secondly, the park is only a two-hour drive from Winnipeg and an hour from an airstrip in Gimli. The attraction therefore was, as stated, the lure of the affluent from outside the province (Man Taylor Muret, 1968). The park does have numerous attractions, but it does not provide the exclusiveness and uniqueness that will entice the number of fly-in tourists to cost justify building and maintaining an airport. The construction of an airport in this type of environment is not consistent with the purpose of a provincial park, because it disrupts the naturalness of the surrounding areas, and removes land that may have been productive for various types of wildlife. Tables 6.48-6.51 represents the key components of the environment that would be affected by the development of the airport/runway at the current site that was initially chosen for it.

Table 6.48 Vegetation Resource Database

13200 - V32	0.48	0.48
82124 - V6	21.20	21.20
82133 - V6	3.40	3.40
90124 - V6	2.32	2.32
90152 - V6	9.56	9.56
99701 - V33	44.84	44.84
99721	7.60	7.60
99822	0.28	0.28
99823	7.84	7.84
99844	2.48	2.48
Total	100.00	100.00

Table 6.49 Terrain Resource Database

Ab8-Fy2	50.84	50.84
Mx	48.52	48.52
Ki6-Pc4	0.64	0.64
Total	100	100.00
H	100.00	100.00
Total	100.00	100.00
Total	2.48	2.48
Major	0.0	0.00
Partial	21.68	21.68
Minimal	75.84	75.84
Total	100.00	100.00

HL	8.12	8.12
ML	2.48	2.48
ND	7.60	7.60
S4	0.48	0.48
S4S5	36.48	36.48
S5	44.84	44.84
Total	100	100.00

None	0	0.00
Total	0	0.00

Table 6.50 Wildlife Database

Class 1	26.92	26.92	0.00	0.00
Class 2	7.60	7.60	9.92	9.92
Class 3	9.56	9.56	34.16	34.16
Class 4	0.0	0.00	0.48	0.48
Class 5	53.44	53.44	52.96	52.96
Class 6	2.48	2.48	2.48	2.48
Total	100.00	100.00	100.00	100.00

High	0.0	0.00
Moderate	0.0	0.00
Low	100.0	100.00
Total	100.00	100.00

None	0	0.00
Total	0	0.00

Table 6.51 Recreation Capability Database

Class 1	0.0	0.00
Class 2	0.0	0.00
Class 3	0.0	0.00
Class 4	1.04	1.04
Class 5	0.0	0.00
Class 6	61.84	61.84
Class 7	37.12	37.12
Total	100.00	100.00

Table 6.52 Soil Suitability for Recreation Uses

Good	0.64	0.64	Good	0.00	0.00
Fair	0.0	0.00	Fair	0.64	0.64
Poor	50.84	50.84	Poor	50.84	50.84
Very Poor	48.52	48.52	Very Poor	48.52	48.52
Total	100	100.00	Total	100.00	100.00

Table 6.53 Soil Suitability for Engineering Uses

Good	0.64	0.64	Good	0.64	0.64
Fair	0.0	0.00	Fair	0.00	0.00
Poor	50.84	50.84	Poor	50.84	50.84
Very Poor	48.52	48.52	Very Poor	48.52	48.52
Total	100	100.00	Total	100.00	100.00

Airstrip/Runway Territorial UETs

In establishing territorial UETs, the focus was first to spatially illustrate a single environmental component. This enabled an understanding of where developments and activities should be located in relation to each key environmental component (Vegetation/Terrain Component and Wildlife Component). The combined UET map represents the overlay of the Vegetation/Terrain Component map and Wildlife Component and encompasses all the environmental components that are being affected.

Vegetation/Terrain Component:

1. Status - Protect *Unique Vegetation/Terrain*, *Rare Vegetation/Terrain*, *Uncommon Vegetation/Terrain*, and *Common Vegetation/Terrain* which are areas of long term concern. Avoid *Unique Cultural Areas*.

2. Modification - No development in *Total* or *Major* areas of modification.

3. Significant Plants/Unique Natural and Cultural Features - Protect all *Unique* and *Rare* plants. Avoid all significant sites including *Archaeological Sites*, *Limestone Cliffs*, *Beaches*, *Salt Licks*, and *Hydrographic Features*.

4. Land Use - Protect *Ecological Protection Areas*, *Heritage Land*, and avoid *Intensive Recreation Development*.

Wildlife Component:

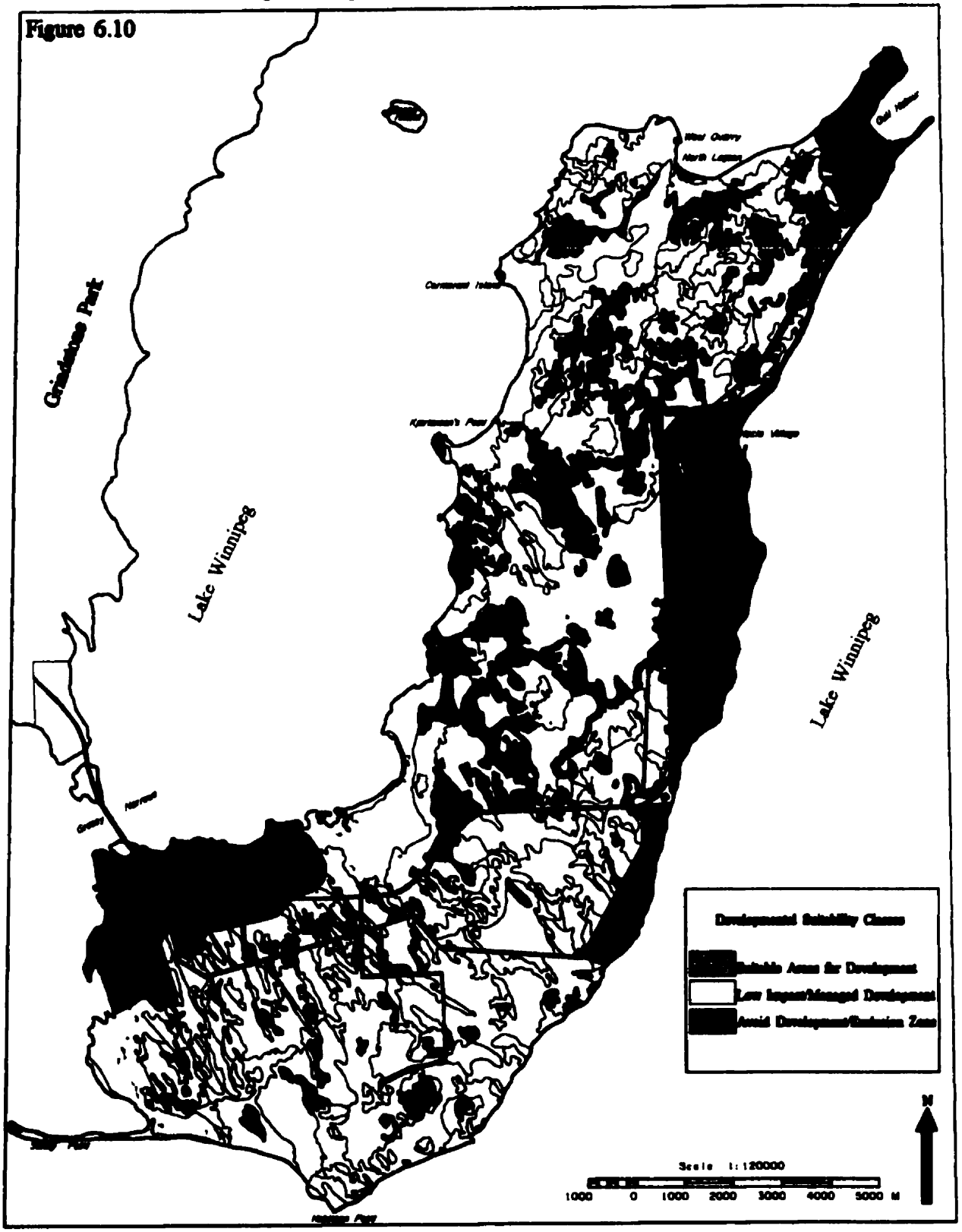
1. Waterfowl - Protect all *Highly Significant/Sensitive* and *Moderately Significant/Sensitive Waterfowl Areas.*

2. Colonial Nesting Species - Protect all *Significant/Sensitive Colonial Nesting Species Sites.*

3. Moose - Protect *Class 1-3 Significant/Sensitive Areas for Moose in Summer and Winter.*

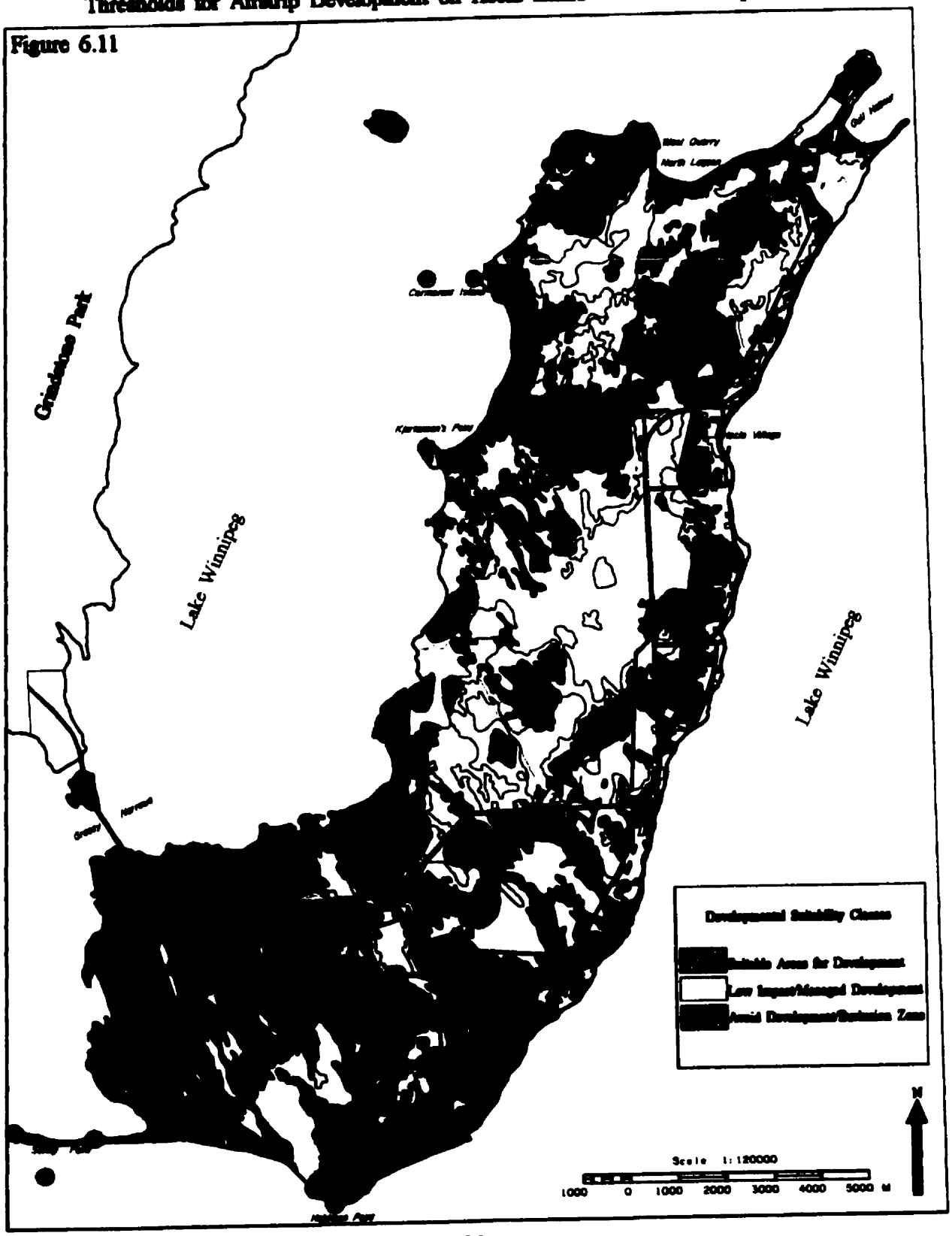
After compiling the results from Table 5.4 into UETs, Figure 6.12 illustrates that there is very little land available for airstrip development on Hecla Island. Most of the area is low quality for wildlife (Figure 6.11) and is considered very abundant in terms of vegetation status with no unique plants (Figure 6.10). It should also be noted that since this development produces a significant impact on the environment, any areas that have been chosen should be carefully assessed before development takes place, and have strict ecological management controls throughout its operation. Therefore, areas suitable for development are classified as Low Impact/Managed development.

Thresholds for Airstrip Development on Hecla Island - Vegetation/Terrain Component

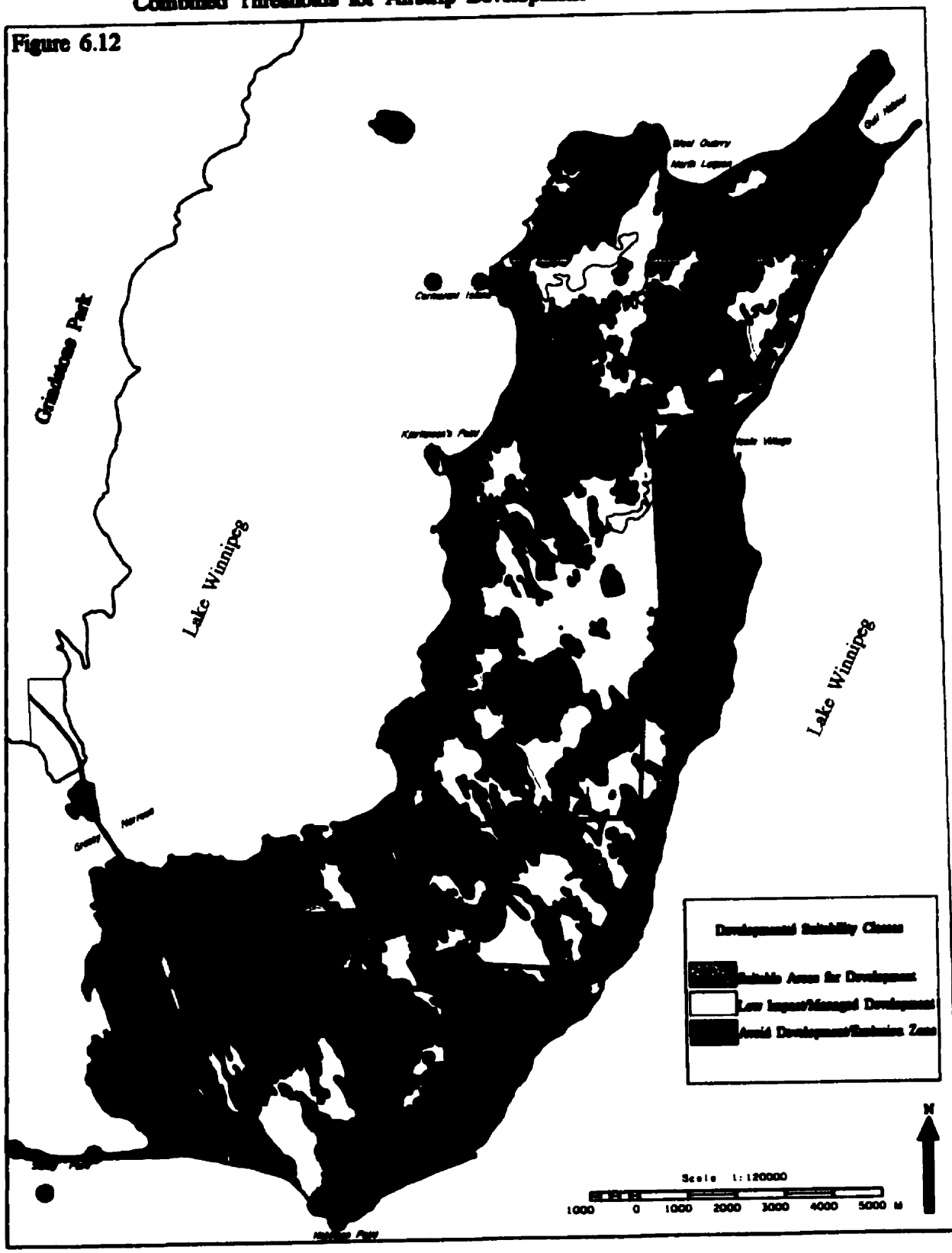


Thresholds for Airstrip Development on Hecla Island - Wildlife Component

Figure 6.11



Combined Thresholds for Airstrip Development on Hecla Island



Minor Recreation Complex

Other findings in Man Taylor Muret (1968) suggest the development of a minor recreation complex on the southeast shoreline of Hecla Island (Figure 4.4). Though no development of this nature has taken place thus far, there is potential for this area to be developed in the future. Therefore, it is necessary to describe the important environmental components of the area to determine whether it is suitable for this use.

Table 6.54 Vegetation Resource Database

11000 - V21	12.48	8.87
82123- V6	0.80	0.57
82134 - V6	83.56	59.41
82144 - V6	14.60	10.38
82152 - V6	10.64	7.57
82153 - V6	3.80	2.70
90154	14.76	10.49
Total	140.64	100.00
HL	0.0	0.00
ML	0.0	0.00
ND	0.0	0.00
S4	12.48	8.87
S4S5	128.16	91.13
S5	0.0	0.00
Total	140.64	100.00

Table 6.55 Terrain Resource Database

Ab	2.04	1.45
Ab5-Fy5	29.16	20.73
Ab7-Fy(P)3	61.52	43.74
Fy(P)	5.20	3.70
Fy(P)7-Ox3	24.96	17.75
Sb	17.76	12.63
Total	140.64	100.00
B	140.64	100.00
Total	140.64	100.00
Total	0.0	0.00
Major	0.0	0.00
Partial	13.28	9.44
Minimal	127.36	90.56
Total	140.64	100.00

None	0	0.00
Total	0	0.00

Table 6.56 Wildlife Database

Class 1	84.28	59.95	0.00	0.00
Class 2	0.00	0.00	0.00	0.00
Class 3	43.88	31.18	128.16	91.13
Class 4	12.48	8.87	12.48	8.87
Class 5	0.0	0.00	0.00	0.00
Class 6	0.0	0.00	0.00	0.00
Total	140.64	100.00	140.64	100.00

High	0.0	0.00
Moderate	0.0	0.00
Low	140.64	100.00
Total	140.64	100.00
None	0	0.00
Total	0	0.00

Table 6.57 Recreation Capability Database

Class 1	0.0	0.00
Class 2	0.0	0.00
Class 3	0.0	0.00
Class 4	130.48	92.78
Class 5	0.0	0.00
Class 6	10.16	7.22
Class 7	0.0	0.00
Total	140.64	100.00

Table 6.58 Soil Suitability for Recreation Uses

Good	0.00	0.00	Good	17.76	12.63
Fair	17.76	12.63	Fair	0.00	0.00
Poor	92.72	65.93	Poor	92.72	65.93
Very Poor	30.16	21.44	Very Poor	30.16	21.44
Total	140.64	100.00	Total	140.64	100.00

Table 6.59 Soil Suitability for Engineering Uses

Good	0.0	0.00	Good	0.00	0.00
Fair	0.0	0.00	Fair	0.00	0.00
Poor	110.48	78.56	Poor	110.48	78.56
Very Poor	30.16	21.44	Very Poor	30.16	21.44
Total	140.64	100.00	Total	140.64	100.00

West Quarry Development Area

The West Quarry site (Figure 4.4), located on the Northwest shores of Hecla Island, has remained relatively free from development. There is a trail that links Gull Harbour and the West Quarry, and hiking along this trail has become a very popular activity for tourists. However, the entire area up to the lagoon is currently being developed into the Northshore Cottage Subdivision. The actual site of the quarry is located within a designated expansion area for a second cottage subdivision, from the lagoon to approximately a kilometre past the quarry, although no plans have been set to develop this site. The area has some unique cultural features, and it also has excellent potential for various types of recreation development. Man Taylor Muret (1968) suggested the section around the lagoon and up to the West Quarry be developed as a major recreation complex with hiking trails, group and tent campground, trailer park, service and accommodation centre, and parking lots. The following tables describe the key environment components in the area that was proposed:

Table 6.60 Vegetation Resource Database

82153 - V6	8.28	25.49
90152 - V6	20.64	63.55
99701 - V33	2.88	8.87
99835	0.68	2.09
Total	32.48	100.00
S4S5	28.92	89.04
S5	2.88	8.87
SU	0.68	2.09
Total	32.48	100.00
None	0	0.00
Total	0	0.00

Table 6.61 Terrain Resource Database

Ab-Rs1	27.76	85.47
Hi6-Bc1-R3	0.76	2.34
Mx	3.96	12.19
Total	32.48	100.00
B	32.48	100.00
Total	32.48	100.00
Total	0.0	0.00
Major	0.0	0.00
Partial	0.0	0.00
Minimal	32.48	100.00
Total	32.48	100.00

Table 6.62 Wildlife Database

Class 1	0.0	0.00	0.00	0.00
Class 2	0.68	2.09	0.00	0.00
Class 3	28.92	89.04	28.92	89.04
Class 4	0.0	0.00	3.56	10.96
Class 5	2.88	8.87	0.00	0.00
Class 6	0.0	0.00	0.00	0.00
Total	32.48	100.00	32.48	100.00

High	0.68	2.09
Moderate	0.0	0.00
Low	31.80	97.91
Total	32.48	100.00
None	0	0.00
Total	0	0.00

Table 6.63 Recreation Capability Database

Class 1	0.0	0.00
Class 2	8.08	24.88
Class 3	9.68	29.80
Class 4	0.0	0.00
Class 5	0.0	0.00
Class 6	14.72	45.32
Class 7	0.0	0.00
Total	32.48	100.00

Table 6.64 Soil Suitability for Recreation Uses

Good	0.00	0.00	Good	0.00	0.00
Fair	0.76	2.34	Fair	0.00	0.00
Poor	27.76	85.47	Poor	28.52	87.81
Very Poor	3.96	12.19	Very Poor	3.96	12.19
Total	32.48	100.00	Total	32.48	100.00

Table 6.65 Soil Suitability for Engineering Uses

Good	0.0	0.00	Good	0.00	0.00
Fair	0.0	0.00	Fair	0.76	2.34
Poor	28.52	87.81	Poor	27.76	85.47
Very Poor	3.96	12.19	Very Poor	3.96	12.19
Total	32.48	100.00	Total	32.48	100.00

Family Vacation Resort

According to DNR (1988), there was a provision to encourage the private sector to develop a 4-season family vacation resort on Hecla Island. It would give families the option of longer term stays (a week plus), that would be more affordable then staying at the Gull Harbour Resort Hotel. There would also be numerous recreation activities geared towards families. A site assessment was carried out on two potential sites in the Gull Harbour area (Figure 4.4), which studied soil drainage, topography, water orientation, development area, expansion potential, linkages to park and recreation amenities, and potential compatibility with other park uses as key factors in the selection of the site (DNR, 1988). Although there has not been an effort to launch this proposal, it still represents a viable plan that should be considered. The tables that follow represent the significant environmental components that would be altered by the location of the family vacation resort at both these sites.

4-Season Resort (Site A)

Table 6.66 Vegetation Resource Database

60134 - V13	2.76	14.41
61144- -V13	6.20	32.36
82134 - V6	6.64	34.66
99731	1.48	7.72
99841	.60	3.13
99843	1.48	7.72
Total	19.16	100.00

RL	1.48	7.72
ML	2.08	10.86
ND	0.0	0.00
S4S5	15.60	81.42
Total	19.16	100.00

None	0	0.00
Total	0	0.00

Table 6.67 Terrain Resource Database

Hi6-Bc1-R3	14.40	75.16
Lt	1.92	10.02
Pe	2.84	14.82
Total	19.16	100.00

B	19.16	100.00
Total	19.16	100.00

Total	2.08	10.86
Major	1.48	7.72
Partial	0.0	0.00
Minimal	15.60	81.42
Total	19.16	100.00

Table 6.68 Wildlife Database

Class 1	6.64	34.66	0.00	0.00
Class 2	8.96	46.76	8.96	46.76
Class 3	0.0	0.00	6.64	34.66
Class 4	0.0	0.00	0.0	0.00
Class 5	0.0	0.00	0.00	0.00
Class 6	3.56	18.58	3.56	18.58
Total	19.16	100.00	19.16	100.00

High	0.0	0.00
Moderate	0.0	0.00
Low	19.16	100.00
Total	19.16	100.00

None	0	0.00
Total	0	0.00

Table 6.69 Recreation Capability Database

Class 1	5.92	30.90
Class 2	0.0	0.00
Class 3	13.24	69.10
Class 4	0.0	0.00
Class 5	0.0	0.00
Class 6	0.0	0.00
Class 7	0.0	0.00
Total	19.16	100.00

Table 6.70 Soil Suitability for Recreation Uses

Good	1.92	10.02	Good	0.00	0.00
Fair	14.40	75.16	Fair	1.92	10.02
Poor	2.84	14.82	Poor	17.24	89.98
Very Poor	0.00	0.00	Very Poor	0.00	0.00
Total	19.16	100.00	Total	19.16	100.00

Table 6.71 Soil Suitability for Engineering Uses

Good	0.0	0.00	Good	0.00	0.00
Fair	4.76	24.84	Fair	16.32	85.18
Poor	14.40	75.16	Poor	2.84	14.82
Very Poor	0.0	0.00	Very Poor	0.00	0.00
Total	19.16	100.00	Total	19.16	100.00

Season Resort (Site B)

Table 6.72 Vegetation Resource Database

SUL	0.72	3.95
82152 - V6	11.52	63.16
99841	4.56	25.00
99843	1.44	7.89
Total	18.24	100.00
UA	0.72	3.95
ML	11.52	63.16
S4S5	6.0	32.89
Total	18.24	100.00
None	0	0.00
Total	0	0.00

Table 6.73 Terrain Resource Database

Hi6-Bc1-R3	14.84	81.36
Lt	3.40	18.64
Total	18.24	100.00
IRD	18.24	100.00
Total	18.24	100.00
Total	6.0	32.89
Major	0.0	0.00
Partial	0.0	0.00
Minimal	12.24	67.11
Total	18.24	100.00

Table 6.74 Wildlife Database

Class 1	0.0	0.00	0.0	0.00
Class 2	0.0	0.00	0.0	0.00
Class 3	11.52	63.16	11.52	63.16
Class 4	0.0	0.00	0.0	0.00
Class 5	0.0	0.00	0.0	0.00
Class 6	6.72	36.84	6.72	36.84
Total	18.24	100.00	18.24	100.00

High	0.0	0.00
Moderate	0.0	0.00
Low	18.24	100.00
Total	18.24	100.00
None	0	0.00
Total	0	0.00

Table 6.75 Recreation Capability Database

Class 1	17.20	94.30
Class 2	0.0	0.00
Class 3	0.0	0.00
Class 4	0.0	0.00
Class 5	0.0	0.00
Class 6	1.04	5.70
Class 7	0.0	0.00
Total	18.24	100.00

Table 6.76 Soil Suitability for Recreation Uses

Good	3.40	18.64	Good	0.00	0.00
Fair	14.84	81.36	Fair	3.40	18.64
Poor	0.0	0.00	Poor	14.84	81.36
Very Poor	0.00	0.00	Very Poor	0.00	0.00
Total	18.24	100.00	Total	18.24	100.00

Table 6.77 Soil Suitability for Engineering Uses

Good	0.0	0.00	Good	0.00	0.00
Fair	3.40	18.64	Fair	18.24	100.00
Poor	14.84	81.36	Poor	0.00	0.00
Very Poor	0.0	0.00	Very Poor	0.00	0.00
Total	18.24	100.00	Total	18.24	100.00

Locating Areas for Future Intensive Development

The Minor Recreation Complex, West Quarry Development Area, and the Family Vacation Resort are all considered intensive developments. Intensive developments indicate a high degree of impact causing a change or modification of the local environment, in contrast to activities such as cross-country skiing and nature study, which only cause a disturbance to the environment, and thus a lower impact. Although these developments have only been proposed, and never constructed, there is still potential for their future development. As a result, each will require permanent structures that could remove key vegetation or habitat in an area. In addition, these developments provide for a wide range of recreational opportunities that require altering, and sometimes total modification of the environment surrounding the development. According to Table 5.4, the potential consequences of these developments are the same for all the environmental components. Hence, the UETs will also correspond for each development, as will the final map that represents the considerations for expansion of these type of facilities.

Territorial UETs for the Minor Recreation Complex, West Quarry Development Area, and the Family Vacation Resort

Vegetation/Terrain Component:

1. Status - *Protect Unique Vegetation/Terrain, Rare Vegetation/Terrain, Uncommon Vegetation/Terrain,* and *Unique Cultural Areas.*

2. Modification - No development in *Total* areas of modification.

3. Significant Plants/Unique Natural and Cultural Features - Protect all *Unique, and Rare Plants; Limestone Cliffs, Archaeological Sites, and Salt Licks.* Development should be managed on *Beaches*, and *Hydrographic* features.

4. Land Use - Avoid *Ecological Protection Areas*

Wildlife Component:

1. Waterfowl - Protect all *Highly Significant/Sensitive Waterfowl Areas.*

2. Colonial Nesting Species - Protect all *Significant Colonial Nesting Species Sites.*

3. Moose - *Protect Class 1 and 2 Significant/Sensitive Areas for Moose in Summer and Winter.*

Soil Component:

1. Rated as *Good* or *Fair* based on *Soil Suitability for Buildings without Basements.*

A new map was produced through the combination of the Vegetation/Land component, Wildlife component, and the inclusion of the soil suitability for intensive development (Figure 6.16). Since the requirement for intensive developments is the

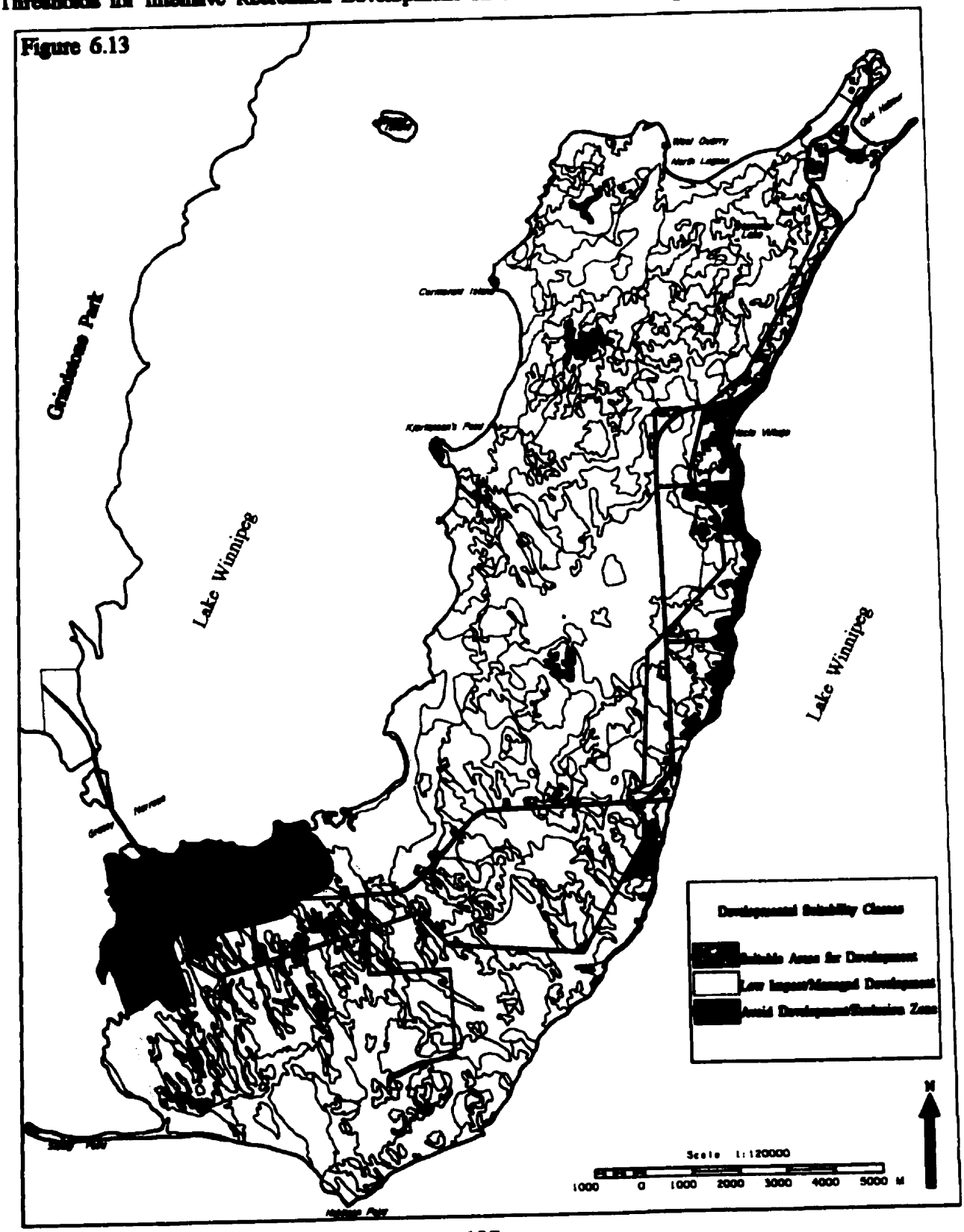
construction of buildings, an attribute extracted for the soil interpretation file determined the suitability of the soil for development of these types of facilities. Those areas selected were lands within the combined map (Figure 6.15) that are suitable for managed development (based on Vegetation/Terrain Component and Wildlife Component) and rated Good or Fair soil suitability (Figure 4.16). As it was formally indicated, if an area is rated *very poor* in terms of soil suitability for building, it does not imply that a facility cannot be built there. It suggests that it would be difficult and more expensive to build under current soil conditions, therefore, the site would have to be improved.

There are many factors that have to be studied when considering the development of an area, and in this study, the focus has been to protect key environmental components on Hecla Island. The study first considers these attributes, and following, other data can be used to narrow down the search.

As previously discussed, since development will involve profound changes to the local environment, an environmental assessment should take place prior to construction. A large part of the island is suitable for intensive development within the Low Impact/Managed development class, indicating this type of development can thrive within Hecla's environment if proper planning and sound ecological management is the focal point of the development. Controls and regulations on future development and expansion are also important in maintaining the environment around the development.

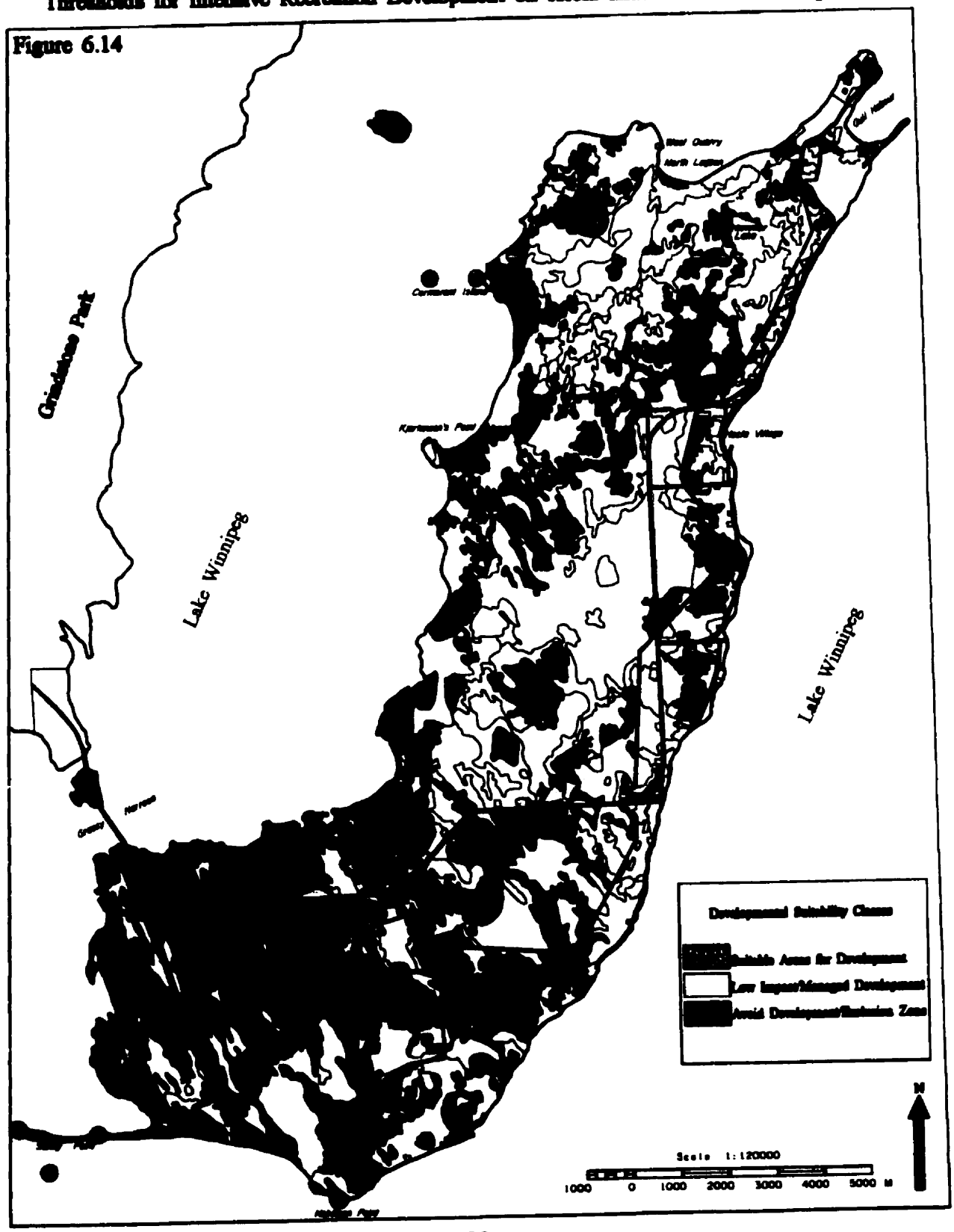
Thresholds for Intensive Recreation Development on Hecla Island - Vegetation/Terrain Component

Figure 6.13



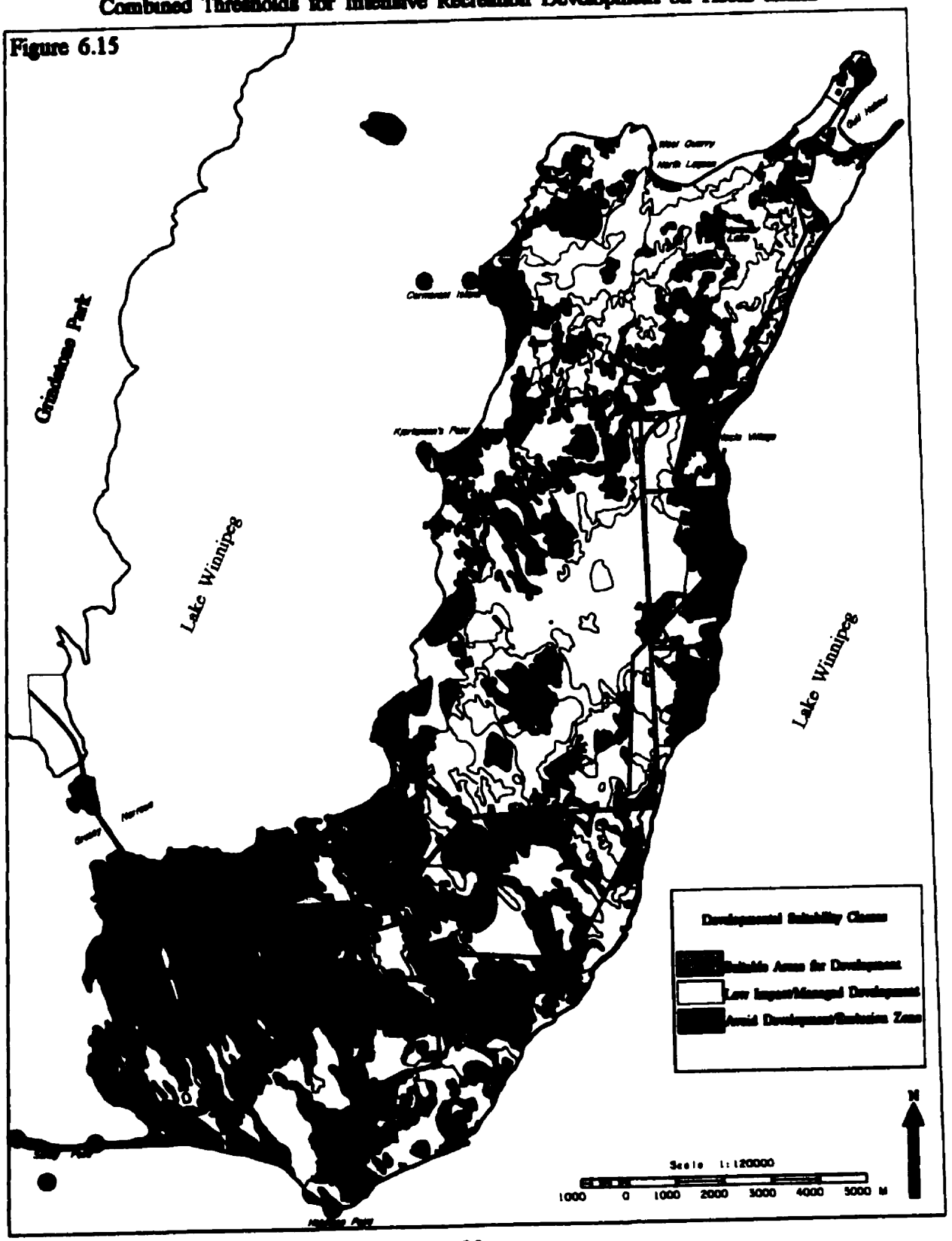
Thresholds for Intensive Recreation Development on Hecla Island - Wildlife Component

Figure 6.14

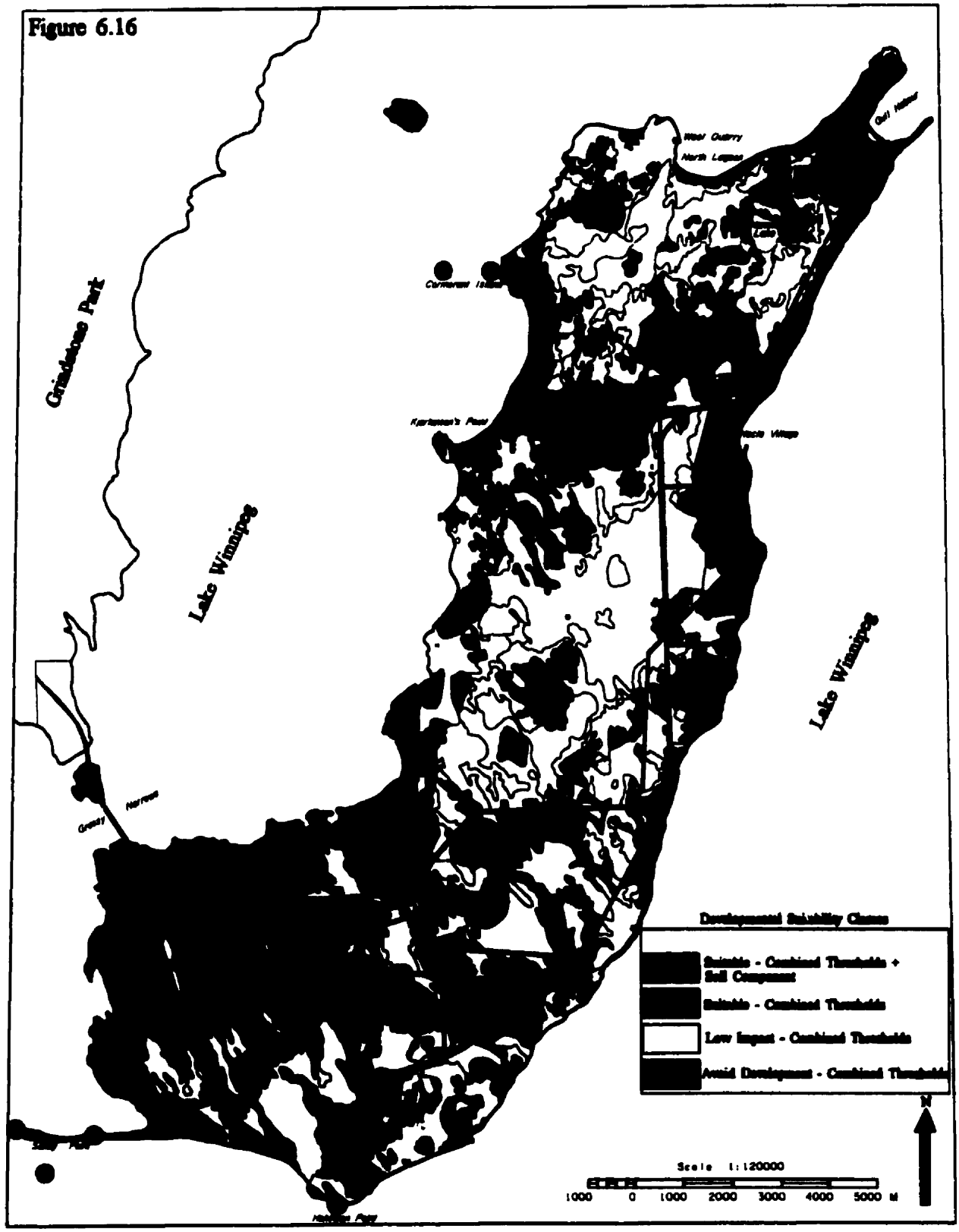


Combined Thresholds for Intensive Recreation Development on Hecla Island

Figure 6.15



Suitable Areas for Intensive Developments on Hecla Island - Inclusion of the Soil Component



Group Use Campground

Group use campgrounds are similar to regular tent campgrounds except the facilities are set up for larger gatherings. Although there are no current group use campground sites on Hecla Island, two have been proposed (Figure 4.4). The following are the resources that would be modified if these areas were developed in the near future:

Table 6.78 Vegetation Resource Database

82134 - V6	4.52	49.35
82153 - V6	4.56	49.78
91144 - V6	0.08	0.87
Total	9.16	100.00
S4S5	9.16	100.00
Total	9.16	100.00

None	0	0.00
Total	0	0.00

Table 6.79 Terrain Resource Database

Ab7-Fy(P)3	4.60	50.22
Ab9-Rs1	4.56	49.78
Total	9.16	100.00
B	9.16	100.00
Total	9.16	100.00
Total	0.0	0.00
Major	0.0	0.00
Partial	0.0	0.00
Minimal	9.16	100.00
Total	9.16	100.00

Table 6.80 Wildlife Database

Class 1	4.52	49.35	0.0	0.00
Class 2	0.0	0.00	0.0	0.00
Class 3	4.64	50.66	9.16	100.00
Class 4	0.0	0.00	0.0	0.00
Class 5	0.0	0.00	0.0	0.00
Class 6	0.0	0.00	0.00	0.00
Total	9.16	100.00	9.16	100.00

High	0.0	0.00
Moderate	0.0	0.00
Low	18.24	100.00
Total	18.24	100.00
None	0	0.00
Total	0	0.00

Table 6.81 Recreation Capability Database

Class 1	0.0	0.00
Class 2	0.0	0.00
Class 3	0.0	0.00
Class 4	0.56	6.11
Class 5	0.0	0.00
Class 6	7.48	81.66
Class 7	1.12	12.23
Total	9.16	100.00

Table 6.82 Soil Suitability for Recreation Uses

Good	0.0	0.00	Good	0.00	0.00
Fair	0.0	0.00	Fair	0.00	0.00
Poor	9.16	100.00	Poor	9.16	100.00
Very Poor	0.00	0.00	Very Poor	0.00	0.00
Total	9.16	100.00	Total	9.16	100.00

Table 6.83 Soil Suitability Engineering Uses

Good	0.0	0.00	Good	0.00	0.00
Fair	0.0	0.00	Fair	0.00	0.00
Poor	9.16	100.00	Poor	9.16	100.00
Very Poor	0.0	0.00	Very Poor	0.00	0.00
Total	9.16	100.00	Total	9.16	100.00

Territorial UETs for Potential Campground Sites

Vegetation/Terrain Component:

1. Status - Protect *Unique Vegetation/Terrain, Rare Vegetation/Terrain* and *Uncommon Vegetation/terrain*. Camping can be included within *Unique Cultural Areas* with effective management controls including enhancing Icelandic themes.

2. Modification - No development in *Total* areas of modification.

3. Significant Plants/Unique Natural and Cultural Features - Protect all *Unique, and Rare* plants. Avoid *Archaeological Sites, Salt Licks, and Beaches*, although with appropriate management, camping can occur at other significant sites.

4. Land Use - Avoid *Ecological Protection Areas*

Wildlife Component:

1. Waterfowl - Protect all *Highly Significant/Sensitive Waterfowl Areas.*

2. Colonial Nesting Species - Protect all *Significant Colonial Nesting Species Sites.*

3. Moose - Protect *Class 1 and 2 Significant/Sensitive Areas for Moose in Summer and Winter.*

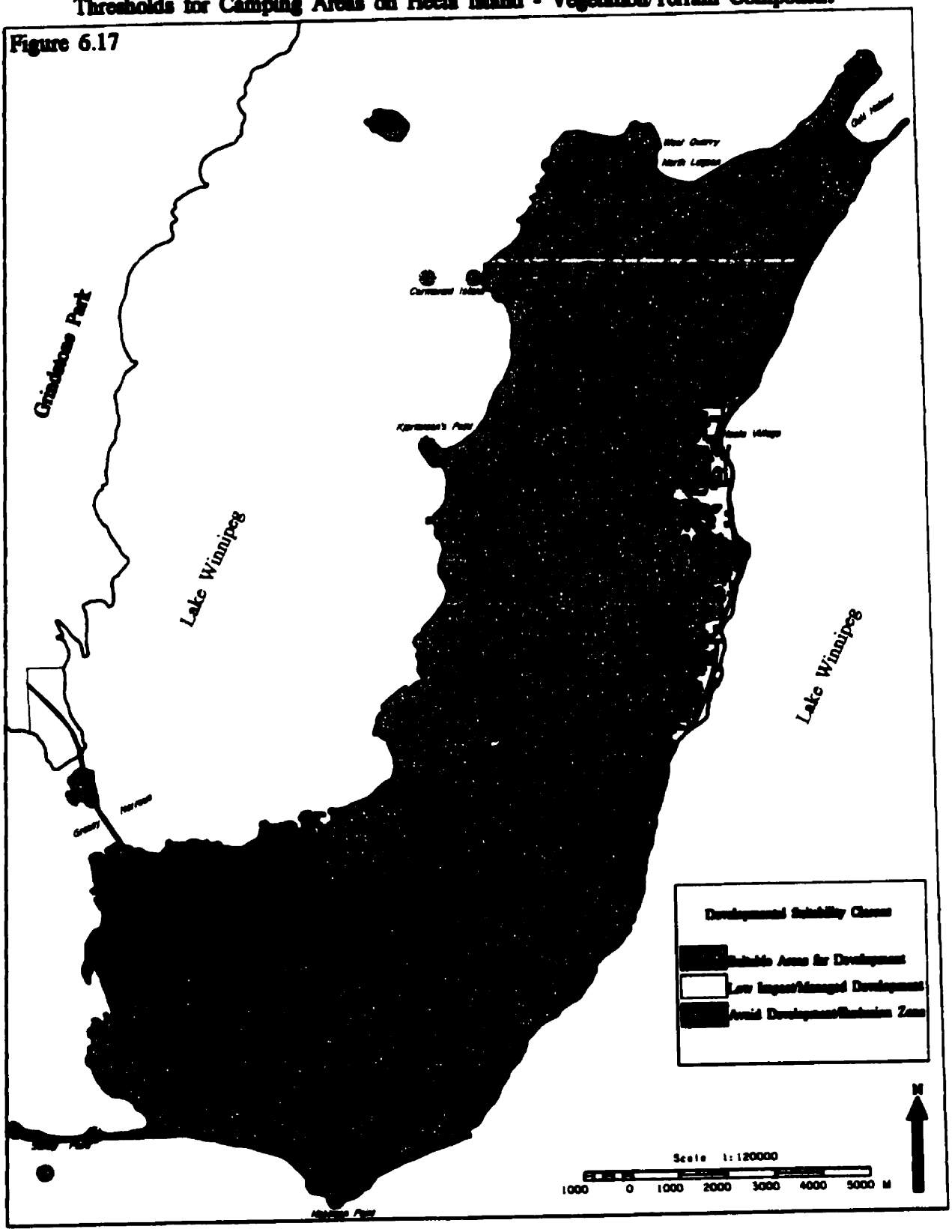
Soil and Recreational Suitability Component:

1. Rated as *Good* or *Fair* based on *Soil Suitability for Camping Areas.*

2. *Recreational Capability Classes 1- 4.*

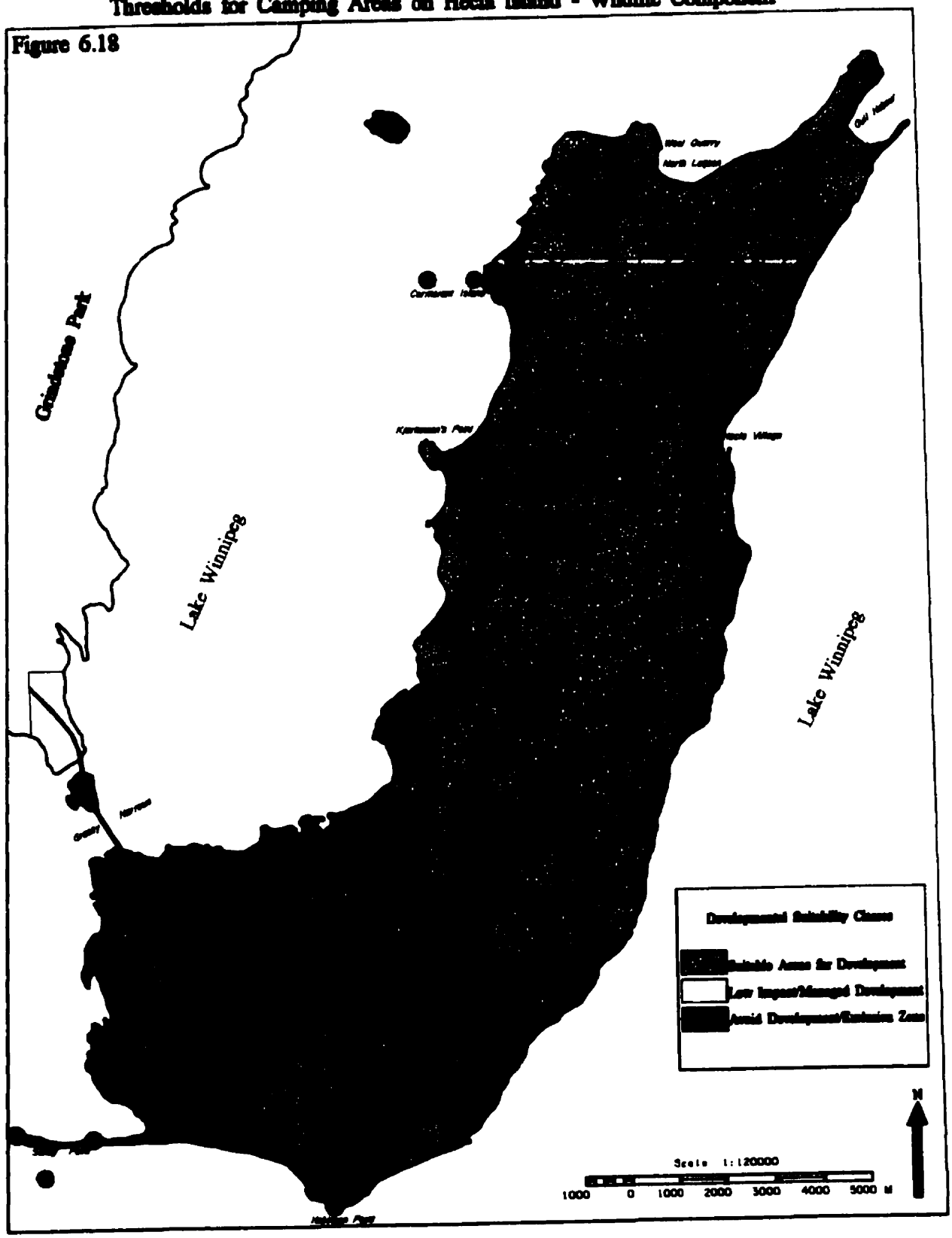
A new map was produced from the combination of Vegetation/Terrain component (Figure 6.17) and the Wildlife component (Figure 6.18) based on soil suitability for camping areas (Figure 4.15), and the recreation capability (Figure 4.19). The inclusion of the recreation capability layer adds components such as aesthetics and access to recreational opportunities such as swimming and boating, which are also very important when locating campgrounds. According to Figure 4.19, the most suitable areas for camping when the recreation capability component is added to the map are along the east shoreline, Hecla Village, and a few sites around Gull Harbour. Figure 6.20 shows that there is substantial space on Hecla Island that can be considered for expansion of camping, while the inclusion of the soil and recreation components significantly reduces these options (Figure 6.20).

Thresholds for Camping Areas on Hecla Island - Vegetation/Terrain Component



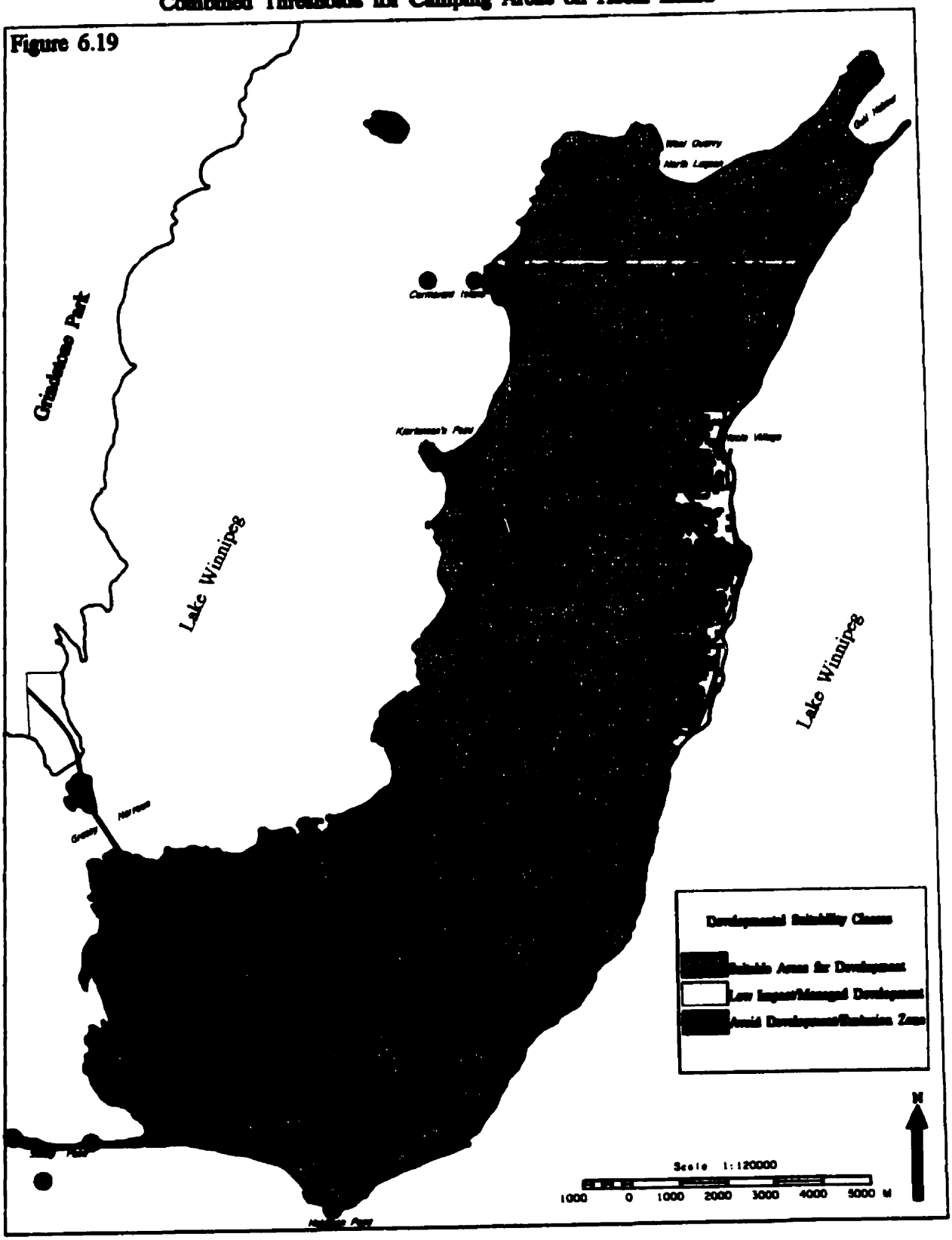
Thresholds for Camping Areas on Hecla Island - Wildlife Component

Figure 6.18

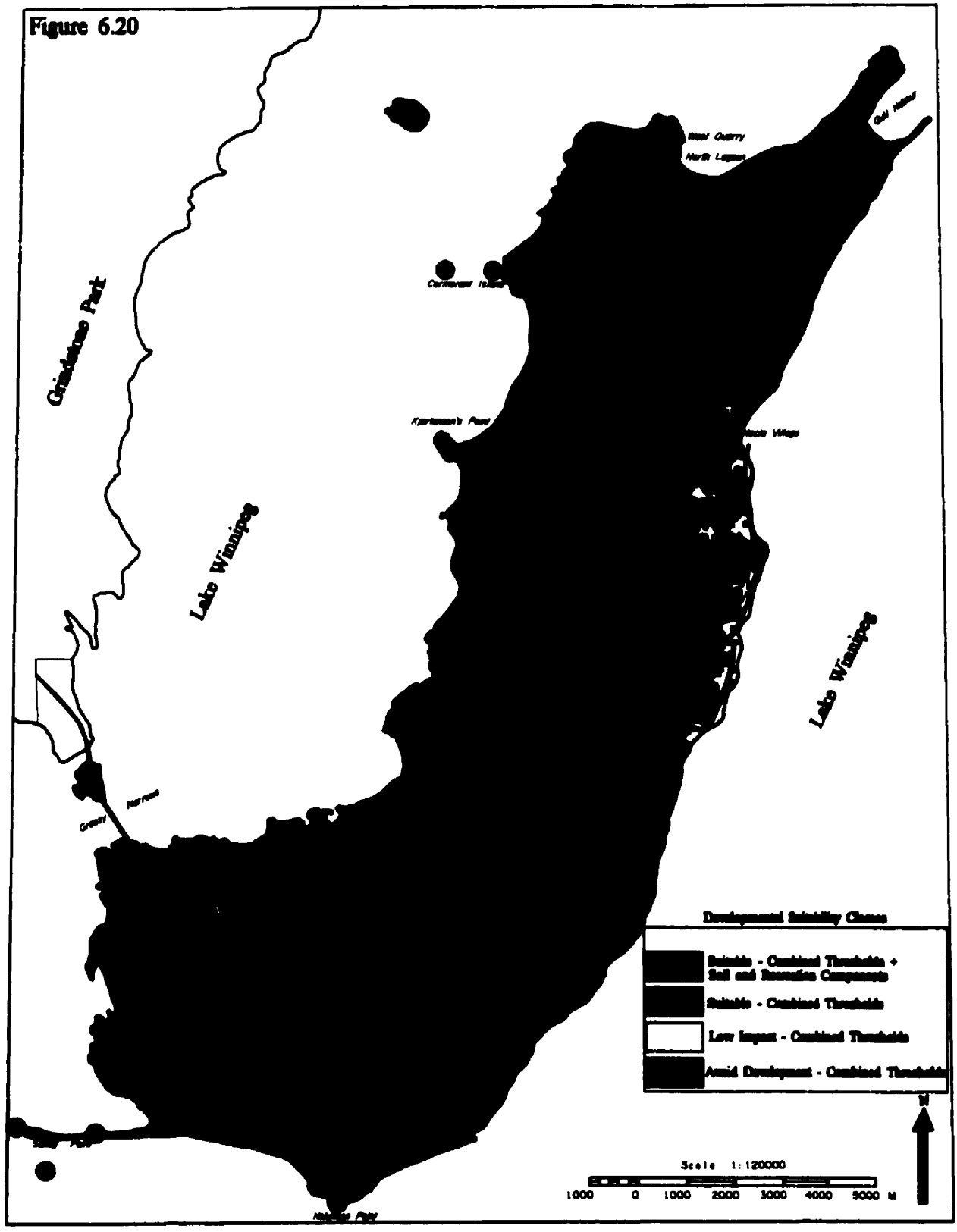


Combined Thresholds for Camping Areas on Hecla Island

Figure 6.19



Suitable Areas for Camping on Hecla Island - Inclusion of the Soil and Recreation Components



Territorial UETs for Future Primitive Hiking and Nature Study Areas

Since there is little development required, primitive hiking and nature study are two activities that provide for a more 'Eco-Friendly' approach to the environment. Most of the users are experienced outdoors-people, and are interested in the wilderness experience of these trips, and it this concern that is the key to enabling these activities to thrive in more sensitive environments.

Vegetation/Terrain Component:

1. Status - None (activities can take place in all areas). In very *Unique* and *Rare* vegetation, development should be maintained at a minimum with nature viewing being the key activity (Low Impact/Managed Development).

2. Modification - *Total* or *Major* areas of modification not compatible with primitive hiking and nature study areas.

3. Significant Plants/Unique Natural and Cultural Features - Protect all *Unique, and Rare Plants*. The locations of unique and rare plants cannot be revealed. All other sites can be utilized.

4. Land Use - Avoid *Intensive Recreational Development* since it is not compatible with this type of activity.

Wildlife Component:

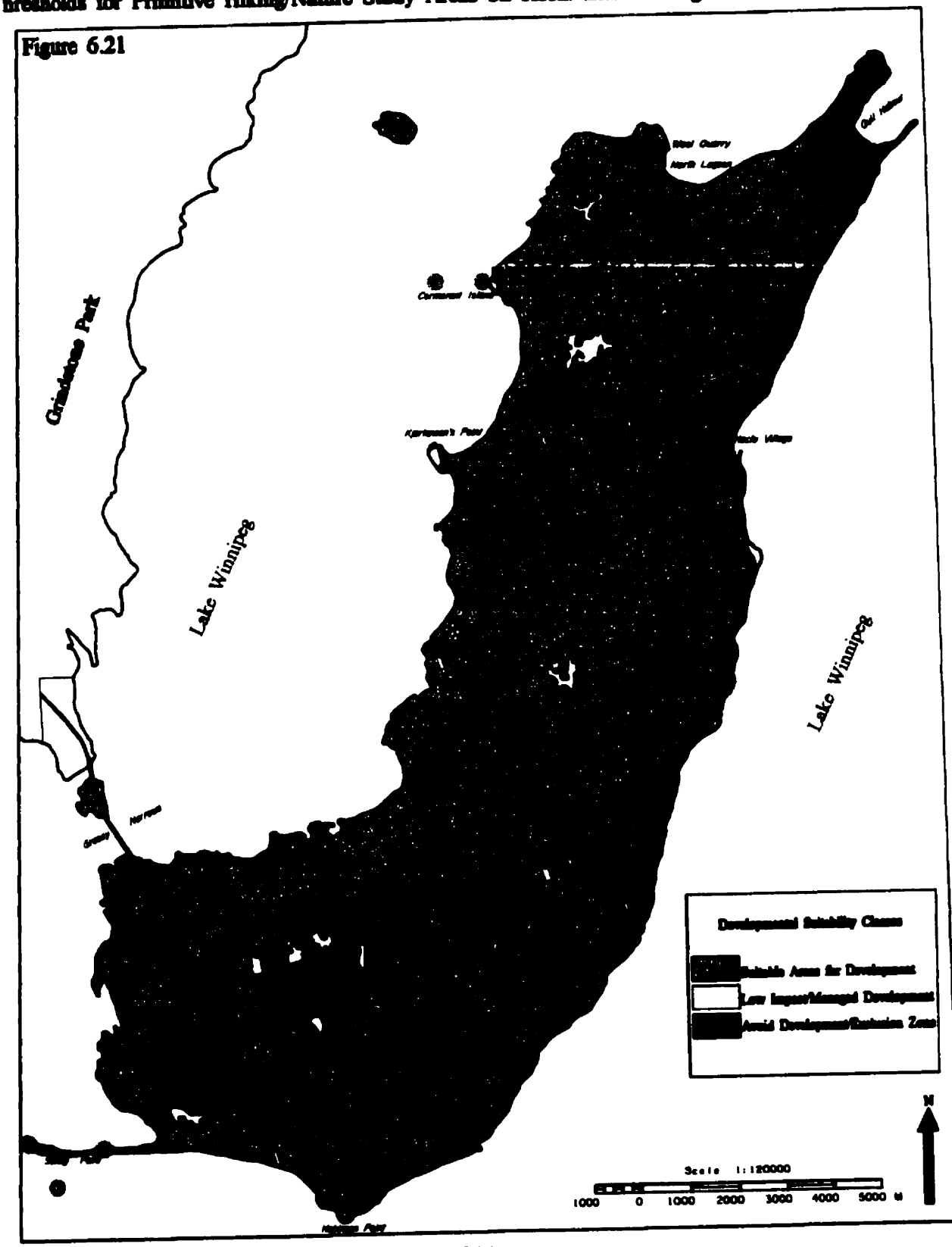
1. Waterfowl - *Highly Significant/Sensitive Waterfowl Areas* can be used with proper management.

2. Colonial Nesting Species - Protect all *Significant Colonial Nesting Species Sites.*

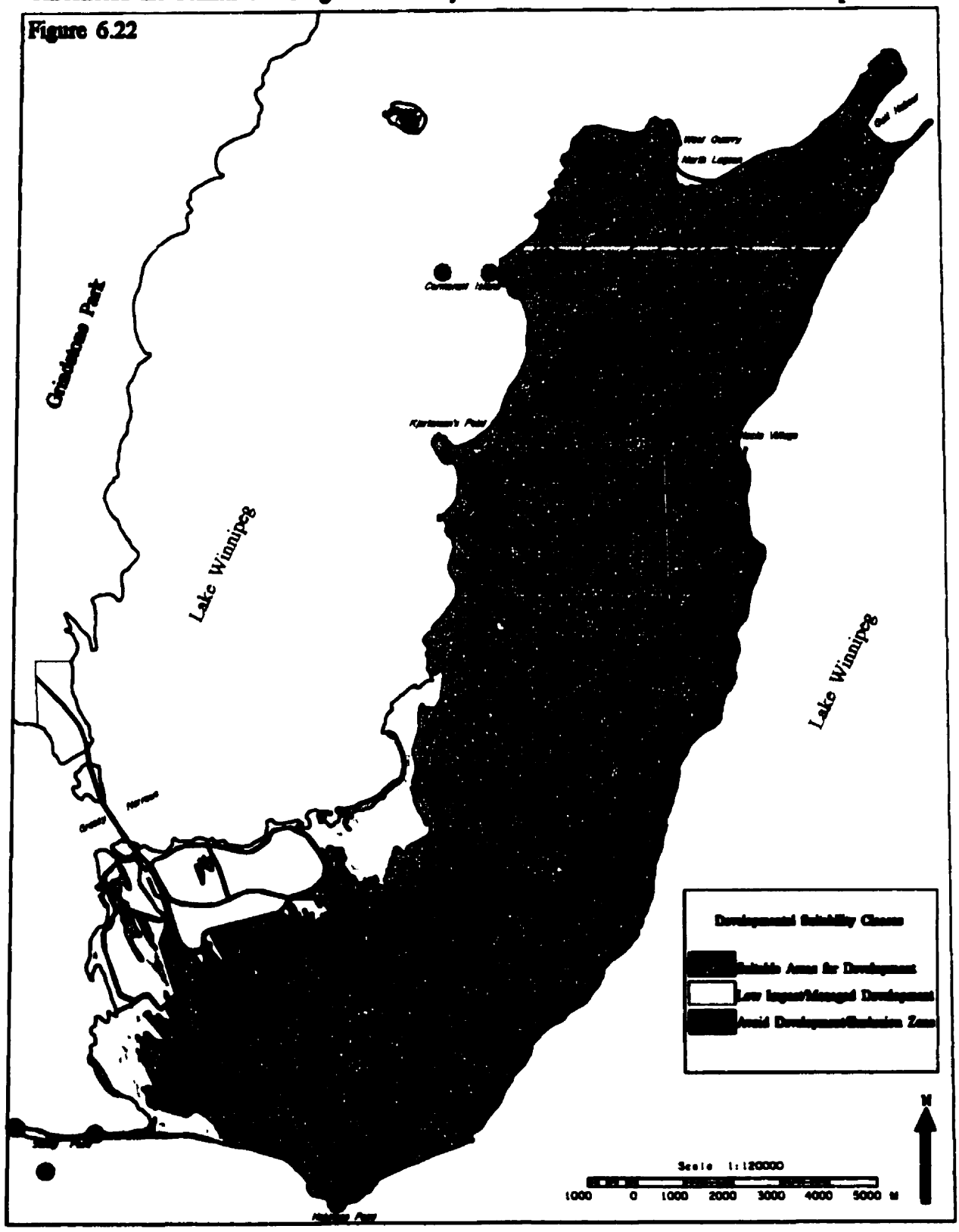
3. Moose - None

The combined threshold map for Primitive Hiking/Nature Study areas (Figure 6.23) indicates that most of the land within the island is suitable for this type of activity, except where sensitive plants and colonial nesting sites are located. Areas with rare vegetation stands or waterfowl nesting areas receive special management attention if this activity requires any new development.

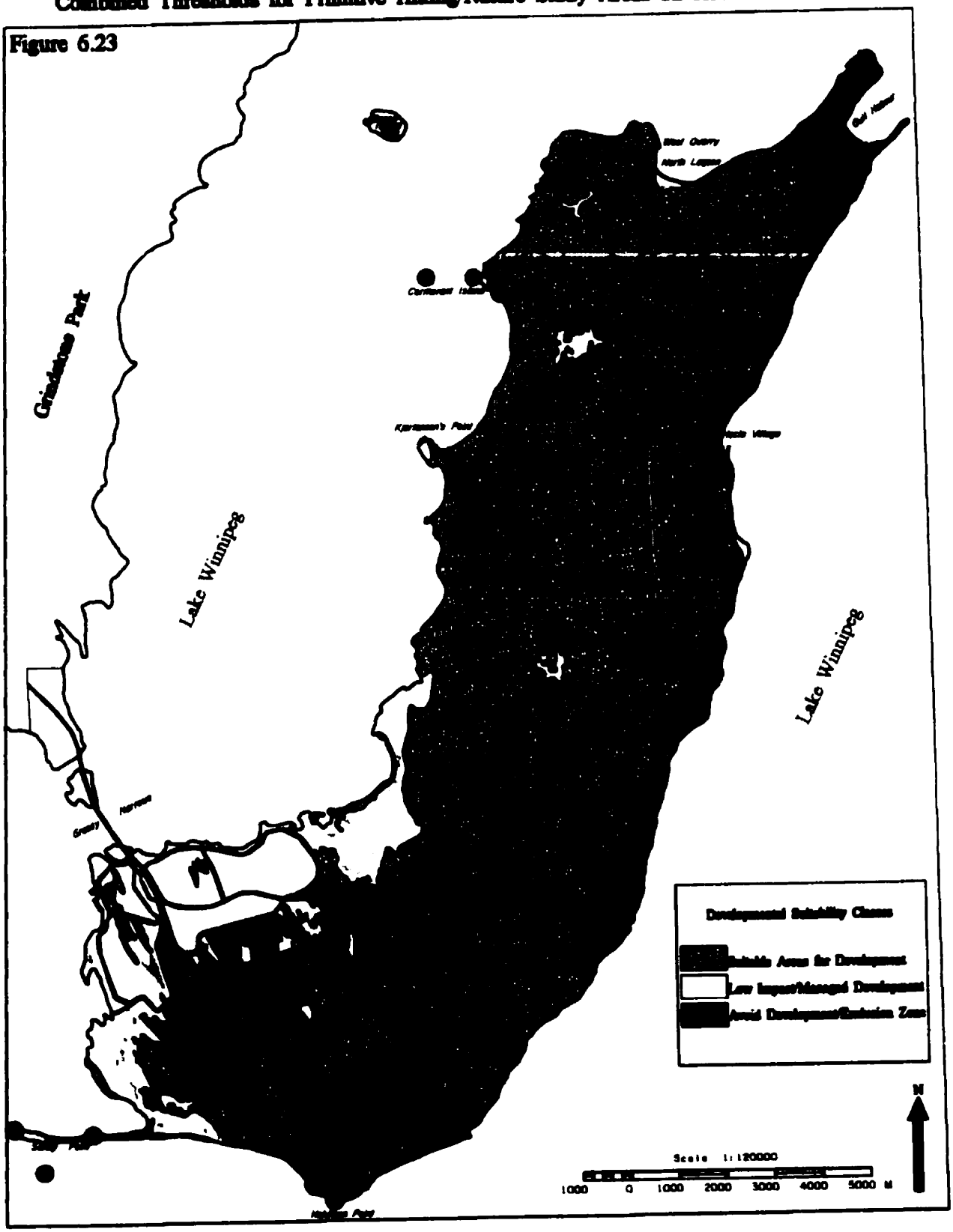
Thresholds for Primitive Hiking/Nature Study Areas on Hecla Island - Vegetation/Terrain Component



Thresholds for Primitive Hiking/Nature Study Areas on Hecla Island - Wildlife Component



Combined Thresholds for Primitive Hiking/Nature Study Areas on Hecla Island



Territorial UETs for Future Roads

The development of major roads through an environment that has been unaffected by humans can produce an immense strain on the land and wildlife, generating unknown cumulative effects that are sometimes difficult to measure. The goal should be to minimize environmental effects by placing roads in the most appropriate locations, causing the least harm to the surrounding area. Once the development is in place, guidelines should be implemented that deal with use and care of the roads, as well as the concern for the wildlife and environment.

Vegetation/Terrain Component:

1. Status - Protect *Unique Vegetation/Terrain, Rare Vegetation/terrain, and Uncommon Vegetation/Terrain.*

2. Modification - No development in *Total* areas of modification.

3. Significant Plants/Unique Natural and Cultural Features - Protect All *Unique, and Rare Plants.* Avoid *Archaeological Sites, Limestone Cliff, Salt Licks and Beaches.* Development on *Hydrographic Features* should be managed.

4. Land Use - Avoid *Ecological Protection Areas.* Cannot avert *Heritage Lands* since they are required for the tourist infrastructure.

Wildlife Component:

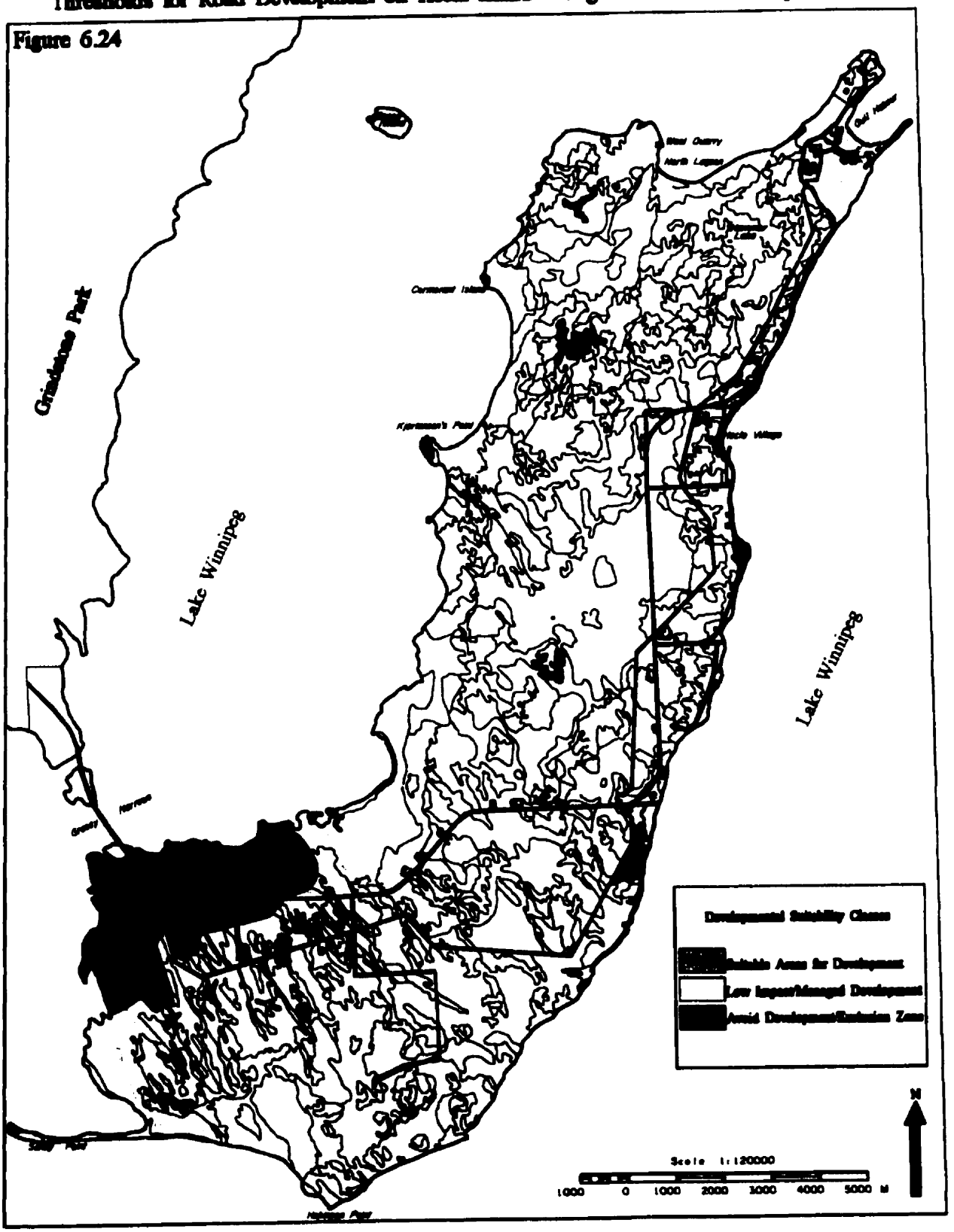
1. Waterfowl - Protect all *Highly Significant/Sensitive and Moderately Significant/Sensitive Waterfowl Areas.*

2. Colonial Nesting Species - Protect all Significant Colonial Nesting Species Sites.

3. Moose - Protect *Class 1 and 2 Significant/Sensitive Areas for Moose in Summer and Winter.*

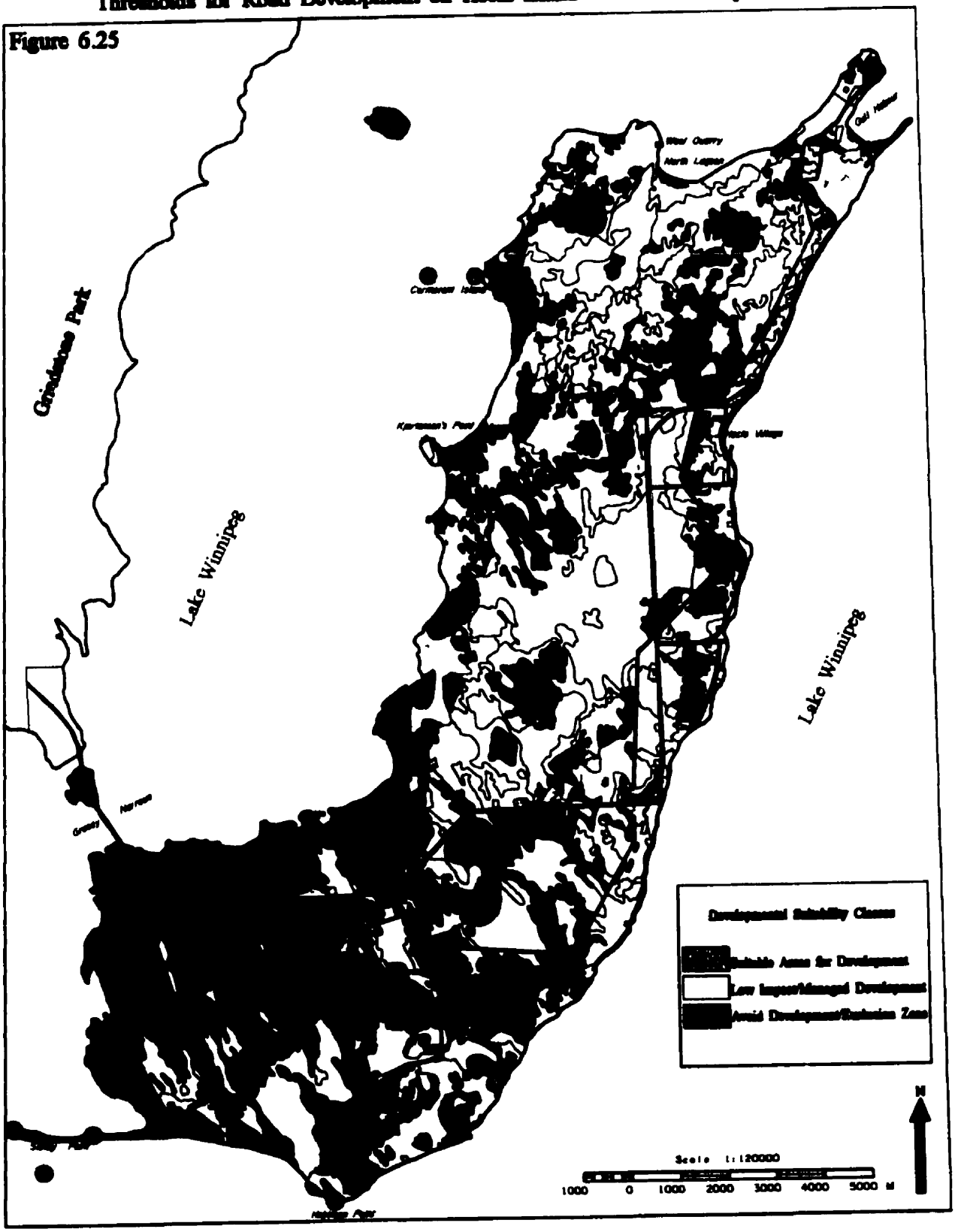
The Combined Threshold Map for Road Development (Figure 6.26) indicates there is plenty of space left for road expansion on Hecla Island. However, since the soil layer was not included in this map, much of the land may be unsuitable due to nature of the soil (ie. poor drainage, peaty surface, weak structure, etc.), although these limitations may be overcome at a higher cost.

Thresholds for Road Development on Hecla Island - Vegetation/Terrain Component

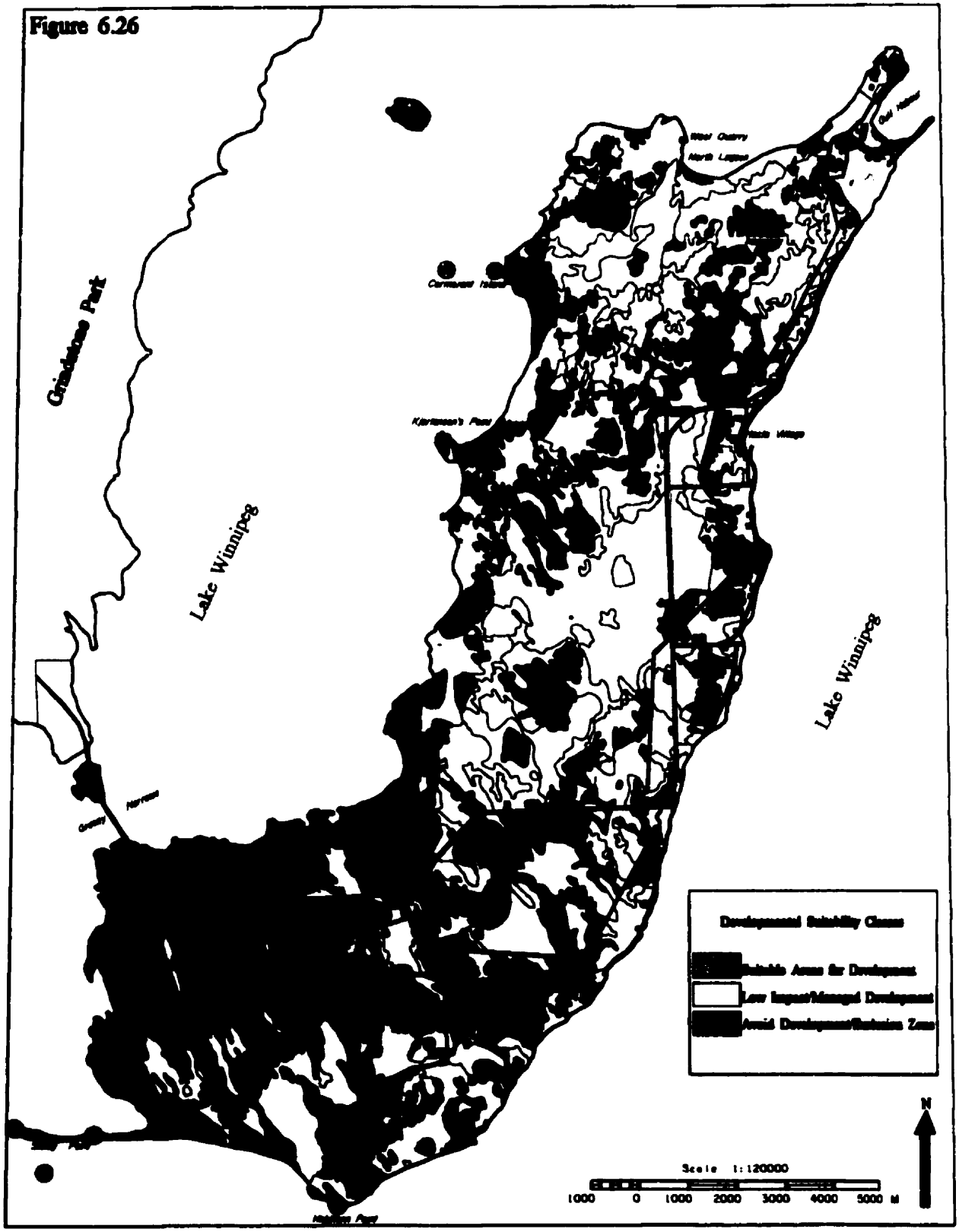


Thresholds for Road Development on Hecla Island - Wildlife Component

Figure 6.25



Combined Thresholds for Road Development on Hecla Island



Territorial UETs for Future Snowmobiling Trails

Like other high impact activities, areas that are suitable for snowmobile trails should be carefully assessed before development takes place, and have strict ecological management controls to guide the use of this activity.

Vegetation/Terrain Component:

1. Status - Protect *Unique Vegetation/Terrain, Rare Vegetation/Terrain, and Uncommon Vegetation/terrain.* Avoid *Unique Cultural Areas.*

2. Modification - No development in *Total or Major* areas of modification.

3. Significant Plants/Unique Natural and Cultural Features - Protect all *Unique, and Rare* plants. Avoid *Archaeological Sites, Limestone Cliffs, Salt Licks* and *Beaches. Hydrographic Features* can be utilized in the winter.

4. Land Use - *Avoid Ecological Protection Area* and *Heritage Land.*

Wildlife Component:

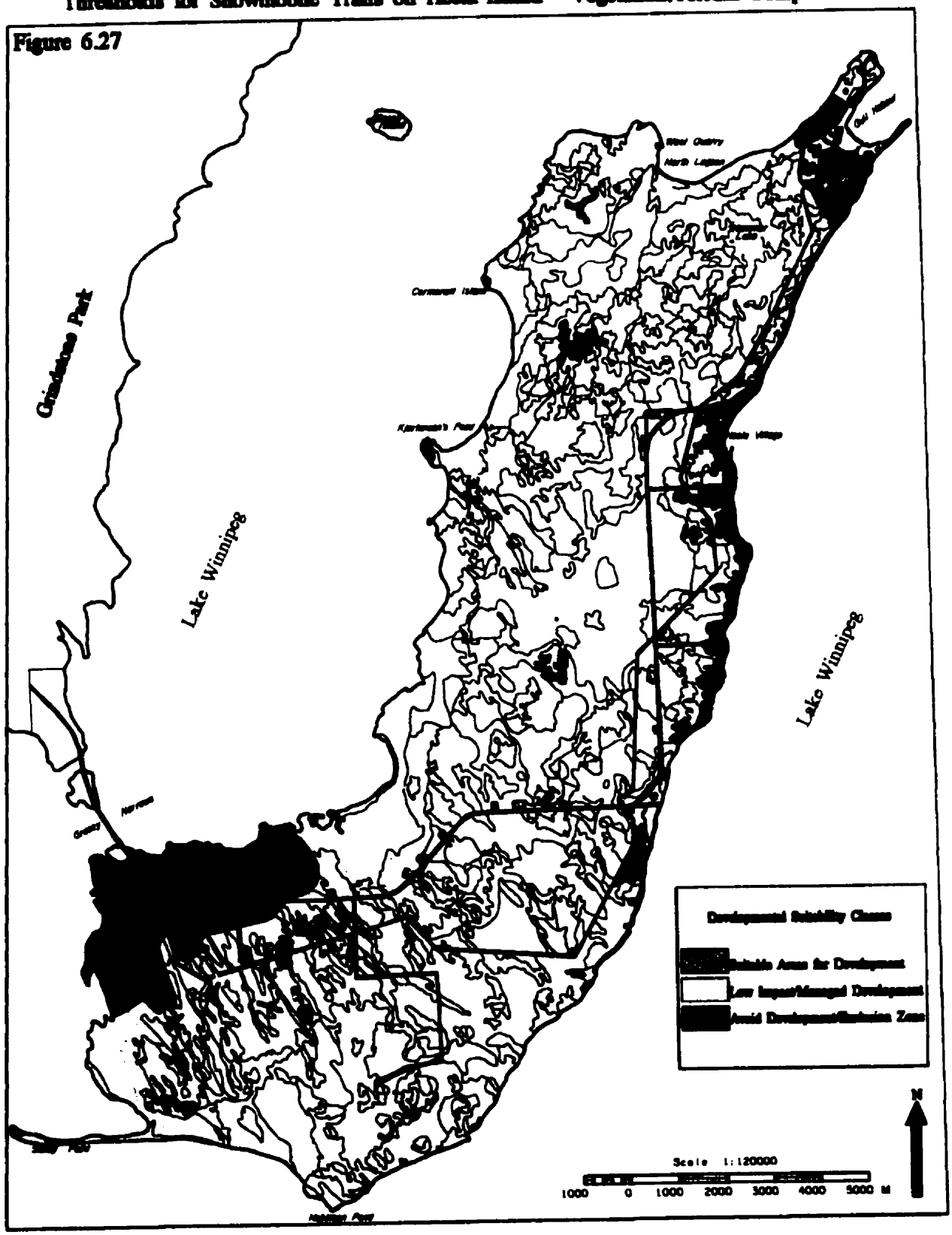
1. Waterfowl - Protect All *Highly Significant/Sensitive Waterfowl Areas.*

2. Colonial Nesting Species - Protect all *Significant Colonial Nesting Species Sites.*

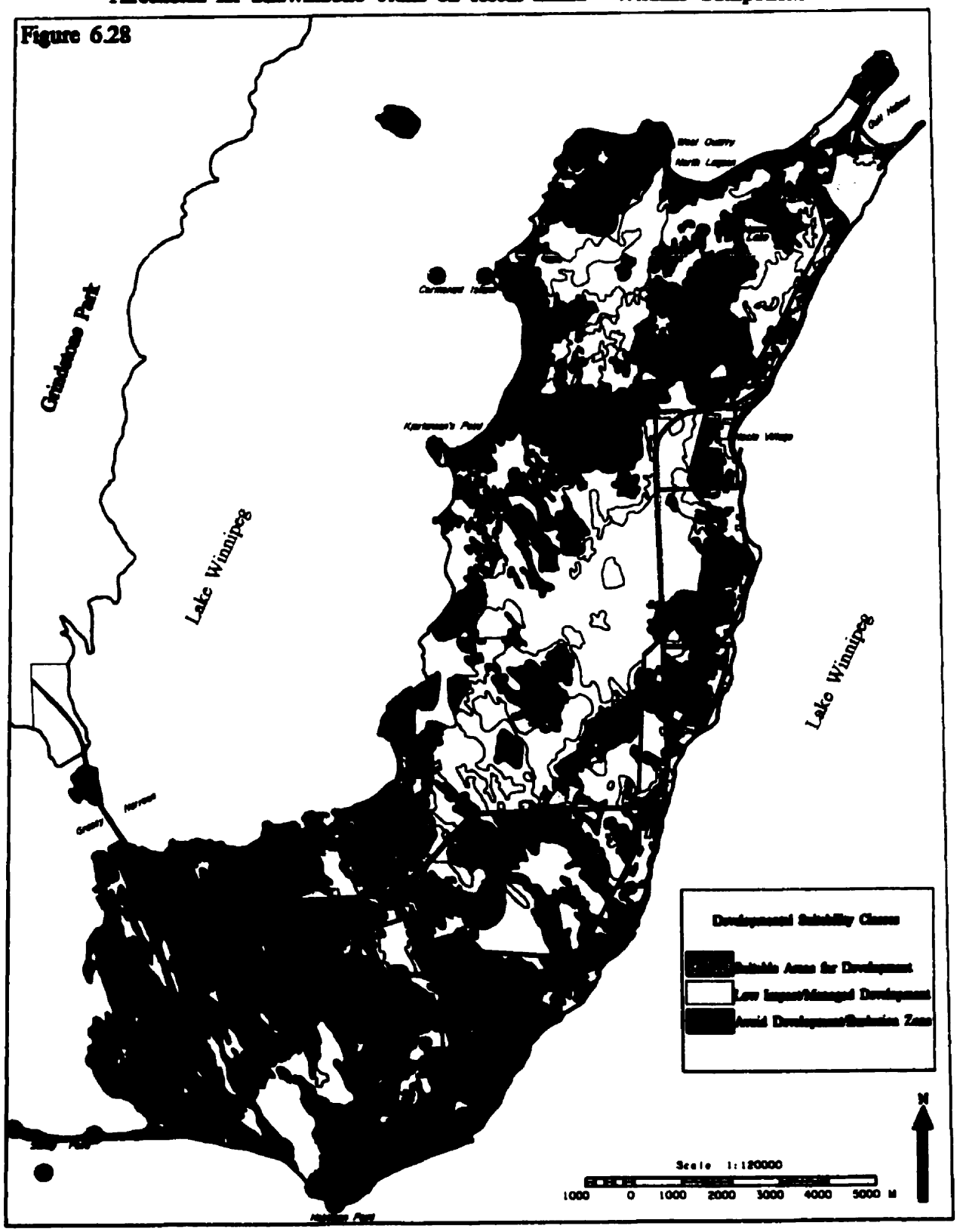
3. Moose - Protect *Class 1,2, and 3 Significant/Sensitive Areas for Moose in Winter*, and *Class 1 and 2 Significant/Sensitive Areas for Moose in Summer.*

Figure 6.29 illustrates that most of the land available for expansion of snowmobile trails on Hecla Island is situated in the central and northern interior of the island.

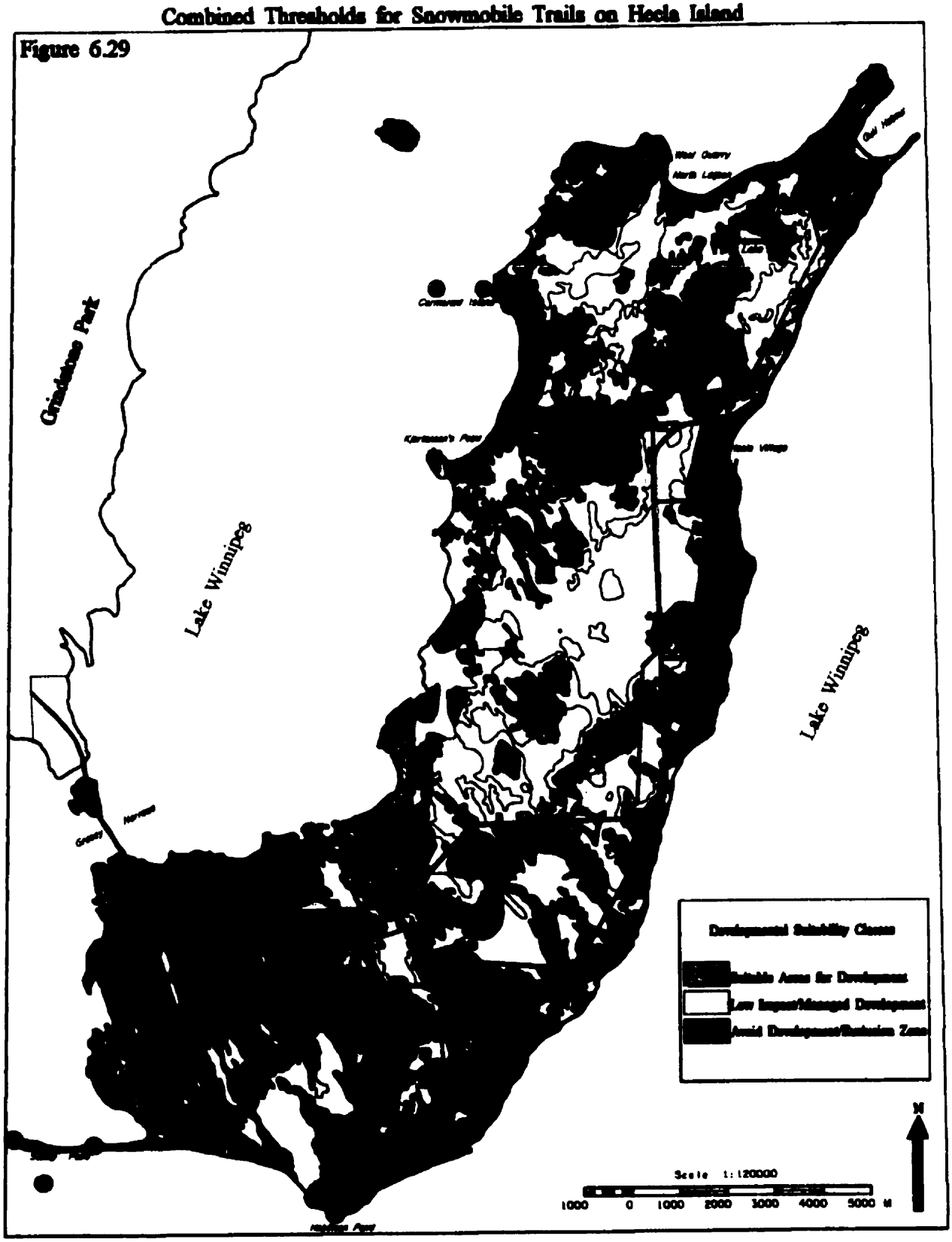
Thresholds for Snowmobile Trails on Hecla Island - Vegetation/Terrain Component



Thresholds for Snowmobile Trails on Hecla Island - Wildlife Component



Combined Thresholds for Snowmobile Trails on Hecla Island



Territorial UETs for Future Cross-Country Skiing/Snowshoeing Trails

Since cross-country skiing and snowshoeing are relatively low impact activities, the disturbance to the environment is less, and therefore there is more land suitable for these activities on Hecla Island (Figure 6.32).

Vegetation/Terrain Component:

1. Status - Protect *Unique Vegetation/Terrain, Rare Vegetation/Terrain, and Uncommon Vegetation/Terrain.*

2. Modification - No development in *Total* areas of modification.

3. Significant Plants/Unique Natural and Cultural Features- Protect all *Unique, and Rare Plants.* Avoid *Archaeological Sites* and *Salt Licks*; sites around *Limestone Cliffs* should be managed.

4. Land Use - Low impact development in *Ecological Protection Areas.*

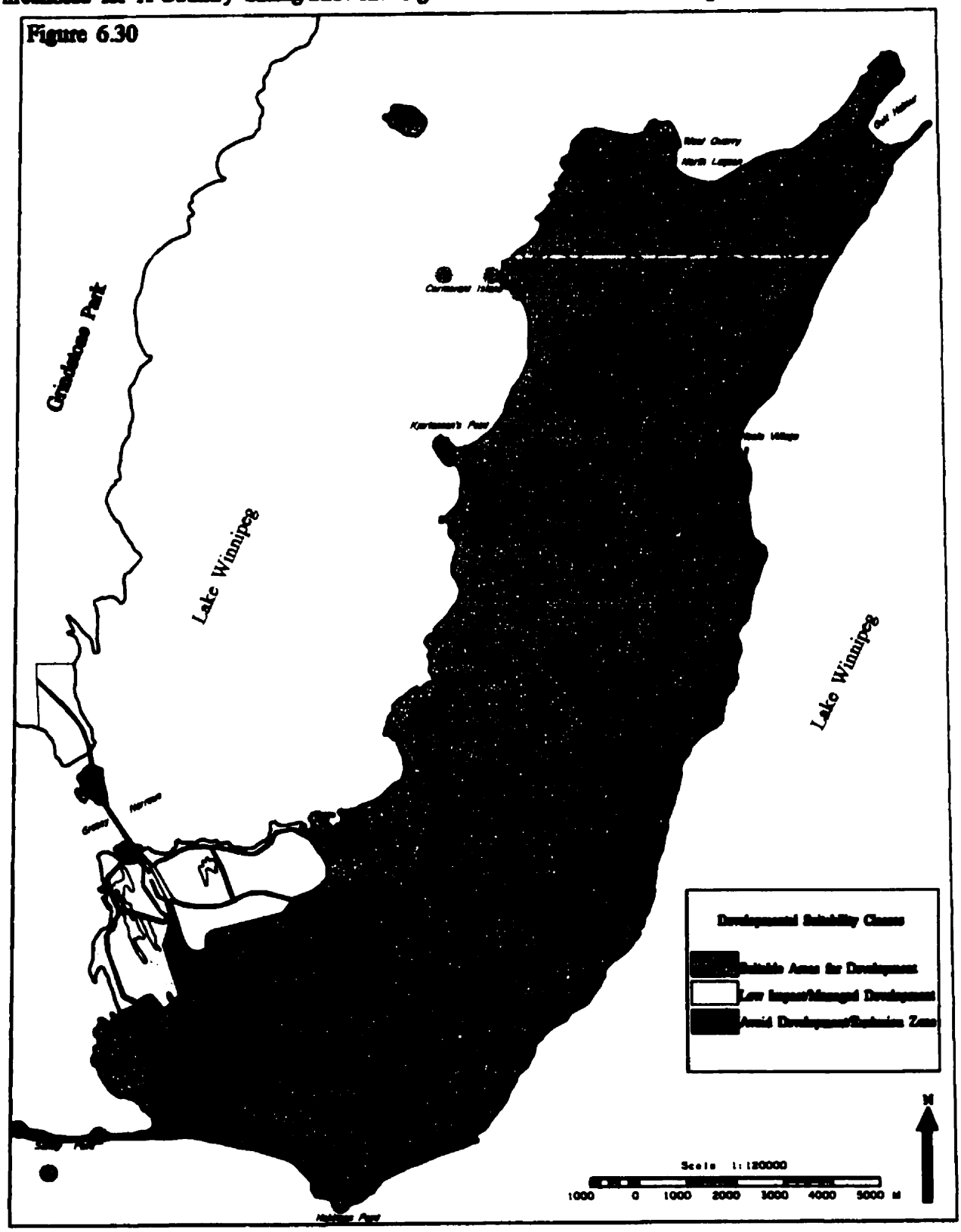
Wildlife Component:

1. Waterfowl - Low impact development in *Highly Significant/Sensitive Waterfowl Areas.*

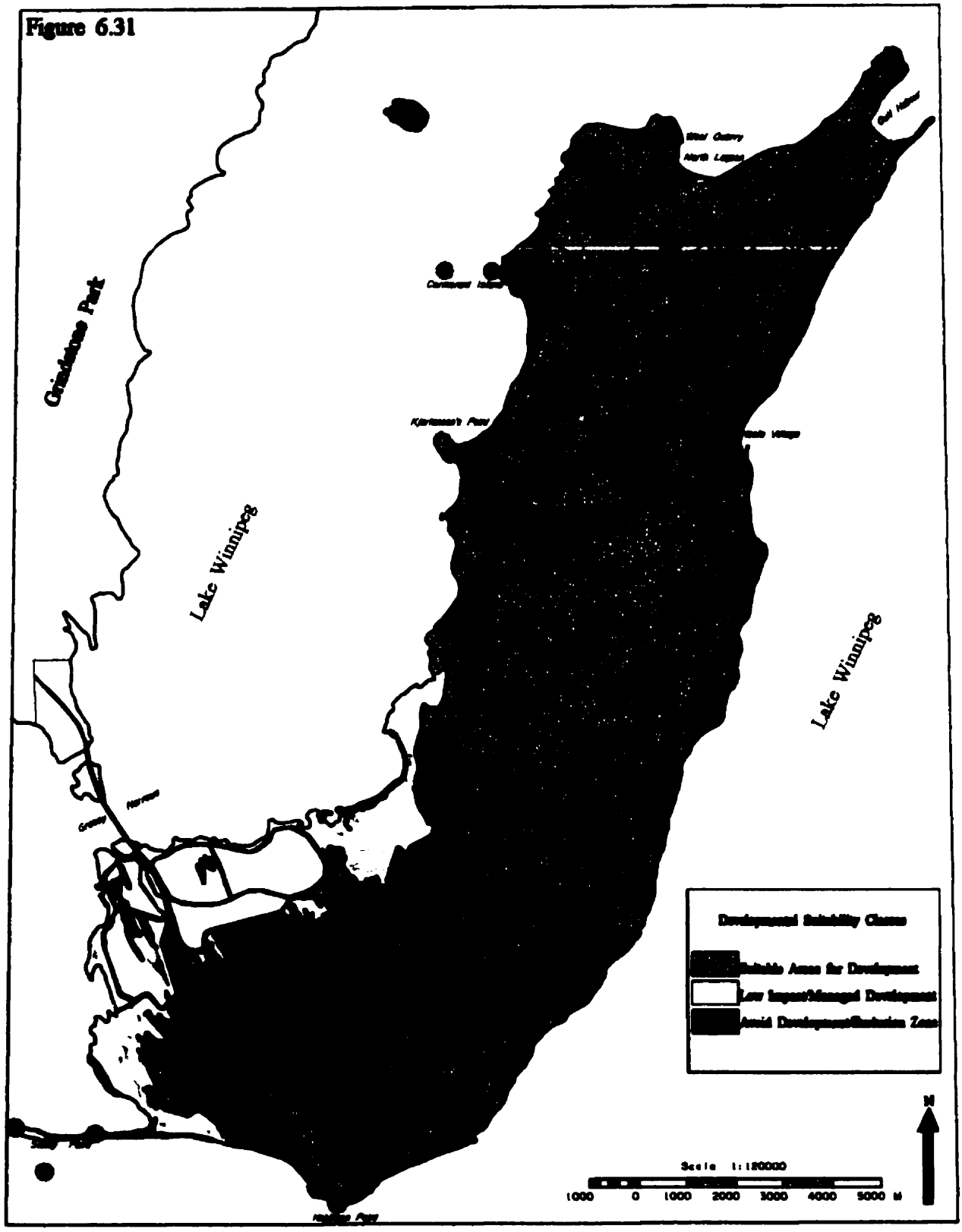
2. Colonial Nesting Species - Protect All Significant Colonial Nesting Species Sites.

3. Moose - Protect *Class 1 and 2 Significant/Sensitive Areas for Moose in Winter, and Class 1 Significant/Sensitive Areas for Moose in Summer.*

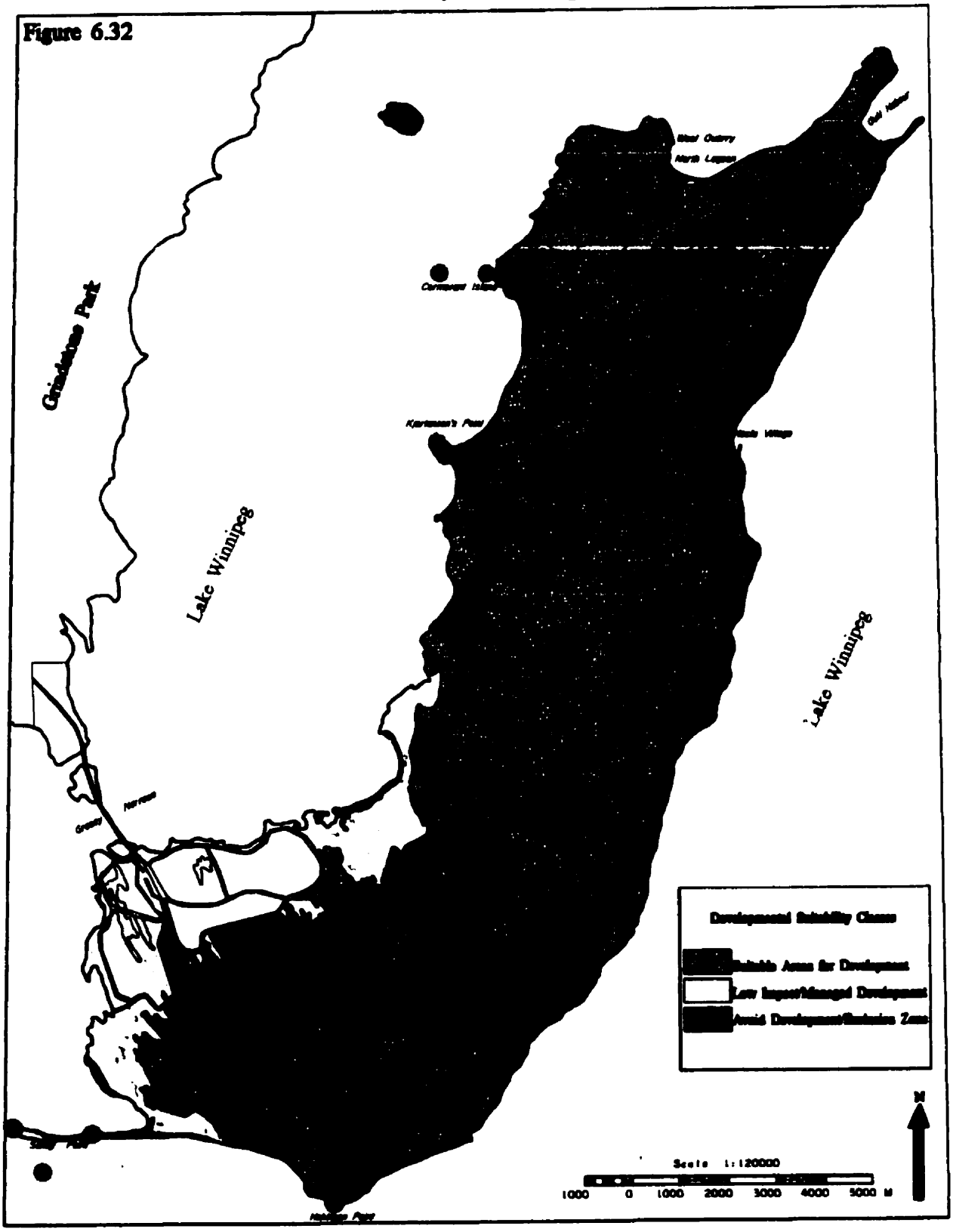
Thresholds for X-Country Skiing/Snowshoeing Trails on Hecla Island - Vegetation/Terrain Component



Thresholds for X-Country Skiing/Snowshoeing Trails on Hecla Island - Wildlife Component



Combined Thresholds for X-Country/Snowshoeing Trails on Hecla Island



Territorial UETs for Future Recreational Hiking

While most of the recreational hiking trails on Hecla Island are located close to Gull Harbour, there is potential for expansion of the trail system throughout most of the island (Figure 6.35).

Vegetation/Terrain Component:

1. Status - Protect *Unique Vegetation/Terrain, Rare Vegetation/Terrain, and Uncommon Vegetation/Terrain.*

2. Modification - No development in *Total* areas of modification.

3. Significant Plants/Unique Natural and Cultural Features - Protect all *Unique, and Rare* plants. Avoid *Archaeological Sites and Salt Licks*; managed sites around *Limestone Cliffs.*

4. Land Use - No development in *Ecological Protection Area.*

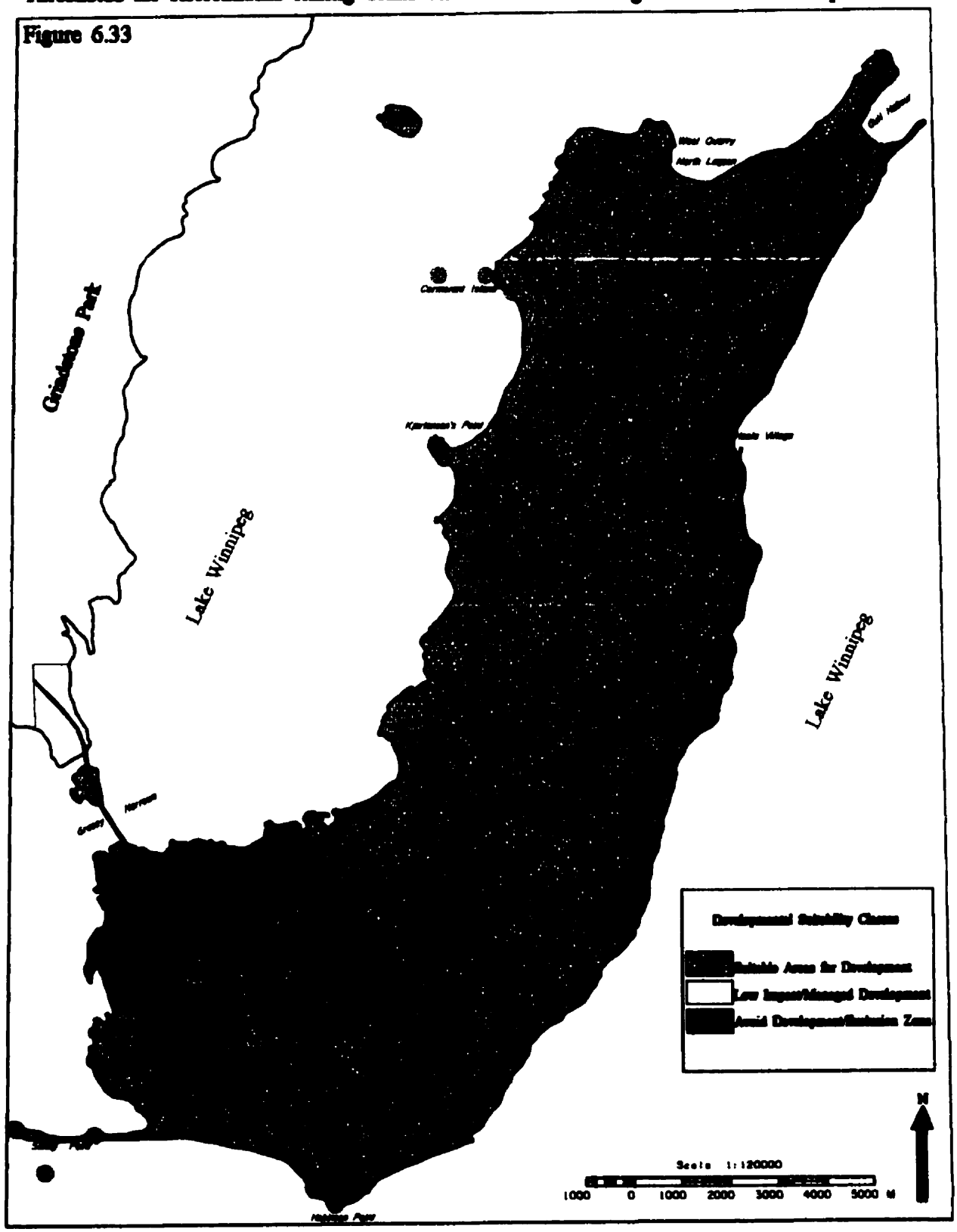
Wildlife Component:

1. Waterfowl - No development in *Highly Significant/Sensitive Waterfowl Areas.*

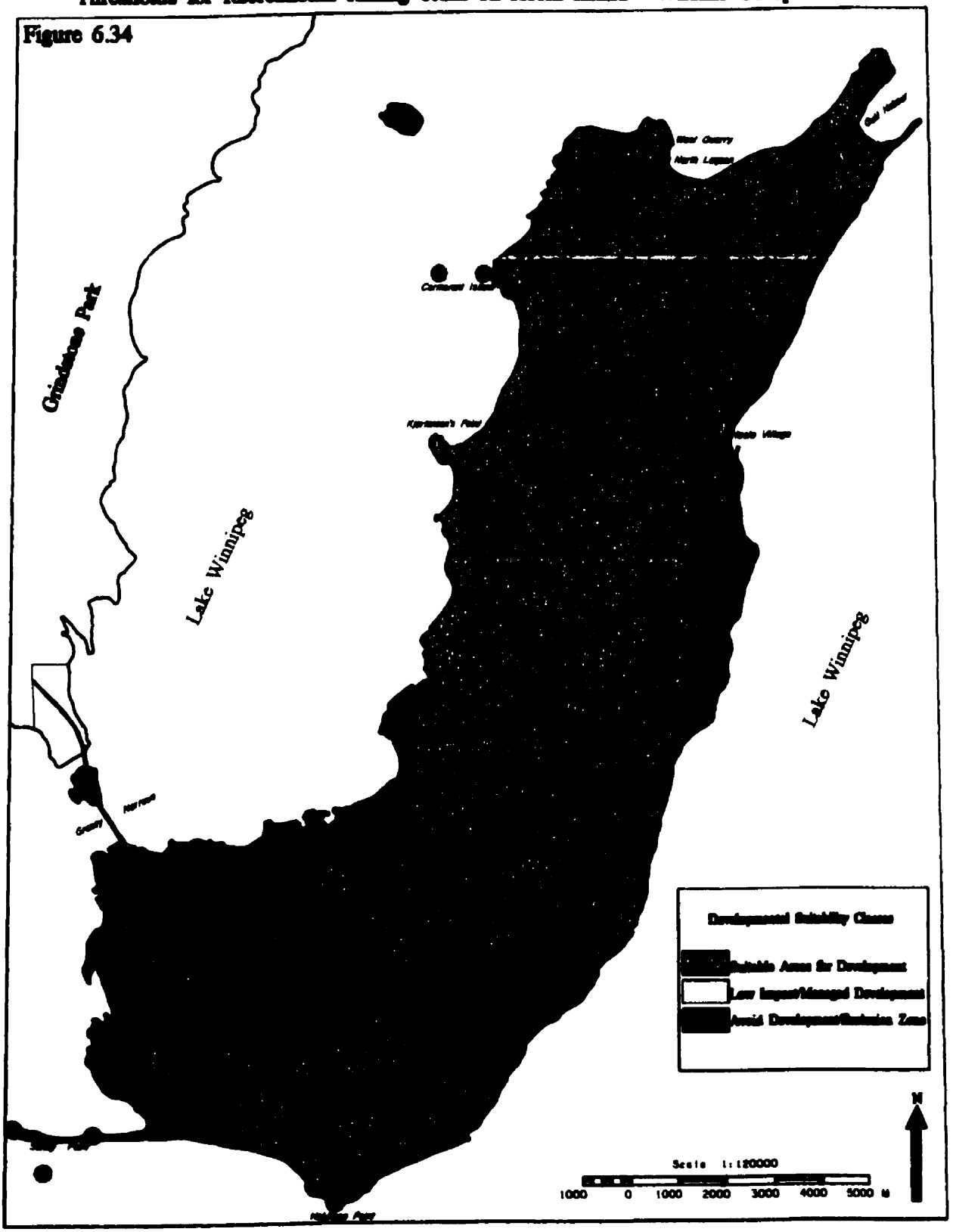
2. Colonial Nesting Species - Protect all *Significant Colonial Nesting Species Sites.*

3. Moose - Protect *Class 1 Significant/Sensitive Areas for Moose in Winter, and Class 1 Significant/Sensitive Areas for Moose in Summer.*

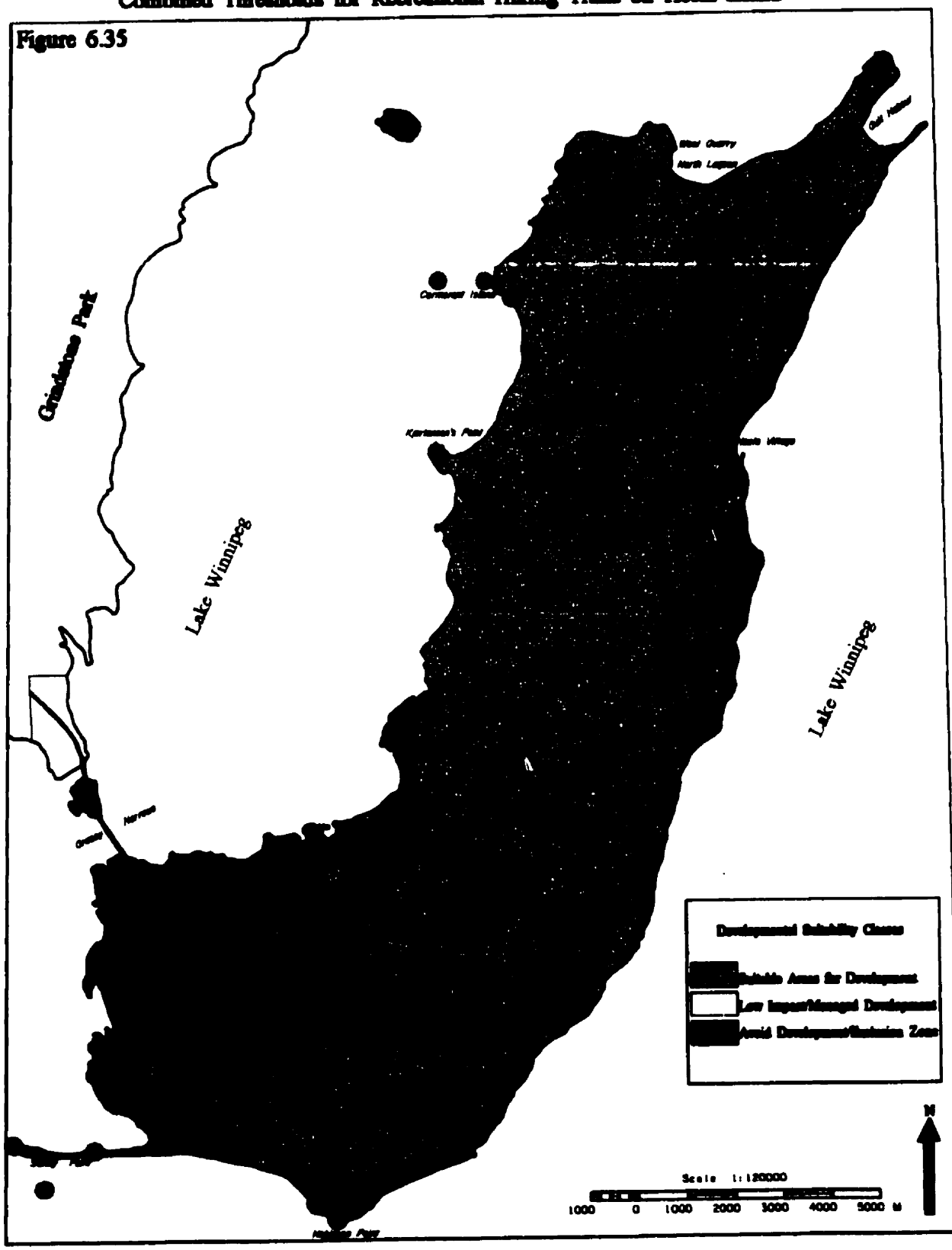
Thresholds for Recreational Hiking Trails on Hecla Island - Vegetation/Terrain Component



Thresholds for Recreational Hiking Trails on Hecla Island - Wildlife Component



Combined Thresholds for Recreational Hiking Trails on Hecla Island



Summary and Conclusion

Although the community that once existed on Hecla Island is no longer present, the character of the island remains distinctively Icelandic, embodying the people that once flourished in the area. The decline of the settlement in the 1960s was primarily due to the attraction and opportunities offered by larger urban centres that could not be provided on Hecla Island with its declining economy and resource base. As a means of bolstering the sagging community, Hecla Island Provincial Park was established in 1969. With the development of a causeway link from the mainland to Hecla Island in 1971, tourism became the main focus of development. There is still resentment by some Icelanders who watched as the government expropriated land, and forced people off the island. After 20 years of decay, the promise of restoring the village was finally fulfilled. Although it was poor compensation for the way the Icelandic people were treated by past governments, the area around the village was recently offered to the descendants of the Icelanders for resettlement. The competition for land and the conflicts that have ensued in the past has only further strengthened the argument that, presumably, the future will be met with more disputes over the use of land on Hecla Island.

The pristine environment on Hecla Island attracts tourists that prize the area for its scenery and wildlife. Hecla Island has a number of unique landscapes and environments that provide extensive habitat for moose and waterfowl, which are an integral part of the tourism industry on Hecla Island. One of the major attractions for tourists is the opportunity to view the wildlife in their natural setting, and thus trails and

other facilities have been constructed to make these sites more favourable for tourists. A key to the development of future tourist-based facilities on Hecla Island should be to design activities that allow tourists to freely interact with the environment, therefore learning aspects that encourage the care for the land around them.

Tourism has often been viewed as a clean industry, because of the myth that it provides only positive impacts, and has negligible effects on the environment. In contrast, the forest industry is constantly under public scrutiny even though innovative approaches in the industry provide many safeguards for maintenance of the forest ecosystem. Under closer examination, facilities used for tourism cause permanent modifications to the environment, while many of the activities can have harmful effects on the land and wildlife. In addition, pressure from developers, and the demands by the typical tourist, fragment the landscape and compete for lands that are crucial to wildlife, and unique in terms of vegetation and aesthetic appeal. Yet, forest stands that have been cut, and will eventually regenerate, still causes more public outcries than the cumulative effects of tourism. Therefore, it is necessary that proper planning tools and methods are designed to manage the resources on Hecla Island, while assisting in targeting suitable areas where new tourism development and activities should be located. It is essential that the valued components of the environment are protected by carefully studying how sensitive they are to effects of tourism development and activities. Similarly, it is necessary that assessments of the environment take place prior to the development of facilities, since it is often difficult to remove aspects of tourism that are successful and beneficial to the local economy once they are in place.

While there are many activities that are well suited to tourism on Hecla Island, it can be argued that certain activities are not as accommodating, since they result in impacts that are too detrimental to the land and wildlife around them. If the role of provincial parks is to preserve and maintain flora and fauna and other key features in the park, while also providing for recreation opportunities, then it is up to park planners to make judgements on what crucial components of the environment should be protected. In addition, park planners have to address conflicts that exist between different users of the environment, and focus on aspects that can effectively promote multi-use activities that work in accordance with each other.

To achieve the aforementioned goals, park planners require tools and techniques that provide support for their decisions in a manner that clearly demonstrates to administrators, as well as private developers, the types of activities and developments that are acceptable in this type of environment, and which areas should be targeted. This was accomplished through the use GIS and the Ultimate Environmental Threshold (UET) method. GIS was used to organize, classify, and analyse data, while the UET method assisted in isolating areas where certain types of tourism development should be avoided due to the potential environmental consequences of development and activities on valued environmental components on Hecla Island.

The methods in this thesis that formed the basis for carrying out the final analysis were as follows:

- compile a list of all relevant tourism developments and activities on Hecla Island,

past, present, and future

- assess the key environmental components on Hecla Island (determine which components are crucial to the success of tourism on Hecla Island, while also protecting other unique and interesting environments)

- compile data and convert into GIS

- classify and assess the characteristics of the key environmental components including moose, waterfowl, colonial nesting birds and other unique sites, and unique plants and vegetation

- assess land characteristics that are important in locating tourist facilities such as the soil suitability and recreation capability of an area. (This was used as ancillary data to further isolate areas having potential for development and activities.)

- analyse the relationship between resources and activities to determine the potential consequences of development, and thus areas where certain activities and development should be targeted

- develop ultimate environmental thresholds for future development and activities on Hecla Island

The final products of this research were maps that provide considerations for the expansion of tourism on Hecla Island. The areas that are available for development are based on the degree of impact. For example, the threshold map for airstrip development on Hecla Island indicates that only sites with common and abundant vegetation, occurring

in unsuitable moose, waterfowl, and colonial nesting bird habitat should be considered for development. In contrast, hiking is less harmful to the environment, therefore, there are many areas where expansion of this activity can take place.

To conclude, the main objective of this thesis was to illustrate areas where tourism development should be located on Hecla Island, while the goal upon completion of the project was to develop a product that would have utility, and could be applied to other environments. The systematic approach that was developed allows additional data to be easily manipulated and combined with other data to provide more support for areas that are most suitable for the expansion of tourism development. However, there are considerations that should be made prior to developing an area. First, the environment is complex, therefore it is critical that people with a general knowledge and understanding of the area are consulted before final decisions on location of tourism development are made. Secondly, in many cases, detailed studies of an area, including comprehensive assessments of important resource information, should be undertaken after general locations have been determined. Finally, although an area may be suitable for a particular type of development, it is important to recognize that impacts do not work independently of one another, but rather are cumulative in nature. There is a combination of many interrelated factors occurring in the past and present within the area, that are sometimes not apparent, eventually leading to detrimental effects on the environment. In closing, this thesis provided one method for examining where to target tourism development on Hecla Island. It is important to understand that opinions may vary on the amount of protection an area should receive. Regardless, there are limits to expansion, and although

views may differ on the degree to which this tourism expansion should take place, quality data sets, and proper methods and analysis will provide the evidence needed to protect key environmental components in an area.

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