

Towards a Conservation Strategy for Sable Island



A CONSERVATION STRATEGY FOR SABLE ISLAND

PREPARED BY

This Conservation Strategy for Sable Island was prepared for Environment Canada's Canadian Wildlife Service, Atlantic Region by Kevin Beson.

ACKNOWLEDGMENTS

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Sable Island is unique in Canada, not only in its physical identity as an offshore island near the edge of the continental shelf, but also as a place with an early and continuing part in the unfolding of Canada's history. The purpose of this document is to set a framework for the preservation of the physical integrity and biological diversity of Sable Island.

The island has been used by humans for over 400 years, and has been changed by this use. The introduction of many exotic plants and animals, including large grazing animals, has permanently altered the pre-contact ecosystem. The essence of this strategy is protection of existing terrain from human-induced destabilization, and conservation of the island's native flora and fauna.

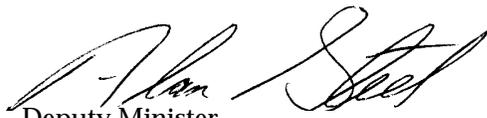
Although present activities have little environmental impact, it is likely that the pattern of human activity on the island will change in the near future. This conservation strategy defines the environmental limits within which future activities should proceed. When a new management regime for Sable Island is achieved, a detailed management plan embodying the environmental ethic of this strategy will be constructed.

We agree that future management of Sable Island will be guided by the recommendations of this conservation strategy.

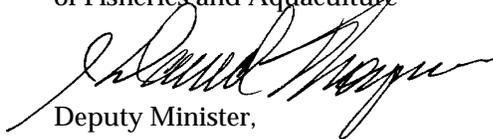
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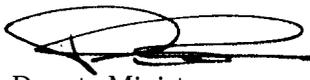
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EXECUTIVE SUMMARY

This conservation strategy was prepared for Environment Canada's Canadian Wildlife Service with the Sable Island Conservation Strategy Advisory Committee. This committee was composed of representatives of Dalhousie University, government and non-government organizations with interests in, and knowledge of, Sable Island. This document defines the environmental limits within which future activities should proceed. The strategy also serves to define the various conservation interests for the island both biological and physical, and therefore provide a basis for the establishment of long-term development principles.

In developing the strategy a number of principles were followed, including recognition that a permanent human presence on the island is advisable if a number of continuing and proposed activities will be accommodated. Many of the proposed activities such as the development of eco-tourism will require this resident presence in order to support necessary infrastructure.

Sable Island, a 41 kilometre long island composed of sand, is the only emergent portion of Sable Island Bank. It is located approximately 290 kilometres Southeast of Halifax, Nova Scotia. The island has a diverse flora and fauna and is stabilised, primarily, by its vegetation cover and the oceanic currents. The best known component of its fauna is a population of feral horses which were introduced sometime shortly after 1738 and whose numbers now range between 150 and 400 individuals. The island supports numerous migrant, and small number of breeding bird species, and has status as a federal Migratory Bird Sanctuary administered by the Canadian Wildlife Service. Sable is the only breeding ground of the rare Ipswich Sparrow, and is also home to small breeding numbers of the threatened Roseate Tern.

The world's largest congregation of breeding Grey Seals which pup between late December and February are found here. There is also a small resident population of Harbour Seals which pup from mid-May to mid-June. The latter species of seals have been in decline.

There has been a continuous human presence on the island since 1801 when the colonial government in Nova Scotia founded a life-saving establishment in an effort to reduce the suffering and loss of life and cargo that resulted from the frequent shipwrecks on and near Sable's shores. At present access to Sable Island is regulated under the legislative authority of the Canada Shipping Act, part xi (ss. 581-589) mandated to the Canadian Coast Guard, Department of Fisheries and Oceans (DFO).

The present administrative focus of the island is the operation of an upper air weather station by Environment Canada's Atmospheric Environment Branch (AEB). From the perspective of conservation, AEB staff have come to serve as *de facto* wardens of Sable Island by enforcing the applicable government regulations and monitoring the activities of individuals on the island. Monitoring has primarily involved ensuring that behaviour falls within the acceptable environmental limits as

required by the applicable regulations.

Although present activities have little environmental impact, it is likely that the pattern of human activity on the island will change in the near future. The greatest change in use will probably be the initiation of organised tourism to the island. If improperly managed, tourism could have a significant environmental impact; if managed wisely it could contribute to the welfare and conservation of the island. A conservation strategy for Sable Island is required to plan the preservation of its biological diversity, and to manage and minimise the impacts of human use.

The establishment of and concurrence with this Conservation Strategy by the primary parties with vested interests in Sable Island is the first step to ensuring that the natural heritage of the island is well outlined and recognised. It provides a solid foundation upon which to take the next steps of developing a comprehensive management plan for the island.

The recommendations of the Conservation Strategy are summarised as follows:

Maintaining a human presence on Sable Island

- Conservation objectives can be best realised if a human presence is maintained on Sable Island.

Island stability

- No surface excavations should be permitted which are likely to cause long-term destabilisation of the island's topography.
- No construction or obstruction that interferes with the natural movement of beach sand or with the near-shore transport of sand will be permitted. However the construction of fences or dikes in conjunction with vegetation planting that encourage sand accumulation in areas that have been subject to anthropogenic disturbance is acceptable.

Dune Structure

- No structures should be placed in areas which would interfere with the natural movements of the island's sand. However, restoration work, such as the construction of fences or dikes which encourage sand accumulation accompanied by transplantation of marram grass may be undertaken in areas where terrain has been destabilised.
- No disruptive activity should be permitted in areas which are vulnerable to destabilisation by wind, such as on dune faces or at the base of dunes.
- Vehicle travel must be restricted to the beaches or over already established roads. Where these roads exist, monitoring should be undertaken to ensure significant destabilisation is not occurring. Special operational requirements for use of vehicles may be sanctioned by the management body governing Sable Island.
- If monitoring reveals anthropogenic destabilisation, action must be taken to stop the activity and if possible repair the damage.

Hydrology

- Monitoring wells should be established around areas of active pumping to monitor the amount of draw-down on the water table. Pumping should cease if evidence of salt water intrusion is detected.
- There must be strict enforcement of appropriate storage and handling regulations and procedures for hydrocarbons. Hydrocarbon spillage must be reported to the regulatory authority immediately.
- Untreated sewage should not be introduced into the water table. Disposal techniques appropriate to the volume and location of the wastes should be implemented.
- Consideration should be given to the installation of storage tanks if it is expected that seasonal demand will exceed the rate of recharge.
- To minimise the impact of salt water intrusion on the fresh water lens through lateral migration, wells should be as close to the island's centre as possible.
- No wells should be placed near areas susceptible to ocean flooding.
- In general no foreign substance should be introduced into the water table.

Conservation of the flora of Sable Island

- An air-photo monitoring program should be established that takes same-scale, same-season air-photo mosaics every five to ten years.
- Vegetation maps in a geographic information system should be derived from aerial photo mosaics so that changes can be detected and quantified.
- Botanists conducting vegetation surveys on Sable should compile their data using a community classification that allows useful comparisons with past surveys.
- Significant plant species should be mapped, and research to document species which may be rare or endemic should be encouraged.
- Habitats of significant species should be accurately mapped.
- The introduction of exotic plants or animals should be prohibited.
- Priority protection should be extended to Sable Island's wetland communities.
- Activities that have the potential to damage the island's vegetation cover should be prohibited.

Feral horses

- Continue to extend legislative protection to the feral horse population.
- Encourage research that would investigate the effects of horses upon the island's topography, flora and fauna.
- If research indicates that horse presence has serious adverse impacts which threaten the natural regulation of the island's ecosystem, consideration should be given to management of the horse population.

Seals

- Activities that force Harbour Seal mothers and pups into the sea, especially during breeding season, or that unduly disturb seals that are hauled-out on the beach should be avoided.
- No human activities should be permitted that unduly disturb Grey Seals during the breeding season or at other times of the year when Grey Seals are hauled out, except where management activities are undertaken by, or under the supervision of, the Department of Fisheries and Oceans.
- Aircraft over-flights should not be allowed below a height of 300m. It is recognised that approaches to land on Sable will be below this height.

Birds

- The island's populations of breeding birds should not be disturbed. This means: avoiding areas where terns are known to nest, avoiding walking in large groups over vegetated terrain, avoiding activities that cause breeding birds to leave their nests, and taking steps to protect and enhance the breeding opportunities of Sable Island's endangered, threatened, or vulnerable bird species, particularly Roseate Terns.
- No non-native animals can be introduced to the island.
- Linkages to U.S. initiatives for Roseate Tern and Ipswich Sparrow protection should be established.
- An updated map of the island's important migratory bird nesting sites should be maintained.
- Sable Island's status as a Migratory Bird Sanctuary should be retained until more comprehensive protection for the island's natural environment is developed.

Invertebrates

- Research contributing to the identification and description of Sable Island's rare and endemic invertebrates should be encouraged.
- Because the areas of highest biological diversity and ecological fragility are found along ponds, special protection must be extended to these areas in any future management regime.
- Habitats of the island's rare and endemic invertebrate populations must be documented and protected.
- Research into Sable Island's micro-invertebrate and sand dwelling species, should be encouraged. The relationships between some invertebrates and the island's vegetation requires further investigation.

Re-introductions

- Re-introductions of extirpated flora and fauna should not be attempted until all immediate conservation concerns have been satisfied.

Present human use

- Sable Island should be promoted as a site for scientific research and monitoring. Many long-term monitoring programs could be administered by Island staff.
- Fuel handling and storage on Sable Island must be strictly monitored and regulations enforced.

The surrounding marine environment

- The focus of this strategy is terrestrial, but it recognises that future management plans should link to coastal zone legislation such as the Oceans Act.

Tourism on Sable Island

- Tourism development should proceed at a slow pace, with tight controls. Restrictions can be modified as more information on the impacts of tourism becomes available.
- A tourism policy for Sable Island must be developed that defines the procedures to be followed in addressing the logistic and operational requirements for tourism.
- Tourism activities should not interfere with the scientific and environmental monitoring operations.
- Tourism should not degrade the island's natural environment by disturbing wildlife or damaging vegetation.
- No treasure hunting or removal of artifacts from Sable Island will be permitted, and the removal of sediment or biological samples for research will be by approval of the managing body only.

Management needs

- Enhanced legal protection should be sought that provides more comprehensive protection to the island's natural values.
- An agreement should be developed between regulatory authorities that will allow management of Sable Island in a manner consistent with the objectives of this conservation strategy.
- An island manager should be designated and supported to represent government authority on the island. This person should have enforcement officer status under relevant conservation authorities, and have the authority to enforce environmental regulations on Sable Island.
- The potential of obtaining international status such as World Heritage Site designation or Biosphere Reserve Status should be investigated.
- The benefits of gaining protection for the island through joint federal-provincial co-designation should be investigated.

Conservation/ protected area designation

- A Sable Island Management Plan embodying the environmental ethic of this conservation Strategy should be constructed under any new conservation designation.

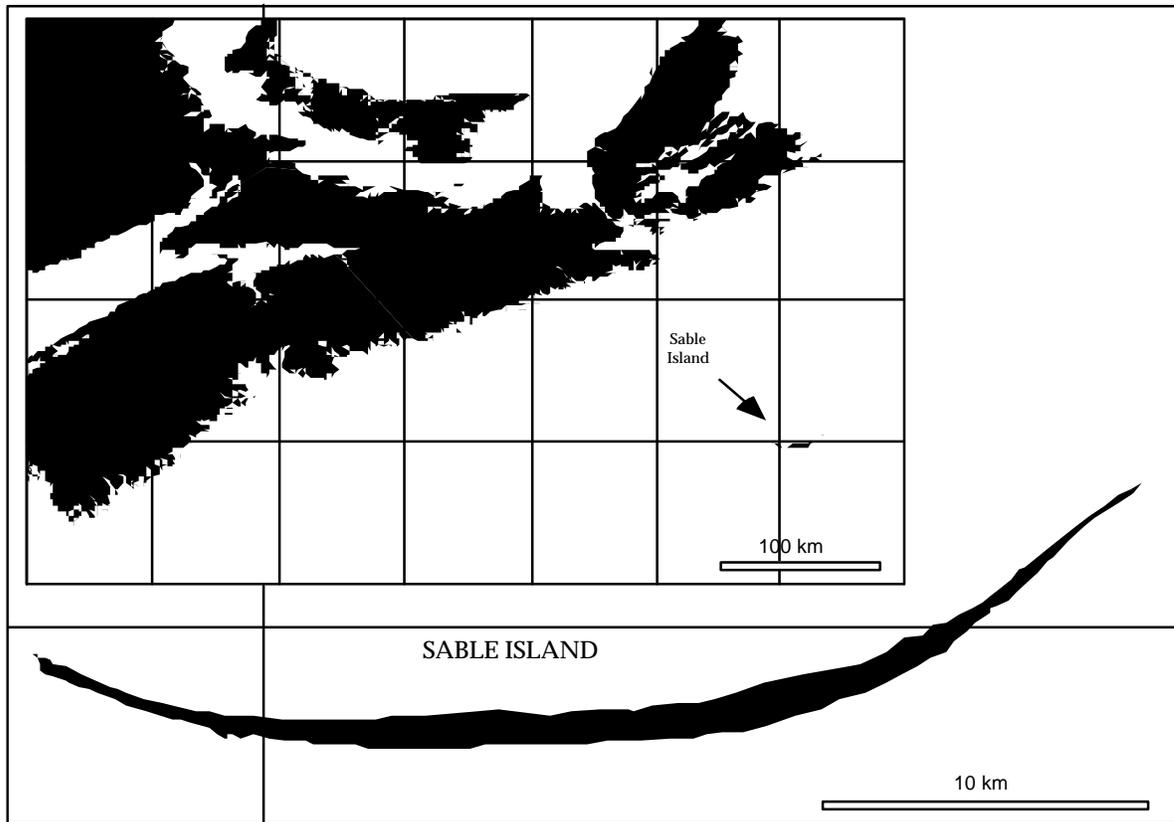


Figure 1 Sable Island and its location relative to the Maritime Provinces

1. INTRODUCTION

Sable Island, the only emergent portion of Sable Island Bank, is located approximately 290 kilometres Southeast of Halifax, Nova Scotia. The island has a diverse flora and fauna and is stabilised, primarily, by its vegetation cover and the oceanic currents. The best known component of its fauna is a population of feral horses which were introduced sometime shortly after 1738 and whose numbers now range between 150 and 400 individuals (Welsh 1975; Christie 1980). The island supports numerous migrant, and small number of breeding bird species, and has status as a federal Migratory Bird Sanctuary. There is a small resident population of Harbour Seals (*Phoca vitulina*) which pup from mid-May to mid-June, and a larger population of Grey Seals (*Halichoerus grypus*) which pup between late December and early February. The island also supports over 170 plant taxa, with a relatively high species diversity around the edges of freshwater ponds and within heath-type communities. Knowledge of Sable Island's invertebrate species is still incomplete, however several endemic species have been described (Wright 1989).

Access to Sable Island is federally regulated under the legislative authority of the Canada Shipping Act, part xi (ss. 581-589) mandated to the Canadian Coast Guard, Department of Fisheries and Oceans (DFO). There has been a continuous human presence on the island since 1801 when the colonial government in Nova Scotia

founded a life-saving establishment in an effort to reduce the suffering and loss of life and cargo that resulted from the frequent shipwrecks on and near Sable's shores. Since then the island has been occupied by shipwreck victims, sealers, staff and family of the life saving establishment, wireless operators, lighthouse keepers, meteorological staff, personnel of various federal and provincial government departments, petroleum industry contractors, and a limited number of tourists and visitors. There has also been a great variety of research into many different aspects of the island, including its history, biology, geology, hydrology, as well as meteorology and atmospheric chemistry.

The present administrative focus of the island is the operation of an upper air weather station by Environment Canada's Atmospheric Environment Branch (AEB). Weather observations began on Sable Island in 1871, although at that time the observations were intermittent. In 1891 the Meteorological Branch of the Ministry of Transportation established a meteorological station and regular weather observations were carried out by the island's lighthouse keepers.

The observation sites changed in the early years of the service, eventually ending up at the West Light. In 1944 the Meteorological Branch constructed a number of separate buildings and began the upper air program. In 1954 the staff house and other buildings were constructed and the operation was moved to its present location. In 1959 the federal government closed the life saving station and the last superintendent left the island in 1962. More buildings were added to the weather station in 1974, 1978, and 1982, bringing to 17 the number of buildings under AEB's control.

From the perspective of conservation, AEB staff have come to serve as *de facto* wardens of Sable Island by enforcing the applicable government regulations and monitoring the activities of individuals on the island. Monitoring has primarily involved ensuring that behaviour falls within the acceptable environmental limits as required by the Sable Island Regulations in the Canada Shipping Act (Appendix 1) and the Migratory Bird Sanctuary Regulations under the Migratory Birds Convention Act (Appendix 2). Although the present activities on Sable Island have little environmental impact, the pattern of human activity on the island will change in the near future. This document responds to this anticipated change by defining the environmental limits within which future activities should proceed.

2. DEVELOPING A CONSERVATION STRATEGY FOR SABLE ISLAND

2.1 CONSERVATION AND THE ROLE OF CONSERVATION STRATEGIES

2.1.1 Defining conservation

For the purposes of this document, conservation is defined as a method of environmental management which is guided by a philosophy of interaction with the natural environment in a manner that does not despoil, exhaust, or extinguish (Jordan, 1995). Conservation is seen as an approach that acknowledges the inherent worth of nature as well as the dependence of humans on a healthy, naturally functioning ecosystem, and does not make humans the central focus of management decisions.

2.1.2 Defining a conservation strategy

The World Conservation Strategy states that the purpose of a conservation strategy is to focus attention on priority requirements for conservation, to stimulate appropriate action, to raise public consciousness and to overcome any apathy or resistance there might be to taking the action needed (IUCN, 1980). For the purposes of this document, a conservation strategy results from the analysis of a biological region and articulates the principles and actions required in order to meet defined conservation goals. It requires an understanding of existing environmental conditions within a eco-region and a identification of the steps necessary to meet the conservation goals. Among the steps in the process are:

- acquiring an understanding of the physical and biological characteristics of the environment;
- understanding the human impacts upon the environment; and
- identifying the actions required to ensure that the physical and biological processes are:
 - protected to the extent that is practicable from human disturbance;
 - regulated by natural environmental controls;
 - rehabilitated, where necessary, to restore natural environmental processes; and
 - monitored and managed in a manner that will allow long-term adherence to the conservation strategy's objectives.

2.2 DEVELOPMENT OF CONSERVATION STRATEGY OBJECTIVES

A conservation strategy for Sable Island is required to preserve its biological diversity, and manage and minimise the impacts of human use. Before human contact, Sable Island was a naturally regulating ecosystem. It was sustainable in the sense that it existed without the impacts, influence or inputs of humans for many thousands of years. Stresses on the island resulted from natural phenomena such as erosion during storms, sea level change, atmospheric and climatic variations induced by glaciation. If we define natural stresses as processes which occur independent of human influence, it is apparent that the line between natural and human-induced stress is becoming increasingly unclear because humans now have the capacity to affect global environmental processes.

Anthropogenic and natural processes may work synergistically to stress the ecosystem, and there is a need to create a strategy that sets limits on the impacts of this interaction. These limits are based upon what is perceived to be in the best, long term, interest of Sable Island. The philosophical approach used in defining this is provided by Aldo Leopold's (1949) argument for the need to develop a land ethic that views *Homo sapiens'* role in the environment, not as a conqueror, but as a member and a citizen of it. This requires a respect for the fellow members of the community and for the community itself. It requires individuals to take responsibility for a community's health. How do humans know what is good or healthy for nature? Leopold suggests that a thing is right when it preserves the integrity, stability and beauty of the biotic community. It is wrong when it tends otherwise.

To focus this philosophical approach, generic objectives for the long term environmental health of Sable Island, are listed. These objectives are modifications of those for living-resource conservation listed in the World Conservation Strategy. To the extent that modifications are made, they are an effort to reduce the anthropocentric focus.

2.3 CONSERVATION STRATEGY OBJECTIVES

Maintain Sable Island's natural ecological processes and preserve its biological diversity by:

- preserving the physical integrity of Sable Island by monitoring and, if necessary, restoring damage to the island's vegetation cover;
- prohibiting activities which have negative or destabilising effects on the island's topography;
- reducing human impacts on the sub-surface fresh water lens;
- limiting inputs of pollutants to the environment to rates which can be dispersed naturally;
- taking steps to identify and preserve the island's rare and endemic species;
- ensuring that human activities do not negatively affect the breeding success birds such as the Ipswich Sparrow (*Passerculus sandwichensis princeps*) and

Roseate Tern (*Sterna dougallii*);

- monitoring the feral horse population and its effects on the island's vegetation and topography;
- restricting the introduction of, and allowing for the removal of, exotic plants and animals;
- ensuring that human activity does not conflict with the management objectives of the regulatory agency responsible for marine mammals (DFO).

Encourage sustainable interaction amongst species and limit interference with naturally regulating ecosystem processes by:

- establishing a legal and administrative framework for the long term management and ecological protection of the island;
- managing introduced species in instances where exotics are thriving at the expense of native species;
- maintaining a continued permanent human presence on the island so long as it can be justified as being to the overall benefit of Sable Island; and
- encouraging the continued use of Sable Island as a natural laboratory and a platform for environmental research.

2.4 MAINTAINING A HUMAN PRESENCE ON SABLE ISLAND

The purposes of this conservation strategy can be best realised if a human presence is maintained on Sable Island.

The complete removal of humans from the island will leave it vulnerable to unregulated access. Experience has shown that buildings and equipment on untended or uninhabited islands are often vandalised, and unregulated access increases the likelihood of abuse or disturbance of components of the island's ecosystem. Legal protection of the island has little meaning or effectiveness without enforcement, and only a resident staff can effectively enforce environmental rules on Sable Island. This argument, that unmonitored visitation would result in environmental damage, can only be proved after the fact, therefore it is prudent to err on the side of caution by maintaining a continuous human presence.

Part-time staffing of the island during the months of highest visitation would also present many logistical difficulties. The rigours of Sable Island's environment require continuous monitoring of infrastructure, i.e. building repair, communications, power generation, etc. This would not permit extended periods of absence.

Sable Island serves as a natural laboratory for many different fields of research. In particular, it is an excellent upper air sampling platform from which pollution from the North American mainland can be monitored without contamination from local pollution sources (Parrish *et al.*, 1993). Upper-air data, tropospheric ozone, and carbon monoxide levels have been monitored for 22 years, and surface weather

observations have been taken for 105 years. Work done here contributes to the understanding of global atmospheric change. It is also an important location for research on Grey Seal population dynamics, relative sea level rise, sediment transport, succession patterns of vegetation, feral horse ecology etc.

These reasons are sufficient to warrant the continued staffing of Sable Island. The principles and recommendations contained in this document are valid regardless of future management regimes, but to a large degree, they assume a continuing human presence on the island. If resident staff are removed, an effective mainland-based monitoring strategy must be developed to maintain environmental protection.

Recommendation

- Conservation objectives can be best realised if a human presence is maintained on Sable Island.

3. PHYSICAL DESCRIPTION OF SABLE ISLAND

3.1 REGIONAL SETTING AND GEOLOGICAL DESCRIPTION

3.1.1 Physical description

Sable Island is located at approximately 60° West longitude and 43°56' north latitude. It is 161 km from the closest point on mainland Nova Scotia (Canso Head), and approximately 290 km south-east of Halifax. Sable Island is crescent shaped, approximately 40 kilometres in length, yet only 1.3 kilometres broad at its widest point. The ends of the island terminate as submerged sand bars that extend far to the east and west.

The north beach is generally narrower than the south beach, but both are flanked by a foredune system formed by prevailing winds. Blowouts (wind-cut gaps in the sand dunes) are prevalent along both sides of the island. The south foredune ridge, which averages between 9 and 12 metres in height, is generally less continuous than that on the north beach, which reaches 25 metres elevation toward the eastern end of the island.

The island's extremities are vegetated mainly by halophytic (salt tolerant) and sand loving vegetation such as sandwort (*Honckeneya peploides*), marram grass (*Ammophila breviligulata*) and beach pea (*Lathyrus maritimus*). The interior topography is characterised by low rolling dunes with numerous freshwater ponds, especially in the western half of the island. Heath-type vegetation is dominant in the island's interior, and is much more diverse and stable than the marginal marram and sandwort-dominated communities. Lake Wallace, a brackish-water lake on the island's south side, is now approximately two kilometres in length, but was once much larger. In earlier years it was protected from the ocean by a line of dunes which has since eroded. Only a low berm remains between the ocean and the lake, which is subject to ocean flooding during storms.

3.1.2 Geological description

Sable Island is a geomorphic oddity. Composed entirely of unconsolidated sand, it is the only exposed portion of the outer continental shelf in the Northwest Atlantic. Sable Island Bank, of which Sable Island is an emergent part, is one of a series of relatively flat banks located on the outer margin of the Scotian Shelf. The majority of the sediment of these banks was deposited during different Pleistocene glaciations. Browns Bank, La Have Bank, and Middle bank are largely composed of older partially lithified rock, while Sable Island has an average of 200 metres of unconsolidated late quaternary sediment (Scott *et al.*, 1989; Boyd *et al.*, 1988).

3.2 ISLAND STABILITY

Early predictions

Many of the early scientific commentaries on Sable Island predicted its rapid erosion and destruction. However, one of the earliest recorded descriptions of the island is that of Johannes de Laet in his *Novus Orbis* (New World) published in 1633. De Laet describes an island with dimensions which approximate its present size. There is no doubt that some of the descriptions of mass wasting on Sable are based in truth. Within the last 100 years a large section of the south beach dune line that once protected the 17 kilometre long Lake Wallace has disappeared, and Lake Wallace is filling with sand. Instances of spectacular erosion during storms have understandably attracted more attention than the accretion which occurs at a much slower pace. Willmore and Tolmie (1956) and James and Stanley (1967) point out that the descriptions of the island's wasting were undoubtedly coloured by the attendant hardships caused by these storms.

Cameron (1965) used aerial photographs to investigate the validity of claims that Sable Island is decreasing in size. Using Des Barres' 1766 map as a base, he compared the Royal Canadian Air Force photographs of the island taken in 1952, 1955, 1959, and 1964 to get an indication of the island's movements. His analysis suggested that Sable Island is not rapidly eroding, but he does contend that the island appears to have become slightly narrower and is slowly migrating to the east. Gray (1992) agrees with Cameron's contention that the island has narrowed but finds no evidence to suggest that the island has migrated eastward. By correcting for errors in previous maps he has compiled and overlaid maps of Sable Island's position for the past 230 years showing that the location of the island has been relatively constant.

Forces of the ocean and wind define the structural history and the future of Sable Island. Wave patterns around Sable vary seasonally with the prevailing winds. In the fall and winter, the winds blow predominantly from the west and north-west creating long-period, high waves. In the summer, the winds moderate and blow mainly from the south-west. The resulting waves on the south beach are smaller in period and amplitude.

Taylor (1982) has observed that near-shore sandbar characteristics, as well as dune height and beach morphology, play an important role in shoreline stability. Specifically, areas of rapid primary dune recession were found to correspond to areas of high beach mobility where offshore submarine bars were absent.

Sable Island also lies at the confluence of a number of ocean currents. Flowing southward, the Labrador current meets and deflects the eastwardly-flowing St. Lawrence Current, resulting in a south-west current flow north of Sable. To the south of the island, the warm Gulf Stream moves in a north-eastward direction. The influence of these currents, associated with a local tidal current, results in a residual counter clockwise flow around the island. (James and Stanley, 1967, Jordan, 1962, James and Stanley, 1968)

Gray (1992) concludes that Sable Island, while it has had a number of different shapes, has not physically moved from its present site. The perception of movement results from a long-term decrease in length, particularly of the eastern extremity, and a decrease in width. Currents and storms, especially severe winter storms, do change the island's shape. This is most apparent in seasonal changes in both the length and curvature of the east and west bars.

Conservation concerns

Sable Island is dynamic, and over the years has changed much in shape and size. Natural erosional episodes may appear to be catastrophic, but they essentially represent a point in a continuum of natural regulation. Sand liberated through erosion becomes available to be deposited in another area of the island. Varying degrees of anthropogenic activity have unquestionably influenced Sable's natural regulation, and activities which endanger stability and natural movement of sand must be avoided.

The recommendations below may be interpreted with some latitude so that legitimate research initiatives are not impeded. If short-term disturbances are allowed, the site must be returned to pre-installation condition on completion.

Recommendations

- No surface excavations should be permitted which are likely to cause long-term destabilisation of the island's topography.
- No construction or obstruction that interferes with the natural movement of beach sand or with the near-shore transport of sand will be permitted. However the construction of fences or dikes in conjunction with vegetation planting that encourage sand accumulation in areas that have been subject to anthropogenic disturbance is acceptable.

3.3 RELATIVE SEA LEVEL RISE

The major long-term natural threat to Sable Island appears to be the steady rise in sea level since the beginning of the Holocene, approximately 10 thousand years ago. The United Nations Intergovernmental Panel on Climate Change (1996) estimates that sea level rise due to thermal expansion of the oceans and the melting of glaciers will be 50 cm between the present and 2100.

Scott *et al.* (1984) suggest that the centre of Sable Island has been stable for the past 7500 years and the island has continually aggraded as sea level rose. This is based upon the radiocarbon dating and pollen analysis of deep organic deposits which have been found in the same vertical location elsewhere on the shelf. Scott *et al.* (1989) point out that comparison of organic peat layers recovered from bore holes on and near Sable Island show that the relief around 8000 years ago was approximately 15-20 m and is comparable to the height of the present day dune system.

Conservation concerns

Sable Island is the only remaining exposed portion on the north-eastern continental shelf. Its tectonic stability and location represent a unique geological record of a continually aggrading offshore platform, and can provide useful data on rates of relative sea level rise. Continued sea level rise may eventually result in the submergence of Sable Island.

3.4 DUNE STRUCTURE

Sable Island's dunes are dynamic structures, susceptible to erosion by the wind and ocean. Running along the central two thirds of the north and south beaches is a line of high dunes which is one of Eastern Canada's largest dune systems. These dunes are the main barrier preventing the ocean from inundating the low heath communities and freshwater ponds in the island's interior. They are fragile habitats which sustain unique ecological processes and examples of highly specialised life forms. Marram Grass (*Ammophila breviligulata*) is good example of such specialisation. It thrives in a dynamic sand environment while at the same time contributes to stability by causing deposition of new sand. Sand dunes also provide a habitat for a diverse vertebrate and invertebrate fauna.

The dunescape of Sable Island, as described by Byrne and McCann (1995), falls into two main categories:

Primary dunes, which have mainly formed in situ along the storm litter line as a result of continuous sand deposition from the near-shore and beach environment. Sandwort and Sea Rocket are often the primary colonisers, followed by marram grass, which facilitates the capture of more sand and allows the dunes to grow. There is a prominent primary dune line that runs along the north beach and a lower primary dune system found along the south beach.

Secondary dunes, which are formed mainly by the migration of lower relief dunes across the interior of the island represent about 12 percent of the island's surface.

The vegetated fore-dunes constitute approximately 21 % of Sable Island's surface. A combination of marram and sandwort hummock dunes make up approximately 2.4 % of the island's area. These are located mainly along the terminal spits and to the east of Lake Wallace. Secondary dunes include formations such as migratory parabolic dunes which are moving south-east from the north beach. Within one of these inland pathways toward the island's east end, is a large unvegetated dome dune (known as bald dune), a dune type unusual in Atlantic Canada.

3.4.1 Dunescape changes

Sable Island is in a state of dynamic equilibrium that involves erosion and deposition of sand. Byrne and McCann (1992) suggest that the primary dunes toward the island's west end are in a state of retreat while the primary dunes of the north beach toward the east end are accreting. It appears that erosion of the primary dune line on the west end is liberating sand that is allowing the accretion of island's East end primary dunes.

Large changes in the island's south shore dunescape have occurred within the past 100 years. Late nineteenth century accounts describe a southern dune ridge which enclosed a 17 kilometre long internal lagoon (Lake Wallace). This lake is now mostly filled with sand liberated from the coastal dune system, leaving a broad area of sand flats and a shallow lake remnant about two kilometres long.

A number of different soil horizons (paleosols) are found within the dunes. Carbon dating indicates that these paleosol layers are 200 to 350 years old (Terasme and Mott, 1971). The inundations of sand which are required for the formation of a peat horizon may have been a result of destabilisation caused by the introduction of grazing mammals by Europeans. It also suggests a relatively lush and stable vegetation cover prior to European contact. Some other human activities which have affected the island's dunescape over the past 400 years include the introduction of horses in the early 18th century, the reintroduction of domestic animals, cultivation of the island by inhabitants of the 19th century life saving establishment, and the creation of trails by vehicles traveling in the stabilised vegetation communities.

Conservation concerns

Caution needs to be exercised when considering dune restoration work. There are natural forces at work which, although they may seem destructive to the long term stability of the island, are nevertheless a part of the island's natural evolutionary process and should not be interfered with needlessly. However restoration should be undertaken in areas of anthropogenic damage. The guiding philosophy for terrain conservation or restoration work now carried out on Sable is "*humans with nature, not humans against nature*".

Near-shore and beach sediment movement play an important role in the stability of the island's fore-dune ridge. It is important that no large scale construction or obstructions interfere with these natural transportation processes.

In order to make judgments about whether or not to undertake dune restoration, a number of factors need to be considered. Zimliki and Welsh (1975) suggest that if a blowout occurs which may allow the ocean to flood stabilised inland communities, thought must be given to the events that led to the formation of the blowout, and the ecological consequences of doing nothing. Lack of action could result in the destruction of old stabilised habitat and the loss of unique floral and faunal communities. Given that the present landscape of Sable is the result of centuries of human abuse, conservation actions can be justified in areas where the human

disturbance may not be immediately apparent.

The recommendations below should not impede legitimate research initiatives on Sable. If the erection of a short term structure is permitted for scientific purposes, the site should be returned to pre-installation condition on completion.

Recommendations

- No structures should be placed in areas which would interfere with the natural movements of sand. However, restoration work, such as the construction of fences or dikes which encourage sand accumulation accompanied by transplantation of marram grass may be undertaken in areas where terrain has been destabilised.
- No disruptive activity should be permitted in areas which are vulnerable to destabilisation by wind, such as on dune faces or at the base of dunes.
- Vehicle travel must be restricted to the beaches or over already established roads. Where these roads exist, monitoring should be undertaken to ensure significant destabilisation is not occurring. Special operational requirements for use of vehicles may be sanctioned by the management body governing Sable Island.
- If monitoring reveals anthropogenic destabilisation, action must be taken to stop the activity and if possible repair the damage.

3.5 HYDROLOGY

A fresh water lens underlies Sable Island and surface exposures of this lens form fresh water ponds along the interior. Most of these ponds are non-potable due to the elevated coliform bacteria levels associated with the horse faeces. Ponds flooded by sea water have pH levels greater than 8, whereas the more stable fresh water inland ponds have a pH range of 4.8-6.8 (Hennigar 1976). The ground water lens has a mean pH in the range of 5.2-6.0. Some of the water bodies found closer to the beaches are brackish as a result of periodic flooding or through airborne sea-spray.

Precipitation recharges the freshwater lens. Because of the high permeability of the sand, care must be taken to prevent contamination of this lens by improper disposal of wastes. Extraction of water must be done at a rate that does not cause salt water intrusion. The stability of the fresh water lens is dependent upon surface topography, the rate of fresh water removal, the rate of recharge and ocean surface flooding. The highest rate of lens recharge occurs between November and February, while the lowest recharge rate occurs from August to October.

The present demand upon the fresh water lens, supplying the AEB compound and limited personnel at DFO and MT&T's facilities, appears to be sustainable. Pumping during times of high recharge is beneficial if heavy use is required or expected. It may be advisable to place water storage tanks on the island, which can be filled during the winter months, if higher water demands are anticipated. Salt water intrusion may result if large water demands correspond to times of low recharge. To

minimise the impact of salt water intrusion on the fresh water lens through lateral migration, wells should be as close to the island's centre as possible. Wells should not be dug where the fresh water lens is thin or in areas susceptible to ocean flooding.

Conservation concerns

The main conservation concerns associated with Sable Island's fresh water lens are the introduction of contaminants and the extraction of water at a rate that cannot be sustained. Sewage and hydrocarbons are the contaminants of immediate concern. Table 1 lists areas at the western end of the island which are presently known to be contaminated by hydrocarbon spillage.

Table 1. Amounts and location of known hydrocarbon-contaminated soils

<i>Location</i>	<i>Estimated contaminated soil volume, m³</i>
AEB Day Tank	6,000-12,000
AEB Tank Farm	3,000-4,000
AEB Propane Building.....	500-1,000
AEB Foundation (suspected)	500-1,000
Former Power House, West Light	500-1,000
DFO Vehicle Garage, West Light.....	500-1,000
Former Tank Farm, West Light	1,000-2,000
CCG Helicopter Refueling Pad	2,500-4,500

Source: Public Works and Government Services Decommissioning Plan (1996)

The large scale excavations required to remove these soils would cause considerable terrain disturbance and at present these concentrations are not endangering a large area of the fresh water lens. There are, however in-situ bio-remediation techniques which may be considered if contamination is endangering the biota.

Recommendations

- Monitoring wells should be established around areas of active pumping to monitor the amount of draw-down on the water table. Pumping should cease if evidence of salt water intrusion is detected.
- There must be strict enforcement of appropriate storage and handling regulations and procedures for hydrocarbons. Hydrocarbon spillage must be reported to the regulatory authority immediately.
- Untreated sewage should not be introduced into the water table. Disposal techniques appropriate to the volume and location of the wastes should be implemented.
- Consideration should be given to the installation of storage tanks if it is expected that seasonal demand will exceed the rate of recharge.
- To minimise the impact of salt water intrusion on the fresh water lens through lateral migration, wells should be as close to the island's centre as possible.

- No wells should be placed near areas susceptible to ocean flooding.
- In general no foreign substance should be introduced into the water table.

4. CONSERVATION OF THE FLORA OF SABLE ISLAND

4.1 DESCRIPTION OF PLANT COMMUNITIES

Sable Island's naturally stabilised topographic features derive their existence mainly from the sand-anchoring properties of vegetation. Efforts to conserve the physical integrity of Sable Island, therefore, must incorporate measures which minimise further damage, and where there is evidence of anthropogenic disturbance, repair any damage to the island's vegetative cover. The sand of which the island is composed is dynamic and it is important to understand the physical processes at work before actions are taken which have the potential to alter terrain.

Unfortunately, the history of human use of Sable Island is one that has not placed great emphasis on the consequences of interference with the natural processes which regulate ecosystems. There have been introductions of many species of plants; some of which have been accidental, but there have also been large-scale organised introductions. One such is the planting project initiated in 1901 by the Experimental Farm in Ottawa. This initiative saw the introduction of 68,755 evergreens of 25 varieties, 12,590 deciduous trees, 79 varieties of shrubs and 20 kilograms of pine seed, virtually all of which died (Freedman *et al.*, 1981).

Terasme and Mott (1971) show that Sable Island's vegetation over the past 11,000 years may not have been substantially different from that which exists today. Peat balls found washed upon the beaches come from organic layers laid down as far back as 8000 years ago. These layers form when organic material is buried by wind-blown sand in areas where the vegetation has been relatively stable. In contrast, the paleosols on Sable Island itself have been found to be only 200 to 350 years old.

The most complete vegetation survey was conducted by Catling *et al.* (1984). This includes a quantitative description of plant communities and an annotated list of all the species which have been recorded on the island. Of those, 154 are believed to have been native, while 79 species are considered to be introduced. In 1981, a total of 177 species were found on the island: 135 native and 42 introduced. Almost all of the native species found by the early botanists are still present, and the major plant communities are characterised by these native species.

Catling *et al.* (1984) note that the most dynamic regions are populated by the marram-forb, sandwort, and marram communities which are maintained by regular inputs of sand. As the amounts of sand deposition decrease, marram-fescue communities become dominant, and with increasing stability and decreasing inputs of new sand, marram-fescue vegetation is replaced by shrub-heath communities. This successional pattern operates from the marginal beach dunes toward the island's centre and represents increasing community stability and diversity toward the island's centre.

4.1.1 Difficulties of documenting vegetation changes

A review of the literature reveals some difficulties in comparing vegetation maps and estimates of the areas of different plant communities compiled by different investigators. Discrepancies in the literature pertaining to the island's vegetation cover can be attributed to a number of factors including, variation in the quality of the aerial photographs, differences in the classification of the various vegetative communities, comparisons of total vegetation cover without accounting for changes in total area of Sable Island, and real change in vegetation composition and distribution.

For example, Welsh (1975) estimates the total vegetated area on Sable Island as 1,071 ha (see Table 2). If Freedman's (1996) estimate of the island's total area (3,048 ha) in 1972 is used, then the estimate of vegetation coverage is 35%. Stobo and McLaren (1975) report 1,018 ha as the island's vegetated area: 33% coverage. Catling *et al.* (1984) include pond vegetation in their estimate of total vegetated area while the two previously mentioned studies do not. If pond area is removed from the Catling *et al.* (1984) study, the total vegetated area becomes 1,262.4 ha; if 3,425 ha is used as the island's total area, then the percentage of vegetated terrain is 36.9%.

The use of a variety of categories and criteria for describing vegetation communities has made it difficult to make rigorous comparisons of the several efforts to catalogue Sable's vegetation. The difficulties of comparison are shown in Table 2. Standardised plant community descriptions will allow changes in vegetation to be detected and described accurately.

Conservation concerns

Many reports within the past 50 to 75 years make reference to decreases in the island's total vegetated terrain. Closer examination, however, shows that comparisons of vegetation percent-coverage figures, without a comparison of methods, does not allow for useful conclusions to be drawn. As the three examples given above indicate, the percentage of vegetation cover between 1972 and 1982 ranges from 33% to 36.9%. These numbers are essentially the same and probably reflect differences in methodology rather than real change. A recent study by Freedman (1996) compared three sets of aerial photos taken in 1963, 1972 and 1981 and showed that there were no major changes in the vegetated area of the island in this period.

Table 2. Estimates of the areas (ha) of plant communities on Sable Island

Stobo & McLaren, 1975	Welsh, 1975	Catling, Freedman & Lucas, 1984
Dense Marram .....480	Dense Marram .....466	.....
Sparse Marram .....274	Sparse Marram .....287	.....
.....	.....	Sparse Grasslands 772.1
.....	Pea, grass, and forbs ...52	.....
.....	Pea 4	.....
.....	Heath .....26	Heath 147
.....	Heath and grass .....187	.....
.....	Juncus and cranberry ...25	Lakeside herbaceous.....23.6
Dense mixed vegetation...202	.....	.....
Sparse mixed vegetation...46	.....	.....
.....	.....	Marram-Forb 299.4
Sandwort.....6	Sandwort .....24	Sandwort.....20.3
Total vegetated area 1,018	Total vegetated area1,071	Total vegetated area ... 1,262.40

Table 3. Comparisons of vegetated terrain based on analysis of air-photo mosaics

Year	Percentage of Vegetated Terrain
1963	37.3
1972	34.0
1981	36.7

Source: Freedman (1996).

It appears that the island's total vegetated terrain has been relatively stable from the 1960's to the 1980's. However on-going monitoring is required to detect changes.

Recommendations

- An air-photo monitoring program should be established that takes same-scale, same-season air-photo mosaics every five to ten years.
- Vegetation maps in a geographic information system should be derived from aerial photo mosaics so that changes can be detected and quantified.
- Botanists conducting vegetation surveys on Sable should compile their data using a community classification that allows useful comparisons with past surveys.

4.2 CHARACTERISTICS OF SABLE ISLAND'S FLORA

Most of the native flora of Sable Island is typical of that of mainland Nova Scotia and north-eastern North America. About 95 taxa are characteristic of the general geographic region (Catling *et al.* 1984). The remaining 70 are characteristic of areas to the north or south, across the Atlantic, or generally have a restricted geographic distribution.

- Twenty four native taxa are characteristic of areas to the north, and the Sable Island communities represent the southern limits of their ranges.
- Eight taxa are characteristic of areas to the south, and Sable Island represents the northern limits of their ranges.
- Two of Sable Island's native plants are considered very restricted in North America but are widely distributed in Europe.
- Thirteen taxa from Sable have a very restricted total distribution. Such isolated plants are especially vulnerable to disturbance by animals or competition from other introduced plants. These taxa have been considered endemic by some botanists and ignored by others who considered them to be minor variations of other common taxa (Catling *et al.* 1984). An analysis of the taxonomic characteristics of these plants is warranted. Of the thirteen restricted taxa, three are endemic to Sable Island and four are limited to the area around the Gulf of St. Lawrence (Table 4).

Table 4. Geographical ranges of taxa with a restricted distribution which are found on Sable Island

Species

Geographic Distribution

<i>Agalinus neoscotia</i>	Sable Island and Western Nova Scotia
<i>Bartonia paniculata</i>	Sable Island, St. Pierre and Miquelon
<i>Calopogon tuberosus</i>	Sable Island and the Magdalen Islands
<i>Epilobium nesophilum</i>	Sable Island
<i>Hieracium scabrum</i>	Sable Island
<i>Juncus pelocarpus</i>	Sable Island and Southwestern Newfoundland
<i>Juniperus communis</i>	Nova Scotia, Nfld., Lab., Ungava, and Hudson Bay
<i>Lathyrus palustris</i>	Sable Island and St. Pierre and Miquelon
<i>Lycopus uniflorus</i>	Sable Island and Western Nova Scotia
<i>Oenothera cruciata</i>	Sable Island
<i>Platanthera lacera</i>	Sable Island and Newfoundland
<i>Polygonum hydropiperoides</i>	Sable Island and Southern Nova Scotia
<i>Rubus xarcuans</i>	Sable Island, Nova Scotia and Massachusetts

Source: Catling et al. 1984.

Table 5. Plant taxa on Sable Island reported as rare in Nova Scotia.

Centunculus minimus
Coeloglossum viride
Tillaea aquatica
Juncus bulbosus
Juncus pelocarpus
Potamongoeton oblongus
 * *Epilobium nesophilum*
 * *Senecio pseudo-arnica*

* plants not found by Catling et al. (1984)

Conservation concerns

The principal threats to vegetation derive from two broad sources.

- Anthropogenic (including introduced species); and
- Environmental threats, originating from the energy of the ocean and the wind.

It is important to restrict activities which can damage the island's vegetation. The stabilised inland freshwater pond and heath communities are areas of highest biological diversity and they must, be protected. Because there is some disagreement on the taxonomy of some plants found on Sable Island, it is important to encourage research that will aid in the classification of undescribed or potentially rare taxa.

Recommendations

- Significant plant species should be mapped, and research to document species which may be rare or endemic should be encouraged.

- Habitats of significant species should be accurately mapped.
- The introduction of exotic plants or animals should be prohibited.
- Priority protection should be extended to Sable Island's wetland communities.
- Activities that have the potential to damage the island's vegetation cover should be prohibited.

5. CONSERVATION OF THE FAUNA OF SABLE ISLAND

5.1 INTRODUCTIONS AND EXTIRPATIONS

Since humans have had contact with Sable Island, many species of animal have been introduced. Early accounts attribute the introduction of cattle to the Portuguese and as many as 800 are reported to have been present in the sixteenth century.

Introductions of Norway Rats (*Rattus norvegicus*) and the House Mouse (*Mus musculus*) have been attributed to shipwrecks. Both before and after the foundation of the Humane Establishment in 1801, many domestic animals, including horses, cattle, goats, sheep, pigs, dogs, cats, and rabbits were introduced. There are also early references to the presence of Red Foxes (*Vulpes vulpes*) on the island. Andrew LeMercier maintained that they were the only four-footed animals present when he took possession of the island in 1738. As recently as the early 1970's, rabbits were released on the island. Apart from seals, the only mammal at large on the island at present is the feral horse (*Equus caballus*).

Over the course of human contact, most of the island's species (both native and introduced) which were of economic value or suitable for food were hunted. One regrettable example includes a population of walrus (*Odobenus rosmarus*) which succumbed to hunting during the eighteenth century.

5.2 FERAL HORSES

The introduction of horses to Sable Island has been ascribed to the Boston merchant and clergyman Andrew LeMercier. In 1738 he petitioned the Nova Scotia Government for control of Sable Island, stressing the humanitarian advantages of placing people on the island. Economics, however, were probably a strong motive in his petition, given the island's potential for harvesting seals and raising cattle and horses. LeMercier's involvement lasted for over 20 years and Christie (1980) suggests that most, if not all of the horses he brought to the island were eliminated after he left. The present population of horses may be descended primarily from an introduction made by Thomas Hancock in 1760, and are most likely Acadian in origin (Christie 1980; B. Christie pers. comm.). The horses are now protected under the Canada Shipping Act's Sable Island Regulations (Appendix 1).

The feral horses have come to personify Sable Island, so decisions which affect their well-being will be subject to close public scrutiny. They are human-introduced exotics which are totally dependent upon the island's vegetation for their nutrition, but there have been no conclusive studies conducted which establish the degree to which the feral horses are affecting the vegetation of Sable Island. The average population size ranges from 150 to 300, and has been recorded as high as 400. Weather seems to have the largest impact on population size with spring mortality closely linked to the severity of the winter (Welsh, 1975). Important factors include the amount of snow cover and rain followed by freezing temperatures which induce hypothermia (Welsh 1975, Z. Lucas pers. comm.).

Conservation concerns

The horses unquestionably have an effect upon the vegetation of the island. The most important question is whether the horses cause damage that endangers the island's stability. Some argue that given the fact that a horse population has been living on the island for over 200 years, their impact on island stability is not a major issue. Others make the point that there have been major changes in the island's morphology since the early eighteenth century, such as the loss of the outer dunes of the south beach, and it is uncertain to what extent the horses are implicated in such changes. There are other factors, such as changes in vegetation succession patterns leading to potential changes in vegetation community types, which could be at play, and would involve longer time periods to detect. While it was not the purpose of Welsh's (1975) study he did address the issue of island stability relating to the effects of horses and could find no conclusive evidence of significant topographic destabilisation as a result of horse behaviour.

The horses have created an extensive series of trails on the inner stabilised terrain, yet, because these areas are relatively sheltered from high-energy winds the trails do not lead to wide-spread destabilisation. Welsh hypothesised that the horses may have an effect by creating trails over dune edges and in areas exposed to high wind energy, with both activities potentially leading to blowouts. Other activities mentioned include damage to marram grass due to trampling, digging and pawing for food, and intensive feeding on dune tops. There is no direct evidence that these activities lead to significant island destabilization.

The island's breeding birds nest on or under the ground, and there has been speculation that horses may have an impact on bird populations by crushing eggs as a result of trampling. If serious damage to Sable Island's ecology were to be demonstrated, a case could be made for management of the horse population. At present the state of knowledge pertaining to the horses' effects on the island do not justify any decisions to manage them. Management could take the form of removal of some or all of the horses and ex-situ protection and management, or the implementation of a program that would maintain the horse population at a level that would be compatible with preservation of the integrity of the island's ecosystem.

It may be that after over 200 years of interaction a biological equilibrium has evolved between horses and the island's vegetation and human management actions are not warranted. However, it can be argued that the very presence of these large herbivores constitutes human interference, and that the island is essentially in an unnatural state as long as the horses remain. This argument would make it easier to justify more widespread restoration and stabilisation work in that it sees the effect of horses on the island's vegetation as widespread.

Recommendations

- Continue to extend legislative protection to the feral horse population.
- Encourage research that would investigate the effects of horses upon the island's

topography, flora and fauna.

- If research indicates that horse presence has serious adverse impacts which threaten the natural regulation of the island's ecosystem, consideration should be given to management of the horse population.

5.3 SEALS

The authority for managing seals is derived from the Fisheries Act, which is administered by DFO. Both Grey and Harbour seals breed on Sable Island. Harp, Hooded, and the occasional Ringed Seal are found on the island's beaches but do not breed there. Most of the research on the seal populations has been conducted by DFO and various universities. Most DFO research concerns population biology, parasitology and food consumption and foraging behaviour, with a major focus on population modeling and impacts on commercial fish species. Since the late 1980's DFO and Dalhousie University have collaborated in the development of contraceptives as a management tool. University research, done for the most part in collaboration with DFO, has covered a wide spectrum including, immunology, behavioural ecology, lipid biochemistry, energetics, physiology of reproduction, genetics, and life history studies.

5.3.1 Harbour seals

Sable Island supports a resident population of Harbour Seals which increased during the 1980s but has been declining since the early 1990s. Annual pup production has declined from about 600 to only 176 pups in 1995. The reasons for this decline are not clear. Among the factors suspected are, shark predation of the pups, reduced fecundity of females, and increased juvenile mortality during the first year of life (W. D. Bowen, pers. comm.). It is also possible that the adults have moved to other breeding sites in Eastern Canada.

Conservation concerns

Harbour Seals give birth from mid - May to mid - June. Although the Sable Island population appears not to be unduly disturbed by vehicle traffic (mainly all-terrain vehicles) high on the beach, they will react to approach on foot by fleeing to the sea, particularly if this approach is along the water's edge. Mothers and their pups frequently enter the sea during the course of the 24 day lactation period. Unexpected entry is commonly the result of horses moving along the surf line. Nevertheless, unexpected forced entry into the water can result in separation and eventual abandonment of pups, particularly during periods of strong wind and high surf. Harbour Seals can usually be approached to within 50 metres without causing undue disturbance.

Recommendations

- Activities that force Harbour Seal mothers and pups into the sea, especially during breeding season, or that disturb seals that are hauled-out on the beach should be avoided.

- Aircraft over-flights should not be allowed below a height of 300m. It is recognised that approaches to land on Sable will be below this height.

5.3.2 Grey Seals

Sable Island supports the largest breeding populations of Grey Seals in the world. The Grey Seals give birth from mid - December to late January, over much of the eastern and western parts of the island. Both exposed beaches and vegetated dunes are used extensively throughout the breeding season. For the remainder of the year, Grey Seals are restricted to the beaches. Large numbers of Grey Seals also haul-out on the island during the moult in May and June.

Grey Seals are quite large mammals (1.5 - 2.5 metres in length) and can move surprisingly quickly on land. Although they can be safely approached on foot to around 15 metres during breeding season, without causing undue disturbance, at other times of the year they are easily disturbed causing flight into the sea. The Grey Seal population on Sable Island has been increasing exponentially at a rate of about 13% per year for the past several decades (W.D. Bowen, pers. comm.).

Conservation concerns

Although Grey seals use a significant portion of the vegetated dunes during the breeding season, there is at present no evidence to suggest that they are negatively affecting the island's vegetative cover. There is considerable additional breeding habitat for Grey Seals on Sable Island which suggests that there is scope for further increase in the population. Interest in the commercial harvest of Grey Seals at Sable Island has been expressed in recent years. Any harvest should be conducted in a way that does not negatively affect the Sable Island ecosystem.

Recommendations

- No human activities should be permitted that unduly disturb Grey Seals during the breeding season or at other times of the year when Grey Seals are hauled out, except where management activities are undertaken by, or under the supervision of, the Department of Fisheries and Oceans .
- Aircraft over-flights should not be allowed below a height of 300m. It is recognised that approaches to land on Sable will be below this height.

5.4 BIRDS

Sable Island has a long history of bird observations. The most complete catalogue is McLaren's (1981) *The Birds of Sable Island* which lists 324 species. The 16 species listed in Table 6 are those which nest regularly on Sable Island.

Table 6. Bird species which nest regularly on Sable Island.

<i>Common name</i>	<i>Species</i>
Leach's Storm-Petrel	<i>Oceanodroma leucorhoa</i>
American Black Duck	<i>Anas rubripes</i>
Northern Pintail	<i>Anas acuta</i>
Green-winged Teal	<i>Anas crecca</i>
Mallard	<i>Anas platyrhynchos</i>
Great Black-backed Gull	<i>Larus marinus</i>
Herring Gull	<i>Larus argentatus</i>
Roseate Tern	<i>Sterna dougallii</i>
Common Tern	<i>Sterna hirundo</i>
Arctic Tern	<i>Sterna paradisaea</i>
Least Sandpiper	<i>Calidris minutilla</i>
Spotted sandpiper	<i>Actitis macularia</i>
Semipalmated Plover	<i>Charadrius semipalmatus</i>
Red-breasted Merganser	<i>Mergus serrator</i>
European Starling	<i>Sturnus vulgaris</i>
Ipswich Sparrow	<i>Passerculus sandwichensis princeps</i>

Source: McLaren, 1981

5.4.1 Ipswich Sparrow

The best-known bird associated with Sable Island is the Ipswich Sparrow, which is a subspecies of the Savannah Sparrow. It breeds only on Sable Island and is listed as 'vulnerable', by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). The Ipswich Sparrow has been the subject of several studies and its life history and biology have been well described (Stobo and McLaren, 1975). The population is around 1000 to 1500 breeding pairs.

The sparrows construct their nests in shallow depressions on the ground which are usually concealed under dense vegetation. Most of the population over-winters along the Atlantic coast of the United States and conservation of the species depends upon adequate protection in their winter habitat as well as continued freedom from ground-dwelling predators on Sable Island (Lock, 1995). At present, there are no major threats to the population. However caution needs to be exercised so that large numbers of people are not permitted to walk among the island's vegetated terrain, possibly trampling nests.

5.4.2 Least Sandpiper

Z. Lucas (pers. comm.) estimates that 30-40 pairs of Least Sandpipers have been breeding on Sable Island over the past five years. The species is fairly common in Canada but the Sable population is significant in that it represents a large concentration of birds at the southern limit of their breeding range.

5.4.3 Terns

Sable Island once supported a vast population of breeding terns. In the early twentieth century a report in St. John (1921) estimated that "After traveling over the greater part of the island and seeing the immense numbers of terns everywhere, from a rough computation of the number per acre and the average of the island we estimate that these birds alone did not fall far short of a million on the island (in Lock, 1973). Tern censuses between 1969 and 1985 estimate that in this period 2000 to 2500 birds were breeding on Sable Island (Lock, unpublished data). Censuses by Z. Lucas in 1993 and 1995 gave 2250 and 2855 terns. Even if the turn-of-the-century population size was greatly over estimated, it is clear that the island's tern population has decreased dramatically.

Sable Island presently supports breeding populations of three species of terns and has been recognised in the Atlantic Region Management Plan for Marine Terns (CWS, 1992) as a "core colony", a key site, deserving management. Roseate Terns have been categorised as 'threatened' by COSEWIC, and fewer than 10 breeding pairs now breed on the island.

The terns are probably the most vulnerable birds on Sable. They are easily flushed from their nests and this exposes their eggs and chicks to predation by gulls. The high levels of predation are reflected in frequent moves of colony sites on the island. If terns begin breeding near established sites of human activity, it is not expected that human activities should be disrupted to accomodate this change.

5.4.4 Gulls

The twentieth century has witnessed large increases in the numbers of many gull populations both in Europe and North America (Lock, 1972; CWS, 1990). Lock (1973) discusses the notion that, prior to the early twentieth century, there were few if any gulls breeding on Sable Island and that it was probably after 1920 that gulls began to breed there. Census data from 1970 to 1985 indicate that the island supported about 1,100 to 1,500 pairs of Great Black-backed Gulls and 2,200 to 2,700 pairs of Herring Gulls (Lock, unpublished data). It appears that their large increases in number on Sable can be viewed as a human induced because their increase results primarily from fishing activities occurring offshore and increasing populations on the mainland (Lock, 1973).

5.4.5 Other birds

The other breeding populations (Table 6) pose no pressing conservation concerns.

Conservation Concerns

The composition of Sable Island's avifauna has changed significantly over the past 100 years, mainly with respect to the great increase in gulls and corresponding decreases in terns. Gulls are efficient predators and scavengers, and gull predation has been implicated in the drastic reduction in the size of the tern population breeding on the island. There is abundant food for terns in the shallow waters around the island and it is clear that Sable, in the absence of gulls, has the potential to be a major tern breeding site.

From the point of view of gull management to benefit terns, Sable island is a good "core colony" for a number of reasons:

- the island is sufficiently far from the mainland that re-population by gulls after a population reduction would be slow;
- high concentrations of Sand Lance (*Ammodytes americanus*) around Sable constitute an abundant food source for breeding terns; and
- human disturbance of the population is minimal and controllable.

If declines in populations of terns are to be arrested, management of gull populations will probably be required. It may be reasonable in the case of Sable Island to manage the gull population to a level consistent with enhancing the breeding success of other bird species.

Recommendations

- The island's populations of breeding birds should not be disturbed. This means: avoiding areas where terns are known to nest, avoiding walking in large groups over vegetated terrain, avoiding activities that cause breeding birds to leave their nests, and taking steps to protect and enhance the breeding opportunities of Sable Island's endangered, threatened, or vulnerable bird species, particularly Roseate Terns.
- No non-native animals can be introduced to the island.
- Linkages to U.S. initiatives for Roseate Tern and Ipswich Sparrow protection should be established.
- An updated map of the island's important migratory bird nesting sites should be maintained.
- Sable Island's status as a Migratory Bird Sanctuary should be retained until more comprehensive protection for the island's natural environment is developed.

5.5 INVERTEBRATES

The most detailed assessments of the invertebrates of Sable Island have been made by biologists from the Nova Scotia Museum . However, the list given in *The Fauna of Sable Island* (Wright, 1989) is incomplete in that it does not include many of the sand-dwelling animals or micro-organisms. Nevertheless, it does give a good listing of the island's macroscopic invertebrates.

5.5.1 Endemics

Sable Island is the home of at least six known endemic invertebrates, forms which are found only on Sable Island (Table 6). In addition Wright (1989) contends that several species of Lepidoptera (butterflies and moths) found on Sable Island may be sufficiently different from mainland populations that they could be classified as subspecies. Among the micro-lepidoptera, there were several species which could not be identified. Wright believes many of these could be undescribed Sable Island endemics. Noteworthy among the stray Lepidoptera which have been sighted on Sable are first records for Nova Scotia of two tropical species. Within Sable's Lepidoptera are two endemic species, one endemic subspecies, and 15 others which are distinct from mainland populations.

Table 7. Sable Island's known endemic invertebrates.

Type

Species

freshwater sponge	<i>Heteromyena macouni</i>
beetle	<i>Pyrrhalta sabelensis</i>
nematode	<i>Koerneria mulveyi</i>
moths	<i>Agrotis arenarius</i>
.....	<i>Papaipema sp.</i>
.....	<i>Orgyia leucostigma sabelensis</i>
scallop (extinct)	<i>Aequipecten irradians sabelensis</i>

Source: (Wright 1989)

Conservation concerns

It appears that the populations of unique Coleoptera (beetles) and Lepidoptera may be consistent with relict fauna which date back to the Wisconsin glaciation, resulting in a unique and fragile population. Interestingly, Wright (1989) notes that at least three species of moths (*Ommatostola lintneri*, *Agrotis arenarius* and *Euxoda detersa*) could possibly have impacts on the island's vegetation cover.

Recommendations

- Research contributing to the identification and description of Sable Island's rare and endemic invertebrates should be encouraged.
- Because the areas of highest biological diversity and ecological fragility are found along ponds, special protection must be extended to these areas in any future management regime.
- Habitats of the island's rare and endemic invertebrate populations must be documented and protected.
- Research into Sable Island's micro-invertebrate and sand-dwelling species, should be encouraged. The relationships between some invertebrates and the island's vegetation requires further investigation.

5.6 RE-INTRODUCTIONS

Sable Island has been much changed by 400 years of human use. Its overall size and vegetated areas have decreased, and several species noted by early visitors no longer occur. Several plant species and the Atlantic Walrus are known to have disappeared.

Attempts to re-introduce locally extinct species are often made in areas which are given a conservation status. While the idea of re-establishing extirpated native species on Sable may be considered, such introductions will not be attempted until appropriate research has been undertaken and immediate conservation concerns have been addressed.

Recommendation

- Re-introductions of extirpated flora and fauna should not be attempted until all immediate conservation concerns have been satisfied.

6. HUMAN INTERACTION WITH SABLE ISLAND

6.1 PRESENT HUMAN USE - FEDERAL GOVERNMENT

6.1.1 Department of Fisheries and Oceans

Canadian Coast Guard. This agency maintains two helicopter pads, a radio beacon and navigation lights at the east and west ends of the island, in addition to a fuel supply and an emergency base. The Coast Guard also provides ship transportation and supply in support of government establishments on the island.

Marine Fish Division. The longest running scientific investigation on Sable Island is DFO's marine mammal program. The breeding performance of and the numbers of Harbour Seals and Grey Seals have been monitored since 1962. More recently, investigations have been directed toward determining the impacts of seals on fisheries and devising strategies to minimise those impacts.

6.1.2 Environment Canada

Atmospheric Environment Branch. In addition to routine weather monitoring, the AEB staff undertake directed meteorological research and monitoring in conjunction with government, National Oceanographic and Atmospheric Administration (NOAA), and university scientists. AEB staff provide aircraft landing service for the approximately 80 annual flights, and provide electrical power to DFO facilities, and emergency repair service for the beacons and other equipment.

Over the last three decades the number of staff at the weather station has been reduced from eight (with some families), to three: an officer in charge, a meteorological technician, and a maintenance person. AEB personnel are the only permanent human presence on the island and they have constituted a vital support for the activities of all other agencies using the island.

Canadian Wildlife Service. Apart from administering the Migratory Bird Sanctuary Regulations, the Canadian Wildlife Service has carried out studies of the interactions of breeding terns and gulls. A field station on the east end of the island is no longer used.

6.1.3 Natural Resources Canada, Geological Survey of Canada (GSC) Atlantic.

In addition to work associated with petroleum exploration and development on and around Sable Island, GSC has carried out studies of sand transport and beach processes on the island and has aided in a program of terrain restoration. Stations to monitor dune and beach changes have been established on the island.

6.1.4 Department of National Defence (DND)

In co-operation with the offshore petroleum industry, DND maintains a supply of aviation fuel on Sable Island.

6.2 PRESENT HUMAN USE - PROVINCIAL GOVERNMENT

6.2.1 Nova Scotia Department of the Environment, Regional Offices Division

Hydrologists from this agency have mapped the fresh water lens which overlies the saline water table. A series of wells were installed which allowed this resource to be monitored.

6.2.2 Nova Scotia Department of Natural Resources

Petroleum Development Agency. This agency has constructed a base camp on the western end of the island. Although the department has not instituted any major investigations or monitoring programs in the past 15 years, the base camp has been used by oil industry personnel, particularly geo-location contractors, and by researchers.

Parks and Recreation Division. The public review committee, assembled under the 1995 Parks and Protected Areas Systems Plan, recommended that Sable Island be considered for designation as a protected area. The Parks and Recreation Division is acting upon this suggestion.

6.2.3 Nova Scotia Department of Education, Museum of Natural History

Museum personnel have collected and catalogued the flora and fauna of Sable Island.

6.3 PRESENT HUMAN USE, NON- GOVERNMENT

6.3.1 Maritime Telephone and Telegraph Company

MT&T have a permanent facility on the island to satisfy the communications demands of the weather station, petroleum industry and researchers. This facility is maintained and monitored by AEB staff.

6.3.2 Positioning contractors

Various companies have accepted contracts to provide radio location services to oil companies carrying out seismic surveys or rig moves.

6.3.3 Helicopter companies

Military helicopters and air charter companies contracted by various interests use the helicopter pads on the island for emergency landing sites in bad weather and as a refueling facility in emergencies. These pads are on continuous standby which requires AEB staff to have spare electrical generating capacity as well other items associated with the maintenance and repair of the necessary infrastructure. The rescue facilities on Sable Island extend the range of Search and Rescue operations by 150 nautical miles.

6.3.4 Oil companies.

At present Pan Canadian Petroleum Ltd. is extracting oil from a marine field to the west of Sable Island and a consortium of companies (Sable Offshore Energy Project) is planning to develop marine gas fields near Sable. The aircraft used in support of offshore industry often use Sable Island as an alternative landing site in flight plans, which extends their operational range when coming from Halifax.

6.3.5 Tourists

The Canadian Coast Guard receives over 100 requests each year from individuals or groups interested in visiting Sable Island. People who will require no assistance in traveling to the island and are essentially self supporting, are often given permission to land. Individuals in this category are usually those who have an interest in Sable Island and plan to be in the vicinity in a boat.

6.3.6 Universities and other researchers

Most of the research on the biota of Sable Island has been carried out by faculty and students of Dalhousie University, with research for theses on the Ipswich Sparrow, Grey and Harbour Seals, horses and gulls. Studies of the Ipswich Sparrow and of Harbour and Grey Seal biology continue, the latter in conjunction with DFO and the Smithsonian Institution. Other Canadian universities have also conducted ornithological, botanical, geological, radio communication and sediment transport studies, and an independent researcher has monitored horse populations and vegetation and carried out beached-bird and marine litter surveys.

Conservation concerns

Sable Island is a unique platform for many different areas of research. With increased marketing and maintenance of infrastructure, research opportunities could be expanded. Meteorological research, such as the upper atmospheric work conducted by NOAA, has a low impact on the island's environment and can serve as a revenue generator to support the island's infrastructure. Current uses of the island are compatible with Sable's conservation objectives.

Recommendations

- Sable Island should be promoted as a site for scientific research and monitoring. Many long-term monitoring programs could be administered by Island staff.
- Fuel handling and storage on Sable Island must be strictly monitored and regulations enforced.

6.4 THE SURROUNDING MARINE ENVIRONMENT

6.4.1 Integrated management

While this is a land-based strategy, the ocean surrounding Sable Island has a strong influence on its environment. For this reason the seas around Sable must be taken into account when developing future management plans for the island.

The recently enacted Oceans Act (January 1997) provides the Department of Fisheries and Oceans with legislation to lead collaborative work on integrated management plans for marine waters, including the designation of marine protected areas. Future integrated management plans influencing the coastal zone of Sable Island should connect with this strategy.

Recommendation

- The focus of this strategy is terrestrial, but it recognizes that future management plans should link to coastal zone legislation such as the Oceans Act.

6.4.2 Offshore petroleum industry

Pan Canadian Petroleum Ltd. are currently extracting hydrocarbons to the southwest of Sable Island and transporting them from the site by tanker. There is a large gas project in the planning phase, Sable Offshore Energy Project, which would see the development of 5 gas production platforms and installation of a pipeline from the production zone to the Nova Scotia mainland. This pipeline will pass within 20 kilometres of Sable Island.

Conservation concerns

A number of concerns with such a large industrial project so close to Sable Island that can be identified:

- The potential for a spill of petroleum resulting from
 - a rupture in a pipeline;
 - a spill from a supply vessel; and
 - a spill from an accident on the drilling platform;
- Environmental impacts resulting from:
 - contamination from drilling muds and well cuttings;
 - noise pollution affecting marine mammals;

Some of these concerns have implications for the conservation of Sable Island. The environmental impact assessment for such projects must explain how each concern will be managed in the development plan. Where research is lacking, studies should be undertaken to provide relevant information. It is expected that the SOEP public environmental review of the project will address some of these concerns.

7. TOURISM ON SABLE ISLAND

Organised tourism on Sable Island need not conflict with the conservation goals for the island. However, several factors need to be considered before tourism becomes a component of Sable Island's management.

Tourism should only proceed at a level that can be sustained by the island's natural environment, and should be reduced or curtailed if there is evidence that increased human presence is causing serious harm. In this context, "serious harm" is defined as an impact that endangers the long-term maintenance of natural ecosystem processes. There are justifiable concerns associated with increasing the numbers of people allowed on the island, and these concerns must be addressed before organised tourism is initiated.

Each year a number of people request the Coast Guard's permission to visit Sable Island. People who will require no assistance in getting to the island and who are essentially self supporting, are often given permission to land. Occasionally, people have been allowed to visit the island to pursue such activities as ham radio operation, photography, and bird-watching. In recent years, the number of tourists that have been given permission to visit Sable Island is in the range 40-50 people per year by aircraft and 100 to 200 by sea (G. Forbes pers. comm.). The term "tourist" in the foregoing discussion refers to individuals who visit Sable Island for purposes unrelated to weather monitoring, research or infrastructure support. This includes politicians, government employees, representatives of the news media, etc. There is at present no organised tourism to Sable.

Some of the questions which need to be confronted when considering an expansion of tourism on Sable Island are:

- Can tourism proceed in a manner that will be economically viable and not lead to the degradation of the island's environment?
- Can tourism provide funds that will support island conservation activities?
- Can tourism proceed in a manner that will not interfere with current and future research or monitoring operations on the island?

7.1 THE COSTS AND BENEFITS OF TOURISM

A financial analysis or business plan that shows the potential profitability of tourism on Sable Island is not sufficient to justify allowing it to proceed. Many factors important to the natural environment of Sable would not be addressed in a business plan, factors such as the impact on the island's flora and fauna, and fresh water. The standard by which organised tourism must be assessed is asking how it helps the island, and not vice versa. Any operator who wishes to conduct touristic activities should be required to present the enterprise to a regulator using a full-cost analysis. This would look at the environmental as well as the economic costs and benefits. Some of the potential costs and benefits associated with tourism include:

Benefits

- Generating revenue that would allow conservation work to proceed, and assist with the upkeep of island's infrastructure.
- Increased profile, provincially, nationally, internationally.
- Environmental education and research.
- Non-consumptive benefits: spiritual, existence value, option value.

Costs

- Potential environmental degradation resulting from: disturbance of island flora and fauna; increased infrastructure requirements; increased solid and liquid waste; disturbance of the island's tranquillity.

In listing these costs and benefits it is acknowledged that the majority of the benefits are essentially human-defined and are not necessarily directly beneficial to Sable Island. In essence tourism is seen as a means of generating revenue to allow conservation activities to proceed. There is no real need to develop tourism from a conservation point of view. In fact there is the potential for a "Catch-22" situation wherein tourism is encouraged in order to raise funds to help conserve the island, but at the same time tourism may cause environmental damage which becomes a conservation concern.

7.2 SABLE ISLAND AS A TOURISM DESTINATION

There are numerous components of Sable Island's environment that will define the type of tourist who would want to visit the island, affect the length of time people will want to stay and the activities in which they would like to engage. Tourists to Sable could include:

Seal Watchers' interests could be catered for, in the main, by one-day group interpretative visits restricted to the beach areas. No tourism activity should be allowed to disturb seal populations, and observations should be made at a distance that does not cause seal disturbance.

Horse Enthusiasts will be interested in observing the feral horse population. Horses can be approached on foot to a comfortable viewing distance (25 meters) without disturbing their normal activities. The horses can be observed from the beaches or in other areas which do not require travel over the island's vegetation. This can be accommodated through one-day interpretive tours.

Birders will be interested in a number of features involving observing the island's breeding populations of birds as well as the potential to sight one of the many strays which occur throughout the year. This type of activity would probably involve overnight stays and is not necessarily conducive to guided groups. The Ipswich Sparrow is abundant and can be easily viewed island-wide. The Island's tern population is vulnerable, and under no circumstances should breeding colonies be disturbed. The best overall bird watching opportunities will

probably occur towards the island centre and involve travel over the heath and grass-vegetated terrain, which could create a conservation concern.

Geologists The structure of Sable Island is geologically interesting and there could be a tourists interested in an interpretative tour based upon the island's geological characteristics. This would involve transporting groups to various examples of geological interest such as Bald Dune, exposed peat layers, and the Wallace Flats on the south beach.

Botanists will be interested in the endemic taxa found on Sable Island as well as the various vegetative communities found in different areas of the island. This will involve interpretive walking tours among the various vegetation communities and require strict supervision. No vegetation should be picked without approval of a regulating body.

7.3 CARRYING CAPACITY

Research into an environment's carrying capacity has proved to be a difficult process to implement in environmental management. The idea of carrying capacity as it pertains to Sable Island, involves the number of humans who can interact with the island without seriously degrading its natural habitat. Because carrying capacity is a vague concept encompassing a wide range of factors, there is no way to come up with an absolute number based upon research that will dictate decisions.

The impacts which can be expected from an increase in human visits to Sable Island include trampling of vegetation, increased sewage and other solid waste disposal, and the potential for disturbance of wildlife. An effective monitoring program, one which allows useful management decisions to be taken before serious environment degradation has occurred, is a necessary component of a tourism development plan

7.4 TOURISM FACTORS TO BE CONSIDERED

Depending on the type and level of interaction that is permitted, increasing the numbers of humans visiting Sable Island will have impacts on its natural environment. Any tourism that is permitted will have to be conducted in a manner that minimises these impacts. Design of a program of tourism for Sable Island must consider the following factors.

7.4.1 Impact on existing operations

The main operations conducted on Sable Island at present are: the operation of the AEB weather station, scientific research, and helicopter operations. AEB staff are the administrative focus for the island. They co-ordinate aircraft landings and serve as interpreters to visitors. Increasing numbers of visitors could place demands on the time of AEB staff which would interfere with their primary task of operating the weather station. If tourism is promoted, an on-island employee must be retained who could act as interpreter and co-ordinator of tourist activities. Open communication between this co-ordinator and the groups operating on the island should eliminate most conflicts.

7.4.2 Methods of access

Ship based. Ships are self-sufficient and people can be housed and fed on board, reducing demands on island infrastructure. The larger cruise ships could be a potential source of visitors, however ship tourism could result in inundation's of tourists which would be difficult to monitor. Only as many tourists as can be adequately monitored should be permitted on Sable Island at one time.

Aircraft based. Aircraft provide fast access to the island and people can come and go on the same day. Aircraft landings require the support of Island staff and this task could disrupt their other duties. Aircraft operations depend on weather conditions which are subject to rapid change on Sable Island, and could result in tourists being required to stay on the island, or frequent delays on the mainland. The impact of aircraft noise on wildlife may need to be addressed if the number of flights is significantly increased.

7.4.3 Interactions with wildlife

The main wildlife interests on Sable involve viewing birds, seals, and horses. No physical contact should be permitted between tourists and wildlife and all viewing should be conducted from a distance that does not cause changes in the animal's behaviour.

7.4.4 Economic value of the program

The imposition of a head tax on tourists visiting Sable Island could raise funds for conservation projects being carried out on the island. Tourism, however, should not be seen as the primary revenue generator of the island. This would place pressures upon regulators to permit tourism at levels which may not be consistent with Island conservation objectives.

7.4.5 Regulation and monitoring

There is a need to develop a tourism policy which delineates the types of tourism possible with the existing infrastructure, and which sets limits on future tourist development so that this activity will remain compatible with conservation goals.

Monitoring of tourism will be at two levels. First, all tour groups will be guided and

the guide will monitor behaviour and take responsibility for enforcing environmental regulations. Second, the overall regulatory authority will rest with the island's administration, which will set limits on tourist activities in consultation with the on-site manager and government and non-government agencies operating on the island.

Legislation extending environmental protection will be defined by the approach to its implementation. On-site management of Sable Island requires a manager who is empowered by law to enforce applicable environmental legislation. This may require the designation of the administrator as a wildlife or conservation officer.

7.4.6 Regulation of access

Tourism on Sable Island may be administered in several ways:

- individuals or groups interested in visiting the island can contact the regulating authority and visits would be arranged on a case-by-case basis;
- a tourism permit could be issued to one or a number of operators who would have the right to operate commercial tourism expeditions to Sable Island; and
- a combination of the two previous options, where commercial permits are awarded, but the possibility of individual visits remains.

Recommendations

- Tourism development should proceed at a slow pace, with tight controls. Restrictions can be modified as more information on the impacts of tourism becomes available.
- A tourism policy for Sable Island must be developed that defines the procedures to be followed in addressing the logistic and operational requirements for tourism.
- Tourism activities should not interfere with the scientific and environmental monitoring operations.
- Tourism should not degrade the island's natural environment by disturbing wildlife or damaging vegetation.
- No treasure hunting or removal of artifacts from Sable Island will be permitted, and the removal of sediment or biological samples for research will be by approval of the managing body only.

8. MANAGEMENT NEEDS

8.1 PRESENT LEGAL DESIGNATION

Sable Island currently receives legal protection from : the Canada Shipping Act, Sable Island Regulations (Appendix 1) and the Migratory Bird Sanctuary (MBS) Regulations under the Migratory Birds Convention Act (Appendix 2). These provide a relatively high degree of protection for the island. The conservation value of the MBS designation is limited primarily to migratory birds and their nests. The MBS regulations are only effective as a conservation tool when the migratory birds are actually nesting and have little effect at other times of the year. The Sable Island Regulations set out activities that are prohibited on the island and control access.

The federal Fisheries Act administered by the DFO also extends protection and management jurisdiction over marine mammals. Particularly relevant to Sable Island is the protection the Fisheries Act extends to seal populations.

While these pieces of legislation have been relatively effective in protecting Sable Island, there are many parts of the island's natural environment which, at present, do not receive adequate protection under law. The extent to which the present regulations are effective can be credited to a number of contributing factors, namely:

- the nature of the people who visit Sable Island including scientists, government personnel, birders, etc., who are generally well informed and well intentioned;
- Sable Island's remote location; and
- the expertise that AEB has developed in serving as administrators of the island's daily operation; and

The present legal designation is not adequate to manage the demands which are expected to be made of Sable Island in the future. Even though existing legislation provides good environmental protection, it is not adequate to manage expected future developments on the island.

Recommendations

- Enhanced legal protection should be sought that provides more comprehensive protection to the island's natural values.
- An agreement should be developed between regulatory authorities that will allow management of Sable Island in a manner consistent with the objectives of this conservation strategy.
- An island manager should be designated and supported to represent government authority on the island. This person should have enforcement officer status under relevant conservation authorities, and have the authority to enforce environmental regulations on Sable Island.
- The potential of obtaining international status such as World Heritage Site designation or Biosphere Reserve Status should be investigated.

- The benefits of gaining protection for the island through joint federal-provincial co-designation should be investigated.

8.2 OPTIONS FOR CONSERVATION/ PROTECTED AREA DESIGNATION

Present legislation governing Sable Island is not comprehensive in its environmental protection. It does not facilitate conservation actions, nor is it effective in accommodating expected future changes in patterns of use of the island. To enhance environmental protection, more comprehensive environmental regulations are required which could come from a legal designation which recognises the island's ecological uniqueness and value. Possible conservation designations are:

Federal

- National Park (National Parks Act);
- National Marine Protected Area (National Parks Act);
- National Wildlife Area (Canada Wildlife Act);
- Protected Marine Area (Canada Wildlife Act);

Provincial

- Nature Reserve (Special Places Protection Act);
- Provincial Park (Provincial Parks Act);
- Wildlife Management Area (Wildlife Act);

International

- Biosphere Reserve (Man and the Biosphere);
- World Heritage Site (UNESCO);

Non-governmental

- Conservation Easement (Conservation Easement Act);

Recommendation

- A Sable Island Management Plan embodying the environmental ethic of this Conservation Strategy should be constructed under any new conservation designation.

8.3 PRIORITY REQUIREMENT

For Sable Island the priority conservation focus must be habitat, everything else devolves from this. The island owes its very existence to the stabilising effect of its vegetative cover and no activity can be permitted which would endanger it.

9. REFERENCES

- Boyd, R., Scott, D.B. and Douma, M., 1988. "Glacial tunnel valleys and Quaternary history of the outer Scotian Shelf." *Geological Society of America Bulletin*, 99, 244-260.
- Byrne, M.-L. and McCann, S.B., 1993. "Internal structure of vegetated coastal sand dunes, Sable Island, Nova Scotia." *Sedimentary Geology*, 84, 199-218.
- Cameron, H.L., 1965. "The shifting sands of Sable Island." *Geographical Rev.* 55: 463-467.
- Catling, P.M., Freedman, B. and Lucas, Z., 1984. "The vegetation and phytogeography of Sable Island, Nova Scotia." *Proceedings of the Nova Scotian Institute of Science*. 34, 181-245.
- Christie, B., 1980. *The Horses of Sable Island*. Halifax: Petheric Press.
- CWS, 1990. *Atlantic Region Gull Management Plan*. Canadian Wildlife Service, Atlantic Region. 15 p.
- CWS, 1992. *Atlantic Region Marine Tern Management Plan*. Canadian Wildlife Service, Atlantic Region, Unpublished report. 27 p.
- Freedman, B., Catling, P.M. and Lucas, Z., 1981. *The Vegetation of Sable Island, Nova Scotia*. Unpublished report, 69pp.
- Freedman, B., 1996. *Airphoto assessment of changes in plant cover on Sable Island, Nova Scotia*. Unpublished report, Canadian Wildlife Service.
- Grey, D.H., 1992. "Where has Sable Island been for the past 200 years?" *CISM Journal ACSGC*, 46(3), 265-275.
- Henniger, T.W., 1976. *Water resources and environmental geology of Sable Island, Nova Scotia*. Report No. 76-1. Province of Nova Scotia. Department of Environment.
- IUCN, 1980. *World Conservation Strategy. Living resource Conservation for Sustainable Development*. With United Nations Environment Program, the World Wildlife Fund and the United Nations Educational Scientific and Cultural Organization. IUCN, Gland, Switzerland.
- James, N.P. and Stanley, D.J., 1967. "Sediment transport on Sable Island, Nova Scotia." *Smithsonian Miscellaneous Collections*. 152(7): 33p.
- James, N.P. and Stanley, D.J., 1968. "Sable Island Bank off Nova Scotia: Sediment dispersal and recent history". *American Association of Petroleum Geologists Bulletin*, 52(11), 2208-2230.
- Jordan, C.F., 1995. *Conservation*. New York: John Wiley and Sons.
- Jordan, G., 1962. "Large submarine sand waves." *Science*, 136, 839-848.
- Leopold, A., 1949. *A Sand County Almanac: and sketches here and there*. London: Oxford University Press.
- Lock, A.R., 1973. *A study of the breeding biology of two species of gulls nesting on Sable*

- Island, Nova Scotia*. Unpublished PhD. Thesis, Dalhousie University: Canada.
- Lock, A.R., 1995. *Towards a conservation strategy for Sable Island*. Canadian Wildlife Service unpublished report, 11pp.
- McLaren, I. A., 1981. "The Birds of Sable Island, Nova Scotia." *Proceedings of the Nova Scotia Institute of Science* 31, Part 1.84pp.
- Parish, D., Holloway, J.S., Trainer, M., Murphy, P.C., Forbes, G.L. and Fehsenfeld, F.C., 1993. "Export of North American ozone pollution to the North Atlantic Ocean." *Science*, 259, 1436-1439.
- Public Works and Government Services, Atlantic Region, 1996. *Decommissioning plan CCME phase IV ESA, AEB facilities Environment Canada Sable Island, Nova Scotia*. Project No. 615988.
- St.John, H., 1921. "Sable Island, with a catalogue of its vascular plants." *Proceedings of the Boston Society of Natural History*, 36, 1-103.
- Scott, D.B., Boyd, R., Douma, M., Medioli, F.S., Yuill, S., Leavitt, E. and Lewis, C.F.M., 1989) "Holocene relative sea-level changes and quaternary glacial events on a continental shelf edge: Sable Island Bank." *Late Quaternary Sea-Level Correlation and Applications*, 105-109.
- Scott, D.B., Medioli, F.S. & Duffett, T.E., 1984. "Holocene rise of relative sea level at Sable Island, Nova Scotia, Canada." *Geology* 12, 173-176.
- Stobo, W.T. and McLaren, I.A., 1975. *The Ipswich Sparrow*. Halifax. Halifax: Nova Scotia Institute of Science.
- Taylor, R.B., 1985. "Coastal morphology and beach mobility." In R.B. Taylor (ed.), *Terrain management activities on Sable Island*. Sable Island Advisory Committee.
- Terasmae, J. and Mott, R.J., 1971. "Postglacial history and palynology of Sable Island, Nova Scotia." *Geoscience and Man*, 3, 1728.
- Welsh, D.A., 1995. *Population, behavioral and grazing ecology of the horses of Sable Island, Nova Scotia*. Unpublished Ph.D. Thesis, Dalhousie University, Canada.
- Willmore, P.L. and Tolmie, R., 1956. "Geophysical observations on the history and structure of Sable Island." *Transactions of the Royal Society of Canada*, 50(3), 13-20.
- Wright, B., 1989. "The Fauna of Sable Island." *Nova Scotia Museum Curatorial Report Number 68*.
- Zimlicki, L.M. and Welsh, D.W., 1974. *Literature Survey for the Terrain Management of Sable Island*. Canadian Wildlife Service, Unpublished Report, 85pp.

10. APPENDICES

APPENDIX 1

REGULATIONS RESPECTING THE GOVERNMENT OF SABLE ISLAND, PURSUANT TO SECTION 583 OF THE CANADA SHIPPING ACT. 9TH NOVEMBER 1961

1. These Regulations may be cited as the Sable Island Regulations.
2. In these Regulations
 - (a) 'Act' means the Canada Shipping Act;
 - (b) 'Agent' means the District Marine Agent of the Department of Transport at Dartmouth, Nova Scotia;
 - (c) 'Island' means Sable Island; and
 - (d) 'Minister' means the Minister of Transport.
3. The Island is under the control, management and administration of the Agent.
4. (1) No person shall go onto the island without prior written permission from the Agent.
(2) Subsection (1) does not apply to:
 - (a) any person to whom the minister has given a licence to reside on the island;
 - (b) any employee of the Government of Canada carrying out duties on the island; or
 - (c) any person landing on the island by reason of stress of weather or by reason of the wreck or distress of any vessel or aircraft.
(3) This Agent shall not give permission for any person to go onto the island unless he is satisfied that such person is adequately supplied and equipped to avoid falling into distress while on the island.
5. No person shall, without prior written permission from the Agent
 - (a) erect any building or other structure on the island or in the waters within one mile thereof;
 - (b) make any excavation or roadway or otherwise disturb the natural contours of the surface of the island or of the bars or coasts thereof;
 - (c) use any explosive on the island or in the waters within one mile thereof; or
 - (d) molest, interfere with, feed or otherwise have anything to do with the ponies on the island.
6. Any person who finds wreck on the island shall take all practicable precautions to save it from damage and shall report the finding to the Agent or to any person designated by the Agent before delivering the wreck to a receiver of wrecks.
7. Every person who violates any provision of these regulations is guilty of an offence and is liable on summary conviction to a fine not exceeding two hundred dollars or to a term of imprisonment not exceeding two months or to both fine and imprisonment.

10.1 . APPENDIX 2.

Migratory Bird Sanctuary Regulations