Beach & Dune Guidance Manual for Providence Bay, Manitoulin Island

Prepared by
The Lake Huron Centre for Coastal Conservation

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Preface

This guidance manual is intended to assist beach-dune conservation efforts at Providence Bay in the Township of Central Manitoulin. It is intended to provide the user with basic information for understanding the physical nature of the waterfront, its sensitivities and how to avoid negative impacts to the system.

The dunes at Providence Bay have developed over centuries. Only in the last few decades have people begun to use this coastal area for recreation and tourism. Sensitive coastal dunes can be severely impacted by people in their desire to use the beach.

A balanced approach is needed that seeks to meet the interests of people using public beaches, and the need to protect dunes and the critical dune vegetation that anchors the dunes. We believe this document achieves that balance.

Community education and awareness about the role and function of dune systems will be one of the most important components of a stewardship program at Providence Bay. This guidance manual provides the basic science and technical information that the reader needs to know before embarking on a stewardship program. Recommendations are made to assist the municipality in managing wind blown sand, community education and controlling public access.

The dune plant “Pitcher’s Thistle” is an endangered species in Canada, and efforts to protect this species and its habitat are extremely important at Providence Bay.

Beach & Dune Guidance Manual for Providence Bay

Introduction

What are Dunes?

A dune may be simply defined as a mound or ridge formed by the deposition of sand. These geologic landforms develop when an abundance of sand combines with wind, vegetation and geography. Dunes along the southern shores of Manitoulin Island have formed over the last 3000 to 4000 years, since post-glacial Lake Nipissing began to recede. Since the composition of dunes is of fine sands, they are particularly vulnerable to erosion—from storm waves and from wind. People's indiscriminate use of dunes can damage or destroy thousands of years of geologic processes in one instance.

Why Beaches and Dunes?

When we talk about dunes, we're really talking about beaches and dunes as a system. Dunes are reliant on the beach for their ongoing sand supply. Likewise, the beach relies on the dune's sand reservoir during periods of high lake levels and storm events. The sand supplied by the dune helps to maintain its form and function. Waterfront management needs to respect beaches and dunes as a system. Understanding that system will help municipal managers make decisions that avoid compromising Providence Bay's beach and dune resources.

Dunes in the broader context

Coastal Dune systems are considered to be among the most fragile ecological features in North America. Great Lakes dune systems in Ontario, due to their extreme rarity and ecological fragility, are of national and global significance. Lake Huron's dunes are found along a fraction of one percent of the lake's 6,000 kilometre shoreline. What

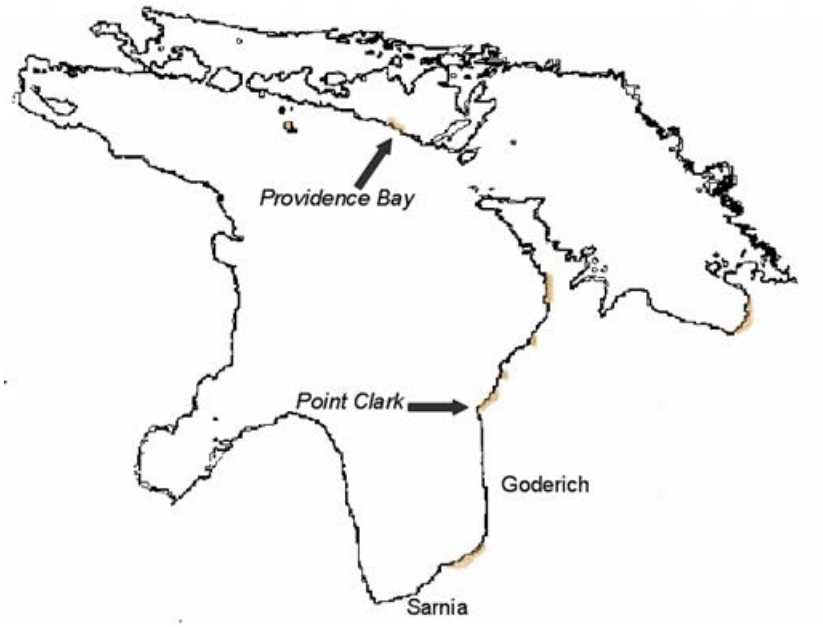
starts to become clear is that in the 'big picture', Lake Huron's dune systems represent an extremely small land mass. Yet these are the areas of the lakeshore that attract thousands of people each summer.

All ecosystems have a certain threshold for being able to absorb human impacts. Dunes, in particular, have a very low threshold. Research has demonstrated that dune vegetation is sensitive to damage by human disturbance (Trowell, 1987). Dunes are vulnerable to wind erosion once the anchoring vegetation on them is damaged or destroyed. Without effective conservation measures, we stand to lose an already limited resource.

Why Conserve Dunes?

Aside from the ecological imperative to protect dunes as critical coastal features and habitats, are there any economic reasons to protect dunes? Consider the following: During the high water levels of 1985-86, millions of dollars were spent to protect coastal properties and municipal waterfronts along Lake Huron. The average cost of an armourstone revetment, for example, was $2000 per linear metre.

Sand dunes have long been known by scientists and re-



source managers to be nature's shore protection. They outperform their structural counterpart by their ability to give and take with the dynamic processes at work along the shoreline. Using $2000/m as the amount that would be required to replace dunes with conventional shore protection, it becomes apparent that the value of dunes to a community can be great. For example, at Providence Bay, the beach and dune system which extends about two kilometres in length, would have a value of about $4 million simply as shore protection. This does not include the aesthetic value of the dunes, important to tourism, or the ecological value of the dunes, important to naturalists and educators. By conserving its dunes, the Township of Central Manitoulin is protecting a multi-million dollar asset.

What makes Providence Bay's Dunes so Special?

The beach and dunes of Providence Bay have evolved into a state of dynamic equilibrium. Without proper care and stewardship, this resource could be lost to future generations.

The bulk of the sand that makes up the beaches and dunes at Providence Bay is relic material. That means it was deposited by waves and winds in historical times. Based on a review of the coastal processes of the area, it was concluded that the Mindemoya River no longer contributes substantial amounts of sand to the coastal system. It was also concluded that there is no sediment contribution from the beaches to the east or west into Providence Bay (Reinders, 1986).

These relic sands have been held in place by the unique configuration of the shoreline. Providence Bay's deep embayment is responsible for the sand being contained within the bay. The beach and dunes of Providence Bay have evolved into a state of dynamic equilibrium. The Bay's beach-dune system should be regarded as a finite, irreplaceable resource. Without proper care and stewardship, this resource could be lost to future generations.

Besides the unique physical attributes of the coast, Providence Bay's dunes have an extraordinary ecology. Some of the plants that grow in the dunes at Providence Bay are rare dune species. For example, Great Lakes Wheat Grass is endemic to the Great Lakes dune systems. It grows nowhere else in the world. Pitcher's Thistle is another globally rare plant. It also has the distinction of being an endangered species in Canada. Other dune plants, like American Beachgrass, while more common, are still

considered Provincially rare plant species.

Land Use Policies - Zoning Protection for Dunes

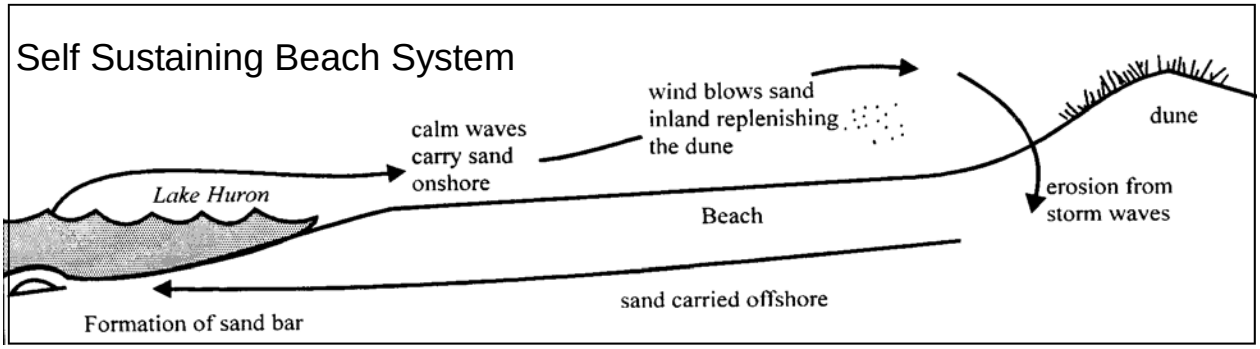
In the mid 1990s the Province of Ontario instituted the Provincial Policy Statement (PPS) under the provincial *Planning Act* which included restricting development from areas defined along the Great Lakes as "Dynamic Beach". The PPS was updated in 2005. It recognized that beaches and dunes play important functions, both ecologically and in terms of protecting the shore during high water levels.

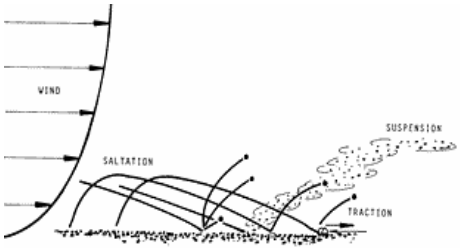
New development along the shoreline, under these new policies, have to be located landward of the front dune or "foredune". In addition, development and site alteration are not permitted in areas of significant habitat of endangered species and threatened species. New development along Providence Bay's waterfront may be affected due to the Pitcher's Thistle (endangered species) population in the area. The PPS restricts 'new' development, and is not intended to address dune stewardship, or best management practices. However, it is one more tool in the dune conservation "toolbox" that municipalities have at their disposal.

The Beach-Dune System

1.1 Beach and Dune Processes and Functions

The beach at Providence Bay owes its existence to the topography of the coast. Providence Bay's beach consists of what is often referred to as a "pocket beach", which is a





Movement of sand by wind

beach formed in small embayments or crenulate ('U' shaped) shorelines.

Sand is continually being eroded and deposited on the shore by waves. Storm waves will erode the beach, taking the sand offshore, and forming a sand bar. The sand bar acts as a temporary protective berm, absorbing wave energy that would otherwise reach the shore causing even more erosion. Once the storm subsides, gentle waves will gradually bring the sand from the sand bar back to the shore and re-deposit it on the beach.

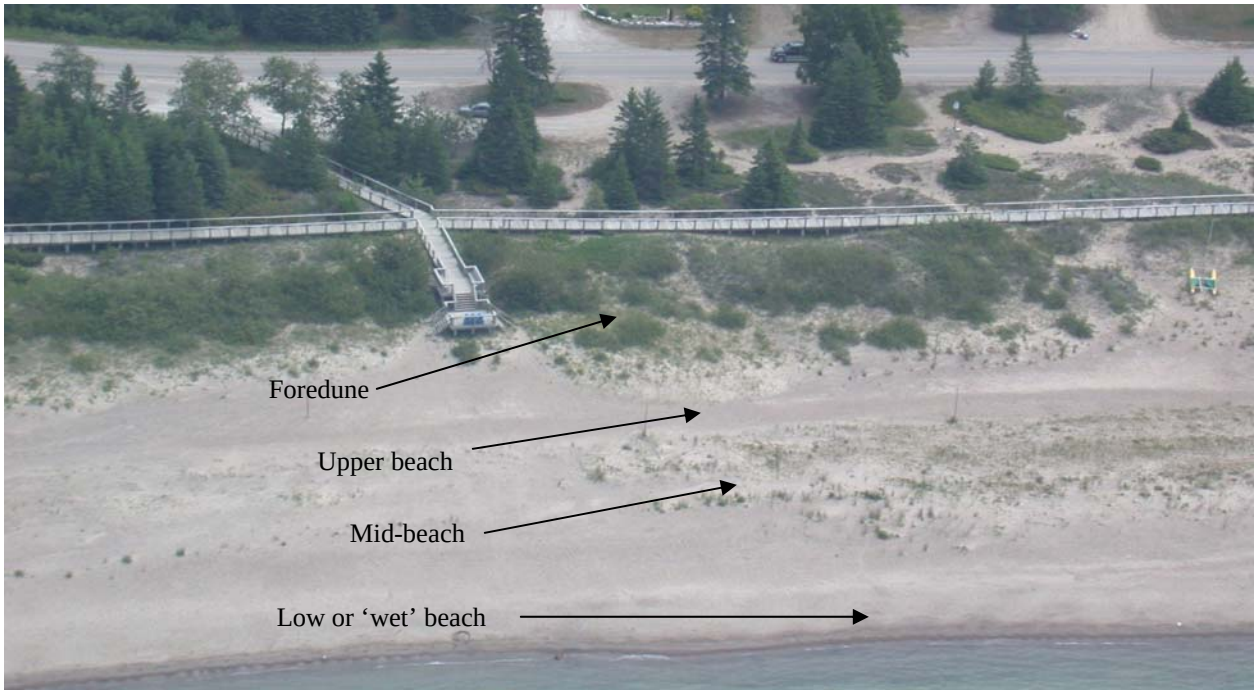
Once onshore, the sand is then prone to movement by wind.

Dunes form when sand is carried by the wind from the beach towards the land. The wind transports the sand in three ways: in ***suspension***, by lifting the smaller, lighter fractions into the airstream and carrying them for long distances; by ***saltation***, as heavier grains are moved in a series of 'hops' and 'jumps' along the beach surface; and as ***surface creep***, in which sand particles are rolled along the surface as a result of wind forces or the impact of descending saltating particles. Although most sand particles are moved by saltation, surface creep may account for 20-25% of the moved sand (Bagnold, 1954). Most of the sand is carried within 0.15 m (6 inches) of the ground surface.

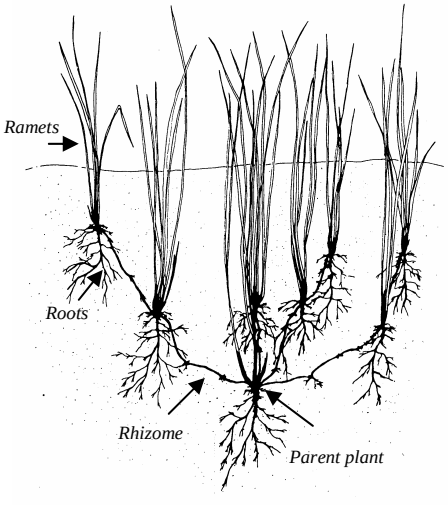
The very fine sands light enough to be carried by suspension are usually carried well outside of the dune system.

Significant sand movement will take place when the wind speed, measured at a height of 1 m (3 ft) above ground level, exceeds 12 knots (6 m per sec). Initiation of sand movement occurs at wind speeds of 5m per second. Onshore winds will dry the sand and selectively pick up the smaller grains of sand (0.08 - 0.5 mm) and move them towards the land. Sand grain sizes in dunes are therefore finer than those on beaches. This is important because fine sand deposits have greater water retention capacity than coarse sands and are therefore more suitable for vegetation growth. Moist sand is moved less easily by the wind than dry sand since moisture promotes surface adhesion. The threshold shear velocity (the wind strength needed to initiate movement) is higher for moist sand.

While wind strength is important, the quantity of sand moved is also influenced by how long the wind is blowing from a particular direction. Wind duration is an important consideration, and knowing the prevailing wind directions



Beach Nomenclature: Low (or wet) beach is the portion of the beach nearest to the shoreline and regularly receives 'swash' or breaking waves. Mid-beach is the area between the low and high beach. It sometimes forms as a swale or small depression. High beach is the dry beach adjacent to the foredune. It rarely gets impacted by waves, except under extreme conditions. The foredune, or 'first dune', is the active, dynamic sand reservoir which waves erode during high lake level conditions.



Growth pattern of American Beachgrass

at certain times of the year can help with determining management strategies for dune conservation and restoration efforts. Winds from the south and southwest are perhaps the most influential in the movement of sand at Providence Bay.

As well as wind speeds and duration, water levels play a significant role in how much sand transportation will take place. During high water levels, more of the beach is submerged and the width of dry beach is less. As a result, less beach is exposed to wind erosion. Conversely, during lower water levels, more beach is exposed and greater wind erosion of the beach is possible. Therefore, periods of dune building tend to occur during lower water levels. Periods of natural dune erosion tend to occur during high lake levels when storm waves erode the base of the dune and carry that sand to offshore bars. What is fundamental to understand is that sand dunes and beaches must be managed as one system. Dunes depend on beach sand for their formation, particularly during low water level periods, and beaches need the sand reserve held in the dunes during high lake levels and storm events.

1.2 Role of Dune Vegetation

When the wind encounters an obstacle such as a clump of vegetation, the wind speed is reduced and the sand grains fall out under gravity, resulting in sand deposition. As the sand accumulation continues, a dune is formed. Dunes form when there is an adequate sand supply and onshore winds of sufficient velocity to move the sand. As the dune builds, it becomes a major obstacle to the landward movement of windblown sand. Thus, the dune serves to conserve sand in close proximity to the beach system.

Dune vegetation promotes the large scale trapping of sand. The stems of dune grasses reduce the wind velocity near the surface, causing the deposition of sand. Plant roots also serve to bind and consolidate the sand. Dune grasses thrive on incoming sand and accelerate their growth to keep up with the increasing height of the dune (Broome *et al,* 1982). The vegetation cover represents the difference between a mobile pile of sand and a stabilized dune (Salmon *et al*, 1982).

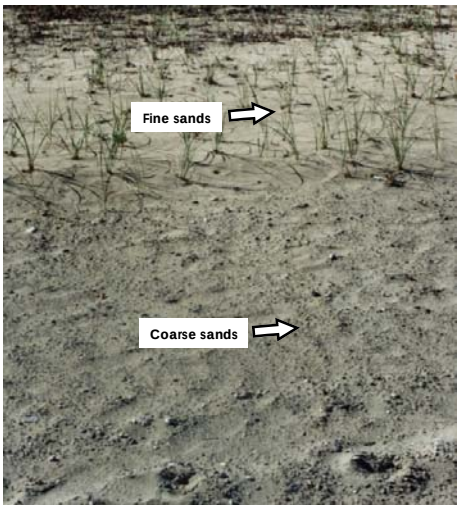
A vegetated dune provides an important reservoir of sand that circulates between the first dune (foredune), the beach, the surf zone and the lake bed, according to lake and wind conditions.

Coastal vegetation is itself dynamic. Earlier, simpler plant communities pave the way for a series of future, more complex communities. This process is known as succession and is reflected in the formation of distinct plant communities over time. These communities are usually quite visible to the observer, yet the transition between plant communities can sometimes be difficult to distinguish.

Pioneer plants trap and hold windblown sand in the foredune and help create conditions which encourage the establishment and growth of other plant communities. All plants, whether they are herbs, shrubs or trees, growing either singly or in groups, have a role in the development of vegetative cover and together they bring about dune stabilization. Windblown sand trapped in the foredune by vegetation serves as a reservoir of sand for the beach during periods of wave erosion. In the absence of sand-trapping dune vegetation, windblown sand from the beach moves inland and is lost from the beach/dune system. Wind erosion of the beach and unvegetated foredunes results in coastline recession. The above-ground parts of dune plants act as obstructions, increase surface roughness and reduce the surface speed of sand-carrying wind. The reduction in wind movement results in the deposition of sand on and around the plant. There is actually a boundary layer where wind velocity equals zero and it is in this zone that sand is deposited. Bare sand has a small boundary layer, whereas research has shown that when an area is planted with American Beachgrass *(Ammophila breviligulata)* this boundary layer is 30 times higher than the bare surface.

American Beachgrass is the most successful sand-trapping plant colonizing dunes along most of the Lake Huron coastline. It has the ability to grow through substantial accumulations of windblown sand. Cycles of sand deposition and plant growth result in dune formation and build-

Sand dunes and beaches must be managed as one system. Dunes depend on beach sand for their formation, particularly during low water level periods, and beaches need the sand reserve held in the dunes during high lake levels and storm events.



Fine sands can be eroded away where vegetation is absent

up.

The development of vegetative cover on newly formed dunes, if not disturbed or trampled, will create conditions which support the colonization and growth of a wider range of plant species. The shade produced by plants keeps surface temperatures lower than on bare sand and, together with reduced wind movement, helps to lower the evaporation rate from the sand surface. Increasing vegetative cover further reduces wind movement, which results in a lower rate of water loss from plant leaves. Dead plants and leaf litter add humus to the sand and act as a mulch. The accumulation of humus results in improved moisture and nutrient-holding capacity of developing dune soils. With lower surface temperatures and increased moisture and nutrient content, the sand can support a greater variety of plants. Thus, the vegetative cover on the dune increases and movement of sand by wind is further decreased.

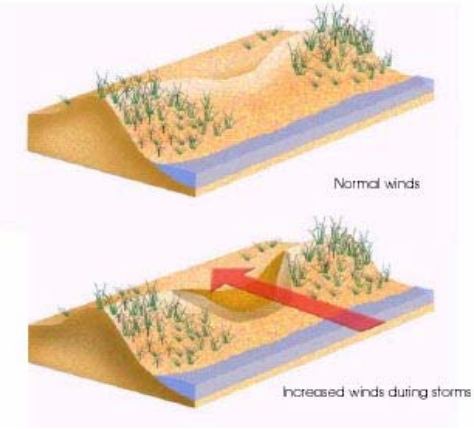
Pioneer plants make up the initial dune vegetation. They are found on the dune nearest the lake, where their survival depends on their ability to establish, grow and reproduce. They must also tolerate strong winds, sandblasting, temperature extremes and occasional inundation by water. Plants with these characteristics are ideally suited as agents for initial stabilization of dunes.

Sand dune grasses are plants which have specifically adapted to the dune environment. The structure of these grasses can resist sand abrasion, wind breakage and water loss. They have adapted to extreme heat (dunes can reach temperatures of 60C in summer!) as well as nutrient deficient soil. Confronted by high winds capable of blowing seeds many kilometres away, these plants have evolved a dual system of reproduction. In addition to the conventional seed production, they send out horizontal stems called ‘rhizomes’ under the surface to push up new growth short distances away. The massive underground root systems that develop provide the dune with structure, making them far more durable than they would be otherwise.

American Beachgrass is a common pioneer plant at Providence Bay, but the globally rare Great Lakes Wheatgrass (*Agropyron psammophilum*), and the globally rare and

endangered Pitcher's Thistle (*Cirsium pitcheri*) are other key dune stabilizers. Where American Beachgrass can tolerate substantial burial by wind generated sand deposition, both the Thistle and Wheatgrass are less tolerant and therefore tend to develop in areas where sand deposition is less. Many dune plants require specific conditions to thrive, and so they tend to grow in more or less predictable, shore-parallel zones within the dunes.

The foredune is the most critical part of the dune system, as far as coastal processes are concerned, and is the area least able to tolerate any human disturbance or development. Vegetation on the foredune builds up the dunes by trapping wind-blown sand, preventing it from being blown inland and lost from the beach system. The sand-binding plants that grow on the foredune and perform this vital function are highly susceptible to damage through human disturbance, like trampling.



Blowout formation

Beach and sand dune vegetation both bind the soil and lower wind velocities causing fine sands to be deposited. This can be observed in beach areas occupied by vegetation and in bare areas caused by human disturbance. Fine sands collect around dune vegetation, while in areas devoid of vegetation, fine sands are eroded away, leaving coarse sands behind.

Some beach and dune plants found at Providence Bay are illustrated in Appendix A.

1.3 Human Impacts to Dunes

Vegetation is absolutely critical to the stability of the dune. Without it the dune is vulnerable to erosion by either wind or waves, or both. Research has demonstrated that dune vegetation is fragile to human disturbance and can be killed by fewer than 200 dune crossings (Bowles and Maun, 1982). Pioneer vegetation may be killed by far fewer passages.

Dunes are fragile systems and trampling by beach goers destroys the vegetation and results in deterioration of the dune. Destruction of vegetation makes the dunes unstable, increases wind erosion and causes the coastline to recede.

As trails are established along frequently used routes through the dunes, the vegetation is destroyed and the wind begins to carry sand from the exposed area. The continual loss of sand deepens the trail. Sloughing away of sand from the trail's sides widens it. As a greater area is exposed to wind erosion, a blowout or washout may develop. As blowouts develop, sand blows inland, often outside of the active beach-dune system. When it does this, it represents a loss to the system. This is of great concern because, as discussed earlier, the beach and dune sediments along Providence Bay's waterfront are relic materials and cannot be replaced naturally. This inland migration of sand can also result in substantial maintenance costs to the town ship as it forms drifts along the roads, boardwalk and beach accessways. A blowout can also represent a reduction of the dune's shore protection capability. This gap in the dunes can allow storm waves to erode much larger segments of the shore than would otherwise be the case.

Vehicular Impacts

The use of vehicles, including ATVs and snowmobiles, can have a profound negative impact of both beaches and dunes.

Impacts to Beaches

Research has identified that vehicle traffic on beaches tended to compact beach sand at depth, but loosened the surface of the beach, thus making it more susceptible to wind and/or swash activity. The shearing and compressional effects of vehicle passage extended to a depth of approximately 20 cm. The shear stresses of turning wheels loosened the sand and broke underground rhizomes as well as crushing seedlings of annuals and young plants of perennials such as American Beachgrass. Vehicle impact also decreased the rate of decay of organic material. The normal bacterial content associated with the organic drift were normally very high, but were markedly reduced when vehicles pulverized the deposits (Stephenson, 1999).

Impacts to Dunes

The fragile nature of dunes and the destructiveness of vehicles and even pedestrian traffic on dunes is well docu-

mented. Since the dunes at Providence Bay are a finite resource, it is critical to manage people's interaction with these features so that negative impacts are kept to a minimum. Beaches are inextricably linked to dunes and so management of dunes must necessarily include the proper management of beaches (Peach, 2004). Vehicle impacts to dunes can cause structural alterations that lead to increased erosion by wind. These alterations disrupt the delicate balance of physical conditions found on the beach – dune region. In addition, sand compaction by vehicles in the backshore area can negatively impact dune plants that would otherwise reduce wind erosion of the beach.

Recreational vehicles, like ATVs and snowmobiles, should be prohibited from operating in the dune areas of Providence Bay. Community education about the use of ATV equipment in sensitive areas should be considered. In addition, the municipality may wish to consider posting restrictions throughout the area and work in cooperation with the Ontario Provincial Police to enforce their restricted operation.

Township maintenance vehicles have historically had access to the waterfront to conduct maintenance activities, like the removal of debris along the beach washed in from the Mindemoya River during the spring freshet. It is important that workers are aware of the sensitivities of the dunes and its vegetation, and take measures to avoid or mitigate damage to the dune. Workers should strive to ensure that their vehicles have minimal contact time with the beach, and during clean-up and maintenance activities, impact as little of the beach-dune area as possible.

Beach Vegetation

In recent years we have experienced a period of lower than average water levels on Lake Huron. This has resulted in much wider beaches, particularly in areas with a shallow nearshore profile (eg. Providence Bay). This period of low lake levels has given rise to the development of beach vegetation along the mid-beach. This is a natural process which should not be disturbed.

The development of beach vegetation has been of concern to some who, being unable to recall vegetation of this ex-

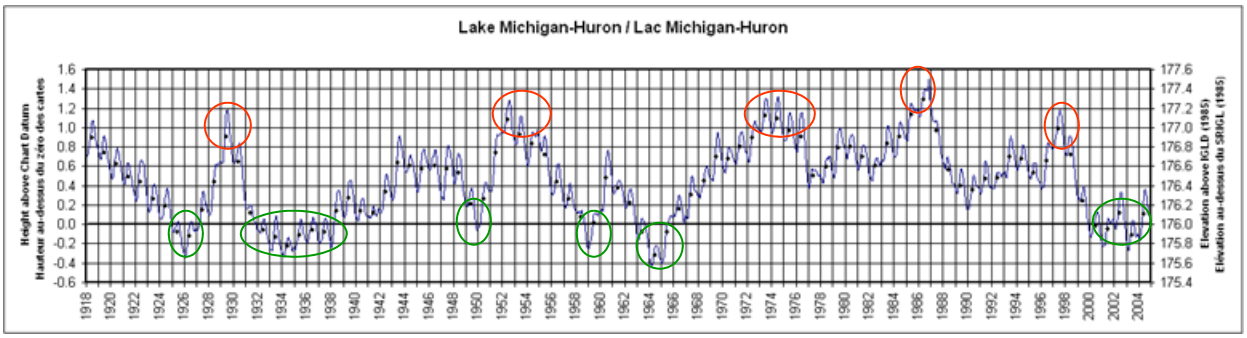
tent on the beach in the past, have demanded its removal. However, one would have to go back a substantial period of time to recall a similar period of low lake levels. Since the late 1960s until 1997, Lake Huron has experienced above average lake levels. To many, that thirty year period would have represented what they believed to be 'normal' lake levels. During this thirty year period when beaches were more narrow and frequently inundated, beach vegetation of this nature would have been much less.

Historical periods of low lake levels (mid-1920s,1930s, mid-1960s) would most certainly have experienced similar vegetation growth. Low lake levels have allowed the buried seeds within the beach to develop into plants. The plants will be eliminated during future periods of higher lake levels and storm events.

Beach vegetation during low lake levels helps the beach to retain sand (reducing wind erosion), and slows the dune building process, effectively allowing certain dune species

Beach vegetation along the mid-beach at Providence Bay has developed during the low lake levels period experienced since the late 1990s. This is a phenomenon that has taken place throughout the Great Lakes.

Hydrograph of Lake Huron showing lake level fluctuations over the period 1918 to 2004. Red circles indicate peaks in lake levels, while green circles represent low lake level periods.



like the endangered Pitcher's Thistle to establish populations at Providence Bay.

The return of higher lake levels will again alter the plant communities found on the beach.

Beach and Dune Conservation Measures

Best Management Practices for Providence Bay

Beach and dune systems are best managed by not interfering with the natural processes, but instead accepting that wave induced erosion will occur during periods of high lake levels, and wind induced sand deposition will be more prevalent during low lake levels. Working with natural lake processes, rather than at odds with them, provides a more harmonious relationship with the lake that is both ecologically sound and economically cost-effective. It must be understood that beaches and dunes are dynamic environments and physical change occurs normally and with regularity.

Dune Stewardship

Dune stewardship is essentially taking care of our beach and dune resources for current and future generations. In the end, our stewardship efforts will not only help to achieve a healthy coastal environment, but help the waterfront-based economy and community focus of Providence Bay.

The Township of Central Manitoulin has a leadership role in dune stewardship. It will set the example of how well, (or how poorly), dune conservation efforts proceed into the future. Effective policies, control of works activities, the measured implementation of dune conservation strategies, and the day-to-day commitment to excellence in dune conservation are all part of the successful stewardship of Providence Bay.

The citizens of the community, and visitors to the Bay

also have a key role. People need to be sensitive to the importance of the beach-dune ecosystem and its value (economically, socially and environmentally) to Providence Bay and to Lake Huron.

With private landowners, efforts can be made to protect or restore dunes on their respective properties. Development plans need to respect dune integrity and landowners need to work within the community's rules for dune conservation. Landowners living adjacent to dunes need to realize that the lakeshore is a dynamic system where change is the rule. They may perceive a change in dune height or configuration as a problem if it affects their traditional view of the lake. However, dune accumulation and dune erosion are a part of the natural beach and dune processes, just as bluff erosion and lakeshore flooding are natural processes in other areas of Lake Huron where people are required to accommodate these changes.

Visitors to Providence Bay are drawn by the attractive beach and natural amenities. With the existence of a nature interpretive centre and an extensive boardwalk system which spans the waterfront, there is an opportunity to educate visitors about the dunes, their sensitivity to human disturbance, and the significance of their ecology.

(1) Education and Awareness Building

One of the biggest challenges in dune conservation is the general lack of awareness about the important functions that dunes provide, and their value ecologically, economically and socially. There is also a poor understanding about how sensitive these coastal features are to human disturbances, and the consequences of these disturbances. Public education about dune conservation is a long term, sustained commitment to provide relevant and appropriate information on protecting Providence Bay's dunes, and their special ecological attributes. It is also a multi-facetted undertaking, requiring different approaches for different target audiences. Strategies will be presented in this manual that will help guide the development of a pub-

lic education program at Providence Bay.

(2) Role of Dune Restoration

Where dune vegetation has been damaged or destroyed by human disturbances leading to blow-out conditions, or where radical site alterations have obliterated part of a dune system, a restoration intervention may be necessary. This can involve the planting of dune vegetation, the placement of wind altering sand fencing, controlling access to the beach through the use of designated pathways or a combination of all of these approaches. Public education is essential in any restoration effort. Dune restoration is an intervention that should not be entered into lightly. There is always the temptation when one encounters bare sand, to want to plant it and stabilize the beach-dune. However, certain species, like Pitcher's Thistle require some form of disturbance or sand accumulation to survive. Prior to restoration, one needs to consider the ecological requirements of this plant community, and the overall effects on the ecosystem.

The Township of Central Manitoulin, who manage the beach at Providence Bay, have begun to encounter some issues related to sand migration and the burial of portions of the boardwalk along the shoreline. Some approaches are presented to help minimize the amount of sand accumulating around the boardwalk. These methods require adapting to changing conditions, whether they be changes in lake levels, or related changes in beach morphology and plant populations.

Management Recommendations for the Providence Bay Waterfront

3.0 Management of the Boardwalk

The extensive boardwalk system at Providence Bay was constructed in the early 1990s. Curiously, the siting of the structure was along the foredune—the most dynamic part of the dune system. As with any static structure built in a dynamic dune environment, problems would soon appear.

Subsequent to the 1997 high lake levels on Lake Huron, water levels dropped over half a metre to below average conditions and remained that way to the present. Lower water level conditions resulted in wider beaches being exposed to wind processes. Dunes along Lake Huron were in their "building" stage. Had the boardwalk at Providence Bay not been present, few would have noticed the landward migration of sand to the dunes. However, given its location relative to the active foredune, sand began to bury portions of the boardwalk.

Sand migration and sand accumulations around the boardwalk soon became an important issue to the municipality because of their responsibility for maintaining the structure. Sand burial of the structure and the concern that the wet sand drifts in contact with the wood undercarriage would begin to rot the wood, led to an application by the municipality to the

Sand accumulations burying the east end of the boardwalk at Providence Bay (summer 2005).

Ministry of Natural Resources to permit excavation and removal of the sand accumulations.

Both the Ministry and the municipality sought advice from the Coastal Centre to determine a course of action. Complicating the issue was the fact that the endangered dune plant Pitcher's Thistle occupied portions of the beach south of the boardwalk and towards the east end. Any attempts to manage the sand drifting would have to have consideration for the habitat requirements of the plant.

The most effective and permanent way to reduce the sand burial problem would be to physically relocate those portions of the boardwalk which are most prone to sand burial—in particular, the boardwalk at the east end of the study area. By relocating the boardwalk from being on top of the active foredune to a more stable area landward (dune trough or secondary dune), the issue would, for the most part, be resolved. However the cost would be substantial and would require altering an existing habitat in the relocation process. This option should be reviewed at such time as the boardwalk needs replacing.

In the immediate term, less costly and less intrusive measures were required. Over the last several years, the Coastal Centre has had success in managing sand drifting in other dune systems along the lake. Through a combination of using sand fencing and beachgrass planting, it has been possible to work with natural processes to meet this objective. The challenge at Providence Bay is to reduce the quantity of wind blown sand that reaches the boardwalk, while at the same time maintaining specific habitat requirements for species like Pitcher's Thistle.

We have recommended the use of sand fencing and targeted beachgrass planting to assist in controlling the accumulations along the boardwalk. Based on past observations of sand accumulations at Providence Bay, windborne sand migration is fairly modest compared with other locations along Lake Huron. Sand fencing is not expected to generate extensive accumulations behind (leeward of) the fence.

The aim of reducing sand accumulations around the

Sand accumulations caused by wind blown sands have caused portions of the boardwalk to become buried.

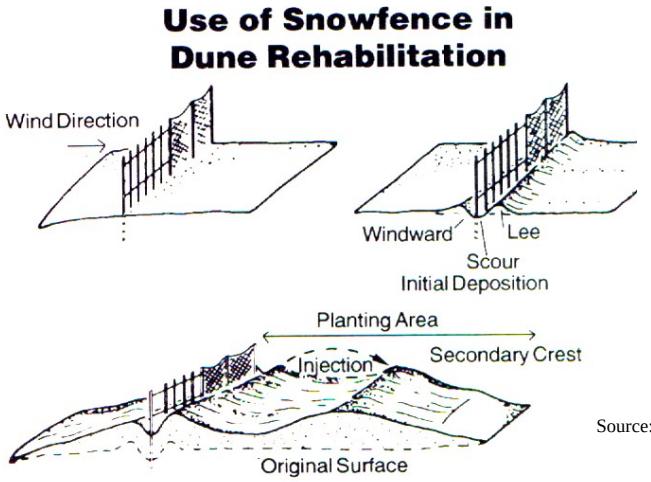
boardwalk will reduce the likelihood of continually having to resort to using heavy equipment in the beach-dune area to excavate sand deposits. It should then be possible for municipal staff to hand dig any accumulations that may occur in future.

3.1 Use of Sand Fencing

Sand fences are used worldwide in beach and dune erosion control efforts. The fencing ideally requires a 40% to 50% porosity for optimum sand accumulation. Typically, wood slat snow fencing is used. Plastic snow fencing has also been used, but it tends to be more prone to vandalism, and decays more readily due to ultraviolet radiation.

The basic premise behind the use of sand fencing is that it slows onshore wind velocities, thus allowing sand to collect behind the fence. The general "rule of thumb" is that all significant sand deposition will occur in an area behind the fence measuring about eight times the height of the fence (Carter, 1993—see diagram below). For a typical one metre high fence, then, one should expect sand accumulations as far back as eight metres behind (or leeward of) the fence.

Sand fencing can be left up year round, but in high tourist locations, like Providence Bay, it is probably desirable to remove the fencing during the summer season. This is quite acceptable since the high winds, and sand erosion, usually occur in the off-season. It is important, though, that the fencing be re-established by early-autumn. If sand fencing is used, it should be installed no later than the Thanksgiving



Source: Carter, 1988

Sand fencing is installed to slow onshore wind velocities allowing sand to collect behind the fence

Day weekend in mid-October, prior to the fall storm season.

Sand fencing can be quite effective at controlling sand accumulations and keeping sand on the beach. However, since the species Pitcher's Thistle cannot tolerate sand accumulations greater than 6 to 8 centimetres per season, it will be important to periodically monitor accumulations and adjust the fence locations throughout the season. To minimize the depth of accumulations at one location, fencing can be gradually moved shoreward as accumulations develop. In doing this, one must be cognizant of the fact that lake level fluctuations like storm surge will occur and the location and placement of fencing must anticipate how far wave action will advance up the beach (towards the dunes), dictating where the fencing should be placed.

While sand fencing is useful initially for accumulating sand, the accumulations are loose sand particles still vulnerable to wind erosion. In most cases of beach and dune restoration and erosion control, sand fencing is used in combination with planting dune vegetation. Fencing acts as a temporary barrier for accumulating sand, but it is the dune vegetation that provides the structure and stability of the dune over time. Generally, sand fencing is used in the first two to three years of a restoration project, until the dune vegetation has become well enough established to function as the primary sand trapping mechanism. In a planting program, the fence also aids with keeping people off the planted area.

Volunteers planting beachgrass in late November.

3.2 Beachgrass Planting

Background

Dune vegetation offers longer term beach-dune 'stabilization' than sand fencing. It functions in the same capacity as sand fencing in slowing wind velocities and allowing wind borne sand particles to collect. Their growth produces a surface roughness which decreases the wind velocity near the ground, thus reducing wind erosion at the sand surface. The plant stems and leaves above the sand surface greatly interfere with sand movement by saltation and surface creep (Woodhouse, 1978). It also, by its massive root structure, gives the developing dune some structure. Dune vegetation is also able to regenerate naturally, providing a permanent cover and requiring no ongoing maintenance.

American Beachgrass is perhaps the most commonly used dune species in dune restoration in North America, but its applicability is limited to areas where relatively large amounts of sand accumulation are expected (e.g. beach and foredune). The Beachgrass cover will continue to trap sand even as it gets buried with sand, as the plants are stimulated to grow by the deposition of sand around them.

Dune restoration planting should occur in late autumn, once the restoration plants are in their dormant state. Fall planting increases the survival of these plants dramatically because they are planted into cool, moist sand, have the following moisture-rich spring to begin establishing roots, and are in a much better state to withstand the rigours of the hot, dry summer ahead. Spring planting is possible, but the success rate drops by 25% or more.

It typically takes a species like American Beachgrass about three to four years to become fully established and begin to fill in the planted area.

Use at Providence Bay

Although American Beachgrass was observed to be sharing the same habitat with Pitchers Thistle at Providence Bay, it is recommended that restoration planting not occur in areas of Pitcher's Thistle habitat until more is known about the affects of restoration activities on Pitcher's Thistle. While

sand fencing can be pulled up and modified to adjust to site conditions, beachgrass is more of a fixed treatment, whereby adjustments are more difficult.

Beachgrass planting is feasible at the far east end of the boardwalk where sand drifting on and around the boardwalk has become a concern. Plots may also be established along other parts of the foredune where the objective is to maintain sand on the beach, and to minimize sand loss from the beach-dune system. Care should be taken, and advice sought for determining appropriate locations for beachgrass restoration.

Beachgrass planting should be considered at the west end adjacent to the playground and parking lot, provided measures are in place to control access around the planted sites. This area of Providence Bay has been altered to allow for public access and use of the beach. As a result, this area of the beach is devoid of sand stabilizing dune vegetation, and sand mobilization and drifting can be extensive.

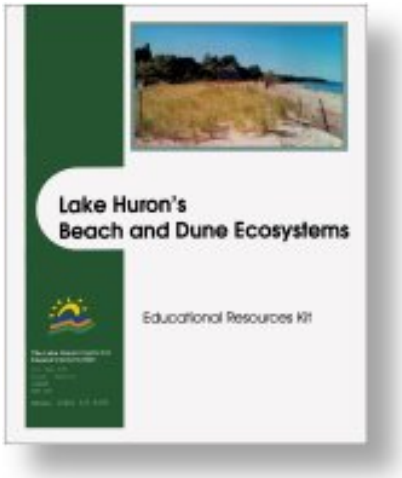
Multiple rows of sand fencing are recommended during below average lake levels when the beach is substantially wider. Multiple lines of fencing will act to alter wind velocities so that sand is deposited on the beach, rather than drift inland. As discussed earlier, fencing alone has its

A combination of sand fencing and beachgrass planting will help to minimize sand drifting and sand loss from the beach system.

limitations in stabilizing loose sands. Planting of American Beachgrass in plots along the north side of the beach adjacent to the parking area would provide more effective stabilization in this area.

3.3 Dune Education and Awareness

The long-term success of any beach-dune conservation process involves a concerted effort to educate and build awareness of the importance and vulnerability of beach-dune systems. Education comes in many forms, and involves every aspect of the community (not just local residents but all those who visit Providence Bay).



Education resources kit—a resource for Elementary teachers and students, emphasizing learning outside the classroom.

Dune Stewardship Literature

As part of this guidance manual, the Coastal Centre prepared a four-page factsheet designed to introduce people to the special natural attributes of Providence Bay, from its irreplaceable and finite sand resources, to the unique dune ecology—including dune species considered to be rare, globally rare and endangered. This is a resource that can be distributed locally, and made available at the interpretive centre and the municipal office. Other literature on dunes or dune species should be developed or collected from other sources for availability and use at the interpretive centre.

Education in a Formal Setting

Formal education in local schools can help a new generation understand and appreciate the lakeshore from an environmental perspective. The Coastal Centre has developed an educational resources kit for elementary schools on Lake Huron's beach and dune ecosystems that contains resources and activities for learning about this coastal environment. It emphasizes field experience where students utilize the dunes as a "living laboratory", learning about species identification, ecological succession and the sensitivities of the dune environment. Involving students in beachgrass planting is a good way to enrich their learning experience outside of the classroom.

Signs

Educational signs are a useful approach to promote a general awareness of beach and dune processes and the pub-

lic's role in their conservation. Different types of signs can be used for different purposes. For instance, *information signs* can inform beach users about the fragile nature of the dunes. Wording would include something like:

> "Sensitive Area—The dunes at Providence Bay provide natural shore protection and are habitat for unique and rare plants. Please take special care not to disturb the dunes. Access the beach only at the marked access crossings."

The language on the signs should be non-threatening (avoid terms like "Keep Out"), advise people why the dunes are so important, and educate them on ways that they can participate in conserving Providence Bay's dunes (e.g. how to access the beach appropriately).

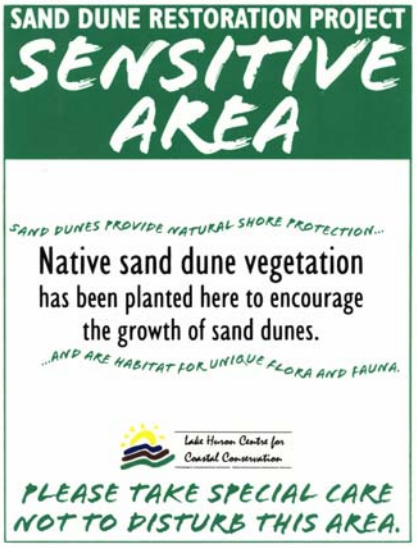
Interpretive signs along the boardwalk will also provide an excellent educational tool, particularly for visitors to Providence Bay. Interpretive signs provide beach users and other interested people with some more detailed information about the dunes. These types of signs should describe a unique feature or aspect of the Providence Bay area, and ask for cooperation in preserving this special environment. Key messages should include:

- The finite nature of the dunes; nationally significant features; fragility and vulnerability to human disturbances.
- The ecology and rarity of dune plants; sensitivities to human disturbance.
- The need for conservation; take action now to preserve Providence Bay's dunes, or they will be lost.

Samples are provided in Appendix B.

Interpretive Centre

The nature interpretation centre at Providence Bay is an excellent facility to set up displays and educate visitors about dune systems. Information at the centre should be "user friendly", but offer an opportunity to provide much more detailed information than outdoor signs. Summer staff should be well versed on the beach and dune ecosystem at Providence Bay, and have some knowledge of dune processes and species identification.



Information signs need to convey to residents and visitors that their activities can have a negative impact if they are not careful.

Dune Education must be an ongoing and sustained program to be effective, but these efforts will provide positive benefits to the Township in the long run.

Interpretive Tours

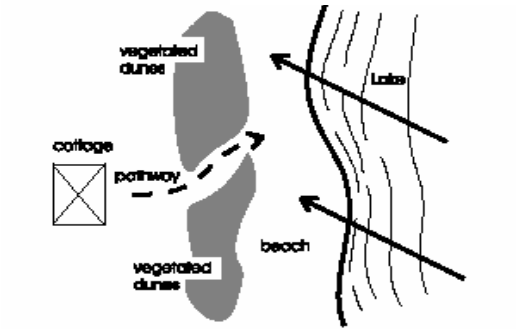
Promoting Providence Bay and the conservation efforts here, could be enhanced by offering interpretive tours led by knowledgeable individuals. Summer staff at the interpretive centre could be trained in educating visitors to Providence Bay about the natural attributes of the dunes, their significance locally, regionally and provincially.

3.4 Role of Local Cottagers

Local cottagers, particularly those west of the parking lot at Providence Bay, have a role to play in dune conservation. This is an important target audience for education and awareness efforts. The dunes adjacent to these cottage properties are currently well maintained. Appropriate access designs that limit beach access to single angled pathways need to be utilized. This will help to minimize dune impacts and the potential for mass sand mobilization caused by unnecessary damage to the dune.

Sometimes private actions can result in the damage or destruction of dunes, either accidentally or deliberately. When it involves private land, often the only recourse is one of offering restoration advice. If it involves Town property, the Town has more control over the situation and can order a restoration.

Radical site alterations which involve mass removal of vegetation and/or grading beach-dune systems are particularly destructive and can lead to mobilization of sand inland. Sand drifting can result in nuisance and damaging accumulations on adjacent properties over substantial distances.



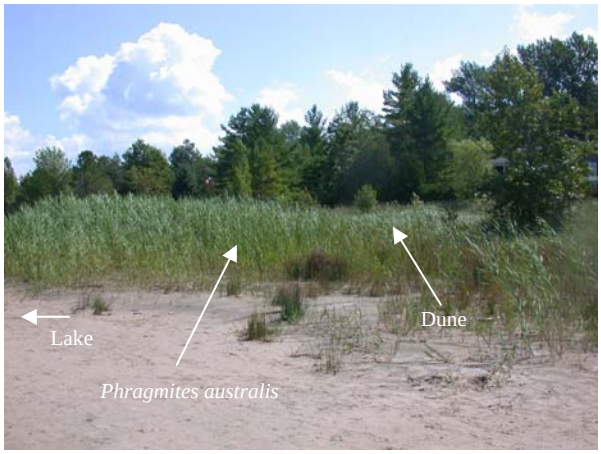
Strong winds off the lake blow sand inland. Small angled pathways through the foredune can prevent winds from eroding a blowout into the dune.

3.5 Emerging Issues

Invasive plant species like *Phragmites australis* (Common Reed) may pose a threat to the dune ecology generally, and Pitcher's Thistle particularly, if it becomes established at Providence Bay. In other areas of Lake Huron where it has become established, the plant forms a dense colony, typically along the mid-beach swale where the sand tends to be wet. For instance, at Point Clark along the southeast shores of Lake Huron, *Phragmites* has aggressively become established in the wet swale, out competing all of the native vegetation that existed previously.

Reaching heights of over two metres, the plant can form a dense wall of vegetation which effectively stops the flow of sand to the dune. Over time, this would likely affect the ecology of the dune, and have unknown consequences. It has been observed (October 2005) on the beach at Providence Bay.

Biologists from the Ministry of Natural Resources should assist in monitoring the extent of spread of this plant, and take action if the plant begins to extend across the beach. Eradication must be strictly targeted and not interfere with native beach plants.



Extent of *Phragmites australis* invasion at Lurgan Beach on the southeastern shores of Lake Huron. This wall of vegetation has the potential to disrupt the ecology of the dunes in this area.

Below, *Phragmites* is observed on the beach at Providence Bay in October 2005. Close monitoring is necessary to avoid the problems experienced on other beaches along Lake Huron.

Conclusion

The Township of Central Manitoulin has the management responsibility over a unique and important coastal environment at Providence Bay. This irreplaceable and non-renewable dune system is an ecological treasure. It also functions as an attraction for tourists and residents alike. With more people using the area as a beach destination, and with people being the major threat to dune systems, active management efforts designed to protect this ecosystem are needed.

The difficulties caused by sand accumulations along the waterfront boardwalk can be attributed to its inappropriate location. The long term solution would centre on relocating those parts of the boardwalk which are currently situated on the foredune. At such a time that the boardwalk needs replacement or major renovations, strong consideration should be made toward relocation, particularly the segment at the east end.

In the meantime, measures have been suggested in this manual that are targeted at minimizing sand accumulations along the boardwalk caused by wind eroded sand. While these methods of altering wind flows and sand deposition patterns are proven to be effective, the sensitive ecological requirements of endangered dune plants, such as Pitcher's Thistle, need to be considered, and accommodations made to promote viable plant populations. A fine balance needs to be struck, where sand accumulations along the boardwalk are minimized, while the habitat requirements of important dune species is preserved.

Community education focusing on the beach-dune system and the special care required to maintain it is integral to the success of a dune conservation program. The Township has a key role in this regard, not only in providing appropriate information, but in the way it carries out its work along the waterfront. The example the Township sets will set a strong direction for the residents and visitors of Providence Bay. The Coastal Centre has had extensive experience in dune education and the Township may con-

sider accessing its resources, and those of members of the Lake Huron Dune Grasslands Recovery Team, to assist in waterfront education activities.

Glossary

Aeolian: pertaining to wind.

Alien plants: Exotic plants which are not endemic to the local ecosystem.

Biodiversity: an array of different animals, fish, waterfowl and plants in nature.

Blow-out: a term used to describe that portion of a dune which has become mobile, or active, due to the absence of vegetation to stabilize it. It can be induced by natural processes, but commonly is a result of human impacts.

Climax community: the community of plants which is the last stage in a succession of plant communities from pioneer stage through a number of intermediate stages. The climax community may be a woodland or herbaceous (grassland) community depending upon available water.

Coastal Ecosystem: an ecosystem which is found specifically within the coast or shoreline region.

Coastal Processes: Natural processes (e.g. Littoral drift, dune accretion, erosion) which occur within the coastal environment.

Dune: ridges or mounds of loose, wind-blown material, usually sand.

Dune Stranding: refers to the ongoing process of aeolian sand migration outside of the natural shore system. Sand becomes stranded outside of the shore system such that waves are no longer able to reclaim the material. Stranding can occur in areas of relic beach and dune deposits.

Endangered: a wildlife species that is facing imminent extirpation or extinction.

Endemic species: a species native and confined to a certain region; having comparatively restricted distribution.

Foredune: the first dune feature landward of the beach, which exhibits some stabilization due to vegetation growth. Storm wave action may reach inland far enough to erode some or all of this feature.

Headland: an erosion resistant point of land, either man-made or natural, extending into the lake; embayments often form between adjacent headlands (e.g. Providence Point and Black Rock).

Invasive plants: species which possess aggressive reproductive qualities that enable them to displace endemic plant species. Examples: Garlic Mustard, Purple Loosestrife (also see Alien Plants).

Lake Algonquin: post glacial lake which existed about 11,000 years B.P. The remnant bluff of Lake Algonquin is a prominent feature from Point Clark to Saugeen Shores.

Lake Nipissing: post glacial lake which existed about 6,000 years B.P. The remnant beach ridges left by Lake Nipissing are still evident landward of the Algonquin bluff.

Nearshore: an indefinite zone extending from the shoreline to just beyond the breaker zone. This is the area where wave energy has a profound influence on the lakebed. This is in contrast to the Offshore, where waves do not impact the lakebed.

Reach: a length of shoreline with fairly uniform onshore and offshore physical features and subject to the same level of wave energy.

Relic deposit: sand deposits which are remnants of a post-glacial lake (e.g. Nipissing).

Rhizome: a horizontal stem, either on or just below ground, especially one that forms roots at the nodes to produce new plants. Many plants spread with rhizomes, since they can send up new stems and leaves as they grow. This way, a colony of plants may start with many of the same species in an area.

Secondary dune: the dune landward of the foredune. It has, through succession, developed a more diverse plant community, more advanced soil structure and generally has a more sheltered climate than the foredune.

Shoals: offshore areas which are more shallow than the surrounding depths.

Species at Risk: According to the Committee on the Status of Endangered Wildlife in Canada, there are currently 487 plant and animal species at risk in Canada. Species at Risk are wild species that are in some danger of disappearing from Canada. Pitcher's Thistle is a Species at Risk in Canada.

Stewardship: management of the heritage of our natural spaces and species in such a way that it can be passed on to future Canadians intact.

Strandline: the line of organic matter that is deposited by wave action along the upper part of the beach. (Also called the 'debris line').

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Appendix A

Beach and Dune Plants of Providence Bay

Beach and Dune Plants of Providence Bay

Illustrations of selected species of significance

American Beachgrass *(Ammophila breviligulata)* - a pioneer species which acts as a primary stabilizer of sand dunes on the Great Lakes. It is particularly adapted to such conditions as sand burial, wind, lack of moisture and lack of nutrients. Its growth habit is stimulated by sand burial by wind blown sand.

Great Lakes Wheatgrass *(Agropyron psammophilum)*

- Great Lakes wheat grass is a striking dune grass with its silvery grey colour. It is considered to be a Provincially rare plant. However, its distribution is so limited, it should be considered to be globally rare. The total distribution of this plant is limited to the shores of Lakes Huron, Superior and Michigan. On the Canadian side of Lake Huron, it is found sporadically from Point Clark at the southern boundary of Bruce County, north to Manitoulin Island.

Pitcher's Thistle *(Cirsium pitcheri)*

Pitcher's Thistle is a plant that grows only in the sand dune systems of Lakes Huron, Michigan and Superior. In Canada, the species occurs at Pinery and Inverhuron Provincial Parks along Lake Huron, a few locations along the Manitoulin Island shoreline, and at one location along Lake Superior. The beaches and dunes of Providence Bay on Manitoulin Island contain about twenty percent of the Canadian population of this plant.

Pitcher's Thistle may grow for five to eight years between seed germination and flowering. After flowering and seed maturity, the plant dies.

Recent studies have indicated that this species is in a state of decline, primarily due to humans trampling the plants directly or by trampling other nearby dune plants, leading to sand erosion and burial of the thistle. Cottage development has also taken its toll on this special plant.

The Pitcher's Thistle is listed as Endangered in Canada and in Ontario.

Wormwood *(Artemisia campestris)*

Wormwood is a biennial plant which is abundant along the Great Lakes. In its first year of growth, it has a strking appearance with its silvery blue leaves and stems. This colour adaptation allows it to reflect light to prevent water loss and aid in transpiration. During its second year of growth it produces large quantities of seeds which germinate from mid April to October, usually after soaking rains. The seeds are then usually dispersed in late fall and winter months after which the plant dies.

Beach Pea *(Lathyrus japonicus)*

Beach Pea is a low, trailing to erect, vine-like plant with purple to blue violet flowers. Beach Pea can thrive on sand dunes and tolerate intense sun.

Sand Cherry (*Prunus pumila*)

Sand Cherry is a low growing, multi-branched shrub which can grow up to 2 metres high, however, most plants are less than one metre. It is identifiable by the low, spreading profile, stout branches, and leathery, sharply pointed leaves. Sand Cherry is one of the early plants to colonize sand dunes

Sand Cherry flowers in May to early July, with white, five-parted flowers. It produces an edible purple to blackish cherry from July to September. The cherry is an important food for birds and other animals who make dunes their habitat.

Sea Rocket *(Cakile edentula)*

This plant can grow in very hostile environments because of the water holding capacity of its stems and leaves. It will often be the only plant growing near the waterline or above the wrack zone. This unusual member of the mustard family occurs in Ontario primarily on the shores of Lake Huron. At maturity, the fruits break into segments that become dispersed in the water, producing new plants when the seeds are washed ashore.

Note: Many other plants exist on the beach and in the dunes at Providence Bay. This list is intended only as a primer to introduce the reader to some of the key plants that you are likely to find at Providence Bay.

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Appendix B

Sample Interpretive Signs for the Boardwalk at Providence Bay