Chapter 1: Introduction

1-1 The Importance of Nature Conservation

The Earth's natural environment is in serious decline, and finding ways to conserve Earth's biota and natural ecosystems requires a strategic approach (Soulé, 1991). Human impingement on remaining natural spaces are causing damage to great numbers of wildlife species and wild areas around the globe. "These places are absolutely priceless. They contain Earth's secrets of life and survival, manifested by natural life forms perfected over millions of years of countless trial-and-error evolutionary experiments. Their like will never be seen again should they vanish. We easily erase legions of living masterpieces, but we cannon make a blade of grass" (Edwards, 1989, p22).

Likely the most commonly stated goal in nature conservation is the protection of biodiversity, which can be defined as "the variety of plants, animals and other living organisms in all their man forms and levels of organization. It includes genes, species, and ecosystems, as well as the processes that link them together" (NSDNR, 1997a, no pg. number). Freedman (1995) defines 3 main reasons for the protection of biodiversity:

1) Intrinsic value—every living thing on Earth has a right to life, regardless of its association with, or lack of association with human survival.

2) Utilitarian reasons—humans require natural resources for survival. It is only through the protection of these resources and the natural processes which sustain them that we can survive as a species.

3) Provision of ecological services—natural ecosystems provide many important ecological services, which are necessary for the survival of all species. Examples of these are purification of soil and water, the production of oxygen and the removal of carbon dioxide from the atmosphere.

Careless management of the earth's natural areas through habitat degradation, over-exploitation, introduction of exotic species and disease, climate change, and pollution of air, soil and water, are undermining the integrity of these natural systems (Soulé, 1991). Nova Scotia is not immune to these increasingly common problems. Only through the proper research and management of our wild spaces can we hope to maintain the natural diversity of the province.

1-2 The Role of Protected Areas

1-2-1 What is a Protected Area?

A protected area can be defined as "an area of land which has been effectively removed from the development stream for the purpose of perpetuating natural conditions, the central role being to protect natural diversity" (Beazley, 1998, p30). Such an area can serve many functions, including those that are social, ecological, cultural, spiritual, and educational. Beazley (1998) states that the most commonly stated goals of protected areas are:

1) to conserve the diversity of habitats and species.
2) to conserve characteristics of rarity or uniqueness.
3) to conserve naturalness and representivity.

1-2-2 Can Protected Areas alone preserve wild spaces?

"Protected areas alone will not preserve the present levels of native biological diversity, let alone provide for evolution (and) speciation" (Beazley, 1998, p39). Natural areas are dynamic systems, and must be treated this way. Species cannot be protected in isolation—we must also protect the interactions between species, and between species and their ecosystems in order to retain the integrity of a system and its function. A protected area must be managed in conjunction with the surrounding landscapes to preserve biodiversity. Biological boundaries are not finite; they will change and evolve over time, due to many factors of species-species relationships and environmental stochasticity (Beazley, 1998).

Beazley (1998) states that protected areas then must be made large enough to encompass the regional natural processes, in order that the integrity of the system is kept intact. It is generally accepted that the larger the protected area, the more likely that it will be able to maintain the ecological processes within it. This is especially true for regions home to large mammals or wide ranging species, which are particularly vulnerable to extinction. Habitat fragmentation should be discouraged, as it decreases the effective habitat size, and breaks up communities and populations into disjunct fragments.

Likewise, isolation of protected areas should be discouraged, as it doesn't allow for the migration of species along natural routes. Abrupt transitions in natural area boundaries will only serve to discourage animal movement. Buffer zones around core protected areas, or wilderness corridors between these areas is one way to achieve this goal of connectivity. Better yet, is the maintenance or restoration of pre-existing connections among connected areas (Beazley, 1998).

1-3 Nova Scotia's Role in Protected Areas

1-3-1 Introduction

Canada, like many other countries, pledged to protect 12% of its lands and waters by the year 2000, following the release of the Bruntland Report from the 1987 meeting of the World Committee on Environment and Development (Hummel, 1995). In 1989 the World Wildlife Fund (WWF) launched the *Endangered Spaces* campaign, with a goal to "establish a network of protected areas representing all of the natural regions of Canada by the year 2000" (Hummel, 1995, p.xiii). This campaign also uses a 12% target for protection of biodiversity, with the provision that this target be met by the year 2000.

When the campaign began, Nova Scotia adopted similar goals; to protect representative areas of lands and waters, and to make the total area of protected lands equal to at least 12% of the province (Stewart, 1995). In 1990 Nova Scotia initiated a *Systems Plan for Protected Areas,* with the following goals:

1) maintain the province's geological, ecological, and species diversity.

2) provide spaces for long-term scientific monitoring and research.

3) enhance the quality of life for Nova Scotians by maintaining natural areas that are diverse and of high ecological integrity.

4) provide opportunities for outdoor research and education.

5) promote stewardships to protect and manage natural areas.

In the Systems Plan, a natural area is defined as "a mosaic of different but interacting ecosystems that are repeated in a similar pattern to form a distinct and definable land unit (NSDNR, 1997a). Under this definition, Nova Scotia has been divided into 80 Natural Landscapes, based on climatic region, geology, surficial material, soil type, landscape, and dominant vegetation (fig. 1-1). The Systems Plan has an objective to protect a representative portion of each of these natural landscapes in at least one protected area.

Fig. 1-1: Natural Landscapes of Nova Scotia, NSDNR (1997c)

Under the Systems Plan, a protected area can be designated as one of three types:

1) Nature Reserve—these are often small sites, and are protected by the strongest legislation (Special Places Protection Act). The goal in these areas is to protect unique, rare or outstanding natural phenomena. The main use of these areas is for scientific research and education, not for recreation.
2) Wilderness Area—these areas are relatively large. The goal in these areas is to protect representative examples of natural landscapes and outstanding natural phenomena. The sites are used for scientific research, education, and low-impact recreation.
3) Provincial Parks—there are no size restrictions on these areas. Their main purpose is to provide for recreation opportunities, such as hiking, canoeing and camping.

(NSDNR, 1997a)

Designation of Wilderness Areas is done at the landscape ecosystem scale. A landscape ecosystems is “made up of all the living and non-living components found in a particular area as well as the interactions that link them together (NSDNR, 1997a). The assumption in this approach is that it will protect all, or almost all, of the species, genes, and processes that are found within each landscape, both the known and the unknown (Beazley, 1998).

In designing the Systems Plan for Protected Areas, the Nova Scotia government has chosen to use representivity as the number one criteria for site selection (Beazley, 1998). Beazley states that this approach does not capture the total variety of “ecosystems or ecotones which exist between and among the natural landscape regions” (1998, p.61). In order to protect natural areas we must protect the processes, attributes and functions of the natural areas. Meyer (1997) states two principles that need to be involved in ecosystem conservation: ecosystems are open entities, which should lead to an emphasis on conserving the flux across ecosystem boundaries and linkages with the surrounding ecosystems; and indirect effects are the rule rather than the exception in most ecosystems. Disruption of one part of an ecosystem will have much broader repercussions. There are certain guidelines which must be followed in order to develop “ecologically sound boundaries” of a protected area, including:

1) encompass the greatest possible proportion of the area drained by the river of highest order.

2) include headwater areas.

3) consider subsurface transbasin water flow.

4) do not sever rare, unique or highly diverse communities.

(Beazley, 1998, p.35)

Management of an area must regard the watersheds as an integral part of the protection of natural areas (Spyksma, 1995).

1-3-2 The status of Nova Scotia’s Protected Areas

Nova Scotia recently protected 31 Wilderness Areas under the Systems Plan for Protected Areas, which corresponds to 5.5% of all of the lands and waters in the province. Including Kejimkujik and Cape Breton Highlands National Parks, this brings the total protected area in Nova Scotia to 8%, still short of the 12% goal (Stewart, 1995).

Nova Scotia is at a disadvantage in comparison with most provinces in Canada, since only 27% of its land mass is owned by the Crown (NSDNR, 1997a). This results in a shortage of lands available for protection and public use, thus intensifying the conflicts which arise between conservation and development. This became particularly apparent in

January of 1997, when the Jim Campbells Barren (JCB), a unique ecosystem mosaic of bogs and barrens, which was removed from the candidate list for Wilderness Areas, in order that mineral exploration could occur (Miller, 1997; Beazley, 1997). After much public outcry, the JCB was relisted in December of the same year.

As a possible solution to these types of conflicts, the Nova Scotia Department of Natural Resources (NSDNR) is developing an Integrated Resource Management plan (IRM) for the provinces undesignated Crown Lands (Beazley, 1997). This plan will take into consideration wildlife, parks, forestry, mineral and energy requirement of the province. The hope is that after development of the IRM, land use conflicts between economic and ecological initiatives will be curtailed, and sustainable development of Crown Lands and resources will be achieved.

1-4 International Biological Program

1-4-1 Introduction

The International Biological Program (IBP) ran from 1964 to 1974, to "study the biological productivity of the earth and relate this to human adaptation and welfare" (Tashereau, 1974, p.iv). The Conservation of Terrestrial Communities Subcommittee (IBP-CT) section of this program was established to identify and set aside ecological reserves (Tashereau, 1974). Development of these reserves had four objectives:

1) conservation of genetic resources
2) to set up datum points from which to measure anthropogenic impacts on natural areas
3) to establish outdoor laboratories for scientific research

4) educational and demonstrative purposes

(Tashereau, 1974)

Tashereau (1974) states that areas were chosen for designation if they showed examples of characteristic or rare plant and animal communities, or were areas of biological or physiographical importance. Most of the areas chosen had experienced little human disturbance. A few had undergone degradation due to human impacts, and these have value for scientific research, in order to observe developmental processes in a modified ecosystem.

1-4-2 IBP's History in Nova Scotia

The Maritime portion of the IBP study was severely limited by time and resources, and as such doesn't properly reflect all of the regional ecosystems. The primary focus of the study was on endangered, relatively undisturbed ecosystems, and on the protection of rare and unique animal and plant communities (Tashereau, 1974). At the end of the program, 69 sites had been chosen in Nova Scotia, equaling 0.36% of the area of the province.

The program made four recommendations to the province at the end of the study:

1) that immediate action be taken to protect the sites until their status is decided.
2) private lands should be purchased, or land stewardships should be arranged with owners of candidate sites.
3) select more areas, and further describe the candidate sites.
4) integrate the sites into regional, multi-use landscape planning

(Tashereau, 1974)

In response to the IBP-CT report, a request was made in May of 1975 by Mr. R.H. Burgess, the Deputy Minister of the Department of Lands and Forests (now NSDNR), which had three components:

1) no development was to be undertaken in these areas.
2) any development that was underway should be stopped.
3) private lands which are potential sites should be purchased.

(Ombudsman, 1991)

These were recommended as interim measures, to be undertaken until designation of the lands as ecological reserves could be achieved.

It was not until June, 1980 that the Nova Scotia government passed the Special Places Protection Act (formally called An Act to Provide for the Preservation, Regulation, and Study of Archaeological and Historical Remains and Paleontological and Ecological Sites), under which the candidate sites could be officially protected (Office of the Legislative Council, 1980). Nature reserves, one the three types of protected areas under the Systems Plan (see section 1-3-1), are protected by this legislation. The purpose of the Act is to provide for the preservation, protection, regulation, acquisition and study of ecological sites which are considered important parts of the natural heritage of the Province, and:

1) are suitable for scientific research and educational purposes.
2) are representative examples of natural ecosystems within the Province.
3) serve as examples of ecosystems that have been modified by man but that offer an opportunity to study the natural recovery of ecosystems from such modification.

4) contain rare or endangered native plants or animals in their natural habitats.
5) provide educational or research field areas for the long-term study of natural changes and balancing forces in undisturbed ecosystems.
6) promote understanding and appreciation among the people of the province of the scientific, educational and cultural values represented by the establishment of Special Places.

(Office of the Legislature, 1980).

Since the Act was passed, only seven sites have been designated as nature reserves. These include some old forests and rare plant refuges (deGooyer, 1999). In April of 1997, NSDNR Minister Eleanor Norrie promised five new nature reserves by the end of the year (NSDNR, 1997b). None was designated. In November of 1998, Environment Minister Don Downe stated in a letter to the Ecology Action Centre (EAC) that “it is anticipated that several designations will be in place by the end of the current fiscal year (March 31, 1999)” (deGooyer, 1999). None has yet been designated, although four sites are currently being discussed, according to a letter by the Deputy Minister of the Environment, Graham Fox, dated March 11th, 1999.

Interim measures have not been properly enacted to protect candidate nature reserves. The Minerals and Energy Branch of the NSDNR does not recognize candidate sites, resulting in mineral licenses and logging permits to be granted in these areas (Beazley, 1998)

The slow rate at which these sites have been designated has been detrimental to the ecological integrity of some of the candidate reserves (Ombudsman, 1991). At least five candidate sites have been damaged or destroyed by forest clear-cutting (deGooyer, 1999). An Ombudsman investigation was called into the negligence of the government in protection of these candidate sites in 1991. This report states that the government accepted responsibility for ensuring that the candidate sites are left in an "undisturbed state" until official designation as Special Places. These sites "will continue to be at some risk until such a time as they have been properly marked and regulated under the Act" (Ombudsman, 1991).

1-5 The Shelburne Barrens as a Special Place

The Shelburne Barrens is a diverse 5653ha piece of land and waters located in the interior of southwestern Nova Scotia (fig. 1-2, fig. 1-3). The Crown holds the rights to 5540ha of this area, and 113ha are privately owned (Tashereau, 1974). It was chosen as a candidate ecological reserve in June, 1971 by the IBP-CT committee, because of its unique features, and as an "example of a modified ecosystem resulting from severe disturbance" (Tashereau, 1974, p95). It was described by the surveyors of the site as,

> A virtually treeless area, characterized by poor soils with a massive iron pan within 15 inches of the surface. Three main habitats with characteristic plant communities occupy this area: an extensive boulder-strewn area characterized by huckleberry (*Gaylussacia baccata*); a gravelly to sandy area dominated by bearberry (*Arctostaphylos uva-ursi*);

Figure 1-2: Approximate location of the Shelburne Barrens study area in southwestern Nova Scotia

Figure 1-3: Boundary of Shelburne Barrens study area

> and a sandy area of regenerating forest, including some ridges of oak
> (*Quercus borealis*).

(Taschereau, 1974, p95)

Due to time and resource limitations, there was little detailed study done of the SB candidate ecological reserve. This may be one of the reasons why 25 years after the IBP-CT report was made public, the site has not achieved status as a Special Place.

In a 1991 report by the Nova Scotia Museum, the Shelburne Barrens was listed as second in priority for conservation (Appendix I). The number one site, Ponhook Lake, has been protected, which should push the Shelburne Barrens up to the number one position.

1-6 Background on Mineral Claims in the SB region

Mineral exploration licenses in the Flintstone Rock area were granted to CAG Enterprises Ltd., by the Mines and Energy Division of the NSDNR, on May 24th, 1996. Figure 1-4 shows the current location of the mineral claims, which lie partially within the candidate protected site. The company applied for claim areas in the portion of the Shelburne Barrens that lay within the Tobeatic candidate Wilderness Area, but they were not successful. The Tobeatic Wilderness Area (TWA) is one of 31 sites protected this year under the Systems Plan for Parks and Protected Areas. A request was again made, in May of 1997, for mineral rights in the TWA. Following the outcry from environmentalists and others around the province, CAG Ent. finally withdrew their request (Gorham, 1997a).

Figure 1-4: Location of CAG Enterprises mineral claims, in relation to the Shelburne Barrens

CAG Ent. is searching for a primary deposit of kaolinite, a clay mineral formed from the weathering of granites *in situ* (see section 2-2-6). This mineral is used as a paper filler and for making ceramics, and can be worth between $150 and $400 a tonne (Gorham, 1997b). According to company agent Bill Shaw, CAG Ent. drilled nine test holes in the spring of 1996. The six test holes which were drilled into granite showed promise, and the company is comparing the deposit to a large kaolinite mine in Cornwall, England, which is held by English China Clays Int. Ltd. According to Mr. Shaw, the deposit area is approximately 6km in length, 200 to 400m wide, and 90m deep, with an estimated 75 tonnes of kaolinite (Gorham, 1997a).

Mineral claim areas have been granted within the Shelburne Barrens, despite its status as a candidate nature reserve. The Mineral and Energy Branch of the Department of Natural Resources and the Department of Mines do not recognize these candidate sites, despite the moratorium that was to be placed on the sites upon receiving candidate status (Ombudsman, 1991). The Shelburne Barrens candidate site was not located on the mineral claim map for the area, in June of 1998, though it was a candidate protected site at the time of map making.

1-7 Potential Environmental Impacts of Kaolinite Mining

1-7-1 Introduction

The extent to which kaolinite mining might stress the Shelburne Barrens region is dependent on many factors, such as the exact location of the mine site, the intensity and the size of the operation. Under current legislation, an exploration company does not have to release any details regarding their exploration activities for two years after the first mineral claim renewal. CAG Ent. is still in its exploration stage, hence details about the claim are not yet available. Most of the information on mining processes and potential effects given in this paper have been made available by English China Clay International Ltd. (ECC). This company is the worlds largest producer of kaolinite, operating out of Cornwall, England (ECC Int., 1996). Because CAG Ent. has compared the deposit in the Flintstone Rock area to the Cornwall deposits, using ECC information on mining processes and environmental effects are presumed to be suggestive of potential effects in the Shelburne Barrens.

1-7-2 Exploration

Ripley *et al* (1996) state that the environmental problems associated with exploration can affect a larger portion of land than the subsequent mining, although the problems are usually less severe and occur over a shorter period of time. Trenching and digging of pits can have long term effects, due to erosion, disturbance of wildlife, and effects on adjacent waterways. Habitats may also be affected by the building of new roads and trails to access the exploration sites.

1-7-3 Mining process

Production of kaolinite can be divided into three sections; open pit extraction, refining, and drying. The mines in Cornwall operate the washing and refining process 24 hours a day, 7 days a week, to increase the rate of clay extraction and minimize problems associated with starting and stopping the machinery involved (Thurlow, 1996).

Open Pit Extraction

The mining of kaolinite is by open pit technique, as the kaolinite is still held within the host rock (see section 2-2-6) (ECC Int., no date). As Thurlow (1992) describes, the first stage of mining requires the removal of the vegetation, soil and till, collectively referred to as the overburden. A heavy earth moving plant is used for this purpose. The granite must then be broken up to expose the kaolinized areas. The clay is not evenly distributed, and large areas of quartz veins and unaltered granite require removal. This breaking up of the bedrock is done by drilling, blasting, or ripping with a bulldozer.

Extraction of the kaolinite is done through a hydraulic mining process (ECC, 1995). A jet of water from a water cannon, known as a Monitor, is fired at the quarry face. The resulting clay, mica and sand slurry flow to the lowest point in the pit, where it is pumped to the sand separation plant. Here the coarse sand is removed and deposited on low profile tips, or waste piles. The remaining clay solution is transported by pipeline to the refining unit.

Refining

Refining is done through a series of mineral processing techniques, which are designed to remove the smaller particles of unwanted material, namely quartz, mica and unaltered feldspar (Thurlow, 1992). Gravity separation in settling ponds made with rock and sand walls allows the heavier materials to settle out. The lighter clays and micas overflow these ponds, and are separated mechanically. The mica solution is pumped to lagoons for further settling, and the clear water on the surface is pumped away for further use.

The clays are removed from the solution through one of two methods: the addition of a chemical flocculant, which clumps the particles together and decreases settling time; or through flotation, where chemicals are added which waterproof the kaolinite, which then float to the surface for removal. The particles which don't float to the surface are discarded. After either method is used, the clays are flocculated using acid, to thicken the material before drying. Many clays are also chemically bleached to improve whiteness (ECC, 1995).

Drying

The drying process firstly converts the liquid clay into a solid material through filtration, followed by thermal drying. The resulting product is normally sold in pelletised form, with particle sizes of 6-12mm.

1-7-4 Environmental Impacts

1-7-4-1 Introduction

The main environmental problems associated with the mining of kaolinite involve: the large amounts of water which is required; the disposal of waste material; and, the creation of a large, open pit (Harris, 1999).

1-7-4-2 On site disturbances

Noise

The mining process involves blasting and drilling, which can be heard over many hundreds of meters or more, depending on the landscape (Ripley *et al.*, 1996). A mining operation will increase the traffic in the area, and possibly require processing plants to be running 24 hours a day. This could have impacts on the wildlife in the area, as well as any homes nearby.

Dust

Ripley *et al.* (1996) gives a good description of the common problems associated with the mining of a primary kaolinite deposit. The mining of kaolinite results in large quantities of ‘rock flour’, small dust sized particulates of rock liberated during crushing and grinding, transportation, and from waste stockpiles (Ripley *et al.*,1996; Horseman, 1999). The action of wind on the quarry face and roads can disperse the clays and micas over large distances, due to their shape, weight, and small size. The control of dust is difficult, because it does not originate from a point source. Watering the roads and quarries is often used to help reduce the quantity of material being picked eroded by the wind.

Surface Disturbance

Kaolinite is not concentrated within the host rock, the way a coal seam or quartz vein is. This results in the production of extremely large pits, and lots of waste material (Ripley *et al.*,1996; Thurlow, 1992). For every tonne of product produced, there are 4 tonnes of sand, 3 tonnes of rock and overburden, and 1 tonne of mica, resulting in an 8:1 waste rock to product ratio (Thurlow, 1992). The rock and sand is disposed of on tips and rock piles around the quarry, which are highly susceptible to erosion by wind and water, due to the loose nature of the waste rock and the lack of vegetation. Rock particles, metals and minerals can be washed from the mine site and enter the surface and ground water near the mine.

In order for a mine to be built and operated, infrastructure is needed. Roads and plants must be built on site, further removing vegetation and compacting the soils. Figure 1-5 shows a kaolinite mine site in Cornwall, England. The mining of kaolinite is a massive operation, and will affect extensive areas of land, as is apparent from this figure.

1-7-4-3 Disturbances to the hydrosphere

The mining of kaolinite requires large volumes of water, both in the excavation of the mineral and during the washing stage. For every tonne of product produced, there are

Figure 1-5: ECC kaolinite mine site, Cornwall, England

5-20 tonnes of water necessary (Thurlow, 1996; Harris, 1999). In England, the water is taken from both surface and ground water reservoirs, by pumping and passive flow into the pit from springs and streams (Watkins, 1999; Wilson, 1999). Old pits in Cornwall which are no longer in use are flooded with water to use during dry periods. Some of this water is able to be recycled, but the majority of it is released downstream (Thurlow, 1996; Watkins, 1999).

Water Quality

Mine water, defined as any rain, snowmelt, surface and ground waters which enter the mine site through passive or active means, is the most difficult of the mining residuals to manage (Ripley *et al*.,1996). As it moves, it picks up particulates of broken rock and products of oxidation, reduction and dissolution, such as acids, alkalis and metals (Ripley *et al.*1996; Harris, 1999). When these waters escape or are released, they can chemically or physically alter surface and groundwaters. Chemical alteration would result in changes in pH values, changes in the ionic concentration of metals, and by the addition of toxins such as bleaches and flocculants (Ripley *et al.*, 1996). The main concern with this type of mining however is the quantity and nature of suspended solids in the water column (Watkins, 1999; Horseman, 1999). By weight, these solids can account for 5-20% of the water released from the mine (Ripley *et al.*,1996). In Cornwall, the river into which the waste wasters are released is known as the White River for this reason (Watkins, 1999).

Below is a list of ways in which mine water escapes from the Cornwall mining operation. It can be assumed that similar risks would exist in Nova Scotia.

- run off from poor containment of water blasting, during excavation of the mine.

- siltation ponds overflowing with partially settled materials, releasing micas, sands, and clays.

- pipeline bursts, due to settling of material in the pipes, causing blockage and an increase in pressure.

- failures of tailing ponds, due to structural flaws

- seepage from tailing ponds, "because earth and rockfill dams have some permeability" (Ripley *et al.*, 1996, p.108).

(Harris, 1999; Ripley *et al.*, 1996)

1-7-4-4 Reclamation

At the completion of the operation, there is a large, deep open pit, as well as "idle pits flooded with water, vast lagoons of grey-white residue and many refining and drying plants" which are no longer of use (ECC, 1995, p.17). In order that this area is able to be used again, reclamation of the land would be necessary.

Reclaimation of a kaolinite mine is difficult, in part due to the size of the pits (Ripley *et al.*, 1996). In the ECC operation, old pits are generally kept open and flooded as a source of water in dry periods, leaving the waste rock in piles over the surrounding landscape. The waste rocks are "badly deficient in nutrients, particularly nitrogen", making primary succession a slow process (ECC, 1995, p.18). Initiation of plant growth is difficult, as the sand piles are easily leached of any nutrient applications. Plantations on unused portions of the Cornwall mines must be done in 3 stages over the course of a ten year period (ECC, 1995). Nitrogen fixing legumes, such as clover are planted by hydrospraying of seeds, fertilizers, and lime onto the waste piles. When the soil has acquired enough nutrients, shrubs and lupins are then planted, followed by trees a few years later.

Reclamation of roads is can be even more difficult than reclaimation of the pits, if paving was involved in their building. Because of this, the roads are often left in place (Ripley *et al.*,1996).

1-8 Study Objectives

There were four main objectives established at the beginning of this study.

1) Complete a survey of the vegetation and landscape features of the Shelburne Barrens candidate nature reserve.

2) Determine whether or not the Shelburne Barrens is a good candidate for a nature reserve, based on the criteria for selection by the IBP committee, and the criteria for designation under the Special Places Protection Act.

3) Review the potential impacts of developing a kaolinite mine in the Flintstone Rock region of the Shelburne Barrens.

4) Make recommendations for management of the area.